

Exhibit A

Project Features that DRP has Misconstrued and/or Contradicted

1. **Storage**: DRP states that there will be no onshore storage at the facility¹. Yet, the trucks and railcars that will be on the site are a form of storage, particularly considering that the perpetual loading of the shipping vessels from the tank trucks and rail tank cars will result in the continuing presence of these tanks on the site.² The number of trucks and railcars that can be accommodated on the racks as well as in the rail and truck yards at the site should be calculated to provide an accurate estimate of the amount of onshore storage at any given time. DRP has also admitted that they will have offshore storage because there will be a “floating storage unit” at the facility.³
2. **Regasification**: In the petition, DRP states that “the LNG transloaded at or transported from the Facility will not be regasified . . . except for the potential limited scenario in which LNG that is transloaded onto waterborne vessels at the Facility is ultimately regasified.”⁴ This is a direct contradiction given that DRP admits that there will be regasification at the facility.
3. **Vaporization and Liquefaction**: DRP states that there will not be any vaporization or liquefaction facilities on site.⁵ This is not consistent with application materials submitted to Greenwich Twp. and/or other agencies which state that a small liquefaction plant is planned for the facility. For instance, the Letter of Intent submitted to USCG, on which CG approval was based, states that Boil Off Gas (BOG) will be collected via a vapor line and the gas and vapors routed through to a “small capacity liquefier” or “gas separator” or the gas and vapors could be flared.⁶ Additionally, DRP states that “boil-off gas and vapors could be collected and routed to small on-site generation equipment used to power limited operations at the Facility”.⁷ This does not comport with the statement that the facility does not include any vaporization facilities because the liquid would need to be regasified for use in generation equipment. Also, the description of the project in TSCA Agreement mentions a “small” liquefaction plant in some descriptions/maps of the project.⁸
4. **Third Party Liquefaction Facilities**: DRP states that liquefaction will take place in the facility in Wyalusing Township, Bradford County, Pennsylvania, or from “third-party

¹ DRP Petition at 6.

² See Resolution #R2019-23 of the Planning/Zoning Board of Greenwich Township Regarding Application No. PB2019-08 of Delaware River Partners LLC Granting Preliminary and Final Site Plan Approval for Property Located at the Former Dupont Repauno Plant, Designated as a Portion of Block 8, Lots 3 & 4 (October 7, 2019) at 7. (stating that there will be surface parking).

³ DRP Petition at 4.

⁴ *Id.* at 5.

⁵ *Id.* at 6.

⁶ See Letter of Intent for Repauno Port and Rail Terminal, Gibbstown, New Jersey (November 16, 2017).

⁷ DRP Petition at 5.

⁸ See Signed Risk Management Program Consent Agreement: 200 N. Repauno Ave, Greenwich Twp, New Jersey, 08027-1096, TCPA ID# 5087, EA ID NOD170001-5087 (June 9, 2017).

liquefaction facilities”.⁹ Prior to this assertion, DEP has never mentioned receipt of LNG from “third-party liquefaction facilities”.

5. Concurrent Operations: DRP states that the Facility will continue to load and unload LHG and other non-LNG cargo during operations, such as roll-on/roll-off and break bulk.¹⁰ This contradicts statements made by DRP to the USCG where DRP expressly states that “LNG, LHG, and other non-hazardous cargo operations will not run concurrently.”¹¹
6. Dock 1:
 - a. Transloading and Delivery/Exportation: DRP states that Dock 1 could be used to support transloading of LNG at the facility and to deliver LNG to a marine vessel moored at Dock 1.¹² However, there is no mention of the use of LNG as cargo in permits for Dock 1 or in the current Toxic Catastrophe Prevention Act (TSCA) Consent Agreement for Dock 1 signed between DRP and DEP.¹³ There is also no approval to allow LNG to be delivered or exported from Dock 1.
 - b. ISO Containers: DRP states that the facility is capable of loading ISOs onto a cargo vessel just like any other bulk-liquid product.¹⁴ There has never been any mention of ISO container delivery of LNG to the facility or export of ISO containers from the terminal. This implies it can be handled at Dock 1 and entails a new use of containers for LNG not approved or reviewed. The list of all containers to be used at the facility filed with NJDEP in the TSCA Consent Agreement with DRP for Dock 1 has no mention of ISO containers.

Additionally, there is no approval of which DRN is aware that has been given by PHMSA for the use of ISO containers at Gibbstown or in transportation to or from Gibbstown. PHMSA states: “For cargo rail shipped in ISO containers, a carrier must obtain either a special permit from the Associate Administrator for Hazardous Material Safety, PHMSA (see part 107.105) or a prior approval from the Associate Administrator for Safety, FRA (see part 174.63). FRA has permitted two waivers for shipping LNG by rail in ISO containers to Florida East Coast Railroad and Alaska Railroad.”¹⁵

- c. Shuttle Vessel: DRP states that they will be using shuttle vessels.¹⁶ However, there has never been any discussion of a shuttle vessel for domestic end users or the regasification of LNG for introduction to a local pipeline. The Letter of Intent filed with USCG 11.16.2017 for the “Repauno Port and Rail Terminal”

⁹ DRP Petition at 5.

¹⁰ *Id.* at 6.

¹¹ See Letter of Intent for Repauno Port and Rail Terminal, Gibbstown, New Jersey (November 16, 2017).

¹² DRP Petition at 4, 6.

¹³ See Signed Risk Management Program Consent Agreement: 200 N. Repauno Ave, Greenwich Twp, New Jersey, 08027-1096, TCPA ID# 5087, EA ID NOD170001-5087 (June 9, 2017).

¹⁴ DRP Petition at 6.

¹⁵ Preliminary Regulatory Impact Analysis, PHMSA-2018-0025 (HM-264) RIN 2137-AF40 (October 2019) at 15.

¹⁶ DRP Petition at 4.

by AcuTech on behalf of DRP for Dock 1 includes a detailed description of the intermodal activities and vessel specifications and there is no mention of any shuttle vessel, ISO containers, or delivery for regasification for local distributors.¹⁷

¹⁷ See Letter of Intent for Repauno Port and Rail Terminal, Gibbstown, New Jersey (November 16, 2017).

**RESOLUTION #R2019-23
OF THE PLANNING/ZONING BOARD OF GREENWICH TOWNSHIP REGARDING
APPLICATION NO. PB2019-08 OF DELAWARE RIVER PARTNERS LLC
GRANTING PRELIMINARY AND FINAL SITE PLAN APPROVAL FOR PROPERTY
LOCATED AT THE FORMER DUPONT REPAUNO PLANT, DESIGNATED AS A
PORTION OF BLOCK 8, LOTS 3 & 4**

WHEREAS, an application has been submitted by Delaware River Partners LLC for Preliminary and Final Site Plan Approval, for property located at a portion of the former DuPont Repauno Plant, and known as a portion of Block 8, Lots 3 & 4, on the Tax Map of the Township of Greenwich, which property is owned by the Applicant; and

WHEREAS, the Applicant has given legal Notice as required by and in accordance with N.J.S.A. 40:55D-12 and applicable Greenwich Township ordinances, by serving proper Notice to property owners within 200 feet of the site, serving Notice on all required governmental agencies and public utilities and by publishing a proper Notice in the newspaper, all at least ten (10) days prior to the hearing; and

WHEREAS, in support of the application the Applicant has submitted the following documents:

1. Letter from the Applicant's attorney, Cameron W. MacLeod, Esq., dated July 12, 2019; and
2. Preliminary and Final Site Plan Application with Exhibits, dated July 12, 2019; and
3. Submission Checklist, dated July 12, 2019; and

4. Trip Generation Memorandum, prepared by Kevin J. Webb, PE., of Langan, 989 Lenox Drive, Suite 124, Lawrenceville, New Jersey 08648, dated July 12, 2019; and
5. Resolution R2017-16 (Block 8, Lots 3 & 4), adopted January 9, 2017; and
6. Resolution R2017-28 (Block 8, Lots 4 & 4.02), adopted November 6, 2017; and
7. Resolution R2019-21 (Block 8, Lots 4 & 4.02), adopted July 1, 2019; and
8. Governing Body Resolution No. 117-2019, adopted July 15, 2019; and
9. Stormwater Management Report, prepared by Edward F. Wilkes Jr., P.E. and Kevin J. Webb, P.E., of Langan, 989 Lenox Drive, Suite 124, Lawrenceville, New Jersey 08648, dated July 12, 2019; and
10. Cover Sheet, Sheet 1 of 35, (All plans prepared and signed by Kevin J. Webb, PE., of Langan, 989 Lenox Drive, Suite 124, Lawrenceville, New Jersey 08648), dated July 12, 2019; and
11. Overall Existing Conditions Plan, Sheet 2 of 35, dated July 12, 2019; and
12. Existing Conditions & Demolition Plan 1, Sheet 3 of 35, dated July 12, 2019; and
13. Existing Conditions & Demolition Plan 2, Sheet 4 of 25, dated July 12, 2019; and

14. Existing Conditions & Demolition Plan 3, Sheet 5 of 25, dated July 12, 2019; and
15. Overall Site Plan, Sheet 6 of 35, dated July 12, 2019; and
16. Site Plan 1, Sheet 7 of 35, dated July 12, 2019; and
17. Site Plan 2, Sheet 8 of 35, dated July 12, 2019; and
18. Site Plan 3, Sheet 9 of 35, dated July 12, 2019; and
19. Overall Vehicle Movement Plan, Sheet 10 of 35, dated July 12, 2019; and
20. Vehicle Movement Plan Insets, Sheet 11 of 35, dated July 12, 2019; and
21. Overall Grading & Drainage Plan, Sheet 12 of 35, dated July 12, 2019; and
22. Grading & Drainage Plan 1, Sheet 13 of 35, dated July 12, 2019; and
23. Grading & Drainage Plan 2, Sheet 14 of 35, dated July 12, 2019; and
24. Grading & Drainage Plan 3, Sheet 15 of 35, dated July 12, 2019; and
25. Utility Plan 1, Sheet 16 of 35, dated July 12, 2019; and
26. Utility Plan 2, Sheet 17 of 35, dated July 12, 2019; and
27. Utility Plan 3, Sheet 18 of 35, dated July 12, 2019; and
28. Lighting Plan 1, Sheet 19 of 35, dated July 12, 2019; and
29. Lighting Plan 2, Sheet 20 of 35, dated July 12, 2019; and
30. Lighting Plan 3, Sheet 21 of 35, dated July 12, 2019; and
31. Lighting Details 1, Sheet 22 of 35, dated July 12, 2019; and
32. Lighting Details 2, Sheet 23 of 35, dated July 12, 2019; and

33. Lighting Details 3, Sheet 24 of 35, dated July 12, 2019; and
34. Overall Soil Erosion & Sediment Control Plan, Sheet 25 of 35, dated July 12, 2019; and
35. Soil Erosion & Sediment Control Plan 1, Sheet 26 of 35, dated July 12, 2019; and
36. Soil Erosion & Sediment Control Plan 2, Sheet 27 of 35, dated July 12, 2019; and
37. Soil Erosion & Sediment Control Plan 3, Sheet 28 of 35, dated July 12, 2019; and
38. Soil Erosion & Sediment Control Notes and Details, Sheet 29 of 35, dated July 12, 2019; and
39. Outfall Profiles & Basin Cross Sections, Sheet 30 of 35, dated July 12, 2019; and
40. Construction Details 1, Sheet 31 of 35, dated July 12, 2019; and
41. Construction Details 2, Sheet 32 of 35, dated July 12, 2019; and
42. Construction Details 3, Sheet 33 of 35, dated July 12, 2019; and
43. Construction Details 4, Sheet 34 of 35, dated July 12, 2019; and
44. Construction Details 5, Sheet 35 of 35, dated July 12, 2019; and
45. At the time of the hearing the following Exhibits were marked:
 - A-1 Overview of the Site (Sheet 2); and
 - A-2 Close Up of the Proposed Facilities (Sheet 6).

WHEREAS, the Greenwich Township Planning/Zoning Board has made its determination in this matter based on the following:

1. The documents set forth above;
2. The representations made by the Applicant in its application and by the Applicant, Delaware River Partners LLC (DRP), through its representatives, experts and witnesses: Kevin Webb, PE, from Langan and its attorney, Douglas Janacek, Esq., of Gibbons P.C., at the time of the hearing before the Board on September 9, 2019;
3. Letter from the Greenwich Township Planning/Zoning Board Engineer, James A. Clancy, PE, PLS, PP, CME, dated August 26, 2019, which is incorporated and made a part of this Resolution by way of reference;
4. Letter from the Greenwich Township Planner, Matthew K. Miller, AIA, PP, dated September 5, 2019, which is incorporated and made a part of this Resolution by way of reference;
5. Letter from the Greenwich Township Master Plan Consultant/Redevelopment Engineer, J. Timothy Kernan, PE, PP, CME, dated August 19, 2019, which is incorporated and made a part of this Resolution by way of reference;
6. Comments made by the Township Planner at the time of the hearing on September 9, 2019;
7. Comments made by the Planning/Zoning Board Engineer, at the time of the hearing on September 9, 2019; and
8. The following members of the public spoke at the time of the hearing before the board on September 9, 2019:

A. Steve Laszczyk, 9 Brandt Avenue. Mr. Laszczyk inquired as to the number of rail cars that can be stored on site at any time. The Applicant indicated that the facility can store up to 80 rail cars at any one time.

B. Ron Cundy, 139 Jackson Avenue. Mr. Cundy asked if there would be any storage of propane. Mr. Webb indicated that the cavern would continue to store butane. The propane would go from rail car to the wharf to a ship. Mr. Cundy further questioned emergency egress should the need arise. He was informed the by-pass road would be the emergency exit.

C. Donna O'Leary, 124 Swedesboro Road. Ms. O'Leary questioned what route would be used for the trucks in this project. Mr. Webb confirmed that the transportation of the LPG would be by train, not truck. Takes approximately 36 to 48 hours to unload an 80 car train.

D. Leslie Feaster, 156 N. Repauno Avenue. Mr. Feaster was concerned about the level of noise. Mr. Webb indicated that the majority of the noise would be in the construction phase.

E. Will Durham, 133 Dupont Avenue. Stated he was a resident for 56 years on Dupont Avenue. He thanked DRP for placing their business in Greenwich Township. He has not had any problems with the construction vehicles and noted that DRP has been very open with the local fire officials.

F. Russell Leone, 657 Paulsboro Road. Mr. Leone wanted to know if they were going to widen Route 44. He was informed they were not widening Route 44.

G. Mark Pandolfo, 251 Marshall Avenue. Inquired about LNG being brought to the site. Mr. Webb informed him that this project was for LPG to be delivered by rail, not LNG.

WHEREAS, the Board, after considering the information and testimony provided at the time of the hearing and examining the submitted and above listed documents, considering the comments and the letters of the Planning/Zoning Board Engineer, James A. Clancy, P.E., C.M.E., the Township Planner, Matthew K. Miller, AIA, PP, NCARB, and the Master Plan Consultant/Redevelopment Engineer, J. Timothy Kernan, PE, PP, CME, makes the following conclusions of law and findings of fact:

1. The Applicant is seeking approval for a subproject referred to as "LPG Transloading Facility" which includes development of a facility on a portion of the subject property to enable transloading of liquefied petroleum gases (LPG) consisting of propane or butane between railcars and ships with the proposed improvements to include rail spurs and storage tracks; a double-sided rail rack for transloading of LPG; aboveground piping and their associated support racks to the existing wharf; a 2,000 square foot operations/control building; associated filling and grading; surface parking; circulation roadways; fire protection system; and ancillary support equipment and utility infrastructure, including stormwater management facilities as set forth the proposal for development dated June 13, 2019.

2. The property in question is Block 8, Lots 3 & 4 which contains approximately 921± acres of the former Dupont Repauno Plant which totals 1,620± acres. The subject parcel is located at the north side of the site adjacent to the

Delaware River and within proximity to the recently developed wharf. The overall property is affected by wetlands and wetlands transition areas, flood hazard and riparian zone areas, waterfront development areas and is located in the M-D Manufacturing District which has also been designated a Redevelopment Area. The proposed use is in keeping with the permitted uses in the M-D Zone and is a permitted use pursuant to the applicable Redevelopment Plan.

3. The surrounding area also contains wetland and wetlands transition areas. The site is bordered to the north by the Delaware River, to the south and southeast by residential areas and to the east by the Ashland Hercules Redevelopment Area.

4. The Applicant requested waivers for landscaping and an opinion/acknowledgment/waiver regarding lighting standards for this application.

5. The Applicant obtained approval for this subproject from the Greenwich Township governing body pursuant to Resolution No. 117-2019. The Applicant acknowledged on the record that it must, as a condition of approval, have a signed Re-Development Agreement with Greenwich Township for this subproject prior to the issuance of a temporary and/or final Certificate of Occupancy or Certificate of Approval; and

6. The Applicant's attorney, Mr. Janacek gave the Board an overview of the project. The Applicant is seeking Preliminary and Final Site Plan Approval for an LPG rail terminal facility to be installed for use in connection with the recently constructed wharf. An operations building, support structures and some grading of

the site will take place. There are no variances needed or requested. Waivers for landscaping and a lighting plan are requested.

6. The Applicant's engineer, Mr. Webb indicated that the site in question is within Block 8, Lots 3 & 4. The development will take place at the riverfront portion, about 4,000 feet from any residential property. It is adjacent to the wharf and near the butane cavern. The work will be immediately east of the cavern.

7. The existing rail line is parallel to A-Line Road. The new rail spur goes to the east of the existing line. Four (4) storage tracks and two (2) tracks for the rack itself. The railrack connects to a pipe rack which leads to the wharf and ultimately to a vessel. Forty (40) rail cars can be on the rack lines. The facility can handle 80 railcars at any one time. There is an Operations and Control building which is 2,000 square feet with 10 parking spaces provided. Typically, it would house 3 to 4 employees.

8. Mr. Webb testified that there is automatic fire suppression in the loop. The new terminal road is parallel to the river which provides access to the operations building and the wharf. A gravel road that connects to A-Line Road is provided for maintenance. Pole mounted lighting at 20 feet is provided for parking and at 30 feet for the roadways. The Applicant agreed to install reflectors in the pavement.

9. No landscaping is proposed for the project as the property is so far away any residential properties, the landscaping would never be seen. The Board's planner supported the waiver for landscaping opining that the landscaping would serve no real purpose.

10. Mr. Webb indicated that the hours of operation would be for the most part 24/7 with multiple shifts. There would be 3 to 4 employees in the Operations Building and a total of 50 to 70 employees working at the site at peak times. This information will be added to the plans.

11. The Applicant has been working with the local fire department regarding emergency response. The Applicant agreed as a condition of approval to add one (1) fire hydrant close to the intersection of the terminal road and the gravel maintenance road.

12. Mr. Janacek confirmed that the Applicant will comply with all the conditions and requirements set forth in all the Board's professionals letters and in the Redevelopment Plan.

13. Mr. Webb confirmed that there is no on site storage of the LPG on site. The LPG goes from the rail car to the wharf to the ship.

14. Mr. Clancy raised the issue of the Applicant repairing pot holes, at a minimum in the area from the security booth to the limit of the new paving. The Applicant agreed to repair the pot holes as requested by Mr. Clancy.

15. Mr. Clancy discussed the issue of additional lighting on the rear of the Operations Building. The Applicant agreed to install two (2) additional shoe box light fixtures at the rear of the Operations Building.

16. Mr. Miller indicated his support for the landscaping waiver due to the distance from any residential area. He further did not see an issue with lighting, again because of the project being so far from any residential area. Mr. Miller noted in Mr. Kernan's letter the potential issue of NJDOT Hazmat Security Plan &

Compliance and NJDOT Hazmat Shippers Registration. The Applicant indicated that they have USDOT certification for the butane operations. If and to the extent required, the Applicant will pursue these requirements and provide proof of compliance to the Board.

17. The Board determined that the waivers for landscaping and for a lighting plan were appropriate given the extreme distance from any residential property being such that the development area will not be seen, the landscaping will serve no real purpose at this industrial site and there will be no possible impact as far as light spillage onto residential properties, and thus granted the waivers for landscaping and a lighting plan.

WHEREAS, the Board, has made its determinations in this matter based on the above exhibits, testimony and oral representations which are incorporated herein by way of reference, and has found and concluded that:

1. The application meets the standards for the granting of Preliminary and Final Site Plan Approval under the Township of Greenwich Zoning Code; and
2. The granting of the Preliminary and Final Site Plan Approval, as well as the requested waiver regarding lighting and landscaping, as revised by the terms and conditions of this Resolution, conform to the standards of sound planning and will have no deleterious effects on the neighborhood from the standpoint of insuring the health, safety, amenities and welfare of the community and are consistent with the purpose and intent of the Zoning Code and Master Plan.

1 2 3 4

WHEREAS, upon motion duly made and seconded to grant the "Application for Land Development" for Preliminary and Final Site Plan Approval, the Board, by a vote of 9 in favor, 0 opposed and 0 abstentions, (Voting for: Sholders, Rush, Shivery, Wagner, Hewes, Byrne, Zampaglione, Chila, and Fairley), voted in favor of granting the application subject to certain conditions contained herein.

NOW, THEREFORE, BE IT RESOLVED, by the Planning/Zoning Board of Greenwich Township that the application of Delaware River Partners LLC requesting Preliminary and Final Site Plan Approval for land located at the former DuPont Repauno Plant, Greenwich Township, New Jersey, also known as a portion of Block 8, Lots 3 & 4, is **HEREBY APPROVED**, subject, however, to the testimony, representations and stipulations of the Applicant and their professionals and witnesses at the time of the hearing and in their submissions, and further specifically, subject to the following terms and conditions:

1. Subject to the Applicant complying with and obtaining any and all necessary approvals from any other local, county, state and/or federal government or administrative body having jurisdiction over all or part of this Site Plan Waiver approval. Those approvals include but are not limited to the following: United States Army Corps of Engineers (modified 1/10/2018); NJDEP Freshwater Wetlands Letter of Interpretation (approved 7/11/2016); NJDEP Waterfront Development/Flood Hazard Area/Coastal Wetlands Multi-Permit (modified 11/29/2018); NJDEP Freshwater Wetlands General Permit (modified 11/29/2018); NJPDES Permits; NJ Toxic Catastrophe Prevention Act (TCPA) Program Approval; NJ Air Pollution Control Act Permit; Greenwich Township Building Department; Greenwich Township

Fire Official; Greenwich Township Sewer Department; Gloucester County Planning Board Approval; and Gloucester County Soil Conservation District; and

2. In accordance with the Code of the Township of Greenwich, §131-39.1 Fees, the Municipal Land Use Law and any other applicable code provision, no permits, approval or certificate shall be issued until all contingencies provided for herein are satisfied and all escrows are paid in full and no Certificate of Occupancy shall be issued and no occupancy shall be permitted until all other contingencies provided for herein are satisfied and all bills and escrows relating to this application for development have been paid in full; and

3. The Planning/Zoning Board Engineer, Township Planner, or Master Plan Consultant/Redevelopment Engineer, as set forth above, shall review all plans and amended plans and inspect the site of the development in order to determine compliance with the terms and conditions of the Planning/Zoning Board approval. Any shortcomings noted by any professional shall be addressed to the satisfaction of the professionals before the issuance of a Certificate of Occupancy. The Applicant shall submit appropriate escrow amounts, as determined by the Planning/Zoning Board Engineer and applicable law, for inspections; and

4. The Applicant shall comply with each and every condition, revision, modification and/or other request contained in the Planner's letter of September 5, 2019, the Engineer's letter of August 26, 2019, and the Master Plan Consultant/Redevelopment Engineer's letter of August 19, 2019, unless otherwise specifically modified herein; and

MIMINO & DENNEN, LLC
ATTORNEYS AT LAW

40 Newton Avenue
Woodbury, New Jersey 08096

5. In accordance with the Statewide Non-Residential Development Fee Act (N.J.S.A. 40:55D-8.1-8.7), the Applicant is required to make payment of a development fee of 2.5% of the equalized assessed value of the non-residential construction, payable in full at the time the project is deemed substantially complete by the Planning Board Engineer or at the time of the request for a certificate of occupancy, whichever comes first; and

6. All previous approvals for this project, including but not limited to the terms and conditions of Resolution R2017-16; Resolution R2017-28 and R2019-21, remain in full force and effect, unless specifically modified pursuant to the terms and conditions of this resolution; and

7. The Applicant, as a condition of approval, must have a signed Re-Development Agreement with Greenwich Township for this subproject prior to the issuance of a temporary and/or final Certificate of Occupancy or Certificate of Approval; and

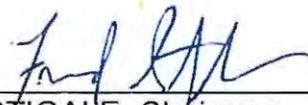
8. The Applicant shall install one (1) fire hydrant close to the intersection of the terminal road and the gravel maintenance road; and

9. The Applicant shall repair the pot holes, at a minimum, in the area from the security booth to the limit of the new paving; and

10. The Applicant shall install two (2) additional shoe box light fixtures at the rear of the Operations Building, or other equivalent lighting to the satisfaction of the Planning/Zoning Board Engineer; and

11. With respect to the issue of NJDOT Hazmat Security Plan & Compliance and NJDOT Hazmat Shippers Registration, if and to the extent required,

The Applicant will pursue these requirements and provide proof of compliance to the Board.



FRED STIGALE, Chairman
Planning/Zoning Board of Greenwich Township

The foregoing Resolution was a memorialization of action taken at a regular meeting of the Planning/Zoning Board of Greenwich Township held on the 9th day of September 2019; and such resolution was adopted by the Planning/Zoning Board of Greenwich Township at its regular meeting held on October 7, 2019, by a vote 8 to approve, 0 to Oppose and 0 to abstain.



KIRK FAIRLEY, Secretary
Planning/Zoning Board of Greenwich Township

THOSE IN FAVOR: Fairly, Wagner, Sholders, Rush, Zampaglione, Hertz, Chole & Shively

THOSE OPPOSED:

THOSE ABSTAINED:



AcuTech Group, Inc.
Washington DC Headquarters
1919 Gallows Road, Suite 900
Vienna, Virginia, USA 22182
Tel: +1.703.676.3180
Fax: +1.703.842.8854
www.acutech-consulting.com

November 16, 2017

Captain Scott Anderson
Captain of the Port, USCG Sector Delaware Bay
ATTN: Facilities and Containers Branch
U. S. Coast Guard
Sector Delaware Bay
1 Washington Avenue
Philadelphia, PA 19148

Re: Letter of Intent for Repauno Port and Rail Terminal, Gibbstown, New Jersey

Dear Captain Anderson:

Delaware River Partners LLC ("DRP") proposes to site, construct, and operate a multi-use, deep-water port and logistics center that may include a variety of separate uses including handling of imported and exported automobiles, other bulk freight and liquid energy products including, but not limited to liquefied petroleum gas ("LPG") and liquefied natural gas ("LNG"). LPG is classified as a liquefied hazardous gas ("LHG") by 33 C.F.R § 127.005.

The focus of this submission is a joint LNG / LHG facility which will be referred to as the "Project". In accordance with the requirements contained in 33 C.F.R. § 127.007, DRP is pleased to submit the following information about the Project. Please note that at the appropriate time, DRP will make the necessary submission(s) to the COTP pursuant to 33 C.F.R. §§ 126 and 154 as it relates to the other proposed uses.

Given the common stakeholders involved throughout the approval and assessment process, as well as the interdependent risk factors that must be examined, DRP requests that the LNG and LHG be examined jointly through a combined Waterway Suitability Assessment ("WSA") that will accurately represent the envisioned operations of the proposed Project. Enclosed with this Letter of Intent is a Preliminary WSA.

The Project would be operated at the site of the proposed Repauno Port and Rail Terminal ("Repauno Facility"), which is located on a 218-acre portion of a 1630-acre tract formerly known as the Dupont Repauno Works at 200 North Repauno Avenue in Gibbstown, Gloucester County, New Jersey. The Repauno Facility will be consistent with other industrial facilities along the riverfront.

The Project's LNG operations will maintain an export capacity of approximately 1.5 million metric tonnes per annum ("MTPA") (roughly 1,670,000 BBL per month). The LHG operations will maintain an

export capacity of approximately 9,600,000 BBL per annum (800,000 BBL per month). Notably, LNG, LHG, or other hazardous or non-hazardous cargo operations will not run concurrently, as the single-berth wharf only permits one vessel to dock at a given time for a single commodity.

1. Name, address and telephone number of the owner and operator

The Project will be owned and operated by DRP, a limited liability company organized under the laws of the State of Delaware, which is doing business as Repauno Port and Rail Terminal. The address and telephone number for DRP is:

Delaware River Partners LLC
d/b/a Repauno Port and Rail Terminal
200 North Repauno Avenue
Gibbstown, NJ 08027
Phone: 856-224-7067

2. The name, address, and telephone number of the Federal, State, or local agency having jurisdiction for siting, construction, and operation

The lead agency with jurisdiction over the Project is the New Jersey Department of Environmental Protection ("NJDEP"). NJDEP will have the responsibility of reviewing the siting, environmental and safety aspects of the project and preparing the environmental documents required pursuant to the agency's governing laws and regulations. The mailing address and telephone number for general inquiries are:

New Jersey Department of Environmental Protection
Bureau of Release Prevention
401 East State Street
Mail Code 22-03D
P.O. Box 420
Trenton, NJ 08625-0420
Phone: 609-633-0610

In addition to the siting and environmental reviews by NJDEP, other agencies participate in the process, such as the U.S. Department of Energy for authorization to export LNG to both Free Trade Agreement and Non-Free Trade Agreement countries, and the Greenwich Township and Gloucester County Planning Boards for related local site plan and construction approvals. A Section 10/404 permit for construction of the Repauno Facility is pending before the U.S. Army Corps of Engineers ("USACE").

3. Name, address, and telephone number of the Repauno Facility

The project name is "Repauno Port and Rail Terminal." The project management offices and point of contact are:

Mr. Jimmy Osman
V.P. Engineering & Development
Repauno Port and Rail Terminal
200 North Repauno Avenue
Gibbstown, NJ 08027
Phone: 856-224-7067

4. The physical location of the Project

The Project will be located on a portion of the Repauno Facility currently being redeveloped by DRP on the site of a former industrial facility along the Delaware River. The Repauno Facility will feature a single, multi-use, deep-water berth and associated port and logistics center facilities, including the proposed Project. The Project will be located at 200 North Repauno Avenue in Gibbstown, Gloucester County, New Jersey, at river mile 86.5 and at Latitude N 39.846/Longitude W 75.296. The Project is adjacent to the Tinicum Range of the Delaware River Channel. A site location map is shown in Figure 1, a site plot plan showing the major components that are planned for the Repauno Facility are shown in Figure 2, including the alignment of the LNG and LHG operations. Figure 3 shows a more detailed view of the wharf.

Figure 1 – Proposed Repauno Facility Location

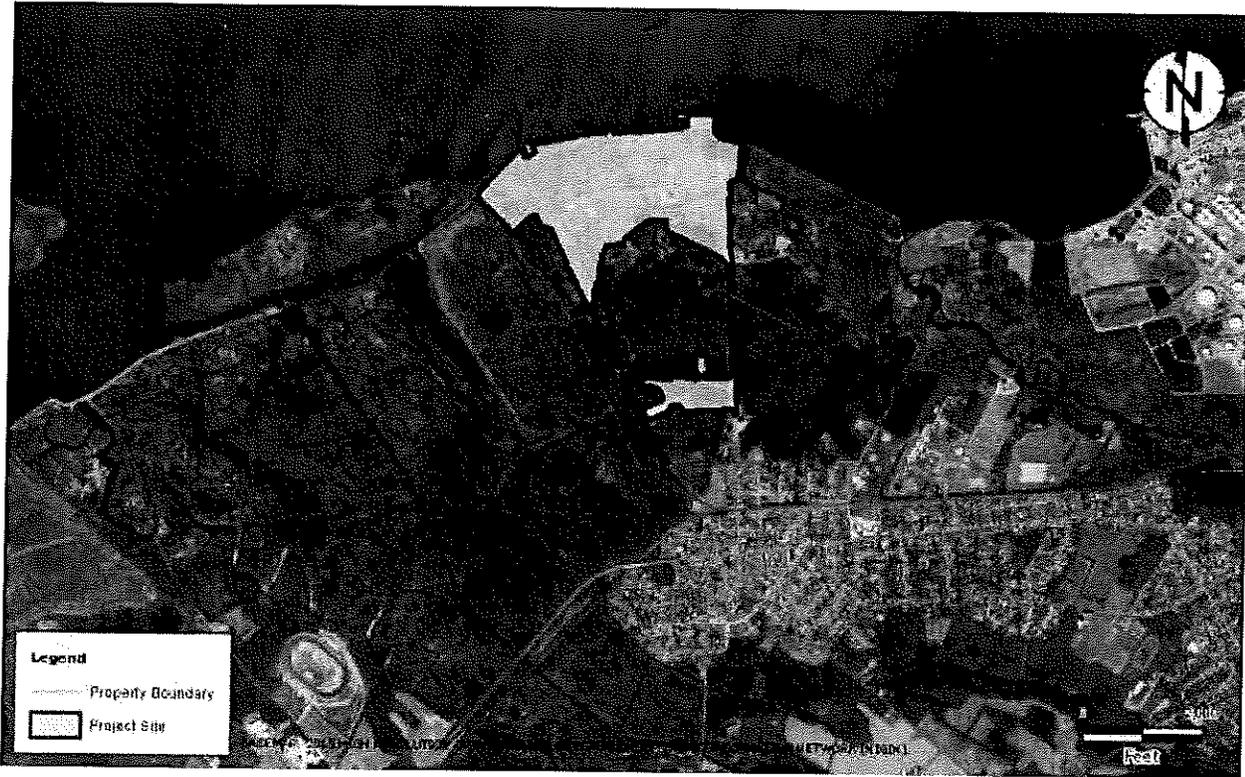


Figure 2 - Proposed Repauno Facility Layout

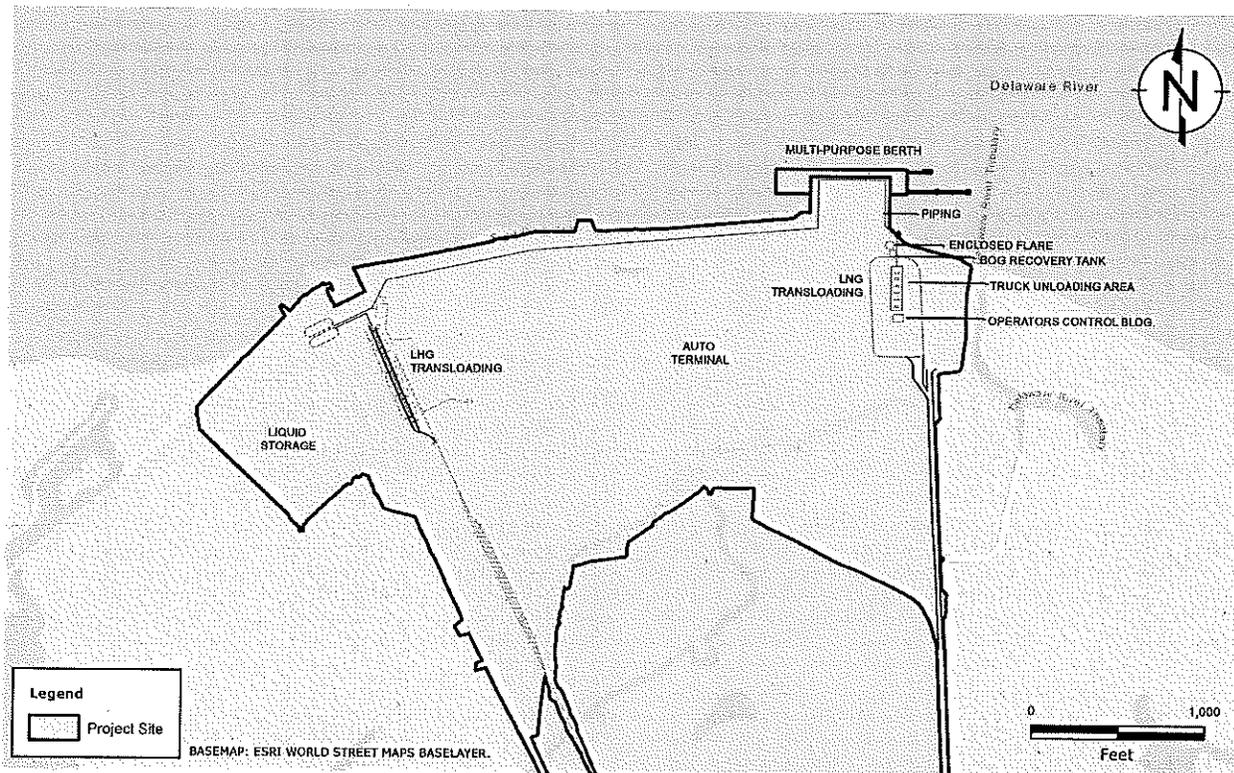
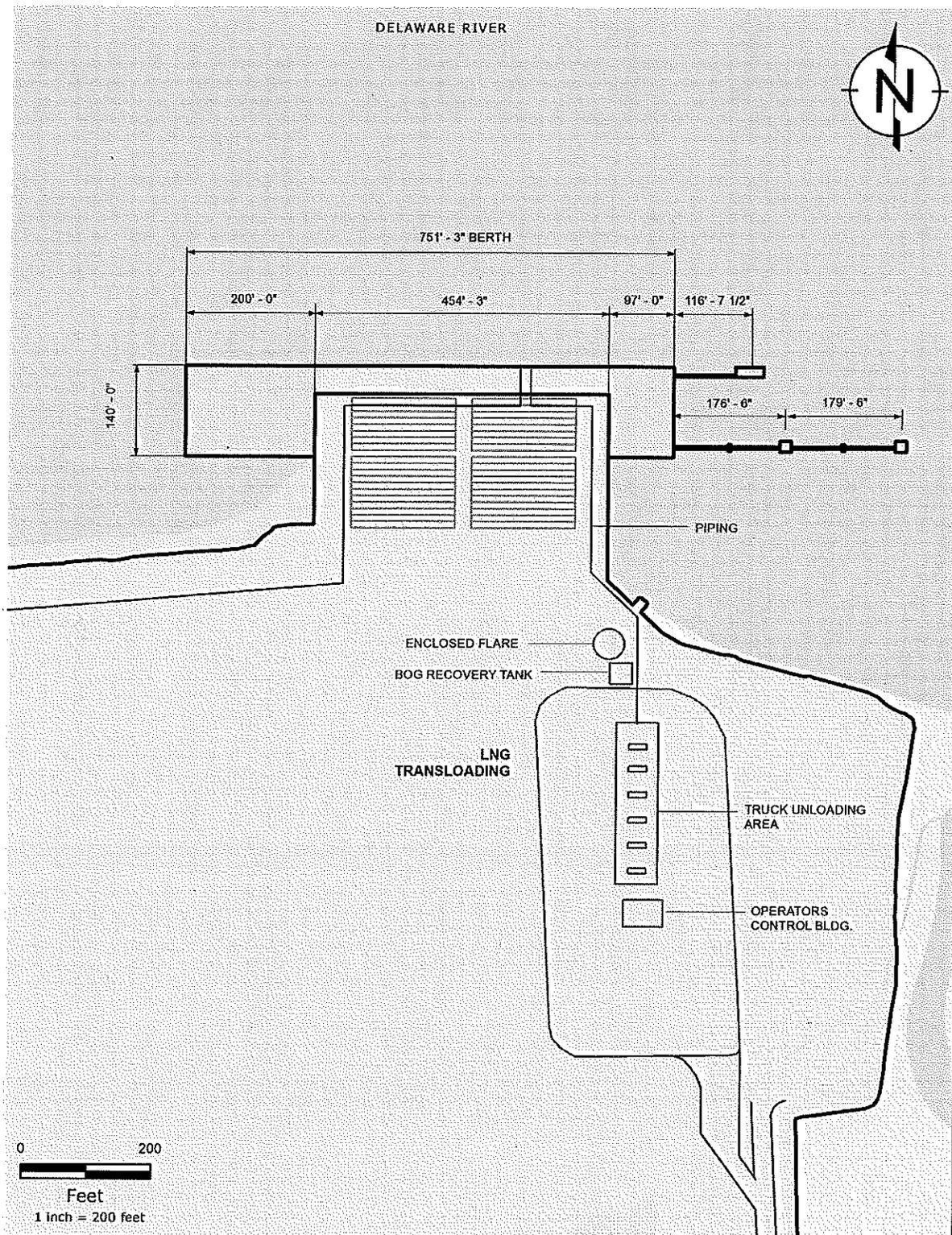


Figure 3 -Proposed Repauno Facility Wharf Layout



5. Overview of the Proposed Project

The Applicant will develop a multi-purpose port facility that will, among other things, provide transloading of LNG and LHG for export. LNG would be delivered to the facility only via trucks and/or rail and pumped directly onboard LNG carriers (“LNGCs”) for export. This process eliminates the need for large-scale, onsite LNG storage or liquefaction while providing an export capacity of 1.5 MTPA (20 MM BBL). Loading a berthed LNG tanker with an expected load of 830,000 BBLs will take an average of 15 days.

LHG would be delivered via railcars or truck, and will be stored onsite. Loading a berthed LHG tanker with an expected capacity of 400,000 BBLs will take an average of 11-12 days.

6. Description of the LNG Handling Facility

The Project would be capable of handling LNG or LHG as described in Sections 6 and 7 hereof. LNG and LHG operations or other cargo deliveries will not run concurrently, as the single-berth wharf only permits one vessel to dock at a given time. For the purposes of this Letter of Intent and the Preliminary WSA, each of the potential maximum yearly LNG and LHG ship calls are analyzed herein. Importantly, however, these projective ship calls represent potential alternatives; they are not cumulative.

The Project will be designed as a modular system to ensure efficient throughput at the facility. The proposed design will allow LNG trucks to unload at a new truck unloading rack located at the east side of the proposed Project site, and south of the new multi-purpose dock. (See proposed Project layout in Figure 2). Notably, the onsite configuration is presently under evaluation and is subject to change during the detailed design of the Project, including the possibility of delivering LNG to the facility via rail.

- LNG will be delivered to the facility through third party LNG trucks. The project is proposing an LNG facility with an initial capacity of up to approximately 1.5 million MTPA of LNG (roughly 1,670,000 BBL per month).
- Product will be pumped directly into the LNGC from the truck rack through ~1,000' long (10" – 12" diameter) vacuum-insulated line via loading arms.
- The new truck rack will consist of a 12-lane rack with 6 unloading pump skids (2 pumps per skid - double sided), and will be capable of unloading 12 LNG trucks simultaneously. (Typical MC-338 DOT LNG Truck has a tank capacity of 290 BBL, but a maximum liquid fill of 260 BBL).
- The proposed capacity of an LNGC that will export LNG from the facility is approximately 1,070,000 BBL, but the maximum liquid fill capacity during loading is 833,330 BBL, in order to accommodate the nominal loaded draft of 40'.
- The LNG transfer line to the LNGC will be sized to handle approximately 2,500 GPM. The estimated volume to be transferred over a 24-hour period is 57,140 BBL. (16 hours actual unloading time and 6-8 hours for hookup, disconnect, and documentation). The truck rack will be able to handle 200-220 trucks per day.

- Loading of a berthed LNG tanker will therefore take an average of 15 days, resulting in approximately 24 LNGC calls on the Project per year, and a total capacity of approximately 20 MM BBL per year (1.5 MTPA).

Boil-Off Gas (BOG) and gas removed from the berthed LNGC will be collected via a vapor line and could be handled in any of the following configurations:

- Process BOG and vapors are routed through a small capacity liquefier; then pushed back into the LNGC. The system consists of a cold box, compressor, N₂ tank and a cold storage bullet tank (1430 BBL capacity).
- Flare the BOG and vapors.
- Collect BOG and run through a gas separator for sale to the grid. (This is to be reviewed with the local utility company).

The LNG handling facility will include a Safety Flare and Vent System for emergency purposes. This system will also provide relief to the LNGC vapor return and piping systems.

The LNG carrier's characteristics and the frequency of the LNG export shipments from the Project

Annual waterway transit information will be coordinated with local Pilots. The Project is being designed with berthing and mooring configurations to accommodate LNGCs. Berthing and mooring configurations will be able to accommodate a typical Aframax class LNGC with capacities up to 170,000 m³ (1.1 MM BBL) (820.2' LOA, 144.4' beam, 40' nominal loaded draft), but the loading capacity will be limited to 833,330 MM BBL in order to accommodate the nominal loaded draft of 40'. There will be approximately twenty-four (24) vessel arrivals each year over a fairly even time period. This results in an estimated two (2) vessels per month.

7. Description of the Liquefied Hazardous Gas (LHG) Handling Facility

As noted above, the single-berth wharf only permits one vessel to dock at a given time. For the purposes of this Letter of Intent and the Preliminary WSA, both the maximum yearly LNG and LHG ship calls are analyzed herein. However, these operations would not run concurrently.

LHG Storage

LHG will arrive at the proposed Project site via rail cars and will then be pumped off into storage tanks. Total onsite storage for this option is ~100,000 BBLs. The vapors from the storage tanks, in addition to BOG from the vessel are compressed, condensed, and then returned to the storage tanks. It is anticipated that a Thermal Oxidizer would also be provided for emergency relief.

Notably, the on-site configuration discussed herein is presently under evaluation and is subject to change during the detailed design of the Project.

LHG Product Shipping

The LHG shipping facilities consist of two LHG tanker loading pumps, each with a rated capacity of 1,750 BBL/hour, a 16" loading line, and an 8" vapor return line, each of which is fitted with fully articulated loading arms (Sizes to be confirmed in the design phase). The 400,000 BBLS refrigerated LHG tanker (Panamax class vessel with 40' nominal loaded draft) will be utilized as a short-term storage vessel during loading periods, enhancing the storage capacity of the facility for the duration of the LHG tanker's berthing. The LHG tanker will dock for approximately 11-12 days for loading operations.

The piping system will be designed as a 300# system to coincide with the pressure ratings of adjoining equipment, including the storage tanks. The vapor generated during the process is recycled to its respective tank. The loading and vapor return arms are then connected to the docked vessel and loading commences at a minimal rate. As conditions in the loading system allow, the loading rate may be increased up to the maximum rate of ~3,500 BBL/hour.

The proposed Project site will include a 20-rail car unloading rack (2x10) capable of offloading LHG at a rate of ~14,000 BBL/day using two 1,750 BBL/hour pumps. These products would be stored in storage tanks built to ASME Sec. VII specifications. Using two 1,750 BBL/hour pumps, the product is transferred from the storage tanks to the berthed vessel via two 16" dock lines for short term storage and eventual export. Cargo will be refrigerated using the LHG tanker's refrigeration system. The associated on-site LHG tank farm could occupy 3+/- acres to accommodate the tanks and associated equipment.

The LHG tanker's characteristics and the frequency of the LHG export shipments from the Project

Annual waterway transit information will be coordinated with local Pilots. The Project is being designed with berthing and mooring configurations to accommodate LHG tankers. Berthing and mooring configurations will be able to accommodate Panamax class LHG tankers with a capacity of 400,000 BBLS. As such, there could be as many as twenty-four (24) vessels calling on the Project each year over a fairly even time period. This results in an estimated vessel arrival twice a month.

8. Description of Non-LNG-and-LHG Cargo Vessels

In addition to LNG and LHG, a variety of cargo vessels (excluding all LNGCs and LHG tankers) could call on the proposed Project. These vessels will transport commodities such as Roll-on/Roll-off ("RoRo"), Break Bulk, and other bulk liquids, potentially including crude oil and refined products. It is important to note, however, that given the constraints of the single multi-purpose berth, if the full number of projected LNG and/or LHG ships call on the Repauno Facility (*i.e.*, 24 LNG and/or LHG vessels per year), no additional cargo types could be accommodated. In short, the cargos and ship calls identified herein are expressed as alternatives; they are not cumulative.

The potential additional cargo types are briefly described below:

- *Roll-on/Roll-off*: A portion of the Repauno Facility could be reserved for transit, storage, and processing facilities for wheeled cargo (i.e., automobiles) transported by RoRo vessels. The Repauno Facility could include facilities for vehicle preparation, intermodal rail transfer, and truck-away loading areas.
- *General and Break-Bulk Cargo*: A portion of the Repauno Facility could also handle perishables, general freight, and break-bulk cargo, including such commodities as fruits and vegetables and other refrigerated goods.
- *Bulk Liquids*: A portion of the Repauno Facility could provide energy product storage. In addition to the liquid petroleum gases identified earlier (including propane and butane), the Repauno Facility could also provide storage for refined petroleum products and crude products.

The multi-purpose berth would be able to accommodate cargo vessels with a maximum length of approximately 870 ft., maximum width of approximately 145 ft., and nominal loaded draft of 40 ft. Vessels would use the Federal navigation channel to move to and from the Repauno Facility. As noted above with respect to the LNG/LHG Project, the single-berth wharf only permits one vessel to dock at a given time. Thus, LNG/LHG and other vessels would not call at the Repauno Facility concurrently. As compared to the above-referenced berthing times for LNG/LHG vessels, a non-LNG/LHG vessel would be at the berth for approximately 2 days during loading/unloading. Thus, these vessels may call on the facility no sooner than every 2 days.

9. Description of Annual Vessel Traffic

As summarized on Table 1-1, it is estimated that the LNG/LHG Project would result in approximately 24 LNG or LHG vessels calling on the Repauno Facility in a given year. The potential number of LNG or LHG vessel calls are expressed as independent maximums for the purpose of the within Preliminary WSA. However, since the single, multi-purpose berth can only accommodate one ship at a time, vessels will not call on the Repauno Facility concurrently and this projected vessel traffic is not cumulative.

Table 1-1: Alternative Utilization of Multi-Purpose Dock for LNG/LHG Project

Commodity	Annual Volume (Estimated)	Units	Vessel Fill Capacity (Estimated)	Annual Number of Vessels (Estimated)
LNG	20,000,000	BBL	833,330	24
Liquefied Gases	9,600,000	BBL	400,000	24

Additionally, annual cargo ship calls were estimated for the other projected cargo commodities that could be handled at the Repauno Facility. It is estimated that the Repauno Facility could handle a maximum of 91 RoRo vessel calls, 11 break-bulk vessel calls, 13 refined product, and 6 crude oil calls. Again, these projected cargo calls are expressed as anticipated maximums, which would not be cumulative and would be reduced by the number of LNG and LHG vessels that call at the Repauno Facility due to the constraints of the single, multi-purpose berth discussed above. If the full number of projected LNG and/or LHG ships call on the Repauno Facility (*i.e.*, 24 LNG and/or LHG vessels per year), no additional cargo types could be accommodated. In short, the cargos and ship calls identified herein are expressed as alternatives; they are not cumulative. The type and total number of vessel calls will be driven by market demand and berth availability in the region.

10. Figures

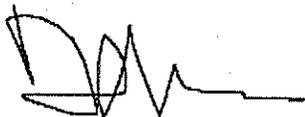
- 1) Proposed Repauno Facility Site Location
- 2) Proposed Repauno Facility Site Layout
- 3) Proposed Repauno Facility Wharf Layout

11. Attachments

- A) NOAA Office of Coast Survey Navigation charts of waterway channels and highlighted LNGC/LHG tanker route.
- B) Commercial, industrial, environmentally sensitive, and residential areas within 15.5 miles of the project site adjacent to the waterway.
- C) Map of waterway channel showing environmental sensitive areas adjacent to the surrounding area.
- D) Preliminary WSA that has been prepared in accordance with the guidance contained in U.S. Coast Guard (“USCG”) NVIC 01-2011.

If the USCG has any questions or requires any additional information or clarification, please feel free to contact Mr. Jimmy Osman, DRP's Vice President of Engineering & Development at 856-224-7067 or josman@repauno.com. AcuTech is acting on behalf of DRP as their designated consultant for preparing the WSA.

Best regards,

A handwritten signature in black ink, appearing to be 'D. Moore', with a horizontal line extending to the right.

On behalf of Delaware River Partners, LLC.

David A. Moore, PE, CSP
President & CEO
AcuTech Group, Inc.
1919 Gallows Road, Suite 900
Vienna, VA 22182
Tel: +1-703-676-3180
Cell: +1-703-598-3921



State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Release Prevention
PO Box 420, Mail Code 22-03D
Trenton, NJ 08625-0420

Tel: (609) 633-0610 Fax: (609) 633-7031

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

BOB MARTIN
Commissioner

June 9, 2017

CERTIFIED MAIL

7013 0600 0001 4658 5086

Gary Lewis, President
DELAWARE RIVER PARTNERS LLC
200 N Repauno Ave
Gibbstown, NJ 08027

Re: Signed Risk Management Program Consent Agreement:
200 N Repauno Ave, Greenwich Twp, New Jersey, 08027-1096
TCPA ID# 5087
EA ID #: NOD170001 - 5087

Dear Mr. Lewis:

Enclosed is a copy of the Consent Agreement signed by DELAWARE RIVER PARTNERS LLC and the Department of Environmental Protection ("the Department") pursuant to N.J.A.C. 7:31-8.1(c), which incorporates 40 CFR 68.220 with revisions. The Department agrees with your revision to Corrective Action 4 to state that labeling of electrical equipment at the cavern area will be completed prior to startup.

This signed Consent Agreement represents the approval of DELAWARE RIVER PARTNERS LLC's risk management program. All corrective actions noted in Attachment A must be implemented within the time frame indicated from the date of this Consent Agreement approval letter.

In addition, you are required to submit to the Department a progress report, prior to the fifteenth of each month, showing implementation of corrective actions and compliance with the indicated schedule. Also, the Department plans to audit your source referenced above pursuant to 40 CFR 68.220(a) incorporated with changes at N.J.A.C. 7:31-8.1(c) and/or conduct compliance inspections pursuant to 40 CFR 68.220(j) incorporated with changes at N.J.A.C. 7:31-8.1(c) at

appropriate intervals to verify compliance with the Toxic Catastrophe Prevention Act (TCPA) and the approved risk management program.

The date the Department signs the Consent Agreement is DELAWARE RIVER PARTNERS LLC's anniversary date. Consequently, pursuant to N.J.A.C. 7:31-4.9 you must submit an annual report within 90 days after the anniversary date.

Please contact John Notta at (609) 984-3691 if you have any questions regarding the approved risk management program.

Your continued cooperation is appreciated.

Sincerely,



Iclal Atay, Ph.D., Chief
Bureau of Release Prevention

c: J. Notta, Chemical Safety Engineer

File: TCPA ID# 5087 - 6



State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Release Prevention
PO Box 420, Mail Code 22-03D
Trenton, NJ 08625-0420

Tel: (609) 633-0610 Fax: (609) 633-7031

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

BOB MARTIN
Commissioner

RISK MANAGEMENT PROGRAM CONSENT AGREEMENT

DELAWARE RIVER PARTNERS LLC

The following Consent Agreement is issued pursuant to the authority vested in the Commissioner of the State of New Jersey Department of Environmental Protection ("The Department") by N.J.S.A. 13:1D-1 et seq. and the Toxic Catastrophe Prevention Act N.J.S.A. 13:1K-19 et seq. and duly delegated to the Chief, Bureau of Release Prevention, Division of Waste Enforcement, Pesticides, and Release Prevention pursuant to N.J.S.A. 13:1B-4 and amendments made thereto.

A risk management program for a Program 3 covered process shall comply with the requirements of N.J.A.C. 7:31 and, at a minimum, include the following program elements:

1. Management system;
2. Process safety information;
3. Process hazard analysis with risk assessment for specific pieces of EHS equipment or operating procedures;
4. Standard operating procedures;
5. EHS operator Training;
6. Mechanical integrity/preventive maintenance;
7. Management of change;
8. Safety reviews: design and pre-startup;
9. Compliance audits;
10. EHS accident or potential catastrophic event investigation;
11. Employee participation;
12. Hot work permit;
13. Contractors;
14. Emergency response.

DELAWARE RIVER PARTNERS LLC hereby agrees to take the listed corrective actions for the material deficiencies set forth in Attachment A and to comply with the schedule as indicated. The regulatory citations in this Consent Agreement are based on the rules as codified at N.J.A.C. 7:31, Toxic Catastrophe Prevention Act Program. DELAWARE RIVER PARTNERS LLC agrees to submit to the Department a progress report, prior to the fifteenth of each month, showing implementation of corrective actions and compliance with the schedule. This signed Consent Agreement shall represent the approval of DELAWARE RIVER PARTNERS LLC's risk management program for the facility located at 200 N Repauno Ave, Greenwich Twp, New Jersey. DELAWARE RIVER PARTNERS LLC agrees to comply with all requirements of N.J.A.C. 7:31, this Consent Agreement and its approved risk management program. Pursuant to N.J.A.C. 7:31-11.4, the Department may assess a civil administrative penalty for each violation of the Toxic Catastrophe Prevention Act and for violations of any rule, Consent Agreement or Addendum, or Administrative Order issued pursuant thereto.

Submissions to the Department should be sent to:

Chief
Bureau of Release Prevention
Division of Waste Enforcement, Pesticides, and Release Prevention
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
P.O. Box 420, Mail Code 22-03D
Trenton, New Jersey 08625-0420

DATE: 6/7/17

BY: [Signature]

TITLE: President

For DELAWARE RIVER PARTNERS LLC

DATE: 6/9/17

BY: [Signature]

TITLE: Chief

for BUREAU OF RELEASE PREVENTION

Attachment A: 3 pages

ATTACHMENT A
DELAWARE RIVER PARTNERS LLC

Program 3 covered process: Butane Storage

EHS: Butane

The Department has determined the following material deficiencies in the risk management program:

1. Requirement: Pursuant to 40 CFR 68.73(d)(2), as incorporated at N.J.A.C. 7:31-4.1(a), inspection and testing procedures shall follow recognized and generally accepted good engineering practices.

Description of Noncompliance: Delaware River Partners (DRP) did not develop inspection and testing procedures for the EHS equipment.

2. Requirement: Pursuant to 40 CFR 68.71(a)(1), as incorporated at N.J.A.C. 7:31-4.1(a), each employee presently involved in operating a process, and each employee before being involved in operating a newly assigned process, shall be trained in an overview of the process and in the operating procedures as specified in 40 CFR 68.69 as incorporated at N.J.A.C. 7:31-4.1(c)8. The training shall include emphasis on the specific safety and health hazards, emergency operations including shutdown, and safe work practices applicable to the employee's job tasks.

Description of Noncompliance: Delaware River Partners (DRP) did not train each employee involved in operating a process in an overview of the process and in the operating procedures as specified in 40 CFR 68.69 as incorporated at N.J.A.C. 7:31-4.1(c)8. Specifically, two operators are not trained.

3. Requirement: Pursuant to 40 CFR 68.71(c), as incorporated at N.J.A.C. 7:31-4.1(a), the owner or operator shall ascertain that each employee involved in operating a process has received and understood the required training.

Description of Noncompliance: Delaware River Partners (DRP) did not ascertain that each employee involved in operating a process has received and understood the required training. Specifically, a written operator test is not developed.

4. Requirement: Pursuant to 40 CFR 68.67(e), as incorporated at N.J.A.C. 7:31-4.1(a), the owner or operator shall establish a system to promptly address the team's findings and recommendations; assure that the recommendations are resolved in a timely manner and that the resolution is documented; document what actions are to be taken; complete actions as soon as possible; develop a written schedule of when these actions are to be completed; communicate the actions to operating, maintenance and other employees whose work assignments are in the process and who may be affected by the recommendations or actions.

Description of Noncompliance: Delaware River Partners (DRP) did not complete actions as soon as possible for the process hazard analysis recommendations. Specifically, Facility Siting and Human Factors recommendations #3, #6, and #7, and Electrical recommendation #13 are not completed.

5. Requirement: Pursuant to 40 CFR 68.69(a)(4), as incorporated at N.J.A.C. 7:31-4.1(a), the owner or operator shall develop and implement written operating procedures that provide clear instructions for safely conducting activities involved in each covered process consistent with the process safety information. The operating procedures shall address safety systems and their functions.

Description of Noncompliance: Delaware River Partners (DRP) did not address safety systems and their functions in the written operating procedures. Specifically, the set points for alarms, interlocks, and relief devices are not finalized.

6. Requirement: Pursuant to 40 CFR 68.77(a), as incorporated at N.J.A.C. 7:31-4.1(a), the owner or operator shall perform a pre-startup safety review for new stationary sources and for modified stationary sources when the modification is significant enough to require a change in the process safety information.

Description of Noncompliance: Delaware River Partners (DRP) did not perform a pre-startup safety review for the facility. Specifically, DRP initiated the review on June 2, 2017, for the planned startup of June 15, 2017.

7. Requirement: Pursuant to 40 CFR 68.95(a)(2), as incorporated at N.J.A.C. 7:31-5.1(a), the owner or operator shall develop and implement an emergency response program for the purpose of protecting public health and the environment. Such program shall include procedures for the use of emergency response equipment and for its inspection, testing, and maintenance.

Description of Noncompliance: Delaware River Partners (DRP) did not develop and implement emergency response program procedures for the use of emergency response equipment and for its inspection, testing, and maintenance. Specifically, the temporary fire pump is not installed.

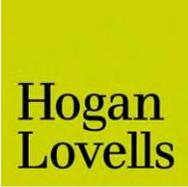
8. Requirement: Pursuant to N.J.A.C. 7:31- 5.2(b)2, each owner or operator shall develop and implement a written emergency response (ER) program which shall include performance of at least one EHS ER exercise per calendar year.

Description of Noncompliance: Delaware River Partners (DRP) did not perform the initial EHS ER exercise.

DELAWARE RIVER PARTNERS LLC shall take the following corrective actions:

1. Comply with requirement within 90 days of the effective date of this document by developing inspection procedures for the EHS equipment by following recognized and generally accepted good engineering practices. [40 CFR 68.73(d)(2)]
2. Prior to startup complete initial operator training. [40 CFR 68.71(a)(1)]
3. Prior to startup develop and administer an operator test that ascertains that each employee has received and understood the required training. [40 CFR 68.71(c)]
4. Prior to startup complete the Facility Siting and Human Factor recommendations #3, #6, and #7, and ~~Electrical recommendation #13~~. [40 CFR 68.67(e)] *Labeling of electrical equipment*
5. Comply with requirement within 90 days of the effective date of this document by reviewing and updating the SOPs to ensure that the safety systems and their functions correctly reflect the actual operating conditions. [40 CFR 68.69(a)(4)] *at the cavern area. YSR 6/7/17*
6. Prior to startup perform a prestart up safety review including a report of any deficiencies and a schedule for completion. Identify and address deficiencies required to be completed prior to startup. [40 CFR 68.77(a)] *DA*
7. Prior to startup install the temporary fire pump as designed. [40 CFR 68.95(a)(2)] *6/9/17*
8. Prior to startup conduct an ER exercise and prepare a written assessment. [N.J.A.C. 7:31-5.2(b)2]

Exhibit B

The logo for Hogan Lovells, featuring the name "Hogan Lovells" in a serif font on a yellow rectangular background.

Hogan Lovells US LLP
Columbia Square
555 Thirteenth Street, NW
Washington, DC 20004
T +1 202 637 6642
F +1 202 637 5910
greg.junge@hoganlovells.com

VIA ELECTRONIC FILING

September 11, 2020

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Re: Delaware River Partners LLC
Petition for Declaratory Order, Docket No. CP20-____-000

Dear Secretary Bose:

Pursuant to Rule 207(a)(2) of the Rules of Practice and Procedure of the Federal Energy Regulatory Commission (“Commission”), 18 C.F.R. § 385.207(a)(2) (2020), Delaware River Partners LLC (“DRP”) hereby electronically files a Petition for Declaratory order and Request for Expedited Action (“Petition”). The Petition seeks a declaratory order from the Commission stating that DRP’s proposed liquefied natural gas transloading operations, as part of its multi-use deep-water seaport and industrial logistics center in Gibbstown, New Jersey (“Facility”) would not subject the Facility to the Commission’s jurisdiction under Section 3 or Section 7 of the Natural Gas Act, 15 U.S.C. §§ 717b, 717f (2018). DRP respectfully requests that the Commission provide the relief sought on an expedited basis but not later than October 30, 2020.

As required by Rule 381.302(a), 18 C.F.R. § 385.302(a) (2020), DRP has paid the required filing fee of \$30,060.00 concurrent with submitting the Petition via the U.S. government’s www.pay.gov website. Attached please find the filing fee receipt.

Should you have any questions about this filing, please contact the undersigned at (202) 637-6642.

Respectfully submitted,

/s/ A. Gregory Junge

A. Gregory Junge
Hogan Lovells US LLP
Counsel for Delaware River Partners LLC

Attachments

Online Payment

Step 3: Confirm Payment

1 | 2 | 3

Thank you.
Your transaction has been successfully completed.

Pay.gov Tracking Information

Application Name: DOE FERC eFiling

Pay.gov Tracking ID: 26PU3IPU

Agency Tracking ID: 1134329_103038

Transaction Date and Time: 09/11/2020 10:33 EDT

Payment Summary

Account Holder Name: [REDACTED]

Payment Amount: \$30,060.00

Account Type: [REDACTED]

Payment Date: 09/14/2020

Routing Number: [REDACTED]

Account Number: [REDACTED]

belief that DRP's Facility would be non-jurisdictional. In addition, DRP has reviewed the Delaware Riverkeeper and the Delaware Riverkeeper Network's ("DRN") Freedom of Information Act ("FOIA") request regarding the Facility in which FERC Staff conveyed to the DRN that the Facility is not subject to the Commission's jurisdiction. Notwithstanding those assurances, DRP hereby seeks confirmation from the Commission, by means of a declaratory order, that the Facility would indeed be non-jurisdictional. DRP has already completed construction of dock infrastructure that could be used to support the transloading of LNG at the Facility in the manner described below and is in the process of permitting additional facilities for the same purpose. DRP respectfully requests that the Commission provide the relief sought on an expedited basis to provide regulatory certainty for DRP's financing counterparties, stakeholders, and customers.

In support hereof, DRP respectfully submits the following:

I.
DESCRIPTION OF PETITIONER

DRP's exact legal name is Delaware River Partners LLC. DRP is a limited liability company formed under the laws of the state of Delaware with its primary place of business at 200 N. Repauno Avenue, Gibbstown, New Jersey 08027. DRP is majority owned by Fortress Transportation and Infrastructure Investors LLC ("FTAI"), which is publicly traded on the New York Stock Exchange (symbol: FTAI) and which owns and acquires high quality infrastructure and equipment that is essential for the transportation of goods and people globally. FTAI currently invests across four market sectors: aviation, energy, intermodal transport and rail. FTAI is externally managed by an affiliate of Fortress Investment Group LLC ("Fortress Investment Group"). DRP and a

subsidiary of New Fortress are parties to an agreement which provides New Fortress's subsidiary with exclusive rights to transload LNG through the Facility.⁴

II. COMMUNICATIONS AND CORRESPONDENCE

All correspondence and communications regarding this filing should be addressed to the following:

- | | |
|---|--|
| <p>* Kenneth G. Charron
Vice President of Law
Delaware River Partners LLC
200 N. Repauno Ave.
Gibbstown, New Jersey 08027
Phone: (856) 224-7041
Email: kcharron@repauno.com</p> | <p>* A. Gregory Junge
Hogan Lovells US LLP
555 Thirteenth Street, NW
Washington, DC 20004
Phone: (202) 637-6642
Email: greg.junge@hovanlovells.com</p> |
|---|--|
- * Persons designated to receive service pursuant to Rule 2010 of the Commission's Rules of Practice and Procedure.

III. BACKGROUND

The Facility is located adjacent to the Delaware River on the grounds of the former DuPont Repauno Site, an approximately 1,630-acre property in Gibbstown, New Jersey. The Facility is a multi-use, deep-water seaport and industrial logistics center located at 200 North Repauno Avenue, Gibbstown, New Jersey. The Facility is designed to handle a range of ships transporting roll-on/roll-off cargo (*e.g.*, automobiles), break-bulk cargo, and bulk-liquid products. LNG will be delivered to the Facility by truck or railcar, *i.e.*, non-pipeline modes of transportation.

The Facility includes one dock ("Dock 1") that is currently capable of receiving an LNG marine vessel. DRP has already constructed truck- and railcar-unloading facilities capable of handling other liquefied gases such as propane and butane ("LHGs")

⁴ Although DRP's majority owner, FTAI, and New Fortress are each publicly traded companies with entirely separate boards of directors and no meaningful shareholder overlap, the entities have certain common management personnel.

at Dock 1. The Facility is currently, therefore, a multi-fuel handling facility. To support potential future volumes of LNG, DRP may construct a second, double-berth dock (“Dock 2”) capable of receiving two marine vessels. Dock 2 would also be a multi-fuel handling facility. DRP plans to construct additional truck- and railcar-unloading facilities to handle LNG transloading operations at the Facility.

In regard to the truck-unloading facilities, DRP plans to construct a multi-lane truck rack with double-sided unloading pump skids, capable of unloading multiple trucks simultaneously. In regard to the railcar-unloading facilities, DRP will construct one or more railcar unloading racks near the truck-unloading facilities. Once at the Facility, the railcars will be spotted for unloading at the rail racks. LNG will be directly transferred from the trucking and railcar facilities by means of a vacuum insulated LNG transfer line, which will deliver LNG to a marine vessel moored at Dock 1 or, if constructed, Dock 2. The LNG trucking and railcar facilities could be bypassed if LNG is delivered by ISO container to the Facility. The Facility is capable of loading such ISOs onto a cargo vessel just like any other bulk-liquid product.

LNG will depart the Facility solely by means of waterborne vessel in three ways. First, the waterborne vessel can transport LNG from the Facility directly to foreign ports without any intermediary transfer. Second, a floating storage unit or shuttle vessel can transport LNG from the Facility and transfer its load of LNG to a larger ocean-going waterborne vessel for delivery to foreign ports. LNG transloaded at the Facility and transported by waterborne vessel in these first two scenarios would be set for export.⁵

⁵ LNG transloaded into the floating storage unit or shuttle vessel could be transported directly to domestic, industrial end-users; however, no such LNG would be regasified and introduced into a domestic downstream pipeline except that LNG may be regasified to for delivery into a local distribution company’s (“LDC”) pipeline in order to serve the LDC’s peaking needs

Third, if LNG is delivered to the Facility in ISO containers, such ISO containers can be loaded onto a waterborne cargo vessel and transported directly to foreign ports or delivered directly to domestic end-users. Alternatively, the LNG delivered to the Facility in the ISO containers can be transloaded onto a waterborne vessel at the Facility and transported directly to foreign ports or domestic end-users. The LNG transloaded at or transported from the Facility will not be regasified and introduced into a domestic downstream pipeline, except for the potential limited scenario in which LNG that is transloaded onto waterborne vessels at the Facility is ultimately regasified for delivery into an LDC's pipeline in order to serve the LDC's peaking needs.

DRP anticipates that the Facility will manage boil-off gas in three ways. First, boil-off gas and vapors could be handled through a capture and return system operated by the marine vessel. Second, boil-off gas and vapors could be collected and routed to small on-site generation equipment used to power limited operations at the Facility. Third, boil off gas could be flared at the Facility; however, DRP anticipates the use of flaring only in limited circumstances.

New Fortress has entered into a multi-year agreement with DRP to have the exclusive right to transload LNG through the Facility. New Fortress anticipates delivering LNG to the Facility by means of truck and railcar from LNG liquefaction facilities being developed by New Fortress, such as the facility in Wyalusing Township, Bradford County, Pennsylvania, or from third-party liquefaction facilities.⁶

The Facility is a multi-use, deep-water seaport and industrial logistics center. As such, in addition to the infrastructure designed to receive and transfer LNG onto marine

⁶ LNG produced at the Wyalusing facility will be loaded into trucks or railcars for delivery by New Fortress to (a) end-use customers in the United States or (b) the Facility for waterborne delivery as described herein or at other ports for similar waterborne delivery.

vessels, the Facility will continue to load and unload LHG and other non-LNG cargo during operations, such as roll-on/roll-off and break bulk. The Facility does not include any vaporization or liquefaction facilities. Nor does the Facility include any onshore storage facilities for LNG.⁷ Accordingly, the Facility will receive and load LNG like it does other commodities and goods as part of its logistics operations as a deep-water seaport.

**IV.
THE FACILITY WOULD NOT BE SUBJECT TO THE COMMISSION'S
JURISDICTION UNDER THE NGA.**

A. The Facility does not satisfy the Commission's three-part test to determine whether a facility is subject to Section 3 of the NGA.

The Commission should find that operating the LNG transloading infrastructure at the Facility would not make the Facility subject to the Commission's jurisdiction under Section 3 of the NGA because it does not meet the definition of an "LNG terminal" as interpreted by the Commission. The Facility will not include a pipeline connection to deliver natural gas to or take regasified LNG from the Facility, and it will not include "natural gas facilities" as understood by the Commission and the regulated community, each of which is necessary for an LNG facility to constitute a jurisdictional "LNG terminal" under Section 3 of the NGA.

Under Section 3 of the NGA, the Commission has jurisdiction over the siting, construction, expansion, and operation of "LNG terminals," which are defined as:

all natural gas facilities located onshore or in State waters that are used to receive, unload, load, store, transport, gasify, liquefy, or process natural gas that is imported to the United States from a foreign country, exported to a foreign

⁷ The property on which the Facility is located includes caverns that can be used for storage of propane, but such facilities are not capable of LNG storage.

country from the United States, or transported in interstate commerce by waterborne vessel⁸

The Commission has applied a three-part test under Section 3 to determine whether a facility constitutes a jurisdictional LNG terminal. Unless a facility satisfies all three prongs, the Commission does not consider it to be an LNG terminal for purposes of asserting jurisdiction under Section 3 of the NGA. Under this test, the facility must:

- (1) receive natural gas or deliver regasified LNG through a “pipeline”;
- (2) be located at the point of import or export such that LNG is directly transferred to or from an ocean-going, bulk-carrier LNG tanker;⁹ and
- (3) have sufficient physical elements to constitute natural gas facilities as commonly understood by the Commission and the regulated community.

The Commission has generally considered four types of LNG facilities when determining the scope of its NGA jurisdiction. First, and obviously jurisdictional, the Commission has authorized a number of traditional LNG terminals, which are connected to major pipeline facilities, which have onshore storage and liquefaction and/or vaporization facilities, and which can load or unload a range of large, ocean-going, bulk-carrier LNG tankers.¹⁰ Second, the Commission has analyzed facilities that were to receive natural gas from a pipeline, liquefy or compress the natural gas on site, hold the

⁸ 15 U.S.C. § 717a.(11) (NGA Section 2(11)).

⁹ See *Pivotal LNG, Inc.*, 151 FERC ¶ 61,006 at P 11 (2015) (“*Pivotal II*”); see also *Emera CNG, LLC*, 148 FERC ¶ 61,219 at P 13 (2014) (“*Emera*”) (providing that the Commission has “only exercised its authority under [S]ection 3 over import or export facilities to regulate (1) pipelines that transport natural gas to or from the United States’ international borders; and (2) coastal LNG terminals that are accessible to ocean-going LNG tankers and connected to pipelines that deliver gas to or take gas away from the terminal”).

¹⁰ See, e.g., *Jordan Cove Energy Project, L.P.*, 170 FERC ¶ 61,202 (2020) (authorizing an LNG terminal under Section 3 of the NGA which will consist of gas inlet and gas conditioning facilities, liquefaction facilities, LNG storage facilities, LNG loading and marine facilities, and support systems, and will connect to the Pacific Connector Gas Pipeline authorized under Section 7 of the NGA, which will supply natural gas to the LNG terminal); *Rio Grande, LNG, LLC*, 169 FERC ¶ 61,131 (2019) (authorizing an LNG terminal under Section 3 of the NGA which will consist of six natural gas liquefaction trains, four LNG storage tanks, two LNG carrier loading berths, a turning basin, LNG and NGL truck loading and unloading facilities, and other support structures, and will connect to the Rio Bravo Pipeline authorized under Section 7 of the NGA, which will supply natural gas to the LNG terminal).

resulting LNG or compressed natural gas (“CNG”) in permanent storage tanks, and send the LNG or CNG out via truck. The Commission has found these facilities to be non-jurisdictional under Section 3 because, in part, they do not load or unload ocean-going, bulk-carrier LNG tankers.¹¹ Third, the Commission has analyzed traditional port facilities that would receive LNG in ISO containers by non-pipeline modes of transportation and load or unload the ISO containers together with other containers of non-LNG cargo. The Commission found these facilities to be non-jurisdictional because they did not include pipeline interconnections and did not include “natural gas facilities” as commonly understood by the Commission and the regulated community.¹² Fourth, the Commission has considered hybrid facilities that were dedicated LNG facilities (rather than traditional container ports) but that would not facilitate the transportation of natural gas by pipeline, generally because they would provide for transportation of LNG by waterborne vessel followed by delivery of LNG to end users via truck or railcar. The Commission held that these facilities were non-jurisdictional because they did not include

¹¹ See, e.g., *Shell U.S. Gas & Power, LLC*, 148 FERC ¶ 61,163 (2014) (“*Shell*”) (declining to assert jurisdiction over two facilities, the first of which would be used to transfer LNG imported from Canada directly from one moored ship to another moored ship or from ship to shore for storage and subsequent distribution by truck or train, and the second of which would liquefy domestically-produced natural gas supplied by a pipeline and transport LNG to (1) other waterborne vessels which would use the LNG as fuel, or (2) to on-shore storage facilities for subsequent transfer to waterborne vessels, trucks, or trains); *Emera*, 148 FERC ¶ 61,219 (declining to assert jurisdiction over facilities that would receive, dehydrate, and compress natural gas into ISO containers, which would then be loaded onto trucks and driven a quarter mile to a berth at the Port of Palm Beach where the containers would be loaded onto a roll-on/roll-off ocean-going carrier); *Pivotal LNG, Inc.*, 148 FERC ¶ 61,164 (2014) (declining to assert jurisdiction over a facility in Trussville, Alabama that would receive natural gas from a local distribution company, liquefy the natural gas, and transport LNG by surface vehicles and eventually by waterborne vessels “within the contiguous 48 states”) (“*Pivotal P*”).

¹² *The Gas Company, LLC*, 142 FERC ¶ 61,036 at PP 14, 17 (2013) (holding that Pier 38 in Honolulu, Hawaii would not constitute a jurisdictional “LNG terminal” because LNG would be offloaded in ISO container tanks just as other standard freight containers are handled at the facility, which the Commission understood not to constitute “natural gas facilities,” and would not deliver regasified LNG into a pipeline at the pier facilities).

pipeline interconnections downstream of the relevant receiving facilities.¹³ Under this series of cases, a facility is an “LNG terminal” only if it meets all three prongs of the jurisdictional test described above by taking natural gas from or delivering regasified LNG into a pipeline, loading LNG into or unloading LNG from ocean-going, bulk-carrier LNG tankers, and consisting of natural gas facilities as commonly understood by the Commission and the regulated community.

The Facility would be non-jurisdictional because it does not have any pipeline interconnection and does not include any natural gas facilities. The Facility will receive LNG by truck and railcar—not by pipeline—from third-party sites and will load the LNG into ocean-going vessels without utilizing storage tanks. Therefore, as explained further below, the Commission should determine that the Facility is not subject to the Commission’s jurisdiction because it does not satisfy the first or third prongs of the Commission’s jurisdictional test.

1. The Facility does not satisfy the first prong of the Commission’s three-part test because it will not receive natural gas or deliver regasified LNG through a pipeline.

The Facility will receive LNG only by truck and railcar, not by pipeline. For the Commission to assert jurisdiction over an LNG import or export facility under Section 3 of the NGA, the facility “must be [] connected to a pipeline that delivers gas to or sends gas from the facility”¹⁴ The Commission has never authorized a facility under Section 3 to import or export “gas carried by truck, train, or waterborne vessel or authorized the site of, or construction and operation of, any complementary facility, such as a road, bridge, railway, or *stand-alone pier*, needed to import or export gas by a non-

¹³ See, e.g., *Shell*, 148 FERC ¶ 61,163 at P 43 (finding that the LNG facilities which would be used to transfer LNG imported from Canada was non-jurisdictional because there was no pipeline interconnection at the facility and no “natural gas facilities”).

¹⁴ *Pivotal II*, 151 FERC ¶ 61,006 at P 11.

pipeline mode of transportation.”¹⁵ All LNG will be delivered to and taken from the Facility by non-pipeline modes of transportation, namely truck, railcar, and waterborne vessel. Therefore, the Facility is not a jurisdictional LNG terminal under Section 3 of the NGA because it does not satisfy the first prong of the Commission’s jurisdictional test.

In *Shell*, the Commission considered the jurisdictional status of an intermediate docking and LNG storage facility in Detour, Michigan (the “Detour Facility”), which would be used to transfer LNG imported from Canada directly from one moored ship to another moored ship, or from ship to shore for storage and subsequent distribution by truck or train.¹⁶ The Commission held that the Detour Facility was not subject to the Commission’s jurisdiction.¹⁷

To support its determination, the Commission explained that the waterborne vessels, trucks, and trains that Shell would use at the Detour Facility are not “natural gas facilities” under the NGA definition of an LNG terminal.¹⁸ The Commission also held that there would be no pipeline interconnections at the Detour Facility to transfer or store imported LNG.¹⁹ Based on these findings, the Commission held that “none of the facilities Shell plans to use in LNG import operations will constitute an ‘LNG terminal’ subject to the Commission’s jurisdiction under [S]ection 3.”²⁰

The Facility is materially similar to Shell’s Detour Facility. LNG will be delivered to the Facility by non-pipeline means, *i.e.*, truck and railcar, and transferred for

¹⁵ *Emera*, 148 FERC ¶ 61,219 at n.16 (emphasis added); *see also Shell*, 148 FERC ¶ 61,163 at P 39 (explaining that the Commission has only granted Section 3 authorization to “coastal LNG facilities that are served by ocean-going, bulk-carrier LNG tankers” and “[e]ach of these facilities has also been connected to pipelines that deliver gas to or take gas away from the terminal”).

¹⁶ *Shell*, 148 FERC ¶ 61,163 at P 4.

¹⁷ *Id.* at P 51. The Commission also considered another facility proposed by Shell less comparable to the Facility here and similarly found it not to be jurisdictional.

¹⁸ *Id.* at P 43.

¹⁹ *Id.*

²⁰ *Id.*

export by non-pipeline means, *i.e.*, a waterborne vessel. There will be no pipeline interconnections at the Facility to transfer or store LNG. Accordingly, under *Shell* the Facility does not satisfy the first prong of the Commission's three-part test and, therefore, is not an LNG terminal subject to the Commission's jurisdiction under Section 3 of the NGA.

2. The Facility does not satisfy the third prong of the Commission's three-part test because it will not contain sufficient physical elements to constitute "natural gas facilities" comprising an LNG terminal.

The Commission does not need to reach a determination regarding whether the Facility contains sufficient physical elements to constitute natural gas facilities comprising an LNG terminal because the Facility will not receive natural gas nor deliver regasified LNG through a pipeline. However, even if the Commission were to continue its analysis, it is evident that the Facility does not satisfy the third prong of the jurisdictional test for three reasons.

First, under *The Gas Company*, the infrastructure at the Facility does not constitute "natural gas facilities." In *The Gas Company*, the Commission analyzed a proposed LNG terminal and found the facility to be non-jurisdictional under Section 3 because it did not include "natural gas facilities."²¹ In that case, The Gas Company proposed to import LNG via ISO containers at existing pier facilities in Honolulu, Hawaii which were already in use for "receiving, loading, and unloading containers filled with other [(non-LNG)] products."²² The Gas Company planned to use mobile regasification units to revaporize LNG from the ISO containers for injection into its pipeline distribution system or transport the LNG in the ISO containers by truck and/or barge to

²¹ *The Gas Company*, 142 FERC ¶ 61,036 at P 17.

²² *Id.* at PP 13, 14.

other points in Hawaii.²³ Although The Gas Company asserted that the proposed project constitutes a jurisdictional LNG terminal, the Commission disagreed.²⁴ The Commission held that the existing pier facilities which receive, load, and unload non-LNG containers cannot be jurisdictional because they are not “facilities [that] constitute ‘natural gas facilities’ as that term is used in the [S]ection 2(11) definition.”²⁵ The Commission then “concluded that the proposed project would not constitute an LNG terminal as contemplated by Congress.”²⁶

Here, the Facility is a multi-use, deep-water seaport and industrial logistics center. The proposed receipt of LNG by truck and railcar, and the transfer of LNG to waterborne vessels at the Facility, is only one piece of the larger operations at the Facility. The Facility is also capable of receiving, loading, and unloading LHG and non-LNG, bulk-cargo and containers, including ISO containers. Accordingly, the Facility would be similar to the existing pier facilities in *The Gas Company* that the Commission held to be non-jurisdictional because they did not constitute “natural gas facilities.” The Facility does not, therefore, constitute a jurisdictional LNG terminal.

Second, the waterborne vessels, trucks, and railcars that will transport LNG to and from the Facility do not constitute “natural gas facilities.” The Commission in *Shell* explained that Congress did “not seek to redefine the term ‘natural gas facilities’ as commonly understood for purposes of Commission jurisdiction,” which has historically applied only “over natural gas pipeline and storage facilities, including LNG facilities,

²³ *Id.* at P 13.

²⁴ *Id.*

²⁵ *Id.* at P 14. The Commission also held that the proposed operations would be non-jurisdictional because The Gas Company would be considered an exempt local distribution company under Section 1(b) or as an exempt Hinshaw company under Section 1(c). *See id.* at P 15.

²⁶ *Id.* at P 17.

that receive and/or send out gas by pipeline.”²⁷ The Commission then held that the waterborne vessels, trucks, and trains that Shell would use at the Detour Facility do not constitute “natural gas facilities” as commonly understood.²⁸ Accordingly, the waterborne vessels, trucks, and railcars used during operations of the Facility cannot, under *Shell*, constitute “natural gas facilities” for purposes of asserting Section 3 jurisdiction.

Third, the Facility does not include features or natural gas facilities that are common to each and every LNG terminal authorized under Section 3 of the NGA. To DRP’s knowledge, all existing Section 3 LNG terminals receive or send out only LNG. As explained above, the Facility is not an LNG-only operation. The Facility is also capable of receiving, loading, and unloading LHG, whether in liquid form or in bulk-cargo containers. The Facility can also handle non-hazardous break-bulk and other cargo, including roll-on/roll-off cargo.

All existing Commission-authorized LNG terminals also include onshore storage tanks. The storage capacities at Section 3-authorized LNG terminals range from 1.59 million cubic feet²⁹ to 14.6 billion cubic feet.³⁰ By contrast, the Facility will not include any liquefaction, regasification, or onshore LNG storage facilities. Accordingly, the Facility would be objectively distinguishable from every LNG terminal previously authorized by the Commission under Section 3 of the NGA.

In sum, the Facility will lack sufficient physical elements that constitute “natural gas facilities” as commonly understood by the Commission and the regulated community.

²⁷ *Shell*, 148 FERC ¶ 61,163 at P 43.

²⁸ *Id.*

²⁹ *Eagle LNG Partners Jacksonville LLC*, 168 FERC ¶ 61,181 at P 3 (2019) (authorizing an LNG terminal with on-site storage capacity of 45,000 cubic meters, an equivalent of 1.59 million cubic feet).

³⁰ *Dominion Cove Point LNG, LP*, 148 FERC ¶ 61,244 at P 5 (2014).

Other than minimal LNG transloading facilities, none of the infrastructure at the Facility nor the modes of transportation used in the LNG transloading operations constitute “natural gas facilities” as that term is used in the definition of an LNG terminal under Section 3 of the NGA. Accordingly, the Facility does not satisfy the third prong of the Commission’s jurisdictional test.

B. The Facility is not a link in the interstate transportation chain subject to the Commission’s NGA Section 7 jurisdiction.

The Commission should find that the Facility would not be subject to the Commission’s jurisdiction under NGA Section 7 because it will not be a link in the interstate transportation of natural gas by pipeline. The Commission has jurisdiction under Section 7 over the transportation, and the sale for resale, of natural gas in interstate commerce and the construction, acquisition, operation, and abandonment of facilities to transport natural gas in interstate commerce.³¹ The NGA defines “interstate commerce” as “commerce between any point in a State and any point outside thereof, or between points within the same State but through any place outside thereof, but only insofar as such commerce takes place within the United States.”³² The Commission has established a general rule that its Section 7 jurisdiction is limited to transportation of natural gas in its gaseous or liquefied state by pipeline only and that this “jurisdiction does not extend to deliveries of natural gas by truck, train, or barge.”³³

LNG leaving the Facility will largely be exported directly to foreign ports; however, DRP is contemplating certain transactions by which LNG could be delivered by waterborne vessel to domestic ports and transported to end-users. In such case, the LNG

³¹ 15 U.S.C. § 717f.

³² 15 U.S.C. § 717a(7).

³³ *Gulf Oil Limited Partnership*, 148 FERC ¶ 61,029 at P 8 (2014).

would be transported *directly* to domestic end users and absolutely none of the LNG transloaded at the Facility would ever be reintroduced into a domestic transportation pipeline. Accordingly, the Facility would not be subject to the Commission's jurisdiction over interstate pipeline facilities.

The Commission has long held that LNG facilities are not subject to Section 7 jurisdiction unless the LNG re-entered a downstream pipeline, such that the non-pipeline mode of transportation from the facility was a link in the transportation of natural gas in interstate commerce by pipeline. In *Air Products and Chemicals, Inc.*, a plant was liquefying methane to be used as fuel in trains and occasionally shipping this LNG by rail for use as vehicle fuel.³⁴ The Commission found that Air Products was not a "natural gas company" under NGA Section 1(b) and that the facilities were non-jurisdictional because they were not "an integral part of the interstate flow" of natural gas.³⁵ While the Commission had previously exercised jurisdiction over LNG facilities that facilitated trucking LNG to other states for reinjection into local distribution lines because those facilities facilitated the chain of interstate transportation, the Air Products facility transformed gas into an "end product" past the "ultimate destination" at the end of an interstate pipeline.³⁶ Similarly, in *Pivotal I*, the Commission declined to exercise Section 3 or Section 7 jurisdiction over a liquefaction facility where the resulting LNG would leave the facility and may be "transported by waterborne vessel to end users in a non-contiguous state or territory (*e.g.*, Hawaii or Puerto Rico)."³⁷ The Commission provided that "[i]nterstate pipelines are the only mode of transportation that Pivotal

³⁴ 58 FERC ¶ 61,199 (1992).

³⁵ *Id.* at p. 61,619.

³⁶ *Id.*

³⁷ *Pivotal I*, 148 FERC ¶ 61,164 at P 2.

specifically states will *not* be used to deliver the gas to the ultimate end users.”³⁸ The Commission explained that the facility would not be subject to its Section 7 jurisdiction because:

[T]he Commission has long-standing precedent finding that its [S]ection 7 jurisdiction does not extend to facilities used solely for the purpose of liquefying gas to transform it into an end product for sale and delivery in its liquid state to end users, with no intent for any of the LNG to be reintroduced into a pipeline.³⁹

In *Pivotal I*, the Commission further declined to assert jurisdiction over Pivotal’s facilities where “[i]t is possible . . . that there will be regasification of LNG for delivery into a [LDC’s] pipeline, in order to serve the LDC’s ‘peaking’ needs.”⁴⁰ The Commission explained that its “concern when presented with liquefaction facilities that will receive gas from a pipeline system and send out LNG by truck or another non-pipeline mode of transportation is whether failure to assert jurisdiction over the liquefaction facilities would allow circumvention of the Commission’s NGA jurisdiction over the interstate transportation of gas by pipeline.”⁴¹ The Commission concluded that, “[b]ased on Pivotal’s description of the planned LNG transactions,” which included the potential regasification of LNG for delivery into an LDC’s pipeline to serve the LDC’s peaking needs, “we find no reason to think any of them present the potential for circumvention of the Commission’s jurisdiction.”⁴² Here, there is potential that LNG transloaded at the facility onto a waterborne vessel could ultimately be regasified and delivered into an LDC pipeline to meet the LDC’s peaking needs. As in *Pivotal I*, the

³⁸ *Id.* at P 5 (emphasis original).

³⁹ *Id.* at P 16.

⁴⁰ *Pivotal I*, 148 FERC ¶ 61,164 at P 22-23.

⁴¹ *Id.* at P 23.

⁴² *Id.*

Commission should conclude that this potential activity does not create jurisdiction under Section 7.

Consistent with these prior findings, the Commission found that it would not have jurisdiction over a facility proposed by Shell (the “Geismar” facility) which would liquefy domestically-produced natural gas to be loaded from the existing dock at the plant to waterborne vessels that would transport LNG to (1) other waterborne vessels for use as fuel, or (2) onshore storage facilities, including facilities in other states, for subsequent transfer to waterborne vessels, trucks, or trains.⁴³ Shell stated to the Commission that “no gas will enter another pipeline system after leaving Shell’s facilities.”⁴⁴ The Commission held that “because Geismar will not liquefy gas in order for it to be transported to a downstream pipeline, but will do so to provide LNG as a product for delivery to end-use customers, Geismar will not be transporting gas in interstate commerce subject to the Commission’s [S]ection 7 jurisdiction.”⁴⁵ The Commission further explained that, “even when gas is delivered to a liquefaction facility by a jurisdictional interstate pipeline, when the purpose of liquefying the gas is to transform it into an ‘end product’ to be delivered by a non-pipeline mode of transportation to end users, the Commission has viewed the liquefaction facility as the ultimate destination for the pipeline transportation of the gas.”⁴⁶ The Commission found that its Section 7 determination was in line with Congressional intent because “the NGA was a ‘remedial statute’ enacted to eliminate abuses by interstate pipelines whose rates for interstate service were beyond state commissions’ control, and because the provisions of [S]ection 7 relating to transportation

⁴³ *Shell U.S. Gas & Power, LLC*, 148 FERC ¶ 61,163 (2014) (“*Shell*”).

⁴⁴ *Id.* at P 26.

⁴⁵ *Id.* at P 46.

⁴⁶ *Id.* at P 29 (internal citations omitted).

only contemplate transportation by pipeline.”⁴⁷ In fact, the Commission has concluded that revaporized LNG from a liquefaction facility in the Marcellus can be reinjected into local distribution company systems if the purpose of the facility is to sell gas in markets that can only be reached by truck rather than “a desire to circumvent” Section 7 jurisdiction.⁴⁸

Here, the Facility will not even have liquefaction capabilities. Rather, the Facility will be merely a conduit for the transportation of LNG by non-pipeline modes of transportation, *i.e.*, receipt by truck or railcar and delivery by waterborne vessel to foreign ports⁴⁹ or domestically to end-users.⁵⁰ Accordingly, the ultimate destination for the pipeline transportation of natural gas would be the liquefaction facilities located prior to the Facility in the transportation chain. The Commission’s Section 7 jurisdiction should terminate at that point. None of the LNG transloaded onto waterborne vessels at the Facility will enter a domestic transportation pipeline prior to consumption by an end-user. Under the long-established principles of Section 7 jurisdiction, then, the Facility would not be subject to the Commission’s Section 7 jurisdiction.

⁴⁷ *Id.* at P 25.

⁴⁸ *Gulf Oil Limited Partnership*, 148 FERC ¶ 61,029 at P 8.

⁴⁹ Exportation to foreign countries would not fit the definition of “interstate commerce” under the NGA. *Border Pipeline Co. v. FPC*, 171 F.2d 149 (D.C. Cir. 1948); *Distrigas Corp. v. FPC*, 495 F.2d 1057, 1065 (D.C. Cir. 1974), *cert denied*, 419 U.S. 834 (1974).

⁵⁰ The Commission has explained that the potential downstream regasification of LNG for delivery into an LDC’s pipeline to serve the LDC’s peaking needs does not confer Section 7 jurisdiction, *See Pivotal I* at P 22-23. *See also Shell* at P 29 n.51 (describing the “additional considerations” that would cause the Commission to “assert[] section 7 jurisdiction over the use of facilities to liquefy gas for transportation by waterborne vessel or truck to an LDC’s non-jurisdictional pipeline system”). None of the “additional considerations” identified by the Commission in *Shell* are present here.

C. Asserting jurisdiction over the Facility creates the potential for overly-expansive federal jurisdiction.

As the Commission’s website explains, there are more than 110 LNG facilities operating in the United States, but only 24 of them are FERC-jurisdictional.⁵¹ Even if the Facility is considered an LNG facility, which it should not be based on its lack of natural gas facilities, it would fall into the well-populated non-jurisdictional category. If the Commission finds that the Facility is a jurisdictional LNG terminal or Section 7 facility, it would result in a great expansion of the government’s regulatory scope. For example, every port in the United States that receives or sends out LNG in ISO containers would be exposed to potential federal jurisdiction under Section 3 of the NGA. Such a result would be an “absurd consequence” that courts have long held should be avoided.⁵²

D. The Facility is extensively regulated and will not exist within a regulatory gap.

The Commission has found that its lack of jurisdiction over a facility “does not mean that other federal, state, and local regulatory agencies lack the authority to impose environmental and safety conditions on the construction and operation of” natural gas facilities.⁵³ The Facility is extensively regulated at the federal and state levels and there is no “regulatory gap” that the Commission could seek to fill by extending its jurisdiction under Section 3 or Section 7 of the NGA outside of its historical contexts. If the Commission declines to assert jurisdiction over the Facility—as DRP respectfully requests the Commission so do—the Facility will remain subject to comprehensive environmental and safety regulation and therefore cannot fall into any regulatory gap.

⁵¹ “LNG,” FEDERAL ENERGY REGULATORY COMM’N (accessed July 14, 2020), <https://www.ferc.gov/industries-data/natural-gas/overview/lng>.

⁵² *See, e.g., U.S. v. Katz*, 271 U.S. 354, 357 (1926) (“All laws are to be given a sensible construction; and a literal application of a statute, which would lead to absurd consequences, should be avoided whenever a reasonable application can be given to it, consistent with the legislative purpose.”).

⁵³ *Emera*, 148 FERC ¶ 61,219 at P 16.

Indeed, a decision by the Commission to exercise jurisdiction over the Facility or the planned export of LNG by third parties via transloading from truck or railcar carrying LNG would not introduce any new permitting requirements that would govern the design, construction, or operation of the Facility.

As a preliminary matter, the U.S. Coast Guard has overseen the design, construction, and implementation of the marine cargo transfer systems under 33 C.F.R. Part 127, and will continue to do so during the operation of the Facility. Before issuing its Letter of Recommendation for the handling of LNG at Dock 1, the U.S. Coast Guard's review of the Facility was comprehensive and analyzed safety and security aspects of the waterway, as outlined in 33 CFR 127.007 and 127.009, including evaluation of the vessel traffic, shoreline residential demographics, climatic weather, identification of environmentally sensitive areas and critical industrial infrastructure, and detection of hazards to navigation. Before handling LNG at a second dock, DRP will work with U.S. Coast Guard to complete the necessary additional review.

The New Jersey Department of Environmental Protection ("NJDEP") also reviewed the project and provided the necessary permits for LNG to be handled at Dock 1 by use of a truck rack planned at the Facility. DRP will work with NJDEP in the event any additional infrastructure is required as well as if any other approvals are required.

A comprehensive regulatory regime already governs the Facility's construction and operation. This reality eliminates the risk of a "regulatory gap."⁵⁴ DRP will continue to coordinate with all agencies, as necessary, to comply with any other applicable environmental, engineering, and safety requirements contained within its permits and authorizations or that are otherwise applicable to the Facility.

⁵⁴ See *Emera*, 148 FERC ¶ 61,219 at PP 16-18.

E. FERC Staff provided guidance that the Facility would be non-jurisdictional.

It is DRP's understanding that New Fortress officials and their outside counsel met with FERC Staff on September 7, 2017, at the offices of the Commission in Washington, DC. At that meeting, New Fortress described to FERC Staff the proposed project at the Facility, including the truck and railcar operations. FERC Staff particularly noted that the as-described project would have no liquefaction, no storage, and no pipeline interconnection. FERC Staff told New Fortress that it believed the Facility would not be subject to the Commission's Section 3 jurisdiction under *Shell* and *The Gas Company*.

It is also DRP's understanding that New Fortress's outside counsel provided a copy of a memorandum summarizing the September 7 meeting to a Senior Attorney in the Office of General Counsel on January 5, 2018. That memorandum, prepared by New Fortress' outside counsel, included a list of attendees, a summary of the discussion, and FERC Staff's opinion that the Facility would be non-jurisdictional. No concern was expressed about the jurisdictional status of the Facility. Please see Attachment A for a copy of the memorandum provided to FERC Staff. It appears that FERC Staff's belief that the Facility would be non-jurisdictional has not changed since then. In a response dated June 27, 2019, to the DRN's FOIA request regarding the Facility, FERC Staff stated that the Facility "is a Hybrid LNG project that is not under FERC's jurisdiction."⁵⁵

New Fortress personnel informed FERC Staff at the September 7 meeting that DRP did not intend to file a petition for declaratory order unless the structure of the

⁵⁵ "Delaware Riverkeeper Network Wins Information Act Appeal Against the Federal Energy Regulatory Commission" at 4 (Aug. 8, 2019), <https://www.delawareriverkeeper.org/sites/default/files/PR%20FERC%20FOIA%20victory%20plus%20decision%20%282019-08-08%29.pdf> (emphasis added).

project or Commission policy changed in such a way to move the project outside the clear bounds of then-current Commission policy and precedent regarding its jurisdiction over LNG facilities. The structure of the project has not changed since that meeting, nor has the Commission's policy and precedent regarding its jurisdiction over LNG facilities. However, based on the Commission's Show Cause Order related to a facility that FERC Staff also believed would be non-jurisdictional and previously conveyed such belief to New Fortress,⁵⁶ DRP now seeks assurance from the Commission that the Facility would indeed be non-jurisdictional.

**V.
REQUEST FOR EXPEDITED ACTION**

DRP respectfully requests that the Commission act on this Petition and provide the relief sought on an expedited basis but no later than October 30, 2020, thereby providing regulatory certainty for DRP's financing counterparties, stakeholders, and customers.

⁵⁶ See Answer of New Fortress Energy LLC at 41-44, Docket No. CP20-466-000, Accession No. 20200720-5156 (filed July 20, 2020).

**VI.
CONCLUSION**

For the reasons set forth herein, DRP respectfully requests that the Commission issue a declaratory order stating that the Facility would not be subject to the Commission's jurisdiction under Section 3 or Section 7 of the NGA. DRP respectfully requests that the Commission issue the aforementioned declaratory order in an expedited manner.

Respectfully submitted,

/s/ Kenneth G. Charron _____

Kenneth G. Charron
Vice President of Law
Delaware River Partners LLC
200 N. Repauno Ave.
Gibbstown, New Jersey 08027
Phone: (856) 224-7041
Email: kcharron@repauno.com

A. Gregory Junge
Hogan Lovells US LLP
555 Thirteenth Street, NW
Washington, DC 20004
Phone: (202) 637-6642
Email: greg.junge@hovanlovells.com

Counsel for Delaware River Partners LLC

September 11, 2020

Attachment A

Vinson&Elkins

Memorandum

Christopher J. Terhune cterhune@velaw.com
Tel +1.202.639.6629

Date: September 7, 2017
To: Britt Rogers
From: Anita R. Wilson
Christopher J. Terhune
Re: Repauno Port – Meeting with FERC Staff

On September 7, 2017, Britt Rogers, Anita Wilson, and Chris Terhune met with various members of the staff of the Federal Energy Regulatory Commission (“FERC”) to discuss the Repauno Port project and whether the project would be subject to FERC’s jurisdiction under the Natural Gas Act. This memorandum summarizes the discussion at that meeting.

FERC Staff Attendees: Rich McGuire (Director of Gas Environment and Engineering within the Office of Energy Projects (“OEP”)), Andrew Kohout (Chief of LNG Branch 1 within Gas Environment and Engineering), Hugh Thomas (Chief of LNG Branch 2 within Gas Environment and Engineering), Pamela Boudreau (Acting Director of the Division of Pipeline Certificates within OEP), Richard Foley (Chief of Certificate Branch 1 within the Division of Pipeline Certificates), Marsha Palazzi (Chief of Certificate Branch 2 within the Division of Pipeline Certificates), Gordon Wagner (Senior Attorney in the Office of General Counsel), and Cyrus Zarraby (Attorney Advisor in the Office of General Counsel).

Summary: Mr. Rogers introduced Fortress Transportation and Infrastructure Partners (“FTIP”) and its various port assets. He then described the Repauno Port project and the activities FTIP may undertake there, including potential transloading of ethane, butane, liquid petroleum gas, and LNG. Mr. Rogers noted that the facility would receive trucks or trains carrying LNG (and have no pipeline connections), then load that LNG onto waterborne vessels. Mr. Rogers also noted that FTIP was working with the New Jersey Department of Environmental Protection and the U.S. Coast Guard on permitting for the port. Mr. Rogers explained that FTIP’s outside counsel (Vinson & Elkins) had determined the project would be non-jurisdictional but FTIP wanted confirmation of this analysis from FERC Staff prior to making a large capital investment or representations to customers.

Gordon Wagner, the most senior lawyer in the room from FERC, agreed that the Repauno Port would be non-jurisdictional as described. He specifically pointed to two FERC orders – *The Gas Company, LLC* and *Shell U.S. Gas & Power, LLC* – as supporting this conclusion, which was consistent with the Vinson & Elkins analysis. FERC Staff noted that (1) they were speaking about the policy as it

V&E Memo

Britt Rogers September 7, 2017 Page 2

currently exists and that policy can change in the future and (2) the only way to obtain certainty is to seek a Declaratory Order from FERC that the port is non-jurisdictional.

FERC Staff noted that, if gas from a pipeline was used to make LNG, that LNG was loaded at the Repauno Port, then the LNG was later regasified and injected back into a pipeline system in the U.S., the facility could become subject to FERC's jurisdiction under Section 7 of the Natural Gas Act as a link in an interstate pipeline chain. The potential introduction of liquefaction at the port was another wrinkle that Staff suggested could give rise to jurisdiction.

FERC Staff noted that, under the current proposal, the port would have no liquefaction, no storage, and no pipeline interconnection. Changing one or more those factors would make the port look more and more like an "LNG terminal" that would be subject to FERC's jurisdiction under Section 3 of the Natural Gas Act. Staff confirmed, however, that the current proposal, which does not have liquefaction, storage, or a pipeline interconnection, was non-jurisdictional under current FERC policy and recent caselaw. FERC Staff also affirmed that the port would remain non-jurisdictional in a hypothetical where gas went through a pipeline to a liquefaction facility away from the port, then was transported by truck or rail to the port and loaded onto a ship for export.

Mr. Rogers informed FERC that, based on this discussion, FTIP did not intend to file a Petition for Declaratory Order or consult FERC further unless the structure of the Repauno Port or FERC policy changed in such a way as to move the project outside the clear bounds of then-current FERC policy and precedent regarding its jurisdiction over LNG facilities.

Document Content(s)

Gibbstown Petition for Declaratory Order.PDF.....1

Exhibit C

August 21, 2017

BEFORE THE
DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
HAZARDOUS MATERIALS SAFETY
APPLICATION
FOR A SPECIAL PERMIT, TO
TRANSPORT METHANE, REFRIGERATED LIQUID IN
DOT 113 TANK CARS

Table of Contents

1. Effective Date of the Permit3

2. Name of Applicant and Contact Information3

3. Ranking Officer3

4. DUNS #3

5. Physical addresses associated with the permits3

6. Applicant registration number3

7. Is confidential treatment requested? (must comply with §105.30(a))3

8. Cite specific regulation from which applicant seeks relief.....3

9. Mode/proposed mode of transportation, including operational controls (if required)3

10. A detailed description of the proposed special permit including as appropriate, written descriptions, drawings, flow charts, plans and other supporting documents4

11. Proposed duration or schedule of events for which the special permit is sought5

12. A statement outlining the basis for seeking relief from compliance5

13. If permit is for a fixed period, how will compliance be achieved at the end of that period?7

14. Identification and description, including an estimated quantity of each shipment (PSN, UN Number, Hazard Class, Packing Group)7

15. Description of each packaging, specification, standard or special permit number, as applicable, to be used in conjunction with the requested special permit7

16. Estimated number of operations or number of shipments to be transported under the special permit.....7

17. A statement as to whether the special permit sought is related to a compliance review, inspection activity, or enforcement action.....7

18. Statement indicating whether the applicant will act as shipper, carrier, or both7

19. Justification of special permit proposal.....7

20. Provide shipping experience and incident experience.....10

21. Statement identifying any increased safety/property risk if permit is granted; description of the risk mitigating factors.....10

22. Show the proposed alternative will achieve required safety level with analysis, test results, identification of hazard.....10

23. If regulations don't establish a safety level, show potential failure mode, probability of failure and risk mitigation.....10

1. **Effective Date of the Permit:** December 31, 2017 (application must be submitted at least 120 days before effective date)
2. **Name of Applicant and Contact Information:** Energy Transport Solutions LLC, 8350 NW 52nd Terrace, Suite 300, Doral, FL 33166

Name: Chris Guinta

E-mail and Phone: ETS Redacted

3. **Ranking Officer:** Chris Guinta, Chief Financial Officer
4. **DUNS #:** [●]
5. **Physical addresses associated with the permits:** Applicant requests authorization to transport liquefied natural gas (LNG) in DOT 113C120W and DOT 113C140W tank cars (as further described below) within the following regions of the United States:

From:	To:
ETS Redacted	

6. **Applicant registration number:** [●]
7. **Is confidential treatment requested? (must comply with §105.30(a))** Yes. Some portions of the application will address matters that the company considers to be confidential as they consist of the company’s know-how regarding the market for its products and the management of shipping and logistical considerations to meet operational and demand commitments.
8. **Cite specific regulation from which applicant seeks relief:** Applicant does not seek relief from a specific prohibition but instead asks PHMSA to expand an existing authorization to materials that are very similar in all important respects to the transportation by rail of other materials. Specifically, Applicant requests to transport methane, which is a refrigerated liquid, by rail. Methane in a cryogenic form is otherwise known as LNG, UN-1972, Packing Group 2.1. LNG is currently authorized for transport by road and ocean carriers but is not included on the list of commodities authorized for transport by rail in tank cars, which is entirely due to the historical lack of interest in transporting LNG by rail. See 49 C.F.R. §§ 172.101; 173.319.
9. **Mode/proposed mode of transportation, including operational controls (if required):** Applicant requests to move LNG by rail in DOT 113C120W and DOT 113C140W tank cars. Operational controls over the movement of LNG will be determined by choosing among the operating practices of the transporting railroads for other cryogenic materials as well as other materials that also present transportation risks when moved by rail or by truck. These requirements will include those applicable provisions of 49 C.F.R. Parts 172, 173 and 174, including § 173.319, which is applicable to the transport of cryogenic liquids in tank cars, and § 174.310, which sets forth operational requirements for High Hazard Flammable Trains (HHFT). The operational controls cited for the transport of HHFT provide a strong operational framework for safe and responsible movement of large quantities of hazardous materials.

Specifically, Applicant proposes to apply these operational controls to LNG trains that consist of 20 or more tank cars in a continuous block on a single train or 35 or more tank cars across an entire train. Applicant

proposes that the railroads transporting the LNG in unit trains conduct a routing analysis of the rail routes consistent with the 27 safety and security factors prescribed in 49 C.F.R. § 172.820 and that State and Regional Fusion Centers have access to schedules and routing for these trains. Applicant further proposes travel restrictions including that unit trains transporting LNG must not exceed 50 MPH. These procedures have been used and proven to be effective in the shipment of other potentially dangerous goods by rail such as those presenting toxic inhalation hazards.

Applicant's DOT 113 tank cars will be equipped with telemetry contemporaneously monitoring the pressure and volume of LNG in each tank car. This information will provide real time insight to aid in the safe transport of LNG. Applicant also proposes that unit trains carrying LNG be equipped with end of train devices or distributed power braking.

As the shipper, Applicant will coordinate with the transporting railroad to focus efforts on prevention of rail incidents or in the case of an occurrence to mitigate and respond. Class I railroads are required to have emergency response plans sufficient to meet the needs of scenarios involving the collision, derailment or equipment malfunctions of trains carrying LNG. These plans generally include the support of environmental emergency responders and heavy equipment contractors. Applicant will review plans of transporting railroads to ensure their plans include equipment unique to the requirements of responding to any such events involving LNG.

Applicant will work with Class II and short-line railroads to ensure their plans and equipment are suited to responding to and mitigating the effects of a release of LNG during collisions or derailments during rail transit. Applicant will also coordinate with transporting railroads to provide familiarization, training, and coordination with first responders along the routes LNG will be transported.

10. [A detailed description of the proposed special permit including as appropriate, written descriptions, drawings, flow charts, plans and other supporting documents:](#) The special permit would authorize Applicant to transport LNG in DOT 113C120W and DOT 113C140W tank cars filled to densities comparable to the maximum filling densities for cargo tanks containing LNG as expressed in 49 C.F.R. § 173.318(f)(3). These are the tank car specifications recommended by the American Association of Railroads (AAR) in their petition submitted for rulemaking to allow methane, refrigerated liquid to be transported by rail in tank cars. Applicant submits that rail transportation is the safest and most efficient mode of transport for moving LNG to ports or domestic customers. Applicant has engaged with the AAR and the Federal Railroad Administration (FRA) on transporting LNG by rail. The AAR supports Applicant's request and the FRA is anticipating this special permit submission.

Applicant will retain an internationally recognized firm to assist in identifying and quantifying the risks associated with train shipments of LNG and will evaluate these risks in light of the protections and measures to address the risks from the transportation by rail and other transportation modalities of other hazardous materials. This risk assessment will be submitted as an addendum to this permit application. The assessment will focus on the risks of operating unit trains of LNG, comparing these risks to other forms of rail and road transportation that have already been approved and evaluating the extent to which similar mitigation measures can be relied on to address the similar but less likely risks associated with transporting LNG. The risk assessment will examine probability of derailment and other events across Class I, II and III rail, loss of containment probability in the event of any such event and risk related to population densities along various rail routes. The risk assessment will be based on anticipated train speeds, the number of cars anticipated on each train, the frequency of shipments, length of route and population along the route.

11. **Proposed duration or schedule of events for which the special permit is sought:** This opportunity will require the Applicant to incur significant capital investments in specialized cryogenic transport equipment. Due to the long lead times and industrial mobilization associated with acquiring specialized cryogenic assets (either rail cars or LNG road tankers) Applicant requests a decision from PHMSA on the issuance of this special permit no later than December 31, 2017. Applicant requests that this special permit be granted for the full two-year period authorized by statute for new special permits, which should be ample time to allow a broader rulemaking to allow transportation of LNG by rail on a nationwide basis through rulemaking under the Administrative Procedures Act.
12. **A statement outlining the basis for seeking relief from compliance:** Applicant asks PHMSA to grant this special permit simply to put LNG on equal footing with other cryogenic materials that can be transported by truck and rail while LNG can be transported only by truck. A recognition by PHMSA that the risks associated with transporting LNG by rail are not materially different than those associated with transporting currently authorized cryogenic materials, or other hazardous materials such as carbon dioxide and hydrogen chloride, by rail would allow Applicant to pursue a real commercial opportunity that offers growth and jobs in the energy industry that can be realized only through the approval of a special permit. Had the technology leaps realized by the energy industry been made when PHMSA was considering whether to authorize the transportation by rail of these other cryogenic materials, there would have been a market for the transportation of LNG that would have led to permission being sought and granted for shipment at that time.

The “fracking” revolution has made natural gas available in significant quantities in locations such as the Marcellus and Bakken, regions not previously associated with the oil and gas industry. The availability of oil and natural gas has made American energy independence a reality and has made U.S. export of LNG commercially viable. In addition to freedom from dependence on foreign gas and oil, fracking promises an opportunity to replace less desirable energy options, such as coal, with cleaner burning natural gas for power generation and transportation fuels.

The United States is expected to become, for the first time, an exporter of natural gas. U.S. natural gas exports are anticipated to reduce energy costs to parts of the world currently without energy or those dependent on more expensive fuels that are environmentally damaging, such as heavy fuel oils. As made evident in President Trump’s recent European trip, the export of U.S. natural gas has positive geopolitical implications.

A welcome byproduct of an increase in both domestic and international natural gas production and consumption will be U.S. energy sector jobs. New job creation can be expected to offset jobs lost to industries hurt by fracking, most particularly jobs in coal.

The biggest challenge in leveraging the abundance of natural gas is transporting the gas from remote fields to traditional infrastructure where the consumers are or where they can get access. Pipelines are slow to build and right of way acquisition can take several years. The only viable alternatives to move natural gas in commercially significant quantities are by rail and over-the-road transportation. To transport outside of a pipeline, natural gas must first be liquefied, reducing its volume at ambient pressures by a ratio of 600 to 1. In fact, the only reason to liquefy natural gas is to “package” it safely and effectively for transportation.

Rail transportation in either unit train or part of manifest freight is the safest, most effective, and efficient mode of transport when compared to over the road transportation. The risk assessment Applicant is contracting with an internationally recognized firm to produce will quantify risk according to all accepted measures, but PHMSA data shows rail transport experiences only 12% of the accidents involving hazardous materials compared to road transportations for quantities closely balanced by volume across both modes of

transport.¹ DOT data additionally shows rail transport experiences only 11% of the fatalities as large trucks per trillion miles.² Rail cars are not weight constrained, locomotives and trains are highly fuel efficient, and trains do not compete for space on busy roads and highways. Rail transportation of LNG will leverage private infrastructure of the railroads. Rail infrastructure in many cases is underutilized.

PHMSA has already correctly concluded that commodities that present far more substantial dangers than LNG can be safely transported by rail and the agency's and industry's experience with implementing these programs afford PHMSA a reasoned basis to reach a similar conclusion with respect to LNG. When comparing the properties of LNG to the properties of other commodities currently authorized for transport by rail, there is no scientific or practical reason for LNG to be precluded from rail transport. LNG is currently missing from the list of commodities authorized for rail transportation simply due to the historical lack of interest in transporting LNG by rail. LNG is similar in all relevant properties to other hazardous materials currently authorized to be transported by rail in DOT 113 tank cars.

PHMSA's regulations authorize the rail transport of cryogenic liquids with similar properties. As one example, ethylene, another liquid, has been safely transported in tank cars for 50 years. The differences between ethylene and LNG are not material from a risk standpoint, and in some cases, LNG is more stable. LNG has a normal boiling point of -260°F, ethylene -160°F. LNG weighs ~3.6 lbs./gal., ethylene 4.7 lbs./gal. Both ethylene and LNG are lighter than air at ambient temperatures and thus any spilled or vented liquid or gas disperses in the air as soon as it warms up to ambient temperature. Indeed, ethylene poses equal or greater reactive risk than LNG. Ethylene has an upper and lower fuel-air flammability percentage between 2%-36% whereas LNG will burn only when mixtures are between 5%-15%. Because of the similarity in these two materials, the regulatory requirements governing the transportation of ethylene will also address risks of transporting LNG. From available record keeping on the frequency of events, the AAR concludes railroads transport cryogenic liquids very safely.

Transportation by rail is undeniably safer than over-the-road transportation, and transportation of LNG via rail should be facilitated. Both modalities have a place in the market but LNG by rail will afford a safer, more manageable method getting natural gas from the production fields to consumers on a large scale. The reason the hazardous materials regulations do not currently authorize the transportation of LNG by rail is simply due to the lack of demand for rail transport of LNG when PHMSA authorized DOT 113 tank cars for the transportation of cryogenic liquids and listed the cryogenic liquids that could be transported in those cars. There was no determination that rail was an unsuitable mode of transporting LNG.

13. **If permit is for a fixed period, how will compliance be achieved at the end of that period?:** Compliance will be achieved if the authority Applicant seeks in the special permit is superseded by amendment to 49 C.F.R. to list LNG as an authorized commodity to be transported by rail.
14. **Identification and description, including an estimated quantity of each shipment (PSN, UN Number, Hazard Class, Packing Group):** Applicant will transport unit train quantities (50-100 cars per day) of UN-1972 Methane, Refrigerated Liquid, packing group 2.1.
15. **Description of each packaging, specification, standard or special permit number, as applicable, to be used in conjunction with the requested special permit:** LNG will be packaged in DOT 113C120W and DOT 113C140

¹ Pipeline & Hazardous Materials Safety Administration, Hazardous Materials Incidents By Year & Mode, for 2006 through 2015, as of 7/20/2016, at <https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?Dashboard>.

² USDOT FMCSA Analysis Division, Large Truck and Bus Crash Facts, 2012, Table 4, available at <http://www.fmcsa.dot.gov/safety/data-and-statistics/large-truck-and-bus-crash-facts-2012-pdf>.

rail cars. DOT 113 railcars are double walled cryogenic tank cars authorized by PHMSA for the transport of other cryogenics such as ethylene and hydrogen. These cars will be filled to maximum densities specified for cargo tanks containing LNG in 49 C.F. R. 173.318(f)(3). DOT 113C120W will be equipped with pressure relief valves that will contain the LNG for 40 days in transportation before venting. DOT 113C140W cars will contain LNG for 45 days in transportation before venting.

Unlike crude oil, LNG has the advantage of being highly consistent in material composition and stable, reducing risk associated with crude oil transport from unidentified volatile components.

LNG is a cryogen and the proposed DOT 113 tank cars recommended for the transport of LNG are thus double walled. The containers have a stainless steel inner tank and the tank is wrapped in “super insulation” and suspended inside a carbon steel outer tank. This design makes the DOT 113 tank cars much more robust than the single wall cars authorized to transport more hazardous crude oil and other flammable liquid products. Puncturing the outer wall of a DOT 113 car will result in a loss of vacuum in the annular space between the tanks but will not in and of itself result in a spill.

16. **Estimated number of operations or number of shipments to be transported under the special permit:** Applicant anticipates operating two unit trains a day.
17. **A statement as to whether the special permit sought is related to a compliance review, inspection activity, or enforcement action:** This special permit is not related to a compliance review, inspection activity or enforcement action. Applicant notes that the AAR has submitted a “Petition for Rulemaking to Allow Methane, Refrigerated Liquid to be Transported in Rail Tank Cars” to update the applicable regulations to allow the activities requested in this special permit.
18. **Statement indicating whether the applicant will act as shipper, carrier, or both.** The applicant will act as the shipper.
19. **Justification of special permit proposal.** Demonstrate the permit achieves a level of safety at least equal to that required by regulation, or is consistent with public interest. The permit would meet this standard because it would simply put LNG on an equal regulatory footing with other cryogenic materials and other hazardous materials that PHMSA allows to be shipped on rail and on truck. Any shipments of LNG by rail would be subject to the same requirements and same mitigation measures as these other materials. Because the domestic sources for natural gas were so much more constrained when PHMSA approved the shipment by rail of these other materials including some cryogenic materials, neither PHMSA nor industry conceived of the circumstances that now exist in the Marcellus Shale and Williston Basin with respect to the production of natural gas and various market opportunities. Allowing these shipments will further integrate natural gas into the U.S. economy by making it more available for power, transportation, marine, aviation and even industrial applications.

In order to ensure that these approvals are properly conceived and applied, Applicant is contracting with an engineering, safety and risk assessment company to conduct a quantitative risk assessment of transporting LNG in DOT 113C120 and 140W rail tank cars in unit trains. When the report of this assessment is complete, it will be provided as an update to this special permit application. Applicant anticipates this report will both (i) demonstrate via analyses, data, and/or test results that issuance of the special permit achieves a level of safety at least equal to that required by regulation and (ii) identify each hazard, potential failure mode and the probability of its occurrence and describe how the risks associated with each are controlled for the duration of the proposed activity as well as the life-cycle of the DOT 113C120 and 140W rail tank cars.

Preliminarily, Applicant notes that LNG is similar in all relevant properties to other hazardous materials currently authorized for transport by rail. It is important to note as well, LNG has been authorized for transport in DOT 113 tank cars by Transport Canada.

LNG is simply natural gas that has been refined to remove water, carbon dioxide, along with hydrocarbons other than methane and then cooled to -260°F where methane, the predominant component of natural gas, transitions from a vapor to a liquid state. LNG is colorless and odorless. Mercaptan, an odorant added to natural gas in pipelines and present when natural gas is made into compressed natural gas (CNG), has a higher freezing point than methane and is removed as natural gas is liquefied.

LNG, or natural gas in its liquid form, will not burn, as natural gas burns only in its vapor state. Natural gas has a high ignition temperature (over 1,000°F) relative to other hydrocarbon fuels, such as diesel (which has an ignition temperature of 500°F). This makes natural gas relatively difficult to ignite. LNG is neither corrosive nor toxic. If LNG spills, it will rise and disperse rapidly as it warms, returning to its vapor form, leaving behind no residues. Natural gas vapor is lighter than air and when released, will rapidly rise into the atmosphere, and disperse. There are no soil remediation requirements after an LNG spill on the ground and LNG will not harm the marine environment. LNG floats on the surface of water as the LNG warms and returns to vapor.

Natural gas vapor has slow flame propagation speed relative to other hydrocarbon fuels. When ignited, natural gas burns from the ignition point back to the source of the fuel. Uncontained natural gas vapors will not explode and contained natural gas vapor will burn and explode only if concentrated in the range of the flammable fuel to air mixture of between 5-15%.

Natural gas and LNG are hazardous and must be handled deliberately in approved containers while following all applicable regulations regarding safe handling and operation. Natural gas is a hydrocarbon, which when burned releases a tremendous amount of energy. LNG is a cryogenic material with the associated hazards of all cryogenics. Natural gas can be handled safely. The properties of natural gas make it less hazardous than other materials and hydrocarbons moving every day on the nation's rail lines.

ETS Redacted Other options for transportation have been considered and are possible, but transportation by rail is the safest and most practical method of transport. **ETS Redacted**

Transportation by truck would be less safe and less practical than rail, as illustrated further below.

Transportation via tanker truck by road would entail close to three times the number of trucks circulating across the nation's highways than moving the same volumes of LNG by rail. Trucks transporting LNG would be loaded to the maximum allowable weight and would be moving intermingled with other commercial and civil traffic on the nation's highways. While the use of individual trucks could reduce the quantity of LNG at any one location at any given time, the movement of the anticipated quantities of LNG would likely increase congestion.

Data provided by the AAR shows trains on average are four times more fuel efficient than trucks.³ Railroads can move one ton of freight an average of 468 miles per gallon of fuel.⁴ Large volumes of LNG transported over the road would translate into hundreds of additional trucks on the highways, potentially contributing to gridlock and other adverse outcomes. For transport efficiency, rail has a clear advantage for transporting LNG, and transport by rail leverages existing rail infrastructure. Fuel consumption and emissions are directly related, meaning that transporting LNG by rail would reduce potential emissions by 75% compared with the expected emissions by trucks.⁵

PHMSA's experience regulating other materials and commodities already authorized for rail transport provide substantial expertise and experience to guide the regulation of rail transport of LNG. In fact, PHMSA has authorized the transport by rail of other hazardous cryogenic liquids such as hydrogen chloride. This experience has allowed PHMSA to develop expertise in addressing the consequences of an accidental release of hydrogen chloride, which would have far greater consequences than release of similar amount of LNG. Likewise, oxygen and hydrogen, both refrigerated liquids, are also authorized for rail transportation in DOT 113 tank cars. Hydrogen has a boiling point of -423°F and oxygen has a boiling point of -297°F. Both are potentially more dangerous than LNG to ship because of their low boiling points. The activities to be authorized by this permit and the associated risks are well within the experience and expertise of PHMSA to address under its existing programs.

The authorization of this permit is consistent with the public interest. Fracking has made available unprecedented quantities of natural gas in the United States. The price of natural gas has fallen to the point where it is not economically viable for pipeline operators to build the infrastructure to transport the natural gas from fields in areas like the Marcellus region. Additionally, the ability to build pipelines faces challenges due to difficulty in right of way acquisition and permitting time. These factors have resulted in stranded natural gas.

Applicant's request will leverage existing rail infrastructure to transport LNG safely between natural gas liquefaction plants and terminals. This activity will create jobs along the entire length of the transportation chain, add to the tax bases of the different states and cities where these activities will occur and help further the goal of energy independence for the United States and North America. Bringing additional amounts of LNG to market will also benefit the environment as cleaner burning natural gas displaces more carbon intensive fossil fuels in power, transportation, aviation and marine settings.

Moving LNG by rail minimizes the direct impact to U.S. taxpayers burdened by supporting the nation's transportation infrastructure. The maintenance of rail lines is the direct responsibility of owning the railroad. The cost of maintaining roads, more quickly degraded by heavy class 8 trucks transporting LNG, will be partially borne by the taxpayer should the permit not be authorized.

Finally, transporting LNG by rail as authorized by this special permit would result in an increase in U.S. exports. Gas from the U.S. can compete with gas from foreign locations such as Trinidad and Tobago, Nigeria and Qatar. U.S. natural gas can also bring lower cost and reliable power to locations currently relying upon outdated and expensive power facilities fired by less environmentally friendly fossil fuels such as diesel and heavy fuel oil. It is in the best interest of the public for PHMSA to authorize this special permit in

³ AAR, The Environmental Benefits of Moving Freight by Rail (June 2017), <https://www.aar.org/BackgroundPapers/Environmental%20Benefits%20of%20Moving%20Freight%20by%20Rail.pdf>.

⁴ Id.

⁵ Id.

parallel with acting to amend 49 C.F.R. to permanently allow the shipment of LNG by rail, as AAR has requested in its petition.

20. Provide shipping experience and incident experience. **ETS Redacted**



21. Statement identifying any increased safety/property risk if permit is granted; description of the risk mitigating factors. Applicant is contracting with an engineering, safety and risk assessment company to conduct a quantitative risk assessment of transporting LNG in DOT 113C120 and 140W rail tank cars in unit trains, which will be provided as an update to this special permit application upon completion. Applicant anticipates this this report will both (i) demonstrate via analyses, data, and/or test results that issuance of the special permit achieves a level of safety at least equal to that required by regulation and (ii) identify each hazard, potential failure mode and the probability of its occurrence and describe how the risks associated with each mode are controlled for the duration of the proposed activity as well as the life-cycle of the DOT 113C120 and 140W rail tank cars.

Applicant recognizes current regulations for the rail transport of hazardous materials require risk mitigation plans. Applicant will review these plans with transporting railroads for situational awareness and to facilitate coordination. Elements of these plans will include train scheduling, incident response planning, active monitoring of rail car locations and pressures. Other possible risk mitigating factors will include actions to be taken by the carrier such as train speed, track inspections, track and rail car condition monitoring (such as hot bearing detectors along the route) and other actions consistent with safe management of train operations.

22. Show the proposed alternative will achieve required safety level with analysis, test results, identification of hazard. Applicant is contracting with an engineering, safety and risk assessment company to conduct a quantitative risk assessment of transporting LNG in DOT 113C120 and 140W rail tank cars in unit trains, which will be provided as an update to this special permit application upon completion. Applicant anticipates this this report will demonstrate via analyses, data, and/or test results that issuance of the special permit achieves a level of safety at least equal to that required by regulation.

23. If regulations don't establish a safety level, show potential failure mode, probability of failure and risk mitigation. The quantitative risk assessment that will be submitted as an update to this special permit application as described above will also identify each hazard, potential failure mode and the probability of its occurrence and describe how the risks associated with each are controlled for the duration of the proposed activity as well as the life-cycle of the DOT 113C120 and 140W rail tank cars.

Exhibit D



August 26, 2016

Submitted electronically and by mail

New Jersey Department of Environmental Protection
Division of Land Use Regulation
P.O. Box 420, Code 501-02A
Trenton, New Jersey 08625
Attn: Greenwich Township Supervisor

Re: File # 0807-16-0001.2, Application submitted by Delaware River partners, LLC re. Property at: 200 N. Repauno Avenue, Block 8; Lots 1, 2, 3, 4, 4.01 and 4.01, Greenwich Township, Gloucester County, NJ

Delaware Riverkeeper Network submits these comments on the flood hazard area individual permit, the individual waterfront development permit, and a coastal wetlands permit for the project referenced above and described in the letter we received from Gibbons Law, Shawn M. LaTourette, attorney for the applicant dated August 1, 2016 (copy attached).

Ms. Suzanne Dietrick, New Jersey Department of Environmental Protection (NJDEP) Case Manager, Land Use Management, informed Delaware Riverkeeper Network that the applications are still under administrative review and that an administrative deficiency letter would be issued this week, keeping the file open for public comment. This comment letter is submitted as an interim step in Delaware Riverkeeper Network's review and analysis of the permit applications for this project.

Delaware Riverkeeper Network submitted two letters to Ms. Suzanne Dietrick and additional emails documenting the files, documents, plans and maps that are missing from the Greenwich Township Municipal Building and seeking guidance about the comment period. Delaware Riverkeeper Network also submitted a letter on August 8 requesting an extension of the public comment period on the above referenced permits and a public hearing on the applications.

Delaware Riverkeeper Network conducted a review of the documents regarding the permit applications available at the municipal building on August 8 and scanned all documents in the file. There were several important documents missing that are needed by our experts whom we have engaged to review the permit applications.

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
drm@delawariverkeeper.org
www.delawariverkeeper.org

We submitted a letter dated August 15, 2016 (copy attached) and an email dated August 24, 2016 to Ms. Suzanne Dietrick detailing the documents that our consultants require but are not available at the municipal building. Our consultants could not conduct a review or prepare an analysis or comments on the applications for the flood hazard area individual permit, the individual waterfront development permit, and a coastal wetlands permit because the required documents were not available. Ms. Dietrick arranged for the applicant's attorney to provide Delaware Riverkeeper Network with documents regarding the permit applications referenced above and access was received on August 25. The files have been transferred to the two consulting firms that Delaware Riverkeeper Network has retained to conduct expert reviews and we will be filing comment on the three permit applications utilizing these files once they have been able to complete the reviews. We will inform Ms. Dietrick if any necessary documents are still missing.

We do not know if the applicant's files are now available at the Greenwich Township Municipal Building but we have spoken with residents who have attempted to review the files, but have not been able to get all the documents needed as recently as Wednesday, August 24. Delaware Riverkeeper Network considers it of utmost importance that the public have access to all documents at the municipal building so that all members of the public can participate in the review and comment process. Delaware Riverkeeper Network also considers it essential that enough time be provided during an open public comment process for the public and our organization to review all files and prepare comment for submission to NJDEP.

In an effort to provide comment in a timely way on what could be gleaned from the permit applications and information that was made available at the municipal building, Delaware Riverkeeper Network submits these comments.

Enclosed is a copy of the review of two permit applications - individual waterfront development permit and coastal wetlands permit - by James A. Schmid, PhD. of Schmid and Company, Consulting Ecologists. Delaware Riverkeeper Network agrees with the findings reported by Dr. Schmid and submits his report as comment on these two permit applications. Delaware Riverkeeper Network will be submitting comment on the flood hazard area permit application when our consultants complete their review of the documents submitted by the applicant for that permit. Further comment may be submitted on the individual waterfront development permit and coastal wetlands permit.

As stated by Dr. Schmid, the scope of the applicant's proposed work is not clearly identified. Some of the aspects of the planned project and existing site of which there is inadequate information or evaluation include: the areas to be utilized for the project, those areas to be "conserved" (although there is no mention of a conservation easement), the plans for further subdivision and use of the property, the plans for the disposal of spoils that would be dredged for the project, location of public access to the Delaware River, and how proposed construction and use relate to onsite existing conditions. Additionally, secondary impacts that will result from the project are sparse and superficial but are required to be addressed as per NJAC 7:7-14.3. The applicant claims that potential impacts to the environment from the proposed permit activities will be minimized but Dr. Schmid states there is no way to independently assess that claim or to begin to review compliance with the numerous relevant coastal policies that have been adopted by NJDEP based on the information provided.

Further details of the inadequacy of the application are documented in Dr. Schmid's report. He concludes that compliance with all of the relevant coastal rules (NJAC 7:7-1 et seq.) has not been demonstrated based on the materials that were available for review.

Thank you for the opportunity to comment on these permits applications.



Maya van Rossum
The Delaware Riverkeeper



Tracy Carluccio
Deputy Director

Attachments:

Letter to DRN from Gibbons Law, Shawn M. LaTourette, attorney for the applicant dated August 1, 2016

Letter to Ms. Suzanne Dietrick, NJDEP from Delaware Riverkeeper Network dated August 15, 2016

Report to Delaware Riverkeeper Network from James A. Schmid, PhD. of Schmid and Company,

Consulting Ecologists dated August 25, 2016



SHAWN M. LATOURETTE
Associate

Gibbons P.C.
One Gateway Center
Newark, New Jersey 07102-5310
Direct: (973) 596-4719 Fax: (973) 639-6262
slatourette@gibbonslaw.com

July 27, 2016

VIA REGULAR & CERTIFIED MAIL (R.R.R.)

Delaware Riverkeeper Network

Delaware Riverkeeper
925 Canal Street, Floor 7
Suite 3701
Bristol, PA 19007

JUL 29 2016

RECEIVED

Re: *Application submitted by:*
Delaware River Partners, LLC
Regarding property at:
200 No. Repauno Avenue
Block 8; Lots 1, 2, 3, 4, 4.01, 4.01 and 4.02
Greenwich Township, Gloucester County

Dear Interested Party:

This letter is to provide you with legal notification that our client, Delaware River Partners LLC (“DRP”), will be submitting applications for a flood hazard area individual permit, an individual waterfront development permit, and a coastal wetlands permit, to the New Jersey Department of Environmental Protection, Division of Land Use Regulation (the “Department” or “NJDEP”) for the development shown on the enclosed plan. A brief description of the proposed development follows:

The DRP Gibbstown Logistics Center will be a multi-use, deep-water seaport and international logistics center at the site of the former DuPont Repauno Works in Gibbstown, New Jersey. This marine terminal is planned to include uses such as an automobile import and processing facility, perishables and bulk cargo handling, a bulk liquids storage and handling facility, logistics and associated warehousing.

The complete permit application package can be reviewed at either the municipal clerk’s office or by appointment at the Department’s Trenton Office. The Department of Environmental Protection welcomes comments and any information that you may provide concerning the proposed development and site. Please submit your written comments within 15 calendar days of the date of this letter to:

New Jersey Department of Environmental Protection
Division of Land Use Regulation
P.O. Box 420, Code 501-02A
Trenton, New Jersey 08625
Attn: Greenwich Township Supervisor

Re: Delaware River Partners, LLC
200 No. Repauno Avenue, Greenwich Twp.
July 27, 2016
Page 2

This letter is also sent to inform you that DRP is submitting an application for a permit or approval to the NJDEP under the Freshwater Wetlands Protection Act rules, N.J.A.C. 7:7A. The permit or approval will either establish the boundary of freshwater wetlands on the above property, or will authorize DRP to conduct regulated activities on the property. Specifically, DRP is applying for the following approvals:

- (1) Individual permit (authorizes regulated activities in wetlands, for example construction or development)
- (2) Open water fill permit (authorizes regulated activities in open waters, for example construction or development)
- (3) Transition area waiver (authorizes regulated activities, for example construction or development, in areas adjacent to wetlands)

The activities for which DRP's application requests NJDEP approval involve:

- Cutting or clearing of trees and/or other vegetation
- Placement of pavement or other impervious surface
- Placement of one or more buildings or other structures

If you would like to inspect a copy of DRP's application, it is on file at the Municipal Clerk's Office in Greenwich Township, or you can call the NJDEP at (609) 777-0454 to make an appointment to see DRP's application at NJDEP offices in Trenton during normal business hours.

The rules governing freshwater wetlands permits and approvals are found in the NJDEP's Freshwater Wetlands Protection Act rules at N.J.A.C. 7:7A. You can view or download these rules on the NJDEP Land Use Regulation Program website at www.state.nj.us/dep/landuse, or you can find a copy of these rules in the county law library in your county courthouse.

As part of the NJDEP's review of DRP's application, NJDEP personnel may visit the subject property, and the portion of any neighboring property that lies within 150 feet of the property line, to perform a site inspection. This site inspection will involve only a visual inspection and possibly minor soil borings using a 4" diameter hand auger. The inspection will not result in any damage to vegetation or to property improvements.

Re: Delaware River Partners, LLC
200 No. Repauno Avenue, Greenwich Twp.
July 27, 2016
Page 3

The NJDEP welcomes any comments you may have on DRP's application. If you wish to comment on DRP's application, your comment should be submitted to the NJDEP *in writing* within thirty (30) days after the Department publishes notice of the application in the DEP Bulletin, a copy of which is available on the NJDEP website at www.nj.gov/dep/bulletin. The Department shall consider all written comments submitted within this time. The Department may, in its discretion, consider comments submitted after this date. Comments cannot be accepted by telephone. Please submit any comments you may have *in writing, along with a copy of this letter, to:*

New Jersey Department of Environmental Protection
Division of Land Use Regulation
Mail Code 501-02A
P.O. Box 420
Trenton, New Jersey 08625
Attn: Gloucester County Section Chief

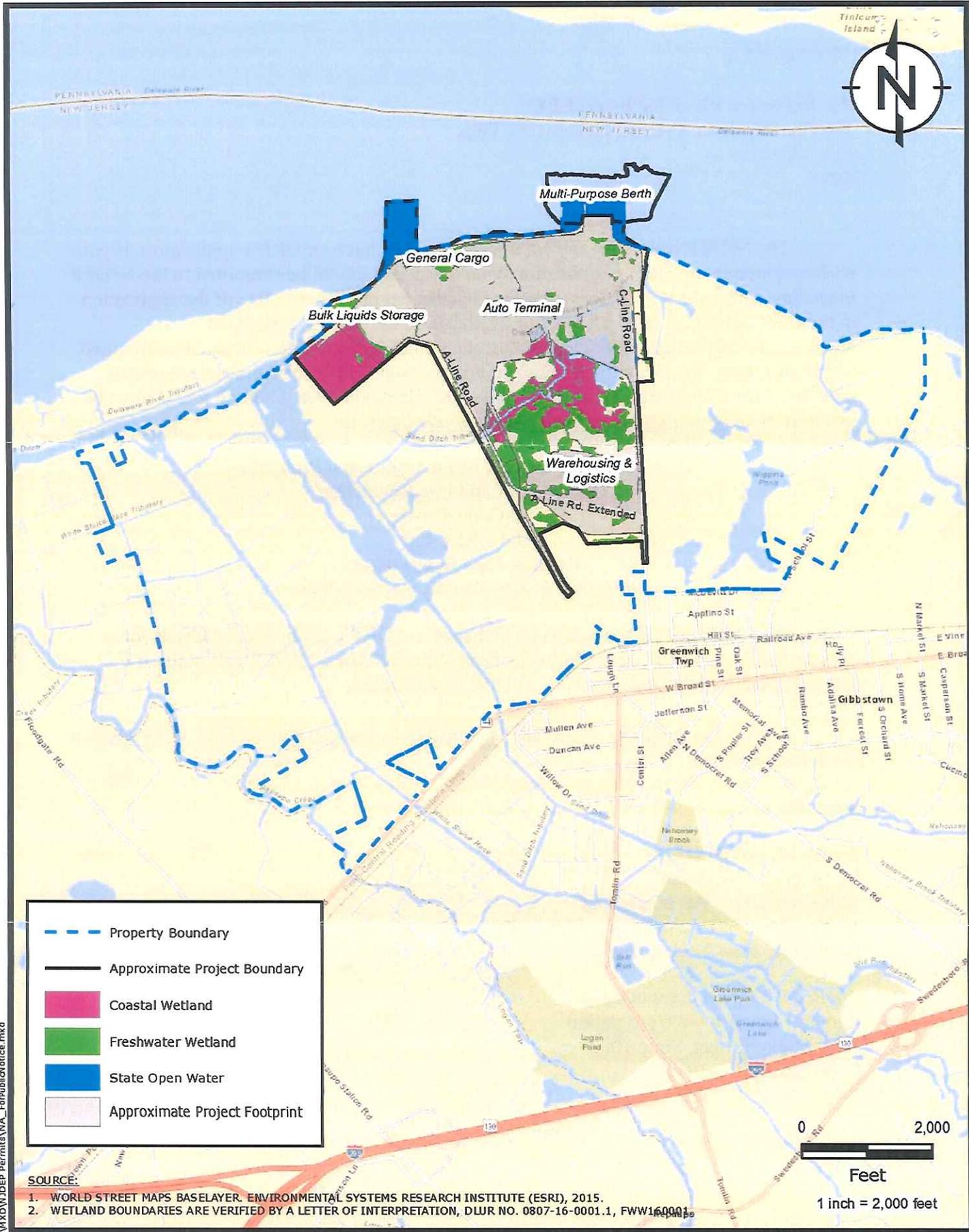
When the NJDEP has decided whether or not DRP's application qualifies for approval under the Freshwater Wetlands Protection Act rules, NJDEP will notify the municipal clerk of the final decision on DRP's application.

If you have questions about DRP's application, you can contact DRP or its agent at the addresses below.

Sincerely,

Shawn M. LaTourette
Attorney for Applicant:
Delaware River Partners, LLC
1345 Avenue of the Americas, 45th Floor
New York, New York 10105

Applicant's Agent: Laura George
Ramboll Environ US Corporation
1760 Market Street, Suite 1000
Philadelphia, PA 19103
Tel.: (215) 523-5603



P:\Projects\Repauro\GIS\W\DRP\DRP Permits\NA_Facility\drp\drp.mxd

RAMBOLL ENVIRON

**DRP GIBBSTOWN LOGISTICS CENTER
SITE LOCATION MAP
GIBBSTOWN, NEW JERSEY**

**FIGURE
1**

DRAFTED BY: HW

DATE: 7/26/2016

02-35702A



August 15, 2016

Suzanne Dietrick
Case Manager, Land Use Management
New Jersey Department of Environmental Protection
Trenton, New Jersey

Re: File # 0807-16-0001.2, Application submitted by Delaware River partners, LLC re. Property at: 200 N. Repauno Avenue, Block 8; Lots 1, 2, 3, 4, 4.01 and 4.01, Greenwich Township, Gloucester County, NJ

Dear Ms. Dietrick,

As a follow up to our letter of August 8 and your email informing us that we have until August 26 to submit comment on the three permits for the above referenced project - flood hazard area individual permit, the individual waterfront development permit, and a coastal wetlands permit – we are submitting this letter based on comments we have received from the wetlands expert we have retained to review the individual waterfront development permit and a coastal wetlands permit. Basically, the files he needs to conduct a review are not available at the Greenwich Township municipal building. We copied the entire box of materials provided by the Township Clerk and there are essential documents and maps missing that our expert requires in order conducting a review for us. We have double-checked with the municipal clerk at Greenwich Township and there are no other documents available.

Please note the following comments regarding the materials made available at the municipal building:

There is no LOI documentation nor any Wetlands Survey or wetlands maps.

The following are other documents referenced but not provided:

Note that the Contents mentions "Site Plans (folded and enclosed separately)" between Volumes 2 and 3.

Volume 4/ Appendix G is mentioned but not included.

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
drm@delawariverkeeper.org
www.delawariverkeeper.org

Project Drawings are mentioned on p. 7

Wetlands Survey (the 16 sheets of the LOI) is mentioned on p. 9 and in the Appendix C LOI.

On p. 50 (Executive Summary #3 file) a Submerged Aquatic Vegetation study is to be performed for the eastern waterfront in the study area but the report is not included.

Other large drawings mentioned in the compliance statement (Executive Summary) text (at page # in parentheses) but not found in the files:

SD-101 (14)
S-100 (14)
D-101 (14, 35, 44, 62)
C-100 (15, 16, 38)
C-401 (16)
C-101 through C-123 (42)
C-113 (44)
C-115 (44)

Also missing are the following documents that are needed to evaluate the site regarding these permits:

The location of SWMUs and AOCs.

A copy of the LURP File 0807-06-0002.1 for GPs and TAWs for site cleanup, per which 2 acres of existing wetlands are to be filled before the present project starts. That file should show locations of the contaminated areas, among other things.

On p. 55 the document claims that a concurrent Freshwater Wetland Permit application is being filed, and thus the project complies with coastal policies on wetlands and transition areas. And yet the FWW application is not included in the documents but is referenced and contains information needed for these permit reviews. It is unknown if the LOI regulatory boundaries are settled yet.

On p. 56 the document says an archaeological study is being undertaken on part of the property that was an old farm. So the archaeological compliance documentation cannot be said to be complete.

On page 70 the document claims low impact because only 220 of the 1,630 acres of project site are being disturbed. Nothing else in this application provides any information about the rest of the 1,630-acre Repauno Works site, yet it is being proposed for further subdivision. An evaluation of the claimed low-impact nature of the project cannot be done unless documentation of the rest of the site's condition and future planning is made available.

Soil Erosion and Sediment Control plans are not available but will affect the wetlands permitting.

We have also engaged a flood hazard area expert to review that permit application and we will inform you if there are documents missing that are needed for that review when we get a report back from the consultant.

Delaware Riverkeeper Network requests that the comment period be indefinitely extended. In order for the public to comment, these applications must be complete and all information needed to conduct a review and analysis must be provided by the applicant. After the application materials have been provided, there must be a period of time allowed for Delaware Riverkeeper Network and members of the public to review the materials and submit comment.

Thank you for the opportunity for input into this process.

Sincerely,



Maya van Rossum
The Delaware Riverkeeper

Tracy Carluccio
Deputy Director

SCHMID & COMPANY INC., CONSULTING ECOLOGISTS
1201 Cedar Grove Road, Media, Pennsylvania 19063-1044
610-356-1416 fax: 610-356-3629
www.schmidco.com

25 August 2016

Tracy Carluccio
Delaware Riverkeeper Network
925 Canal Street, Suite 3701
Bristol, Pennsylvania 19007

In re: Proposed Gibbstown Logistics Center at DuPont Repauno Works

Dear Ms. Carluccio:

Per your request I have reviewed information provided to me from permit applications to develop a multi-use general cargo port at the former DuPont Repauno Works along the Delaware River in Gloucester County, New Jersey. This letter transmits my comments.

You provided me with all the information that you could obtain from the municipal clerk concerning applications to the New Jersey Department of Environmental Protection (NJDEP) that would be required to authorize port development on this inactive industrial site. It appears that Greenwich Township received incomplete copies of the applications. Complete copies of permit applications to NJDEP are required to be filed with any municipality. That a municipality's files would be so incomplete regarding active applications is highly unusual in my experience with New Jersey permits. I recommend that you secure a complete copy of these applications and related files.

My principal conclusion from reviewing the information is that there is insufficient information to provide a thorough review of this project. In particular, most site-specific drawings cited in the application documents are missing. These omissions include all site plans, wetland delineation maps, wetland documentation and Letter of Interpretation application files, soil erosion and sediment control plans, and stormwater management plans. Some existing conditions information is acknowledged as incomplete in the application text. In general, proposed construction activities are not shown in relation to onsite existing conditions, so there is no way independently to assess the applicant's claims regarding minimization of potential impacts or to begin to review compliance with the numerous relevant coastal policies that have been adopted by NJDEP. In addition, a significant number of applicable policies have not been addressed (see below).

The scope of the applicant's proposed work is not clearly identified. Apparently the current applications deal primarily with about 233 acres within 381 acres of a 1,630-acre property. Ground elevations are to be raised by fill and regrading on about 218 acres. Most contaminated soils apparently are to be covered by fill and pavement, rather than excavated and removed offsite. Existing conditions appear to have been addressed for that 233-acre parcel to some extent, although the resulting drawings have

not been provided to me. The initial project for the subject property apparently was larger by 50 acres, although no graphic depiction of the earlier plan appears in the files. The reduced area appears to have been near the center of the construction site, where 44 acres of an existing regrowth deciduous forest now are to be preserved, apparently in isolation from remaining onsite wetlands. Whether a conservation easement will encumber the 44 acres was not stated.

Even now, some or all of the remainder of the property is vaguely said to be slated for further subdivision, with no details offered. Some of the land east and west of the proposed port complex is proposed for encumbrance by conservation easement, according to a conceptual mitigation plan, although there is no discussion of the amount of land involved. Mitigation is proposed for sections of the property outside the currently proposed construction footprint, although existing conditions have not been examined there, such as the extent of wetlands and present soil contamination. The applicant takes "credit" for buffering provided by the entire Repauno Works property, but does not clearly indicate which (if any) of the remaining land will undergo future development. Adjacent to the project site the applicant believes that there is "ample" high quality habitat. The applicant states an intent to provide public access to the Delaware River somewhere within the 1,630-acre property, but no such access shown on any drawing provided to me.

Approval is being sought to fill about 8 acres of freshwater wetlands, 49 acres of transition areas, 6 acres of coastal wetlands, less than half an acre of state open waters, and 7.2 acres of riparian zones, in addition to 2 acres of freshwater wetlands already approved for fill during ongoing site remediation independent of this port project. The stated acreage of aquatic and transition area fill varies from place to place in the application documents.

Onsite road and rail facilities, as well as wharf berths along the waterfront, will be improved to facilitate movement of cargo. Powerlines apparently will be placed underground. The construction of onsite pipelines to convey liquid petroleum pipelines is not clearly discussed in the application, and whether offsite pipeline construction will tie the site into existing regional pipelines is unknown. The applicant does not say that adequate connection to municipal sewage treatment abuts the property, or whether offsite sewer line construction will be necessary. The applicant claims that truck traffic offsite will not cause problems, but provides no existing conditions data or projected traffic estimates to support this claim. The applicant reports township efforts to create a highway bypass to reduce traffic in residential neighborhoods of Gibbstown. No mass transit facilities exist or are proposed to bring workers to the marine terminal.

The site itself exhibits complex conditions as a result of past industrial use for chemical manufacturing over more than a century. As a consequence, most of the extensive wetlands on the property have long been diked off from full tidal exchange with the Delaware River. Large areas have been filled, and about 4 miles of artificial ditches were constructed during the years of chemical manufacture. The resulting pattern of wetlands (nearly 50 acres each of freshwater and coastal wetlands) and state open waters (about 20 acres including tidal and nontidal) and largely manmade uplands

within the proposed construction site is quite complex. Outside the proposed construction footprint there has been somewhat less past disturbance, with considerable variation from place to place. Hence environmental sensitivity as defined in NJDEP coastal policies would be expected to vary dramatically across the property.

The current extent of tidal fluctuation in water levels within the property apparently has not been determined. There is no description of actual current water quality in the ditches and waters onsite. Stormwater apparently is to be collected into newly constructed basins, but no stormwater analysis was provided forecasting future water quality (Volume III = Appendix G is absent from the files you provided). No improvement of the applicant-characterized "poor" quality existing aquatic habitat in onsite state open waters is proposed. Proposed impervious surfaces are to occupy 220 acres, 13% of the 1,630-acre property (presumably not counting stormwater basins). How much of the remaining land will be vegetated and how much will be open water was not stated. Summary written comments on specific existing wetland parcels are provided, but no drawings show their locations. Additional fill is proposed in some of the coastal and freshwater wetlands and in regulated transition areas adjacent to them, but again, no drawings show the location of proposed incursions into NJDEP-regulated areas. Archaeological investigations into a former farm in the southeastern section of the construction area where warehouse construction is proposed are not complete.

There is also a long history of discharge of wastewater laced with chemical contaminants onto this property. Considerable sampling has been undertaken, and cleanup operations are underway on some parts of the property. How the proposed development will relate to ongoing site remediation is not shown on any of the drawings you provided, and how the time frame for proposed remediation interacts with proposed port construction is not made clear. Apparently there has been little or no chemical sampling in sections of the site now under consideration for future development and for habitat improvement as partial mitigation for proposed fill. The excavation that may be necessary for such mitigation and for wharf construction may encounter acid-producing soils, but the applicant apparently has not searched for such soils onsite. Thus there is a serious potential for ongoing pollution of onsite ecosystems and the Delaware River that must be examined carefully. The source of potable water to be used at the port complex is not stated. It likely will come from groundwater, either onsite or municipal. No project use is quantified.

State endangered and threatened species such as bald eagles and ospreys currently nest onsite and will not benefit from the proposed port development and industrial activity. Dredging of more than 450,000 cubic yards of bottom sediments from 29 acres (again, this number varies within the applications) of the Delaware River potentially may damage endangered species of sturgeon if not performed carefully, and the applicant's specific plans for disposal of dredged spoil are not identified. The applicant does not commit to use silt curtains to contain turbidity during dredging operations. Dredging is claimed to have no impact on groundwater resources, but no information is provided on groundwater recharge along the Gloucester County shoreline. Submerged aquatic vegetation was surveyed in small areas of shallows near the proposed wharf in December, and the applicant recognizes a need for additional investigation of

submerged aquatic vegetation during the growing season. The onsite flora was not cataloged, either for the construction areas or the surrounding “high quality” habitat on and near the subject property. No information is provided on the location of areas judged to be “forested” and “not forested” in terms of NJDEP coastal policies, although the applicant apparently has measured their extent from aerial photographs.

I noted no consideration given to planning for the likely rise in sea level during the operational life of this facility, which apparently is to last for some unspecified number of decades if hoped-for marine trade revives. Onsite railroad grades, roadways, and parking lot elevations are not proposed to be raised above existing design flood elevations because of cost and unidentified “additional wetland impacts”. There is no discussion of plans for future decommissioning of the facility at the end of its economic life.

The old Repauno Works site is a brownfield waterfront location potentially developable as a marine terminal with access to the Delaware River navigation channel and transoceanic commerce. Redevelopment of disused industrial sites is encouraged by New Jersey coastal policies, provided potential adverse impacts are minimized. It is possible that the proposed impacts are justifiable, but the present information allows no way to confirm that impacts have been minimized or that conceptual suggestions for mitigation are appropriate.

Compliance with NJDEP coastal policies cannot be determined from the information made available to me. The applicant has addressed claimed compliance with a number of sections of the New Jersey coastal zone management policies (NJAC 7:7-1 et seq.). I append a list of 26 additional policies that appear relevant and should be discussed thoroughly in the compliance statement.

I hope this information is useful for your purposes.

Yours truly,

A handwritten signature in cursive script, appearing to read "James A. Schmid".

James A. Schmid, Ph. D.

Attachment

Apparent Omissions from Applicable Coastal Policies Discussed in existing Compliance Statement

Most of these cited policies appear applicable. Applicant should state the reasons why any deemed not applicable are considered so.

All cites to NJAC 7:7-

- 9.49 Dredged material management areas
 - 11.1 T/E species
 - 11.2 Habitat impact assessment
 - 11.3 Habitat evaluation
 - 11.4 Standards for reporting
- 12.8 Environmental dredging in Special Hazard areas
- 12.17 Dams and impoundments (dikes and sluice gates)
- 12.19 Realignment of water areas
- 12.23 Living shorelines
- 13.3 Impervious upland waterfront development
- 13.4 Vegetation in upland waterfront development
- 13.10 Development potential for major industrial development
- 15.4 Energy development (storage of liquid petroleum)
- 16.5 Groundwater
- 16.8 Air quality (expected emissions from ships, trucks, storage tanks)
- 16.9 Public access to waterfront
- 16.12 Traffic
- 17.2 General mitigation requirements
- 17.3 Timing
- 17.4 Amount
- 17.5 Property suitability (ecological risk)
- 17.10 SAV mitigation
- 17.11 Intertidal/subtidal shallows
- 17.12 Riparian zone
- 17.13 Wetlands
- 17.14 Wetland mitigation hierarchy



November 15, 2016

Suzanne Dietrick
Case Manager, Land Use Management
New Jersey Department of Environmental Protection
Trenton, New Jersey

Re: Comment Gibbstown Logistics Center (Repauno Site) Greenwich Township, Gloucester County, NJ,
NJDEP LOI # 0807-16-0001.1 for Delaware River Partners, LLC

Dear Ms. Dietrick,

Delaware Riverkeeper Network submits this comment and enclosed report by Schmid and Company on the above referenced permit application, NJDEP LOI # 0807-16-0001.1 for Delaware River Partners, LLC for the proposed Gibbstown Logistics Center. We have submitted comments and expert reports over the past few months on the record to the Department regarding the proposed project's several outstanding permit applications.

Delaware Riverkeeper Network is submitting this comment based on files we received through the Open Public Records Act and files available at the Greenwich Municipal Building for the wetlands permit applications. As you know, the Department issued a deficiency letter dated August 26, 2016 for the project's permit applications until more information was submitted by the applicant. We were informed that the comment period for the permits that were in process was being left open until the record was complete. Schmid and Company prepared a report based on the files that were available for three permit applications; Delaware Riverkeeper Network submitted those comments during the original comment period for the noticed permits.

Delaware Riverkeeper Network submits this comment and report on the LOI whether or not the LOI comment period is still considered officially open. Schmid and Company is not able to prepare a review of NJDEP # 0807-16-0001.2-FWW160001 and #0807-16-0001.2-FWW160002 due to the lack of information, inaccurate information and missing information in the LOI and other documents pertaining to these freshwater wetlands permits applications. Enclosed is a detailed review of the LOI documents and their deficiencies, explaining why revisions to the LOI information are needed to allow Schmid and Company to prepare comment on the freshwater wetlands permit applications that are still in review by the Department.

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
drm@delawareriverkeeper.org
www.delawareriverkeeper.org

Delaware Riverkeeper Network supports and endorses Schmid and Company's conclusions and recommendations that based on the inconsistencies, internal contradictions, and other poorly defined information in the LOI that the LOI drawings be revised and that the Department revise and reissue the LOI letter and that copies of that revised letter be made publicly available for review. These revisions are necessary in order for Schmid and Company to prepare an accurate assessment of the proposed project's impacts on the freshwater wetlands at this site.

Delaware Riverkeeper Network also inquires about the multiple freshwater wetland permits for this project. Our understanding of the regulations is that multiple permits are NOT allowed where an Individual Permit is required. Statewide General Permits often can be combined for a project up to the overall maximum limit of impact but multiple Individual Permits cannot be approved for a single project, nor can Statewide General Permits be used where an Individual Permit is necessary. The present set of applications seems to illegally piecemeal this project and misapply the required permitting.

Thank you for the opportunity to comment.

Sincerely,

Handwritten signatures in blue ink. The signature on the left reads "Maya van Rossum" and the signature on the right reads "Tracy Carluccio".

Maya van Rossum
the Delaware Riverkeeper

Tracy Carluccio
Deputy Director

Attached: Schmid and Company Inc. report re. NJDEP LOI # 0807-16-0001.1 for Delaware River Partners, LLC dated October 14, 2106

SCHMID & COMPANY INC., CONSULTING ECOLOGISTS
1201 Cedar Grove Road, Media, Pennsylvania 19063-1044
610-356-1416 fax: 610-356-3629
www.schmidco.com

14 October 2016

Maya K. van Rossum
Delaware Riverkeeper Network
925 Canal St., Suite 3701
Bristol, Pennsylvania 19007

In re: NJDEP LOI # 0807-16-0001.1 for Delaware River Partners, LLC
Gibbstown Logistics Center (Repauno Site)
Greenwich Township, Gloucester County

Dear Ms. van Rossum:

Pursuant to your request we have reviewed certain information related to the above-referenced NJDEP Freshwater Wetlands Letter of Interpretation (LOI). In particular, we reviewed the text of the Line Verification LOI letter issued by the New Jersey Department of Environmental Protection (NJDEP) on 11 July 2016, and the LOI Amendment letter issued by NJDEP on 29 July 2016. We also reviewed a letter dated 27 May 2016 from Laura George (Ramboll Environ) to Brett Kosowski (NJDEP) providing revised information in support of the applicant's LOI application (6 page letter, without referenced attachments). Finally, we reviewed pdfs of a single set of 17 drawings related to the subject LOI that had been provided to you by the NJDEP separately from the LOI letters. The status of those drawings is unclear --- as discussed below, they appear to be preliminary interim drawings rather than the final verified survey drawings.

We understand that additional files and documentation associated with the LOI application, including the applicant's 18 July 2016 letter requesting clarification of the resource value classification (RVC) of various wetlands, have not yet been provided by NJDEP in response to your Open Public Records Act request. Our lack of those files compounds our difficulty in understanding precisely what the NJDEP confirmed at this site and the basis for its determinations. We offer the following comments based on the information currently available to us.

General Comments

- The LOI letter ambiguously identifies the subject property as:

Block(s)/ Lot(s): [8 / (current) 2, 3, 4.01, 4.02, and (current portions 1 and 4)]; (proposed) 4.08
Greenwich Twp., Gloucester County

Many of the "verified" flag points, however, are located on other proposed lots, outside the LOI Boundary Limit according to the drawings. It is unknown whether the NJDEP collected any additional LOI fees for their review and verification of these offsite areas.

- The LOI verifies the surveyed limits of state open waters and freshwater wetlands, but it also appears to tacitly confirm or revise the unsurveyed boundaries of coastal wetlands transferred from maps promulgated under the Wetlands Act of 1970. In some places on this site those coastal wetland boundaries appear to have changed, and it is unclear whether those changes are a result of fill which was legally placed.

- Both the 11 July and the 29 July LOI letters contain the following language on page 1:

Based upon the information submitted, and upon site inspections conducted by Division staff on March 22th, 2016 and April 13th, 2016, the Division has determined that the wetlands and waters boundary line(s) as shown on plan map sheets entitled: "PLAN OF WETLANDS AND TOPOGRAPHY, DRP GIBBSTOWN LOGISTICS CENTER No. 200 REPAUNO AVENUE, TOWNSHIP OF GREENWICH, GLOUCESTER COUNTY, NEW JERSEY", consisting of sixteen (16) sheets labeled Drawing No. W-2 through W-17, dated 12/29/2015, last revised on 06/08/2016, and prepared by Monarch Surveying & Engineering, are accurate as shown

This determination is specifically contradicted on pages 2, 3, and 4, where it is stated that more than 50 specific flag points denote lines that are "incorrectly labeled, not verified, and to be ignored".

- On page 6 of the LOI Amendment letter the Department states that the applicant can rely on this jurisdictional determination for "five years from the date of this letter", but that contradicts the statement on page 1 of the same letter which states that "the expiration date (5 years from [sic] the date of the original LOI) remains unchanged".

- The basis for classifying specific freshwater wetlands as having Exceptional or Intermediate resource value is not explained in the LOI letters, nor is it clear from the drawings reviewed.

- There are hand-lettered notations and hand-applied colored highlighting here and there on individual drawing sheets which are nowhere explained. Specific notations on several of the drawings refer to "Amendment 7/25", but that is not otherwise described.

- Drawings W-2 through W-17 each has an "Approved" stamp from the NJDEP-Division of Land Use Regulation, but there is no File number or approval date printed on or with the stamp.

- We question whether the drawings we received and reviewed (as pdfs provided by NJDEP) are the "official" LOI-verified drawings. Both the 11 July 2016 and the 29 July 2016 LOI letters state that the approved drawings were "prepared by Monarch Surveying & Engineering" and are "dated 12/29/2015, last revised on 06/08/2016". That suggests that the 29 July 2016 LOI Amendment does not involve any changes in any flag locations, but only in the Resource Value Classification (RVC) of some wetlands (as noted above, we had only one set of drawings to review). In our experience, the RVC of verified wetlands is listed in the LOI letter, and is not depicted on the drawings. If the RVC is depicted on the drawings, and especially if it has changed since a previous drawing was issued, the change typically is made to the drawing by the surveyor along with a formal revision date; it is **not** handwritten onto the surveyed drawing as has been done on the drawings we received from NJDEP.

- The LOI letter identifies, for each separate drawing, the specific flag point numbers that encompass State Open Waters, Coastal Wetlands, and freshwater wetlands by RVC applicable to that drawing. In many instances, the last item listed simply states that "all remaining wetland points" are

"Intermediate" (for example). That can, and does, create confusion regarding the "remaining" points --
- it would be preferable, and more accurate, to list the specific flag point numbers that constitute those "remaining" ones.

- The LOI letter is not consistent in describing whether a listed series of points encloses a wetland area or encloses an upland within a wetland area. For example, for Sheet W-11, the LOI lists as Exceptional points DU4-1 thru DU4-14 without noting that that area is an upland and the Exceptional wetland is outside of it.

- There are numerous discrepancies and contradictions in the RVCs within the LOI letter itself, and also between the LOI letter and the drawings (whether surveyed or handwritten), as further detailed below.

Sheet W-1

- The "Overall Plan" (Sheet W-1 of 17) provides an overview of waters and wetlands on the subject property at a design scale of 1 inch = 300 feet. Sheet W-1 is not stamped as "Approved" as are Sheets W-2 through W-17. It also is not referenced in the LOI letter. Sheet W-1 appears to represent an index map for the individual sheets that supply field-flagged boundary line numbers, but it inaccurately identifies the outline of many of the individual sheets. The amount of overlap between individual sheets is inconsistent and inaccurately shown on this index, and the standard convention of using "match lines" has not been used.

- This sheet provides 13 general "Notes" describing compilation from various sources and an inaccurate partial summary of regulated waters and wetlands, but none of those Notes is repeated on Sheets W-2 through W-17, although each of them refers to several of the Notes. A legend key is provided, the same as the legend key on the other sheets, but a separate Legend (showing features common to all sheets) is provided only on Sheet W-1. Also provided only on Sheet W-1 is a purported bearings and distances for a proposed Lot 4.08 encompassing 380.764 +/- acres within a much larger tract of land. Because this sheet has information relevant to each of the subsequent 16 individual sheets, but that information is not printed on them, this sheet likely should be confirmed by NJDEP and included as part of the LOI (after first being corrected as discussed above).

- The Delaware River is not shown as State Open Waters, contradicting several labels on this and on individual sheets. The "Area Within Waters of the United States" symbol is not readable on the paper print or color image of Sheet W-1. All State-regulated wetlands and State open waters are defined as Waters of the United States (NJAC 7:7A-1.4).

- Acreage entries in the Table of "Regulated Waters" areas are grossly incorrect in terms of NJAC 7:7A-1.4 definitions and not relevant to this LOI tract.

Sheet W-2

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.

- The State Open Waters symbol from the legend is not used, but it is needed on this sheet.
- Points identifying Intermediate Value wetlands should be listed, not simply noted as "all remaining".

Sheet W-3

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.
- The State Open Waters symbol from the legend is not used, but it is needed on this sheet.

Sheet W-4

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.
- The State Open Waters symbol from the legend is used on some, but not on all State Open Waters as needed.
- The following points confirmed in the LOI letter are outside the LOI Boundary:
 - EL26 thru EL19
 - EL19 to DR134
 - DR134 thru 136
- Points identifying Intermediate Value wetlands should be listed, not simply noted as "all remaining".

Sheet W-5

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.
- The LOI letter states that "DR-7 thru DR-35 was incorrectly labeled on the plan, this is to be ignored and is not verified", which contradicts the statement on page 1 that the plans are accurate as shown.
- Exceptional Value Wetland points AA-FW-3 thru AA-FW-6 are not shown on this sheet.
- The State Open Waters symbol from the legend is not used, but it is needed on this sheet.
- The following coastal wetlands apparently filled are not identified:
 - beyond points AE-119A and AE-120
 - between LOI Boundary and points DR-35 thru DR-49
- The following points confirmed in the LOI letter are outside the LOI Boundary:
 - DR14 thru DR18 (of these, as noted above, only DR-7 thru DR-35 presumably
 - DR23 thru DR49 are "to be ignored and are not verified").

- Points identifying Intermediate Value wetlands should be listed, not simply noted as "all remaining". At minimum, it should say "all remaining *freshwater* wetlands", because some of the remaining wetlands are coastal wetlands.

Sheet W-6

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.

- Exceptional Value Wetland point AJ 101 is not shown on this sheet.

- Flags of Wetland MB-W4 zig-zag across the ditch and are not connected consecutively as suggested in the LOI letter.

- Exceptional Value Wetland AJ is outside the LOI Boundary, and point AJ101 is not shown or labeled on this sheet.

- Points identifying Intermediate Value wetlands should be listed, not simply noted as "all remaining".

Sheet W-7

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.

- Ordinary Value Wetland point O17 is not labeled on this sheet.

- Ordinary Value Wetland PD-W2 is shown in more readable detail on "Inset A", but that inset is not on this sheet. Note should say "See Inset A on *Sheet W-8*".

- Likewise, the note for Inset D should say "See Inset D on *Sheet W-8*".

- Exceptional Value Wetland points DW3A-19 thru DW3A-21A should be added to the list in the LOI letter. Also, point DW3A-19 has only a hand-written label on this sheet.

- Points identifying Intermediate Value wetlands should be listed, not simply noted as "all remaining". At minimum, it should say "all remaining *freshwater* wetlands", because some of the remaining wetlands are coastal wetlands.

- Some labels on the drawings appear to contradict the LOI letter, or at least create confusion. For example, on this sheet Wetland N (points N1 thru N14) has a label "Drainage Ditch" which might suggest an ordinary resource value wetland, but it is not listed as Ordinary in the LOI letter and so presumably it is meant to be among the "all remaining" Intermediate wetlands. Similarly, "AF Basin" (points AF101 thru AF134) is identified in the LOI letter as an ordinary value wetland, but it is labeled on the drawing as "Permitted Waste Treatment System" which suggests it could be an unregulated feature.

Sheet W-8

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.

- The following points confirmed in the LOI letter are outside the LOI Boundary:

SOW: EL8A to EL9

EL11 to EL13

EL25 to EL29C

Intermediate: W4-7 to W4-17

W7-3 to W7-8

Exceptional: EL5 to EL7 (handwritten notations on the drawing depict this as both Exceptional and Intermediate value, and the legend shows it as SOW)

- Points identifying Intermediate Value wetlands should be listed, not simply noted as "all remaining". At minimum, it should say "all remaining *freshwater* wetlands", because some of the remaining wetlands are coastal wetlands.

- The LOI letter states that "EL30 thru EL33 was incorrectly labeled on the plan, this is to be ignored and is not verified", which contradicts the statement on page 1 that the plans are accurate as shown.

- Were the former Coastal Wetlands now apparently filled, shown in Inset C, filled lawfully?

Sheet W-9

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.

- Coastal wetland points AA100 thru AA100B confirmed in the LOI letter are outside the LOI Boundary.

- A single point (AE104A) does not define a wetland polygon -- the LOI letter should describe what this point connects with.

- Coastal wetland point AA106C is not labeled by the surveyor on this sheet.

- There is a box that says "See Inset B", but there is no such inset on this or any other sheet.

- Points identifying Intermediate Value wetlands should be listed, not simply noted as "all remaining". At minimum, it should say "all remaining *freshwater* wetlands", because some of the remaining wetlands are coastal wetlands.

- The LOI letter states that "DR2 thru DR18 was incorrectly labeled on the plan, this is to be ignored and is not verified", which contradicts the statement on page 1 that the plans are accurate as shown.

Sheet W-10

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.
- Handwritten notations on drawings say Freshwater Wetland at DW3-158A, 161 to 161A is Exceptional Resource Value, but LOI letter lists it as Intermediate Resource Value. It is unclear if point DW3-158 is confirmed as part of this wetland (it is shown but not listed in the LOI letter for this sheet).
- The surveyor has not provided a label for Intermediate wetland point DW3-158A.
- Labels are missing for the following points: PMDA-W3-10, PMDA-W3-11, PMDA-W3-21, PMDA-W3-24, and PMDA-W3-28 thru -30.
- Points identifying Coastal wetlands should be listed, not simply noted as "all remaining".
- The following points confirmed in the LOI letter are outside the LOI:
 - Exceptional: AJ-100 thru AJ-106
MB-W3-28 thru MB-W3-37
 - Ordinary: MB-W1-10
 - Coastal?: KW-1
MB-W1-1 thru MB-W1-4
MB-W1-14 thru MB-W1-16

Sheet W-11

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.
- Handwritten symbols on the sheet show Freshwater Wetland at DW3-116A through 118 as Exceptional Resource Value, but LOI letter lists it as Intermediate Resource Value.
- The handwritten notations and symbols are not always consistent. In some places, large triangles are hand-drawn over the flag points to identify a point as belonging to an Exceptional Value wetland (*e.g.*, DW3-27 thru DW3-40 and DW3 60 thru DW3-73), but in other places a note is written in the middle of the wetland that all of the points are considered Exceptional Value (*e.g.*, PMDA-W4-01 thru PMDA-W4-25).
- Freshwater Wetland points DW3-159 to -158A, and 162B are listed as Exceptional in the LOI letter for this sheet, but were listed as Intermediate on Sheet 10.
- The surveyor has not provided a label for wetland point DW3-158A.
- A single point (DW3-162B) does not define a wetland polygon -- the LOI letter identifies this point as Exceptional Value, but it is unclear from both the LOI letter and the drawing what this point connects with.
- When flag numbers are not consecutive on a given sheet, the LOI should not list them as though they are: The LOI letter states that DW3-53 thru DW3-27 are Exceptional value, but there is a large gap in

these numbers (there are no points DW3-51 through DW3-40) on this sheet). If the LOI letter is going to list points sheet by sheet, then it should only identify the points actually shown on a given sheet.

- The former coastal wetlands at DW3A-16C, 16D, 17, 17B, 17C; at PMDA-W2-36A, 37, 38, 38A; and at PMDA-W2-33, 34, 34A now apparently are filled.

- Points identifying coastal wetlands should be listed, not simply noted as "all remaining".

Sheet W-12

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.

- The former coastal wetlands northeast of DW3A-25, 26, 27, 28, 29, 29A, 29B, 29C, 29D, 30, 31, 31A, 32 and south of CLR27 now apparently are filled.

- The promulgated coastal wetlands boundary apparently is being revised to identify filled land at DW3A-72, 72A, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 89A.

- Handwritten notations are contradictory and confusing: point EL5, 6, and 7 have Exceptional Value notations, but are labeled Intermediate on one side and SOW on the other. These points also are outside the LOI Boundary. Points EL 32, EL33, and EL34 also are outside the LOI Boundary.

- Part of the AQ Wetland is listed as Exceptional (AQ93 thru AQ103) and part is Intermediate (AQ103 thru AQ105), but it is unclear what causes the change in RVC within the same wetland. Also, part of Wetland AQ is outside the LOI Boundary (AQ93 thru AQ95).

- Other wetland points that are outside the LOI Boundary include: W4-7 to W4-8, AX100 to AX103, AX106 to AX107, AT99 to AT103, and AT128 to AT130.

- Exceptional wetland point DW3-22 is missing from the sheet, as is its label.

- LOI letter listing of Exceptional value points DW3A-31A thru DW3A-72A should actually start with DW3A-31 (rather than DW3A-31A).

- The LOI letter states that "EL32 thru EL35 was incorrectly labeled on the plan, this is to be ignored and is not verified", which contradicts the statement on page 1 that the plans are accurate as shown.

- Points identifying coastal wetlands should be listed, not simply noted as "all remaining".

Sheet W-13

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.

- There are major discrepancies between this sheet and Sheet W-14 where they overlap (and the overlap is significantly more than any other two sheets).

- Resource Value Classification as Exceptional directly contradicts classification as Intermediate on Sheet W-14 for DW3-148 through DW3-154F; DW3-141 through 147I; DW3-118 through 140G; DW3-105 through DW3-92; and DW2A-1 through DW2A-5, DW2A-5 through DW2A-27a, DW2A-27a through DW2-31.
- Conversely, Resource Value classification as Intermediate on this sheet directly contradicts classification as Exceptional on Sheet W-14 for DW3-160 through DW3-158A.
- The following points are outside the LOI Boundary:
 - AP110 to AP119 to MW-3 to WM-1
 - LW-13 to LW-2
 - KW1 to KW7
 - NW-1 to NW-4
 - MB-WI-16
- Points identifying coastal wetlands should be listed, not simply noted as "all remaining".

Sheet W-14

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.
- This sheet is located to the *east* of Sheet W-13, yet it shows more detail to the *west* (and outside of the LOI Boundary) than is shown on Sheet W-13. There are numerous conflicts with RVC between this sheet and Sheet W-13, as listed above.
- For Exceptional Resource Value Classification, DW3-72 through DW3-78 apparently should be through DW3-79.
- For Intermediate Resource Value Classification DW3-76 apparently should be DW3-79 through DW3-105.
- The flag location and part of the label are missing for wetland points DW3-45T and DWS-45M, and the flag location and label are missing for DWS-45L (all of which are listed in the LOI letter for this sheet).
- Points identifying coastal wetlands should be listed, not simply noted as "all remaining".

Sheet W-15

- This sheet contains many sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.
- The following verified flag points are outside the LOI Boundary depicted on drawing:

AR102 to AR107	X1 to X7
AS100 to AS105	Y1 to Y8
AS112 to AS114	Z2 to Z4

- The label is missing for Exceptional RV wetland point DW3-450 and partly for point AS101.
- Handwritten notes on wetland DW2 (points DW2-4M thru DW2-8) label it both as "Exceptional" and as "IRV per amendment 7/25"; the LOI letter lists it as Intermediate.

Sheet W-16

- This sheet contains sporadic hand-drawn notations and hand-applied colored highlights which are not certified by a licensed surveyor.
- Exceptional RV wetland flag points listed in the LOI letter all are outside the LOI Boundary.
- RVC is not stated for adjacent freshwater wetlands WL-A5 through WL-A26 verified in LOI 0807-07-0002.1 (January 2013).
- Points identifying Intermediate Value wetlands should be listed, not simply noted as "all remaining".

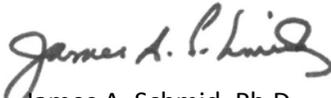
Sheet W-17

- This sheet contains hand-applied colored highlights which are not certified by a licensed surveyor.
- Points identifying Intermediate Value freshwater wetlands should be listed; instead the LOI letter says "All wetland points" are Intermediate, which clearly is wrong because it also lists some Exceptional Value wetland points. At minimum it should say "All *remaining freshwater* wetland points".

Based on the inconsistencies, internal contradictions, and other issues identified above we recommend that the LOI drawings be formally revised by the surveyor to accurately display the information which NJDEP has verified. Furthermore, we recommend that the LOI letter be revised and reissued by NJDEP and that copies of the revised drawings and reissued LOI letter be provided to Gloucester Township and made available to the public. These revisions must be made prior to any evaluation of any permit applications for this site.

Please let us know if you have any questions about any of the above.

Yours truly,


James A. Schmid, Ph.D.
President


Stephen P. Kunz
Senior Ecologist

cc: Tracy Carluccio



February 14, 2017

Suzanne Dietrick
Case Manager, Land Use Management
New Jersey Department of Environmental Protection
Trenton, New Jersey

Re: Comment Gibbstown Logistics Center (Repauno Site) Greenwich Township, Gloucester County, NJ;
Revised Multi-Permit Application to DLUR on Delaware River Partners, LLC permit applications under
NJAC 7:8 Stormwater Management Rules and NJAC Flood Hazard Area Control Act.

Dear Ms. Dietrick,

Delaware Riverkeeper Network submits this comment letter and attached expert report by Princeton Hydro regarding the Flood Hazard Area and Stormwater Management permit applications regarding the Delaware River Partners proposed Gibbstown Logistics Center.

Delaware Riverkeeper Network requests a public hearing on the proposed project under wetlands regulations, NJAC 7:7A-12.4. The nature, size, and scope of the proposed activities at this site will have substantial impact on wetlands on the site, the species that rely on these resources, and is of great interest to the public. Valuable information can be obtained from the public at a public hearing on this project, improving the understanding of its potential impacts.

The proposed project is simply too expansive and too heavy in scope for the Repauno site. Much of this site has reverted to natural conditions and is no longer the industrial landscape it was when in use by Dupont. The applicant is essentially shoehorning a huge development onto a site unsuited for this type and scope of development and use. The site contains large expanses of natural systems that are regulated areas, such as wetlands and riparian areas and is rich in flora and fauna habitat. Yet the proposed use of the site, the amount of development proposed, the infrastructure required and activities that will occur during construction and during the life of the project do not provide protection or minimization of impacts. Instead, the applicant tries to squeeze his intended use on to the site, regardless of the negative impacts to the resources and natural assets that are there. Further, the applicant does not attempt to provide mitigation for the losses that will occur.

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
drm@delawareriverkeeper.org
www.delawareriverkeeper.org

Throughout the applications, the applicant shows disregard for regulatory controls, an attempt to avoid regulation, does not show that resources are protected to the maximum extent practicable, and does not provide adequate justification for disturbance and degradation that would occur. There are numerous examples in the application package that demonstrate this. The applicant shows disregard for the wetlands on the site with the proposal to place stormwater infrastructure in the wetlands and the transition areas of wetlands. The applicant attempts to circumvent regulations by misinterpreting the exemption of “water dependent” projects, allowing intrusions into riparian and other natural areas that are not water dependent. The applicant claims an unlawful exemption from regulation by the refusal to recognize impervious liners of wet ponds as impervious. The applicant proposes to place dredged fill from the river channel into a “process ditch” without following channel modification requirements or assessing the full impacts. These are just some examples of why these applications are deficient. The attached expert report from Princeton Hydro provides a complete assessment of these and many more reasons these permits must not be issued.

The applicant has unlawfully segmented this project, ignoring the requirement that all aspects of the applicant’s development project must be considered under the federal definition of a “Single and Complete Project”, as per 33 CFR 330.2(i). Some portions of the site are under approval or request for approval by the municipality but are not part of these applications. Caverns on the site are planned to be used for hazardous liquid storage; how the project development will effect ongoing clean-up activities of contaminated groundwater at the site is not examined; warehouses are planned on portions of the site that are not part of this application package; there may be pipeline facilities developed at the site. The applicant must present all development on this entire site applying the definition of a Single and Complete Project but has not done so.

Delaware Riverkeeper Network will be filing additional comments and expert reports by February 17, the deadline for comments on these applications.

Thank you for the opportunity to comment.

Sincerely,

Handwritten signatures in blue ink. The signature on the left is 'Maya van Rossum' and the signature on the right is 'Tracy Carluccio'.

Maya van Rossum
the Delaware Riverkeeper

Tracy Carluccio
Deputy Director

Attached: Princeton Hydro DRP Gibbstown Logistics Center, Delaware River Partners LLC, Stormwater and Flood Hazard Area Review, Greenwich Township, Gloucester County, New Jersey, dated 2.13.17

February 13, 2017

Delaware Riverkeeper Network
Attn: Tracy Carluccio
Deputy Director
925 Canal Street 7th Floor
Suite 3701
Bristol, PA 19007

*Scientists, Engineers &
Environmental Planners
Designing Innovative
Solutions for Water,
Wetland and Soil
Resource Management*

**Re: DRP Gibbstown Logistics Center
Delaware River Partners LLC
Stormwater and Flood Hazard Area Review
Greenwich Township, Gloucester County, New Jersey
pH No. 1020.022**

Dear Tracy,

We have reviewed the plans and supporting calculations for consistency with the requirements of the N.J.A.C. 7:8 Stormwater Management Rules and N.J.A.C. 7:13 Flood Hazard Area Control Act.

Our review has indicates that the project does not meet numerous requirements of both the Flood Hazard Area and Stormwater Management Rules. More specifically, the project's proposed stormwater management does not meet the State water quality requirements. As you are aware, the project site is essentially surrounded by sensitive freshwater and coastal wetland habitat. Therefore, it is imperative that the proposed stormwater management system fully comply with the requirements set forth by the New Jersey Department of Environmental Protection (NJDEP).

Documents Reviewed

The following documents were provided to us for the purpose of our review:

- DRP Gibbstown Logistics Center Permit Plan Set prepared by Moffatt and Nichol dated July 2016, revised December 9, 2016.
- Stormwater Management Report for DRP Gibbstown Logistics Center, Township of Greenwich, Gloucester Country, New Jersey prepared by Langan Engineering and Environmental Services, Inc. dated July 2016, revised December 2016.
- Operations and Maintenance Manual Stormwater Management Facilities for DRP Gibbstown Logistics Center, Township of Greenwich, Gloucester Country, New Jersey prepared by Langan Engineering and Environmental Services, Inc. dated July 2016, revised December 2016, dated December 2016
- Copy of the December 9, 2016 DLUR application in response to the NJDEP Notice of Administrative and Technical Deficiencies prepared by Ramboll Environ.

□ 1108 Old York Road PO Box 720
■ 1200 Liberty Place
□ 203 Exton Commons
□ 20 Bayberry Road

Princeton Hydro, LLC
Ringoes, NJ 08551
Sicklerville, NJ 08081
Exton, PA 19341
Glastonbury, CT 06033

t. 908.237.5660 f. 908.237.5666
t. 856.629.8889 f. 856.629.8866
t. 610.524.4220 f. 610.524.9434
t. 860.652.8911 f. 860.652.8922

The following section provides more detailed comments on this application

Introduction

Since the last submission, one of the proposed wet pond systems has been eliminated. In total there are three (3) wet ponds, two (2) underground detention vaults and four (4) certified Manufactured Treatment Devices (MTD) to meet Total Suspended Solids (TSS) removal rates.

The applicant has claimed that peak flow control requirements are not applicable for a large portion of the project in accordance with NJAC 7:8-5.4(a)3.iv due to the project site being located in a tidal flood hazard area.

We offer the following comments related to the proposed stormwater features. For consistency we have included our original comment, the applicant's response (in italics) and our response in bold font.

Low Impact Development

1. One of the key elements of Low Impact Development is the preservation of natural features especially those that are important to the maintenance of water quality. In this case all four (4) proposed wet ponds are located in wetlands or wetland transition areas and in some cases both. Relative to wet ponds 3A and 4 entire sections of transition area are proposed to be eliminated so that the toe of the basin berm borders the existing wetland. The need to place stormwater facilities in regulated areas represents a failure to realistically understand the requirements of wetland avoidance and minimization as set forth in the 404(b)1 Guidelines. The need to encroach into regulated features such as wetlands and wetland transition areas provides a clear indication that the site is too small for the proposed use.

Through an iterative feasibility and design process, Delaware River Partners (DRP) has conceived a redevelopment plan that meets the project's needs, while avoiding or minimizing environmental impacts to the maximum extent practicable. Specifically, DRP has further reduced potential wetland impacts by nearly ten acres, to a total of 4.789 acres. The design process and potential impacts to wetlands are further described in the application documents, including the revised Alternatives Analysis and Compliance Statement. Low impact development techniques that disconnect impervious coverage and extend time of concentration pathways have been incorporated in the Marine Terminal South area. Specifically, flush curb has been provided to promote vegetative conveyance in lieu of traditional curbed inlets.

Since the last submission, Wet Pond 3A has been eliminated entirely from the Post Development Sub Watershed Plan and Wet Pond 4 has been converted into a larger wet pond, named "Wet Pond 3". The specific location and intended function of the flush curbs as noted in the applicant's response is not clear from our review.

Water Quality

2. The proposed wet ponds currently do not meet TSS removal requirements for 80% removal as designed and there are also significant discrepancies between the design plans and supporting calculations for the proposed structures. Currently, the storage representation in the plans and calculations is not consistent for Wet Pond 1. The volume in the calculations is overrepresented compared to what is depicted in the project design plans. The NJ BMP Manual states that the minimum required ratio of the permanent pool volume to the Water Quality Design Storm volume is 1:1. Wet Pond 5D does not appear to meet the requirements for TSS removal of 80% as the ratio is less than 1:1.

There are three proposed wet ponds included in the development. Wet Pond 2B provides a 2:97:1 ratio of permanent pool volume to stormwater quality storm runoff volume with an extended detention time of 12 hours. The resulting TSS removal rate is 85%. Wet Pond 3 provides a pool volume ratio of 3:1 with more than 24 hours of extended detention. The resulting TSS removal rate is 90%. Wet Pond 5D provides a pool volume ratio of 1.16:1 with 24 hours of extended detention. The resulting TSS removal rate is 81%.

The plan revisions adequately address this comment.

3. Wet Ponds 5D and 2B are both also prone to short-circuiting because the inflow outfalls are very close to the outlets creating a shortened residence time and therefore cannot meet the 80% TSS removal rate. Furthermore, there are two (2) copies of "Wet Pond A" Pond Reports found in the Stormwater Management Report. Inconsistent labeling of wet ponds and stormwater management facilities does not allow for proper review and analysis of the proposed design. Details for Wet Pond Profile 1 and 2 are inconsistent.

The wet ponds have been renamed and refined based on the redesigned Marine Terminal layout. Updated plans, calculations, and sections are provided in the submission documents. The outlet structures for Wet Pond 5D have been relocated to accommodate the new outfall location. The outlet control structure locations for Wet Pond 2B are based on the outfall locations and New Jersey Standards for Soil Erosion and Sediment Control (SESC). Specifically, the SESC standards require the outfalls to be separated by a minimum of 50 feet. Additionally, we have strategically located the outfalls to avoid wetlands disturbance. Revised routing calculations indicate runoff from the water quality storm will be detained for 12 hours.

The locations of the outlets for Wet Pond 5D and 2B have been revised to reflect this comment.

4. The hydrograph summary report for the manufactured water quality devices lists the Jellyfish 12 peak flow is over 12 cfs, which exceeds the maximum design treatment flow rate listed in Table 1 (approximately 4 cfs) in the certification letter. The call-outs for the Jellyfish 12 are inconsistent in the plans and water quality summary. Finally, the design flow rate for the Vortechs 1421 has not been provided in the certification letter.

5. *The underground basin and MTD configuration has been revised based on the new marine terminal layout. Watershed 5C is treated by four Jellyfish-12 devices in series, which are capable of treating up to 4.63 cfs individually or up to 18.52 cfs collectively. The water quality peak discharge is 17.67 cfs, which will be distributed evenly to each device. The Vortechs PC1421 MTD is the manufacturer's model number for the Vortechs 16000. For clarity, DRP's plans have been revised to indicate the Vortechs 16000 device.*

This item has been addressed.

6. The wetlands located in and around the project site will likely be adversely impacted by the development and its proposed stormwater management features. As designed, the closed wetland system located in Marine Terminal South will likely be negatively impacted (drained) as a result of the fact that the wetland is located at an elevation of approximately six (6) feet, which is three (3) feet higher than the stated normal water surface elevation of Wet Pond 3A. Wet Pond 3A also appears to have a lowest orifice elevation stated to be at an elevation of 4.75, which is inconsistent with the stated anticipated normal water surface. Similarly, the outlet of Wet Pond 4 is also well below the wetland and may also serve to artificially lower the groundwater table thereby negatively impacting the regulated wetland. Depth to groundwater should be provided in order to determine if and how the wet ponds will be impacted by the groundwater table and if the basins will draw water from the wetlands. It is unrealistic to suggest that the wetland may not be impacted as it is indicated in the plans.

7. *The revised layout for Marine Terminal South includes Wet Pond 3, which has been designed with a normal water surface elevation (NWS) of 3.0. The adjacent wetlands are located at elevations 2.0 – 4.0. The proposed pond NWS is based on an evaluation of soils throughout the site and the observation of standing water at lower elevations. Furthermore, DRP proposes to line the wet pond with a clay liner to ensure that the pond does not draw groundwater or drain the wetlands. It is Langan's professional opinion that DRP is proposing a pond in an appropriate location on the tract with a normal water surface that will not jeopardize the viability of the adjacent wetlands.*

The wet ponds are proposed with a clay liner as shown on the detail on Sheet C-506. However, the detail notes that the clay liners are not to be installed where groundwater is encountered. Therefore our original comment still stands and as designed the wet ponds with normal water surface elevations near or below adjacent wetlands will be prone to artificially lower the groundwater table and impact adjacent sensitive habitat.

8. The design criteria for wet ponds in the NJ BMP Manual states the minimum inflow must be 20 acres or a water budget analysis must be provided. Wet Pond 2 has 17 acres of drainage and Watershed 1A in the Marine Terminal South is approximately 13 acres. No water budget analysis is provided.

For clarity "Wet Pond 2" has been renamed "Wet Pond 2B" to match the name of its respective watershed. Wet Pond 2B has a drainage area of 14.52 acres, which is less than the 20-acre requirement. A water budget analysis has been added to the revised Stormwater Management Report under Section 3.8 to demonstrate that the normal water surface elevation of the pond will be sustained throughout the year. Supporting calculations can be found in Appendix G. Wet Pond 3 has a drainage area of 17.6 acres, which is less than the 20-acre requirement. A water budget analysis has been added to the revised Stormwater Management Report under Section 4.9 to demonstrate that the normal water surface elevation of the pond will be sustained throughout the year. Supporting calculations are provided in Appendix O. All other wet ponds have a contributing area greater than 20 acres.

This item has been addressed. No further response is necessary.

9. Finally, massive portions to the western part of the site are not proposed to have any water quality treatment measures whatsoever. The applicant argues that since there is no vehicular traffic they need not provide any water quality measures. However, proposed use of the site is high intensity and industrial; including storage of large quantities of hazardous material. Therefore, regardless of what the potential amount of vehicular traffic may or may not be, the site represents a water quality "hot spot" requiring comprehensive water quality treatment. The failure to treat stormwater runoff from impervious surfaces represents a conflict with New Jersey's water quality standards.

The stormwater management regulations require water quality measures for impervious areas only. Traditionally, gravel areas do not represent an impervious surface; however, we recognize the intent of the regulations and have provided water quality measures for all gravel surface areas that have the potential for vehicle traffic. The decision to omit water quality measures from the areas within the containment berms was based on discussions with NJDEP stormwater management reviewers. The bermed containment areas will be equipped with sensors and infrastructure that provide the ability to capture all liquid and prevent contaminants from being discharged to the downstream waterways. All stormwater runoff from impervious surfaces and gravel areas exposed to vehicular traffic are proposed to be treated in compliance with the State's water quality standards.

No further explanation is given regarding what type of "sensors and infrastructure" are proposed, it is assumed that these items are likely associated with emergency spill response measures. Our comment specifically related to the non-point source

water quality issues that should be expected from an area that would be expected to product comparatively high levels of non-point source pollution. Furthermore, the gravel area is completely lined and is therefore impervious.

Groundwater Recharge

10. Section 3.5 of the stormwater management report states that “...there will be no post development annual recharge volume deficit” since the site is not mapped to provide any groundwater recharge under existing conditions. However, undoubtedly the site currently provides some amount of shallow groundwater recharge which may partially support surrounding freshwater wetlands. Under proposed conditions the site’s impervious coverage will increase by more than 100 acres; eliminating any groundwater recharge.

According to N.J.A.C. 7:8-5.6(b)1, the New Jersey Geological Survey Report GSR-32 A Method for Evaluating Groundwater-Recharge Areas in New Jersey may be used to calculate and ultimately demonstrate compliance with the NJ standards for groundwater recharge. Based on the NJDEP Annual Groundwater Recharge Analysis Spreadsheet (based on GSR-32) the proposed development will not create an annual deficit in groundwater recharge. The soils in and around the proposed area of improvements are Hydrologic Soil Group D, which are categorized by wet clayey soils that prevent water from recharging the underlying aquifers.

We agree the Groundwater Recharge Analysis Spreadsheet suggests that there is no groundwater recharge in the existing condition. However, we reiterate that the site currently provides some amount of shallow groundwater recharge which may partially support surrounding freshwater wetlands. The site’s impervious coverage will increase by more than 100 acres; eliminating any groundwater recharge.

Peak Flow Rate Control

As stated previously, the applicant has indicated that a large portion of the site is exempt from the peak flow rate requirements, in accordance with NJAC 7:8-5.4(a)3iv. Specifically they assume that the northern portion of the site which drains directly to the Delaware River is exempt.

11. In the Marine Terminal North Pre-Development Watershed Plan Drawing DA101 and Marine Terminal Southern Area Drawing WB301, the time of concentration drainage path does not start at the edge of the sub-watershed, thereby effectively reducing the apparent time of concentration under existing conditions. The calculations should be revised to reflect appropriate travel lengths. Under post development conditions, watershed DA-2b has a sheet flow length of 350 feet, much greater than the 100 feet limit which is generally accepted.

The watersheds have been redefined based on the revised marine terminal layout. The time of concentration paths have been revised accordingly. A maximum sheet flow path length of 150 feet is assumed, which is generally accepted under NRCS TR-55 methodology.

This item has not been addressed. The flow length for Watershed DA-2B has not revised from 350 feet in the latest submission.

12. The pre-development and post-development curve numbers used in the applicant's analysis are inappropriate for the project site. The gravel substrate to be used across the site was represented by a lower Curve Number (CN) than is appropriate for this type of land use in accordance with standard engineering practice. The CN selected by the applicant, per TR-55, is applicable only to gravel roads and streets including a pervious right of way (which does not exist in this application). In order to more accurately reflect the runoff from gravel parking lots standard engineering practice would dictate use of a CN value of 96 as being reasonable for the gravel roadway surface itself. The supporting calculations for the project use a CN value of 91. Furthermore, the CN value for any of the gravel areas where an impervious liner is proposed should be 98.

The selection of a CN value of 91 for gravel areas is appropriate given the proposed use of those areas. The vast majority of proposed gravel areas will not be exposed vehicular traffic, meaning the gravel will not be compacted such that a higher CN would be appropriate.

We reiterate that if an impervious liner is proposed, then the area should be expected to have the hydrologic response of an impervious surface (CN = 98).

Flood Hazard Area+

The proposed project requires an individual Flood Hazard Control Act Individual Permit and thus must fully satisfy the applicable requirements of (N.J.A.C. 7:13), However rather than illustrate compliance the applicant relies on rhetoric. The applicant's letter dated December 9, 2016 in response to the project's technical deficiencies indicates that the design was modified to "further reduce overall land disturbance and impacts to environmental features, including wetlands". The applicant appears to fixate on the reduction of wetlands impacts while ignoring the impacts to the flood hazard area and riparian zone. A review of the development reflects a very similar footprint with minor adjustments to the "Logistics and Value Added Area". This area was shifted to the south and is not contiguous with the other section of the Marine Terminal as a way to minimize impacts to the forested wetland complex. A notation exists on the plans stating that the proposed project lies within the Special Flood Hazard Area as indicated on the FEMA Map No. 34015C00058F dated August 17, 2016 but the elevation does not appear on the plans. G-103 entitled, "Flood Hazard Verification" was provided in the plan set. It is

stated in the Compliance Statement that a FEMA Method 2 delineation of the Flood Hazard Area was performed, however an Engineering Report detailing the delineation of the FHA has still not been provided. A Riparian Zone Boundary (Sheet C-003) sheet has been added to the plan set as required for all Individual FHA Permit applications. The temporary versus permanent riparian zone disturbance areas are not apparently obvious. The follow table was provided to reflect the riparian zone disturbance:

Table 4 – Summary of Resource impacts reflects the following as it relates to Riparian Zone Disturbance

Resource	Resource Value	Permanent Disturbance (Ac)	Temporary Disturbance (Ac)	Undisturbed (Ac)
Riparian Zone	Vegetated	3.036	0.489	9.513
	Non-Vegetated	2.252	0.228	3.913

The applicant continues to state that per NJAC 7:13-11.2(p) that the project is a water dependent development along a tidal water that will obtain a CZM Permit and that there is no limit on disturbance to vegetation in the riparian zones and no mitigation is required or proposed. Importantly, the application conveniently omitted relevant portions of NJAC 7:13-11.2(p) that directs an applicant for a FHA individual Permit to the definition of water dependent development at NJAC 7:7-1.5. This definition states that “Water dependent” means development that cannot physically function without direct access to the body of water along which it is proposed. The definition goes on to state that “uses, or portions of uses, that can function on sites not adjacent to the water are not considered water dependent”. The definition at NJAC 7:7-1.5 cannot be any clearer as it provides an example that states “in a maritime operation, a dock or quay and associated unloading area would be water dependent, but an associated warehouse would not be water dependent. The applicant’s position that riparian zone impacts are limitless is therefore obviously flawed. Since portions of the project are not water dependent and in those areas riparian zones impacted by non-water dependent uses must be fully accounted for and described in the application. As such any proposed buildings, warehouses and their accompanying parking lots that are not consistent with the definition of a water dependent use must therefore account for impacts to riparian zones as part of the application.

In addition, the applicant’s interpretation of the rules remains unchanged. They continue to circumvent the regulations in their entirety. As the FHA rules specifically reference compliance with the Coastal Zone Management Rules with regard to water dependent uses, the riparian zone limits would be restricted to those portions of the site located within the Coastal Zone. Sheet C003 of the plan set indicates that the Coastal Zone is limited to the portion of the site immediately adjacent to the Delaware River. In accordance with NJAC 7:7E-1.2 the extent of the coastal zone is 500 feet from the mean high water line. As such any portion of the site outside of NJDEP’s definition of the coastal zone would not be covered by NJAC 7:13-11.2(p) and thus require compliance under a different standard.

Moreover, the FHA regulations also state that “for any proposed water dependent development, the application must demonstrate that there is no other feasible location onsite to construct the development that would reduce or eliminate the area of riparian zone vegetation to be cleared, cut and/or removed. The applicant has now provided an Alternatives Analysis whereby they conclude that “there is no suitable alternative site for this project in the region and DRP has selected a redevelopment program that minimizes environmental impacts by concentrating the project within previously disturbed areas that housed over a century of industrial development”. The applicant explains that site has been designed to coincide with the previous development where the development was concentrated in the northern waterfront area. The proposed pier and ship berth coincides with the existing deteriorated wharf and berth minimizing the amount of new dredging. An open platform structure is proposed to extend beyond the current footprint of the wharf by the open structure avoiding fill in open water. The applicant further explains that the development plans have “undergone several design iterations in order to reduce impacts to the wetlands, riparian zones and other regulated resources to the maximum extent practicable without impacting the overall project purpose”. The applicant does not consider reducing the scope of their project area to minimize or avoid potential environmental impacts.

The alternatives analysis provided an evaluation of the following properties:

1. Existing SJPC facilities in City and County of Camden
2. DuPont property in Carney’s Point, Salem County
3. Ferro Industrial site in Logan Township, Gloucester County
4. Raccoon Island Site in Logan Township, Gloucester County
5. Former BP Oil Terminal Site in Paulsboro, Gloucester County
6. Former DuPont Repauno site in Greenwich Township, Gloucester County
7. Southport Brownfield Development Area in Gloucester City, Camden County
8. Penn Terminal site in Eddystone, Delaware County, PA
9. Southport Marine Terminal Complex in Philadelphia, Philadelphia County, PA.

The below table was reported and ranked the impacts for the various sites.

	No Action Alternative	SJPC Camden Terminals	DuPont Carney's Point	Ferro Industrial Site	Raccoon Island	Paulsboro Marine Terminal	Former DuPont Repauno Site	Southport Brownfield	Penn Terminal	Southport Marine Terminal
Environmental Impacts	No Impact	2 – Low Impact	4 – High Impact	5 – Highest Impact	5 – Highest Impact	3 – Medium Impact	2-3 Low to Medium Impact	4 – High Impact	3 – Medium Impact	3 – Medium Impact
Project Purpose	Not Met	Not Suitable	Suitable	Not Suitable	Suitable	Not Suitable	Suitable	Not Suitable	Not Suitable	Not Suitable
Logistics	N/A	Not Favorable	Not Favorable	Not Favorable	Not Favorable	Not Favorable	Favorable	Not Favorable	Not Favorable	Not Favorable
Cost	N/A	Moderate Cost	Moderate Cost	Highest Cost	Highest Cost	Lowest Cost	Moderate Cost	High Cost	Moderate Cost	Moderate Cost
Technology	N/A	Required	May be Required	May be Required	Not Required	Not Required	Not Required	May be Required	Required	May be Required

While all sites are redevelopment sites with environmental constraints, the applicant concluded that the DRPs objective for the Marine Terminal would be best suited for the former DuPont Repauno Site. Although the site contains all the amenities that are required for a marine terminal the environmental resources have not been clearly and objectively shown to be protected to the maximum extent practicable. Moreover, as previously indicated full compliance with the riparian zone requirements of the FHA remains unsatisfied.

It seems unlikely that any riparian vegetation associated with the many regulated waters onsite could be sacrificed as part of this project without further evaluation. It does not appear that that the applicant will provide mitigation for the cleared riparian zone vegetation as the applicant states in the compliance statement that pursuant to NJAC 7:13-11.2(p) and tables 11.2, there is no limit on disturbances to riparian zones in tidal areas for water dependent uses provided that the disturbance is justified. This element of the FHA rules has not been established and based on the language of NJAC 7:13-11.2(p) the absence of any riparian zone impact limit if justified would be restricted to the portion of the site in the site considered to be regulated under the Coastal Zone Management Rules. Based on the plan sheet entitled Upland General Arrangement Plan Riparian Areas, sheet C-003, Index 38 of 156, the Coastal Zone is limited to the portion of the site immediately adjacent to the Delaware River.

The applicant states in the compliance documents that all proposed buildings will be located at least 25 feet from the top of the bank or edges of water. Furthermore, all proposed buildings

will be designed to withstand flooding pressures up to the FFE elevation. The plans indicated that the FFE is 11.00 feet.

Dredging within a portion of the Delaware River is necessary to make the proposed port accessible to vessel traffic from the federal navigation channel. With regard to NJAC 7:13-11.1 Requirements for a regulated activity in a channel, the compliance statement mentions the proposed dredging and the consequent permanent placement of fill within the Process Ditch, a portion of which is a regulated water and the balance a permitted wastewater treatment ditch. The applicant states that the “process ditch must be filled in order to construct the project in a way that meets the project purpose. The Process Ditch is a man-made ditch originally constructed to convey industrial wastewater, which now serves as part of a stormwater management system”.

The applicant states in the Compliance Statement and Alternatives Analysis that the project has been “substantially reduced and reconfigured to avoid impacts to regulated areas, including riparian zones and regulated waters. Disturbance to the channel has been reduced to the maximum extent practicable and the activities proposed within the regulated channels are required to meet the purpose of the project”. Details to demonstrate channel stability are still not clearly defined as required by the regulation. It would follow that issues could result from potential channel instability due to the placement of fill. More importantly key elements of this section of the FHA such as NJAC 7:13-11.1(b)2 were not included in the compliance statement. This requirement states that “[D]isturbance to the channel is eliminated where possible; where not possible to eliminate, disturbance is minimized through methods including relocating the project and/or reducing the size or scope of the project. No discussion regarding compliance with this section of the regulation was provided.

Lastly, no attempt was made to illustrate the project’s compliance with NJAC 7:13-11.1(c) which includes the following; “[T]he Department shall issue an individual permit for a channel modification only if the applicant demonstrates that, in addition to meeting the requirements of (b) above, the channel modification meets at least one of the following requirements: 1. The channel modification is necessary to improve the ecological health of the regulated water and its riparian zone, or to control existing flooding or erosion which poses an immediate threat to life, property or a lawfully existing structure; or 2. The channel modification is necessary for the construction of a bridge or culvert, and the following requirements are satisfied: i. The disturbance to the channel is the minimum necessary to successfully implement the project; ii. A bridge is constructed rather than a culvert, where feasible; iii. The length of channel covered by a bridge or enclosed in a culvert is the minimum feasible; and iv. No more than 200 linear feet of channel (including the bridge or culvert) is disturbed unless the applicant demonstrates that disturbance to a longer segment of channel cannot feasibly be avoided. It is clear from the above requirement that impacts to channels are viewed seriously by the NJDEP and no provision for the elimination of a channel is provided. Full compliance with all elements of this regulation must be required of the applicant. If an applicant is unable to comply with this regulation a hardship exception would be required. It is assumed that this is the reason for the hardship

exception but not definite as this section of the regulation is not addressed in the compliance documents.

With regard to NJAC 7:13-11.6 - requirements for a regulated activity in or affecting a present or documented habitat for threatened and endangered species, the Natural Heritage Database does not indicate that there are any threatened and endangered species that are critically dependent on the regulated waters for their survival. The applicant states in their application documents that no vegetation within 1,000 feet of the identified bald eagle nest will be disturbed. The applicant states that “out of abundance of caution, the project has been redesigned to avoid disturbing more than 20 acres of contiguous wooded habitat. Additionally, in areas of potential roosting habitat, tree removal will be avoided to the maximum extent practicable during summer roosting season from April through September 30”. Impacts to the Atlantic and shortnose Sturgeon will be avoided by conducting work within the recommended construction window and implementing dredging best management practices. The applicant stated that “given the nominal estimated increase in ship traffic, it is unlikely that there will be significant adverse impacts to the Atlantic or shortnose sturgeon as a result of the proposed project”. It appears that this comment has been addressed by the applicant.

NJAC 7:13-12.1 (Requirements that apply to all regulated activities) requires that the regulated activities not cause a significant and adverse effect on: water quality, aquatic biota, water supply, flooding, drainage, channel stability, T&E species, navigation, energy production and fishery resources. The applicant states that through the use of BMPs and appropriate erosion control measures sediment runoff to the Delaware River and other waterways will be minimized. The applicant states that post construction drainage will be redirected into stormwater management facilities and construction of the site will not adversely affect drainage on the project site. More discussion and comments related to the project’s proposed stormwater management and compliance with NJAC 7:13-12.2 is provided in the Stormwater Management section of this letter above.

With respect to NJAC 7:13-12.3 (Requirement for excavation, fill and grading activities), the compliance statement states that a portion of the Process Ditch will be filled in order to facilitate proper internal circulation between internal areas of the Marine Terminal. Under existing conditions, the Process Ditch is the site’s major internal waterway. A large portion of the Process Ditch will be completely filled/eliminated under proposed conditions; including an estimated 1,000 linear feet of the regulated portion of the waterway which has a drainage area of greater than 50 acres. In fact, the drainage area of the portion of the waterway to be filled/eliminated is as large as 120 acres. No adjustments to the design have been made to address comments relative to excavation, fill and grading activities.

The applicant states that the application complies with NJAC 7:13-12.4 Requirements for a structure, however, no details or notes are provide on the plans to reflect compliance for structures within the regulated area, other than the FFE is 11.0. In addition and in accordance with NJAC 7:13-12.4(d) for structures located adjacent to channels, channel erosion must also be addressed.

The compliance statement also states that it is not feasible to construct the proposed rail line and private roadway and parking area one foot above the Flood Hazard Area Design Flood elevation, per NJAC 7:13-12.6 (requirements for a railroad, roadway and parking area). Drawings C-101 through C-123 indicated that some of the parking spaces and access driveways will not be constructed above the regulatory flood hazard area elevation. Most driveways will be situated at or above the flood hazard area elevation. However, due to the existing road elevations, the applicant states that it is not “feasible to construct all the driveways above the flood hazard elevation. All loading spaces and trailer stalls will be constructed no less than 1.5 feet below the flood hazard design elevation to ensure mobility and prevent water damage during flooding conditions. All parking areas consisting of 10 or more spaces constructed below the flood elevations will be signed per NJAC 7:13-12.6(f)v. Unfortunately, the application has not provided the justification to support this claim.

As discussed in this review letter this application remains deficient as it continues to fail to adequately address regulatory compliance starting with its failure to clearly identify the areas covered by various regulations including the Freshwater Wetlands Protection Act, Flood Hazard Area Control Act and the Waterfront Development Rules. For example, although the application has now identified the Coastal Zone, the applicant continues to apply its importance beyond its regulatory limits. For example, although the area of the site under Coastal Zone jurisdiction may be considered for a water dependent use, as it relates to riparian zones those areas outside of the coastal zone should be reviewed solely under the requirements of the Flood Hazard Control Act. In the absence of this fundamental step in the regulatory process, it remains difficult to understand how this project complies with all of the relevant New Jersey regulations. The failure to accurately apply the limits of the Coastal Zone is apparent in the applicant’s calculations of the impervious cover limits in which the entire site is included. Please refer to Sheet C-003 to see the actual limit of the Coastal in which the Coastal Zone rules apply. As previously mentioned the maximum extent of the Coastal Zone in this part of New Jersey is 500 feet from the Mean High Tide line. It appears that the numbers provided are based on the land area of the 371 acre project site rather than that of the subset of the land that constitutes the Coastal Zone.

In addition, the level of ecological impact assessment associated must be commensurate with the magnitude of this project. In other words the application must rely on facts in which to base its position; that the project will or will not have significant impacts rather than rhetoric. For example, the applicant indicates that “regulated portions of the Process Ditch must be filled in order to construct the Project in a way the meets the project purpose.



The Process Ditch is a man-made ditch originally constructed to convey industrial wastewater, which now serves as part of a stormwater management system for the Property". The issue of concern is that the Process Ditch is a regulated water with a riparian zone and as indicated on the 2016 photograph a forested riparian zone. The filling of the Process Ditch related to the flood hazard rules is described as follows; "fill within the Process Ditch is not expected to significantly adversely impact aquatic biota. Because the proposed activities are water dependent, mitigation for impacts to riparian vegetation are not required. Accordingly, this condition is met." As previously stated the regulations do not include this area as being part of the proposed water dependent use so impacts warrant mitigation as well as an alternatives analysis that seeks to avoid and minimize impacts. Moreover, the use of rhetoric to quantify impacts is inappropriate for a project of this magnitude. In addition, due to the forested nature of the riparian zone impacts it should be readily apparent that project impacts will go well beyond aquatic biota and should also evaluate migratory birds including waterfowl, wading birds, shorebirds and passerines. The assessment of impacts for this loss of a regulated water and riparian zone lacks a sufficient level of ecological analysis to justify the project and indicate that the project will not result in a significant adverse impact. This loss of this resources is especially problematic in that it is at the headwaters of a larger downgradient system. Lastly, instead of seeking to avoid regulated impacts the applicant instead simply indicates that the filling proposed "within regulated channels is required to meet the basic purpose of the project" and that the "selected site configuration minimizes impacts to the riparian areas the maximum extent practicable". It should be readily apparent that statements such as these simply serve as an apology for the project without any realistic attempt to minimize impacts. As with all large redevelopment projects the applicant's ideal project should not dictate the extent of regulated activities and as in this case, there is ample opportunity to avoid impacts by reducing the size of the project.

The proposed project contemplates a sufficient amount of regulated impacts to warrant a public hearing. In accordance with N.J.A.C. 7:7A-12.4 we recommend that a public hearing be scheduled to discuss the issue raised in this letter as well as any other relevant regulatory and environmental issues.

This concludes our initial review of the DRP Gibbstown Logistics Center. We reserve the right to make additional comments in the future as it becomes necessary. I look forward to meeting with you to discuss this report in detail and answer any questions that you may have. Please do not hesitate to contact me with any questions. We appreciate the opportunity to provide you with these services.

Sincerely,



Mark Gallagher
Vice President



Clay Emerson, Ph.D. PE CFM
Senior Project Manager

KK
Cc: Kelly Klein
Encl: (0)



February 17, 2017

Suzanne Dietrick
Case Manager, Land Use Management
New Jersey Department of Environmental Protection
Trenton, New Jersey

Re: Comment Gibbstown Logistics Center (Repauno Site) Greenwich Township, Gloucester County, NJ;
Revised Multi-Permit Application to DLUR on Delaware River Partners, LLC permit applications including
permits regarding freshwater wetlands, coastal wetlands, and waterfront development

Dear Ms. Dietrick,

Delaware Riverkeeper Network submits this comment letter and attached expert report by Schmid & Company Inc., Consulting Ecologists regarding the Multi-Permit Application to DLUR regarding the Delaware River Partners proposed Gibbstown Logistics Center.

Delaware Riverkeeper Network requests a public hearing on the proposed project under wetlands regulations, NJAC 7:7A-12.4, based on the important issues that have been raised in the attached report. It is critically important that the public be informed and has the opportunity to comment on the proposed project and the impacts of the development and activities of the proposed project on wetlands and related resources. Dr. Schmid points out that how environmental protection will be maximized needs to be fully and publicly disclosed for this large and complex project, recommending a public hearing as the minimum outreach that should be made by the Department. Delaware Riverkeeper Network considers public input into the decisionmaking process essential and that public engagement will help inform and improve the decisions that are made by the Department.

Delaware Riverkeeper Network supports the analyses and conclusions of the Schmid & Company report. The inconsistencies, internal contradictions, uncertainties and other issues that have been meticulously examined in the report establish that the proposed permits are not ready for action by the Department and the lack of adequate information does not allow a conclusion that the proposed activities comport with regulations. In fact, Schmid & Company conclude that revisions must be made to correct these inconsistencies and apparent errors; applications must be revised and resubmitted before the Department can finalize evaluation of the applications for the site. Once that is accomplished, Delaware Riverkeeper Network and the public can review and comment on the applications containing complete information as required by regulation.

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
drm@delawareriverkeeper.org
www.delawareriverkeeper.org

Much of this large riverfront and river-connected property, which is now naturally vegetated and habitat-rich after decades of dormancy as an industrial site, is proposed for expansive, intense, and multi-faceted activities. Yet the impacts that would occur from the proposed project on the important wetlands, riparian, riverine, ground and surface water, and flora and fauna species and habitat on the site have not been fully identified or analyzed in the application materials. The successful avoidance and/or minimization of adverse impacts to these resources cannot be concluded from the information presented and Schmid & Company advises that this must be accomplished by the applicants. Delaware Riverkeeper Network opposes the issuance of approvals for any of the multi-permit applications for this project.

Thank you for the opportunity to comment.

Sincerely,

Handwritten signatures in blue ink. The signature on the left is 'Maya K. van Rossum' and the signature on the right is 'Tracy Carluccio'.

Maya van Rossum
the Delaware Riverkeeper

Tracy Carluccio
Deputy Director

Attached: Schmid and Company Inc., Consulting Ecologists report re. Multi-permit applications to NJDEP for Delaware River Partners LLC Gibbstown Logistics Center (Repauno Site Redevelopment), Greenwich Township, and Gloucester County, NJ dated February 17, 2017

SCHMID & COMPANY INC., CONSULTING ECOLOGISTS
1201 Cedar Grove Road, Media, Pennsylvania 19063-1044
610-356-1416 fax: 610-356-3629
www.schmidco.com

17 February 2017

Maya K. van Rossum
Tracy Carluccio
Delaware Riverkeeper Network
925 Canal St., Suite 3701
Bristol, Pennsylvania 19007

In re: **Applications to NJDEP for Delaware River Partners, LLC**
Gibbstown Logistics Center (Repauno Site Redevelopment)
Greenwich Township, Gloucester County

Dear Ms. van Rossum and Ms. Carluccio:

Pursuant to your request we have reviewed certain information related to the above-referenced permit applications as revised through 9 December 2016. The project site is large. Its pattern of waters, waste treatment facilities, coastal wetlands, and freshwater wetlands is complex as a result of topography and past land uses.

We note that additional changes have been made in the Resource Value Classifications assigned to freshwater wetlands on the subject property in a second amended LOI dated 11 October 2016, but a number of contradictions remain unaddressed since our letter to you dated 14 October 2016. These contradictions carry over into the applicant's site plans dated December 2016. Until resolved, they render unclear the environmental sensitivity under present conditions at the project site. Consequently it is impossible to make a rational evaluation of the permit applications.

We also note that supplemental information was provided and certain changes were made in the applicant's site plans between August and December 2016 in response to the Department of Environmental Protection's 26 August 2016 deficiency letter. Some of these changes appear to have reduced the extent of proposed development within wetlands and associated regulated areas. It is gratifying to observe steps take to reduce the proposed direct wetland impacts. But there are many remaining questions as to whether proposed impacts in fact have been minimized and wetland avoidance maximized, as required by regulation. Few of the concerns expressed in our letter to you dated 25 August 2016 have been addressed. In the paragraphs below we offer first our concerns with the LOI and then our comments on the permit applications.

Freshwater Wetlands Letter of Interpretation (LOI)

Application was made for a Letter of Interpretation covering parts of the applicant's property during January 2016 (File 0807-16-0001.1). As of this date we have not seen the accompanying consultant's report, wetland documentation forms, the unrevised set of drawings dated 29 December 2015, or the

intermediate version of those drawings dated 23 May 2016 (which added certain wetlands following field inspections by agency reviewers). Greenwich Township claims never to have had a copy of this application and has never been able to make it available for public review. We understand that you have also requested a copy of this information from the New Jersey Department of Environmental Protection, but it has not been provided by them in response to your Open Public Records Act request. We are not aware that the LOI files have been provided to Greenwich Township, as requested in the Department's deficiency letter.

We have reviewed the text of the Line Verification LOI letter issued by the New Jersey Department of Environmental Protection on 11 July 2016, and the LOI Amendment letters issued on 29 July and 11 October 2016. We reviewed a single set of 17 drawings related to the subject LOI that had been provided to you electronically by the Department separately from the LOI letters. The status of those drawings is unclear --- as discussed in detail in our 14 October 2016 comments, they appear to be the 8 June 2016 drawings marked up by the Department's staff during preliminary review of Resource Value Classifications. We have never seen a final set of clean, unmarked LOI drawings.

The LOI letters all refer to the set of drawings as of the applicant's third (last) revision dated 8 June 2016. We believe that the applicant has transferred those approved wetland boundaries to its V series and C series of site plans in the permit applications. No flag points or line segments are labeled on those site plan drawings, however, so we cannot confirm accurate transcription. The applicant claims that there are 62 wetland polygons onsite (December 2016 compliance statement, page 10), but there is no way readily to confirm this tally. In a table included on permit application Sheet C-001, the applicant lists the areal extent of impacts associated with 33 wetlands. For clarity we reference our specific comments to the applicant's flag numbers shown on the LOI drawings.

We previously provided comments to you on the two July LOI letters in our comments dated 14 October 2016. Some of the issues we raised regarding the July LOI letters continue to be problems with the 11 October 2016 LOI, and there are new problems as well, all of which have a direct effect on any evaluation of the proposed project. The Department's Resource Value Classification (RVC) of freshwater wetlands affects the standards applicable to evaluating requests for damaging them. The RVC also establishes the extent of regulated Transition Areas adjacent to those wetlands. We offer the following comments based on the information currently available to us.

Some of the more significant problems with the 11 October LOI amendment include the following:

- The Department's basis for classifying specific freshwater wetlands on this project site as having Exceptional or Intermediate resource value is not explained in the LOI letters, nor is it clear from the drawings reviewed. The Department clearly disagrees with many of the applicant's recommended classifications, which themselves are not clearly explained.

- Wetland DW3 in the south-central section of the site consists of 5 distinct parcels. In the original LOI, all 5 parcels of Wetland DW3 were assigned the RVC of Exceptional Value. In the 29 July LOI

Amendment, 4 of the 5 parcels were classified as Exceptional Value; a small 0.12-acre rectangular area bounded by Flags DW3-158 through DW3-161A was inexplicably changed to Intermediate Value. In the October LOI, that 0.12-acre parcel plus 3 others (and possibly part of the fourth, see below) were classified as Intermediate Value. We can see no obvious reason for these changes, and no justification was articulated by the Department for these changes in its LOI amendments.

- The part of a parcel of DW3 that might possibly have been reclassified to Intermediate Value in the October LOI involves the southwestern section of the largest of the 5 separate parcels; specifically the part bounded approximately by Flags DW3-76 through DW3-105 (LOI Sheets 13 and 14). That part of Wetland DW3 is classified differently in the Department's listing for the two adjacent, overlapping sheets in the October LOI. It is classified as Exceptional Value in the listing for LOI Sheet 13 (DW3-92 through DW3-106M, DW3-79 through DW3-87), but it is classified as Intermediate Value in the listing for LOI Sheet 14 (DW3-76 through DW3-105). The applicant apparently used this discrepancy to its advantage and selected the lesser value (Intermediate) for this section of the wetland, showing only a 50-foot wide Transition Area on Project Drawing Sheets V-119 and C-119. The discrepancy in the value classification for this section of Wetland DW3 has not been resolved by the Department.

- If the portion of Wetland DW3 south of a line connecting Flags DW3-105 to DW3-76 was intentionally reclassified to Intermediate Value, no reason occurs to us for splitting this large, contiguous, forested wetland into two RVC categories. All nesting habitats mapped for bald eagle and osprey (per Appendix E of the December 2016 Joint Permit Application) extend across this entire central forest wetland and do not arbitrarily split it into two.

- Similarly, Wetland DW2 on LOI Sheet 14 (Flags DW2-8 through DW2-27M, DW2-27M to DW2A-1, DW2A-1 through DW2A-5, DW2A-5 to DW2-27a, DW2-27a through DW2-4M) is classified as Intermediate Value in the October LOI, but as Exceptional Value in the original July LOI. It was inexplicably reclassified to Intermediate Value in the 29 July Amendment. This wetland is within the same central forest area as Wetland DW3 just to its north (Flags DW3-38 through DW3-62) and as Wetland DW1 (Exceptional Value) just to its east (Flags DW1-1 through DW1-18).

- Wetland U (Flags U-1 through U-24; LOI Sheet 15) was classified as Exceptional Value in both July LOIs, but was inexplicably changed to Intermediate Value in the October LOI. This change has the effect of reducing the encroachments for which approval is required on Project Drawing Sheets V-122 and C-122.

- In some places on this site coastal wetlands now are surrounded by or bordered by uplands where the officially promulgated upper inland wetland boundary indicates that there previously was wetland. It is unclear whether those changes are a result of fill which was illegally placed since implementation of the Wetlands Act of 1970. If no prior authorization had been granted, the apparent fill in such areas may need to be authorized by inclusion in the current application. In our experience, where potential enforcement issues such as this arise, the applicant must resolve such matters with the Department before a permit can be issued. Specific examples on this project site include: LOI Sheet 8 Inset C, LOI

Sheet 10 near Flags PMDA-East-1 and PMDA-West-5, LOI Sheet 11 near Flag DW3A-17, LOI Sheet 12 by Flag DW3A-32, and LOI Sheet 13 by Flag KW-1.

- The LOI letter addresses freshwater wetlands, State Open Waters, and coastal wetlands. State Open Waters are not consistently or completely shown on the approved LOI drawings or on the applicant's site plans. The Department should see that all State Open Waters are clearly indicated when the other necessary corrections are made to the approved drawings.

- All onsite freshwater wetland polygons are classified as either Exceptional Value, Intermediate Value, or Ordinary Value, and they have an associated, regulated Transition Area of 150, 50, or 0 feet in width, respectively. No mention is made in the LOI letter about the buffer width associated with onsite coastal wetlands. Regulated transition areas adjacent to coastal wetlands can be as much as 300 feet in width, according to NJAC 7:7-9.28, as the Department specifically noted on page 5 of its LOI letters. Yet the Department failed to specify the width of coastal wetland transition areas on this site. In its June (page 3) and December (page 4) 2016 conceptual mitigation plans the applicant assumes that each coastal wetland has the same buffer as the transition area of nearby, adjacent freshwater wetlands. In some cases, however, there are more than one RVC of freshwater wetlands adjacent to a coastal wetland polygon. Coastal wetland buffers are difficult to discern on the applicant's December site plan revisions, because all buffers are identified the same, whereas on the July site plans, freshwater and coastal buffers were identified separately. The Department must specify the width of coastal wetland transition areas here, whether they are all the same or vary from polygon to polygon.

Furthermore, we have no evidence that the Department concurs with the applicant's assumption that coastal wetland transition areas should be the same as those around nearby freshwater wetland transition areas. That assumption limits any possible coastal wetland buffers onsite to 150 feet in width, based on the underlying presumption that the onsite coastal wetlands "are not subject to tidal influence due to a system of tide gates and levees". This presumption cannot be accepted without proof. Typically in impounded riparian wetlands in New Jersey, tidal influence is dampened by water control structures but not eliminated. The movement of aquatic organisms is reduced by tide gates, but not necessarily eliminated. If present, the remaining tidal fluctuations onsite can be readily measured by a recording tide gage. The Department must decide whether it accepts this applicant's unsupported claim that the onsite "coastal wetlands are functionally equivalent to delineated freshwater wetlands" (December 2016 conceptual wetlands mitigation proposal, p. 10) and can be mitigated by the proposed purchase of freshwater mitigation bank credits. It would be appropriate for the Department to advise the public of the technical or policy basis for any such determinations.

Additional and continuing unresolved concerns regarding the LOI, previously raised in our comments dated 14 October 2016, include the following:

- The October LOI letter ambiguously identifies the subject property as:

Block(s)/ Lot(s): [8 / (current) 2, 3, 4.01, 4.02, and (current portions 1 and 4)]; (proposed) 4.08
Greenwich Twp., Gloucester County

Many of the "verified" flag points, however, are located on other proposed lots, outside the LOI Boundary Limit according to the drawings. It is unusual in our experience for the Department to verify flag locations beyond the limits of the specific LOI area for which an application fee has been paid.

- Like those dated 11 July and 29 July, the October LOI letter contains the following language on page 1:

Based upon the information submitted, and upon site inspections conducted by Division staff on March 22th, 2016 and April 13th, 2016, the Division has determined that the wetlands and waters boundary line(s) as shown on plan map sheets entitled: "PLAN OF WETLANDS AND TOPOGRAPHY, DRP GIBBSTOWN LOGISTICS CENTER No. 200 REPAUNO AVENUE, TOWNSHIP OF GREENWICH, GLOUCESTER COUNTY, NEW JERSEY", consisting of sixteen (16) sheets labeled Drawing No. W-2 through W-17, dated 12/29/2015, last revised on 06/08/2016, and prepared by Monarch Surveying & Engineering, are accurate as shown

The statement above is then specifically contradicted on pages 2, 3, and 4, where it is set forth that more than 50 specific flag points denote lines that are "incorrectly labeled, not verified, and to be ignored". The Department cannot have it both ways. The LOI drawings must be corrected.

- On page 6 of the LOI Amendment letters the Department states that the applicant can rely on this jurisdictional determination for "five years from the date of this letter", but that contradicts the statement on page 1 of the same letters which declares that "the expiration date (5 years from [sic] the date of the original LOI) remains unchanged". It would not be difficult for the Department to eliminate this contradiction.

- The LOI letter is not consistent in describing whether a listed series of flags encloses a wetland area or encloses an upland "island" within a wetland area. For example, for Sheet W-11, the LOI lists as Exceptional Value Flags DU4-1 through DU4-14 and Flags DU5-1 through DU5-14, without noting that those flags outline two upland islands within the Exceptional Value Wetland which surrounds them.

- We observe that the July 2016 submission of permit applications included the Department's September 2015 checklist for LOI submissions. Page 8 of 8 from that document specifically directs applicants to name all the line segments between each pair of individually named flag points, so that ambiguities can be avoided when reciting RVC assignments. Such guidance would be particularly appropriate to a complex site such as this, for which the original LOI application was submitted in late January 2016, months after the Department's checklist revisions were made available. The applicant, however, elected not to name any wetland boundary line segments. Apparently Department staff did not notice or request compliance with its directives, which might have helped to eliminate the confusion in the LOIs for this project site as described above.

Permit Applications

The applicant's 29 June 2016 submission of permit applications (apparently filed on 1 August 2016) contained a list of 26 Land Use Regulation files pending or issued for the subject property since July 2008. Prior permit files were not mentioned, such as the 1965 approval of cavern storage for anhydrous ammonia, which the Department authorized for reuse to store petroleum products in Commissioner Martin's letter of 11 August 2016. We note that the applicant hopes to store butane in the cavern at a much higher pressure than authorized in Commissioner Martin's letter. A waterfront

development permit was determined to be unnecessary for reactivation of this cavern, and associated rail improvements within the flood hazard area were deemed approved by rule, in the Department's letter of 27 June 2016. Several freshwater wetlands general permits were approved on 14 July 2016 pertaining to those parts of this applicant's property identified as Lots 4.05 and 4.06 in Block 8. None of the port project drawings identifies those nearby lots, although the proposed cold storage facilities on them are expected to function in conjunction with the proposed port.

The applicant's 9 December 2016 submission in response to deficiencies noted by the Department addressed pending individual permits for work in freshwater wetlands and coastal wetlands, in flood hazard areas, and for waterfront development, plus a transition area waiver for freshwater wetland transition areas. We do not know whether the Freshwater Wetlands General Permit 1 application dated August 2016 for clearing 0.3 acres of freshwater wetlands for onsite railroad reconstruction has been approved or not. Similarly, we do not know the status of the FWW General Permit 4 application for work by Chemours in the nitrobenzene area. No water quality certificate was requested in the 29 June 2016 application form, but the need for it is acknowledged in the December 2016 compliance statement. We do not know whether federal dredging and filling permit or berth construction permit applications have been filed with the Army Corps of Engineers, whether soil erosion and sediment control plans have been filed with the Gloucester County Conservation District, or whether local approvals have been requested from Greenwich Township and Gloucester County.

The applicant states in its revised December 2016 compliance document that direct impacts on regulated wetlands (6 acres coastal wetlands, 10 acres freshwater wetlands, plus 0.5 acre open waters for which application fees were paid) have been reduced 72%, from 16 acres to about 4.5 acres of wetlands; state open water impact was reduced to 0.2 acre. The project footprint properly has been reduced in several locations, as shown on the December site plan drawings. No drawings label in detail the size of individual wetland areas proposed to be affected, so it is not possible to verify the applicant's totals of direct impact. The applicant nowhere discusses the indirect impacts on remaining wetlands and wildlife that would result from disturbing 233 acres of land on the project site, from creating a net of 203 acres of new impervious surfaces, and from returning economic activity to a site virtually inactive for 30 years where native vegetation has been reestablishing itself.

The July documents indicate fee payment for proposed disturbance in less than 6 acres of regulated freshwater wetland transition areas but proposed construction in 46 acres of such transition areas; the December submission has reduced proposed impacts on freshwater transition areas, after the Department's revisions of resource value classifications, by nearly half to 24.65 acres (drawing C-001). Proposed impacts on coastal wetlands reportedly have been reduced to 0.3 acre and on coastal wetland transition areas to 0.9 acre. About 0.2 acre of state open waters is to be impacted directly, not counting proposed dredging of 457,000 cubic yards of material from about 29 acres of the Delaware River. The new berth also would include a platform above the River occupying about 2.5 acres extending beyond the existing solid fill wharf at Crab Point.

In July 2016 the applicant took “credit” for reducing its initial hoped-for footprint for complete, unconstrained development on the 381-acre project site next to the waterfront by about 50 acres because of the presence of 114 acres of wetlands and state open waters onsite (not counting artificial wastewater management ditches). The applicant claimed then to have refined the project footprint so as to “...reduce impacts to wetlands to the maximum extent feasible...”. The significant further reduction of coastal plus freshwater wetland impact between July and December 2016, however, serves to call into question this previous claim. On p. 21 of the July 2016 compliance statement, the applicant went on to say: “All steps having been taken to reduce the development footprint to meet the project demand, there is no practicable alternative to the selected configuration of the project that would have a less adverse impact on the aquatic ecosystem or would not involve a freshwater wetland or State open water”. The December 2016 compliance statement (p. 20) similarly claims: “The selected project design minimizes impacts to the environment to the maximum extent practicable.” The obvious question is whether, by looking at the site plans once more, the applicant could again reduce its proposed wetland impacts substantially without compromising the basic purpose of the project? Has the applicant truly avoided/minimized wetland impacts this time around? From inspection of the plans we think further reductions could be made.

The applicant properly moved various warehouses on the December 2016 plans away from the waterfront, inasmuch as they do not require a waterfront location within a port facility. But that process could be carried farther. For example, December 2016 site plan drawings C-104 and C-109 show a proposed employee parking lot with 106 spaces. Employee parking easily could be provided inland, with a shuttle to the proposed terminal, thereby freeing up land along the waterfront for uses actually requiring location along the Delaware River. Employee safety would benefit, inasmuch as personal vehicles would not have to use onsite roadways constructed below flood elevation. Some of the proposed roadway encroachments into wetlands appear unnecessary and avoidable. On Sheets C-118 to C-119, however, there is proposed incursion into intermediate value Wetland S that might be avoided by a very minor shift of the proposed disturbance to the west. On Sheet C-121, there is another proposed incursion into intermediate value Wetland A that might be avoided by a very minor shift of the proposed disturbance to the west.

Similarly, no justification has been provided for the proposed storage of crude oil (twelve 120-foot diameter tanks), refined product (six 175-foot diameter tanks), and pressurized petroleum (six 82-foot diameter spherical tanks) at the waterfront. No doubt it would be possible to place this proposed petroleum storage in uplands remote from the waterfront itself, yet connected to the proposed multi-purpose ship berth by pipelines operable even during flood events, and thereby free up most of the 60 acres of waterfront land currently proposed for petroleum liquids storage. The currently proposed petroleum storage area is 36% larger than such storage in the applicant’s original concept for this project (44.2 acres, p. 61, December 2016 alternative analysis). The applicant has offered no justification for the proposed amount of waterfront petroleum storage, which clearly could be reduced to enlarge workspace along the waterfront. The proposed pipelines that are to connect onsite storage with existing pipelines offsite are not shown on the current drawings, although the ability to connect

the proposed petroleum storage with existing pipelines was a major factor attracting the applicant to this site.

It is difficult to interpret one section of the December plans. In a change from the July drawings, there now appear to be no plans for disturbing about 600 feet of railway on drawings C-115 and C-118. This section of the railroad previously was within the proposed limit of disturbance.

The Department must confirm the applicant's reported total of about 39 acres of impervious surfaces existing on the project site (including 10 acres of gravel). The December 2016 site plan drawings C-001 and C-002 state that existing impervious surfaces were estimated using recent aerial photography. There is no claim that these estimates were confirmed by field investigations. The extent of existing impervious surface on the property is significant for identification of environmental sensitivity of the site. It is a basic factor in stormwater calculations. Also, the applicant proposes not to compensate for about 2.5 acres of transition area disturbance in areas identified as impervious.

As of the December 2016 submission there were no comments on this project from the State Historic Preservation Office. Except for a small area in the southern part of the project site, no archaeological investigations were undertaken, despite the long prehistoric use of the site and prior identification of significant prehistoric remains. There is a high potential for remaining onsite artifacts.

The December 2016 documents provide more information concerning the location of regulated riparian areas than were provided in July. Nevertheless, the Department must look closely at the proffered extent of riparian zones. Given the tidal nature of the streams on the project site, currently reduced by water control structures, there appear to be no onsite natural watercourses where the drainage area is less than 50 acres. Hence the extent of riparian zones appears to have been significantly underestimated on site plan drawing C-003. That drawing also appears to conflict with drawings such as C-114 and C-109. Consequently the extent of proposed disturbance of riparian vegetation is underreported. It is not clear from the application whether any of the currently proposed 3 acres of permanent disturbance to vegetated riparian zones requires mitigation, whether substantially more than 3 acres of vegetated riparian zone will be disturbed and thus actually require mitigation, and if so, what the riparian mitigation will be.

The applicant states that past fill has covered over any acid-producing soils that may have existed onsite as suggested by regional mapping. There will, however, necessarily be excavation associated with the proposed construction. No field documentation supports the claim that acid-producing soils are absent and will not be encountered during project construction. Disturbance of such soils presents a potential adverse impact on water quality.

The applicant states that the New Jersey Natural Heritage Program database did not report any plants of concern on the project site (December 2016 compliance statement, page 12). Thus no directed search for rare plants was performed. Yet this vicinity was a prime botanical collecting area for Witmer Stone during the late nineteenth century. On a disturbed, industrial site within the Repaupo Creek watershed

and Delaware River margin about 1 mile southwest of the project site a brief botanical survey in 1995 yielded a diverse flora of three dozen kinds of shrubs and woody vines, 27 kinds of trees, and more than 200 species of herbs. Included were *Rhexia virginica* var. *ventricosa* (Endangered in New Jersey) and *Utricularia gibba* (rare in New Jersey and protected in the Pinelands and the Highlands). On a recent Philadelphia Botanical Club visit to parcels adjacent to this site *Najas gracillima* and *Bidens bidentoides* (both species listed as imperiled in New Jersey and protected in the Highlands) were found by Gerry Moore. There is a high probability that other State-listed rare plants exist on the Repauno site. No survey by qualified botanists has been performed here during appropriate field seasons.

The applicant does not propose to raise access roads and railroads above flood elevation during period of freshwater or tidal flooding. This appears short-sighted, given the expected rise in flood events associated with global warming. Inasmuch as existing rail lines are to be reballasted and furnished with new ties and rails, this would appear to be the time to raise the tracks above flood elevation. Similarly, access roads are to be widened and resurfaced, and also should be raised above flood elevation. It is not clear whether the rest of the proposed 200 acres of new impervious surfaces are going to be placed above flood elevation, but that also would appear prudent to minimize future damage to life and property. The applicant has provided no substantiation of claimed excessive cost or “additional wetland impacts” that lead it to reject adequate flood protection. The potential impact of the proposed new impervious material on groundwater recharge along the Gloucester County shoreline has not been thoroughly addressed.

The applicant has proposed to restore onsite waters, wetlands, and wetland transition areas where temporary impacts are deemed essential to construct this project. In addition the applicant has considered possibilities for compensatory mitigation for what it considers unavoidable permanent impacts on regulated waters and wetlands. A summary of what the applicant understood to be required mitigation was presented in the July 2016 conceptual mitigation proposal and revised in December 2016.

At present it is not clear how much unavoidable impact is necessary to develop a logistics center on the Repauno site. As discussed above, some dramatic reductions in proposed impact to regulated areas were made between July and December 2016. Additional reductions almost certainly are possible. The Department must determine how much impact is actually unavoidable and requires mitigation. There is no proposed mitigation for the currently expected loss of 0.064 acre of submerged aquatic vegetation in the Delaware River or the dredging of 2 acres of tidal shallows.

The applicant currently proposes to compensate for all of its acknowledged permanent impacts to state open waters, freshwater wetlands, coastal wetlands, and transition areas by purchase of 4.8 acres of credits from an offsite freshwater wetland mitigation bank. Onsite mitigation opportunities exist, but are not proposed for other than temporary construction impacts. The applicant identifies opportunities for onsite wetland creation, restoration, and enhancement, but expresses concern for the feasibility of such manipulations given the past history of site contamination. The applicant also

has expressed a willingness to provide public access to the waterfront remote from the active port facilities, but has not shown a location for such access on project drawings. It is also unclear whether any limitations on future public access are entailed by the deed restriction on use of the property.

There is no consideration given to the decommissioning of this facility at the end of its economic life. Moreover, no information is provided by the applicant concerning plans for the remainder of its Repauno property, although the applicant takes credit for its adjacent lands as buffering against non-industrial uses. No conservation easement is proffered for the central forest or for wetlands within the project site. Instead, the applicant indicates that further subdivision for development is under consideration. The Department owes the public an explanation of why it has been approving numerous general permits for this property, when Department regulations require that proposed activities be combined into individual permits.

Based on the inconsistencies, internal contradictions, uncertainties, and other issues identified above we recommend that the LOI drawings be formally revised by the surveyor to accurately display the information which the Department has verified. Furthermore, we recommend that the LOI letter be revised, corrected, completed, and reissued by the Department and that copies of the revised drawings and reissued LOI letter be provided to Gloucester Township and made available to the public.

We further recommend that the issues raised above under Permit Applications and in our prior correspondence be examined carefully by the Department, after securing the appropriate but currently deficient information from the applicant, as appropriate. The LOI revisions must be made and reflected in the permit applications prior to the Department's final evaluation of any permit applications for this site.

Finally, once the Department has gained clear and consistent information regarding the project site and what is to be constructed on it, the Department should hold a public hearing to disclose its understanding of the consequences in the event this project were approved, and how environmental protection is to be maximized. Given the limited availability of information to date regarding this large and complex project, a public hearing would be the minimum outreach that should be made regarding these applications.

Please let us know if you have any questions about any of the above.

Yours truly,



James A. Schmid, Ph.D.
President



Stephen P. Kunz
Senior Ecologist



June 20, 2019

Ms. Diane Dow
Director, Division of Land Use Regulation
New Jersey Department of Environmental Protection
P.O. Box 420, Code 501-02A
Trenton, New Jersey 08625
diane.dow@dep.nj.gov

Re: Delaware River Partners, Gibbstown Logistic Center - Dock 2, Gibbstown, Greenwich Township, Gloucester County, NJ, Waterfront Development IP In-Water, #0807-16-0001.2, WFD190001

Delaware Riverkeeper Network (DRN) submits these comments on the referenced draft Waterfront Development Permit. DRN opposes the issuance of the Waterfront Development Permit (WFD) for Dock 2 of the Gibbstown Logistics Center. The draft permit does not comply with the rules that apply to the WFD permit. The application does not meet the requirements of the Coastal Zone Management Rules (CZM NJAC 7:7), the NJ Department of Environmental Protection Flood Hazard Area Control Act Rules (FHACA Rules NJAC 7:13), and does not satisfy the provisions of the NJ State Individual Water Quality Certificate and NJ Tidelands License. There is critical information and analysis missing from the application that is necessary to judge if the WFD Individual Permit Application for Dock 2 is in compliance. Furthermore, information that is provided does not demonstrate that the project is in compliance with these rules and regulations. The Department must reject the draft permit and find the application invalid. The Water Quality Certification that accompanied the draft permit is, in turn, also invalid and must be rescinded.

The WFD Permit must be denied; three top reasons the Compliance Statement is invalid

The most significant error in the applicant's Compliance Statement is the exclusion of the CZM Use Rules Subchapter 15.4. The applicant erroneously answered "no" as to the applicability of this section of the CZM rules but should have answered "yes" to the applicability of 7:7-15.4(p), (q), and (s). These sections address new Tanker terminals, the storage of crude oil, gases and other potentially hazardous liquid substances and Liquefied Natural Gas (LNG).

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
drm@delawariverkeeper.org
www.delawariverkeeper.org

7:7-15.4(s): There is no description of the LNG Project, which is the most significant use at the facility in terms of potential environmental, public health and safety impacts that would result from the WFD activities. LNG handling and export from the terminal would be substantial. In a Letter of Inquiry submitted by the applicant to the U.S. Coast Guard in November 2017 the applicant states that 200-220 trucks will travel each day to the facility carrying LNG and will transload 12 LNG trucks simultaneously to shipping vessels, which would be docked at the two new berths¹. The LNG shipping vessels could be as many as 24 each year, according to the Letter of Inquiry, carrying 1.5 MTPA (20 MM BBL). It is important to note that the Letter of Inquiry was written when only one berth was planned; the additional two berths will increase the shipping traffic, the transport to the site, the transloading activity and supplemental support services such as electricity and other infrastructure required for LNG. It will also increase environmental impacts including adverse impacts on the river's water quality, air emissions and deposition of emitted pollutants on water, land, soil, and vegetation, and other impacts such as the carbon footprint. The WFD permit application states that the expected volume of "new" liquid cargo ships to Dock 2 is 37 vessels per year.² It is unknown if this includes LNG, which is not mentioned in any description of the project or is based only on the LHG shipments or "other liquids" such as crude oil and refined products"³. The dangers and environmental implications of LNG handling, transit, transfer, and export are discussed later in this comment. The impacts of the full scope of the LNG project and the LNG-specific issues must be analyzed and considered to comply with this subsection of the CZM rules.

The relevant subsection at 7:7-15.4(s) states:

(s) Standards relevant to liquefied natural gas (LNG) facilities are as follows:

1. New marine terminals and associated facilities that receive, store, and vaporize liquefied natural gas for transmission by pipeline are discouraged in the coastal zone unless a clear and precise justification for such facilities exists in the national interest; the proposed facility is located and constructed so as to neither unduly endanger human life and property, nor otherwise impair the public health, safety and welfare, as required by N.J.S.A. 13:1910f; and such facilities comply with the Coastal Zone Management rules.

¹ Letter to Captain Scott Anderson, Captain of the Port, USCG Sector Delaware Bay, from AcutTech, November 16, 2017.

² APPLICATION FOR WATERFRONT DEVELOPMENT INDIVIDUAL PERMIT, PROJECT: DRP GIBBSTOWN LOGISTICS CENTER (DOCK 2), APPLICANT: DELAWARE RIVER PARTNERS LLC, 200 NORTH REPAUNO AVENUE, BLOCK 8, LOT 4, GREENWICH TOWNSHIP, GLOUCESTER COUNTY, NEW JERSEY, ALTERNATIVES ANALYSIS, DOCK 2, DRP GIBBSTOWN LOGISTICS CENTER, GIBBSTOWN, GLOUCESTER COUNTY, NEW JERSEY, 2.2.4 Berth Demand at Gibbstown Logistics Center, Table 1, PDF Page 218.

³ Letter to Captain Scott Anderson, Captain of the Port, USCG Sector Delaware Bay, from AcutTech, November 16, 2017.

i. LNG facilities shall be sited and operated in accordance with the standards set forth in the Natural Gas Act of 1938, 15 U.S.C. §§ 717-717z, the Natural Gas Policy Act of 1978, 15 U.S.C. §§ 3301-3432, the Outer Continental Shelf Lands Act, 43 U.S.C. §§ 1331 et seq., the Energy Policy Act of 1992, P.L. 102-486, 106 Stat. 2776, October 24, 1992, and the National Environmental Policy Act, 42 U.S.C. §§ 4321 et seq., which set forth standards for siting, design, installation, inspection, testing, construction, operation, transportation of gas, replacement, and maintenance of facilities.

ii. In determining the acceptability of proposed LNG facilities the Department will consider siting criteria including, but not limited to:

(1) The risks inherent in tankering LNG along New Jersey's waterways;

(2) The risks inherent in transferring LNG onshore; and

(3) The compatibility of the facility with surrounding land uses, population densities, and concentrations of commercial or industrial activity.

(Emphasis added)

iii. New LNG facilities that liquefy, store and vaporize LNG to serve demand during peak periods shall be located in generally remote, rural, and low-density areas where land use controls and/or buffer zones are likely to be maintained.

2. Rationale: The Pipeline Safety Act of 1979, P.L. 96-129, amended the Natural Gas Pipeline Safety Act of 1968 and sets forth requirements for the safe operation of pipelines transporting natural gas and liquefied petroleum gases, and provides standards with respect to the siting, construction, and operation of liquefied natural gas facilities.

The State recognizes the responsibilities of various federal agencies, including the U.S. Coast Guard and Office of Pipeline Safety Operations in the U.S. Department of Transportation, the Economic Regulatory Administration in the U.S. Department of Energy (US DOE), and the independent Federal Energy Regulatory Commission within USDOE, for management of various aspects of the siting and operations of LNG facilities.

Importation facilities for LNG are discouraged in view of the present sources of LNG from politically unstable countries. The use of natural gas for base load electric generation purposes is consistent with the Power Plant and Industrial Fuel Use Act of 1978, P.L. 95-620. The availability of domestic sources of LNG and a demonstrated need that such importation facilities are in the national interest dictate the consideration of applications for such facilities on a case-by-case basis.

The tankering, transfer, and storage of LNG pose significant risks to public health, safety and welfare and may cause serious adverse environmental impacts which may not be restricted to one state, given the likely potential locations of LNG terminals along interstate waterway. New Jersey therefore recommends that the siting of LNG facilities be treated as a regional issue on an interstate basis. (Emphasis added)

7:7-15.4(q): The Dock 2 expansion of the terminal triples the number of the berths available for ships and ship traffic to and from the deepwater port. The WFD permit application states that the

expected volume of “new” liquid cargo ships to Dock 2 is 37 vessels per year with 370 total dock days for Dock 2.⁴ This is in addition to 100 vessels of other cargo from Dock 1, which includes some additional bulk liquids, with 290 total dock days for Dock 1 according to Table 1.⁵ In the application at Section 4.4, it is stated that the shipping vessels will be “new vessels on the Delaware River”. Clearly, these “new vessels” must be carefully considered and the potential impacts to shipping and the Delaware River must be assessed in order to satisfy the implementing rule. This subsection is clearly applicable to the Gibbstown Logistics Center.

The relevant subsection 7:7-15.4(q) states:

(q) Standards relevant to tanker terminals are as follows:

1. New or expanded tanker facilities are acceptable only in existing ports and harbors where the required channel depths exist to accommodate tankers. (Emphasis added)

i. Multi-company use of existing and new tanker terminals is encouraged in the Port of New York and New Jersey and the Port of Camden and Philadelphia, where adequate infrastructure exists to accommodate the secondary impacts which may be generated by such terminals, such as processing and storage facilities.

2. New tanker terminals are discouraged in areas not identified in (q)1 above. (Emphasis added)

3. Offshore tanker terminals and deepwater ports are discouraged.

4. Rationale: Onshore tanker facilities pose potential adverse environmental impacts and could encourage secondary development activity that is not necessarily coastal dependent. Also, even medium sized tankers require minimum channel depths of 30 feet, which excludes locations within the CAFRA area. New or expanded tanker terminals are therefore directed toward New Jersey's established port areas. Deepwater ports appear attractive to industry due to increasingly larger tankers, limitations on dredging and the scarcity of waterfront land. However, a deepwater port may, depending on its location, cause severe adverse primary and secondary impacts on the built, natural, and social environment. (Emphasis added)

7:7-15.4(p): The planned storage of Liquefied Hazardous Gas (LHG) in the on-site cavern, in tanks, sphere tanks, rail cars, trucks, and ships in the berths while they are being loaded for 10 to

⁴ APPLICATION FOR WATERFRONT DEVELOPMENT INDIVIDUAL PERMIT, PROJECT: DRP GIBBSTOWN LOGISTICS CENTER (DOCK 2), APPLICANT: DELAWARE RIVER PARTNERS LLC, 200 NORTH REPAUNO AVENUE, BLOCK 8, LOT 4, GREENWICH TOWNSHIP, GLOUCESTER COUNTY, NEW JERSEY, ALTERNATIVES ANALYSIS, DOCK 2, DRP GIBBSTOWN LOGISTICS CENTER, GIBBSTOWN, GLOUCESTER COUNTY, NEW JERSEY, 2.2.4 Berth Demand at Gibbstown Logistics Center, Table 1, PDF Page 218.

⁵ Ibid.

15 days clearly requires the applicant to address the issues of the storage of gases and other hazardous bulk liquids under this subsection. While the terminal at the deepwater port is water-dependent, the amount and scope of storage, including the volumes that would be contained in all storage vessels at one time on the site (including the cavern, tanks, rail cars, trucks, ships and other containers on the site) must be fully disclosed, assessed in terms of management, handling, emissions and environmental impacts and must be justified due to proximity to the residential community of Gibbstown, the day care center and playground adjacent to the site. In a Letter of Inquiry submitted by the applicant to the U.S. Coast Guard in November 2017, the description of the LHG project, which includes butane and other natural gas liquids, states that the LHG will arrive by rail cars and be transloaded to storage from a 20-rail car unloading rack with as many as 24 shipping vessels each year.⁶ It is important to note that the Letter of Inquiry was written when only one berth was planned; the additional two berths will increase the shipping traffic and the transport to the site, the storage in mobile containers and the activity on the site. As previously stated, the WFD permit application states that the expected volume of “new” liquid cargo ships to Dock 2 is 37 vessels per year with 370 total dock days for Dock 2. The volume of LHG, the full scope of the LHG project, the operations in light of other operations on the site, the management and the potential impacts of the LHG must be analyzed and considered. This subsection of the CZM rules may also be considered to apply to the LNG project operations.

The relevant subsection 7:7-15.4(p) states:

(p) Standards relevant to storage of crude oil, gases and other potentially hazardous liquid substances are as follows:

1. The storage of crude oil, gases and other potentially hazardous liquid substances as defined in N.J.A.C. 7:1E-1.1 under the Spill Compensation and Control Act (N.J.S.A. 58:10-23.11 et seq.) is prohibited on barrier islands and discouraged elsewhere in the CAFRA area.
2. *The storage of crude oil, gases and other potentially hazardous liquid substances is conditionally acceptable in the Urban Area, Northern Waterfront and Delaware River regions if it is compatible with or adequately buffered from surrounding uses. (Emphasis added)*
3. The storage of crude oil, gases and other potentially hazardous liquid substances is not acceptable where it would limit or conflict with a potential recreational use.
4. The storage of crude oil, gases and other potentially hazardous liquid substances is not acceptable along the water's edge unless the storage facility is supplied by ship, in which

⁶ Letter to Captain Scott Anderson, Captain of the Port, USCG Sector Delaware Bay, from Acutech, November 16, 2017.

case it is acceptable on the filled water's edge provided the storage facility complies with (p)1, 2 and 3 above.

5. Rationale: Major storage facilities for potentially hazardous substances are not entirely coastal-dependent and will not be permitted where storage might limit or conflict with recreational or open space uses of the coast.

Finally, DRN points out that the project, by the applicant's own admission, has substantially changed from when the plans were designed for one dock with one berth, for which the original NJDEP permits were issued.

There are many important changes at the site, including:

- the addition of LNG
- the substantial expansion of ship traffic up to at least 37 shipping events per year from 24 for the bulk liquids originally
- the increase in the number of ships that can be accommodated at the 3 berths and increased shipping traffic
- the mixing of different operations such as LHG, LNG, and other cargo at the Gibbstown Logistics Center
- the increased activity at the site with additional transloading operations occurring simultaneously and the additional truck and rail deliveries into the site
- the additional equipment and facilities to be located on site due to bulk liquid handling
- the considerable increase in truck and rail traffic to carry in bulk liquids including LNG, LHG and other liquids such as crude oil and refined products that would be exported by ship
- the potential for increased storage capacity on the site, as yet undisclosed
- the question of how much shipping of other non-liquid RO/RO type cargoes will be done at Dock 1, considering that Dock 1 will also ship bulk liquids according to the application
- the internal traffic patterns that will change due to different cargoes and different delivery and transloading systems
- the re-thinking of whether warehouse and other planned facilities for non-liquid cargo at the site are necessary

There are also questions regarding the need for other permitting and/or approvals by the project including, naming a few, approvals from the U.S. Coast Guard, the Federal Energy Regulatory Commission, the Pipeline and Hazardous Materials Safety Administration (PHMSA), U.S. Department of Transportation, and the Federal Railroad Administration. It is not disclosed whether any pipelines will be used, constructed, renovated, repurposed, or accessed through the project or for the project, which is important information that must be provided. A Department of Energy permit is listed as a needed permit in the application but it is not discussed in the application, demonstrating further subterfuge by the applicants about the veiled plan to export LNG from Gibbstown Logistics Center.

DRN points out that the original WFD permit (for Dock 1) appears invalid at this point due to these changes and the lack of disclosure and planning for the handling and export of LNG. DRN

supports and advocates for the rescinding of current WFD permit based on the changed project. DRN also supports and advocates that all NJDEP land use permits, the stormwater permit, and waterfront-related permits granted to Gibbstown Logistics Center be rescinded to reflect the changes described by the applicant in the application for a WFD permit for Dock 2.

The environmental, health and safety impacts and risks of LNG at this site

It is essential that the application and compliance statement include all relevant details about the LNG project. LNG has significant ramifications environmentally, for public safety, and for shipping on the Delaware River system.

There is no discussion or analysis of any of these issues, including but not limited to: the safety, pollution and health implications of trucking (anticipated to at least triple; the anticipated truck traffic created by the LNG facility for the local community has the likely potential of being quite massive given that the LNG will be transferred to the ships via a truck rack that is being designed to handle 200 to 220 trucks per day) and railing in the significant volumes of LNG anticipated for the site (1.5 million metric tonnes per year in the initial Letter of Intent to Coast Guard, which is now potentially tripled due to two additional berths); the ramifications of transloading LNG from 12 trucks simultaneously to the LNG shipping vessels; the storing of LNG on a ship while it is slowly loaded over a period of approximately 15 days; what LNG exports from Gibbstown means for shipping, ship traffic and the business operations of other shippers operating through Delaware River ports; the climate change and other environmental impacts of exporting LNG from this site including the cradle to grave hazardous pollutants releases and the methane and carbon emissions; onsite environmental impacts due to the activity that will be enabled by the additional berths; the health and safety ramifications of having an LNG operation of this kind on the Delaware River including for the surrounding community; the transport by truck and rail from the Pennsylvania liquefaction plant hundreds of miles by truck and/or rail and the environmental and health and safety impacts of the liquefaction processing facility planned for Wyalusing Township, Bradford County, PA; the implications for other shippers and port operations (there is anticipated to be two LNG export operations a month – 24 a year – from this site, and, in Table 1 on PDF page 218, a total of 37 per year of bulk liquids is projected and 100 of other types of cargo although it is unclear how many of the bulk liquid shipments would be LNG and how many would be LHG); the impacts on the endangered Atlantic and Shortnose Sturgeon or the designated Atlantic Sturgeon Critical Habitat in the River; the impacts on other fish and wildlife species, including raptors; the short and long term impacts on Submerged Aquatic Vegetation in the Project Area; the water quality ramifications due to the release of ballast water from LNG ships; the air and other ramifications of boil-off from containers on site, including truck tanks, rail cars, and ships; flaring off of gas and other vapors and/or the construction and operation of a “small capacity liquefier” to capture vented gas and vapors or the construction and operation of a gas separator for the sale of emitted gas to the grid; just to name a few.

It is notable that in a November 16, 2017 letter to the US Coast Guard, Delaware River Partners notes the limitations caused by having just a single-berth at this site while also accommodating an

LNG operation there – i.e. that “LNG, LHG, or other hazardous or non-hazardous cargo operations will not run concurrently, as the single-berth wharf only permits one vessel to dock at a given time for a single commodity.” The potential conflicts and/or heightening of dangers in handling of both LNG and LHG at the same time on the same location, along with other bulk cargo at this site, was obviously recognized by Delaware River Partners in the Letter of Inquiry. LHG would be brought to the site via rail car, the volume, frequency of deliveries, full scope of the rail delivery system and the related environmental and safety ramifications of which have not been analyzed. The project includes at least ~3 acres of storage tanks, including at least one sphere tank, a subsurface cavern and associated equipment as additional project elements. Also mentioned in the Letter of Inquiry to the Coast Guard is a “small capacity” liquefier that consists of a “cold box”, compressor, N2 tank and a cold storage bullet tank (1430 BBL capacity), a flare, a gas separator, and a Thermal Oxidizer.⁷ The placement, management, and operation of all of these facilities on the site must be fully analyzed in combination with the LNG/LHG activities at the site.

The proposal to truck/rail in the LNG along with long offloading times resulting in approximately 15 days of storage on vessels prior to shipment from the dock raises additional impacts that need to be assessed and addressed, in addition to the environmental (including climate change) and health consequences.

As noted in this comment, there are a wealth of environmental and public impacts that need to be fully assessed by the Department when considering the proposed LNG use at this site. Issues that need to be considered include, but are not limited to:

- The safety, pollution and health implications of truck and rail traffic necessary to support the LNG (and LHG) operations proposed for the site. It is anticipated that truck traffic will at least triple over current levels as a result of the LNG export portion of the proposal.
- The crucial safety ramifications, of storing LNG on a ship while it is slowly loaded over a period of approximately 15 days. This practice is not used currently by the LNG industry and prolongs the risk-heavy operations involved with transloading LNG. There is no explanation or justification presented for the use of the highly risky slow-loading operations, especially when compared with alternative operations for ship loading that would be more efficient and would not prolong the very dangerous operation of transloading directly from trucks or rail cars to shipping vessels. There is also no explanation given for the lack of storage on site of LNG, which would negate the requirement to transload directly from trucks or rail cars to ship vessels.
- The ramifications of the proposed LNG exports for endangered populations such as the Delaware River Atlantic Sturgeon that are being severely impacted by ship strikes along the Delaware. Given that there are less than 300 spawning adults left of the Delaware River’s genetically unique population of Atlantic Sturgeon, the ramifications of increased ship traffic and ship strikes is serious and potentially catastrophic.

⁷ Letter to Captain Scott Anderson, Captain of the Port, USCG Sector Delaware Bay, from Acutech, November 16, 2017.

- The gas and vapor emissions released from the stored LNG containers known as “boil-off” that are vented or captured and re-liquefied on site or sold off through some other means of delivery off-site.
- The onsite environmental impacts of exporting LNG from this site.
- The environmental and climate impacts from the gas in its full life cycle.
- The safety ramifications of having an LNG operation of this kind on the Delaware River considering the residential areas, local traffic, day care center, and playground adjacent to the site.
- The implications for other shippers and business, bridge and port operations that will result from the LNG export use of the site.
- The impacts on the endangered Atlantic and Shortnose Sturgeon and the designated Atlantic Sturgeon Critical Habitat that will be impacted. The Delaware River population of Atlantic Sturgeon is genetically unique with a surviving population that includes less than 300 spawning adults.⁸ The loss of any individual must be prevented. The Delaware River population of Atlantic Sturgeon, along with the entire NY Bight Distinct Population Segment (DPS), of which the Delaware River population is a part, are designated as endangered pursuant to the Endangered Species Act. In addition, the Delaware River’s population of Shortnose Sturgeon is also listed as federally endangered and suffers low population figures.
- The water quality ramifications due to the release of ballast water from LNG ships. The “... discharge of ballast water and sediment from ships during LNG terminal loading operations may result in the introduction of invasive aquatic species.”⁹
- The water quality ramifications due to dredging and the potential resuspension/reintroduction from CDF discharges of contaminants to the Delaware River, including PCBs. CDFs holding dredged sediments from Delaware River dredging projects have been a demonstrated source of toxic contamination to the River, inflicting serious water quality impacts.
- Releases, spills or leaks during storage, transfer and/or transport of LNG.¹⁰
- The safety issues of the trucking, rail transport, storage, and transfer of LNG is dangerous if there is an accident or incident, and is in need of careful consideration for the local community and the communities along the transit routes.
- Given the site’s history of industrial operations, the known contamination that has and still does exist on the site, and its superfund status, there is a need to consider the potential synergy of harm that could occur if there was a catastrophic release at the site. Known contaminants of concern at the site include nitrobenzene, aniline and mixed acids, sodium nitrite and nitrosylsulfuric acid.
- No specifications, size, location, environmental impacts or emissions from the “small” liquefaction plant, beyond a brief list of components, are provided. What would be the

⁸ ASSRT (Atlantic Sturgeon Status Review Team) 2007. Status Review of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

⁹ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

¹⁰ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

limits on the size of such a facility and how will this component be monitored? Are there required setback distances or safety zones for this liquefaction plant?

- The entire site is in the flood hazard area. What are the implications of a flood for the LNG operations and LHG operations if there were a flood during transfer operations or storage onsite? With climate changing increasing the frequency, duration and magnitude of floods, this is an obvious and serious consideration due to sea level rise forecasted for the Delaware River Basin and the resulting impacts on all operations located on the river, especially those in a flood hazard area. The ramifications of catastrophic flooding due to climate change is compounded by the known flood and safety ramifications of storm surge in the Delaware Estuary.
- EPA identified the Repauno site in 2003 as one of the largest PCB point sources in the Delaware Estuary (among the top 10). Additional dredging, site disturbance and stormwater systems will disturb PCBs, which have been found in near-shore sediments and in runoff from the site. There is a zone of highly contaminated sediments immediately adjacent to the shore and port facility. The remobilization (and dewatering of dredged sediments) will create re-release of PCBs into the estuary, including in Atlantic Sturgeon spawning habitats. The ramifications for the reintroduction of PCBs into the environment needs careful assessment.
- Risk of accidents, incidents, fire or explosion during transport storage and/or transfer of LNG.¹¹ While it is asserted there will be no onsite storage of LNG, the process of loading each ship will take on the order of 15 days—this translates into 15 days of storage on the vessel while loading operations are taking place. The potential safety implications need to be examined and disclosed. “Natural gas is combustible, so an uncontrolled release of LNG poses a serious hazard of explosion or fire.”¹² The greatest LNG hazards include pool fires, flammable vapor clouds and flameless explosion.¹³
- A pool fire occurs if LNG spills near an ignition source and in fact ignites, “the evaporating gas in a combustible gas-air concentration” burns above the LNG pool, and then proceeds to spread as the LNG pool expands away from its source and continues evaporating.¹⁴ Pool fires are intense and will burn more hotly and rapidly than oil or gasoline.¹⁵ Pool fires cannot be extinguished – “all the LNG must be consumed before they go out.”¹⁶
- Flammable vapor clouds happen if there is an LNG spill that does not immediately ignite and instead evaporates forming a vapor cloud.¹⁷ Vapor clouds can drift a distance from

¹¹ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

¹² CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

¹³ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

¹⁴ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

¹⁵ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

¹⁶ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

¹⁷ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

the site of the spill.¹⁸ If the vapor cloud encounters an ignition source then “those portions of the cloud with a combustible gas-air concentration will burn.”¹⁹ While a vapor cloud is not toxic, it can displace breathable air and as a result cause asphyxiation.²⁰ A vapor cloud explosion is the mechanism used in a thermobaric weapon that uses air to generate a high-temperature explosion, producing a long duration blast wave. These weapons are also termed a fuel-air bomb.²¹ This is the threat that LNG storage and transport brings to the Gibbstown region and to every traffic route used to carry the LNG to the Delaware River and on the river during export.

- Extremely cold LNG can injure through direct contact.²² It has been said, “...environmental damage associated with an LNG spill would be confined to fire and freezing impacts near the spill since LNG dissipates completely and leaves no residue.”²³
- “LNG spilled directly onto a warm surface (such as water) could result in a sudden phase change known as a Rapid Phase Transition (RPT).”²⁴ “If LNG spills on water, it could theoretically heat up and regasify almost instantly in a ‘flameless explosion’.”²⁵
- New information has shown that LNG can cause a catastrophic BLEVE or Boiling Liquid Expanding Vapor Explosion if the vessel is exposed to high temperatures or a fire. The expansion of the liquid LNG in a vessel causes the pressurized liquid to boil, and the gas takes up more room than the liquid, stressing the container as pressure builds. Relief valves are only designed to release pressure slowly to keep equilibrium in the pressurized container. Exposed to high heat, the valve will fail to keep up and the metal will weaken, cracks will result in the container, causing LNG to be released with an explosion.²⁶ The result is a BLEVE, a catastrophic failure of the container. A BLEVE can weaken metal around the explosion area, including train tracks.

¹⁸ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

¹⁹ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁰ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²¹ https://en.m.wikipedia.org/wiki/Thermobaric_weapon

²² CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²³ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁴ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

²⁵ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁶ https://en.m.wikipedia.org/wiki/Boiling_liquid_expanding_vapor_explosion

The application does not comply with CZM Rules

Following are some of the reasons that the proposed project and the application that describes the project is not in compliance with CZM rules on Special Areas.

Compliance Statement 6.1.1

(NJAC 7:7-9.5): Finfish migratory pathways

“(c) Development which lowers water quality to such an extent as to interfere with the movement of fish along finfish migratory pathways or to violate State and Delaware River Basin Commission water quality standards is prohibited.

1. Mitigating measures are required for any development, which would result in lowering dissolved oxygen levels, releasing toxic chemicals, raising ambient water temperature, impinging or suffocating fish, entrainment of fish eggs, larvae or juveniles, causing siltation, or raising turbidity levels during migration periods.”

There is no demonstration in the application of the level to which the adverse impacts to the water quality in the active project area will be “minor” and “temporary” resulting from in-water dredging due to “potential increase in suspended solids”. The BMPs that would be employed do not address the ongoing stirring up of sediments with the operation and travel of ships to and from the berths and the potential for ship traffic and operations during transloading to interfere with fish migration and the habitat of the Atlantic sturgeon, shortnose sturgeon and anadromous fish species that are known to migrate through the region. The dredge equipment that would be employed to dredge the 665,000 cubic yards of sediment over 45 acres is described as an “environmental clam shell” and the barge design is said to minimize spillage and the release of turbid water. It is also stated that the operation will be performed in a manner that limits dragging on the bottom of the river during dredging. However, it is stated that adverse water quality impacts will nonetheless occur, demonstrating the lack of a fully environmentally safe dredging operation. It seems, based on the application supporting documents, that these environmental measures will be employed for contaminated sediments – will they be employed for all dredged sediments? It is also stated that the silt and sand sediments will be amended for truck transport but it is not stated what the amending agent would be. There are significant negative environmental and water quality impacts from certain amending agents. The use of amending agents but be fully disclosed to meet this subsection of the rule.

Further, the potential for the suspended solids to contain contaminants that are in the dredged materials, or are carried to the 45-acre area to be dredged with the stormwater and runoff pollutants or the groundwater base flow to the river and shallows from the Repauno Superfund site is not examined or discussed. Considering the long history of industrial use of the DuPont Repauno site and the use of the property for other industrial operations as well, there is a risk of stirring up and re-suspending contaminants through dredging and day-to-day operation at the berths and landside facilities that can in turn effect migrating finfish. This needs further analysis.

Compliance Statement 6.1.2

(NJAC 7:7-9.6): Submerged Vegetation Habitat

The SAV habitat is prohibited from being developed to protect these special habitats. A bed of submerged aquatic vegetation (American eelgrass) is located in the active project area but the applicant states it is being avoided. Appendix C shows the extensive bed within the project area. A survey of the SAV bed immediately prior to the planned dredge operations must be done to accurately identify the SAV's location during the spring growing season. The applicant's consultant (Matrix) performed the survey in September 2018. Accurate location of the SAV bed is essential. The potential for damage to the SAV from shading from the trestle structure and ships is not explored and must be.

Compliance Statement 6.1.11

(NJAC 7:7-9.36): Endangered and Threatened Wildlife or Plant Species Habitats

Development of endangered and threatened species (wildlife or plant) is prohibited unless an Impact Assessment demonstrates that there will be no direct or secondary adverse impacts *on the site or the surrounding area*. (Emphasis added) The Assessment (Appendix D) does not demonstrate adequately that the Atlantic Sturgeon habitat will not be adversely impacted. Potential takes of the Atlantic Sturgeon and shortnose sturgeon is projected in the Appendix and can be expected.

The Delaware River Atlantic Sturgeon are currently being severely impacted by ship strikes along the Delaware River with the current level of shipping; any increase will have an adverse impact for both the Atlantic sturgeon and the shortnose sturgeon. The ramifications of increased ship traffic and ship strikes is serious and potentially catastrophic. The Delaware River population of Atlantic Sturgeon is genetically unique with a surviving population that includes less than 300 spawning adults.²⁷ With numbers this precariously low, the responsibility for vigilant protection by our federal agencies could not be greater. The Delaware River population of Atlantic Sturgeon, along with the entire NY Bight Distinct Population Segment (DPS), of which the Delaware River population is a part, are designated as endangered pursuant to the Endangered Species Act. In addition, the Delaware River's population of Shortnose Sturgeon is listed as federally endangered and suffers low population figures. The endangered Atlantic and Shortnose Sturgeon and the designated Atlantic Sturgeon Critical Habitat will be impacted.

A study of mortality rates on Atlantic sturgeon in the Delaware River between 2005 and 2008 found that 50% of the mortalities were the result of vessel strikes. The remaining 50% were too decomposed to determine if they were caused by vessel strikes but it is likely most were.²⁸ For small remnant populations of Atlantic sturgeon, such as that in the Delaware River, the loss of just a few individuals per year due to anthropogenic sources of mortality, such as vessel strikes, may

²⁷ ASSRT (Atlantic Sturgeon Status Review Team) 2007. Status Review of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

²⁸ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

continue to hamper restoration efforts.²⁹ According to a 2010 research article on vessel strikes, “Both the dredging to deepen the channel and the subsequent increase in large vessel traffic may further hamper the recovery of the Delaware River Atlantic sturgeon population.”³⁰ Of critical importance, this study is concerned about the size of the vessels resulting from deepening as opposed to any increase in the volume of vessels. The larger size of the vessels from the deepened channel will likely increase the number of vessel strikes for both sturgeon species.³¹

The continued dredging of new deep-water areas will further impact Atlantic sturgeon spawning by accelerating the intrusion of brackish water into the hard-bottom spawning grounds, and thus forcing Atlantic sturgeon to spawn further upstream in the zone of depressed dissolved oxygen. This shift then exposes the eggs and larvae of newly spawned Atlantic sturgeon to low oxygen conditions from which they may not survive. This “squeeze” between increased salt intrusion in the estuary downstream (exacerbated by channel deepening, new deep-dredged berthing areas, and rising sea levels) and the near-lethal dissolved oxygen levels upstream limits the ability of Atlantic sturgeon to successfully reproduce, and increases the likelihood of extinction. This project makes a significant contribution to such salt-intrusion by adding 45 acres of new deep-water channel and berthing to an estuary under siege.³²

The remobilization (and dewatering of dredged sediments) will create higher exposure to PCBs and other contaminants, and the Atlantic Sturgeon spawning and rearing that begins in June and extends the early-life-stages through July and August, with increasing evidence for high aggregations of young-of-year in the Proposed Project vicinity, means that elevated exposure will occur for larval and juvenile stages of this endangered species in the Delaware River. The currently proposed BMPs, methods such as avoidance, minimization, and mitigation and timing are insufficient to protect this endangered species habitat and the surrounding area, and more evidence and analysis would be required to comply with this subsection of the CZM rules regarding protection of the Atlantic Sturgeon and the shortnose sturgeon.

A report dated August 26, 2016 that was submitted to the Department prepared by James Schmid and Company stated that bald eagles and ospreys nest on site.³³ Further analysis would need to be done to show that the nearest bald eagle nest is on Monds Island, as the application states, and that the osprey nest on the relic piling at the Repauno site will not be disturbed by any environmental changes including noise, air emissions, construction, site activities and storage, shipping and related activities at Gibbstown Logistics Center. Additionally, other wildlife species and plant species have been identified over recent years at the Repauno site and further analysis is required to accurately map all relevant habitat and the surrounding area that may be impacted by the Dock 2 activities and operations.

²⁹ Ibid.

³⁰ Ibid.

³¹ Ibid.

³² Moberg and DeLucia. 2016. Potential Impacts of Dissolved Oxygen, Salinity and Flow on the Successful Recruitment of Atlantic Sturgeon in the Delaware River. The Nature Conservancy. Harrisburg, PA. 69 pp.

³³ Report to Delaware Riverkeeper Network from James A. Schmid, PhD. of Schmid and Company, Consulting Ecologists dated August 25, 2016.

Compliance Statement 6.1.12
(NJAC 7:7-9.37): Critical Wildlife Habitats

Development that would negatively affect critical wildlife habitats is discouraged. The applicant states that the NJ Natural Heritage Database and the NJ Landscape Project identified foraging habitat for the great blue heron. The applicant additionally states that a breeding colony of heron is located on Monds Island, one mile from the project site. Is this mile measured to the dock? Is the measurement from the Federal Navigation Channel where the ships would travel? It should be to accurately assess the impacts to these birds. The many species that may visit the site include the 26 bird species in the list provided by the applicant including the federally threatened Red Knot (*Calidris canutus rufa*), and Cooper's Hawk. Also identified for the site is the federally threatened bog turtle and a vernal pool habitat. It is stated that no critical habitat has been designated for Red Knot or the bog turtle. There must be field surveys to accurately identify habitat and individual species that are located on the site.

Appendix B does not provide a comprehensive picture of the natural conditions on the larger property and the development site, to give context to the project area. The large contiguous acreage of the Repauno site and the area used by species has developed over approximately 30 years, as the former industrial Repauno site remained largely fallow. It is a 1,856-acre site located along the Delaware River in Gloucester County, NJ. The site is bounded to the north by the Delaware River, to the east by a former Hercules Chemical manufacturing plant, to the south by the city of Gibbstown, and to the west by wetlands and Repauno Creek. The western half of the site consists almost entirely of surface water bodies and wetlands. The eastern half of the site also consists of some upland and wetland ecological communities.³⁴ Altogether, the site contains approximately 1,500 acres of wetlands.³⁵ The Gibbstown Logistics Center is planned to use 218 acres on the northeastern portion of the site. The largely natural area that had grown up on this property is ripe for the many species that could live here and must be fully investigated before the conclusions that the applicant draws can be considered valid and in compliance with this subsection of the CZM rules.

Compliance Statement 6.1.14
(NJAC 7:7-9.39): Special Hazard Areas

This subsection discourages development within or proximate to areas that pose special hazards. This subsection requires evaluation based on the LNG activities, including transloading, transporting into the site and shipping and the potential for hazards related to the transport into, loading, handling and storage of LHG, crude oil, and refined bulk liquids at the Gibbstown Logistics Center. LNG is not mentioned and, as discussed earlier in this comment, poses many special hazards. Additionally, the former use of the site for munitions, the possible presence of

³⁴ EPA (2003). RCRA Corrective Action – DuPont Repauno Facility. *Documentation of Environmental Indicator Determination*. Retrieved from https://www3.epa.gov/region02/waste/dup_r750.pdf

³⁵ Fichera, A. (2015). Land sale raises hopes for new South Jersey port. *Philly.com*, March 22, 2015. Retrieved from http://articles.philly.com/2015-03-22/news/60349872_1_port-facility-chemical-plant-gibbstown

hazardous residues or contaminants in the soil, sediment, materials on site, groundwater or surface water of the site must be evaluated for potential hazards.

This superfund site may pose a hazard applicable to this subsection of the CZM rules. DuPont operated the site as an explosive manufacturing facility from 1880 to about 1950. In 1917, DuPont expanded operations to include the manufacturing of organic compounds, which continued until 1986. All explosive manufacturing and ammonia production were discontinued during the 1960s. Repauno is a Superfund site undergoing remediation (<https://cumulis.epa.gov/supercpad/CurSites/calinfo.cfm?id=0200783>). The area previously used by DuPont as a terminal location for anhydrous ammonia began being cleaned for reuse in 2002, according to the 2002 Annual Groundwater Progress report.³⁶ One of the dangerous contaminants on the site is nitrobenzene, a highly toxic chemical classified by the Centers for Disease Control as “Immediately Dangerous to Life or Health” if people are exposed at specific concentrations. Nitrobenzene is a likely human carcinogen according to the US Environmental Protection Agency (EPA) and is linked to several carcinomas and cancers as well as other dangerous human health effects. The area where the logistics center would operate is the area most likely exposed to aniline, a toxic chemical with adverse health effects; aniline is involved with the processing of benzene to make nitrobenzene. The area where acids were used is also at least partly included in the logistics center active project area. Whether they are located in the areas adjacent to or effected by the Dock 2 activities needs to be evaluated through onsite sampling and mapping. These acids were most likely “mixed acids” associated with the nitrobenzene manufacturing process and are toxic.

In 1990, 8,500 tons of sediments were removed from the ditches in the former nitrobenzene and PMDA/DMT production areas.³⁷ In the three rounds of sitewide investigation completed in 1993, 1996, and 2000 respectively, DuPont screened all Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) for their investigation/remediation priorities and focused on the migration/flow of groundwater and the soils in former production areas. The currently ongoing fourth round of investigation is to complete the investigation of the remaining two SWMUs/AOCs and to conduct an ecological risk assessment for the wetlands, streams, and the ditch system.³⁸

In 1985, DuPont installed a system to pump contaminated groundwater and to treat it. The groundwater interceptor system has been in operation since, in conjunction with a groundwater monitoring program, owned and operated by Chemours, DuPont’s spinoff company, since 2015. Chemours is required to continue the groundwater interceptor system together with the sitewide groundwater monitoring program to confirm that contaminated groundwater is under control. The current plans show that some monitoring wells that are part of the Gibbstown Logistics Center parking area will be paved over, jeopardizing the continued use of these wells for monitoring the cleanup. This disruption of the sampling record must be avoided.

³⁶ EPA (2003). RCRA Corrective Action – DuPont Repauno Facility. *Documentation of Environmental Indicator Determination*. Retrieved from https://www3.epa.gov/region02/waste/dup_r750.pdf

³⁷ EPA (2005). DuPont Company – Repauno Plant. *Region 2 RCRA Cleanup Fact Sheet*. Retrieved from <https://www3.epa.gov/region02/waste/fsdupont.htm>

³⁸ Ibid.

In addition, several different companies have leased areas at the Repauno facility. In 1998, Repauno Products LLC purchased the manufacturing operation that produced sodium nitrite and nitrosylsulfuric acid. In 1999, Spring AG purchased the industrial diamond refining operation, which ceased in late 2002. Industrial diamond processing may have used chemical vapor deposition or other dangerous processes that are used to manufacture industrial and synthetic diamonds, contributing additional contaminants to the site's environment that require investigation prior to use of the property. Furthermore, it is stated in the application that fill was placed on the property at some point. What was this fill and has it been fully tested and characterized? Has it been accurately mapped so sampling and analysis can be done? Contaminants in fill placed on the site from somewhere else, whether dredge spoils, imported material, or other fill, must be found, sampled for, and identified in order to fully answer the question of whether existing programs or plans for the site for Dock 2 have adequately addressed this subsection of the CZM rules.

Following are some of the reasons that the proposed project and the application that describes the project is not in compliance with CZM rules on General Water Areas.

Compliance Statement 6.2.2
NJAC 7:7-12.7: New Dredging

New dredging is considered acceptable if certain conditions are met. Particularly important for this site is the condition that requires a demonstrated need that cannot be satisfied by existing facilities (NJAC 7:7-12.7(c)1.) and also that special water areas not be significantly disturbed. The applicant does not satisfy these conditions through its application. The Alternatives Analysis (Appendix E) relies heavily on the former use of the DuPont Repauno property and other industrial activities in the region to justify the Dock 2 additional activities and development. The proximity to Monds Island, Little Tinicum Island, the John Heinz National Wildlife Refuge at Tinicum and the naturally restored contiguous habitat on the Repauno property and some other fallow properties in the surrounding area is an important context not recognized or assessed in terms of impact of the activities that would be approved and enabled by the WFD permit and the Water Quality Certificate. This important setting must be considered under this subsection to assess the impacts of new dredging on these natural resources and features.

Following are some of the reasons that the proposed project and the application that describes the project is not in compliance with CZM rules on Location.

Compliance Statement 6.3.1
NJAC 7:7-14.2: Basic Location Rule

The location for development can be rejected or conditionally approved by the Department to provide public health, safety and welfare, to protect wildlife and marine fisheries, and to preserve, protect, and enhance the natural environment. The applicant fails to consider the important naturally restored condition of the Repauno property and adjacent, local and regional natural resources that would greatly benefit from preservation and protection. The loss of the natural

condition, habitats and quality of the Gibbstown Logistics Center site and the fragmentation of the natural systems in the surrounding area will be great. However, the applicant does not discuss, measure, or assess this impact. The applicant simply relies on the 100-year historic use of the Repauno property prior to its abandonment as an industrial location. It has been decades since heavy industrial use of the property has occurred, and the natural environment has subsumed the location and should be considered as a natural asset of great value.

The applicant's Alternatives Analysis (Appendix E) does not consider the natural assets at the site. In fact, the applicant states in the Alternatives Analysis a circular justification for the project at this location stating that because the site is undergoing redevelopment as a marine terminal with Dock 1 and the associated landside development, it is "the most feasible alternative for the proposed project". Simply because the Gibbstown Logistics Center is being constructed does not provide justification or rationale for further impacting natural resources and assets for Dock 2. The subsection of the CZM rule requires consideration and analysis in the determination by the Department on the WFD permit and the Water Quality Certificate.

Following are some of the reasons that the proposed project and the application that describes the project is not in compliance with CZM Use Rules.

Compliance Statement 6.4.2
(NJAC 7:7-15.9): Port

Ports are expected to be placed where other ports are or adjacent to other ports. The applicant maps regional port facilities but does not give full information about the ability of those ports to include the planned uses for Dock 2. In addition, buffering and compatibility with surrounding uses is of importance under this subsection. The subsection NJAC 7:7-15.9 states, in relevant part:

"(c) New port uses outside of existing ports as defined at N.J.A.C. 7:7-9.11(a) are acceptable only when there is a clear demonstration of need, and when suitable land and water area is not available in or adjacent to an existing port.

(d) New or expanded ports must be compatible with surrounding land uses and provide for maximum open space and physical and visual access to the waterfront, if this access does not interfere with port operations or endanger public health and safety. New or expanded ports must also not interfere with national, State, county or municipal parks, recreational areas, or wildlife refuges.

(e) New, expanded or redeveloped port facilities must have direct access to navigation channels of sufficient depth for anticipated vessel access, with minimal dredge and fill requirements, adequate access to road, rail transportation, and adjacent land with sufficient load bearing capacity for structures."

The need for the activities related to LNG has not been addressed at all. LNG export has not been justified as a beneficial activity that would warrant the environmental, health and safety

impacts of an LNG project at this location. As previously stated this location has great benefit for natural resource reasons and, in a natural condition, has compatibility with surrounding land uses in this area. The residential nature of Gibbstown, located right up against the Gibbstown Logistics Center, the day care center, playground and other community assets and attributes that make up the municipal setting of this community are not compatible with the industrial uses related to Dock 2 that are proposed at the site. In fact, the projected enormous increase of new truck traffic (200-220 trucks per day, at least), the new and increased railroad operations into and from the site, the industrial transformation of the site from a now largely natural condition at the site and on the rest of the Repauno property, the lights, noise, odors, air emission, water quality degradation, and the health and safety threats from LNG as well as the additional LHG and other bulk liquids that are planned to be handled related to the approval of Dock 2 by the WFD permit, is a liability for the local community and will work against the protection, quality of life and community values of Gibbstown. Many people who live in Gibbstown and the surrounding area have never experienced industrial activity at this site due to at least one generation of the local population only knowing the site as a natural resource.

The applicant also does not explore what the property value impacts will be for people who own homes and property adjacent to the property and in the surrounding area. Those people and businesses that were required to be notified of the project were not given the full story and do not know about the LNG Project at the Gibbstown Logistics Center, making those notifications invalid. Notifications to the public and adjacent properties must be reissued with full and comprehensive information about the LNG Project included.

Residents of the area opposed LNG at the site when it was first proposed in 2016, which led to it being dropped by the applicant. It has now become clear that the applicant continued to secretly move ahead with LNG export at Gibbstown without disclosing this, leaving people who live in the area in the dark about the plans for the site. Of course, the public and, in some cases, agencies were also kept ignorant of the behind-the-scenes LNG Project that Delaware River Partners and New Fortress Energy was stealthily progressing. A news article about local concerns related to LNG at the Gibbstown Logistics Center site from 2016 is attached to a copy of Delaware Riverkeeper Network's June 14, 2019 letter to the US Army Corps of Engineers Philadelphia District regarding this project, which is enclosed with this comment.

Compliance Statement 6.5.1
(NJAC 7:7-16.2): Marine Fish and Fisheries

Activity that would adversely impact marine fish is discouraged. As previously stated in this comment, the unacceptable and unjustified harm to the Atlantic sturgeon, the shortnose sturgeon, and other fish and fisheries has the potential to have devastating, even catastrophic effects on these species that live in these marine waters. The subsection NJAC 7:7-16.2 states, in part:

7:7-16.2 – Marine fish and fisheries

(a) Marine fish are marine and estuarine animals other than marine mammals and birds. Marine fisheries means:

1. One or more stocks of marine fish which can be treated as a unit for the purposes of conservation and management and which are identified on the basis of geographical, scientific, technical, recreational and economic characteristics; and

2. The catching, taking or harvesting of marine fish.

(b) Any activity that would adversely impact the natural functioning of marine fish, including the reproductive, spawning and migratory patterns or species abundance or diversity of marine fish, is discouraged. In addition, any activity that would adversely impact any New Jersey based marine fisheries or access thereto is discouraged, unless it complies with (c) below.” (Emphasis added)

These fish species will be adversely impacted and the critical habitat for the Atlantic sturgeon will be degraded through the Dock 2 activities. The applicant has not provided the protections that would prevent the harms that this subsection discourages. The WFD permit and Water Quality Certificate cannot be approved until these proofs are provided by the applicant.

No Compliance Statement regarding this subsection of CZM rule (NJAC 7:7-16.3): Stormwater Management

7:7-16.6 – Stormwater Management

The project is required to comply with the NJ Stormwater regulations to prevent runoff, encourage infiltration of precipitation, and reduce flooding and adverse water quality and receiving stream impacts from increased volume and rate of stormwater and polluted runoff. The project has a general permit covering stormwater management but does not have a permit covering the industrial stormwater generated by the site. A NJ Pollution Discharge Elimination System (NJPDES) permit is required for the property, as confirmed by the Delaware River Basin Commission (DRBC) in its docketing of the Docket 1 original project in 2017 and the Dock 2 expansion in June 2019. It is essential that the release of PCBs from the Repauno property, including the Gibbstown Logistics Center site, be controlled to enable the cleanup of PCB contamination in the Delaware Estuary and Bay under the current TMDL.

The control of the release of other contaminants that are in the groundwater and may be in soils and sediments at this site through effective stormwater management is also essential to provide the needed environmental protection and prevention of the migration and release of hazardous pollution. The planned handling, transfer, and storage of LHG, crude oil, other bulk liquids, and the presence and transloading of LNG at Gibbstown Logistics Center require effective stormwater management to prevent pollution and increased runoff resulting from the large increase in impervious surfaces and the handling and storage of hazardous materials on the site. The need for comprehensive and beneficial stormwater management at this site is discussed further in the Delaware Riverkeeper Network’s June 7, 2019 comment to the DRBC regarding DOCKET NO. D-2017-009-2 , DELAWARE RIVER BASIN COMMISSION , Delaware River Partners LLC, Gibbstown Logistics Center, Dock 2 , Greenwich Township, Gloucester County, New Jersey. A copy of the comment is enclosed with this comment. The subsection NJAC 7:7-16.3 states, in part:

(a) If a project or activity meets the definition of “major development” at N.J.A.C. 7:8-1.2, then the project or activity shall comply with the Stormwater Management rules at N.J.A.C. 7:8.³⁹

(b) Rationale: The Stormwater Management Rules (N.J.A.C. 7:8) specify standards for State, municipal and regional stormwater management. These rules provide minimum statewide runoff techniques, as well as special protection measures for environmentally sensitive water and land areas. Because development and land use activities contribute greatly to the types and amount of pollutants that are found in stormwater runoff, it is appropriate for major development projects in the coastal zone to comply with the Stormwater Management Rules’ standards.

Following are some of the reasons that the proposed project and the application that describes the project is not in compliance with CZM Resource Rules.

Compliance Statement 6.5.2
(NJAC 7:7-16.3): Water Quality
and
Compliance Statement 6.5.4
(NJAC 7:7-16.8): Air Quality

These subsections require protection of water and air resources. As previously discussed in this comment, and in the enclosed letter and comment, the water quality impacts and the potential for hazardous air emissions and methane and carbon air emissions from the activities that would be approved by the WFD Permit have not been justified by the applicant. There must be full and comprehensive analysis done of the LNG and LHG Projects to adequately demonstrate that the projects comply with these subsections, the Water Quality Certificate and the Flood Hazard Rules.

The Proposed Project is not in Compliance with Flood Hazard Area Rules NJAC 7:13-11.1

The Department only approves activity in a channel under certain conditions. One key requirement at NJAC 7:13-11.1(b) 4. is that there is enhancement of aquatic habitat where prevention is not possible. The applicant addresses this requirement in a cavalier fashion, without any enhancements provided. The applicant simply states that some natural features were avoided and does not address the needed to replace the value of what is negatively impacted. Throughout the application, the applicant is denying harm and promising avoidance and best management without fully assessing the natural resources, without on-the-ground analysis of natural conditions in the surrounding area and on the site, without acknowledging the natural resources and species in the region, and only choosing to examine the project as they envision it.

³⁹ The referenced definition is: ““Major development” means any “development” that provides for ultimately disturbing one or more acres of land or increasing impervious surface by one-quarter acre or more. Disturbance for the purpose of this rule is the placement of impervious surface or exposure and/or movement of soil or bedrock or clearing, cutting, or removing of vegetation. Projects undertaken by any government agency which otherwise meet the definition of “major development” but which do not require approval under the Municipal Land Use Law, [N.J.S.A. 40:55D-1 et seq.](#), are also considered “major development.”” N.J.A.C. 7:8-1.2

The worst aspect of this lack of comprehensive analysis is the cover-up of the LNG use at this project through the expansion allowed by the WFD for Dock 2, which undermines the credibility of the findings presented by the consultant for Delaware River Partners and New Fortress Energy. Based on the weak and incomplete information provided by the applicant, the application and planned project cannot be considered to comply with the Flood Hazard Area rules.

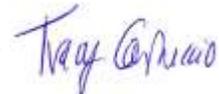
Archeological Resources

Appendix G PHASE IA HISTORICAL & ARCHAEOLOGICAL RESOURCE IMPACT SURVEY and reports including the Phase I Underwater Archaeological Investigations, Thompson Point, Repauno Site, Delaware River, Greenwich Township, Gloucester County, New Jersey and the Phase I Underwater Archaeological Investigations, Thompson Point, Repauno Site, Delaware River, Greenwich Township, Gloucester County, New Jersey document historic and prehistoric resources at Thompson's Point which could be impacted by the proposed project. It is stated that there was a Native American archaeological site previously documented within the project site at Thompson Point, but that this location is not likely to yield significant Native American archaeological remains due to the changes in the environment over the years. One of the changes was the potential location of an early historic site dating from the late 17th through the 19th century. Both of these archeological sites are expected to be too disturbed to be significant. However, only a Phase 1 survey has been done. The potential for finding important archeological resources at Thompson Point is great, due to previous findings. Sonar did yield some potential finds that are documented in these reports. DRN disagrees that further investigation under a Phase 2 study is not warranted. The cultural importance of prehistoric history is too great to be glossed over based on a guess that subsequent uses have destroyed the value of Thompson Point, which is famous in local lore as an important Native American site. DRN advocates that Thompson Point not be allowed to be further destroyed because of a guess and that a Phase 2 study be required to further investigate this important location.

Conclusion

The draft permit does not comply with the rules that apply to the WFD permit. The application does not meet the requirements of the Coastal Zone Management Rules (CZM NJAC 7:7), the NJ Department of Environmental Protection Flood Hazard Area Control Act Rules (FHACA Rules NJAC 7:13), and does not satisfy the provisions of the NJ State Individual Water Quality Certificate and NJ Tidelands License. There is critical information and analysis missing from the application that is necessary to judge if the WFD Individual Permit Application for Dock 2 is in compliance. Furthermore, information that is provided does not demonstrate that the project is in compliance with these rules and regulations. The Department must reject the draft permit and find the application invalid. The Water Quality Certification that accompanied the draft permit is, in turn, also invalid and must be rescinded.

Respectfully submitted,

Maya van Rossum
the Delaware Riverkeeper

Tracy Carluccio
Deputy Director

Enclosures:

June 14, 2019 letter from Delaware Riverkeeper Network to the US Army Corps of Engineers Philadelphia District regarding CENAP-OP-R-2016-0181-39 -- Gibbstown Logistics Center port expansion.

June 7, 2019 comment from Delaware Riverkeeper Network to the DRBC regarding DOCKET NO. D-2017-009-2 , DELAWARE RIVER BASIN COMMISSION , Delaware River Partners LLC, Gibbstown Logistics Center, Dock 2 , Greenwich Township, Gloucester County, New Jersey.

CC: Suzanne Dietrick, Case Manager, Land Use Management, NJDEP
suzanne.dietrick@dep.nj.gov



June 14, 2019

Lieutenant Colonel Kristen Dahle, Commander
Mike Hayduk, Chief, Application Section II &
District Engineer

US Army Corps of Engineers Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Submitted via email to Lawrence Slavitter lawrence.m.slavitter@usace.army.mil

Re: CENAP-OP-R-2016-0181-39 -- Gibbstown Logistics Center port expansion.

To Whom It May Concern,

The Delaware Riverkeeper Network requests that you formally re-open the comment period on CENAP-OP-R-2016-0181-39 for expansion of the Gibbstown Logistics Center port. Critical information has come to light about the intended use of this expansion to support Liquefied Natural Gas (LNG) exports. These important facts were not properly disclosed to the public with sufficient clarity or detail to support informed public comment, nor were they meaningfully considered by the US Army Corps of Engineers in the public notice or project materials in a way that could/would support informed and meaningful public comment or Army Corps decision-making. As a result, the public has been denied a full and fair opportunity to comment on this proposal. In addition, there has been a failure to fulfill your obligations for review pursuant to the National Environmental Policy Act, critical for Army Corps decision-making and informed public comment. Therefore, we request that full disclosure of the LNG aspects of the proposal be released to the public, including the environmental, port, and public safety consequences, and thereafter a 90-day public comment period be provided.

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
dm@delawareriverkeeper.org
www.delawareriverkeeper.org

The Army Corps Will Violate Federal Law If It Approves the Gibbstown Logistics Center Proposal.

The US Army Corps of Engineers (Army Corps) has not fulfilled its legal obligations pursuant to the National Environmental Policy Act (NEPA). The Army Corps has not undertaken the necessary reviews or made the public disclosures required by NEPA. Issuing an Army Corps approval for the Gibbstown Logistics Center (CENAP-OP-R-2016-0181-39), which now undeniably includes an LNG export operation, would be a violation of federal law that will be subject to legal challenge.

NEPA is our “basic national charter for protection of the environment.”¹ NEPA makes environmental protection a part of the mandate of every federal agency² by requiring that federal agencies take environmental considerations into account in their decision-making “to the fullest extent possible.”³ Pursuant to NEPA federal agencies must consider environmental harms and the means of preventing them in a “detailed statement” before approving any “major federal action significantly affecting the quality of the human environment.”⁴ This required analysis serves to ensure that “the agency will not act on incomplete information, only to regret its decision after it is too late to correct.”⁵ Approval of the LNG export facility proposed definitely meets the standard of requiring NEPA review.

A. Army Corps Has Failed to Provide Proper Public Disclosure.

In addition to fulfilling its overall legal obligation to provide a full and fair opportunity for public comment, including providing full information on the actual project being proposed, there is an obligation on the Army Corps for full disclosure and an engaged public process pursuant to NEPA.

NEPA “guarantees that the relevant information [concerning environmental impacts] will be made available to the larger audience,” including the public, “that may also play a role in the decision-making process and the implementation of the decision.”⁶ As NEPA’s implementing regulations explicitly provide, “public scrutiny [is] essential to implementing NEPA.”⁷ The opportunity for public participation guaranteed by NEPA ensures that agencies will not take final action until after their analysis of the environmental impacts of their proposed actions has been subject to public scrutiny.⁸

NEPA is an “environmental full disclosure law.”⁹ It requires that an agency obtain and consider detailed information concerning environmental impacts, and it “ensures that an agency will not act on incomplete information, at least in part, by ensuring that the public will be able to analyze and comment on an action’s environmental implications.”¹⁰ The information provided to the public “must

¹ 40 C.F.R. § 1500.1(a).

² See 42 U.S.C. § 4332(1).

³ 42 U.S.C. § 4332.

⁴ Id. § 4332(2)(C).

⁵ *Marsh v. Oregon Natural Res. Council*, 490 U.S. 360, 371 (1979).

⁶ *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989).

⁷ 40 C.F.R. § 1500.1(b).

⁸ See *N. Plains Res. Council v. Surface Transp. Bd.*, 668 F.3d 1067, 1085 (9th Cir. 2011) (noting that where “data is not available during the EIS process and is not available to the public for comment,” the process “cannot serve its larger informational role, and the public is deprived of their opportunity to play a role in the decision-making process”) (quoting *Robertson*, 490 U.S. at 349).

⁹ *Monroe Cnty. Conservation Council, Inc. v. Volpe*, 472 F.2d 693, 697 (2d Cir. 1972).

¹⁰ *Ohio Valley Env'tl. Coal. v. U.S. Army Corps of Eng'rs*, 674 F. Supp. 2d 783, 792 (S.D. W. Va. 2009) (internal quotation marks and citations omitted).

be of high quality” because “[a]ccurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA.”¹¹

The Army Corps did not fully or fairly disclose the intended use of the proposed Gibbstown Logistics Center expansion to support LNG exports, including bringing LNG to the site via truck and/or rail. These important facts were not properly disclosed to the public with sufficient clarity or detail to support informed public comment, nor were they meaningfully considered by the Army Corps in the public notice or project materials in a way that could/would support informed and meaningful public comment or agency decisionmaking. As a result, the public has been denied a full and fair opportunity to comment on this proposal as anticipated by NEPA.

The fact that the Army Corps, on page 3 of the public notice for comment, mentions that the “site will be designed to handle a multitude of products” amongst them being LNG does not provide full and fair public notification when you look at the notice as a whole and when you look across the board at the discussion by the agencies and file materials Delaware Riverkeeper Network secured through legal information requests. The Army Corps may have made a passing reference to LNG in its April 4, 2019 public notice and call for comment but that passing mention cannot be said to rise to the level of being clear about what is being proposed for the site – the notice merely states that the “site will be designed to handle a multitude of products” and lists several items with LNG being part of the list. This reference does not make clear to the public that LNG exports is an intended and primary focus of the new expansion, nor does it give any detail about the volumes of LNG being proposed, the thousands of truck trips that will be required to bring the gas to the site, the level of rail traffic that will be required, the source of the gas and the implications of its extraction, to what degree there will be onsite storage and increased shipping traffic, etc. In addition, given that dearth of information about the LNG export goal, plan and/or impacts in the documents we secured via FOIA, as well as the lack of NEPA documentation and analysis, the public notice cannot be said to rise to the level of full and fair public notice of the proposal; rather, it is a clear and obvious obfuscation.

B. The Army Corps Did Not Assess nor Disclose to Any Meaningful Degree, the Environmental, Safety, Community, Economic or Port Impacts.

A proper NEPA assessment must fully assess and disclose the complete range of environmental consequences of the proposed action, including “ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, [and] cultural” impacts, “whether direct, indirect, or cumulative.”¹² Direct effects are “caused by the action and occur at the same time and place.”¹³ Indirect effects are those impacts that are caused by the action, but occur “later in time or farther removed in distance, but are still reasonably foreseeable,” and may include “growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.”¹⁴ Cumulative impacts are “impact[s] on the environment which result[] from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes

¹¹ 40 C.F.R. § 1500.1(b).

¹² 40 C.F.R. §§ 1502.16(a), (b); 1508.8.

¹³ 40 C.F.R. § 1508.8(a).

¹⁴ 40 C.F.R. § 1508.8.

such other actions.”¹⁵ NEPA also prohibits segmentation in order to avoid full and fair review of the implications and impacts of a project or action.

LNG has significant ramifications environmentally, for public safety, and for shipping on the Delaware River system. There is no discussion or analysis of any of these issues, including but not limited to: the safety, pollution and health implications of trucking (anticipated to at least triple; the anticipated truck traffic created by the LNG facility for the local community has the likely potential of being quite massive given that the LNG will be transferred to the ships via a truck rack that is being designed to handle 200 to 220 trucks per day) and railing in the significant volumes of LNG anticipated for the site (1.5 million metric tonnes per year); the ramifications of storing LNG on a ship while it is slowly loaded over a period of at least 15 days; what LNG exports from Gibbstown means for shipping, ship traffic and the business operations of other shippers operating through Delaware River ports; the climate change and other environmental impacts of exporting LNG from this site including the onsite impacts, but also the ramifications from the gas extraction activities that will be induced/supported by this operation and the downstream impacts from the use of the gas; the safety ramifications of having an LNG operation of this kind on the Delaware River including for the surrounding community; the implications for other shippers and port operations (there is anticipated to be 2 LNG export operations a month – 24 a year – from this site); the impacts on the endangered Atlantic and Shortnose Sturgeon or the designated Atlantic Sturgeon Critical Habitat in the River; the water quality ramifications due to the release of ballast water from LNG ships; the air and other ramifications of flaring off of gas and/or the construction and operation of a small capacity liquefier on site; just to name a few.

It is notable that in a November 16, 2017 letter to the US Coast Guard, Delaware River Partners notes the limitations caused by having just a single-berth at this site while also accommodating an LNG operation there – i.e. that “LNG, LHG, or other hazardous or non-hazardous cargo operations will not run concurrently, as the single-berth wharf only permits one vessel to dock at a given time for a single commodity.” Clearly, the applicant and the agencies knew that LNG was an intended goal of this project whether it was a single-berth or two-berth design and so there is no excuse not to have considered the impacts that constructing and operating an LNG export facility at this site (including the delivery of LNG by rail and truck) during review of stage 1 as well as the current stage 2 of this project and there is no excuse for not having notified the public of this intended use in the Army Corps’ April 4, 2019 public notice.

In addition to the failure to consider the environmental, safety, economic, and port ramifications of the proposed LNG operation at the site, there has also been a failure to consider the proposed Liquefied Hazardous Gas (LHG) Handling facility proposed for the site. According to the November 2017 letter to the Coast Guard the LHG operation is anticipated to include 24 vessels a year (2 a month) at the site creating additional potential pressures for Delaware River port traffic, particularly when considered along with the anticipated 24 vessels a year of LNG. In addition, there will be constructed ~100,000 BBL of onsite storage, with the vessels also being used for storage in order to increase the onsite storage capacity. LHG will be brought to the site via rail car, the environmental and safety ramifications of which have also not been analyzed. The project includes ~3 acres of tanks and associated equipment as additional project elements. This information also required full analysis

¹⁵ 40 C.F.R. § 1508.7 (emphasis added).

by the Army Corps, particularly the ramifications of having both the proposed LNG and LHG at the same location.

C. The Current Proposal is a Clear Case of Illegal Segmentation.

NEPA prohibits segmentation of projects for purposes of NEPA review. As stated by the DC Circuit in *Delaware Riverkeeper Network, et al. v. Federal Energy Regulatory Commission*, 753 F.3d 1304, 1307 (D.C. Cir. 2014):

“An agency impermissibly “segments” NEPA review when it divides connected, cumulative, or similar federal actions into separate projects and thereby fails to address the true scope and impact of the activities that should be under consideration. The justification for the rule against segmentation is obvious: it “prevent[s] agencies from dividing one project into multiple individual actions each of which individually has an insignificant environmental impact, but which collectively have a substantial impact.” *NRDC v. Hodel*, 865 F.2d 288, 297 (D.C. Cir. 1988)” The rule against segmentation requires the federal agency, in this case, to consider all connected and cumulative actions.”

It has now become clear to the Delaware Riverkeeper Network that the prohibition against segmentation has in fact been violated. Not only was the expansion of the facility reasonably foreseeable, but it now appears that this expansion was planned all along and that expansion was documented by the company.

- In a July 24, 2016 Philadelphia Inquirer news article, the company admits that it had envisioned LNG for this site: “Although a company prospectus last year envisioned a liquefied natural gas (LNG) facility at Repauno - disconcerting some residents and environmental groups such as the Sierra Club and the Delaware Riverkeeper – ‘that is no longer in our designs,’ Lewis said.” As a result, having an LNG operation at this site was clearly considered and therefore it was reasonably foreseeable that LNG would become a serious component of this operation at some point. It now seems obvious that while Delaware River Partners removed the LNG prospect from its application materials in 2016, it had every intention to restore that component of the project at a future date, and simply removed it to lighten the level of agency and public scrutiny and review that would be given to the project during the reviews that were taking place for stage 1 of the Gibbstown Logistics Center.
- A November 16, 2017 Letter of Intent was submitted to the US Coast Guard specifically describing the project as being an LNG facility. This letter was sent to the US Coast Guard before the Army Corps issued its approval for stage 1 of this project on December 21, 2017. And so, it is clear that Delaware River Partners knew, and the Army Corps should have known, that the ultimate goal of the project was to build an LNG facility at this site. The letter to the Coast Guard has significant detail, including the anticipated export capacity of the site (1.5 million metric tonnes). The failure to consider the full project, including the LNG component, is a clear case of segmentation in violation of federal law. It is clear, should have been clear to the Army Corps, and would have been clear to the Army Corps had it done its NEPA due diligence, that the two stages of the project were and are interdependent and are clearly two parts of the same whole. There is a clear violation of the prohibition against segmentation that has taken place/is taking place at this site.

- There is clearly a foreseeable expansion of the facility to accommodate additional LNG capacity in the future (i.e. a state 3 of the project) given that the November letter to the Coast Guard describes the current project as “proposing an LNG facility with an initial capacity of up to approximately 1.5 million MTPA of LNG (roughly 1,670,000 BBL per month).” The descriptive language of “initial capacity” makes clear that more LNG exports are to come, that there will be additional expansions, and that such expansions need consideration as part of this current project in order to avoid additional segmentation violations.

Further, NEPA requires consideration of all reasonably foreseeable impacts resulting from a proposed action, activity or project. The facts above make clear that the LNG component has always been reasonably foreseeable.

D. A Full Environmental Impact Statement Is Clearly Mandated.

Authorizing the Gibbstown Logistics Center to export LNG and to construct and operate LNG export facilities demands an Environmental Impact Statement (EIS) pursuant to NEPA because this project will clearly have significant effects on the human environment. Unquestionably, construction and operation of the export facilities, including the transportation of the liquified natural gas (LNG) to the site via truck and rail will have significant effects that trigger the mandate for a full NEPA EIS. In addition, there will be upstream and downstream impacts with respect to the extraction and use of the source fracked gas that are related and reasonably foreseeable actions which must be considered. Export of LNG will induce additional shale gas extraction/production in upstream regions, result in increased downstream uses, increased domestic gas prices, and increased greenhouse gas emissions and global warming. Each of these effects has direct importance to the Army Corps’ consideration of the Gibbstown Logistics port expansion proposal which includes LNG export as a significant, if not primary, goal of the project.

LNG operations pose specific and adverse risks to surrounding neighborhoods as well as the local, regional and national environment. The inclusion of LNG operations is a significant aspect of the Gibbstown Logistics Center expansion that must receive full NEPA EIS review. Further, the Applicant has already segmented its operations at Gibbstown into different projects, even though they all support each other. Continuing to permit such segmentation masks the environmental and health harms of Delaware River Partners’ operations as a whole. The proposal to truck/rail in the LNG along with long offloading times resulting in at least 15 days of storage on vessels raises additional impacts that need to be assessed and addressed, in addition to the environmental (including climate change) and health consequences at the point of gas extraction and as the result of downstream use. There are also implications for port traffic along the Delaware River in need of meaningful consideration and review.

The Delaware Riverkeeper Network (DRN) has been reviewing documents from multiple agencies regarding this Gibbstown Logistics Center expansion. Delaware Riverkeeper Network has conducted file reviews, secured and reviewed documents via the Freedom of Information Act and state right to know laws. At no point did the Delaware Riverkeeper Network see documents in the file that even resembled the necessary review pursuant to NEPA – neither an Environmental Assessment nor an Environmental Impact Statement—of the LNG export proposal being advanced here. And certainly, there has been no NEPA public comment process that would allow the public to assess and/or comment upon such an analysis.

As noted throughout this letter, there are a wealth of environmental and public impacts that need to be fully assessed pursuant to NEPA. Issues that need to be considered in a NEPA EIS include, but are not limited to:

- The safety, pollution and health implications of truck and rail traffic necessary to support the LNG (and LHG) operations proposed for the site. It is anticipated that truck traffic will at least triple over current levels as a result of the LNG export portion of the proposal. Truck racks that will be used to transfer the LNG from truck to ship will be designed to accommodate 200 to 220 trucks per day; a clear indication of the massive volume of truck traffic that will be created by the proposed LNG operations at the site. This will result in tremendous air pollution, noise pollution, property value, quality of life, traffic impact and traffic safety concerns that must be assessed. LNG volumes anticipated for the site are 1.5 million metric tonnes per year. It is anticipated that offloading from truck to rail will take 15 days. There will clearly be a massive uptick in the volume of truck traffic that this LNG facility will induce.
- The ramifications, particularly safety ramifications, of storing LNG on a ship while it is slowly loaded over a period of at least 15 day.
- The ramifications of the proposed LNG exports for shipping, ship traffic and the business operations of other shippers operating through Delaware River ports as well as for endangered populations such as the Delaware River Atlantic Sturgeon that are being severely impacted by ship strikes along the Delaware. Given that there are less than 300 spawning adults left of the Delaware River's genetically unique population of Atlantic Sturgeon, the ramifications of increased ship traffic and ship strikes is serious and potentially catastrophic.
- The onsite environmental impacts of exporting LNG from this site.
- The upstream climate and environmental ramifications of the gas extraction activities that will be induced/supported by this operation. Increased shale gas extraction, including drilling and fracking, is a related, connected and foreseeable outcome of the proposed Gibbstown LNG facility given that the facility is intended to secure and support increased shale gas development in order to supply the facility with shale gas for export. As such, NEPA requires consideration of the environmental and community impacts of shale gas development that will result in order to supply the Gibbstown LNG facility. Shale gas development is an extraordinarily land and water-intensive process that converts agricultural, forest, and range lands to industrial uses, consumes millions of gallons of water per well, and generates huge quantities of hazardous wastes, and results in tremendous and harmful volumes of climate changing emissions as well as the release of other hazardous air pollutants.¹⁶

¹⁶ Shale gas extraction is also a significant source of hazardous air pollution, including methane, volatile organic chemicals (VOCs), and air toxics such as benzene and ethylbenzene. In July 2011, EPA proposed a suite of draft regulations under the Clean Air Act to set new source performance standards for VOCs and sulfur dioxide, an air toxics standard for oil and natural gas production, and an air toxics standard for natural gas transmission and storage. Final regulations are due by April 3, 2012. See <http://www.epa.gov/airquality/oilandgas/> The Department of Energy's advisory panel on shale gas has urged EPA to extend these rules to existing shale gas production sources and to adopt regulations addressing methane explicitly. Bridget DiCosmo, "DOE Panel Urges EPA to Strengthen Proposed Air Rules for 'Fracking,'" Nov. 10, 2010, <http://insideepa.com/201111102381935/EPA-Daily-News/Daily-News/doe-panel-urges-epa-to-strengthen-proposed-air-rules-for-fracking/menu-id-95.html> Methane is twenty times more potent a greenhouse gas than carbon dioxide. See <http://www.climate-science.gov/infosheets/highlight1/default.htm>

The oil and gas industry is the single largest source of methane emissions in the US, accounting for nearly 40% of national methane emissions. See <http://epa.gov/airquality/oilandgas/pdfs/20110728factsheet.pdf>

- The downstream environmental and climate impacts from the use of the gas to be exported.
- The safety ramifications of having an LNG operation of this kind on the Delaware River including for the surrounding community.
- The implications for other shippers and port operations that will result from the LNG export use of the site at a rate of 2 LNG export vessels a month / 24 a year.
- The impacts on the endangered Atlantic and Shortnose Sturgeon and the designated Atlantic Sturgeon Critical Habitat that will be impacted. The Delaware River population of Atlantic Sturgeon is genetically unique with a surviving population that includes less than 300 spawning adults.¹⁷ With numbers this precariously low, the responsibility for vigilant protection by our federal agencies could not be greater. The Delaware River population of Atlantic Sturgeon, along with the entire NY Bight Distinct Population Segment (DPS), of which the Delaware River population is a part, are designated as endangered pursuant to the Endangered Species Act. In addition, the Delaware River’s population of Shortnose Sturgeon is also listed as federally endangered and suffers low population figures.
- The water quality ramifications due to the release of ballast water from LNG ships. The “... discharge of ballast water and sediment from ships during LNG terminal loading operations may result in the introduction of invasive aquatic species.”¹⁸
- The water quality ramifications due to dredging and the potential resuspension/reintroduction from CDF discharges of contaminants to the Delaware River, including PCBs. CDFs holding dredged sediments from Delaware River dredging projects have been a demonstrated source of toxic contamination to the River, inflicting serious water quality impacts.
- The air and other ramifications of flaring off of gas and/or the construction and operation of a small capacity liquefier on site as discussed in a letter sent on November 16, 2017 to the US Coast Guard.
- Releases, spills or leaks during storage, transfer and/or transport of LNG.¹⁹
- Risk of accidents, incidents, fire or explosion during transport storage and/or transfer of LNG.²⁰ While it is asserted there will be no onsite storage of LNG, the process of loading each ship will take on the order of 15 days—this translates into 15 days of storage on the vessel while loading operations are taking place. The potential safety implications need to be examined and disclosed. “Natural gas is combustible, so an uncontrolled release of LNG poses a serious hazard of explosion or fire.”²¹ The greatest LNG hazards include pool fires, flammable vapor clouds and flameless explosion.²²
 - A pool fire occurs if LNG spills near an ignition source and in fact ignites, “the evaporating gas in a combustible gas-air concentration” burns above the LNG pool, and then proceeds

¹⁷ ASSRT (Atlantic Sturgeon Status Review Team) 2007. Status Review of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

¹⁸ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

¹⁹ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

²⁰ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

²¹ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²² CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

to spread as the LNG pool expands away from its source and continues evaporating.²³ Pool fires are intense and will burn more hotly and rapidly than oil or gasoline.²⁴ Pool fires cannot be extinguished – “all the LNG must be consumed before they go out.”²⁵

- Flammable vapor clouds happen if there is an LNG spill that does not immediately ignite and instead evaporates forming a vapor cloud.²⁶ Vapor clouds can drift a distance from the site of the spill.²⁷ If the vapor cloud encounters an ignition source then “those portions of the cloud with a combustible gas-air concentration will burn.”²⁸ While a vapor cloud is not toxic, it can displace breathable air and as a result cause asphyxiation.²⁹ Extremely cold LNG can injure through direct contact.³⁰ It has been said that “environmental damage associated with an LNG spill would be confined to fire and freezing impacts near the spill since LNG dissipates completely and leaves no residue.”³¹
- “LNG spilled directly onto a warm surface (such as water) could result in a sudden phase change known as a Rapid Phase Transition (RPT).”³² “If LNG spills on water, it could theoretically heat up and regasify almost instantly in a ‘flameless explosion’.”³³

- Given the site’s history of industrial operations, the known contamination that has and still does exist on the site, and its superfund status, there is a need to consider the potential synergy of harm that could occur if there was a catastrophic release at the site. Known contaminants of concern at the site include: nitrobenzene, aniline and mixed acids, sodium nitrite and nitrosylsulfuric acid.
- The entire site is in the flood hazard area. What are the implications of a flood for the LNG operations and LHG operations if there were a flood during transfer operations or storage onsite? With climate changing increasing the frequency, duration and magnitude of floods, this is an obvious and serious consideration. The ramifications of catastrophic flooding due to climate change is compounded by the known flood and safety ramifications of storm surge in the Delaware Estuary.
- The Gibbstown Logistics Center is located next to a residential area. There is a day care center and housing in Gibbstown adjacent to the Block and Lot of this site. These residential and day

²³ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁴ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁵ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁶ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁷ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁸ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁹ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

³⁰ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

³¹ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

³² IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

³³ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

care uses are not compatible with an LNG export operation. The safety issues of the trucking, rail transport, storage, and transfer of LNG is dangerous if there is an accident or incident, and is in need of careful consideration.

- The economic ramifications of the proposed LNG export. By causing an increase in shale gas prices here in the U.S., there is widespread concern that the export of shale gas to foreign countries will adversely impact a number of other industries and the economic benefits and jobs they provide.³⁴
- LNG infrastructure can be vulnerable to terrorist attack.³⁵ This threat needs serious consideration. While, according to a report prepared for Congress in 2003, it was reported that “No LNG tanker or land-based LNG facility has been attacked by terrorists ... similar natural gas and oil facilities have been favored terror targets internationally.”³⁶ Among the catastrophic events that can result from an accident or attack at an LNG facility are pool or vapor cloud fires.³⁷
- EPA identified the Repauno site in 2003 as one of the largest PCB point sources in the Delaware Estuary (among the top 10). Additional dredging, site disturbance and stormwater systems will disturb PCBs, which have been found in near-shore sediments and in runoff from the site. There is a zone of highly contaminated sediments immediately adjacent to the shore and port facility. The remobilization (and dewatering of dredged sediments) will create re-release of PCBs into the estuary, including in Atlantic Sturgeon spawning habitats. The ramifications for the reintroduction of PCBs into the environment needs careful assessment. Given that there is a reasonably foreseeable future expansion at this site to accommodate increased LNG operations, there needs to be consideration of this expansion for issues such as PCBs and other environmental effects.
- The job impacts of the proposal are in need of consideration and public disclosure. LNG exports, while creating some jobs in the gas industry, many temporary, creates a net job loss effect for the country. In fact, LNG exports could result in the net loss of as many as 270,000 jobs per year in our country.³⁸ The job implications must be assessed

The Army Corps is in clear violation of NEPA if it grants any approvals for the Gibbstown Logistics Center CENAP-OP-R-2016-0181-39 at this time. In addition, the Army Corps is in violation of its legal and moral obligations to ensure the public is fully aware, and given full opportunity to comment upon, the proposal to place an LNG export facility in the heart of our Delaware River community so close to residential communities, including vulnerable populations such as children. We urge and request that you take a step back; that you provide full and accurate information to the public about this project, including the LNG exports; and that you give the public a full 90 days to review and comment once that information has been released. We also urge that you fully comply with NEPA, and that means undertaking a full EIS review, including associated public comment.

³⁴ [Unanswered Questions About the Economic Impact of Shale Gas Exports: Don't Jump to Conclusions. Comments on NERA Study](#), prepared by Jannette M. Barth, Ph.D., Economist, Pepacton Institute LLC, Dec 11,2012.

³⁵ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

³⁶ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

³⁷ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

³⁸ [Will LNG Exports Benefit the United States Economy](#), Synapse Energy Economics Inc, January 23, 2013

Respectfully & Urgently,



Maya K. van Rossum
the Delaware Riverkeeper
Delaware Riverkeeper Network



Tracy Carluccio
Deputy Director
Delaware Riverkeeper Network

Attachments:

1. *Plan to revive old South Jersey industrial site draws fans and fears*, Philadelphia Inquirer, July 24, 2016
2. Letter to Captain Scott Anderson, Captain of the Port, USCG Sector Delaware Bay, from AcutTech, November 16, 2017

Cc: Captain of the Port, U.S. Coast Guard Sector Delaware Bay



AcuTech Group, Inc.
Washington DC Headquarters
1919 Gallows Road, Suite 900
Vienna, Virginia, USA 22182
Tel: +1.703.676.3180
Fax: +1.703.842.8854
www.acutech-consulting.com

November 16, 2017

Captain Scott Anderson
Captain of the Port, USCG Sector Delaware Bay
ATTN: Facilities and Containers Branch
U. S. Coast Guard
Sector Delaware Bay
1 Washington Avenue
Philadelphia, PA 19148

Re: Letter of Intent for Repauno Port and Rail Terminal, Gibbstown, New Jersey

Dear Captain Anderson:

Delaware River Partners LLC ("DRP") proposes to site, construct, and operate a multi-use, deep-water port and logistics center that may include a variety of separate uses including handling of imported and exported automobiles, other bulk freight and liquid energy products including, but not limited to liquefied petroleum gas ("LPG") and liquefied natural gas ("LNG"). LPG is classified as a liquefied hazardous gas ("LHG") by 33 C.F.R. § 127.005.

The focus of this submission is a joint LNG / LHG facility which will be referred to as the "Project". In accordance with the requirements contained in 33 C.F.R. § 127.007, DRP is pleased to submit the following information about the Project. Please note that at the appropriate time, DRP will make the necessary submission(s) to the COTP pursuant to 33 C.F.R. §§ 126 and 154 as it relates to the other proposed uses.

Given the common stakeholders involved throughout the approval and assessment process, as well as the interdependent risk factors that must be examined, DRP requests that the LNG and LHG be examined jointly through a combined Waterway Suitability Assessment ("WSA") that will accurately represent the envisioned operations of the proposed Project. Enclosed with this Letter of Intent is a Preliminary WSA.

The Project would be operated at the site of the proposed Repauno Port and Rail Terminal ("Repauno Facility"), which is located on a 218-acre portion of a 1630-acre tract formerly known as the Dupont Repauno Works at 200 North Repauno Avenue in Gibbstown, Gloucester County, New Jersey. The Repauno Facility will be consistent with other industrial facilities along the riverfront.

The Project's LNG operations will maintain an export capacity of approximately 1.5 million metric tonnes per annum ("MTPA") (roughly 1,670,000 BBL per month). The LHG operations will maintain an

export capacity of approximately 9,600,000 BBL per annum (800,000 BBL per month). Notably, LNG, LHG, or other hazardous or non-hazardous cargo operations will not run concurrently, as the single-berth wharf only permits one vessel to dock at a given time for a single commodity.

1. Name, address and telephone number of the owner and operator

The Project will be owned and operated by DRP, a limited liability company organized under the laws of the State of Delaware, which is doing business as Repauno Port and Rail Terminal. The address and telephone number for DRP is:

Delaware River Partners LLC
d/b/a Repauno Port and Rail Terminal
200 North Repauno Avenue
Gibbstown, NJ 08027
Phone: 856-224-7067

2. The name, address, and telephone number of the Federal, State, or local agency having jurisdiction for siting, construction, and operation

The lead agency with jurisdiction over the Project is the New Jersey Department of Environmental Protection ("NJDEP"). NJDEP will have the responsibility of reviewing the siting, environmental and safety aspects of the project and preparing the environmental documents required pursuant to the agency's governing laws and regulations. The mailing address and telephone number for general inquiries are:

New Jersey Department of Environmental Protection
Bureau of Release Prevention
401 East State Street
Mail Code 22-03D
P.O. Box 420
Trenton, NJ 08625-0420
Phone: 609-633-0610

In addition to the siting and environmental reviews by NJDEP, other agencies participate in the process, such as the U.S. Department of Energy for authorization to export LNG to both Free Trade Agreement and Non-Free Trade Agreement countries, and the Greenwich Township and Gloucester County Planning Boards for related local site plan and construction approvals. A Section 10/404 permit for construction of the Repauno Facility is pending before the U.S. Army Corps of Engineers ("USACE").

3. Name, address, and telephone number of the Repauno Facility

The project name is "Repauno Port and Rail Terminal." The project management offices and point of contact are:

Mr. Jimmy Osman
V.P. Engineering & Development
Repauno Port and Rail Terminal
200 North Repauno Avenue
Gibbstown, NJ 08027
Phone: 856-224-7067

4. The physical location of the Project

The Project will be located on a portion of the Repauno Facility currently being redeveloped by DRP on the site of a former industrial facility along the Delaware River. The Repauno Facility will feature a single, multi-use, deep-water berth and associated port and logistics center facilities, including the proposed Project. The Project will be located at 200 North Repauno Avenue in Gibbstown, Gloucester County, New Jersey, at river mile 86.5 and at Latitude N 39.846/Longitude W 75.296. The Project is adjacent to the Tinicum Range of the Delaware River Channel. A site location map is shown in Figure 1, a site plot plan showing the major components that are planned for the Repauno Facility are shown in Figure 2, including the alignment of the LNG and LHG operations. Figure 3 shows a more detailed view of the wharf.

Figure 1 – Proposed Repauno Facility Location



Figure 2 - Proposed Repauno Facility Layout

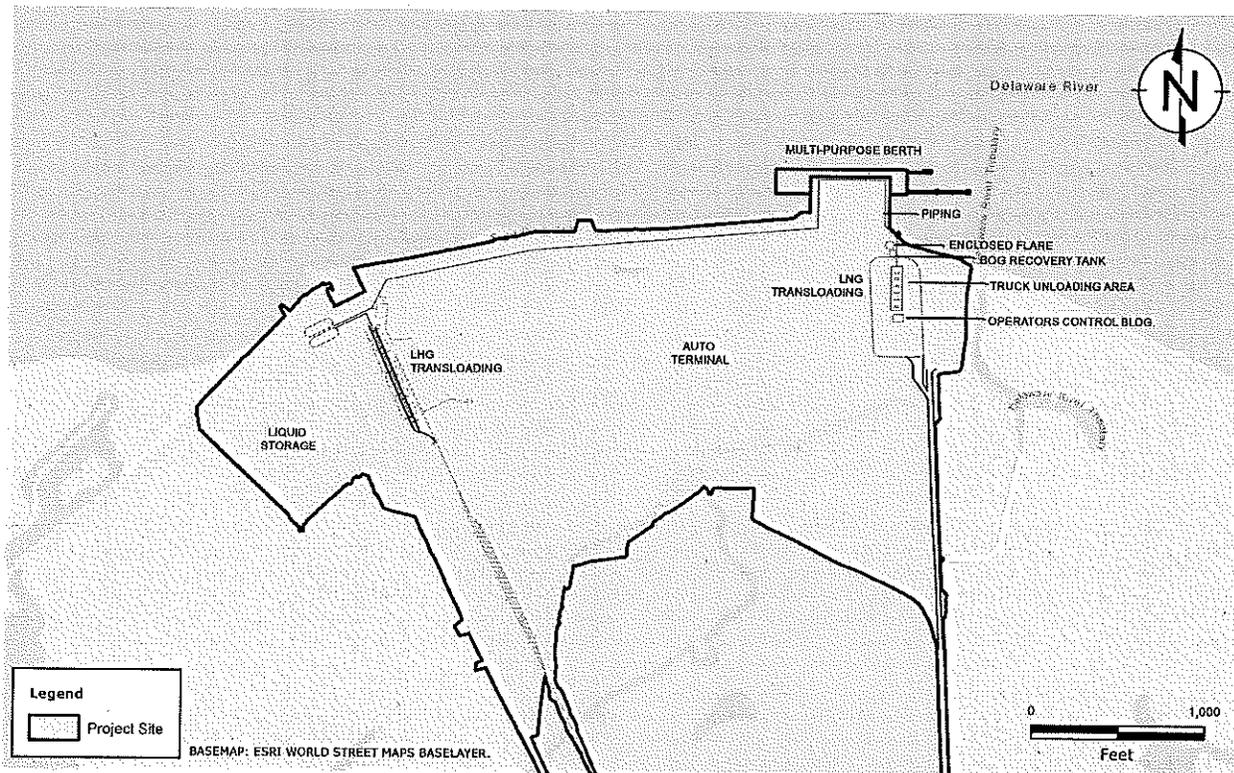
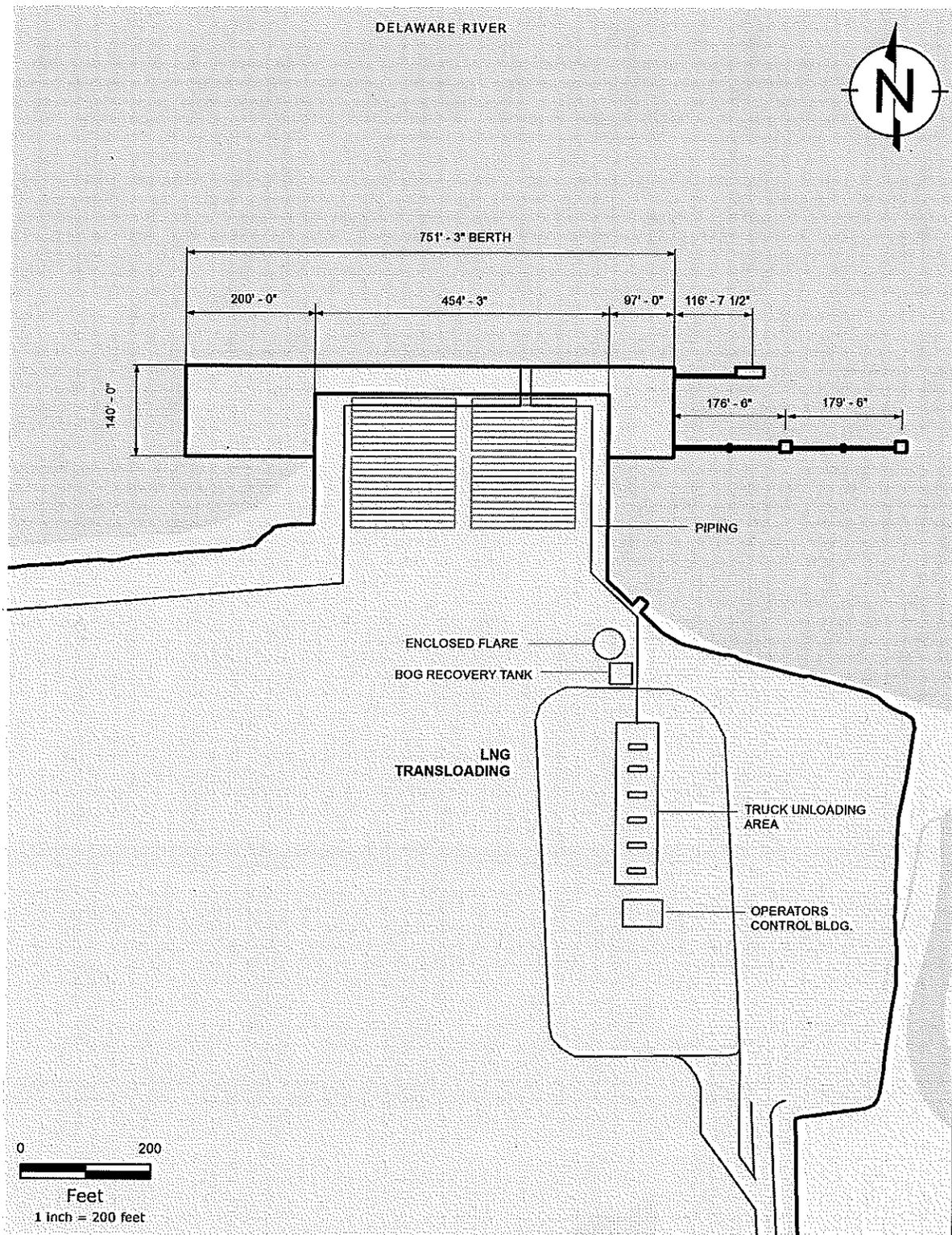


Figure 3 -Proposed Repauno Facility Wharf Layout



5. Overview of the Proposed Project

The Applicant will develop a multi-purpose port facility that will, among other things, provide transloading of LNG and LHG for export. LNG would be delivered to the facility only via trucks and/or rail and pumped directly onboard LNG carriers (“LNGCs”) for export. This process eliminates the need for large-scale, onsite LNG storage or liquefaction while providing an export capacity of 1.5 MTPA (20 MM BBL). Loading a berthed LNG tanker with an expected load of 830,000 BBLs will take an average of 15 days.

LHG would be delivered via railcars or truck, and will be stored onsite. Loading a berthed LHG tanker with an expected capacity of 400,000 BBLs will take an average of 11-12 days.

6. Description of the LNG Handling Facility

The Project would be capable of handling LNG or LHG as described in Sections 6 and 7 hereof. LNG and LHG operations or other cargo deliveries will not run concurrently, as the single-berth wharf only permits one vessel to dock at a given time. For the purposes of this Letter of Intent and the Preliminary WSA, each of the potential maximum yearly LNG and LHG ship calls are analyzed herein. Importantly, however, these projective ship calls represent potential alternatives; they are not cumulative.

The Project will be designed as a modular system to ensure efficient throughput at the facility. The proposed design will allow LNG trucks to unload at a new truck unloading rack located at the east side of the proposed Project site, and south of the new multi-purpose dock. (See proposed Project layout in Figure 2). Notably, the onsite configuration is presently under evaluation and is subject to change during the detailed design of the Project, including the possibility of delivering LNG to the facility via rail.

- LNG will be delivered to the facility through third party LNG trucks. The project is proposing an LNG facility with an initial capacity of up to approximately 1.5 million MTPA of LNG (roughly 1,670,000 BBL per month).
- Product will be pumped directly into the LNGC from the truck rack through ~1,000' long (10" – 12" diameter) vacuum-insulated line via loading arms.
- The new truck rack will consist of a 12-lane rack with 6 unloading pump skids (2 pumps per skid - double sided), and will be capable of unloading 12 LNG trucks simultaneously. (Typical MC-338 DOT LNG Truck has a tank capacity of 290 BBL, but a maximum liquid fill of 260 BBL).
- The proposed capacity of an LNGC that will export LNG from the facility is approximately 1,070,000 BBL, but the maximum liquid fill capacity during loading is 833,330 BBL, in order to accommodate the nominal loaded draft of 40'.
- The LNG transfer line to the LNGC will be sized to handle approximately 2,500 GPM. The estimated volume to be transferred over a 24-hour period is 57,140 BBL. (16 hours actual unloading time and 6-8 hours for hookup, disconnect, and documentation). The truck rack will be able to handle 200-220 trucks per day.

- Loading of a berthed LNG tanker will therefore take an average of 15 days, resulting in approximately 24 LNGC calls on the Project per year, and a total capacity of approximately 20 MM BBL per year (1.5 MTPA).

Boil-Off Gas (BOG) and gas removed from the berthed LNGC will be collected via a vapor line and could be handled in any of the following configurations:

- Process BOG and vapors are routed through a small capacity liquefier; then pushed back into the LNGC. The system consists of a cold box, compressor, N₂ tank and a cold storage bullet tank (1430 BBL capacity).
- Flare the BOG and vapors.
- Collect BOG and run through a gas separator for sale to the grid. (This is to be reviewed with the local utility company).

The LNG handling facility will include a Safety Flare and Vent System for emergency purposes. This system will also provide relief to the LNGC vapor return and piping systems.

The LNG carrier's characteristics and the frequency of the LNG export shipments from the Project

Annual waterway transit information will be coordinated with local Pilots. The Project is being designed with berthing and mooring configurations to accommodate LNGCs. Berthing and mooring configurations will be able to accommodate a typical Aframax class LNGC with capacities up to 170,000 m³ (1.1 MM BBL) (820.2' LOA, 144.4' beam, 40' nominal loaded draft), but the loading capacity will be limited to 833,330 MM BBL in order to accommodate the nominal loaded draft of 40'. There will be approximately twenty-four (24) vessel arrivals each year over a fairly even time period. This results in an estimated two (2) vessels per month.

7. Description of the Liquefied Hazardous Gas (LHG) Handling Facility

As noted above, the single-berth wharf only permits one vessel to dock at a given time. For the purposes of this Letter of Intent and the Preliminary WSA, both the maximum yearly LNG and LHG ship calls are analyzed herein. However, these operations would not run concurrently.

LHG Storage

LHG will arrive at the proposed Project site via rail cars and will then be pumped off into storage tanks. Total onsite storage for this option is ~100,000 BBLs. The vapors from the storage tanks, in addition to BOG from the vessel are compressed, condensed, and then returned to the storage tanks. It is anticipated that a Thermal Oxidizer would also be provided for emergency relief.

Notably, the on-site configuration discussed herein is presently under evaluation and is subject to change during the detailed design of the Project.

LHG Product Shipping

The LHG shipping facilities consist of two LHG tanker loading pumps, each with a rated capacity of 1,750 BBL/hour, a 16" loading line, and an 8" vapor return line, each of which is fitted with fully articulated loading arms (Sizes to be confirmed in the design phase). The 400,000 BBLS refrigerated LHG tanker (Panamax class vessel with 40' nominal loaded draft) will be utilized as a short-term storage vessel during loading periods, enhancing the storage capacity of the facility for the duration of the LHG tanker's berthing. The LHG tanker will dock for approximately 11-12 days for loading operations.

The piping system will be designed as a 300# system to coincide with the pressure ratings of adjoining equipment, including the storage tanks. The vapor generated during the process is recycled to its respective tank. The loading and vapor return arms are then connected to the docked vessel and loading commences at a minimal rate. As conditions in the loading system allow, the loading rate may be increased up to the maximum rate of ~3,500 BBL/hour.

The proposed Project site will include a 20-rail car unloading rack (2x10) capable of offloading LHG at a rate of ~14,000 BBL/day using two 1,750 BBL/hour pumps. These products would be stored in storage tanks built to ASME Sec. VII specifications. Using two 1,750 BBL/hour pumps, the product is transferred from the storage tanks to the berthed vessel via two 16" dock lines for short term storage and eventual export. Cargo will be refrigerated using the LHG tanker's refrigeration system. The associated on-site LHG tank farm could occupy 3+/- acres to accommodate the tanks and associated equipment.

The LHG tanker's characteristics and the frequency of the LHG export shipments from the Project

Annual waterway transit information will be coordinated with local Pilots. The Project is being designed with berthing and mooring configurations to accommodate LHG tankers. Berthing and mooring configurations will be able to accommodate Panamax class LHG tankers with a capacity of 400,000 BBLS. As such, there could be as many as twenty-four (24) vessels calling on the Project each year over a fairly even time period. This results in an estimated vessel arrival twice a month.

8. Description of Non-LNG-and-LHG Cargo Vessels

In addition to LNG and LHG, a variety of cargo vessels (excluding all LNGCs and LHG tankers) could call on the proposed Project. These vessels will transport commodities such as Roll-on/Roll-off ("RoRo"), Break Bulk, and other bulk liquids, potentially including crude oil and refined products. It is important to note, however, that given the constraints of the single multi-purpose berth, if the full number of projected LNG and/or LHG ships call on the Repauno Facility (*i.e.*, 24 LNG and/or LHG vessels per year), no additional cargo types could be accommodated. In short, the cargos and ship calls identified herein are expressed as alternatives; they are not cumulative.

The potential additional cargo types are briefly described below:

- *Roll-on/Roll-off*: A portion of the Repauno Facility could be reserved for transit, storage, and processing facilities for wheeled cargo (i.e., automobiles) transported by RoRo vessels. The Repauno Facility could include facilities for vehicle preparation, intermodal rail transfer, and truck-away loading areas.
- *General and Break-Bulk Cargo*: A portion of the Repauno Facility could also handle perishables, general freight, and break-bulk cargo, including such commodities as fruits and vegetables and other refrigerated goods.
- *Bulk Liquids*: A portion of the Repauno Facility could provide energy product storage. In addition to the liquid petroleum gases identified earlier (including propane and butane), the Repauno Facility could also provide storage for refined petroleum products and crude products.

The multi-purpose berth would be able to accommodate cargo vessels with a maximum length of approximately 870 ft., maximum width of approximately 145 ft., and nominal loaded draft of 40 ft. Vessels would use the Federal navigation channel to move to and from the Repauno Facility. As noted above with respect to the LNG/LHG Project, the single-berth wharf only permits one vessel to dock at a given time. Thus, LNG/LHG and other vessels would not call at the Repauno Facility concurrently. As compared to the above-referenced berthing times for LNG/LHG vessels, a non-LNG/LHG vessel would be at the berth for approximately 2 days during loading/unloading. Thus, these vessels may call on the facility no sooner than every 2 days.

9. Description of Annual Vessel Traffic

As summarized on Table 1-1, it is estimated that the LNG/LHG Project would result in approximately 24 LNG or LHG vessels calling on the Repauno Facility in a given year. The potential number of LNG or LHG vessel calls are expressed as independent maximums for the purpose of the within Preliminary WSA. However, since the single, multi-purpose berth can only accommodate one ship at a time, vessels will not call on the Repauno Facility concurrently and this projected vessel traffic is not cumulative.

Table 1-1: Alternative Utilization of Multi-Purpose Dock for LNG/LHG Project

Commodity	Annual Volume (Estimated)	Units	Vessel Fill Capacity (Estimated)	Annual Number of Vessels (Estimated)
LNG	20,000,000	BBL	833,330	24
Liquefied Gases	9,600,000	BBL	400,000	24

Additionally, annual cargo ship calls were estimated for the other projected cargo commodities that could be handled at the Repauno Facility. It is estimated that the Repauno Facility could handle a maximum of 91 RoRo vessel calls, 11 break-bulk vessel calls, 13 refined product, and 6 crude oil calls. Again, these projected cargo calls are expressed as anticipated maximums, which would not be cumulative and would be reduced by the number of LNG and LHG vessels that call at the Repauno Facility due to the constraints of the single, multi-purpose berth discussed above. If the full number of projected LNG and/or LHG ships call on the Repauno Facility (*i.e.*, 24 LNG and/or LHG vessels per year), no additional cargo types could be accommodated. In short, the cargos and ship calls identified herein are expressed as alternatives; they are not cumulative. The type and total number of vessel calls will be driven by market demand and berth availability in the region.

10. Figures

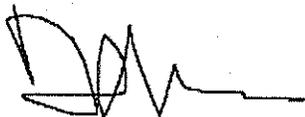
- 1) Proposed Repauno Facility Site Location
- 2) Proposed Repauno Facility Site Layout
- 3) Proposed Repauno Facility Wharf Layout

11. Attachments

- A) NOAA Office of Coast Survey Navigation charts of waterway channels and highlighted LNGC/LHG tanker route.
- B) Commercial, industrial, environmentally sensitive, and residential areas within 15.5 miles of the project site adjacent to the waterway.
- C) Map of waterway channel showing environmental sensitive areas adjacent to the surrounding area.
- D) Preliminary WSA that has been prepared in accordance with the guidance contained in U.S. Coast Guard (“USCG”) NVIC 01-2011.

If the USCG has any questions or requires any additional information or clarification, please feel free to contact Mr. Jimmy Osman, DRP's Vice President of Engineering & Development at 856-224-7067 or josman@repauno.com. AcuTech is acting on behalf of DRP as their designated consultant for preparing the WSA.

Best regards,

A handwritten signature in black ink, appearing to be 'D. Moore', with a horizontal line extending to the right.

On behalf of Delaware River Partners, LLC.

David A. Moore, PE, CSP
President & CEO
AcuTech Group, Inc.
1919 Gallows Road, Suite 900
Vienna, VA 22182
Tel: +1-703-676-3180
Cell: +1-703-598-3921

ADVERTISEMENT

Plan to revive old South Jersey industrial site draws fans and fears

by David O'Reilly, Staff Writer, Posted: July 24, 2016



MICHAEL ARES / STAFF PHOTOGRAPHER

Outside a vast brownfield in Gibbstown that is home to crumbling roads, empty storage tanks, and vacant sheds, a modest brick sign points to both the gritty past and the greener prospects of Gloucester County's economy.

Repauno Plant shout its bold, stainless steel letters. Below them, the faint outline of a pried off logo whispers a bygone name: *DuPont*.

Home to a DuPont Corp. factory complex that for 120 years manufactured dynamite and the chemicals for making Dacron, the Repauno site belched gas, leaked benzene, shed asbestos, occasionally exploded, and employed thousands, earning it the affectionate nickname "Uncle DuPont" before it shut down nearly 20 years ago.

Now a 300-acre section of this 1,700-acre tract on the Delaware River appears destined to become one of the largest privately owned ports in the Northeast.

ADVERTISEMENT

On July 1, after two years of negotiations, Delaware River Partners L.L.C., a subsidiary of Fortress Investment Group L.L.C., acquired the site from a DuPont subsidiary. It will keep the Repauno name.

The project is welcomed by many, but also has aroused trepidation among residents that it will create new hazards with truck and rail traffic.

At the direction of state and federal agencies, DuPont undertook extensive pollution remediation of the tract starting in the 1980s. The company ceased operations here in 1999 but leased parts of it until 2004.

Underground pumps, monitored by the Department of Environmental Protection, still carry away for treatment benzene in the soil that otherwise would leach into groundwater.

ADVERTISEMENT

State and local leaders are confident the new port will be a positive presence in the township and county.

"This will be a big job generator," said Senate President Stephen Sweeney, whose Third Legislative District includes Gibbstown, also known as Greenwich Township. "We've been working on this since 2005."

The Repauno port will sit just two miles south of the publicly funded Paulsboro Marine Terminal, due to open this fall. They will be the first major ports built on the Delaware River in more than 50 years.

Sweeney said he was confident the state and county would find the funds to create a connector road from the port to Route 44, I-295, and the New Jersey Turnpike that would allow most truck traffic to bypass Gibbstown's residential areas.

"It's going to happen," he said.

Assemblyman John J. Burzichelli, (D., Paulsboro), chair of the appropriations committee and a former mayor of Paulsboro, echoed Sweeney's optimism.

A similar bypass road connecting the Paulsboro terminal to the highways cost \$22 million.

Like Sweeney - who as a young union ironworker found occasional work at DuPont repairing buildings after they'd exploded - many in town talk excitedly of jobs at mention of the name "Repauno."

ADVERTISEMENT

"It was the town," said Kevin Herzberg, 33, whose tidy brick house on Lough Lane was built on land provided by "Uncle DuPont."

"My dad, my uncle, my grandfather, my grandmother, and my great-grandmother all worked there one time or another," said Herzberg, who grew up in Gibbstown.

And no matter what DRP plans to build on the property - "even a refinery," he said - "I think it's a good thing."

No refinery is contemplated, said Gary Lewis, managing director of Manhattan-based Fortress.

ADVERTISEMENT

"The Repauno site has all the characteristics that a port developer looks for," Lewis explained in an email last week. "Deep water, rail access, highway access, and most importantly, proximity to major markets."

He said DRP expects to create:

Industrial warehouses for the importation and distribution of fruits, flowers and vegetables;

A "roll-on, roll-off" parking facility for the shipping and distribution of automobiles;

An 8 million gallon storage facility for butane, using an underground granite cavern on the property;

A solar grid capable of generating 20 megawatts of electricity.

Lewis declined to say what DRP paid for the site or what it expects to invest in improvements, but he projects 500 to 1,000 full-time jobs on-site if all the planned elements come to fruition.

The company declined a request by the Inquirer to tour the property. Google Maps' overhead images show several dozen buildings and tanks still standing, and numerous rectangles of concrete or asphalt where former buildings were demolished.

Fortress/DRP hopes this fall to start construction of a 207,000-square-foot refrigerated warehouse, with operations to begin by spring. Gibbstown's planning board gave the warehouse preliminary approval early this month.

Although a company prospectus last year envisioned a liquefied natural gas (LNG) facility at Repauno - disconcerting some residents and environmental groups such as the Sierra Club and the Delaware Riverkeeper - "that is no longer in our designs," Lewis said.

Just how safe and "green" the Repauno site will be under DRP's stewardship remains a matter of concern for some, however.

"This is Railroad Avenue," said 44-year-old Rich Friendlich, who had walked the half block from his home on Logan Avenue to twin railroad tracks running at right angles to his street.

Just beyond lay the open field where DRP wants to build the first of two or more refrigerated warehouses.

"The trains already come through here every 30 to 90 minutes," he said, moments after a lone Norfolk Southern locomotive chugged slowly by. "How many more will there be when they start operations?" he asked.

He and his wife, Karen Capozzi, said they are glad DRP has dropped plans for an LNG port, but butane storage worries them.

Rail carriers already park tank cars close by their home, Capozzi said. "They sit for days, and you can smell this awful chlorine smell."

"And we still haven't heard," Friendlich said, "how they plan to transport the butane."

The couple created the organization Concerned Citizens for the Development of the Repauno site. Its website is repaunocitizens.com.

Their neighbor Emily Buchenhorst, 46, said her biggest worry is the trucks that will soon be traveling in and out of the port. They will be passing and turning less than 10 feet from her home on Repauno Avenue. "They could hit my house," said Buchenhorst, a resident for 13 years.

Mary Rogers, 61, a 37-year resident of Repauno Avenue, said she fears for the children who play and ride bicycles on her street, and worries that rumbling trucks could disturb the foundations of older homes.

And Suzanne DeRemigio, 60, who has lived 36 years on Logan Avenue, voiced fears that if there are frequent rail accidents in Gibbstown, such as the 2012 Conrail chemical spill in neighboring Paulsboro, "we wouldn't be able to sell our houses."

Greenwich Township Mayor George Shivery was emphatic, however, that he, the township council, and planning board will not allow any new industries to pose the kinds of hazards that DuPont - which manufactured the dynamite used to build the Panama Canal - inflicted.

"We grew up when all this manufacturing was in full bloom," Shivery, 69, recalled. "The acid fumes would put spots on your aluminum siding, and the cancer rate, the asbestosis, was just unbelievable. We all had parents and great-grandparents whose lives were shortened by it.

"We just didn't know about those problems then. Now we do. We're very sensitive to these issues," Shivery said.

"We won't want anything out there that goes 'Boom!' "

SPONSORED CONTENT
Understated Is Overrated. The All-New Chevy Blazer.

by Chevrolet



doreilly@phillynews.com

856-779-3841

Posted: July 24, 2016 - 3:01 AM

David O'Reilly, Staff Writer

 **View 1 Comment**



June 7, 2019

Delaware River Basin Commission
West Trenton, New Jersey

Re: DOCKET NO. D-2017-009-2 , DELAWARE RIVER BASIN COMMISSION , Delaware River Partners LLC, Gibbstown Logistics Center, Dock 2 , Greenwich Township, Gloucester County, New Jersey

Delaware Riverkeeper Network (DRN) submits this comment in opposition to the approval of Docket D-2017-009-2 on behalf of our approximately 20,000 members throughout the Delaware River Watershed including residents in the closest Gloucester County communities. The Delaware Riverkeeper Network (DRN) is a private non-profit membership organization, championing the rights of our communities to a Delaware River and tributary streams that are free flowing, clean, healthy, and abundant with a diversity of life.

DRN submits that, based on review of the materials submitted to Delaware River Basin Commission (DRBC) by the applicant, this project will have substantial negative impacts on the Delaware River, its water quality, its habitats, and the species that live, forage, shelter, migrate through and reproduce in the River, Estuary and Bay. DRN also submits that the application is substantially lacking in critical information for and assessment of described and yet-to-be described or assessed aspects of the proposed project. DRN requests that Docket approval be denied or, in the alternative, the Docket be withdrawn and specific reviews and analyses are conducted before further consideration of the project.

DRN points out that we commented on the last docket proposed and approved by DRBC in November 2017 for the Gibbstown Logistics Center (D-2017-009-1). Concerns we expressed about the incompleteness of the application materials, unfortunately, remain. We point out DRBC did not heed these concerns in 2017 and since it appears now that New Fortress Energy may have been planning LNG export from this site at that time but did not disclose that information, our concerns were well-founded and should have led to DRBC insisting that the missing information be provided before the first docket was approved. If that had been done, the public and the agencies may have learned of the planned export of LNG from the Center and a comprehensive analysis of the project would have been required.

As stated by DRN in our comment letter dated November 17, 2017:

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
drm@delawareriverkeeper.org
www.delawareriverkeeper.org

DRBC states its draft Docket is to approve dredging and the construction of a deepwater berth for the proposed Delaware River Partners (DRP) Gibbstown Logistics Center (“the Proposed Project”). However, the current draft docket, despite claiming to approve only the dredging and deep-water berth construction project, approves stormwater outfalls and land disturbances. Furthermore, the docket states that DRP “...is required to submit detailed site plans to the DRBC for the remainder of the Logistics Center, including the proposed: Automobile import area/parking lot; processing facilities; perishables, bulk-liquids and gases, and bulk cargo handling areas; warehouses and associated buildings; stormwater management system (including stormwater outfalls); and the associated infrastructure”.¹

Based on this lack of essential information, until all plans are completed, submitted to and assessed by DRBC, the draft docket for the Proposed Project should be put on hold. It is unreasonable to move ahead with an application that is so obviously incomplete and lacking in adequate assessment and review. It is impossible to accurately assess the potential impacts on the water resources of the Basin with the information made available for only a portion of the Proposed Project.

We point out that the condition (C.I.(c)) of the 2017 DRBC Docket, which requires the missing information to be provided, seems not to have been met by Delaware River Partners because in subsequent file reviews conducted by DRN through FOIA, we have not seen any written material in the files disclosing the plans of the applicant to include LNG as a cargo. This is despite repeated public statements by New Fortress Energy that LNG would be processed from Marcellus Shale gas in Bradford County, Pennsylvania, trucked to the Delaware River and exported out of the country through the Delaware River ports. The U.S. Army Corps of Engineers (ACE) Public Notice of April 4, 2019, listed various cargo to be transloaded at the Gibbstown Logistics Center. Included in the list was liquefied natural gas (LNG) and yet this was not added to this new draft docket for Dock 2. Obviously, the follow up information – site plans for handling of all cargo - that was to be provided by the applicant was either not supplied to DRBC or DRBC decided not to include LNG in the list of cargo published in the new draft docket. Either way, the public was deprived of this information and the missing information regarding the products to be handled at the Center, makes the application deficient based on incompleteness.

DRN points out that the exclusion of LNG from the cargo list is additionally important because of the dangers of handling and transloading LNG. LNG is arguably the most consequential and dangerous product to be handled at the Center, making it a glaring omission. We are including information regarding the potential impacts of LNG release and the special circumstances LNG requires at the end of this comment.

The additional dredging and deep-water berth construction project, named Dock 2, poses several unacceptable environmental hazards and potential pollution sources for the Delaware River and the region.

Environmental Impacts of the Proposed Activities Contained in the Draft Docket

Dredging: The dredging of 665,000 cubic yards of sediment from the Delaware River to provide a channel to the Federal Navigation Channel would go to a depth of 43 feet below mean water lower low water over a 45-acre area. Allowed is a two-foot overdraft. This almost doubles the amount of material that will be dredged for the entire Gibbstown Logistics Center project, increasing greatly the adverse environmental

¹ Docket No. D-2017-009-1, p. 3.

footprint of the dredging from the originally proposed Dock 1. The sediment to be dredged is silt, fine sand, and trace gravel, according to the draft docket. DRN is very concerned about the impacts of the dredging on water quality, fish, and aquatic life. We do not agree that the prevention measures included in the draft docket for controlling the sediment will provide adequate protection to species in the area of the Center.

The Delaware Riverkeeper Network has commented in the past on the significant environmental impacts that dredging causes in this section of the Delaware River. First, deepening 45 acres of river area to a depth of -40 feet mean lower low water with a 2-foot overdraft will open this newly deepened area to the potential for an increased risk of harm if there is a catastrophic spill event. With a deepened area, ships will access the proposed deepwater port and, when filled for export will be heavily laden with LNG, natural gas liquids or other chemicals. Using the catastrophic experience of the Athos I oil spill of November 26, 2004, the volume of carried material available to leak and wreak havoc on the environment and our communities will be greater and therefore more dangerous with the added capacity of the proposed port's dredging of 45 acres.²

The Athos I catastrophe exposed 115 miles of River, 280 miles of shoreline, 16,500 birds, as well as many species of fish, shellfish, and wildlife and a variety of important habitats to the heavy crude it dumped into the Delaware River.² Habitats, wildlife, water quality, air quality, industry, recreation, and communities were all significantly harmed by the spill. Any project that will increase the magnitude of such a tremendous level of damages in the event of a future catastrophe is a danger to all of these natural and human resources.

Adding LNG transport to the dangers of shipping on the river exponentially increases the potential for a far-reaching catastrophe. Considering that the zone of blast around a container release and/or fire is at least one mile and could be miles larger depending on how quickly the gas cloud created by the vaporizing LNG spreads, communities along the river, including metropolitan areas such as Philadelphia, Camden, Chester and other high density population centers), passing ships, bridges, facilities such as airports (the Gibbstown Logistics Center is across the river from the Philadelphia Airport), motor vehicle traffic and workers would all be exposed to potential life-threatening injury if an LNG marine vessel were to have an accident and release LNG. There is no discussion in the Docket about the shipping dangers that the dredging would enable. This is one reason why a comprehensive environmental analysis of this LNG project is required.

Dredge spoils significantly increase the amount of heavy metals and toxins that would be released into waterways and the environment², especially with the amount of material that appears to be contaminated at this site. The impacts of the spoil disposal plans and potential pollution impacts could have significant community and environmental effects. The threat posed by dredged spoils is known to be a source of water pollution after on-land disposal.² In addition to polluting the water and land, there are likely to be air quality impacts including NOx emissions associated with the construction and associated traffic from this additional dock and dredging project that should be considered as well. Yet there is no analysis of air pollution in the draft docket.

Atlantic sturgeon will be directly negatively impacted by the development and operation of this site. The draft docket states that the revised wharf design is under review currently by USACE in consultation with

² Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

NMFS regarding two threatened and endangered sturgeon species, and the critical habitat for the Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). However, the docket fails to acknowledge that the federal government established the Delaware Estuary as Critical Habitat for the New York Bight DPS of Atlantic Sturgeon in August 2017. DRBC's Water Quality Regulations at §4.30.5-B.1 acknowledge that the Commission must evaluate Critical Habitat, and that this evaluation must follow its Rules of Practice and Procedure. Despite the federal ruling, DRBC has yet to initiate its procedures for verifying the Critical Habitat established by the federal government, and the role that Critical Habitat will play in docket decisions. DRBC should not approve any project that could directly and indirectly affect this Critical Habitat until it has completed all necessary procedures in the Critical Habitat evaluation. To do so would be premature, would undermine the required process for DRBC review and approvals, would be unfair in terms of just application of its regulations, and jeopardizes the Critical Habitat of the Atlantic Sturgeon. The DRBC is not ready to grant approval to any project that involves the Critical Habitat of the Delaware Estuary for the New York Bight DPS of Atlantic Sturgeon.

Both direct take and incidental take of sturgeon are a distinct possibility with a project of this nature. Both the Atlantic sturgeon and shortnose sturgeon are threatened and adversely affected by dredging and effects to water quality including dissolved oxygen (DO) levels, water temperature, and contaminants.² The proposed project will entail significant levels of dredging as well as significant water quality effects and dramatic changes in important habitats including juvenile habitat and spawning grounds.

The dredging of river systems significantly impacts aquatic ecosystems in a number of ways that will harm both sturgeon species. Among the effects that the project will have on the Delaware River populations of both sturgeon species are:

- ✓ Deep-draft vessel traffic in the Delaware River has been cited as the biggest threat to the survival of the Delaware River population Atlantic sturgeon; the increased vessel traffic and increased area for deep-draft vessels to strike Atlantic sturgeon directly resulting from this project will significantly increase sturgeon vessel strikes and could accelerate the extinction of this endangered species population.³
- ✓ Dredging activities remove, disturb, dispose of and re-suspend river sediments, modifying the river bottom substrate and impacting the community of benthic macrofauna;
- ✓ Dredging operations can remove or bury organisms and destroy benthic feeding areas;
- ✓ Dredging operations can create noise and disturbance, and can disrupt spawning migrations;
- ✓ Dredging activities can re-suspend contaminants, affect turbidity and siltation, and deposit fine sediments in spawning habitats; and
- ✓ Dredging activities alter the hydrodynamic regime, alter physical habitats, and create the loss of riparian habitat.²

The act of dredging can entrain sturgeon, taking them up into the dredge drag-arms and impeller pumps and resulting in death.² New data from tagged Atlantic sturgeon continue to show their presence in or near the main navigation channel, making them vulnerable to direct take by dredging operations, as well as direct take from the larger vessels that will be using the channel.² These lethal takes are significant for a species

³ Brown and Murphy. 2010. Atlantic Sturgeon Vessel-Strike Mortalities in the Delaware Estuary. Fisheries 35(2): 72-83.

that is at such low levels (fewer than 300, maybe even fewer than 100), and as genetically unique as the Atlantic sturgeon of the Delaware River are.²

Dredging in the portions of the River near Philadelphia is likely to be detrimental to the successful spawning of sturgeon in the Delaware – not just because of the act of dredging but also because of the degradation of spawning habitat.² Dredging increases the level of suspended sediments and contaminants in the water. An increase in suspended sediments could be detrimental to egg survival of sturgeon – increasing the probability that eggs adhere to suspended solids and suffocate.² increasing contaminant loads can alter growth and reproductive performance in sturgeon.²

Dredging is a factor in the destruction, modification, or curtailment of the Atlantic sturgeon’s habitat and range.² The environmental impacts of dredging include direct removal or burial of organisms, elevated turbidity or siltation, contaminant re-suspension, noise or disturbance, alterations to hydrodynamic regime and physical habitat, and loss of riparian habitat.² Furthermore, an increase in vessel traffic on the Delaware River resulting from the project would increase the likelihood of vessel strikes to sturgeon.²

A study of mortality rates on Atlantic sturgeon in the Delaware River between 2005 and 2008 found that 50% of the mortalities were the result of vessel strikes. The remaining 50% were too decomposed to determine if they were caused by vessel strikes but it is likely most were.² For small remnant populations of Atlantic sturgeon, such as that in the Delaware River, the loss of just a few individuals per year due to anthropogenic sources of mortality, such as vessel strikes, may continue to hamper restoration efforts.² According to a 2010 research article on vessel strikes, “Both the dredging to deepen the channel and the subsequent increase in large vessel traffic may further hamper the recovery of the Delaware River Atlantic sturgeon population.”² Of critical importance, this study is concerned about the size of the vessels resulting from deepening as opposed to any increase in the volume of vessels. The larger size of the vessels from the deepened channel will likely increase the number of vessel strikes for both sturgeon species.²

The continued dredging of new deep-water areas will further impact Atlantic sturgeon spawning by accelerating the intrusion of brackish water into the hard-bottom spawning grounds, and thus forcing Atlantic sturgeon to spawn further upstream in the zone of depressed dissolved oxygen. This shift then exposes the eggs and larvae of newly spawned Atlantic sturgeon to low oxygen conditions from which they may not survive. This “squeeze” between increased salt intrusion in the estuary downstream (exacerbated by channel deepening, new deep-dredged berthing areas, and rising sea levels) and the near-lethal dissolved oxygen levels upstream limits the ability of Atlantic sturgeon to successfully reproduce, and increases the likelihood of extinction. This project makes a significant contribution to such salt-intrusion by adding 45 acres of new deep-water channel and berthing to an estuary under siege.⁴

The remobilization (and dewatering of dredged sediments) will create higher exposure to PCBs and other contaminants, and the Atlantic Sturgeon spawning and rearing that begins in June and extends the early-life-stages through July and August, with increasing evidence for high aggregations of young-of-year in the Proposed Project vicinity, means that elevated exposure will occur for larval and juvenile stages of this endangered species in the Delaware River. The currently proposed methods and timing are insufficient to

⁴ Moberg and DeLucia. 2016. Potential Impacts of Dissolved Oxygen, Salinity and Flow on the Successful Recruitment of Atlantic Sturgeon in the Delaware River. The Nature Conservancy. Harrisburg, PA. 69 pp.

protect this endangered species, and more evidence and analysis would be required in order to claim that the project does not impair NOAA Trust Resources, fish and wildlife, and the water resources of the Basin.

In November of 2010, researchers discovered beds of freshwater mussels in the Delaware River between Chester, PA and Trenton, NJ.² The species found included the alewife floater (*Anodonta implicata*) and the tidewater mucket (*Leptodea ochracea*), only found in New Jersey in the tidal Delaware River; the pond mussel (*Ligumia nasuta*) and the yellow lampmussel (*Lampsilis cariosa*), both considered critically-imperiled; and the creeper (*Strophitus undulatus*) and the eastern floater (*Pyganodon cataracta*) both considered vulnerable; as well as the eastern elliptio (*Elliptio complanata*), the only mussel known to be native to our Delaware River that is not considered to be in jeopardy.² Mussels are not mentioned in the application or in the applicant's Compliance Statement. Particularly because some of these estuarine species are state-listed and/or critically imperiled, the extent and composition of these mussel beds needs to be accurately surveyed prior to any in-water work at the site. Once the locations, abundance, and identify of these species are documented, a relocation plan would be needed to move individual mussels out of areas where direct mortality might occur.

Freshwater mussels can live 80 to 100 years old, and most species do not begin reproducing until they are 8 to 10 years old.² Because they are so slow growing and don't begin to reproduce until this older age, they are not able to quickly recover from disturbances and the population cannot recover quickly from impacts that result in death to individuals.² Freshwater mussels require a fish host, a specific species depending on the mussel, to complete their life cycle. Activities that damage the needed fish hosts in turn do direct harm to the freshwater mussel species they help serve in the life cycle.²

Mussels are vital for filtering pollution and filling important habitat niches. Experts believe that revitalizing freshwater mussels in the Delaware River could improve water quality downstream and thereby benefit estuarine species.² All of the freshwater mussels in the Delaware River system, except for one (the Eastern elliptio, *Elliptio complanata*), are identified by one or more of the states as endangered, threatened, imperiled, vulnerable, critically impaired, very rare, extremely rare or extirpated.²

Freshwater mussels are very sensitive to water quality. Exposure to contaminants either directly via dissolved compounds or contaminants that are particle-mediated can have adverse consequences.² Freshwater mussels are highly exposed to changes in water quality because of their filtering activities and the passage of large volumes of water across many thin tissue layers. Dissolved toxins, such as heavy metals, are rapidly taken up by direct absorption and indirectly via food.² Because this project will likely result in pollution both directly and through contaminants from spoil disposal, the implications of this pollution for the mussels in this area must be examined.

Stressed mussels require more oxygen. The dredging described for this project is a threat to any submerged aquatic vegetation in the area that is critical for providing oxygen in the Estuary, including the Philadelphia reach of the River, which includes the location of the proposed project. Although dissolved oxygen levels can become excessively low in this area even today, they have improved significantly compared to decades past. In fact, the DRBC is considering elevating their "Aquatic Life Designated Use" rule in this section of the Delaware River to maintain and protect dissolved oxygen levels.⁵ Increased sedimentation from

⁵ Delaware River Basin Commission (2017) Draft Resolution, February 23, 2017. Retrieved from http://www.nj.gov/drbc/library/documents/Res_EstuaryAquaticLifeUses_draft022317.pdf

dredging activity inhibits mussels and their host fish species from taking in oxygen.² Additionally, invasive or exotic species resulting from interbasin transfers of water can be a very direct threat to freshwater mussels as well as many other species. Increased ballast water from deeper ships, and increased ship traffic, brought up the River by a deeper channel could heighten this risk.² The issue of invasive and exotic species and ballast water and their ecological and economic implications for freshwater mussels and other River fish and wildlife species must also be considered.

Identification of host fish needed for freshwater mussels is one of the least studied aspects of freshwater mussel life history. American eel are known to be hosts for *Elliptio complanata*; some believe they are in fact the preferred host.² Some species of trout and yellow perch too can serve as hosts and data shows that some of the species found in the tidal estuary, *Strophitus undulatus*, can use pumpkinseed and yellow perch.² Shad too are considered by some as possible host species.² The potential impacts to these host species are additional factors to consider when assessing the threats to mussels.

There is evidence that the acoustic impacts from construction activities, such as those described for this project, can significantly harm fish.⁶ The effects of underwater sounds created by pile driving on fish may range from a brief acoustic annoyance to instantaneous lethal injury depending on many factors.⁵ Even at non-lethal levels, low levels of acoustic damage may result in the fish not being able to swim normally, detect predators, stay oriented relative to other fish in the school, or feed or breed successfully.⁵ This is a potential threat to all fish, including both sturgeon species as well as all the fish that serve as host species to mussels.

There are bald eagle (*Haliaeetus leucocephalus*) nests and osprey (*Pandion haliaetus*) nests near or within the project site.⁷ Even with the best mitigation plan in place, there would inevitably be some level of disturbance to these nests versus the no-action alternative, which would leave the nests as they currently are. The nests are not even mentioned in the public notice and this is an issue that the public should be aware of. While formerly a highly-degraded site when DuPont owned and operated the property, the wetland and upland portions of the site have reverted to a natural state with a diverse ecosystem suitable as nesting habitat for these two imperiled bird species. Any disturbances or alterations to these nesting areas could be detrimental to the breeding success of these birds and therefore the future viability of their populations in this area.

The additional deepened 45 acres of river area that would provide access to the proposed deepwater port Dock 2 would result in larger and deeper draft vessels coming up the River. The draft docket states ocean-going vessels up to 966 feet long with a draft of 39.7 feet will be accommodated at the two deep after berths. This triples the amount of vessel traffic that was originally planned for the facility. This additional traffic being layered on to the facility is not being analyzed in the draft docket in terms of the amount of truck traffic, parking areas, turning radius areas and other related knock-on logistical needs that are available on this site, which had some non-specified areas but without an analysis showing that the additional traffic can be handled at the Center, it is unknown if the site is too small for this additional vessel

⁶ Delaware Riverkeeper Network (2011). Supplemental Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁷ Ramboll Environ (2016). Compliance Statement in Support of Multiple Individual Permit Applications. Appendix E, Habitat Impact Assessment Report, July 2016.

traffic. The additional ship traffic and the specific types of ships required for LNG and NGL overseas transport will significantly increase. There is no discussion of this in the draft docket.

Additionally, the additional emissions of the truck traffic, impacts of rail traffic, and other related environmental impacts are not discussed in the docket, nor is any additional stormwater runoff (in terms of quantity and also quality due to the additional traffic and additional types of cargo, including LNG) and other related infrastructure need to handle and service the new shipping traffic. The transloading area needs to also be analyzed to be certain the additional cargo that will be transloaded, especially if it is hazardous material such as NGL or LNG or other bulk liquids that possess toxic properties can be safely handled with adequate environmental protections and that stormwater produced will not pollute receiving waterways?

Again, this is an example of partial review of the proposed Dock 2 that represents segmentation of the project since DRBC had included stormwater outfalls and systems on land in the 2017 docket but does not here address that infrastructure that now may need to be changed due to the additional activities Dock 2 will enable. When will these aspects of the expanded project be assessed and will DRBC consider these aspects as they have in the last docket? How can DRBC conclude that water resources will not be adversely impacted without this analysis? Furthermore, if LNG is the cargo that is being added with Dock 2, or is among the cargo being added, what special considerations and conditions will be required to assure the handling and transloading of the LNG can be safely accomplished? This is not discussed in the draft docket.

Another question that must be answered is whether simultaneous handling of LNG and other cargoes, including dangerous NGLs, can be done safely. If the transloading to the ship from truck or railcar is considered similar to “truck to ship bunkering” when assessed by the U.S. Coast Guard, there are Coast Guard regulations that apply to these activities when there are SIMOPS or “simultaneous operations” planned in the same vicinity. The usual procedure is for a Policy Letter to be issued by the Coast Guard after the specific logistics are evaluated.⁸ Similar to SIMOPS considerations, it is additionally important to evaluate the activities and storage planned for export of other products such as NGL from the terminal for compatibility with LNG activities. An informed decision needs to be made about timing, location, and proximity to the LNG facilities and activities. It may be that other activities planned for the terminal cannot occur at the same site that is handling LNG. This issue must be resolved prior to any further permitting for the Gibbstown Logistics Center facility.

More shipping vessels mean more ballast water needs, discharges, and impacts. Impingement and entrainment of the variety of species discussed in this comment and beyond due to the intake and discharge of ballast water could be significant. The increased intake of ballast water from the River as a result of the commercial vessels coming into the River due to this project would entrain early life stages of commercially and recreationally important fish including American shad, alewife, blueback herring and striped bass.² The cumulative effects of this impingement and entrainment need to be considered in conjunction with the impingement and entrainment that already occurs at existing cooling water intakes operating in the Delaware Estuary and River, including the nearby Paulsboro and West Deptford Township facilities.

⁸ CG-OES Policy Letter, No.01-17, JUN - 8 2017, GUIDANCE FOR EVALUATING SIMULTANEOUS OPERATIONS (SIMOPS) DURING LIQUEFIED NATURAL GAS (LNG) FUEL TRANSFER OPERATIONS, Ref: (a) CG-OES Policy Letter No, 01-15.

In addition, the concerns about invasive exotic species that may result from larger discharges of ballast water from larger vessels cannot be overstated in terms of either ecological or economic impacts. The invasion of such species into major ports and waterways of the U.S. have cost billions of dollars in control efforts and lost economic value from damage to important fish and wildlife species as well as the habitats that support them.² For more information see

http://water.epa.gov/polwaste/vwd/ballastwater/invasive_species_index.cfm

http://water.epa.gov/polwaste/vwd/ballastwater/invasive_species_bal_links.cfm

<http://www.invasivespecies.gov/index.html>

DRN is very concerned about the release of PCBs from the site. EPA identified the Repauno site in 2003 as one of the largest PCB point sources in the Delaware Estuary (among the top 10). A TMDL was established for the Estuary to remediate the contamination. Dredging; construction in the water, riverbank and on uplands; and site disturbance and stormwater systems will disturb PCBs, which have been found in near-shore sediments and in runoff from the site. There is a zone of highly contaminated sediments immediately adjacent to the shore and port facility. DRBC's dedicated role in reducing PCBs in the Estuary and its role to ensure that PCB Pollution Minimization Plans (PMP) are effectively implemented is compromised by the plan to disturb, construct on, and dredge this site.

The 2017 DRBC docket approved dredging and other disturbances that could significantly increase PCB loading to the already-impaired Delaware Estuary. DRBC did require in the current docket a PCB sampling program to be conducted by Delaware River Partners and stated that capping to raise the site to a higher elevation would help to minimize PCB release. We did not see any analysis that proves that statement. A NPDES permit was supposed to be required to assess PCB migration from the site and to possibly require a separate pollutant minimization plan to be conducted by Delaware River Partners. However, the project is currently under construction while no NPDES permit is in place that requires sampling and monitoring of the release of PCBs during this critical disturbance phase of the project.

There are several unaddressed questions regarding this PCB issue. First, the sampling and the controls should have gone into operation prior to dredging and land disturbance that could release PCBs but this apparently is not the case unless the NPDES permit has been issued without public disclosure. Second, Chemours claims that the site is "substantially remediated" for PCBs yet there is no evidence that PCBs are remediated and the sampling as recently as 2018 shows otherwise. Third, Chemours currently operates the site remediation program, including a groundwater pumping system which is supposed to continue during the operation of the facility. If the 2017 DRBC Docket condition is carried out, how will the Delaware River Partners operation of a separate PCB plan, possibly connected to the stormwater infrastructure, be coordinated physically, managerially, and legally in concert with the cleanup of the groundwater by Chemours?

DEP had informed DRBC during the last docket review that there would be a stormwater permit issued for the facility that would address the PCB issues through a DEP-issued NPDES permit. However, there was no stormwater permit issued after the DRBC Docket was approved. Instead, after a year of phone calls and file reviews, DRN finally got a copy of the stormwater permit in 2019 for the site – a permit DEP claimed did not exist since the time DRN filed an OPRA for the project. It was issued in 2017 but had no mention of PCBs. This permit was not even contained in the DRBC's files.

More perplexing is that the 2017 DRBC docket at C.(I)l. requires that when the DEP NPDES permit is issued “the docket holder shall perform an investigation of the site to assess the disposition of stormwater and the flow paths for the individual stormwater outfalls either directly or indirectly to the Delaware River in order to develop and implement a PCB stormwater sampling plan. Upon evaluation of the sampling results by the NJDEP in consultation with the DRBC, DRP may be required to develop and implement a separate PMP for PCBs in accordance with Section 4.30.9 of the Commission’s Water Code and Water Quality Regulations (18 CFR Part 410).”⁹

The draft docket has no mention of a NPDES permit and records obtained by DRN from DRBC through FOIA, show that the applicant stated that a NJPDES permit is pending in an email dated May 14, 2019. However, a week later an email from the applicant dated May 21, 2019 states, without any explanation, that the NJPDES permit is “not required”. The NPDES permit is not listed in Table B-1 in the draft docket. DRN asks why the NPDES permit was, suddenly, not required, who made that determination and why and how is a condition of the current (2017) docket summarily violated? How will the PCB sampling program be carried out, how will PCB be controlled from the site for the current development of the site and what precautionary measures are being taken by DRBC to ensure that the PCBs released from the activities required for Dock 2 do not contribute to PCB contamination of the Delaware River Estuary?

The Gibbstown Logistics Center is wholly compromised by its location on a highly contaminated property. Construction and operation of the Center can be expected to disturb and mobilize soil, sediment, surface water and groundwater pollution that is present on this Superfund site. This is a former industrial site that is under remediation known as the Repauno Plant. It is a 1,856-acre site located along the Delaware River in Gloucester County, NJ. The site is bounded to the north by the Delaware River, to the east by a former Hercules Chemical manufacturing plant, to the south by the city of Gibbstown, and to the west by wetlands and Repauno Creek. The western half of the site consists almost entirely of surface water bodies and wetlands. Former and current production operations are located in the northeastern part of the site. Several production areas have discontinued operations and structures have been razed. The eastern half of the site also consists of some upland and wetland ecological communities (EPA, 2003). Altogether, the site contains approximately 1,500 acres of wetlands (Fichera, 2015). The Gibbstown Logistics Center is planned to use 218 acres.

DuPont operated the site as an explosive manufacturing facility since 1880. In 1917, DuPont expanded operations to include the manufacturing of organic compounds, which continued until 1986. All explosive manufacturing and ammonia production were discontinued during the 1960s. Repauno is a CERCLA site undergoing remediation (<https://cumulis.epa.gov/supercpad/CurSites/calinfo.cfm?id=0200783>). The area previously used by DuPont as a terminal location for anhydrous ammonia began being cleaned for reuse in 2002, according to the 2002 Annual Groundwater Progress report (EPA, 2003).

One of the dangerous contaminants on the site is nitrobenzene, a highly toxic chemical classified by the Centers for Disease Control as “Immediately Dangerous to Life or Health” if people are exposed at specific concentrations. Nitrobenzene is a likely human carcinogen according to the United States EPA and is linked to several carcinomas and cancers as well as other dangerous human health effects. The area where the logistics center would operate is the area is most likely exposed to aniline, a toxic chemical with adverse health effects; aniline is involved with the processing of benzene to make nitrobenzene. The area where

⁹ Docket No. D-2017-009-1, p. 9.

acids were used is also at least partly included in the proposed site. These acids were most likely “mixed acids” associated with the nitrobenzene manufacturing process and are toxic. Redevelopment can disturb and distribute in unforeseen ways contaminants that remain on the property. DRN advocates that no disturbance of the contaminated site be allowed until all contaminants are removed from the soil, sediment, groundwater, surface water, wetlands and other related natural systems.

In addition, several different companies have leased areas at the Repauno facility. In 1998, Repauno Products LLC purchased the manufacturing operation that produced sodium nitrite and nitrosylsulfuric acid. In 1999, Spring AG purchased the industrial diamond refining operation, which ceased in late 2002. Industrial diamond processing may have used chemical vapor deposition or other dangerous processes that are used to manufacture industrial and synthetic diamonds, contributing additional contaminants to the site’s environment that require investigation prior to use of the property.

In 1990, 8,500 tons of sediments were removed from the ditches in the former Nitrobenzene and PMDA/DMT production areas (EPA, 2005). In the three rounds of sitewide investigation completed in 1993, 1996, and 2000 respectively, DuPont screened all Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) for their investigation/remediation priorities and focused on the migration/flow of groundwater and the soils in former production areas. The currently ongoing fourth round of investigation is to complete the investigation of the remaining two SWMUs/AOCs and to conduct an ecological risk assessment for the wetlands, streams, and the ditch system (EPA, 2005). In 1985, DuPont installed a system to pump contaminated groundwater and to treat it. The groundwater interceptor system has been in operation since, in conjunction with a groundwater-monitoring program, owned and operated by Chemours, DuPont’s spinoff company since 2015. Chemours is required to continue the groundwater interceptor system together with the sitewide groundwater monitoring program to confirm that contaminated groundwater is under control. How the operation of the Center and the remediation program will compatibly operate is difficult to understand and needs further analysis by EPA, DEP and other relevant agencies, including DRBC, due to the potential for negative impacts from pollution to the water resources of the Delaware River Basin.

DEP is supposed to impose restrictions on the use of groundwater for as long as it remains contaminated (EPA, 2005). The draft docket states that water and sewer for the Center will be provided by the local municipal facilities, which is important for public health and safety. Has there been an analysis that shows the local facilities have the capacity to add the Center? EPA claimed in 2005 that the site was no longer a risk for human exposure and groundwater contamination (Romalino, 2015). These new uses at the site should require a re-analysis of that conclusion. The site plans call for one or more of the monitoring wells being used to track remediation to be paved over for a parking lot. Baseline and years of data will be compromised if consistent sampling is lost. It is essential that the current monitoring wells remain.

Permits

As stated in the letter dated June 3, 2019 submitted by DRN to DRBC, there are several permits that have not been identified by the applicant that are needed for this project. Some permits that are still needed are listed in the letter but we also point out that other permits should have also been identified in the draft docket but were not. These include approvals from the United States Coast Guard under 18 CFR Parts 153 and 157? Has Delaware River Partners filed a Letter of Intent (LOI), which is due one year in advance? Has a Water Suitability Assessment been filed with the LOI as required at 33CFR 127.007 (f) and (g)? Has

the Coast Guard issued a Letter of Recommendation? These analyses are essential to the decisionmaking about this facility, which may not proceed without the Coast Guard reviews. There has been no determination that the Delaware River at this location is suitable for LNG marine traffic. Until there is a Coast Guard determination for the transport from this terminal, it is premature to consider other approvals. The application is deficient for not including this important permit, in addition to the other federal and state permits DRN has listed in our letter.

Environmental and Health and Safety Impacts Regarding LNG

DRN provides the following information about the unique dangers of LNG and its transport, storage, and handling, illustrating that LNG is a special product that needs specific conditions that DRN does not consider to be available at this site or within the Delaware River Watershed:

It is known that, upon release in a liquid state, LNG expands to a gas cloud that is 600 times larger than the amount of liquid. The gas cloud then moves across the surface, can travel many miles quickly and can also become trapped under spaces that confine the gas, providing the conditions that cause explosion and, if there is a point of ignition such as a spark or flame, fire will result.

New information has shown that LNG can cause a catastrophic BLEVE or Boiling Liquid Expanding Vapor Explosion if the vessel is exposed to high temperatures or a fire. The expansion of the liquid LNG in a vessel causes the pressurized liquid to boil, and the gas takes up more room than the liquid, stressing the container as pressure builds. Relief valves are only designed to release pressure slowly to keep equilibrium in the pressurized container. Exposed to high heat, the valve will fail to keep up and the metal will weaken, cracks will result in the container, causing LNG to be released with an explosion.¹⁰ The result is a BLEVE, a catastrophic failure of the container. There are many incidents over the years of BLEVE catastrophes¹¹, some as recent as 2019, but the fact that a BLEVE can occur with LNG has only recently been established.

When the gas or vapor cloud in the container is released because it is flammable, it is likely to ignite after the BLEVE, typically causing a fireball that burns fast, hot and wide. A fuel air explosion can also occur, known as a “vapor cloud explosion”. A vapor cloud explosion is the mechanism used in a thermobaric weapon that uses air to generate a high-temperature explosion, producing a long duration blast wave. These weapons are also termed a fuel-air bomb.¹² This is the threat that LNG storage and transport brings to the Gibbstown region and to every traffic route used to carry the LNG to the Delaware River and on the river during export.

On dry land such as a terminal where LNG is stored or is contained in tankers on trucks or rail cars, a BLEVE where there is no liquid in the local environment to absorb the heat, can rupture even faster than a vessel on water. Truck transport regulations are being closely examined due to an increase in accidents involving truck transport of LNG. While it used to be assumed that truck transport had a low potential for explosion or fire, an accident in Spain changed that:

“In 2002, an LNG truck in Spain flipped over, burned, then exploded into a 500-foot fireball that killed the driver and burned two others. ‘The severity of this kind of explosion is something people haven’t usually considered applicable to LNG trucks,” says Jerry Havens, former director of the

¹⁰ https://en.m.wikipedia.org/wiki/Boiling_liquid_expanding_vapor_explosion

¹¹ Ibid.

¹² https://en.m.wikipedia.org/wiki/Thermobaric_weapon

Chemical Hazards Research Center at the University of Arkansas. ‘But what happened in Spain changes that picture. It shows you've got the potential for a massive explosion.’”¹³

In the accident in Spain, a BLEVE occurred, which resulted in death to the driver and burns to two people approximately 650 feet away, and threw large flaming debris, including the truck’s diesel engine, for 853 feet. A similar LNG truck accident with a catastrophic fire occurred in Spain in 2011, killing the driver.¹⁴ It was pointed out by an analyst in Savannah Georgia during debate over LNG truck transport that a pool fire and and/or explosion involving an LNG truck may have a low probability but it has a high consequence with instant injuries or death for those within several hundred feet.¹⁵ The chances, according to the analyst, of an LNG truck accident are 200 to 1.¹⁶ This is a great risk for populated areas and truck routes through urban centers.

Regarding rail use, the U.S. Department of Transportation’s Federal Highway Administration (FRA) nor the Pipeline and Hazardous Materials Safety Administration (PHMSA) have not approved rail car regulations for the transport of LNG yet. There has been very limited use of rail so far, with only one approval in Alaska by the Obama Administration, local small use in Florida, and some use in Canada. Statistics that claim few accidents mean that trucking of LNG is safe are misleading because, similar to crude oil transported in unsafe train cars a few years ago before the Bakken crude phenomena, it has been rarely done. For Bakken oil trains, accidents increased 400% in one year once volume of traffic increased, creating the biggest jump in deadly and/or catastrophic train accidents in years.

The Trump Administration has provided a big push for the use of rail for LNG transport in April 2019 with President Donald Trump issuing an executive order directing federal regulators to create new rules allowing rail companies to transport LNG by rail in the next 13 months, or less.¹⁷ Considering the length of time it customarily takes PHMSA and the Federal Railroad Administration to develop new car specifications and use regulations, one year is a truncated period that fast-tracks the approval the President is seeking. The priority, according to LNG promoters, is a quick approval to meet the need for the industry to serve new markets. This does not inspire confidence in the results.

In the event of a release of LNG, the LNG must gas off naturally, as the container cannot be capped or interacted with, the area must be immediately evacuated and secured, ignition sources must be eliminated, and water cannot be used, as the release is cryogenic. Water can plug the valves of the container with ice and any cold air release can freeze skin in seconds and can even turn air to liquid or solid form, removing oxygen, an obvious disaster for anyone in the area. These handling procedures apply to any container of LNG under pressure, including those used in transportation such as truck or rail containers or storage vessels at a terminal, ships, or at a liquefaction facility.¹⁸ The dangers of an LNG release and fire from a tank accident are unique to LNG and require special handling due to the highly dangerous properties of the

¹³ <https://www.csmonitor.com/2006/0707/p02s01-usgn.html>

¹⁴ https://www.researchgate.net/publication/235976022_Explosion_of_a_road_tanker_containing_liquified_natural_gas

¹⁵ <https://www.savannahnow.com/article/20101006/NEWS/310069738>

¹⁶ Ibid.

¹⁷ <https://www.govinfo.gov/content/pkg/FR-2019-04-15/pdf/2019-07656.pdf>

¹⁸ PHMSA, “Safe Transport of Energy Products”, <https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/research-and-development/hazmat/58176/day-1-pm-2.pdf>

LNG and its gases. This is well illustrated in a report of an LNG tank truck accident in Belgium, which has been used as a “lessons learned” example by first response trainers ¹⁹

When a fire erupts around or under a LNG container, it can cause a BLEVE quickly, in as little as 15 minutes for a large tank (2 ½ minutes for a small tank). Once a fire ignites around the container, the 2000 Department of Transportation (DOT) Emergency Response Guidebook (ERG) states that a 1,600-meter perimeter must be isolated around the container, as explained in the relevant text at Guide #112, the same as for explosives such as bombs and artillery. Since water cannot be used to cool the container or extinguish the fire, and the evacuation area is so large, the fire response is, especially if there are no lives at risk, for firefighters and first responders to evacuate the 1,600-meter area and let the fire burn out, similar to the response to crude oil derailments that risk explosion. In fact, even removing the damaged container can be risky. An example of how firefighters in Utah decided to handle a train derailment with damaged propane tanks illustrates the risks – it was less dangerous to detonate the cars in place than move them.²⁰ Of course, this is not possible in a populated area, begging the question of how much risk for communities is involved with flammable liquid in rail cars.

This makes the transport of LNG in containers and the storage of containers of LNG inherently dangerous and inappropriate for populated areas. The proposed Logistics Center is located next to a residential area in Gibbstown. There is a day care center and housing in Gibbstown adjacent to the Block and Lot of this site. These residential and day care uses are not compatible with the proposed activity, especially if the activity includes handling of hazardous substances such as LNG or NGL or other bulk liquids. Prevention of exposure to toxics and hazardous materials is the only way to provide protection to the especially vulnerable population of children at a day care center and to the workers, residents and families who are located adjacent to the site.

The transport routes, not yet identified by New Fortress, are through communities across Pennsylvania and New Jersey. Has the proximity of the LNG activities to structures, receptors, and residences been calculated and are there sufficient separation distances as required by U.S.DOT? US DOT has requirements (in 49 CFR Part 193) for thermal radiation and vapor dispersion hazard-based exclusion distances around land based, fixed LNG terminals. This is an essential analysis for the protection of Gibbstown and the region.

Transportation safety issues, while previously not a large concern when truck and rail transport was rare, are emerging as an important concern across the nation as transport by truck increases and rail is expected to be used as a major means of transport for an expanding industry in the near future. The Marcellus Shale has made Pennsylvania the second largest producer of natural gas in the nation, and the industry is looking for new markets and new means of delivering gas products. So, transport is ramping up to substantially increase. However, the current anti-regulation climate at the federal level means that the safety measures required for safe transport are not likely to be enacted under the current Trump Administration. The US Department of Transportation’s upper management and policymakers are heavily influenced by or transferred directly into their positions from industry and have been actively carrying out a roll back of transportation regulations. According to an Associated Press investigative report, the rolling back of transportation regulations and the elimination of regulations that were in progress, has been and is increasingly a hallmark of the Trump Administration.

¹⁹ <https://www.ctif.org/sites/default/files/2018-09/Retex%20LNG%202018%2006%2006%20ENG-reduced%20size.pdf>

²⁰ <https://www.desmogblog.com/2019/04/17/trump-executive-order-lng-rail-bomb-train-risks>

“Industry’s influence on regulations generally “is probably more powerful than it has ever been,” said Neil Eisner, who was the DOT assistant general counsel in charge of overseeing the issuing of regulations for more than three decades. DOT says having industry insiders in leadership positions provides deep practical experience in how the transportation industry works.”²¹

The AP article goes on to use as an example the statement by USDOT DOT of its intention to repeal “a 2015 rule opposed by freight railroads requiring trains that haul highly flammable crude oil be fitted with advanced braking systems that stop all rail cars simultaneously instead of conventional brakes that stop cars one after the other”.²² Delaware Riverkeeper Network and many other organizations and safety groups when proposed by USDOT after the deadly Lac-Mégantic rail disaster in Canada where 47 people died and a town was destroyed, supported this rule.

“Trump has made reducing regulations a priority, seeing many rules as an unnecessary burden on industry. Last month he tweeted that his administration “has terminated more UNNECESSARY Regulations, in just 12 months, than any other Administration has terminated during their full term in office...”

The good news is,” he wrote, ‘THERE IS MUCH MORE TO COME!’²³

However, not every effected sector is supportive of the relaxation of regulations. Reflecting the concerns of workers:

“These rules have been written in blood,” said John Risch, national legislative director for the International Association of Sheet Metal, Air, Rail and Transportation Workers. “But we’re in a new era now of little-to-no new regulations no matter how beneficial they might be. The focus is what can we repeal and rescind.”²⁴

Additionally, it is unknown how the truck or rail-delivered LNG will be transloaded and what transfer systems will be employed. There is a cavern on the site that was presumably going to be used for natural gas liquids (NGL), although it was stated at the DRBC Hearing that there would be no storage on site of bulk liquids. Funds have been invested by the owner of the property in renovation of the cavern but whether it is expected to be enlarged and what is to be stored in it, is unknown but should be publicly disclosed and disclosed to all agencies, including DRBC. Storage conditions, even if kept in idling or parked trucks, are critical to avoid releases of the super-cooled LNG for safety as well as climate impact considerations. DRN asks why the site plans show a bulk liquid tank area, a sphere tank area and the on-site cavern for bulk liquids storage if, as stated by DRBC staff at the public hearing, there will be no bulk liquid storage on site and only truck or rail transloading directly to ships?

Another important consideration is the use of trucks to carry the LNG product will increase emissions of natural gas constituents, including methane, into the air and will emit hazardous air pollutants due to diesel exhaust. The emission of air pollutants to communities along the transport route unjustly exposes people to health hazards that they may be unaware of due to the transient nature of the vehicles. There should be an

²¹ <https://www.apnews.com/1936e77a11924c909880f1ef014c7ca7>

²² Ibid.

²³ Ibid.

²⁴ Ibid.

analysis of the truck route impacts on communities, environmental justice areas, and areas such as the Delaware River valley where there is already a non-attainment area for ozone, resulting in smog and the resulting respiratory and other adverse health effects that accompany air pollution and the deposition of air pollutants on water, such as the Delaware River, the water supply for millions in the region. The venting of the trucks (or railcars) is necessary en route to avoid over-pressurization, so those emissions are unavoidable but nonetheless, unacceptable.

As explained in an article about LNG-powered ships in Washington state, natural gas is composed mostly of methane, which is one of the four major greenhouse gases and a culprit in the the global warming of our atmosphere, exacerbating climate change. Moreover, methane leaks throughout the entire gas development process, from fracking at the extraction well, through pipeline and compressor delivery systems, during storage and in end use such as power plants and gas processing and petrochemical facilities, including when it is used for fuel in shipping. The article states “The International Coalition for Clean Transportation estimates [2.2-4.6% of methane on ships](#) escapes into the atmosphere after passing through the engine without combusting. This is known as methane slip and its rate depends on the type of engine.”²⁵

It explains further, that “Again, LNG is composed chiefly of methane, which is itself a nasty greenhouse gas – 86 times worse than CO₂ over a 20 year span and 36 times worse over a 100 year span. New research actually suggests that those numbers may be [underestimated by as much as 14%](#). This means that we don’t want to be adding any more methane to the atmosphere and, in fact, scientists point out that we can have [more immediate impacts on lessening climate change by reducing methane](#) since it doesn’t last as long in the atmosphere as CO₂. Alarming, US methane emissions [have risen 30%](#) in the past decade thanks mostly to the central US, a hotbed of fracking.”²⁶

The impacts of greenhouse gas emissions that will be released by this project are substantial and can be minimized if gas products – LNG and NGL -- are eliminated as cargo that will be handled at the Gibbstown Logistics Center. Methane and carbon are leaked, released or burned through the full life cycle of the hydraulically fractured (fracked) gas produced for this project – from extraction by fracking through delivery systems such as pipelines and compressors to the liquefaction plant, the processing at the LNG liquefaction plant, the transport by truck, rail, or pipeline to the export terminal, any interim storage, transloading of the material the storage in the ocean-going vessel and then the final re-gasification of the LNG and its end use. This uncontrollable and inefficient process is also deadly in its effects on atmospheric warming and the climate crisis we are facing globally. It is irresponsible and shortsighted to support the further development of fracked gas projects. At the very least, a climate change impact analysis must be done for this project to measure and then assess the potential effects of the full life cycle of LNG and NGL greenhouse gas emissions and climate change effects that would be produced for the Gibbstown Logistics Center.

This comment is submitted in addition to the two letters submitted by Delaware Riverkeeper Network to DRBC dated June 3, 2019 and May 28, 2019, and the verbal testimony of Tracy Carluccio at the public hearing of June 6, 2019.

Conclusion

²⁵ <https://www.350tacoma.org/the-origins-of-lng-as-a-maritime-fuel/>

²⁶ Ibid.

The draft docket is deficient and misleading. It lacks essential information and continues to obfuscate the major intended use of the facility, LNG export. DRN requests that the draft docket be held back from the DRBC's business meeting based on its incompleteness. We point out the lack of adequate time for the Commissioners to review the project to be a major obstacle for a full and fair review (only 2 days before the meeting when the usual review period for the Commissioners is 30 days).

If the docket is included on the agenda at the business meeting, we request the Commissioners either disapprove the draft docket based on the evidence presented showing substantial harm to Delaware River water resources or withdraw the draft docket from consideration until a comprehensive analysis by all relevant agencies is complete and permits have been subject to public review and input. If the DRBC considers this docket in the future, DRN requests that after all other permitting and exhaustive environmental reviews are complete, DRBC provide at least a 60 day comment period for the draft docket so the public can be afforded the time and information needed to assess and provide input into the decisionmaking.

Respectfully submitted,

Handwritten signatures in blue ink. The signature on the left is 'Maya van Rossum' and the signature on the right is 'Tracy Carluccio'.

Maya van Rossum
the Delaware Riverkeeper

Tracy Carluccio
Deputy Director



April 29, 2020

Ms. Sunila Agrawal
Bureau of Stationary Sources
New Jersey Department of Environmental Protection
401 E State Street, 2nd Floor, PO Box 420, Mail Code 401-02
Trenton, New Jersey 08625

Submitted by email to: Sunila.Agrawal@dep.nj.gov

Re: DRAFT PRECONSTRUCTION PERMIT MODIFICATION FACILITY: DELAWARE RIVER PARTNERS LLC Program Interest (PI): 56309 / Permit Activity Number: PCP190002

Delaware Riverkeeper Network submits these comments on behalf of our 25,000 members and in service of our mission to defend and enhance the Delaware River Watershed, its habitats, environment, and communities. Delaware Riverkeeper Network Deputy Director Tracy Carluccio made oral testimony at the New Jersey Department of Environmental Protection (DEP) virtual Public Hearing held on April 22, 2020. These comments are submitted in addition to that testimony.

Delaware Riverkeeper Network objects to the proposed Air Pollution Control Preconstruction Permit Modification for Delaware River Partners' (DRP) Gibbstown Logistics Center (GLC) and requests that the permit modification be denied. As stated in verbal testimony, Delaware Riverkeeper Network states that both the process and the substance of the proposal does not meet the requirements of New Jersey's air quality regulations or the required federal standards and processes that protect air quality and prevent degradation.

The proposed permit modification notification states:

“The original permit allowed the facility to transload product between railcars/tanker trucks and the existing hard rock cavern on site. This modification would allow the facility to further transload product between railcars and marine vessels at the existing multi-purpose dock as the facility will construct additional two rail loading racks and an enclosed flare (CD3).” (Revised Notice 4/8/2020)

The notification continues:

“Both the existing permit and the modification application only allows storage and transfer of LPG (butane and/or propane); it does not allow storage and transfer of natural gas and/or liquid natural gas.” (Revised Notice 4/8/2020)

The Draft Permit states that butane and propane (LPG) will be transferred and that rail cars, tanker trucks, marine vessels, and the underground storage cavern will be degassed and depressurized, utilizing two enclosed flares for control of emissions. There is currently one flare for the underground storage cavern that stores butane. The flare is permitted by NJDEP to degas butane. The proposed permit modification will allow for the expansion of liquid petroleum gases to be handled at the site to include propane. It will also allow the expansion of operations to include two rail racks of 20 cars each, totaling 40 rail cars and the handling of gases from the operations at the truck loading rack and the marine loading dock, where one ship would be accommodated at one berth (Dock 1).

Air Pollution and Public Health Impacts

Under this permit modification, there would be continuous emissions of pollutants that include methane, volatile organic compounds (VOC), Nitrogen Oxide, Carbon Monoxide, Carbon Dioxide, Total Suspended Particulate Matter, Particulate Matter 10, and Sulphur Dioxide. The Hazardous Air Pollutants emissions are below the required reporting threshold, according to information provided by DRP to NJDEP. (Emissions Calculations, Potential to Emit, Delaware River Partners Gibbstown Logistics Center, EXCEL) VOC emissions would increase from 5.44 tons/year to 8.61 tons/year, and increase of 2.66 tons/year, according to the proposed permit. These pollutants will be in the air breathed by the people who live, work, and recreate in the region around the GLC and the emissions will contribute NOx and VOC to the region's airshed, which is a nonattainment area for ozone. The emissions will impact climate through carbon and methane emissions to the atmosphere.

The American Lung Association (ALA) reports that the Philadelphia-Camden region has air pollution problems that negatively impact human health. In a recent study comparing air quality across the United States it was found that the Philadelphia-Camden region ranked 23 for high ozone days out of 229 metropolitan areas; ranked 48 for 24-hour particle pollution out of 216 metropolitan areas; and ranked 12 for annual particle pollution out of 204 metropolitan areas. (American Lung Association, "State of the Air", 2020, <http://www.stateoftheair.org/city-rankings/most-polluted-cities.html>). Both Delaware and Philadelphia Counties are graded by the ALA as "F" for High Ozone Days (<http://www.stateoftheair.org/city-rankings/states/pennsylvania/>). Gloucester and Camden Counties are graded as "F" for High Ozone Days (<http://www.stateoftheair.org/city-rankings/states/new-jersey/>).

The report at <http://www.stateoftheair.org/air-quality-facts/> states that:

- Breathing ozone irritates the lungs, resulting in something like a bad sunburn within the lungs.
- Breathing in particle pollution can increase the risk of lung cancer, according to the World Health Organization.
- Particle pollution can also cause early death and heart attacks, strokes and emergency room visits for people with asthma and cardiovascular disease.
- Particles are smaller than 1/30th the diameter of a human hair. When you inhale them, they are small enough to get past the body's natural defenses.
- Ozone and particle pollution are both linked to increased risk of lower birth weight in newborns.
- People who work or exercise outside face increased risk from the effects of air pollution.
- Millions of people are especially vulnerable to the effects of air pollution, including infants, older adults and people with lung diseases like asthma.

- People of color and those earning lower incomes are often disproportionately affected by air pollution that put them at higher risk for illnesses.
- Air pollution is a serious health threat. It can trigger asthma attacks, harm lung development in children, and can even be deadly.

According to Pennsylvania Department of Environmental Protection (PADEP), Delaware and Philadelphia Counties, which include the Philadelphia metropolitan region and the Delaware River region at Gibbstown, are a nonattainment area for ozone, based on federal standards. PADEP explains this status:

“There are six [principal pollutants](#), that act as indicators of air quality in this country. The Clean Air Act calls them "criteria pollutants". The National Ambient Air Quality Standards ([NAAQS](#)) are the concentrations of these principal pollutants, above which, adverse effects on human health may occur.

Areas of Pennsylvania where [air pollution levels](#) consistently stay below these standards are designated "attainment." Areas where air pollution levels persistently exceed these standards are designated "nonattainment".”

(<https://www.dep.pa.gov/Business/Air/BAQ/Regulations/Pages/Attainment-Status.aspx>)

The U.S. Environmental Protection Agency (EPA) designates the Philadelphia-Wilmington-Trenton area as nonattainment area for ozone.

(https://www3.epa.gov/airquality/urbanair/sipstatus/reports/nj_elembypoll.html#ozone-1hr_1979_53)

NJDEP reports that all of New Jersey is a nonattainment area for ozone, including Gloucester, Camden, and Salem Counties on the Delaware River. (<https://www.nj.gov/dep/cleanairnj/ozone.html>)

NJDEP explains on their website the connection between ozone and smog:

“Ground-level ozone, also known as smog, is an air pollutant known to cause a number of health effects and negatively impact air quality and the environment in the state of New Jersey. Ozone is formed when oxides of nitrogen (NOx) and volatile organic compounds (VOCs) react in the presence of sunlight. Smog can irritate any set of lungs, but those with lung-related deficiencies should take extra precautions on bad ozone days.”

(<https://www.nj.gov/dep/cleanairnj/whatissmog.html>)

Both NOx and VOCs will be continuously emitted by the LPG operations being permitted by the proposed permit modification for Dock 1 at GLC. This will harm the region, could increase the number and severity of pollution warning days in the region, and will result in human health harm as described by ALA.

Project Review

Delaware Riverkeeper Network filed in the United States District Court for the District of New Jersey an appeal of the Army Corps of Engineers permit for the Gibbstown Dock 2 project on April 22, 2020 (Civ. No.: 1:20-cv-4824) (“the Complaint”). One of Delaware Riverkeeper Network’s claims is that the Corps violated the Administrative Procedure Act (“APA”), 5 U.S.C. § 706, by failing to comply with the Clean Air Act, 42 U.S.C. §§ 7401–7671q, by failing to determine whether the Dock 2 project will conform to the state implementation plan in a nonattainment area for ozone. (Complaint attached)

The Complaint also spells out why segmentation is unlawful under the National Environmental Policy Act, which is applicable to the Army Corps' review of the Gibbstown Dock 2 Project. The tenants of NEPA are founded on the same principles as the Clean Air Act's New Source Review program, which includes the Non-Attainment New Source Review and the Prevention of Significant Deterioration program, which does not allow segmentation to avoid jurisdictional thresholds.

The GLC export terminal has been under development for several years, seeking approval in stages according to the DRP's business plan. Different agencies have reviewed the project for different permits, plans and approvals, often without knowledge of the facts presented in applications to agencies other than their own. This has led to a piecemeal approval process for the GLC, starting in 2015 when the project was described as one dock with one shipping berth and infrastructure on land to deliver various cargoes by truck and rail with export by shipping vessels.

As stated in Delaware Riverkeeper Network's Complaint:

85. In a May 14, 2015 filing with the United States Securities and Exchange Commission describing its acquisition of the Gibbstown Logistics Center, FTAI stated that it "intend[s] to utilize the existing infrastructure for our development plans, including constructing refrigerated warehouses for perishable goods, building a dock and using remaining acreage for additional warehouse space, bulk storage and a liquid natural gas facility."

86. In a July 24, 2016 Philadelphia Inquirer article, FTAI's managing director was quoted as saying that an LNG facility was "no longer in [FTAI's] designs [.]" ("Plan to revive old South Jersey industrial site draws fans and fears", by David O'Reilly, Staff Writer, Philadelphia Inquirer, Posted: July 24, 2016

https://www.inquirer.com/philly/news/new_jersey/20160724_Plan_to_revive_old_South_Jersey_industrial_site_draws_fans_and_fears.html)

The Delaware River Basin Commission (DRBC) docket approval for the GLC in 2017 described the project as:

"The docket holder proposes to construct a new multi-use, deep-water port and logistics center to accommodate a range of ocean-going vessels of a maximum length of 870 feet and maximum draft of 40 feet, and will include a marine terminal for automobile import (roll-on/roll-off), a parking lot for vehicles, processing facilities, perishables handling, non-containerized break bulk cargo handling, bulk-liquids and gases handling, two warehouse buildings, and a stormwater management system and associated infrastructure." (DRBC DOCKET NO. D-2017-009-1, p. 2)

The Army Corps of Engineers Public Notice described the activity at GLC in 2017 as:

"The applicant's stated purpose is to redevelop a site and create a deep water marine terminal that can accommodate vessels with a maximum length of 870 feet with a maximum of a 40 foot draft." (U.S. Army Corps of Engineers Public Notice #CENAP-OP-R-2016-0181-39)

Since the approvals given by those agencies and others, the project has greatly changed, based on the New Fortress Energy's market plans, according to news articles. (Fortress Transportation and Infrastructure Investors (FTIA) is tied to New Fortress Energy and Delaware River Partners (DRP) is a subsidiary of New Fortress Energy). These changes have been incrementally added between 2015 and 2020, each being

considered separately and without consideration of the upcoming planned operations and construction at GLC.

The July 16 2019 Army Corps of Engineers Public Notice described a second dock for the facility (“Dock 2”) and included a description of the handling of Liquefied Natural Gas (LNG) as a major activity for the proposed expansion of GLC. The Notice described the activity as LNG being transported into the GLC site at a rate of 13 trucks per hour, 24/7; each truck carrying approximately 12,000 gallons of liquid; LNG being directly loaded from the truck to the shipping vessel at the berth of Dock 2; with a ship loading time of approximately two weeks. (U.S. Army Corps of Engineers Supplemental Public Notice #CENAP-OP-R-2016-0181-39)

The DRBC approved docket for GLC Dock 2 describes the project as:

“The GLC, which is currently under construction, is a multi-use marine terminal and international logistics center located at the former Repauno site (also formerly known as the “Chemours Repauno industrial site” and “DuPont Repauno Works”) in Greenwich Township, Gloucester County, New Jersey. Previous DRBC, federal, state and local approvals for the GLC authorized Delaware River dredging and construction for the deep-water berth referred to as “Dock 1,” consisting of one-ship berth on a pile-supported wharf structure. Dock 2 will consist of an additional pile-supported wharf structure that accommodates two ship berths and associated infrastructure. The construction of Dock 2 involves dredging approximately 665,000 cubic yards (cy) of sediment from the Delaware River to a depth of 43 feet below (-43) mean lower low water (MLLW) to accommodate the two deep-water berths.” (DRBC DOCKET NO. D-2017-009-2, June 12, 2019, p. 1)

“Dock 2 will consist of a wharf featuring two deep water berths to accommodate a range of ocean-going vessels of a maximum length of 966 feet and maximum draft of 39.7 feet. The project involves dredging of approximately 665,000 cy of Delaware River sediment (primarily silts and sands) in a 45-acre area to provide access to the Federal Navigation Channel of the Delaware River. Dock 2 is designed for the loading of bulk liquid products directly from railcar or truck onto ocean-going vessels for export and includes infrastructure for transloading operations. Dock 2 will support the transloading of a variety of bulk liquid products, including butane, isobutane, propane (collectively liquefied petroleum gas, or LPG), liquefied natural gas (LNG), and ethane. The products will arrive at the site via truck and/or railcar. Once at the site, the products will be transferred to vessels via on-site infrastructure.” (DRBC DOCKET NO. D-2017-009-2, June 12, 2019, p. 2)

According to these descriptions, the project has grown by June 2019 to two docks with 2 berths at the new Dock 2, larger marine vessels from a maximum length of 870 feet to a maximum length of 966 feet entering the export and leaving terminal docks, expanded the LPG activities and infrastructure, included using both rail cars and trucks for LPG and LNG transport, and shifted focus of the majority of activity at GLC from dry cargo to liquid cargo, which appears now, by volume, to be primarily LNG.

The reason the project added the use of railcars for the transport of LNG is because the Pipeline and Hazardous Materials Safety Administration granted a Special Permit for the transport of LNG by railcar from New Fortress Energy’s planned LNG liquefaction plant in Wyalusing, Bradford County, PA to GLC in December 2019. The permit was applied for on August 21, 2017 by Energy Transfer Solutions, a subsidiary of New Fortress Energy but the public was not aware of the application and apparently some agencies were not aware of a potential Special Permit that would add railcar transport of LNG to GLC’s operations. LNG

is banned from being transported by railcar on the nation's railways due to safety concerns; this Special Permit is an exception to that prohibition and the only transport of this kind using rail cars (as opposed to ISO containers). The Special Permit was granted by PHMSA only for transport between these 2 locations and allows up to 100 rail cars to be shipped daily to GLC from Wyalusing. (Pipeline and Hazardous Materials Safety Administration, Special Permit DOT-SP 20534 to Energy Transport Solutions, LLC, 12.05.2019)

Apparently, the application for this Special Permit was not known by the Army Corp of Engineers at the time of the supplemental Public Notice in July 2019 since it is not mentioned in the description of the project. Once again, the GLC project has been changed by the addition of rail car shipments of LNG up to 100 cars per day, changing substantially the volume of cargo that can be transferred at the terminal. The most recent approvals for GLC's Dock 2 by federal and state agencies do not reflect an accurate or comprehensive environmental assessment of the potential impacts of the construction and operations that can occur due to this piecemeal and non-transparent progression of permitting for GLC.

Further evidence of an attempt to segment the review of this project is the lack of disclosure of concurrent applications before different agencies by DRP. For instance, despite the statement reported in the Philadelphia Inquirer in 2016 by Gary Lewis of New Fortress Energy that LNG was "no longer in the plans", by September 2017, the company had applied to the U.S. Coast Guard for approval to ship LNG by marine vessel on the Delaware River from GLC. But this was not disclosed to the municipality or the public.

From DRN's Complaint appealing the Army Corps of Engineers permit for the Gibbstown Dock 2 project: 88. On November 16, 2017, in a Letter of Intent to the United States Coast Guard, Sector Delaware Bay, a consultant for DRP described the Gibbstown Logistics Center as a "multi-use, deep-water port and logistics center that may include a variety of separate uses including handling of imported and exported automobiles, other bulk freight and liquid energy products including, but not limited to liquefied petroleum gas ("LPG") and liquefied natural gas ("LNG")."

89. The November 16, 2017 Letter of Intent also stated that DRP would be seeking authorization from the United States Department of Energy "to export LNG to both Free Trade Agreement and Non-Free Trade Agreement countries[.]"

The public, and apparently some agencies, were not aware of the application to the U.S. Coast Guard or DRP's plans to seek approval from the Department of Energy to export LNG for sale overseas, further dividing the scope of this project into small, disconnected parts, with the true nature of the company's plans hidden from the public and from reviewing agencies. The result, once again, is segmentation of the various aspects of the project and the lack of proper review by agencies with jurisdiction due to the missing but essential information.

Finally, another example of the piecemeal development of GLC is the lack of accuracy and clarity of the true build-out of traffic to be generated by the project at the county and municipal level. Different descriptions have been offered at Greenwich Township Zoning and Planning Board Hearings and at Gloucester County agency reviews. For instance, a report prepared for the Rt. 44 Bypass, which would service GLC, projected over 1,650 trucks trips each day would come and go from the Gibbstown Logistics Center.

According to Gloucester County's report:

“Additionally, proposed development at the DuPont Repauno site, located adjacent to Repauno Avenue north of Route 44, is expected to be completed by Year 2020 and includes warehousing, liquid storage, an auto storage terminal and a marine terminal. These land uses are expected to generate approximately 8,450 daily trips to/from the DuPont Repauno site, including nearly 1,650 truck trips.” (“Drainage & SWM Report for Route 44 Truck Bypass and DuPont Port Access, Township of Greenwich, Gloucester County, NJ” *Prepared for: Gloucester County Improvement Authority Prepared by: McCormick Taylor, Inc., February 2019, Page 2*)

According to the July 16 2019 Army Corps of Engineers Public Notice, the number of trucks carrying LNG for Dock 2 would be 13 per hour and the number of trucks for Dock 1 is not specified by the Army Corps or DRBC. However, the discrepancy between 1,650 truck trips per day and 312 trucks per day (or, 624 truck trips per day) is enormous and the environmental impacts of such a large volume have not been addressed. The discrepancy indicates either an attempt to piecemeal the growth of the traffic and its environmental impacts over time as the development of the docks and associated infrastructure plays out or it is plain obfuscation on the part of the applicant regarding the information provided to the various agencies regarding the project. The result is the same: the project is not completely evaluated by any one agency as a whole, at build out, denying the opportunity for a full and comprehensive analysis of the environmental impacts of GLC.

In DRN's Complaint appealing the Army Corps of Engineers permit for the Gibbstown Dock 2 project, segmentation is raised as an important issue:

43. “Similar actions, . . . when viewed with other reasonably foreseeable or proposed agency actions, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography.” 40 C.F.R. § 1508.25(a)(3). (page 11)

44. “An agency impermissibly ‘segments’ NEPA review when it divides connected, cumulative, or similar federal actions into separate projects and thereby fails to address the true scope and impact of the activities that should be under consideration.” *Delaware Riverkeeper Network v. F.E.R.C.*, 753 F.3d 1304, 1313 (D.C. Cir. 2014). (page 11)

45. The rule against segmentation “prevent[s] agencies from dividing one project into multiple individual actions each of which individually has an insignificant environmental impact, but which collectively have a substantial impact.” *Id.* at 1314 (quoting *NRDC v. Hodel*, 865 F.2d 288, 297 (D.C. Cir. 1988)) (alteration in original). (page 11)

102. The April 4, 2019 Notice stated that “[t]he site will be designed to handle a multitude of products including butane, isobutane, propane, liquefied natural gas (LNG) and ethane, as well as a variety of other liquid products.” (page 20)

103. On May 30, 2019, in a comment provided to the Army Corps, NMFS expressed a concern that the Dock 2 project was not included in the original Dock 1 permitting process, despite that the “applicant had intended from the outset of the development at this site to construct more than one wharf[.]” Accordingly, NMFS stated “the full environmental effects of the total action at the site have not been fully evaluated and it appears that the project has been segmented in order to avoid the appearance of significance of the total action as part of the [NEPA] review.” (page 20)

This evidence of segmentation and piecemeal development is relevant for the subject proposed air permit modification because the modification only considers one part of the project's activities that result in air pollution. The same piecemeal approach is being used in regards to the air permitting as it has been with other agencies throughout GLC's development. The first air quality permit was for the one flare for the butane cavern, now this modification is for another flare and expansion of the LHG activities and infrastructure at GLC. DRP will next come back to NJDEP for the Dock 2 flare, which will include LNG.

DRP received the Dock 2 Waterfront Development Permit from NJDEP on September 10, 2019. There is no explanation as to why they are not applying for the full build-out of GLC, including all cargoes, at this time. Additionally, there are planned sphere tank(s) at a "tank farm" that is shown on various iterations of DRP's site plans for GLC and a proposed "small capacity" natural gas liquefier on site. There has even been some discussion of DRP adding another underground cavern on the property. The development plans for GLC are not fully understood or disclosed and shift according to DRP and New Fortress Energy's business plans, which benefit from a lack of comprehensive and unsegmented review of the needed permits.

NJDEP must insist that DRP disclose its complete build-out plans for GLC. DRP should apply for a Title V permit based on all activities and operations that are planned at GLC and not be allowed to segment off partial activities, which has the effect of unlawful segmentation that avoids jurisdictional review and prevents a full environmental analysis of the emissions from GLC.

Climate Impacts

The activities at GLC that involve the transport, transloading, storage, and shipping of LPG, the subject of this proposed permit modification, will release methane and carbon, as per the calculations submitted by DRP. The full life cycle releases of methane and carbon (carbon dioxide and carbon monoxide) must be considered to accurately assess the potential impacts of these greenhouse gas emissions. That includes the releases from the extraction point (the shale gas well); the transport by pipeline, truck and/or rail to Gibbstown; the handling and storage of LPG at GLC; the marine vessel storage; and the end use of the gas.

The American Lung Association points out that climate change enhances conditions for ozone to form and makes it harder to keep ozone from forming. As discussed earlier in this comment, VOCs and NOx will both be emitted if this permit modification is approved. The American Lung Association also states that climate change increases the risk of wildfires that spread particle pollution and ozone in the smoke.

<http://www.stateoftheair.org/air-quality-facts/>

It is incumbent upon each state agency to perform its part in meeting the adopted goals of the State of New Jersey to reduce greenhouse gas emissions as declared in the NJ Energy Master Plan, the Global Warming Response Act, Governor Murphy's Executive Orders, and New Jersey's service to the nation's responsibility to international climate accords. Methane and carbon emissions cannot be expanded, which this proposed permit modification will allow, without undermining these priority commitments. Some reasons New Jersey must act to reduce, not increase, these emission are:

- The 2019 Intergovernmental Panel on Climate Change ("IPCC") report from the United Nations describes how the ocean and cryosphere have and are expected to change with ongoing global warming,

the risks and opportunities these changes bring to ecosystems and people, and mitigation, adaptation and governance options for reducing future risks.¹

- The Intergovernmental Panel on Climate Change (“IPCC”) report says limiting warming to 1.5C will require reducing greenhouse gases by 45% from 2010 levels by 2030 and that there can be no carbon emissions from energy production by about 2050.²
- Scientists estimate that at least 45% - 50% reduction of greenhouse gases must be achieved by 2030 in order to effectively limit atmospheric warming. “Emissions need to be halved by 2030 to limit warming to 1.5 degrees Celsius but temperatures are on track to reach double that by the end of the century even if countries’ current plans are fully implemented, research by scientists shows.”³
- Rising air and water temperatures and changes in precipitation are intensifying droughts, increasing heavy downpours and flooding, reducing snowpack, and causing declines in surface water quality, with varying impacts across different regions of the country.⁴ Changes in temperature and precipitation are increasing air quality and health risks from wildfire and ground-level ozone pollution. All of these climate change impacts effect water resources, including river flows, temperature, and seasonal variability, reservoir levels, water quality and the concentration of pollutants in bath ground and surface water, Delaware River Watershed species (both flora and fauna) and their habitats, recreation, economic values, and human health.
- Climate change has already had observable impacts on biodiversity, ecosystems, and the benefits they provide to society. These impacts include the migration of native species to new areas and the spread of invasive species, which will worsen and could affect ecological balance.⁵
- Yields from major U.S. crops are expected to decline as a consequence of increases in temperatures and possibly changes in water availability (drought conditions), soil erosion, and disease and pest outbreaks.⁶
- The Fourth National Climate Assessment looks at the Northeast region climate impacts. These are among expected changes in the near term:
 - Less distinct seasons with milder winter and earlier spring conditions are already altering ecosystems and environments in ways that adversely impact tourism, farming, forestry, and other economies.⁷
 - Warmer ocean temperatures, sea level rise, and ocean acidification threaten ocean habitats, ecosystem services, and livelihoods.⁸
 - Major negative impacts on critical infrastructure, urban economies, and nationally significant historic sites are already occurring and will become more common with a changing climate.⁹
 - Changing climate threatens the health and well-being of people in the Northeast through more extreme weather, warmer temperatures, degradation of air and water quality, and sea level rise.¹⁰

¹ Intergovernmental Panel on Climate Change, *Summary for Policymakers, Revised on January 2019 by the IPCC, Switzerland*, ISBN 978-92-9169-151-7, downloaded at: <https://www.ipcc.ch/sr15/>

² Ibid.

³ <https://climateactiontracker.org/publications/warming-projections-global-update-dec-2018/>

⁴ Intergovernmental Panel on Climate Change, *Summary for Policymakers, Revised on January 2019 by the IPCC, Switzerland*, ISBN 978-92-9169-151-7, downloaded at: <https://www.ipcc.ch/sr15/>

⁵ USGCRP, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: Report-in-Brief* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 186 pp. Retrieved from <https://nca2018.globalchange.gov/> at 16.

⁶ Ibid at 14.

⁷ Ibid at 116.

⁸ Ibid at 117.

⁹ Ibid at 117.

¹⁰ Ibid at 117.

- Weather events have become more frequent and more intense. Anthropogenic climate change has increased precipitation, winds, and extreme sea level events associated with a number of observed tropical- and extra-tropical cyclones.¹¹
- Extreme El Niño and La Niña events are likely to occur more frequently with global warming and are likely to intensify existing impacts, with drier or wetter responses in several regions across the globe, even at relatively low levels of future global warming.¹²
- Sea level rise translates into river level rise in the tidal Delaware River. The rising of the seas moves upriver from the ocean, the Bay, the estuary and into tidal reaches of the river, raising the river's level and the level of the river's freshwater tributaries. In the nontidal river and its watershed, extreme weather events cause inland flooding and its cascade of impacts to natural ecosystems, streams, habitats, infrastructure and the human environment, and to the hydrology of waterways and the hydrologic cycle, which is altered by increased stormwater runoff, wetland disruption and less natural infiltration and natural floodplain functions.
- Sea level rise is a dramatic and measurable impact of climate changes. Impacts will be exacerbated in cases of land reclamation and where anthropogenic barriers prevent inland migration of marshes and mangroves and limit the availability and re-location of sediment.¹³ In the absence of adaptation, more intense and frequent extreme sea level events, together with trends in coastal development, will increase expected annual flood damages by 2-3 orders of magnitude by 2100.¹⁴
- Since the early 1980s, the occurrence of harmful algal blooms (HABs) and pathogenic organisms (e.g. *Vibrio*) has increased in coastal areas in response to warming, deoxygenation and eutrophication, with negative impacts on food provisioning, tourism, the economy, and human health.¹⁵
- Rutgers University's report published in 2019 points out that "New Jersey has already been disproportionately affected by climate change—sea-level rise projections in New Jersey are more than two times the global average."¹⁶ This is consistent with the findings of other reports that from Virginia northward, sea level rise is having greater effects. New Jersey's condition is exacerbated by the fact that, as the Rutgers Study explains, "Over the last four thousand years, the dominant long-term driver of SLR in New Jersey has been the sinking of the land as part of the ongoing response to the disappearance of the North American ice sheet."¹⁷
- In a report published last year by the Rhodium Group, New Jersey damages from climate change were examined and calculated. In addition to the growing extent and costs of coastal flooding, the report points out "While New Jersey's coastal communities face the bulk of hurricane-driven flood risk, the potential for wind damage from these storms extends inland. Four decades ago, the odds that an average

¹¹ IPCC (2019). The Ocean and Cryosphere in a Changing Climate. Intergovernmental Panel on Climate Change. Retrieved from https://report.ipcc.ch/srocc/pdf/SROCC_FinalDraft_FullReport.pdf at 6-3.

¹² Ibid at 6-4.

¹³ Ibid at 4-5.

¹⁴ Ibid.

¹⁵ Ibid at 5-5.

¹⁶ Kopp, R.E., C. Andrews, A. Broccoli, A. Garner, D. Kreeger, R. Leichenko, N. Lin, C. Little, J.A. Miller, J.K. Miller, K.G. Miller, R. Moss, P. Orton, A. Parris, D. Robinson, W. Sweet, J. Walker, C.P. Weaver, K. White, M. Campo, M. Kaplan, J. Herb, and L. Auermuller. New Jersey's Rising Seas and Changing Coastal Storms: Report of the 2019 Science and Technical Advisory Panel. Rutgers, The State University of New Jersey. Prepared for the New Jersey Department of Environmental Protection. Trenton, New Jersey. p. 1 <https://bloustein.rutgers.edu/njdep-releases-report-on-sea-level-rise-building-on-previous-rutgers-studies/>

¹⁷ Ibid. p. 9.

New Jersey home outside the state’s coastal counties would experience hurricane-force winds in a given year was less than 1-in-200. That has grown to between 1-in-30 and 1-in-100.”¹⁸

The report explains:

“Global average temperatures have risen by 2° Fahrenheit since the late nineteenth century and by more than 1° Fahrenheit over the past four decades, with the pace of warming accelerated as concentrations of carbon dioxide (CO₂) and other greenhouse gases in the atmosphere have increased. Oceans are also responding to these changes. Sea surface temperature in the Northeast US has warmed faster than 99% of the global ocean since 2004, and projections indicate that this area will continue to warm more quickly than other ocean regions through the end of the century.⁵ 2018 also marked the warmest year on record for ocean heat content, surpassing a record set in 2017.⁶ Warming oceans take up more space, a process known as thermal expansion, which contributes—along with melting glaciers and ice sheets—to sea-level rise.”¹⁹

- The damage to buildings in all the counties along Delaware River tidal waters has increased due to climate impacts since 1980 according to the Rhodium Group study. Mapping shows the greatest increases for the Delaware estuarine waters to be Cape May County (from 20.9% to 27% - both from the Delaware Bay and the Atlantic Ocean) and Salem County (12.5% to 15.3%).²⁰
- The “increase in expected average annual loss, as a percent of county output, due to changes in sea level and expected hurricane activity since the 1980s” is greatest in Cape May, Hudson, and Salem Counties of all New Jersey counties, according to the Rhodium study.²¹ This is a significant cost for these two Delaware River Basin counties.
- Storm surge exacerbates the flooding from storm-induced flooding and was an important factor in the damages caused by Hurricane Sandy in 2012.²²
- The Delaware Valley Regional Planning Commission (DVRPC) reports “...water levels of the tidal section of the Delaware River will rise as sea level rises along the Atlantic Coast. These rising water levels will be a permanent change to the landscape and will introduce new flooding vulnerabilities along the Delaware that communities will need to address.”²³
- In the NOAA Technical Report on global and relative sea level rise, it is concluded that seas will continue to rise due to climate change even if substantial action is taken now to address climate change impacts.

These impacts include:

“Significant, direct impacts of long-term [relative sea level] (RSL) rise, including loss of life, damage to infrastructure and the built environment, permanent loss of land (Weiss et al., 2011), ecological regime shifts in coastal wetlands and estuary systems (Kirwan et al., 2010), and water quality impairment (Masterson et al., 2014), also occur when key thresholds in the coastal environment are crossed (Wong et al., 2014).²⁴

- In an earlier DVRPC report, the study on the effects of sea level rise concluded:

¹⁸ RHODIUM GROUP, “NEW JERSEY’S RISING COASTAL RISK”, October 2019. p. 2 https://rhg.com/wp-content/uploads/2019/10/Rhodium_NJCoastalRisk_Oct2019final.pdf

¹⁹ Ibid. p. 3, 4.

²⁰ Ibid. Figure 4, p. 7.

²¹ Ibid. Figure 8, p. 12.

²² Ibid. p. 7.

²³ DVRPC, Coastal Effects of Climate Change in Southeastern PA, Introduction and Project Background, November 5, 2019. <https://www.arcgis.com/apps/MapSeries/index.html?appid=8080c91a101d460a9a0246b90d4b4610>

²⁴ National Oceanic and Atmospheric Administration, U.S. DEPARTMENT OF COMMERCE, National Ocean Service Center for Operational Oceanographic Products and Services, “GLOBAL AND REGIONAL SEA LEVEL RISE SCENARIOS FOR THE UNITED STATES”, NOAA Technical Report NOS CO-OPS 083, Silver Spring, Maryland, January 2017. P. 1

“The study concludes that a three- to four-foot rise in sea level during the next 100 years will have a wide range of impacts. Rising seas will inundate almost all of Pennsylvania's 1,500 acres of tidal wetlands. The salt line in the Delaware River will migrate further upstream, threatening Philadelphia's drinking water supply. The pollutants found in contaminated sites may be released into estuary waters. Efforts to increase public access to the waterfront may be jeopardized by rising waters.”²⁵

It is important that NJDEP recognize that the emission of fugitive methane, which is not included in the calculations and planning regarding this permit modification - nor any other NJDEP permit - is highly consequential in terms of the area greenhouse gas contribution to the atmosphere. This is illustrated by various recent analyses that address the potency of methane as a greenhouse gas:

- Greenhouse gas emissions must address methane, which means curtailing natural gas development. According to recent tracking greenhouse gas reports, “However, energy-related carbon dioxide emissions were at a record high last year and new renewable power capacity has stalled after years of strong growth. At the same time, methane, a more potent greenhouse gas than carbon dioxide, has risen in recent years due to oil and gas production, including fracking.”²⁶
- Atmospheric methane levels rose steadily during the last few decades of the 20th century before leveling off for the first decade of the 21st century.²⁷ Since 2008, however, methane concentrations have again been rising rapidly. This increase, if it continues in coming decades, will significantly increase global warming and undercut efforts to reach the COP21 target of < 2 degrees C above the pre-industrial baseline by 2021.²⁸ Limiting warming to 1.5C will be even more difficult, if not impossible.
- The composition of natural gas is about 95% methane. Methane leaks or is vented or flared at all stages of the natural gas process (extraction/production, gathering, processing, transmission, storage, local distribution and consumption). Methane is 86 times more efficient than CO₂ at trapping heat over a 20-year period.²⁹ Unless methane emissions are dramatically and intentionally reduced, it will be impossible to meet the required 45% reduction of greenhouse gases that the IPCC and other scientists have concluded is necessary to meet climate goals.
- Natural gas systems emit more anthropogenic methane than any other source in the United States, and are the third highest source for carbon dioxide emissions nationally.³⁰ Natural gas, considered “clean” or a “bridge fuel” is, in fact, a bigger problem than other fossil fuels due to uncontrolled and uncontrollable leaks, intentional flaring and venting. “Methane is far more potent than carbon dioxide in contributing to climate change. That makes it particularly harmful to the environment when it is

²⁵ DVRPC, “Sea Level Rise Impacts in the Delaware Estuary of Pennsylvania”, Product No.: 04037, 6/2004, Abstract.

<https://www.dvrpc.org/Products/04037/>

²⁶ <https://www.insurancejournal.com/news/international/2019/06/19/529839.htm>

²⁷ Howarth, R. (2019). Ideas and perspectives: is shale gas a major driver of recent increase in global atmospheric methane? *Biogeosciences* (16), 3033-3046. Retrieved from <https://www.biogeosciences.net/16/3033/2019/bg-16-3033-2019.pdf>

²⁸ Ibid.

²⁹ Myhre, G. et al. 2013. Anthropogenic and Natural Radiative Forcing. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Stocker, T.F., D. Qin, G.K. Plattner, M.Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Midglet (eds). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. and https://en.wikipedia.org/wiki/Global_warming_potential

³⁰ EPA 2016. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014.

<https://www.epa.gov/ghgemissions/us-greenhouse-gas-inventory-report-1990-2014>

discharged into the atmosphere. In the U.S. alone, the methane that leaks or is released from oil and gas operations annually is equivalent to the greenhouse gas emissions from more than 69 million cars, according to a Wall Street Journal analysis using conversion formulas from the Environmental Protection Agency and emissions estimates for 2015 published last year in the journal Science.”³¹

- Methane’s impact on atmospheric warming is much shorter and simpler than carbon, as explained in the VOX.com article: “Reduced emissions [of methane] have an almost immediate climate impact. It’s a short-term climate lever, and if the countries of the world are going to hold rising temperatures to the United Nations’ target of “well below” 2 degrees Celsius above the preindustrial baseline, they’re going to need all the short-term climate levers they can get.”³²
- According to Dr. Howarth of Cornell University, the planet is going to continue to warm to 1.5 degrees C in 12 years and to 2 degrees C in 35 years or less unless we substantially cut methane emissions.³³ He points out that the planet responds much faster to methane than carbon dioxide. There is already so much carbon in the atmosphere that the ONLY hope of meeting global climate targets is to address methane because that can quickly reduce greenhouse gases and slow the warming of the atmosphere.³⁴

Conclusion and Recommendation

Delaware Riverkeeper Network opposes the proposed Air Pollution Control Preconstruction Permit Modification for Delaware River Partners’ (DRP) Gibbstown Logistics Center (GLC) and respectfully requests that the permit modification be denied. The proposed permit action does not meet the requirements of the Air Pollution Control Act, Chapter 106, P.L. 1967 (N.J.S.A. 26:2C-1 et. seq.) and enabling state regulations the required federal standards and processes that protect air quality and prevent degradation. Any future applications for air pollution control permits submitted to NJDEP must include all emissions generated by GLC at build out, allowing for the fulfillment of a comprehensive, nonsegmented review by NJDEP pursuant to the provisions of New Jersey’s Air Pollution Control Act and enabling regulations and the federal Clean Air Act.

Thank you for the opportunity to comment.

Respectfully submitted,



Maya van Rossum
the Delaware Riverkeeper

Tracy Carluccio
Deputy Director

Imbedded Attachment: Delaware Riverkeeper Network Complaint filed in the United States District Court for the District of New Jersey appealing the Army Corps of Engineers permit for the Gibbstown Dock 2 project, April 22, 2020 (Civ. No.: 1:20-cv-4824)

³¹ Wall Street Journal, *The Leaks That Threaten the Clean Image of Natural Gas*, <https://www.wsj.com/articles/the-leaks-that-threaten-the-clean-image-of-natural-gas-11565280375>

³² <https://www.vox.com/energy-and-environment/2019/8/15/20805136/climate-change-fracking-methane-emissions>

³³ Dr. Robert Howarth, Cornell University, “COP21 Reflections on the Historic Paris Climate Agreement”, http://events.cornell.edu/event/cop21_reflections_on_the_historic_climate_agreement

³⁴ Ibid.

Kacy C. Manahan, Esq. (N.J. Bar No. 275122018)
Delaware Riverkeeper Network
925 Canal Street, Suite 3701
Bristol, PA 19007
215-369-1188 x115
kacy@delawareriverkeeper.org

Attorney for Plaintiffs

**UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF NEW JERSEY**

DELAWARE RIVERKEEPER NETWORK,
and MAYA VAN ROSSUM, the
DELAWARE RIVERKEEPER,

Plaintiffs,

Civ. No.: 1:20-cv-4824

v.

UNITED STATES ARMY CORPS OF
ENGINEERS, RYAN D. MCCARTHY,
Secretary of the Army (in his official
capacity), R.D. JAMES, Assistant Secretary
of the Army for Civil Works (in his official
capacity), LIEUTENANT GENERAL TODD
T. SEMONITE, Commanding General of the
U.S. Army Corps of Engineers (in his official
capacity), MAJOR GENERAL JEFFREY L.
MILHORN, Commander and Division
Engineer of the U.S. Army Corps of
Engineers North Atlantic Division (in his
official capacity), LIEUTENANT COLONEL
DAVID PARK, Commander of the U.S.
Army Corps of Engineers Philadelphia
District (in his official capacity), and
EDWARD E. BONNER, Chief of the
Regulatory Branch of the U.S. Army Corps of
Engineers Philadelphia District (in his official
capacity),

**COMPLAINT FOR DECLARATORY
AND INJUNCTIVE RELIEF**

Defendants.

TO THE HONORABLE COURT:

Plaintiffs Delaware Riverkeeper Network and Maya van Rossum, the Delaware Riverkeeper, by and through their undersigned counsel, allege as follows:

INTRODUCTION

1. In this action, Plaintiffs the Delaware Riverkeeper Network and Maya van Rossum, the Delaware Riverkeeper (collectively, “DRN”), 925 Canal Street #3701, Bristol, Pennsylvania 19007, challenge the United States Army Corps of Engineers’ (“Corps” or “Army Corps”), 441 G Street NW, Washington, District of Columbia 20001, February 28, 2020 Public Notice (“Notice”) regarding the issuance of a permit to Delaware River Partners, LLC (“DRP”) pursuant to Section 10 of the Rivers and Harbors Act, 33 U.S.C. § 403, and Section 404 of the Clean Water Act, 33 U.S.C. § 1344, for the construction of a proposed new docking facility (“Dock 2 Facility”), which will transfer liquefied natural gas (“LNG”) to docked vessels.

2. This action by the Army Corps is arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law under the Administrative Procedure Act (“APA”), 5 U.S.C. § 706. The Corps violated the APA by failing to comply with the National Environmental Policy Act (“NEPA”), 42 U.S.C. §§ 4321–4370h, which requires a “detailed statement by the responsible official” regarding “major Federal actions significantly affecting the quality of the human environment[.]” The Corps’ public interest review pursuant to its own regulations at 33 C.F.R. § 320.4 was arbitrary and capricious because it did not give sufficient weight and analysis to climate change impacts and safety concerns. Finally, the Corps violated the APA by failing to comply with the Clean Air Act, 42 U.S.C. §§ 7401–7671q, by failing to determine whether the Dock 2 project will conform to the state implementation plan in a nonattainment area for ozone.

3. Until Defendants comply with the requirements of the APA by completing and complying with all applicable federal and state laws, rules, and regulations, Plaintiffs will seek temporary, preliminary, or permanent injunctions against any activities in furtherance of the Dock 2 Project, and any other such relief as Plaintiffs deem appropriate.

4. This relief is necessary to preserve the status quo, to prevent illegal agency action, and to forestall irreparable injury to the environment and to Plaintiffs' interests.

JURISDICTION

5. This Court has jurisdiction over this action pursuant to 28 U.S.C. § 1331 (federal question jurisdiction); 5 U.S.C. § 702 (APA); and may issue a declaratory judgment and further relief pursuant to 28 U.S.C. §§ 2201 and 2202 (declaratory and injunctive relief).

6. Venue is proper in this Court pursuant to 28 U.S.C. § 1391(e) because a substantial part of the events or omissions giving rise to the claims occurred in this District. Venue is also proper in this District because Plaintiffs and a substantial number of the members of Plaintiff organization Delaware Riverkeeper Network reside, work, and/or recreate in the District. Venue is also proper in this District because the Dock 2 facilities are located in Greenwich Township in New Jersey, and the adverse effects of the facilities will substantially affect New Jersey.

7. Plaintiffs have no adequate remedy at law. Unless this Court grants the requested relief, the Defendants' actions will continue to cause irreparable harm to the environment, to Plaintiffs, and to the public in violation of state and federal law and the public interest. No monetary damages or other legal remedy could adequately compensate Plaintiffs or the public for these harms. Plaintiffs are persons adversely affected or aggrieved by federal agency action within the meaning of Section 702 of the APA. 5 U.S.C. § 702.

PARTIES

A. Plaintiffs

8. Plaintiff Delaware Riverkeeper Network was established in 1988 to protect and restore the Delaware River, its tributaries and habitats. To achieve these goals, Delaware Riverkeeper Network organizes and implements stream restoration projects, volunteer water quality and ecosystem monitoring, educational programs, community technical assistance projects, environmental advocacy initiatives, community/member action and involvement projects, recreational activities, and environmental litigation throughout the entire Delaware River watershed, including the Delaware Estuary and Delaware Bay, and at a state or national level when necessary to advance the organization's mission. The watershed includes portions of New Jersey, New York, Pennsylvania, and Delaware. Delaware Riverkeeper Network is a not-for-profit membership organization with over 25,000 members, including members who live in, work in, and/or recreate in the State of Delaware, the State of New Jersey, and the Commonwealth of Pennsylvania. Delaware Riverkeeper Network members fish, canoe, kayak, boat, swim, birdwatch, hike, bike, and participate in other recreational activities in the Lower Delaware River Watershed, including in the State of New Jersey. Delaware Riverkeeper Network undertakes numerous activities and initiatives that take place in, directly benefit from, and/or directly impact State of New Jersey waters, habitats, ecosystems, and communities.

9. Plaintiff the Delaware Riverkeeper, Maya K. van Rossum, is a full-time privately-funded ombudsman who is responsible for the protection of the waterways in the Delaware River Watershed. The Delaware Riverkeeper advocates and works for the protection and restoration of the ecological, recreational, commercial and aesthetic qualities of the Delaware River, its estuary, bay, tributaries, and habitats. The Delaware Riverkeeper regularly visits the Delaware River for

personal and professional reasons. The Delaware Riverkeeper is the chief executive officer of the Delaware Riverkeeper Network.

10. Delaware Riverkeeper Network brings this action on behalf of its members, including many who live in the vicinity of the Delaware River and Estuary, or rely on them for recreational, professional, personal, or aesthetic uses, and will suffer injuries from the ecological and/or economic damage and the safety concerns caused by the Dock 2 Project. The Corps' violation of the APA causes Delaware Riverkeeper Network members to also suffer procedural and substantive injuries from the Corps' arbitrary and capricious action, which fails to comply with state and federal law.

11. Delaware Riverkeeper Network also brings this action on behalf of itself. The Corps' violation of the APA causes Delaware Riverkeeper Network to suffer substantive and procedural injuries from the Corps' arbitrary and capricious action, which fails to comply with state and federal law.

B. Defendants

12. Defendant Army Corps is a Federal agency of the United States of America, within the Department of the Army of the United States Department of Defense. The Corps has been delegated responsibility by the Department of the Army for, among other things, construction, management, and operation of various rivers, lakes and other water resources of the United States of America, and the issuance, modification and revocation of permits relative to various activities taken or proposed to be taken on waters of the United States and its tributaries. The Corps issued a permit to DRP allowing it to construct the Dock 2 Facilities. Army Corps Headquarters are located at 441 G Street NW, Washington, DC 20314-1000.

13. Defendant the Honorable Ryan D. McCarthy is named in his official capacity as the Secretary of the Army. Secretary McCarthy is responsible for implementing the policies, procedures and requirements of the Corps and applicable statutes and regulations relative to all water resources and Corps-owned or operated properties within the United States of America.

14. Defendant the Honorable R.D. James is named in his official capacity as the Assistant Secretary of the Army for Civil Works. Assistant Secretary James establishes policy direction and provides supervision of the Department of the Army functions relating to all aspects of the Army Corps' Civil Works program, including programs for conservation and development of the nation's water and wetland resources, flood control, navigation, and shore protection.

15. Defendant Lieutenant General Todd T. Semonite is named in his official capacity as the Chief of Engineers and Commanding General of the Army Corps. As Chief of Engineers, an Army Staff Principal, Lt. Gen. Semonite advises the Secretary of the army and other Principal Officials on matters related to general, combat, and geospatial engineering; construction, real property, public infrastructure and natural resources science and management. As the Army Corps Commanding General, he is responsible for more than 32,000 civilian employees and 700 military personnel who provide project management, construction support and science and engineering expertise in more than 110 countries.

16. Major General Jeffrey L. Milhorn is named in his official capacity as Commander and Division Engineer of the U.S. Army Corps of Engineers, North Atlantic Division. Major General Milhorn oversees an annual program of more than \$5 billion to plan, design, and construct projects to support the military, protect America's water resources, mitigate risk from disasters, and restore and enhance the environment. He is also responsible for a variety of Division engineering and

construction activities for international, federal, state and local governments and agencies in more than a dozen Northeastern states as well as overseas.

17. Lieutenant Colonel David C. Park is named in his official capacity as the Commander of the U.S. Army Corps of Engineers, Philadelphia District. Lieutenant Colonel David C. Park leads a 500-person District with missions that include dredging waterways for navigation, protecting communities from flooding and coastal storms, responding to natural and declared disasters, regulating construction in the nation's waters and wetlands, remediating environmental hazards, restoring ecosystems, building facilities for the Army and Air Force, and providing engineering, contracting and project management services for other government agencies upon request.

18. Edward E. Bonner is named in his official capacity as the Chief of the Regulatory Branch and District Engineer of the U.S. Army Corps of Engineers, Philadelphia District.

19. The Delaware River and Bay is a part of the water resources of the United States overseen and managed by the Philadelphia District of the Army Corps. Authority to issue the permit described herein has been delegated to the District Engineer of the Philadelphia District.

STATUTORY FRAMEWORK GIVING RISE TO PLAINTIFF'S CLAIMS FOR RELIEF

A. NEPA and Implementing Regulations

20. NEPA's essential purpose is "to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment." 40 C.F.R. § 1500.1(c).

21. To accomplish that purpose, NEPA requires that all agencies of the Federal government must prepare a "detailed statement" regarding all "major Federal actions significantly affecting the quality of the human environment[.]" 42 U.S.C. § 4332(2)(C).

22. This statement, known as an Environmental Impact Statement (“EIS”), must describe (1) the “environmental impact of the proposed action”; (2) any “adverse environmental effects which cannot be avoided should the proposal be implemented”; (3) any “alternatives to the proposed action”; and (4) any “irreversible or irretrievable commitment of resources which would be involved in the proposed action should it be implemented.” *Id.*

23. “Major Federal actions” requiring preparation of an EIS include projects and programs entirely or partly financed, assisted, conducted, regulated, or approved by Federal agencies. 40 C.F.R. § 1508.18(a).

24. The Council on Environmental Quality (“CEQ”) is an agency within the Executive Office of the President and has promulgated regulations implementing NEPA. 40 C.F.R. §§ 1500-1508.

25. CEQ regulations direct Federal agencies to adopt their own regulatory procedures to supplement CEQ regulations. 40 C.F.R. § 1507.3. The Army Corps’ NEPA regulations are found at 33 C.F.R. Part 230.

26. CEQ regulations describe the process by which a Federal agency must decide whether to prepare an EIS. 40 C.F.R. § 1501.4.

27. First, a Federal agency must determine whether the proposed action is one which normally requires an EIS or whether the proposed action is categorically excluded by the Federal agency’s supplemental NEPA regulations. 40 C.F.R. § 1501.4(a).

28. If the proposed action does not belong in either category, CEQ regulations direct the Federal agency to “prepare an environmental assessment [(“EA”)]” and to “involve environmental agencies, applicants, and the public, to the extent practicable, in preparing” the EA. 40 C.F.R. § 1501.4(b).

29. CEQ regulations direct the Federal agency to “make its determination whether to prepare an [EIS]” based on the EA. 40 C.F.R. § 1501.4(c).

30. If the Federal agency “determines on the basis of the environmental assessment not to prepare an [EIS],” then it should “[p]repare a finding of no significant impact,” also known as a FONSI. 40 C.F.R. § 1501.4(e).

31. CEQ regulations delineate factors that must be considered in determining the significance of an action, including context and intensity. 40 C.F.R. § 1508.27.

32. In evaluating the intensity of an action, “[r]esponsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action.” 40 C.F.R. § 1508.27(b). Relevant factors include:

(2) The degree to which the proposed action affects public health or safety.

....

(4) The degree to which the effects on the quality of the human environment are likely to be highly controversial.

(5) The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.

(6) The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.

(7) Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.

40 C.F.R. § 1508.27(b).

33. An EIS must “provide full and fair discussion of significant environmental impacts and shall inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment.” 40 C.F.R. § 1502.1.

34. When more than one Federal agency “[p]roposes or is involved in the same action” or “[i]s involved in a group of actions directly related to each other because of their functional interdependence or geographical proximity[,]” then a “lead agency shall supervise the preparation of an environmental impact statement[.]” 40 C.F.R. § 1501.5.

35. The scope of an EIS includes connected actions, cumulative actions, and similar actions, as well as the direct, indirect, and cumulative impacts of the action. 40 C.F.R. § 1508.25(a), (c).

36. CEQ regulations require Federal agencies to consider “direct effects,” defined as effects “which are caused by the action and occur at the same time and place.” 40 C.F.R. § 1508.8(a).

37. Federal agencies must also consider “indirect effects,” which are defined as “effects which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.” 40 C.F.R. § 1508.8(b).

38. Cumulative impacts “result[] from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.” 40 C.F.R. § 1508.7.

39. Also within the scope of an agency’s NEPA review are connected actions, cumulative actions, and similar actions. 40 C.F.R. § 1508.25(a).

40. “Connected actions” are “closely related and therefore should be discussed in the same impact statement.” 40 C.F.R. § 1508.25(a)(1).

41. Actions are considered connected if they “automatically trigger other actions which may require environmental impact statements,” “cannot or will not proceed unless other actions are

taken previously or simultaneously,” or “[a]re interdependent parts of a larger action and depend on the larger action for their justification.” *Id.*

42. CEQ regulations also require that “cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts” be considered in a single EIS. 40 C.F.R. § 1508.25(a)(2).

43. “Similar actions, . . . when viewed with other reasonably foreseeable or proposed agency actions, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography.” 40 C.F.R. § 1508.25(a)(3).

44. “An agency impermissibly ‘segments’ NEPA review when it divides connected, cumulative, or similar federal actions into separate projects and thereby fails to address the true scope and impact of the activities that should be under consideration.” *Delaware Riverkeeper Network v. F.E.R.C.*, 753 F.3d 1304, 1313 (D.C. Cir. 2014).

45. The rule against segmentation “prevent[s] agencies from dividing one project into multiple individual actions each of which individually has an insignificant environmental impact, but which collectively have a substantial impact.” *Id.* at 1314 (quoting *NRDC v. Hodel*, 865 F.2d 288, 297 (D.C. Cir. 1988)) (alteration in original).

46. Regulations governing the preparation of Environmental Assessments (“EAs”) are found at 40 C.F.R. § 1508.9 and 33 C.F.R. § 230.10.

47. EAs are “concise public document[s]” intended to “provide sufficient evidence and analysis for determining whether to prepare” an EIS or a FONSI. 40 C.F.R. § 1508.9(a)(1).

48. An EA “[s]hall include brief discussions of the need for the proposal, of alternatives . . . , of the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted.” 40 C.F.R. § 1508.7(b).

49. The Corps is required to “prepare an environmental assessment . . . when necessary under the procedures adopted by [the Corps] to supplement [CEQ] regulations[.]” 40 C.F.R. § 1501.3(a).

50. Corps regulations state that “regulatory actions,” such as permits, are “[a]ctions normally requiring an EA, but not an EIS[.]” 33 C.F.R. § 230.7(a).

51. The district commander is responsible for making the determination whether to prepare an EIS or a FONSI and for “keeping the public informed of the availability of the EA and FONSI.” 33 C.F.R. § 230.10.

52. CEQ’s “Forty Questions” Guidance strongly encourages circulation of a draft EA “where there is either scientific or public controversy over the proposal.” Coun. On Env’tl. Quality, Forty Most Asked Questions Concerning CEQ’s National Environmental Policy Act Regulations, 46 Fed. Ref. 18026 (Mar. 23, 1981), as amended (1986).

53. The district commander must prepare a record of decision “for the signature of the final decisionmaker[.]” 33 C.F.R. § 230.14.

54. CEQ regulations direct agencies to prepare a FONSI if the agency determines on the basis of the EA not to prepare an EIS, 40 C.F.R. § 1508.13, and, at a minimum, make the FONSI available to the affected public. 40 C.F.R. § 1506.6; 40 C.F.R. § 1501.4(e).

55. CEQ regulations require the agency to “[m]ake diligent efforts to involve the public in preparing and implementing [its] NEPA procedures” and “[p]rovide public notice of . . . the availability of environmental documents so as to inform those persons and agencies who may be interested or affected.” 40 C.F.R. § 1506.6(a), (b).

B. The Army Corps’ Regulatory Public Interest Review

56. The Corps’ public interest review applies to Clean Water Act Section 404 permits as well as Rivers and Harbors Act Section 10 Permits. 33 C.F.R. § 320.4.

57. During the public interest review, the Corps engages in “an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use” by “weighing . . . all . . . factors which become relevant in each particular case.” The Corps weighs the “benefits which reasonably may be expected to accrue from the proposal” against its “reasonably foreseeable detriments.” 33 C.F.R. § 320.4(a)(1).

58. The Corps’ decision “should reflect the national concern for both protection and utilization of important resources” and must include the consideration of “[a]ll factors which may be relevant to the proposal . . . including the cumulative effects thereof[.]” *Id.*

59. Among those relevant factors are “conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people.” *Id.*

C. Clean Air Act and Implementing Regulations

60. The Clean Air Act was enacted to, among other things, “protect and enhance the quality of the Nation’s air resources so as to promote the public health and welfare and the productive capacity of its population” and “to encourage and assist the development and operation of regional air pollution prevention control programs.” 42 U.S.C. § 7401(b)(1), (4).

61. To that end, the United States Environmental Protection Agency (“EPA”) has identified air pollutants “the emissions of which . . . cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare,” known as criteria pollutants. 42 U.S.C. § 7408(a)(1)(A).

62. For each of the criteria pollutants, EPA has promulgated primary and secondary ambient air quality standards which are requisite to protect the public health and welfare. 42 U.S.C. § 109; *see also* 40 C.F.R. Part 50.

63. The Clean Air Act requires states to adopt implementation plans, which “provide[] for implementation, maintenance, and enforcement of” the primary and secondary air quality standards promulgated by EPA. 42 U.S.C. § 7410; *see also* § 7407.

64. Under the Clean Air Act, the United States is divided into geographical air quality control regions, which may be designated as nonattainment (does not meet air quality standards), attainment (meets air quality standards), or unclassifiable. 42 U.S.C. § 7407(b), (d).

65. The Clean Air Act prohibits any “department, agency, or instrumentality of the Federal Government” from licensing, permitting, or approving “any activity which does not conform to an implementation plan” if the activity is to take place in a nonattainment area. 42 U.S.C. § 7506(c)(1), (5).

66. The head of the Federal “department, agency or instrumentality” is responsible for assuring that the activity conforms to the state implementation plan. *Id.*

67. “Conformity” means that the activity “conform[s] to an implementation plan’s purpose of eliminating or reducing the severity and number of violations of the national ambient air quality standards and achieving expeditious attainment of such standards” and that the activity will not “cause or contribute to any new violation of any standard in any area,” “increase the frequency or severity of any existing violation of any standard in any area,” or “delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.” 42 U.S.C. § 7506(c)(1)(A)–(B).

68. The EPA's regulations governing the conformity determination process are found at 40 C.F.R. §§ 93.150–93.165.

69. According to EPA regulations, a “Federal agency must make a determination that a Federal action conforms to the applicable implementation plan . . . before the action is taken.” 40 C.F.R. § 93.150(b).

70. A Federal agency must first engage in an applicability analysis to determine whether a conformity determination is required for the Federal action. 40 C.F.R. § 93.153(b).

71. “[A] conformity determination is required for each criteria pollutant or precursor where the total of direct and indirect emissions caused by a Federal action would equal or exceed” the rates specified in 40 C.F.R. § 93.153(b)(1) or (2). *Id.*

72. “Caused by . . . means emissions that would not otherwise occur in the absence of the Federal action.” 40 C.F.R. § 93.152.

73. “Direct emissions” are “those emissions of a criteria pollutant or its precursors that are caused or initiated by the Federal action and originate in a nonattainment or maintenance area and occur at the same time and place as the action and are reasonably foreseeable.” *Id.*

74. “Indirect emissions” are “those emissions of a criteria pollutant or its precursors: (1) That are caused or initiated by the Federal action and originate in the same nonattainment or maintenance area but occur at a different time or place as the action; (2) That are reasonably foreseeable; (3) That the agency can practically control; and (4) For which the agency has continuing program responsibility.” *Id.*

75. Continuing program responsibility “means a Federal agency has responsibility for emissions caused by: (1) Actions it takes itself; or (2) Actions of non-Federal entities that the Federal agency, in exercising its normal programs and authorities, approves, funds, licenses or

permits, provided the agency can impose conditions on any portion of the action that could affect the emissions.” *Id.*

76. If the applicability analysis reveals that a conformity determination is needed, the Federal agency must make a conformity determination and must provide public notice and allow for public comment. 40 C.F.R. §§ 93.154, 93.156(b).

FACTS GIVING RISE TO PLAINTIFF’S CLAIMS FOR RELIEF

A. Overview of the Dock 2 Project

77. DRP is a subsidiary of Fortress Transportation and Infrastructure Investors, LLC (“FTAI”), a company that invests across a number of major sectors within the transportation industry, including aviation, energy, intermodal transport and rail.

78. DRP is developing a site located at Block 8, Lots 1, 2, 3, 4, 4.01, and 4.02 in Greenwich Township, Gloucester County, New Jersey, commonly known as 200 North Repauno Avenue (the “Gibbstown Logistics Center”).

79. The Gibbstown Logistics Center is located on the site of a former DuPont facility, which was in use for over one hundred years for explosives manufacturing, anhydrous ammonia production, and the manufacturing of organic compounds.

80. DuPont’s operations ceased in 1986, and the site began remediation in 2002.

81. The subject of this Complaint is the proposed Dock 2 Project, a new marine terminal consisting of two loading platforms, eight breasting dolphins, eleven mooring dolphins, walkways to provide access between the loading platforms and dolphins, a trestle supporting a one-lane vehicular roadway with adjacent pedestrian access and an internal pipe system for the transfer of bulk liquid product, including LNG, and mechanical dredging in the Delaware River.

82. The LNG operations at the proposed Dock 2 Facility will involve the arrival of LNG by truck (approximately fifteen trucks per hour, twenty-four hours per day, seven days per week, carrying 12,000 gallons of LNG per truck based on information submitted to the Corps by DRP), and by railcar pursuant to a special permit from the United States Department of Transportation Pipeline and Hazardous Materials Safety Administration (“PHMSA”) (up to 100 railcars per day according to the PHMSA special permit conditions).

83. The LNG will be pumped directly from the truck or railcar into a LNG vessel docked at Dock 2. It will take approximately two weeks to fill each LNG vessel.

84. The plan is for LNG trucks to access the site via a new by-pass proposed by Gloucester County, which will divert the truck traffic from Route 44 and avoid residential areas of Gibbstown.

B. The Army Corps’ Approval of the Dock 1 Project

85. In a May 14, 2015 filing with the United States Securities and Exchange Commission describing its acquisition of the Gibbstown Logistics Center, FTAI stated that it “intend[s] to utilize the existing infrastructure for our development plans, including constructing refrigerated warehouses for perishable goods, building a dock and using remaining acreage for additional warehouse space, bulk storage and a liquid natural gas facility.”

86. In a July 24, 2016 Philadelphia Inquirer article, FTAI’s managing director was quoted as saying that an LNG facility was “no longer in [FTAI’s] designs[.]”

87. On March 7, 2017, the Army Corps issued a Public Notice regarding receipt of an application under Section 10 of the Rivers and Harbors Act, 33 U.S.C. § 403, and Section 404 of the Clean Water Act, 33 U.S.C. § 1344, submitted by DRP for “installing docking structures, performing dredging and installing 6 outfall structures” (the “Dock 1 Project”).

88. On November 16, 2017, in a Letter of Intent to the United States Coast Guard, Sector Delaware Bay, a consultant for DRP described the Gibbstown Logistics Center as a “multi-use, deep-water port and logistics center that may include a variety of separate uses including handling of imported and exported automobiles, other bulk freight and liquid energy products including, but not limited to liquefied petroleum gas (“LPG”) and liquefied natural gas (“LNG”).”

89. The November 16, 2017 Letter of Intent also stated that DRP would be seeking authorization from the United States Department of Energy “to export LNG to both Free Trade Agreement and Non-Free Trade Agreement countries[.]”

90. On December 8, 2017, pursuant to the Endangered Species Act Section 7 consultation requirement, 16 U.S.C. § 1536(a)(2), the National Marine Fisheries Service (“NMFS”), of the United States Department of Commerce’s National Oceanic and Atmospheric Administration issued a Biological Opinion concluding that construction of the Dock 1 project would not adversely affect the listed species shortnose and Atlantic sturgeon, sea turtles, and whales, and that it would not adversely affect Atlantic sturgeon critical habitat. The Biological Opinion also concluded that vessel traffic due to operation of the Dock 1 project would result in adverse effects to listed sturgeon, but concluded that the effect would not jeopardize their continued existence.

91. On December 21, 2017, the Army Corps issued a permit with special conditions to DRP for the construction of the Dock 1 Project.

C. The Army Corps’ Approval of the Dock 2 Project.

92. Over a year later, on March 6, 2019, the Corps received an Application for Individual Permit (“Application”) under Section 10 of the Rivers and Harbors Act, 33 U.S.C. § 403, and Section 404 of the Clean Water Act, 33 U.S.C. § 1344, submitted by DRP for the Dock 2 Project.

93. The Application described the project site as “Dock 2 at Gibbstown Logistics Center, Block 8, Lots 2, 3, 4.01, 4.02, Portions of Lot 4, Greenwich Township, Gloucester County, New Jersey.”

94. The Application describes the project purpose as: “to construct a dock and berths that will provide safe navigational access, mooring, and loading equipment for two vessels up to 173,400 cubic meters in capacity.”

95. The Dock 2 project is further described in the Application as “a deep-water facility for the export of bulk liquid products.”

96. The Application acknowledges that the Dock 2 project will require “[Department of Energy (“DOE”)] Part 590 Approval.”

97. The Natural Gas Act (“NGA”) prohibits the import or export of liquefied natural gas from or to a foreign country without prior approval from the DOE. 15 U.S.C. § 717b. Those who wish to import or export LNG must file for authorization pursuant to DOE regulations found in 10 C.F.R. Part 590.

98. On March 15, 2019, following an inquiry by DRN, the Corps asked DRP whether the Gibbstown Logistics Center would be considered an LNG facility.

99. On March 19, 2019, DRP’s consultant answered that the Gibbstown Logistics Center was not an LNG facility “within the meaning of the applicable regulations” because there “will be no on-site manufacturing or processing of liquefied natural gas . . . nor will LNG be transmitted by pipeline to or from the GLC. LNG will simply be transloaded from truck or rail car, through on-site infrastructure, and onto vessels for export.”

100. On April 4, 2019, the Corps issued a Public Notice No. CENAP-OR-R-2016-0181-39, which described the Application and solicited comments from the public.

101. The April 4, 2019 Notice stated that “[c]omments are used in the preparation of an Environmental Assessment and/or an Environmental Impact Statement pursuant to the National Environmental Policy Act.”

102. The April 4, 2019 Notice stated that “[t]he site will be designed to handle a multitude of products including butane, isobutane, propane, liquefied natural gas (LNG) and ethane, as well as a variety of other liquid products.”

103. On May 30, 2019, in a comment provided to the Army Corps, NMFS expressed a concern that the Dock 2 project was not included in the original Dock 1 permitting process, despite that the “applicant had intended from the outset of the development at this site to construct more than one wharf[.]” Accordingly, NMFS stated that “the full environmental effects of the total action at the site have not been fully evaluated and it appears that the project has been segmented in order to avoid the appearance of significance of the total action as part of the [NEPA] review.”

104. NMFS’s May 30, 2019 comment also stated that the Dock 2 project was a modification of the Dock 1 project, therefore consultation under the ESA needed to be re-initiated.

105. On June 14, 2019, DRN sent a letter to the Army Corps requesting that it re-open the public comment period for 90 days regarding the Dock 2 project.

106. DRN’s June 14, 2019 request was based on the April 4, 2019 Notice’s failure to include the fact that the Dock 2 project would allow the Gibbstown Logistics Center to export LNG.

107. On July 16, 2019, the Corps issued a Supplemental Public Notice regarding the Dock 2 project.

108. The Supplemental Public Notice was to “provide[] additional information not included in the original public notice and expand[] [the Corps’] discussion of the public interest

factors relevant to the Corps of Engineer review which will also be considered for preparation of an Environmental Assessment prepared under [NEPA].”

109. The Supplemental Public Notice stated that “[LNG] will not be processed or stored on the project site. This product will arrive at the proposed structure via truck or tanker railcar.”

110. The Supplemental Public Notice solicited additional public comment for a fifteen-day period.

111. During that additional public comment period, DRN commented that an EIS must be prepared by the Corps due to the magnitude of the impact the proposed LNG export operations would have on the human environment, including:

- a. Increased ship traffic and increased docking
- b. Storage of liquefied hazardous gas (“LHG”) on site
- c. Additional equipment and facilities on site
- d. Increased motor vehicle traffic, including trucks
- e. Increased rail traffic
- f. Impact of port construction
- g. Harm to marine fish and fisheries from both construction and operation
- h. Increased impermeable surfaces creating stormwater runoff
- i. Dredging activity in the Delaware River at a site with known contaminants
- j. Impact on submerged aquatic vegetation
- k. Impacts on endangered and threatened wildlife
- l. Impacts on state and federal protected critical wildlife habitats
- m. Development of a known contaminated site
- n. Impacts on the scenic and recreational values of the naturally-restored site

- o. Development within a floodplain
- p. Unique safety risks and dangers of LNG and LHG transport and handling
- q. Impacts of transporting LNG by motor vehicle from Pennsylvania to the facility
- r. Impacts of transporting LNG by railcar from Pennsylvania to the facility
- s. Impacts of ballast water releases from vessels
- t. Climate change impacts of exporting LNG, including onsite, downstream use, and upstream/induced production
- u. Air quality impacts of construction and operation
- v. Potential release of PCBs due to construction or operation of the site

112. DRN also highlighted in its comment that the Dock 2 project may require “approvals from the U.S. Coast Guard, the Federal Energy Regulatory Commission, the Pipeline and Hazardous Materials Safety Administration (PHMSA), U.S. Department of Transportation, and the Federal Railroad Administration.”

113. On August 19, 2019, the EPA’s Region 2 office submitted a comment to the Corps advising it that the Dock 2 project was “within the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE nonattainment area for the ozone National Ambient Air Quality Standards” and that the project must undergo a “general conformity applicability analysis” pursuant to 40 C.F.R. § 93.153.

114. On August 21, 2019, Energy Transport Solutions, LLC applied to PHMSA for a special permit to “authorize the transportation in commerce of methane, refrigerated liquid in DOT specification 113C120W tank cars” between Wyalusing, Pennsylvania, and Gibbstown, New Jersey.

115. On September 26, 2019, the Army Corps re-initiated consultation with NMFS because the Dock 2 project was a modification of the Dock 1 project. The Corps prepared a “Biological Assessment of Effects to Endangered Species Act Listed Species.”

116. On November 19, 2019, NMFS informed the Army Corps that “the effects of the currently proposed action are not likely to adversely affect any ESA-listed species or critical habitat under our jurisdiction” and that the Biological Opinion remains valid based on NMFS’s evaluation of the impacts of both Dock 1 and Dock 2, collectively.

117. On December 5, 2019, Energy Transport Solutions, LLC received a special permit from PHMSA authorizing “the transportation in commerce of methane, refrigerated liquid in DOT specification 113C120W tank cars.”

118. On February 28, 2020, the Army Corps issued a public notice stating: “Based on all available information, it is the determination of this office that the project is Not Contrary to the Public Interest, and as such, a Department of the Army permit has been issued to Delaware River Partners LLC for the work as proposed.”

119. The Army Corps’ February 28, 2020 Public Notice did not mention NEPA.

120. On March 5, 2020, in response to a Freedom of Information Act (“FOIA”), 5 U.S.C. § 552, request by DRN, the Army Corps produced a “Memorandum for Record” from CENAP-OP-R-2016-0181-39 titled “Department of the Army Environmental Assessment and Statement of Findings for the Above-Referenced Standard Individual Permit Application” (“Memorandum for Record”).

121. The Memorandum for Record was not “Approved by” Defendant Edward E. Bonner, District Engineer and Chief of the Regulatory Branch of the Army Corps Philadelphia District.

122. Mr. Bonner is the “final decisionmaker” as to the Dock 2 permit, as his signature was required to make the permit effective.

123. The Corps’ own NEPA regulations require Mr. Bonner’s signature on any record of decision under NEPA. 33 C.F.R. § 230.14.

124. As of the date of this filing, the Army Corps has not published a draft EIS, EA, or EA/FONSI, nor has it published a final EIS, EA, or EA/FONSI.

125. The Memorandum for Record contains the Corps’ public interest review.

126. In addressing “conservation,” the Corps stated that “[i]mpacts for resources outside the control of the Corps are being addressed by the appropriate state/Federal resource agency.”

127. In addressing “general environmental concerns,” the Corps stated that “[w]hile impacts will result from the development and operation of the facility, overall impacts on the environment will be mitigated with the inclusion of special conditions.”

128. In addressing “safety,” the Corps stated that “[t]he applicant has stated that all state and Federal regulations as required by law will be followed at the project site.”

129. In addressing the “needs and welfare of the people,” the Corps notes that “[a]s previously stated, petroleum products will be required [by] the world for years to come. As with all industrial sites, there [is] the potential for accidents that can affect the surrounding community. The applicant has stated that all safety measures as required by law will be followed at the project site.”

130. In addressing “climate change,” the Corps concluded that “[t]he proposed activities within the Corps federal control and responsibility likely will result in a negligible release of greenhouse gases into the atmosphere when compared to global greenhouse gases emissions.”

131. The Corps further stated that “authorized impacts to aquatic resources can result in either an increase or decrease in atmospheric greenhouse gas” and that those “impacts are considered de minimis.”

132. The Corps went on to admit that “[g]reenhouse gas emissions associated with the Corps federal action may also occur from the combustion of fossil fuels associated with the operation of construction equipment, increases in traffic, etc. The Corps has no authority to regulate emissions that result from the combustion of fossil fuels.”

133. However, the Memorandum for Record later states that “[t]he decision to issue this permit was partially based upon the proposal for truck traffic accessing the port via the Gloucester County Route 44 by-pass in order to minimize traffic impacts to the community. As such, trucks containing Liquefied Natural Gas or other liquid petroleum products shall not access the site other than from the by-pass. Should the development of the by-pass be delayed or abandoned, you shall contact this office and no work shall begin until this office has re-evaluated traffic impacts to the community.”

134. In the Memorandum for Record the Corps stated that the Dock 2 project “has been analyzed for conformity applicability” pursuant to the Clean Air Act and “[i]t has been determined that the activities proposed under this permit will not exceed de minimis levels of direct or indirect emissions of a criteria pollutant or its precursors.”

135. The Memorandum for Record goes on to say that “[a]ny later indirect emissions are generally not within the Corps’ continuing program responsibility and generally cannot be practicably controlled by the Corps.”

COUNT I: RELIEF SOUGHT PURSUANT TO THE ADMINISTRATIVE PROCEDURE ACT FOR VIOLATIONS OF THE NATIONAL ENVIRONMENTAL POLICY ACT

136. Plaintiffs hereby repeat and incorporate by reference all of the above allegations, set forth in paragraphs 1 through 135.

137. The Army Corps' action in issuing a permit for the Dock 2 Project without preparing an EA as required by NEPA and its implementing regulations is arbitrary and capricious, an abuse of discretion, and otherwise not in accordance with law.

138. NEPA requires that all agencies of the Federal government must prepare a "detailed statement" regarding all "major Federal actions significantly affecting the quality of the human environment," also known as an EIS. 42 U.S.C. § 4332(2)(C).

139. If an action is neither categorically excluded from NEPA nor is the type of action typically requiring an EIS, CEQ regulations direct the Federal agency to prepare an EA and to "involve environmental agencies, applicants, and the public, to the extent practicable, in preparing" the EA. 40 C.F.R. § 1501.4(b).

140. Corps regulations state that "regulatory actions," such as permits, are "[a]ctions normally requiring an EA, but not an EIS[.]" 33 C.F.R. § 230.7(a).

141. Thus, DRP's application for a permit to construct Dock 2 triggered the Corps regulation requiring an EA.

142. The district commander is responsible for making the determination whether to prepare an EIS or a FONSI and for "keeping the public informed of the availability of the EA and FONSI." 33 C.F.R. § 230.10.

143. CEQ's "Forty Questions" Guidance strongly encourages circulation of a draft EA "where there is either scientific or public controversy over the proposal." Coun. On Env'tl. Quality,

Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, 46 Fed. Reg. 18026 (Mar. 23, 1981), as amended (1986).

144. At no point during the permit process did the Corps make available a draft or final EA to the public, despite the considerable controversy surrounding this first LNG export facility proposed in the region, thus circumventing the requirements of NEPA.

145. The district commander must prepare a record of decision "for the signature of the final decisionmaker[.]" 33 C.F.R. § 230.14.

146. The final decisionmaker is District Engineer and Chief of the Regulatory Branch Edward E. Bonner, as his signature was required to make the Dock 2 permit effective.

147. Although the Corps' Memorandum for Record, which purportedly includes an EA/FONSI, has a signature line for Edward E. Bonner, his signature was not affixed to that document.

148. CEQ regulations direct agencies to prepare a FONSI if the agency determines on the basis of the EA not to prepare an EIS, 40 C.F.R. § 1508.13, and, at a minimum, make the FONSI available to the affected public. 40 C.F.R. § 1506.6; 40 C.F.R. § 1501.4(e).

149. The Memorandum for Record, purportedly including an EA/FONSI, was not made available to the affected public, and was obtained in its incomplete form via a FOIA request from DRN.

150. CEQ regulations require the agency to "[m]ake diligent efforts to involve the public in preparing and implementing [its] NEPA procedures" and "[p]rovide public notice of . . . the availability of environmental documents so as to inform those persons and agencies who may be interested or affected." 40 C.F.R. § 1506.6(a), (b).

151. Throughout the permit process, the Corps has failed to involve the public in preparing and implementing its NEPA procedures. NEPA was mentioned in the April 4, 2019 Public Notice and the July 16, 2019 Supplemental Public Notice, but a draft EA was never circulated, and when the permit was ultimately issued, the February 28, 2020 Public Notice made no mention of the outcome of the Corps' NEPA process.

152. The Corps' issuance of the permit, without engaging in a NEPA analysis, constitutes a final agency action reviewable by this Court under the APA. 5 U.S.C. § 704.

153. The Corps' issuance of the Dock 2 permit without following the procedures required by NEPA was arbitrary, capricious, an abuse of discretion, and not in accordance with law in violation of the APA. 5 U.S.C. § 706.

154. The Corps must re-initiate the NEPA process and circulate a draft EA for public comment, due to the highly controversial nature of this being the first LNG export facility in the region, which will be using trains (pursuant to a special permit) and trucks to bring LNG to the facility rather than pipelines.

155. Ultimately, the Corps should prepare an EIS that includes within its scope the environmental impacts of both the Dock 1 and Dock 2 facilities, as well as the environmental impacts of the scheme to transport LNG by truck and railcar from Pennsylvania to the Gibbstown Logistics Center for export. The Corps should also analyze the effects of upstream induced fracking and downstream consumption of LNG.

156. This Court should declare the Corps action to be arbitrary and capricious, an abuse of discretion, and not in accordance with law, and enjoin the effectiveness of the Dock 2 permit pending the Corps' full and complete compliance with NEPA.

**COUNT II: RELIEF SOUGHT PURSUANT TO THE ADMINISTRATIVE
PROCEDURE ACT DUE TO AN ARBITRARY AND CAPRICIOUS PUBLIC
INTEREST REVIEW**

157. Plaintiff hereby repeats and incorporates by reference all of the above allegations, set forth in paragraphs 1 through 156.

158. The Army Corps' action in issuing a permit for the Dock 2 Project was based on an inadequate, arbitrary, and capricious public interest review in violation of the APA.

159. The Corps' public interest review applies to Clean Water Act Section 404 permits as well as Rivers and Harbors Act Section 10 Permits. 33 C.F.R. § 320.4.

160. During the public interest review, the Corps engages in "an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use" by "weighing . . . all . . . factors which become relevant in each particular case." The Corps weighs the "benefits which reasonably may be expected to accrue from the proposal" against its "reasonably foreseeable detriments." 33 C.F.R. § 320.4(a)(1).

161. The Gibbstown Logistics Center's Dock 2 Facility will be the first LNG export facility in the region, utilizing a new method of transporting and transloading LNG by rail, and increasing the demand for fracked gas in the region.

162. The Corps acknowledged in its Memorandum for Record that although it knows that approximately fifteen trucks carrying LNG will enter the Gibbstown Logistics Center per hour, the incoming volume of railcars carrying LNG was never provided to the Corps by DRP.

163. The Corps acknowledged in its Memorandum for Record that greenhouse gases will be emitted from construction activities and traffic at the Dock 2 Facility, but states that the Corps does not have the authority to regulate these emissions.

164. At the same time, the Corps has chosen to condition the Dock 2 permit on the construction and utilization of the Gloucester County by-pass, which is based on off-site traffic concerns, without explaining why this area of regulation is not beyond the Corps' purview.

165. Even if the Corps' assertion that it cannot control emissions was correct, the Corps' public interest review is not limited to factors that are within its direct regulatory control, as those factors include "conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people." 33 C.F.R. § 320.4(a)(1).

166. The Corps' decision "should reflect the national concern for both protection and utilization of important resources" and must include the consideration of "[a]ll factors which may be relevant to the proposal . . . including the cumulative effects thereof[.]" Id.

167. Accordingly, the Corps arbitrarily and capriciously refused to consider the foreseeable greenhouse gas emissions that would result from the construction and operation of the Dock 2 Facility.

168. The Corps should not have issued the Dock 2 permit without first obtaining all necessary information from DRP to determine the amount of greenhouse gases that will be emitted by the Dock 2 Facility, both through its construction and operation, and through upstream induced fracking and downstream combustion of natural gas.

169. By considering only the benefits of LNG export and refusing to acknowledge its detrimental effects, the Corps has abdicated its responsibility to holistically determine whether the Dock 2 Project is contrary to the public interest.

170. The Corps' issuance of the permit, without completing a comprehensive public interest review, constitutes a final agency action reviewable by this Court under the APA. 5 U.S.C. § 704.

171. The Corps' issuance of the Dock 2 permit without completing a comprehensive public interest review was arbitrary, capricious, an abuse of discretion, and not in accordance with law in violation of the APA. 5 U.S.C. § 706(2).

172. This Court should declare the Corps action to be arbitrary and capricious, an abuse of discretion, and not in accordance with law, and enjoin the effectiveness of the Dock 2 permit pending the Corps' full and complete public interest review of the proposed project.

**COUNT III: RELIEF SOUGHT PURSUANT TO THE ADMINISTRATIVE
PROCEDURE ACT FOR VIOLATIONS OF THE CLEAN AIR ACT**

173. Plaintiff hereby repeats and incorporates by reference all of the above allegations, set forth in paragraphs 1 through 172.

174. The Army Corps' action in issuing a permit for the Dock 2 project without complying with relevant federal and state law regarding the control of air pollution for the Dock 2 project is arbitrary and capricious, an abuse of discretion, and otherwise not in accordance with law.

175. The Clean Air Act prohibits a Federal agency from licensing, permitting, or approving any activity that does not conform to a state's implementation plan if the activity is to take place in a nonattainment area. 42 U.S.C. § 7506(c)(1), (5).

176. The Dock 2 project is to take place in the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE nonattainment area for the ozone National Ambient Air Quality Standards.

177. In its Memorandum for Record, the Army Corps arbitrarily and capriciously concluded that emissions from the Dock 2 project would be de minimis, without identifying the sources of the emissions, the pollutants or precursors to be emitted, or the quantities of emissions.

178. The Corps further stated that indirect emissions resulting from the Dock 2 facility are not within the Corps' control, which was an arbitrary and capricious conclusion and directly contrary to the EPA's regulatory definition of "indirect emissions." 40 C.F.R. § 93.152.

179. That the Corps has chosen to exercise control over the traffic flow into the Gibbstown Logistics Center as a condition of the Dock 2 permit is directly contrary to its assertion that it cannot control emissions from the Dock 2 facility, thus, the assertion is arbitrary, capricious, and not in accordance with the Clean Air Act and its implementing regulations.

180. The Army Corps is in violation of the APA because it has violated the Clean Air Act and state law by issuing the Dock 2 permit without having conducted an applicability analysis to determine whether a conformity determination is necessary.

181. The Corps' issuance of the permit, without a valid applicability analysis, constitutes a final agency action reviewable by this Court under the APA. 5 U.S.C. § 704.

182. The Corps must re-initiate the applicability analysis as required by 40 C.F.R. § 93.153, and quantify the amount of direct and indirect emissions to be caused by the Dock 2 facility in order to determine if they will exceed the rates listed in 40 C.F.R. § 93.153(b)(1) and (2).

183. This Court should declare the Corps action to be arbitrary and capricious, an abuse of discretion, and not in accordance with law, and enjoin the effectiveness of the Dock 2 permit pending the Corps' full and complete compliance with the Clean Air Act.

PRAYER FOR RELIEF

WHEREFORE, Plaintiffs pray for relief as follows:

1. For a declaratory judgment that, pursuant to the Administrative Procedure Act, the Army Corps' action of issuing the Dock 2 Permit is arbitrary and capricious, and not in accordance with law. The declaration is warranted and should further declare:
 - a. Under NEPA, the Defendants failed to follow its procedures by failing to involve the public in the drafting of an EA, and failed to provide a record of decision; therefore, the Dock 2 Permit is vacated and remanded to the Corps so that it may comply with NEPA prior to granting or denying DRP's permit application.
 - b. Under the Corps' own public interest review regulations, Defendants' decision that the Dock 2 Project was not contrary to the public interest was arbitrary, capricious, and an abuse of discretion because it failed to account for the detrimental effects of greenhouse gas emissions and safety risks associated with the Dock 2 Project; therefore, the Dock 2 Permit is vacated and remanded to the Corps so that it may engage in a comprehensive public interest review prior to granting or denying DRP's permit application.
 - c. Under the Clean Air Act, the Defendants improperly limited the scope of emissions to be included in its applicability analysis thereby avoiding the requirement to engage in a conformity determination as required by 42 U.S.C. § 7506; therefore, the Dock 2 Permit is vacated and remanded to the Corps so that the agency may perform an applicability analysis that includes all direct and indirect emissions of pollutants caused by the Dock 2 Project, prior to granting or denying DRP's permit application.

2. For a preliminary and permanent order enjoining the effectiveness of the Dock 2 Permit pending full and complete compliance with:
 - a. Administrative Procedure Act, 5 U.S.C. §§ 701–706.
 - b. National Environmental Policy Act, 42 U.S.C. §§ 4321–4370h.
 - c. Public Interest Review Regulations, 33 C.F.R. § 320.4(a); and
 - d. Clean Air Act, 42 U.S.C. §§ 7401–7671q.
3. For this Court to retain continuing jurisdiction to review Defendants’ compliance with all judgments and orders entered herein;
4. For an award of Plaintiffs’ costs of litigation, including reasonable attorney’s fees; and
5. For such other and further relief as the Court may deem just and proper to effectuate a complete resolution of the legal disputes between Plaintiffs and Defendants.

Respectfully Submitted,

s/ Kacy C. Manahan
Kacy C. Manahan, Esq.
Delaware Riverkeeper Network
925 Canal Street #3701
Bristol, PA 19007
215-369-1188 x115
kacy@delawariverkeeper.org

*Attorney for Plaintiffs Delaware
Riverkeeper Network and Maya van
Rossum, the Delaware Riverkeeper*

DATE: April 22, 2020

Exhibit E



June 14, 2019

Lieutenant Colonel Kristen Dahle, Commander
Mike Hayduk, Chief, Application Section II &
District Engineer

US Army Corps of Engineers Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Submitted via email to Lawrence Slavitter lawrence.m.slavitter@usace.army.mil

Re: CENAP-OP-R-2016-0181-39 -- Gibbstown Logistics Center port expansion.

To Whom It May Concern,

The Delaware Riverkeeper Network requests that you formally re-open the comment period on CENAP-OP-R-2016-0181-39 for expansion of the Gibbstown Logistics Center port. Critical information has come to light about the intended use of this expansion to support Liquefied Natural Gas (LNG) exports. These important facts were not properly disclosed to the public with sufficient clarity or detail to support informed public comment, nor were they meaningfully considered by the US Army Corps of Engineers in the public notice or project materials in a way that could/would support informed and meaningful public comment or Army Corps decision-making. As a result, the public has been denied a full and fair opportunity to comment on this proposal. In addition, there has been a failure to fulfill your obligations for review pursuant to the National Environmental Policy Act, critical for Army Corps decision-making and informed public comment. Therefore, we request that full disclosure of the LNG aspects of the proposal be released to the public, including the environmental, port, and public safety consequences, and thereafter a 90-day public comment period be provided.

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
dm@delawareriverkeeper.org
www.delawareriverkeeper.org

The Army Corps Will Violate Federal Law If It Approves the Gibbstown Logistics Center Proposal.

The US Army Corps of Engineers (Army Corps) has not fulfilled its legal obligations pursuant to the National Environmental Policy Act (NEPA). The Army Corps has not undertaken the necessary reviews or made the public disclosures required by NEPA. Issuing an Army Corps approval for the Gibbstown Logistics Center (CENAP-OP-R-2016-0181-39), which now undeniably includes an LNG export operation, would be a violation of federal law that will be subject to legal challenge.

NEPA is our “basic national charter for protection of the environment.”¹ NEPA makes environmental protection a part of the mandate of every federal agency² by requiring that federal agencies take environmental considerations into account in their decision-making “to the fullest extent possible.”³ Pursuant to NEPA federal agencies must consider environmental harms and the means of preventing them in a “detailed statement” before approving any “major federal action significantly affecting the quality of the human environment.”⁴ This required analysis serves to ensure that “the agency will not act on incomplete information, only to regret its decision after it is too late to correct.”⁵ Approval of the LNG export facility proposed definitely meets the standard of requiring NEPA review.

A. Army Corps Has Failed to Provide Proper Public Disclosure.

In addition to fulfilling its overall legal obligation to provide a full and fair opportunity for public comment, including providing full information on the actual project being proposed, there is an obligation on the Army Corps for full disclosure and an engaged public process pursuant to NEPA.

NEPA “guarantees that the relevant information [concerning environmental impacts] will be made available to the larger audience,” including the public, “that may also play a role in the decision-making process and the implementation of the decision.”⁶ As NEPA’s implementing regulations explicitly provide, “public scrutiny [is] essential to implementing NEPA.”⁷ The opportunity for public participation guaranteed by NEPA ensures that agencies will not take final action until after their analysis of the environmental impacts of their proposed actions has been subject to public scrutiny.⁸

NEPA is an “environmental full disclosure law.”⁹ It requires that an agency obtain and consider detailed information concerning environmental impacts, and it “ensures that an agency will not act on incomplete information, at least in part, by ensuring that the public will be able to analyze and comment on an action’s environmental implications.”¹⁰ The information provided to the public “must

¹ 40 C.F.R. § 1500.1(a).

² See 42 U.S.C. § 4332(1).

³ 42 U.S.C. § 4332.

⁴ Id. § 4332(2)(C).

⁵ *Marsh v. Oregon Natural Res. Council*, 490 U.S. 360, 371 (1979).

⁶ *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989).

⁷ 40 C.F.R. § 1500.1(b).

⁸ See *N. Plains Res. Council v. Surface Transp. Bd.*, 668 F.3d 1067, 1085 (9th Cir. 2011) (noting that where “data is not available during the EIS process and is not available to the public for comment,” the process “cannot serve its larger informational role, and the public is deprived of their opportunity to play a role in the decision-making process”) (quoting *Robertson*, 490 U.S. at 349).

⁹ *Monroe Cnty. Conservation Council, Inc. v. Volpe*, 472 F.2d 693, 697 (2d Cir. 1972).

¹⁰ *Ohio Valley Env'tl. Coal. v. U.S. Army Corps of Eng'rs*, 674 F. Supp. 2d 783, 792 (S.D. W. Va. 2009) (internal quotation marks and citations omitted).

be of high quality” because “[a]ccurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA.”¹¹

The Army Corps did not fully or fairly disclose the intended use of the proposed Gibbstown Logistics Center expansion to support LNG exports, including bringing LNG to the site via truck and/or rail. These important facts were not properly disclosed to the public with sufficient clarity or detail to support informed public comment, nor were they meaningfully considered by the Army Corps in the public notice or project materials in a way that could/would support informed and meaningful public comment or agency decisionmaking. As a result, the public has been denied a full and fair opportunity to comment on this proposal as anticipated by NEPA.

The fact that the Army Corps, on page 3 of the public notice for comment, mentions that the “site will be designed to handle a multitude of products” amongst them being LNG does not provide full and fair public notification when you look at the notice as a whole and when you look across the board at the discussion by the agencies and file materials Delaware Riverkeeper Network secured through legal information requests. The Army Corps may have made a passing reference to LNG in its April 4, 2019 public notice and call for comment but that passing mention cannot be said to rise to the level of being clear about what is being proposed for the site – the notice merely states that the “site will be designed to handle a multitude of products” and lists several items with LNG being part of the list. This reference does not make clear to the public that LNG exports is an intended and primary focus of the new expansion, nor does it give any detail about the volumes of LNG being proposed, the thousands of truck trips that will be required to bring the gas to the site, the level of rail traffic that will be required, the source of the gas and the implications of its extraction, to what degree there will be onsite storage and increased shipping traffic, etc. In addition, given that dearth of information about the LNG export goal, plan and/or impacts in the documents we secured via FOIA, as well as the lack of NEPA documentation and analysis, the public notice cannot be said to rise to the level of full and fair public notice of the proposal; rather, it is a clear and obvious obfuscation.

B. The Army Corps Did Not Assess nor Disclose to Any Meaningful Degree, the Environmental, Safety, Community, Economic or Port Impacts.

A proper NEPA assessment must fully assess and disclose the complete range of environmental consequences of the proposed action, including “ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, [and] cultural” impacts, “whether direct, indirect, or cumulative.”¹² Direct effects are “caused by the action and occur at the same time and place.”¹³ Indirect effects are those impacts that are caused by the action, but occur “later in time or farther removed in distance, but are still reasonably foreseeable,” and may include “growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.”¹⁴ Cumulative impacts are “impact[s] on the environment which result[] from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes

¹¹ 40 C.F.R. § 1500.1(b).

¹² 40 C.F.R. §§ 1502.16(a), (b); 1508.8.

¹³ 40 C.F.R. § 1508.8(a).

¹⁴ 40 C.F.R. § 1508.8.

such other actions.”¹⁵ NEPA also prohibits segmentation in order to avoid full and fair review of the implications and impacts of a project or action.

LNG has significant ramifications environmentally, for public safety, and for shipping on the Delaware River system. There is no discussion or analysis of any of these issues, including but not limited to: the safety, pollution and health implications of trucking (anticipated to at least triple; the anticipated truck traffic created by the LNG facility for the local community has the likely potential of being quite massive given that the LNG will be transferred to the ships via a truck rack that is being designed to handle 200 to 220 trucks per day) and railing in the significant volumes of LNG anticipated for the site (1.5 million metric tonnes per year); the ramifications of storing LNG on a ship while it is slowly loaded over a period of at least 15 days; what LNG exports from Gibbstown means for shipping, ship traffic and the business operations of other shippers operating through Delaware River ports; the climate change and other environmental impacts of exporting LNG from this site including the onsite impacts, but also the ramifications from the gas extraction activities that will be induced/supported by this operation and the downstream impacts from the use of the gas; the safety ramifications of having an LNG operation of this kind on the Delaware River including for the surrounding community; the implications for other shippers and port operations (there is anticipated to be 2 LNG export operations a month – 24 a year – from this site); the impacts on the endangered Atlantic and Shortnose Sturgeon or the designated Atlantic Sturgeon Critical Habitat in the River; the water quality ramifications due to the release of ballast water from LNG ships; the air and other ramifications of flaring off of gas and/or the construction and operation of a small capacity liquefier on site; just to name a few.

It is notable that in a November 16, 2017 letter to the US Coast Guard, Delaware River Partners notes the limitations caused by having just a single-berth at this site while also accommodating an LNG operation there – i.e. that “LNG, LHG, or other hazardous or non-hazardous cargo operations will not run concurrently, as the single-berth wharf only permits one vessel to dock at a given time for a single commodity.” Clearly, the applicant and the agencies knew that LNG was an intended goal of this project whether it was a single-berth or two-berth design and so there is no excuse not to have considered the impacts that constructing and operating an LNG export facility at this site (including the delivery of LNG by rail and truck) during review of stage 1 as well as the current stage 2 of this project and there is no excuse for not having notified the public of this intended use in the Army Corps’ April 4, 2019 public notice.

In addition to the failure to consider the environmental, safety, economic, and port ramifications of the proposed LNG operation at the site, there has also been a failure to consider the proposed Liquefied Hazardous Gas (LHG) Handling facility proposed for the site. According to the November 2017 letter to the Coast Guard the LHG operation is anticipated to include 24 vessels a year (2 a month) at the site creating additional potential pressures for Delaware River port traffic, particularly when considered along with the anticipated 24 vessels a year of LNG. In addition, there will be constructed ~100,000 BBL of onsite storage, with the vessels also being used for storage in order to increase the onsite storage capacity. LHG will be brought to the site via rail car, the environmental and safety ramifications of which have also not been analyzed. The project includes ~3 acres of tanks and associated equipment as additional project elements. This information also required full analysis

¹⁵ 40 C.F.R. § 1508.7 (emphasis added).

by the Army Corps, particularly the ramifications of having both the proposed LNG and LHG at the same location.

C. The Current Proposal is a Clear Case of Illegal Segmentation.

NEPA prohibits segmentation of projects for purposes of NEPA review. As stated by the DC Circuit in *Delaware Riverkeeper Network, et al. v. Federal Energy Regulatory Commission*, 753 F.3d 1304, 1307 (D.C. Cir. 2014):

“An agency impermissibly “segments” NEPA review when it divides connected, cumulative, or similar federal actions into separate projects and thereby fails to address the true scope and impact of the activities that should be under consideration. The justification for the rule against segmentation is obvious: it “prevent[s] agencies from dividing one project into multiple individual actions each of which individually has an insignificant environmental impact, but which collectively have a substantial impact.” *NRDC v. Hodel*, 865 F.2d 288, 297 (D.C. Cir. 1988)” The rule against segmentation requires the federal agency, in this case, to consider all connected and cumulative actions.”

It has now become clear to the Delaware Riverkeeper Network that the prohibition against segmentation has in fact been violated. Not only was the expansion of the facility reasonably foreseeable, but it now appears that this expansion was planned all along and that expansion was documented by the company.

- In a July 24, 2016 Philadelphia Inquirer news article, the company admits that it had envisioned LNG for this site: “Although a company prospectus last year envisioned a liquefied natural gas (LNG) facility at Repauno - disconcerting some residents and environmental groups such as the Sierra Club and the Delaware Riverkeeper – ‘that is no longer in our designs,’ Lewis said.” As a result, having an LNG operation at this site was clearly considered and therefore it was reasonably foreseeable that LNG would become a serious component of this operation at some point. It now seems obvious that while Delaware River Partners removed the LNG prospect from its application materials in 2016, it had every intention to restore that component of the project at a future date, and simply removed it to lighten the level of agency and public scrutiny and review that would be given to the project during the reviews that were taking place for stage 1 of the Gibbstown Logistics Center.
- A November 16, 2017 Letter of Intent was submitted to the US Coast Guard specifically describing the project as being an LNG facility. This letter was sent to the US Coast Guard before the Army Corps issued its approval for stage 1 of this project on December 21, 2017. And so, it is clear that Delaware River Partners knew, and the Army Corps should have known, that the ultimate goal of the project was to build an LNG facility at this site. The letter to the Coast Guard has significant detail, including the anticipated export capacity of the site (1.5 million metric tonnes). The failure to consider the full project, including the LNG component, is a clear case of segmentation in violation of federal law. It is clear, should have been clear to the Army Corps, and would have been clear to the Army Corps had it done its NEPA due diligence, that the two stages of the project were and are interdependent and are clearly two parts of the same whole. There is a clear violation of the prohibition against segmentation that has taken place/is taking place at this site.

- There is clearly a foreseeable expansion of the facility to accommodate additional LNG capacity in the future (i.e. a state 3 of the project) given that the November letter to the Coast Guard describes the current project as “proposing an LNG facility with an initial capacity of up to approximately 1.5 million MTPA of LNG (roughly 1,670,000 BBL per month).” The descriptive language of “initial capacity” makes clear that more LNG exports are to come, that there will be additional expansions, and that such expansions need consideration as part of this current project in order to avoid additional segmentation violations.

Further, NEPA requires consideration of all reasonably foreseeable impacts resulting from a proposed action, activity or project. The facts above make clear that the LNG component has always been reasonably foreseeable.

D. A Full Environmental Impact Statement Is Clearly Mandated.

Authorizing the Gibbstown Logistics Center to export LNG and to construct and operate LNG export facilities demands an Environmental Impact Statement (EIS) pursuant to NEPA because this project will clearly have significant effects on the human environment. Unquestionably, construction and operation of the export facilities, including the transportation of the liquified natural gas (LNG) to the site via truck and rail will have significant effects that trigger the mandate for a full NEPA EIS. In addition, there will be upstream and downstream impacts with respect to the extraction and use of the source fracked gas that are related and reasonably foreseeable actions which must be considered. Export of LNG will induce additional shale gas extraction/production in upstream regions, result in increased downstream uses, increased domestic gas prices, and increased greenhouse gas emissions and global warming. Each of these effects has direct importance to the Army Corps’ consideration of the Gibbstown Logistics port expansion proposal which includes LNG export as a significant, if not primary, goal of the project.

LNG operations pose specific and adverse risks to surrounding neighborhoods as well as the local, regional and national environment. The inclusion of LNG operations is a significant aspect of the Gibbstown Logistics Center expansion that must receive full NEPA EIS review. Further, the Applicant has already segmented its operations at Gibbstown into different projects, even though they all support each other. Continuing to permit such segmentation masks the environmental and health harms of Delaware River Partners’ operations as a whole. The proposal to truck/rail in the LNG along with long offloading times resulting in at least 15 days of storage on vessels raises additional impacts that need to be assessed and addressed, in addition to the environmental (including climate change) and health consequences at the point of gas extraction and as the result of downstream use. There are also implications for port traffic along the Delaware River in need of meaningful consideration and review.

The Delaware Riverkeeper Network (DRN) has been reviewing documents from multiple agencies regarding this Gibbstown Logistics Center expansion. Delaware Riverkeeper Network has conducted file reviews, secured and reviewed documents via the Freedom of Information Act and state right to know laws. At no point did the Delaware Riverkeeper Network see documents in the file that even resembled the necessary review pursuant to NEPA – neither an Environmental Assessment nor an Environmental Impact Statement—of the LNG export proposal being advanced here. And certainly, there has been no NEPA public comment process that would allow the public to assess and/or comment upon such an analysis.

As noted throughout this letter, there are a wealth of environmental and public impacts that need to be fully assessed pursuant to NEPA. Issues that need to be considered in a NEPA EIS include, but are not limited to:

- The safety, pollution and health implications of truck and rail traffic necessary to support the LNG (and LHG) operations proposed for the site. It is anticipated that truck traffic will at least triple over current levels as a result of the LNG export portion of the proposal. Truck racks that will be used to transfer the LNG from truck to ship will be designed to accommodate 200 to 220 trucks per day; a clear indication of the massive volume of truck traffic that will be created by the proposed LNG operations at the site. This will result in tremendous air pollution, noise pollution, property value, quality of life, traffic impact and traffic safety concerns that must be assessed. LNG volumes anticipated for the site are 1.5 million metric tonnes per year. It is anticipated that offloading from truck to rail will take 15 days. There will clearly be a massive uptick in the volume of truck traffic that this LNG facility will induce.
- The ramifications, particularly safety ramifications, of storing LNG on a ship while it is slowly loaded over a period of at least 15 day.
- The ramifications of the proposed LNG exports for shipping, ship traffic and the business operations of other shippers operating through Delaware River ports as well as for endangered populations such as the Delaware River Atlantic Sturgeon that are being severely impacted by ship strikes along the Delaware. Given that there are less than 300 spawning adults left of the Delaware River's genetically unique population of Atlantic Sturgeon, the ramifications of increased ship traffic and ship strikes is serious and potentially catastrophic.
- The onsite environmental impacts of exporting LNG from this site.
- The upstream climate and environmental ramifications of the gas extraction activities that will be induced/supported by this operation. Increased shale gas extraction, including drilling and fracking, is a related, connected and foreseeable outcome of the proposed Gibbstown LNG facility given that the facility is intended to secure and support increased shale gas development in order to supply the facility with shale gas for export. As such, NEPA requires consideration of the environmental and community impacts of shale gas development that will result in order to supply the Gibbstown LNG facility. Shale gas development is an extraordinarily land and water-intensive process that converts agricultural, forest, and range lands to industrial uses, consumes millions of gallons of water per well, and generates huge quantities of hazardous wastes, and results in tremendous and harmful volumes of climate changing emissions as well as the release of other hazardous air pollutants.¹⁶

¹⁶ Shale gas extraction is also a significant source of hazardous air pollution, including methane, volatile organic chemicals (VOCs), and air toxics such as benzene and ethylbenzene. In July 2011, EPA proposed a suite of draft regulations under the Clean Air Act to set new source performance standards for VOCs and sulfur dioxide, an air toxics standard for oil and natural gas production, and an air toxics standard for natural gas transmission and storage. Final regulations are due by April 3, 2012. See <http://www.epa.gov/airquality/oilandgas/> The Department of Energy's advisory panel on shale gas has urged EPA to extend these rules to existing shale gas production sources and to adopt regulations addressing methane explicitly. Bridget DiCosmo, "DOE Panel Urges EPA to Strengthen Proposed Air Rules for 'Fracking,'" Nov. 10, 2010, <http://insideepa.com/201111102381935/EPA-Daily-News/Daily-News/doe-panel-urges-epa-to-strengthen-proposed-air-rules-for-fracking/menu-id-95.html> Methane is twenty times more potent a greenhouse gas than carbon dioxide. See <http://www.climate-science.gov/infosheets/highlight1/default.htm>

The oil and gas industry is the single largest source of methane emissions in the US, accounting for nearly 40% of national methane emissions. See <http://epa.gov/airquality/oilandgas/pdfs/20110728factsheet.pdf>

- The downstream environmental and climate impacts from the use of the gas to be exported.
- The safety ramifications of having an LNG operation of this kind on the Delaware River including for the surrounding community.
- The implications for other shippers and port operations that will result from the LNG export use of the site at a rate of 2 LNG export vessels a month / 24 a year.
- The impacts on the endangered Atlantic and Shortnose Sturgeon and the designated Atlantic Sturgeon Critical Habitat that will be impacted. The Delaware River population of Atlantic Sturgeon is genetically unique with a surviving population that includes less than 300 spawning adults.¹⁷ With numbers this precariously low, the responsibility for vigilant protection by our federal agencies could not be greater. The Delaware River population of Atlantic Sturgeon, along with the entire NY Bight Distinct Population Segment (DPS), of which the Delaware River population is a part, are designated as endangered pursuant to the Endangered Species Act. In addition, the Delaware River’s population of Shortnose Sturgeon is also listed as federally endangered and suffers low population figures.
- The water quality ramifications due to the release of ballast water from LNG ships. The “... discharge of ballast water and sediment from ships during LNG terminal loading operations may result in the introduction of invasive aquatic species.”¹⁸
- The water quality ramifications due to dredging and the potential resuspension/reintroduction from CDF discharges of contaminants to the Delaware River, including PCBs. CDFs holding dredged sediments from Delaware River dredging projects have been a demonstrated source of toxic contamination to the River, inflicting serious water quality impacts.
- The air and other ramifications of flaring off of gas and/or the construction and operation of a small capacity liquefier on site as discussed in a letter sent on November 16, 2017 to the US Coast Guard.
- Releases, spills or leaks during storage, transfer and/or transport of LNG.¹⁹
- Risk of accidents, incidents, fire or explosion during transport storage and/or transfer of LNG.²⁰ While it is asserted there will be no onsite storage of LNG, the process of loading each ship will take on the order of 15 days—this translates into 15 days of storage on the vessel while loading operations are taking place. The potential safety implications need to be examined and disclosed. “Natural gas is combustible, so an uncontrolled release of LNG poses a serious hazard of explosion or fire.”²¹ The greatest LNG hazards include pool fires, flammable vapor clouds and flameless explosion.²²
 - A pool fire occurs if LNG spills near an ignition source and in fact ignites, “the evaporating gas in a combustible gas-air concentration” burns above the LNG pool, and then proceeds

¹⁷ ASSRT (Atlantic Sturgeon Status Review Team) 2007. Status Review of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

¹⁸ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

¹⁹ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

²⁰ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

²¹ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²² CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

to spread as the LNG pool expands away from its source and continues evaporating.²³ Pool fires are intense and will burn more hotly and rapidly than oil or gasoline.²⁴ Pool fires cannot be extinguished – “all the LNG must be consumed before they go out.”²⁵

- Flammable vapor clouds happen if there is an LNG spill that does not immediately ignite and instead evaporates forming a vapor cloud.²⁶ Vapor clouds can drift a distance from the site of the spill.²⁷ If the vapor cloud encounters an ignition source then “those portions of the cloud with a combustible gas-air concentration will burn.”²⁸ While a vapor cloud is not toxic, it can displace breathable air and as a result cause asphyxiation.²⁹ Extremely cold LNG can injure through direct contact.³⁰ It has been said that “environmental damage associated with an LNG spill would be confined to fire and freezing impacts near the spill since LNG dissipates completely and leaves no residue.”³¹
- “LNG spilled directly onto a warm surface (such as water) could result in a sudden phase change known as a Rapid Phase Transition (RPT).”³² “If LNG spills on water, it could theoretically heat up and regasify almost instantly in a ‘flameless explosion’.”³³

- Given the site’s history of industrial operations, the known contamination that has and still does exist on the site, and its superfund status, there is a need to consider the potential synergy of harm that could occur if there was a catastrophic release at the site. Known contaminants of concern at the site include: nitrobenzene, aniline and mixed acids, sodium nitrite and nitrosylsulfuric acid.
- The entire site is in the flood hazard area. What are the implications of a flood for the LNG operations and LHG operations if there were a flood during transfer operations or storage onsite? With climate changing increasing the frequency, duration and magnitude of floods, this is an obvious and serious consideration. The ramifications of catastrophic flooding due to climate change is compounded by the known flood and safety ramifications of storm surge in the Delaware Estuary.
- The Gibbstown Logistics Center is located next to a residential area. There is a day care center and housing in Gibbstown adjacent to the Block and Lot of this site. These residential and day

²³ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁴ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁵ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁶ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁷ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁸ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

²⁹ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

³⁰ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

³¹ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

³² IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

³³ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

care uses are not compatible with an LNG export operation. The safety issues of the trucking, rail transport, storage, and transfer of LNG is dangerous if there is an accident or incident, and is in need of careful consideration.

- The economic ramifications of the proposed LNG export. By causing an increase in shale gas prices here in the U.S., there is widespread concern that the export of shale gas to foreign countries will adversely impact a number of other industries and the economic benefits and jobs they provide.³⁴
- LNG infrastructure can be vulnerable to terrorist attack.³⁵ This threat needs serious consideration. While, according to a report prepared for Congress in 2003, it was reported that “No LNG tanker or land-based LNG facility has been attacked by terrorists ... similar natural gas and oil facilities have been favored terror targets internationally.”³⁶ Among the catastrophic events that can result from an accident or attack at an LNG facility are pool or vapor cloud fires.³⁷
- EPA identified the Repauno site in 2003 as one of the largest PCB point sources in the Delaware Estuary (among the top 10). Additional dredging, site disturbance and stormwater systems will disturb PCBs, which have been found in near-shore sediments and in runoff from the site. There is a zone of highly contaminated sediments immediately adjacent to the shore and port facility. The remobilization (and dewatering of dredged sediments) will create re-release of PCBs into the estuary, including in Atlantic Sturgeon spawning habitats. The ramifications for the reintroduction of PCBs into the environment needs careful assessment. Given that there is a reasonably foreseeable future expansion at this site to accommodate increased LNG operations, there needs to be consideration of this expansion for issues such as PCBs and other environmental effects.
- The job impacts of the proposal are in need of consideration and public disclosure. LNG exports, while creating some jobs in the gas industry, many temporary, creates a net job loss effect for the country. In fact, LNG exports could result in the net loss of as many as 270,000 jobs per year in our country.³⁸ The job implications must be assessed

The Army Corps is in clear violation of NEPA if it grants any approvals for the Gibbstown Logistics Center CENAP-OP-R-2016-0181-39 at this time. In addition, the Army Corps is in violation of its legal and moral obligations to ensure the public is fully aware, and given full opportunity to comment upon, the proposal to place an LNG export facility in the heart of our Delaware River community so close to residential communities, including vulnerable populations such as children. We urge and request that you take a step back; that you provide full and accurate information to the public about this project, including the LNG exports; and that you give the public a full 90 days to review and comment once that information has been released. We also urge that you fully comply with NEPA, and that means undertaking a full EIS review, including associated public comment.

³⁴ [Unanswered Questions About the Economic Impact of Shale Gas Exports: Don't Jump to Conclusions. Comments on NERA Study](#), prepared by Jannette M. Barth, Ph.D., Economist, Pepacton Institute LLC, Dec 11,2012.

³⁵ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

³⁶ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

³⁷ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

³⁸ [Will LNG Exports Benefit the United States Economy](#), Synapse Energy Economics Inc, January 23, 2013

Respectfully & Urgently,



Maya K. van Rossum
the Delaware Riverkeeper
Delaware Riverkeeper Network



Tracy Carluccio
Deputy Director
Delaware Riverkeeper Network

Attachments:

1. *Plan to revive old South Jersey industrial site draws fans and fears*, Philadelphia Inquirer, July 24, 2016
2. Letter to Captain Scott Anderson, Captain of the Port, USCG Sector Delaware Bay, from AcutTech, November 16, 2017

Cc: Captain of the Port, U.S. Coast Guard Sector Delaware Bay



AcuTech Group, Inc.
Washington DC Headquarters
1919 Gallows Road, Suite 900
Vienna, Virginia, USA 22182
Tel: +1.703.676.3180
Fax: +1.703.842.8854
www.acutech-consulting.com

November 16, 2017

Captain Scott Anderson
Captain of the Port, USCG Sector Delaware Bay
ATTN: Facilities and Containers Branch
U. S. Coast Guard
Sector Delaware Bay
1 Washington Avenue
Philadelphia, PA 19148

Re: Letter of Intent for Repauno Port and Rail Terminal, Gibbstown, New Jersey

Dear Captain Anderson:

Delaware River Partners LLC ("DRP") proposes to site, construct, and operate a multi-use, deep-water port and logistics center that may include a variety of separate uses including handling of imported and exported automobiles, other bulk freight and liquid energy products including, but not limited to liquefied petroleum gas ("LPG") and liquefied natural gas ("LNG"). LPG is classified as a liquefied hazardous gas ("LHG") by 33 C.F.R. § 127.005.

The focus of this submission is a joint LNG / LHG facility which will be referred to as the "Project". In accordance with the requirements contained in 33 C.F.R. § 127.007, DRP is pleased to submit the following information about the Project. Please note that at the appropriate time, DRP will make the necessary submission(s) to the COTP pursuant to 33 C.F.R. §§ 126 and 154 as it relates to the other proposed uses.

Given the common stakeholders involved throughout the approval and assessment process, as well as the interdependent risk factors that must be examined, DRP requests that the LNG and LHG be examined jointly through a combined Waterway Suitability Assessment ("WSA") that will accurately represent the envisioned operations of the proposed Project. Enclosed with this Letter of Intent is a Preliminary WSA.

The Project would be operated at the site of the proposed Repauno Port and Rail Terminal ("Repauno Facility"), which is located on a 218-acre portion of a 1630-acre tract formerly known as the Dupont Repauno Works at 200 North Repauno Avenue in Gibbstown, Gloucester County, New Jersey. The Repauno Facility will be consistent with other industrial facilities along the riverfront.

The Project's LNG operations will maintain an export capacity of approximately 1.5 million metric tonnes per annum ("MTPA") (roughly 1,670,000 BBL per month). The LHG operations will maintain an

export capacity of approximately 9,600,000 BBL per annum (800,000 BBL per month). Notably, LNG, LHG, or other hazardous or non-hazardous cargo operations will not run concurrently, as the single-berth wharf only permits one vessel to dock at a given time for a single commodity.

1. Name, address and telephone number of the owner and operator

The Project will be owned and operated by DRP, a limited liability company organized under the laws of the State of Delaware, which is doing business as Repauno Port and Rail Terminal. The address and telephone number for DRP is:

Delaware River Partners LLC
d/b/a Repauno Port and Rail Terminal
200 North Repauno Avenue
Gibbstown, NJ 08027
Phone: 856-224-7067

2. The name, address, and telephone number of the Federal, State, or local agency having jurisdiction for siting, construction, and operation

The lead agency with jurisdiction over the Project is the New Jersey Department of Environmental Protection ("NJDEP"). NJDEP will have the responsibility of reviewing the siting, environmental and safety aspects of the project and preparing the environmental documents required pursuant to the agency's governing laws and regulations. The mailing address and telephone number for general inquiries are:

New Jersey Department of Environmental Protection
Bureau of Release Prevention
401 East State Street
Mail Code 22-03D
P.O. Box 420
Trenton, NJ 08625-0420
Phone: 609-633-0610

In addition to the siting and environmental reviews by NJDEP, other agencies participate in the process, such as the U.S. Department of Energy for authorization to export LNG to both Free Trade Agreement and Non-Free Trade Agreement countries, and the Greenwich Township and Gloucester County Planning Boards for related local site plan and construction approvals. A Section 10/404 permit for construction of the Repauno Facility is pending before the U.S. Army Corps of Engineers ("USACE").

3. Name, address, and telephone number of the Repauno Facility

The project name is "Repauno Port and Rail Terminal." The project management offices and point of contact are:

Mr. Jimmy Osman
V.P. Engineering & Development
Repauno Port and Rail Terminal
200 North Repauno Avenue
Gibbstown, NJ 08027
Phone: 856-224-7067

4. The physical location of the Project

The Project will be located on a portion of the Repauno Facility currently being redeveloped by DRP on the site of a former industrial facility along the Delaware River. The Repauno Facility will feature a single, multi-use, deep-water berth and associated port and logistics center facilities, including the proposed Project. The Project will be located at 200 North Repauno Avenue in Gibbstown, Gloucester County, New Jersey, at river mile 86.5 and at Latitude N 39.846/Longitude W 75.296. The Project is adjacent to the Tinicum Range of the Delaware River Channel. A site location map is shown in Figure 1, a site plot plan showing the major components that are planned for the Repauno Facility are shown in Figure 2, including the alignment of the LNG and LHG operations. Figure 3 shows a more detailed view of the wharf.

Figure 1 – Proposed Repauno Facility Location

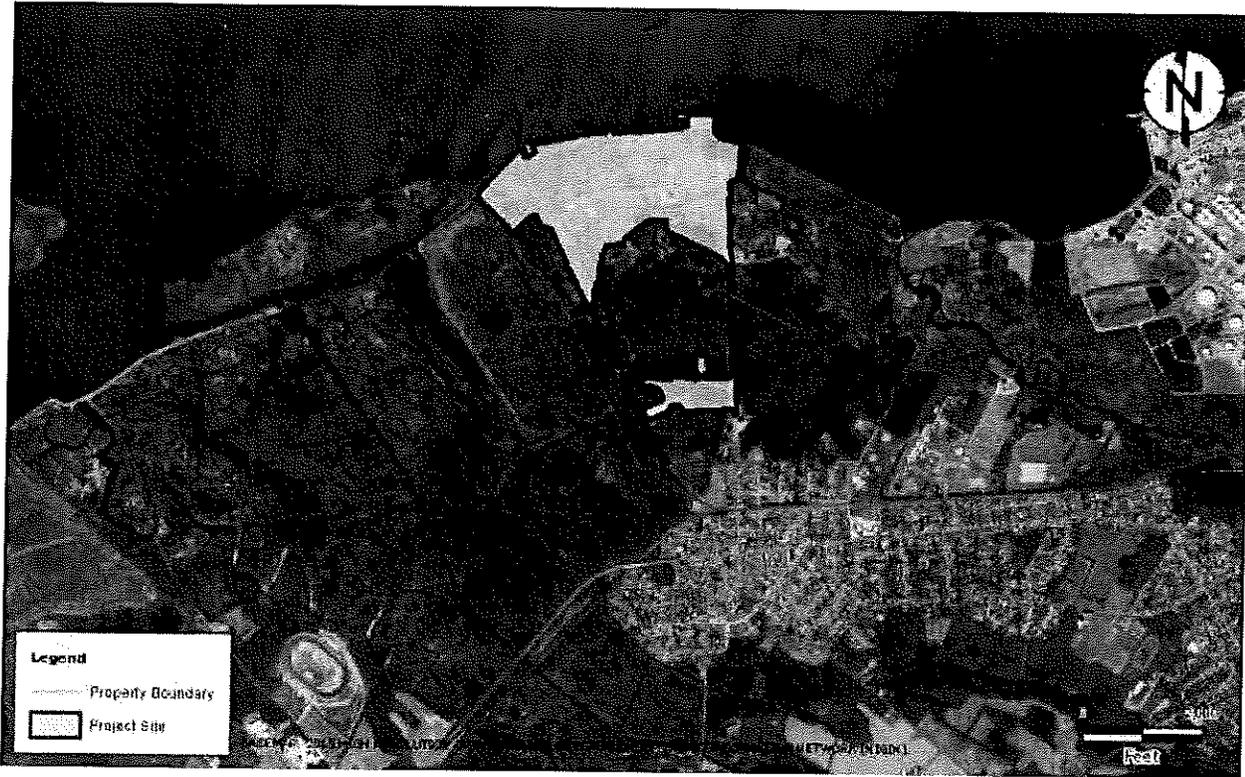


Figure 2 - Proposed Repauno Facility Layout

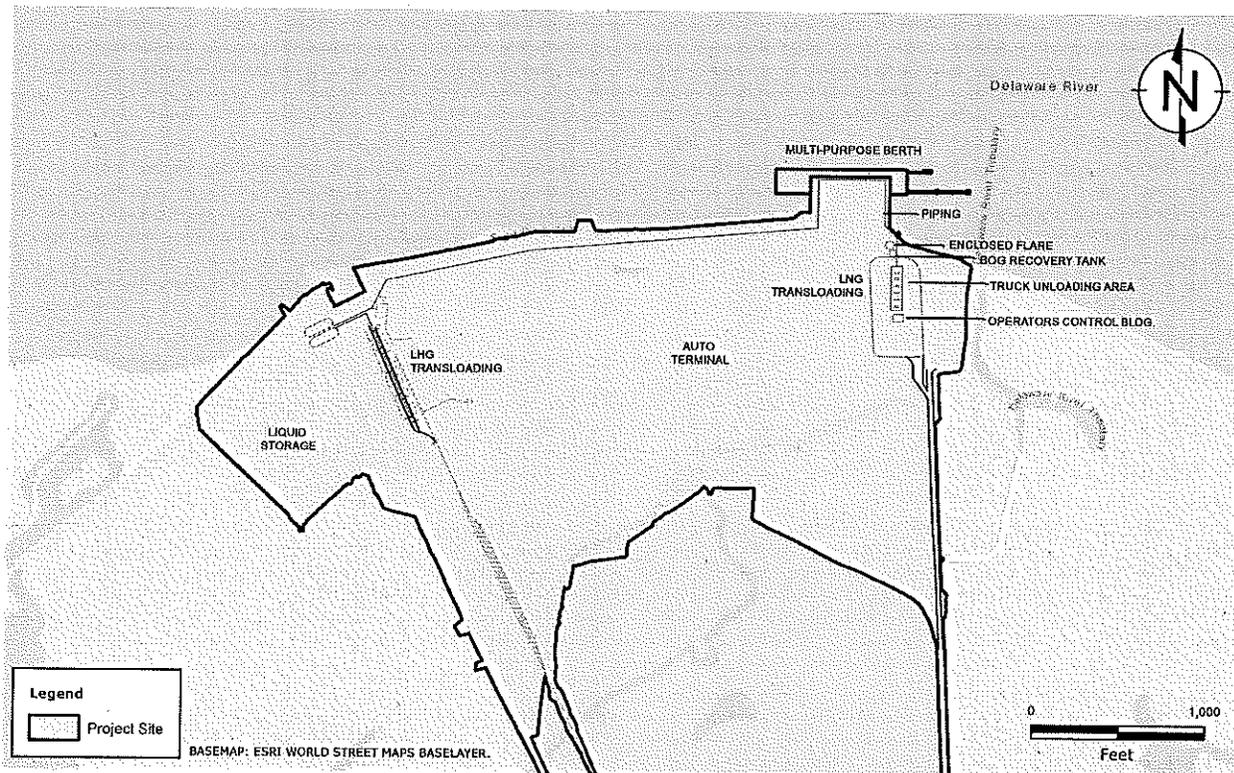
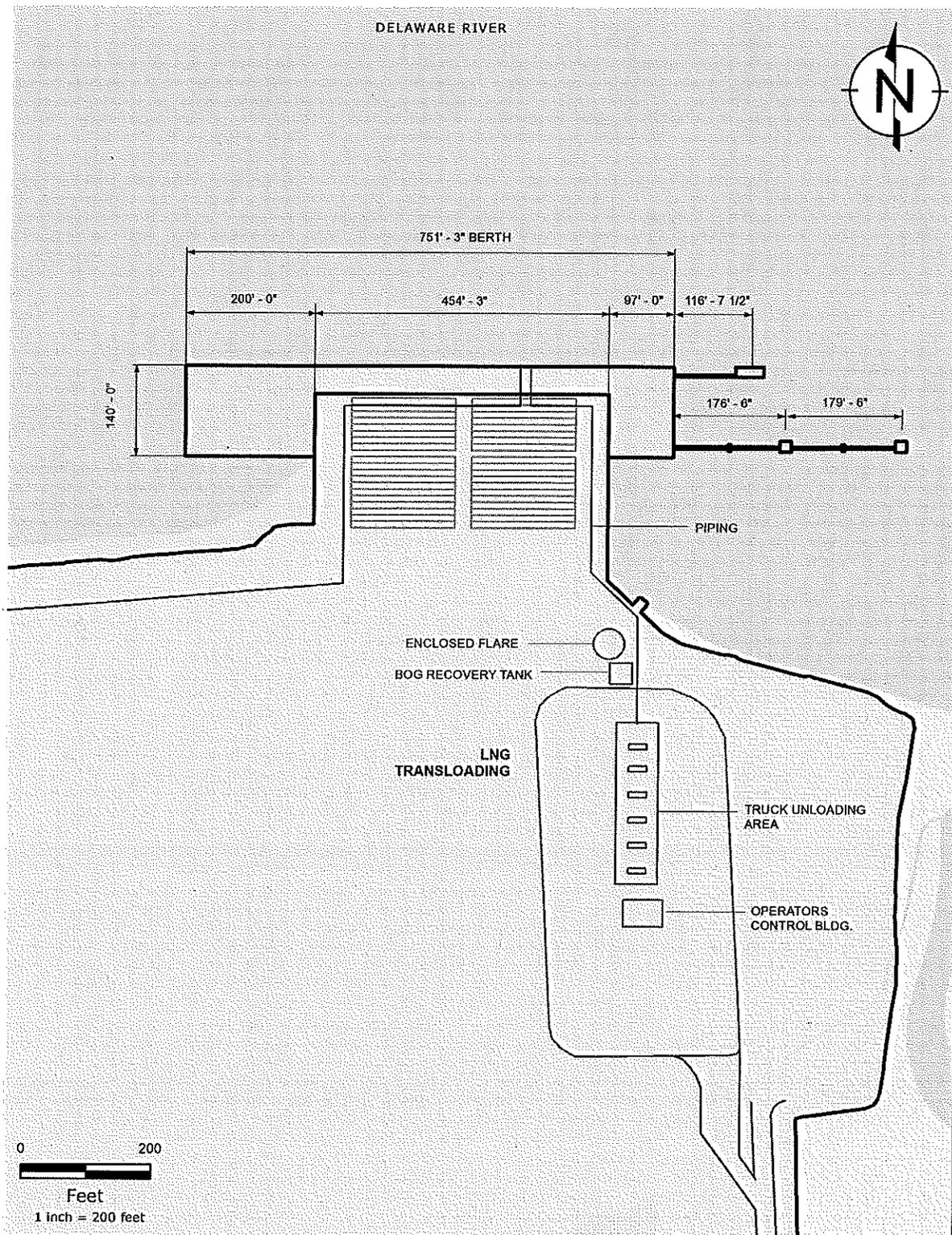


Figure 3 -Proposed Repauno Facility Wharf Layout



5. Overview of the Proposed Project

The Applicant will develop a multi-purpose port facility that will, among other things, provide transloading of LNG and LHG for export. LNG would be delivered to the facility only via trucks and/or rail and pumped directly onboard LNG carriers (“LNGCs”) for export. This process eliminates the need for large-scale, onsite LNG storage or liquefaction while providing an export capacity of 1.5 MTPA (20 MM BBL). Loading a berthed LNG tanker with an expected load of 830,000 BBLs will take an average of 15 days.

LHG would be delivered via railcars or truck, and will be stored onsite. Loading a berthed LHG tanker with an expected capacity of 400,000 BBLs will take an average of 11-12 days.

6. Description of the LNG Handling Facility

The Project would be capable of handling LNG or LHG as described in Sections 6 and 7 hereof. LNG and LHG operations or other cargo deliveries will not run concurrently, as the single-berth wharf only permits one vessel to dock at a given time. For the purposes of this Letter of Intent and the Preliminary WSA, each of the potential maximum yearly LNG and LHG ship calls are analyzed herein. Importantly, however, these projective ship calls represent potential alternatives; they are not cumulative.

The Project will be designed as a modular system to ensure efficient throughput at the facility. The proposed design will allow LNG trucks to unload at a new truck unloading rack located at the east side of the proposed Project site, and south of the new multi-purpose dock. (See proposed Project layout in Figure 2). Notably, the onsite configuration is presently under evaluation and is subject to change during the detailed design of the Project, including the possibility of delivering LNG to the facility via rail.

- LNG will be delivered to the facility through third party LNG trucks. The project is proposing an LNG facility with an initial capacity of up to approximately 1.5 million MTPA of LNG (roughly 1,670,000 BBL per month).
- Product will be pumped directly into the LNGC from the truck rack through ~1,000' long (10" – 12" diameter) vacuum-insulated line via loading arms.
- The new truck rack will consist of a 12-lane rack with 6 unloading pump skids (2 pumps per skid - double sided), and will be capable of unloading 12 LNG trucks simultaneously. (Typical MC-338 DOT LNG Truck has a tank capacity of 290 BBL, but a maximum liquid fill of 260 BBL).
- The proposed capacity of an LNGC that will export LNG from the facility is approximately 1,070,000 BBL, but the maximum liquid fill capacity during loading is 833,330 BBL, in order to accommodate the nominal loaded draft of 40'.
- The LNG transfer line to the LNGC will be sized to handle approximately 2,500 GPM. The estimated volume to be transferred over a 24-hour period is 57,140 BBL. (16 hours actual unloading time and 6-8 hours for hookup, disconnect, and documentation). The truck rack will be able to handle 200-220 trucks per day.

- Loading of a berthed LNG tanker will therefore take an average of 15 days, resulting in approximately 24 LNGC calls on the Project per year, and a total capacity of approximately 20 MM BBL per year (1.5 MTPA).

Boil-Off Gas (BOG) and gas removed from the berthed LNGC will be collected via a vapor line and could be handled in any of the following configurations:

- Process BOG and vapors are routed through a small capacity liquefier; then pushed back into the LNGC. The system consists of a cold box, compressor, N₂ tank and a cold storage bullet tank (1430 BBL capacity).
- Flare the BOG and vapors.
- Collect BOG and run through a gas separator for sale to the grid. (This is to be reviewed with the local utility company).

The LNG handling facility will include a Safety Flare and Vent System for emergency purposes. This system will also provide relief to the LNGC vapor return and piping systems.

The LNG carrier's characteristics and the frequency of the LNG export shipments from the Project

Annual waterway transit information will be coordinated with local Pilots. The Project is being designed with berthing and mooring configurations to accommodate LNGCs. Berthing and mooring configurations will be able to accommodate a typical Aframax class LNGC with capacities up to 170,000 m³ (1.1 MM BBL) (820.2' LOA, 144.4' beam, 40' nominal loaded draft), but the loading capacity will be limited to 833,330 MM BBL in order to accommodate the nominal loaded draft of 40'. There will be approximately twenty-four (24) vessel arrivals each year over a fairly even time period. This results in an estimated two (2) vessels per month.

7. Description of the Liquefied Hazardous Gas (LHG) Handling Facility

As noted above, the single-berth wharf only permits one vessel to dock at a given time. For the purposes of this Letter of Intent and the Preliminary WSA, both the maximum yearly LNG and LHG ship calls are analyzed herein. However, these operations would not run concurrently.

LHG Storage

LHG will arrive at the proposed Project site via rail cars and will then be pumped off into storage tanks. Total onsite storage for this option is ~100,000 BBLs. The vapors from the storage tanks, in addition to BOG from the vessel are compressed, condensed, and then returned to the storage tanks. It is anticipated that a Thermal Oxidizer would also be provided for emergency relief.

Notably, the on-site configuration discussed herein is presently under evaluation and is subject to change during the detailed design of the Project.

LHG Product Shipping

The LHG shipping facilities consist of two LHG tanker loading pumps, each with a rated capacity of 1,750 BBL/hour, a 16" loading line, and an 8" vapor return line, each of which is fitted with fully articulated loading arms (Sizes to be confirmed in the design phase). The 400,000 BBLS refrigerated LHG tanker (Panamax class vessel with 40' nominal loaded draft) will be utilized as a short-term storage vessel during loading periods, enhancing the storage capacity of the facility for the duration of the LHG tanker's berthing. The LHG tanker will dock for approximately 11-12 days for loading operations.

The piping system will be designed as a 300# system to coincide with the pressure ratings of adjoining equipment, including the storage tanks. The vapor generated during the process is recycled to its respective tank. The loading and vapor return arms are then connected to the docked vessel and loading commences at a minimal rate. As conditions in the loading system allow, the loading rate may be increased up to the maximum rate of ~3,500 BBL/hour.

The proposed Project site will include a 20-rail car unloading rack (2x10) capable of offloading LHG at a rate of ~14,000 BBL/day using two 1,750 BBL/hour pumps. These products would be stored in storage tanks built to ASME Sec. VII specifications. Using two 1,750 BBL/hour pumps, the product is transferred from the storage tanks to the berthed vessel via two 16" dock lines for short term storage and eventual export. Cargo will be refrigerated using the LHG tanker's refrigeration system. The associated on-site LHG tank farm could occupy 3+/- acres to accommodate the tanks and associated equipment.

The LHG tanker's characteristics and the frequency of the LHG export shipments from the Project

Annual waterway transit information will be coordinated with local Pilots. The Project is being designed with berthing and mooring configurations to accommodate LHG tankers. Berthing and mooring configurations will be able to accommodate Panamax class LHG tankers with a capacity of 400,000 BBLS. As such, there could be as many as twenty-four (24) vessels calling on the Project each year over a fairly even time period. This results in an estimated vessel arrival twice a month.

8. Description of Non-LNG-and-LHG Cargo Vessels

In addition to LNG and LHG, a variety of cargo vessels (excluding all LNGCs and LHG tankers) could call on the proposed Project. These vessels will transport commodities such as Roll-on/Roll-off ("RoRo"), Break Bulk, and other bulk liquids, potentially including crude oil and refined products. It is important to note, however, that given the constraints of the single multi-purpose berth, if the full number of projected LNG and/or LHG ships call on the Repauno Facility (*i.e.*, 24 LNG and/or LHG vessels per year), no additional cargo types could be accommodated. In short, the cargos and ship calls identified herein are expressed as alternatives; they are not cumulative.

The potential additional cargo types are briefly described below:

- *Roll-on/Roll-off*: A portion of the Repauno Facility could be reserved for transit, storage, and processing facilities for wheeled cargo (i.e., automobiles) transported by RoRo vessels. The Repauno Facility could include facilities for vehicle preparation, intermodal rail transfer, and truck-away loading areas.
- *General and Break-Bulk Cargo*: A portion of the Repauno Facility could also handle perishables, general freight, and break-bulk cargo, including such commodities as fruits and vegetables and other refrigerated goods.
- *Bulk Liquids*: A portion of the Repauno Facility could provide energy product storage. In addition to the liquid petroleum gases identified earlier (including propane and butane), the Repauno Facility could also provide storage for refined petroleum products and crude products.

The multi-purpose berth would be able to accommodate cargo vessels with a maximum length of approximately 870 ft., maximum width of approximately 145 ft., and nominal loaded draft of 40 ft. Vessels would use the Federal navigation channel to move to and from the Repauno Facility. As noted above with respect to the LNG/LHG Project, the single-berth wharf only permits one vessel to dock at a given time. Thus, LNG/LHG and other vessels would not call at the Repauno Facility concurrently. As compared to the above-referenced berthing times for LNG/LHG vessels, a non-LNG/LHG vessel would be at the berth for approximately 2 days during loading/unloading. Thus, these vessels may call on the facility no sooner than every 2 days.

9. Description of Annual Vessel Traffic

As summarized on Table 1-1, it is estimated that the LNG/LHG Project would result in approximately 24 LNG or LHG vessels calling on the Repauno Facility in a given year. The potential number of LNG or LHG vessel calls are expressed as independent maximums for the purpose of the within Preliminary WSA. However, since the single, multi-purpose berth can only accommodate one ship at a time, vessels will not call on the Repauno Facility concurrently and this projected vessel traffic is not cumulative.

Table 1-1: Alternative Utilization of Multi-Purpose Dock for LNG/LHG Project

Commodity	Annual Volume (Estimated)	Units	Vessel Fill Capacity (Estimated)	Annual Number of Vessels (Estimated)
LNG	20,000,000	BBL	833,330	24
Liquefied Gases	9,600,000	BBL	400,000	24

Additionally, annual cargo ship calls were estimated for the other projected cargo commodities that could be handled at the Repauno Facility. It is estimated that the Repauno Facility could handle a maximum of 91 RoRo vessel calls, 11 break-bulk vessel calls, 13 refined product, and 6 crude oil calls. Again, these projected cargo calls are expressed as anticipated maximums, which would not be cumulative and would be reduced by the number of LNG and LHG vessels that call at the Repauno Facility due to the constraints of the single, multi-purpose berth discussed above. If the full number of projected LNG and/or LHG ships call on the Repauno Facility (*i.e.*, 24 LNG and/or LHG vessels per year), no additional cargo types could be accommodated. In short, the cargos and ship calls identified herein are expressed as alternatives; they are not cumulative. The type and total number of vessel calls will be driven by market demand and berth availability in the region.

10. Figures

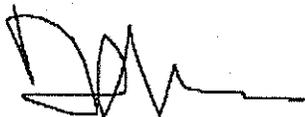
- 1) Proposed Repauno Facility Site Location
- 2) Proposed Repauno Facility Site Layout
- 3) Proposed Repauno Facility Wharf Layout

11. Attachments

- A) NOAA Office of Coast Survey Navigation charts of waterway channels and highlighted LNGC/LHG tanker route.
- B) Commercial, industrial, environmentally sensitive, and residential areas within 15.5 miles of the project site adjacent to the waterway.
- C) Map of waterway channel showing environmental sensitive areas adjacent to the surrounding area.
- D) Preliminary WSA that has been prepared in accordance with the guidance contained in U.S. Coast Guard (“USCG”) NVIC 01-2011.

If the USCG has any questions or requires any additional information or clarification, please feel free to contact Mr. Jimmy Osman, DRP's Vice President of Engineering & Development at 856-224-7067 or josman@repauno.com. AcuTech is acting on behalf of DRP as their designated consultant for preparing the WSA.

Best regards,

A handwritten signature in black ink, appearing to be 'D. Moore', with a horizontal line extending to the right.

On behalf of Delaware River Partners, LLC.

David A. Moore, PE, CSP
President & CEO
AcuTech Group, Inc.
1919 Gallows Road, Suite 900
Vienna, VA 22182
Tel: +1-703-676-3180
Cell: +1-703-598-3921

ADVERTISEMENT

Plan to revive old South Jersey industrial site draws fans and fears

by David O'Reilly, Staff Writer, Posted: July 24, 2016



MICHAEL ARES / STAFF PHOTOGRAPHER

Outside a vast brownfield in Gibbstown that is home to crumbling roads, empty storage tanks, and vacant sheds, a modest brick sign points to both the gritty past and the greener prospects of Gloucester County's economy.

Repauno Plant shout its bold, stainless steel letters. Below them, the faint outline of a pried off logo whispers a bygone name: *DuPont*.

Home to a DuPont Corp. factory complex that for 120 years manufactured dynamite and the chemicals for making Dacron, the Repauno site belched gas, leaked benzene, shed asbestos, occasionally exploded, and employed thousands, earning it the affectionate nickname "Uncle DuPont" before it shut down nearly 20 years ago.

Now a 300-acre section of this 1,700-acre tract on the Delaware River appears destined to become one of the largest privately owned ports in the Northeast.

ADVERTISEMENT

On July 1, after two years of negotiations, Delaware River Partners L.L.C., a subsidiary of Fortress Investment Group L.L.C., acquired the site from a DuPont subsidiary. It will keep the Repauno name.

The project is welcomed by many, but also has aroused trepidation among residents that it will create new hazards with truck and rail traffic.

At the direction of state and federal agencies, DuPont undertook extensive pollution remediation of the tract starting in the 1980s. The company ceased operations here in 1999 but leased parts of it until 2004.

Underground pumps, monitored by the Department of Environmental Protection, still carry away for treatment benzene in the soil that otherwise would leach into groundwater.

ADVERTISEMENT

State and local leaders are confident the new port will be a positive presence in the township and county.

"This will be a big job generator," said Senate President Stephen Sweeney, whose Third Legislative District includes Gibbstown, also known as Greenwich Township. "We've been working on this since 2005."

The Repauno port will sit just two miles south of the publicly funded Paulsboro Marine Terminal, due to open this fall. They will be the first major ports built on the Delaware River in more than 50 years.

Sweeney said he was confident the state and county would find the funds to create a connector road from the port to Route 44, I-295, and the New Jersey Turnpike that would allow most truck traffic to bypass Gibbstown's residential areas.

"It's going to happen," he said.

Assemblyman John J. Burzichelli, (D., Paulsboro), chair of the appropriations committee and a former mayor of Paulsboro, echoed Sweeney's optimism.

A similar bypass road connecting the Paulsboro terminal to the highways cost \$22 million.

Like Sweeney - who as a young union ironworker found occasional work at DuPont repairing buildings after they'd exploded - many in town talk excitedly of jobs at mention of the name "Repauno."

ADVERTISEMENT

"It was the town," said Kevin Herzberg, 33, whose tidy brick house on Lough Lane was built on land provided by "Uncle DuPont."

"My dad, my uncle, my grandfather, my grandmother, and my great-grandmother all worked there one time or another," said Herzberg, who grew up in Gibbstown.

And no matter what DRP plans to build on the property - "even a refinery," he said - "I think it's a good thing."

No refinery is contemplated, said Gary Lewis, managing director of Manhattan-based Fortress.

ADVERTISEMENT

"The Repauno site has all the characteristics that a port developer looks for," Lewis explained in an email last week. "Deep water, rail access, highway access, and most importantly, proximity to major markets."

He said DRP expects to create:

Industrial warehouses for the importation and distribution of fruits, flowers and vegetables;

A "roll-on, roll-off" parking facility for the shipping and distribution of automobiles;

An 8 million gallon storage facility for butane, using an underground granite cavern on the property;

A solar grid capable of generating 20 megawatts of electricity.

Lewis declined to say what DRP paid for the site or what it expects to invest in improvements, but he projects 500 to 1,000 full-time jobs on-site if all the planned elements come to fruition.

The company declined a request by the Inquirer to tour the property. Google Maps' overhead images show several dozen buildings and tanks still standing, and numerous rectangles of concrete or asphalt where former buildings were demolished.

Fortress/DRP hopes this fall to start construction of a 207,000-square-foot refrigerated warehouse, with operations to begin by spring. Gibbstown's planning board gave the warehouse preliminary approval early this month.

Although a company prospectus last year envisioned a liquefied natural gas (LNG) facility at Repauno - disconcerting some residents and environmental groups such as the Sierra Club and the Delaware Riverkeeper - "that is no longer in our designs," Lewis said.

Just how safe and "green" the Repauno site will be under DRP's stewardship remains a matter of concern for some, however.

"This is Railroad Avenue," said 44-year-old Rich Friendlich, who had walked the half block from his home on Logan Avenue to twin railroad tracks running at right angles to his street.

Just beyond lay the open field where DRP wants to build the first of two or more refrigerated warehouses.

"The trains already come through here every 30 to 90 minutes," he said, moments after a lone Norfolk Southern locomotive chugged slowly by. "How many more will there be when they start operations?" he asked.

He and his wife, Karen Capozzi, said they are glad DRP has dropped plans for an LNG port, but butane storage worries them.

Rail carriers already park tank cars close by their home, Capozzi said. "They sit for days, and you can smell this awful chlorine smell."

"And we still haven't heard," Friendlich said, "how they plan to transport the butane."

The couple created the organization Concerned Citizens for the Development of the Repauno site. Its website is repaunocitizens.com.

Their neighbor Emily Buchenhorst, 46, said her biggest worry is the trucks that will soon be traveling in and out of the port. They will be passing and turning less than 10 feet from her home on Repauno Avenue. "They could hit my house," said Buchenhorst, a resident for 13 years.

Mary Rogers, 61, a 37-year resident of Repauno Avenue, said she fears for the children who play and ride bicycles on her street, and worries that rumbling trucks could disturb the foundations of older homes.

And Suzanne DeRemigio, 60, who has lived 36 years on Logan Avenue, voiced fears that if there are frequent rail accidents in Gibbstown, such as the 2012 Conrail chemical spill in neighboring Paulsboro, "we wouldn't be able to sell our houses."

Greenwich Township Mayor George Shivery was emphatic, however, that he, the township council, and planning board will not allow any new industries to pose the kinds of hazards that DuPont - which manufactured the dynamite used to build the Panama Canal - inflicted.

"We grew up when all this manufacturing was in full bloom," Shivery, 69, recalled. "The acid fumes would put spots on your aluminum siding, and the cancer rate, the asbestosis, was just unbelievable. We all had parents and great-grandparents whose lives were shortened by it.

"We just didn't know about those problems then. Now we do. We're very sensitive to these issues," Shivery said.

"We won't want anything out there that goes 'Boom!' "

SPONSORED CONTENT
Understated Is Overrated. The All-New Chevy Blazer.
by Chevrolet



doreilly@phillynews.com

856-779-3841

Posted: July 24, 2016 - 3:01 AM

David O'Reilly, Staff Writer

 **View 1 Comment**



July 31, 2019

US Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Submitted via email to Lawrence Slavitter: lawrence.m.slavitter@usace.army.mil

**Re: CENAP-OP-R-2016-0181-39 -- Gibbstown Logistics Center Port Expansion,
Supplemental Public Notice.**

To Whom It May Concern,

Delaware Riverkeeper Network (DRN) submits this comment in opposition to the approval of **CENAP-OP-R-2016-0181-39** on behalf of our approximately 20,000 members throughout the Delaware River Watershed including residents in the closest Gloucester County communities. The Delaware Riverkeeper Network (DRN) is a private non-profit membership organization, championing the rights of our communities to a Delaware River and tributary streams that are free flowing, clean, healthy, and abundant with a diversity of life.

Delaware River Partners (DRP), for New Fortress Energy, has applied for permits to build a second dock with two additional ship berths at the Gibbstown Logistics Center (Logistics Center). Originally billed as a warehouse-type terminal with one dock and one berth, the Logistics Center was going to handle automobiles, dry and refrigerated cargo and natural gas liquids (NGL). The current project proposes to store and export bulk liquids such as natural gas liquids (NGL) like propane and butane on site, utilizing above ground tanks and the old cavern built by DuPont for the manufacture of explosives decades ago. The new proposal by DRP is for an additional dock and berths intended to handle Liquefied Natural Gas (LNG) for export.

The Delaware Riverkeeper Network appreciates that in response to the comments we have submitted, as well as a meeting with staff, that the US Army Corps of Engineers has provided this additional public notice with additional details and time for public comment.

The Army Corps must Secure Complete and Final Information Regarding the Scope, Size, Capacity, Feasibility, and Design of the Project in order to Meaningfully Assess its Impacts and to be able to Fulfill its NEPA and Legal Review Obligations.

It is notable that this most recent Army Corps notice:

- confirms that Dock 2 is to be constructed for purposes of serving LNG exports from the site;
- LNG will be transported to the site via truck and rail;
- that the level of truck traffic generated by this new primary use is “approximately 13 trucks per hour ... 24/7” and 15 trucks per hour for both LNG and Liquefied Hazardous Gas (LHG)
- that each truck will carry approximately 12,000 gallons of product;
- That ship loading time will be approximately 2 weeks;
- That a new access road is proposed for construction to the site at some point in the undetermined future. The current access road is located approximately 110 feet from the nearest township residential community with loading and unloading operations taking place a minimum of a mile from residential communities. Future transloading of LNG from trucks to ships will be located about 1 mile from the residential community, which includes a day care center, the Greenwich Township Broad Street Public School, Little League athletic fields, public buildings and other community locations.

It is important to note that the supplemental Public Notice for the Logistics Center port expansion is only examining Dock 2 with two new berths and the activities and operations related to Dock 2. Dock 1 has been approved and will result in impacts that must be considered in concert with Dock 2. The precise activities and volume of operations on the water, at the Docks and on the land for Dock 1 are unknown at this time as the facility operations are being revised by the applicant. A new site plan application is expected to be submitted but has not yet been submitted to Greenwich Township Planning and Zoning Board according to Gibbstown Township municipal government staff. There is also an approval required from Gloucester County. Details about the operations related to Dock 1 may be clearer after the local government processes are complete. Additionally, the draft NJDEP Waterfront Development Permit has been proposed and a public comment period has been completed but any changes to the Logistics Center based on the state permitting agency are also unknown at this time.

The Army Corps must be sure to Consider the Following Items while Conducting its Public Interest Review.

Under 33 CFR 320.40 (a)(1), Public interest review,

“The decision whether to issue a permit will be based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use on the public interest. Evaluation of the probable impact which the proposed activity may have on the public interest requires a careful weighing of all those factors which become relevant in each particular case. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. The decision whether to authorize a proposal, and if so, the conditions under which it will be

allowed to occur, are therefore determined by the outcome of this general balancing process. That decision should reflect the national concern for both protection and utilization of important resources. All factors which may be relevant to the proposal must be considered including the cumulative effects thereof: among those are conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people. For activities involving 404 discharges, a permit will be denied if the discharge that would be authorized by such permit would not comply with the Environmental Protection Agency's 404(b)(1) guidelines. Subject to the preceding sentence and any other applicable guidelines and criteria (see §§ 320.2 and 320.3), a permit will be granted unless the district engineer determines that it would be contrary to the public interest.”

As identified in the supplemental notice, the Army Corps must review the following Public Review Interest Factors when evaluating the permit application.

- Conservation
- Economics
- Aesthetics
- General Environmental Concerns
- Wetlands
- Historic Properties
- Fish and Wildlife Values
- Flood Hazards
- Floodplain Values
- Land Use
- Navigation
- Shore Erosion and Accretion
- Recreation
- Water Supply and Conservation
- Water Quality
- Energy Needs
- Safety
- Food and Fiber Protection
- Mineral Needs
- Consideration of Property Ownership
- Needs and Welfare of the People

A. The Army Corps must Evaluate the Project’s Potential Impacts to Water Quality.

The Army Corps must consider impacts to water quality during its review as required by 33 CFR 320.4(d):

(d) Water Quality. Applications for permits for activities which may adversely affect the quality of waters of the United States will be evaluated for compliance with applicable effluent limitations and water quality standards, during the construction and subsequent operation of the proposed activity. The evaluation should include the consideration of both point and non-point sources of pollution. It should be noted, however, that the Clean Water Act assigns responsibility for control of non-point sources of pollution to the states. Certification of compliance with applicable effluent limitations and water quality standards required under provisions of section 401 of the Clean Water Act will be considered conclusive with respect to water quality considerations unless the Regional Administrator, Environmental Protection Agency (EPA), advises of other water quality aspects to be taken into consideration.

This review also requires that the Army Corps look to applicable federal and state laws and regulations. 33 CFR 320.4(j)(1) requires:

(j) Other Federal, state, or local requirements.

(1) Processing of an application for a DA permit normally will proceed concurrently with the processing of other required Federal, state, and/or local authorizations or certifications. Final action on the DA permit will normally not be delayed pending action by another Federal, state or local agency (See 33 CFR 325.2 (d)(4)). However, where the required Federal, state and/or local authorization and/or certification has been denied for activities which also require a Department of the Army permit before final action has been taken on the Army permit application, the district engineer will, after considering the likelihood of subsequent approval of the other authorization and/or certification and the time and effort remaining to complete processing the Army permit application, either immediately deny the Army permit without prejudice or continue processing the application to a conclusion. If the district engineer continues processing the application, he will conclude by either denying the permit as contrary to the public interest or denying it without prejudice indicating that except for the other Federal, state or local denial the Army permit could, under appropriate conditions, be issued.

As it stands, the Logistics Center does not meet the requirements of the Coastal Zone Management Rules (CZM NJAC 7:7), the NJ Department of Environmental Protection Flood Hazard Area Control Act Rules (FHACA Rules NJAC 7:13), and does not satisfy the provisions of the NJ State Individual Water Quality Certificate and NJ Tidelands License. Nor has the project complied with the NJ Toxic Catastrophe Prevention Act (TCPA NJAC 7:31).

i. The Projects Ability to Comply with the Coastal Zone Management Act as well as Other State and Federal Laws that Impact Water Quality Compliance Must be Evaluated.

For the Public Interest Review, Army Corps is required to consider impacts to coastal zones, 33 CFR 320.4:

(h) Activities affecting coastal zones. Applications for DA permits for activities affecting the coastal zones of those states having a coastal zone management program approved by

the Secretary of Commerce will be evaluated with respect to compliance with that program. No permit will be issued to a non-federal applicant until certification has been provided that the proposed activity complies with the coastal zone management program and the appropriate state agency has concurred with the certification or has waived its right to do so. However, a permit may be issued to a non-federal applicant if the Secretary of Commerce, on his own initiative or upon appeal by the applicant, finds that the proposed activity is consistent with the objectives of the Coastal Zone Management Act of 1972 or is otherwise necessary in the interest of national security. Federal agency and Indian tribe applicants for DA permits are responsible for complying with the Coastal Zone Management Act's directives for assuring that their activities directly affecting the coastal zone are consistent, to the maximum extent practicable, with approved state coastal zone management programs.

Under New Jersey Law, LNG Specific issues must be analyzed according to the mandates in 7:7-15.4(s), which states:

(s) Standards relevant to liquefied natural gas (LNG) facilities are as follows:

1. New marine terminals and associated facilities that receive, store, and vaporize liquefied natural gas for transmission by pipeline are discouraged in the coastal zone unless a clear and precise justification for such facilities exists in the national interest; the proposed facility is located and constructed so as to neither unduly endanger human life and property, nor otherwise impair the public health, safety and welfare, as required by N.J.S.A. 13:1910f; and such facilities comply with the Coastal Zone Management rules.

i. LNG facilities shall be sited and operated in accordance with the standards set forth in the Natural Gas Act of 1938, 15 U.S.C. §§ 717-717z, the Natural Gas Policy Act of 1978, 15 U.S.C. §§ 3301-3432, the Outer Continental Shelf Lands Act, 43 U.S.C. §§ 1331 et seq., the Energy Policy Act of 1992, P.L. 102-486, 106 Stat. 2776, October 24, 1992, and the National Environmental Policy Act, 42 U.S.C. §§ 4321 et seq., which set forth standards for siting, design, installation, inspection, testing, construction, operation, transportation of gas, replacement, and maintenance of facilities.(Emphasis added)

ii. In determining the acceptability of proposed LNG facilities the Department will consider siting criteria including, but not limited to:

- (1) The risks inherent in tankering LNG along New Jersey's waterways;*
- (2) The risks inherent in transferring LNG onshore; and*
- (3) The compatibility of the facility with surrounding land uses, population densities, and concentrations of commercial or industrial activity.*
(Emphasis added)

iii. New LNG facilities that liquefy, store and vaporize LNG to serve demand during peak periods shall be located in generally remote, rural, and low-density areas where land use controls and/or buffer zones are likely to be maintained.

2. Rationale: The Pipeline Safety Act of 1979, P.L. 96-129, amended the Natural Gas Pipeline Safety Act of 1968 and sets forth requirements for the safe operation of pipelines transporting natural gas and liquefied petroleum gases, and provides standards with respect to the siting, construction, and operation of liquefied natural gas facilities. The State recognizes the responsibilities of various federal agencies, including the U.S. Coast Guard and Office of Pipeline Safety Operations in the U.S. Department of Transportation, the Economic Regulatory Administration in the U.S. Department of Energy (US DOE), and the independent Federal Energy Regulatory Commission within USDOE, for management of various aspects of the siting and operations of LNG facilities.

Importation facilities for LNG are discouraged in view of the present sources of LNG from politically unstable countries. The use of natural gas for base load electric generation purposes is consistent with the Power Plant and Industrial Fuel Use Act of 1978, P.L. 95-620. The availability of domestic sources of LNG and a demonstrated need that such importation facilities are in the national interest dictate the consideration of applications for such facilities on a case-by-case basis.

The tankering, transfer, and storage of LNG pose significant risks to public health, safety and welfare and may cause serious adverse environmental impacts which may not be restricted to one state, given the likely potential locations of LNG terminals along interstate waterway. New Jersey therefore recommends that the siting of LNG facilities be treated as a regional issue on an interstate basis.¹(Emphasis added)

The newly proposed Logistics Center LNG export terminal, including pipelines that will take the gas from tanker trucks to vessels, for the purpose of receiving, storing for 15 days on the vessel during loading operations, for export raises serious and significant concerns for the environment, human life, the public safety and welfare, and for property. Given that the gas may be bound for foreign nations it cannot be argued to be in the national interest, rather it is being proposed and advanced solely for corporate gain. The construction of the proposed Logistics Center LNG export facility is a clear danger to safety in our region, including those communities and shippers that will be passed along its route.

ii. The Negative Impacts from the Expansion of Tanker Terminals must be Adequately Assessed.

The Dock 2 expansion of the terminal triples the number of the berths available for ships and ship traffic to and from the deepwater port – while the previously approved Dock 1 project included 1 shipping berth, Dock 2 adds 2 more, thereby increasing dramatically the capacity of the site. The New Jersey Waterfront Development (NJWFD) permit application states that the expected volume of “new” liquid cargo ships to Dock 2 is 37 vessels per year with 370 total dock days for Dock 2.² This is in addition to 100 vessels of other cargo from Dock 1, which includes

¹ 7:7-15.4(s).

² Application For Waterfront Development Individual Permit, Project: DRP Gibbstown Logistics Center (Dock 2), Applicant: Delaware River Partners LLC, 200 North Repauno Avenue, Block 8, Lot 4, Greenwich Township,

some additional bulk liquids, with 290 total dock days for Dock 1 according to Table 1.³ In the application at Section 4.4, it is stated that the shipping vessels will be “new vessels on the Delaware River”. Clearly, these “new vessels” must be carefully considered and the potential impacts to shipping and the Delaware River must be assessed in order to satisfy the implementing rule. This subsection is clearly applicable to the Logistics Center.

The relevant subsection 7:7-15.4(q) states:

(q) Standards relevant to tanker terminals are as follows:

1. New or expanded tanker facilities are acceptable only in existing ports and harbors where the required channel depths exist to accommodate tankers. (Emphasis added)

i. Multi-company use of existing and new tanker terminals is encouraged in the Port of New York and New Jersey and the Port of Camden and Philadelphia, where adequate infrastructure exists to accommodate the secondary impacts which may be generated by such terminals, such as processing and storage facilities.

2. New tanker terminals are discouraged in areas not identified in (q)1 above. (Emphasis added)

3. Offshore tanker terminals and deepwater ports are discouraged.

4. Rationale: Onshore tanker facilities pose potential adverse environmental impacts and could encourage secondary development activity that is not necessarily coastal dependent. Also, even medium sized tankers require minimum channel depths of 30 feet, which excludes locations within the CAFRA area. New or expanded tanker terminals are therefore directed toward New Jersey's established port areas. Deepwater ports appear attractive to industry due to increasingly larger tankers, limitations on dredging and the scarcity of waterfront land. However, a deepwater port may, depending on its location, cause severe adverse primary and secondary impacts on the built, natural, and social environment. (Emphasis added)

We note that the information being provided to the various agencies differs, and so neither the public nor the Army Corps can properly assess this project based on the information provided to date. For example, as discussed above, while the NJWFD permit application states that the expected volume of “new” liquid cargo ships to Dock 2 is 37 vessels per year with 370 total dock days for Dock 2 suggesting 10 days loading time for each vessel, materials provided to the Coast Guard are clear that loading time will require a period of **at least** 15 days thereby requiring at least 555 dock days. Given that the LNG is going to be stored on the ships during the 15+ days of loading, the length of time at the dock is material and important, particularly from a public safety perspective.

Gloucester County, New Jersey, Alternatives Analysis, Dock 2, DRP Gibbstown Logistics Center, Gibbstown, Gloucester County, New Jersey, 2.2.4 Berth Demand At Gibbstown Logistics Center, Table 1, Pdf Page 218.

³ Ibid.

iii. The Storage of Crude Oil, Gases and Other Potentially Hazardous Liquid Substances, Presents Unique Dangers that must be accounted for.

The planned storage of Liquefied Hazardous Gas (LHG) in the on-site cavern, in tanks, sphere tanks, rail cars, trucks, and ships in the berths while they are being loaded for 10 to 15 days clearly requires the applicant to address the issues of the storage of gases and other hazardous bulk liquids under this subsection. While the terminal at the deepwater port is water-dependent, the amount and scope of storage, including the volumes that would be contained in all storage vessels at one time on the site (including the cavern, tanks, rail cars, trucks, ships and other containers on the site) must be fully disclosed, assessed in terms of management, handling, emissions and environmental impacts and must be justified due to proximity to the residential community of Gibbstown, the day care center, playground, school, athletic fields, churches, and public buildings adjacent to the Logistics Center property. In a Letter of Inquiry submitted by the applicant to the U.S. Coast Guard in November 2017, the description of the LHG project, which includes butane and other natural gas liquids, states that the LHG will arrive by rail cars and be transloaded to storage from a 20-rail car unloading rack with as many as 24 shipping vessels each year.⁴ It is important to note that the Letter of Inquiry was written when only one berth was planned; the additional two berths will increase the shipping traffic and the transport to the site, the storage in mobile containers and the activity on the site. As previously stated, the NJWFD permit application states that the expected volume of “new” liquid cargo ships to Dock 2 is 37 vessels per year with 370 total dock days for Dock 2. The volume of LHG, the full scope of the LHG project, the operations in light of other operations on the site, the management and the potential impacts of the LHG must be analyzed and considered. This subsection of the CZM rules may also be considered to apply to the LNG project operations.

The relevant subsection 7:7-15.4(p) states:

(p) Standards relevant to storage of crude oil, gases and other potentially hazardous liquid substances are as follows:

1. The storage of crude oil, gases and other potentially hazardous liquid substances as defined in N.J.A.C. 7:1E-1.1 under the Spill Compensation and Control Act (N.J.S.A. 58:10-23.11 et seq.) is prohibited on barrier islands and discouraged elsewhere in the CAFRA area.

2. *The storage of crude oil, gases and other potentially hazardous liquid substances is conditionally acceptable in the Urban Area, Northern Waterfront and Delaware River regions if it is compatible with or adequately buffered from surrounding uses. (Emphasis added)*

3. The storage of crude oil, gases and other potentially hazardous liquid substances is not acceptable where it would limit or conflict with a potential recreational use.

⁴ Letter to Captain Scott Anderson, Captain of the Port, USCG Sector Delaware Bay, from AcutTech, November 16, 2017.

4. The storage of crude oil, gases and other potentially hazardous liquid substances is not acceptable along the water's edge unless the storage facility is supplied by ship, in which case it is acceptable on the filled water's edge provided the storage facility complies with (p)1, 2 and 3 above.

5. Rationale: Major storage facilities for potentially hazardous substances are not entirely coastal-dependent and will not be permitted where storage might limit or conflict with recreational or open space uses of the coast.

iv. Changes in Construction and Operation Plans at the Site Are Yet to be Factored into the Applicant's Numerous Permit Applications.

Finally, DRN points out that the project, by the applicant's own admission, has substantially changed from when the plans were designed for one dock with one berth. These changes include but are not limited to:

- the addition of LNG
- the substantial expansion of ship traffic up to at least 37 shipping events per year from 24 for the bulk liquids originally
- the increase in the number of ships that can be accommodated at the 3 berths and increased shipping traffic
- the mixing of different operations such as LHG, LNG, and other cargo at the Gibbstown Logistics Center
- the increased activity at the site with additional transloading operations occurring simultaneously and the additional truck and rail deliveries into the site
- the additional equipment and facilities to be located on site due to bulk liquid handling
- the considerable increase in truck and rail traffic to carry in bulk liquids including LNG, LHG and other liquids such as crude oil and refined products that would be exported by ship
- the potential for increased storage capacity on the site, as yet undisclosed
- the question of how much shipping of other non-liquid RO/RO type cargoes will be done at Dock 1, considering that Dock 1 will also ship bulk liquids according to the application
- the internal traffic patterns that will change due to different cargos and different delivery and transloading systems
- the re-thinking of whether warehouse and other planned facilities for non-liquid cargo at the site are necessary

There are also questions regarding the need for other permitting and/or approvals by the project including, naming a few, approvals from the U.S. Coast Guard, the Federal Energy Regulatory Commission, the Pipeline and Hazardous Materials Safety Administration (PHMSA), U.S. Department of Transportation, and the Federal Railroad Administration. It is not disclosed whether any pipelines will be used, constructed, renovated, repurposed, or accessed through the project or for the project, which is important information that must be provided. A Department of Energy permit is listed as a needed permit in the Delaware River Basin Commission Docket for Dock 2 but it is not discussed in any documents that DRN has reviewed, demonstrating a lack

of transparency on the part of the applicants about the veiled plan to export LNG from the Logistics Center.

v. The Proposed Project Will Adversely Impact the Surrounding Environment Due to the Construction of Ports.

Ports are expected to be placed where other ports are or adjacent to other ports. The applicant maps regional port facilities but does not give full information about the ability of those ports to include the planned uses for Dock 2. In addition, buffering and compatibility with surrounding uses is of importance under this subsection. The subsection NJAC 7:7-15.9 states, in relevant part:

“(c) New port uses outside of existing ports as defined at N.J.A.C. 7:7-9.11(a) are acceptable only when there is a clear demonstration of need, and when suitable land and water area is not available in or adjacent to an existing port.

(d) New or expanded ports must be compatible with surrounding land uses and provide for maximum open space and physical and visual access to the waterfront, if this access does not interfere with port operations or endanger public health and safety. New or expanded ports must also not interfere with national, State, county or municipal parks, recreational areas, or wildlife refuges.

(e) New, expanded or redeveloped port facilities must have direct access to navigation channels of sufficient depth for anticipated vessel access, with minimal dredge and fill requirements, adequate access to road, rail transportation, and adjacent land with sufficient load bearing capacity for structures.”

The need for the activities related to LNG has not been addressed at all. LNG export has not been justified as a beneficial activity that would warrant the environmental, health and safety impacts of an LNG project at this location. This location has great benefit for natural resource reasons and, in a natural condition, has compatibility with surrounding land uses in this area. The residential nature of Gibbstown, located right up against the Logistics Center, homes, a day care center, playground, the Broad Street Public School, Little League athletic fields, the local VFW Post, Greenwich Township Municipal Building and Police Department, and the U.S. Post Office, and other community assets and attributes that make up the municipal setting of this community are not compatible with the industrial uses related to Dock 2 that are proposed at the site. In fact, the projected enormous increase of new truck traffic, the new and increased railroad operations into and from the site, the industrial transformation of the site from a now largely natural condition at the site and on the rest of the Repauno property, the lights, noise, odors, air emission, water quality degradation, and the health and safety threats from LNG as well as the additional LHG and other bulk liquids that are planned to be handled related to the approval of the project by the Army Corps, is a liability for the local community and will work against the protection, quality of life and community values of Gibbstown. Many people who live in Gibbstown and the surrounding area have never experienced industrial activity at this site due to at least one generation of the local population only knowing the site as a natural resource.

The applicant also does not explore what the property value impacts will be for people who own homes and property adjacent to the property and in the surrounding area. Those people and businesses that were required to be notified of the project were not given the full story and do not know about the LNG Project at the Logistics Center, making those notifications invalid. Notifications to the public and adjacent properties must be reissued with full and comprehensive information about the LNG Project included.

Residents of the area opposed LNG at the site when it was first proposed in 2016, which led to it being dropped by the applicant. It has now become clear that the applicant continued to secretly move ahead with LNG export at Gibbstown without disclosing this, leaving people who live in the area in the dark about the plans for the site. Of course, the public and, in some cases, agencies were also kept ignorant of the behind-the-scenes LNG Project that Delaware River Partners and New Fortress Energy was stealthily progressing. A news article about local concerns related to LNG at the Logistics Center site from 2016 was sent in a June 14, 2019 letter from DRN to the US Army Corps of Engineers Philadelphia District regarding this project.

vi. The Proposed Project Will Adversely Impact Marine Fish and Fisheries.

Activity that would adversely impact marine fish is discouraged. The unacceptable and unjustified harm to the Atlantic sturgeon, the shortnose sturgeon, and other fish and fisheries has the potential to have devastating, even catastrophic effects on these species that live in these marine waters. The subsection NJAC 7:7-16.2 states, in part:

7:7-16.2 – Marine fish and fisheries

(a) Marine fish are marine and estuarine animals other than marine mammals and birds.

Marine fisheries means:

1. One or more stocks of marine fish which can be treated as a unit for the purposes of conservation and management and which are identified on the basis of geographical, scientific, technical, recreational and economic characteristics; and
2. The catching, taking or harvesting of marine fish.

(b) *Any activity that would adversely impact the natural functioning of marine fish, including the reproductive, spawning and migratory patterns or species abundance or diversity of marine fish, is discouraged.* In addition, any activity that would adversely impact any New Jersey based marine fisheries or access thereto is discouraged, unless it complies with (c) below.” (Emphasis added)

These fish species will be adversely impacted and the critical habitat for the Atlantic sturgeon will be degraded through the Dock 2 activities. The applicant has not provided the protections that would prevent the harms that this subsection discourages in any materials provided to agencies thus far.

vii. The Proposed Project's Stormwater Management must be Evaluated to Ensure Adequate Protection of Groundwater.

7:7-16.6 – Stormwater Management

The project is required to comply with the NJ Stormwater regulations to prevent runoff, encourage infiltration of precipitation, and reduce flooding and adverse water quality and receiving stream impacts from increased volume and rate of stormwater and polluted runoff. The project has a general permit covering stormwater management but does not have a permit covering the industrial stormwater generated by the site. A NJ Pollution Discharge Elimination System (NJPDES) permit is required for the property, as confirmed by the Delaware River Basin Commission (DRBC) in its docketing of the Docket 1 original project in 2017 and the Dock 2 expansion in June 2019. The increase in volume and rate of flow of stormwater, the potential for pollutants to be carried in stormwater from the activities at the site, and the reduction of groundwater infiltration of precipitation are all impacts that are to be expected with the new impervious surfaces and the handling of dangerous materials at the Logistics Center. The day to day introduction of new hazardous materials such as NGLs and other liquid and dry cargo that may contain contaminants, the activities on the site that employ fuels such as diesel fuels, the deposition on land of polluting air emissions such as volatile organic compounds and hydrocarbons, the handling of chemicals, and the transloading of LNG and NGLs, all are potential sources of pollution that can deposit on the land and be carried into tributaries and the Delaware river in stormwater runoff. In addition to other pollutants known to already be present on this Superfund site that could be discharged in stormwater, PCBs are a documented ongoing pollutant of concern. It is essential that the release of PCBs from the Repauno property, including the Logistics Center site, be controlled to enable the cleanup of PCB contamination in the Delaware Estuary and Bay under the current PCB TMDL.

The control of the release of other contaminants that are in the groundwater and may be in soils and sediments at this site through effective stormwater management is also essential to provide the needed environmental protection and prevention of the migration and release of hazardous pollution. The planned handling, transfer, and storage of LHG, crude oil, other bulk liquids, and the presence and transloading of LNG at Logistics Center require effective stormwater management to prevent pollution and increased runoff resulting from the large increase in impervious surfaces and the handling and storage of hazardous materials on the site; expansive, mandatory monitoring of stormwater for contaminants is essential throughout the life of the project. The need for comprehensive and beneficial stormwater management at this site is discussed further in the Delaware Riverkeeper Network's June 7, 2019 comment to the DRBC regarding DOCKET NO. D-2017-009-2 , DELAWARE RIVER BASIN COMMISSION , Delaware River Partners LLC, Gibbstown Logistics Center, Dock 2 , Greenwich Township, Gloucester County, New Jersey. A copy of the comment is enclosed with this comment. The subsection NJAC 7:7-16.3 states, in part:

(a) If a project or activity meets the definition of “major development” at N.J.A.C. 7:8-1.2, then the project or activity shall comply with the Stormwater Management rules at N.J.A.C. 7:8.⁵

(b) Rationale: The Stormwater Management Rules (N.J.A.C. 7:8) specify standards for State, municipal and regional stormwater management. These rules provide minimum statewide runoff techniques, as well as special protection measures for environmentally sensitive water and land areas. Because development and land use activities contribute greatly to the types and amount of pollutants that are found in stormwater runoff, it is appropriate for major development projects in the coastal zone to comply with the Stormwater Management Rules’ standards.

viii. Project does not meet New Dredging Requirements under New Jersey State Law.

New dredging is considered acceptable if certain conditions are met, NJAC 7:7-12.7. Particularly important for this site is the condition that requires a demonstrated need that cannot be satisfied by existing facilities (NJAC 7:7-12.7(c)1) and also that special water areas not be significantly disturbed. The applicant does not satisfy these conditions through its NJWFD application. Instead, the NJWFD application Alternatives Analysis (Appendix E) relies heavily on the former use of the DuPont Repauno property and other industrial activities in the region to justify the Dock 2 additional activities and development. The proximity to Monds Island, Little Tinicum Island, the John Heinz National Wildlife Refuge at Tinicum and the naturally restored contiguous habitat on the Repauno property and some other fallow properties in the surrounding area is an important context not recognized or assessed in terms of impact of the activities that would be approved and enabled if this project is allowed to continue. This important setting must be considered under this subsection to assess the impacts of new dredging on these natural resources and features.

B. Army Corps must ensure the Public Interest Review Accounts for All Threats to Fish and Wildlife.

As part of its Public Interest Review, the Army Corps must consider the impacts on fish and wildlife from the project. As 33 CFR § 320.4(c), Fish and Wildlife, states:

“In accordance with the Fish and Wildlife Coordination Act (paragraph 320.3(e) of this section) district engineers will consult with the Regional Director, U.S. Fish and Wildlife Service, the Regional Director, National Marine Fisheries Service, and the head of the agency responsible for fish and wildlife for the state in which work is to be performed, with a view to the conservation of wildlife resources by prevention of their direct and indirect loss and damage due to the activity proposed in a permit application. The Army will give full consideration to the views of those agencies on fish and wildlife matters in deciding on the issuance, denial, or conditioning of individual or general permits.”

⁵ The referenced definition is: ““Major development” means any “development” that provides for ultimately disturbing one or more acres of land or increasing impervious surface by one-quarter acre or more. Disturbance for the purpose of this rule is the placement of impervious surface or exposure and/or movement of soil or bedrock or clearing, cutting, or removing of vegetation. Projects undertaken by any government agency which otherwise meet the definition of “major development” but which do not require approval under the Municipal Land Use Law, [N.J.S.A. 40:55D-1 et seq.](#), are also considered “major development.”” N.J.A.C. 7:8-1.2

The following are some of the reasons that the proposed project threatens fish and wildlife.

i. The Project Threatens Finfish Migratory Pathways.

Under New Jersey Law, The Coastal Zone Management Act identifies migratory pathways that are protected for finfish, these pathways are threatened by this project. The CZM states:

(c) Development which lowers water quality to such an extent as to interfere with the movement of fish along finfish migratory pathways or to violate State and Delaware River Basin Commission water quality standards is prohibited.

1. Mitigating measures are required for any development, which would result in lowering dissolved oxygen levels, releasing toxic chemicals, raising ambient water temperature, impinging or suffocating fish, entrainment of fish eggs, larvae or juveniles, causing siltation, or raising turbidity levels during migration periods.

In all materials DRN has seen related to the Logistics Center's proposal, there is no demonstration of the level to which the adverse impacts to the water quality in the active project area will be "minor" and "temporary" resulting from in-water dredging due to "potential increase in suspended solids". The Best Management Practices (BMPs) that would be employed do not address the ongoing stirring up of sediments with the operation and travel of ships to and from the berths and the potential for ship traffic and operations during transloading to interfere with fish migration and the habitat of the Atlantic sturgeon, shortnose sturgeon and anadromous fish species that are known to migrate through the region. The dredge equipment that would be employed to dredge the 665,000 cubic yards of sediment over 45 acres is described as an "environmental clam shell" and the barge design is said to minimize spillage and the release of turbid water. DRP has stated that the operation will be performed in a manner that limits dragging on the bottom of the river during dredging. However, it has also stated that adverse water quality impacts will nonetheless occur, demonstrating the lack of a fully environmentally safe dredging operation. It seems, based on the materials DRN has seen, that these environmental measures will be employed for contaminated sediments – will they be employed for all dredged sediments? The materials also state that the silt and sand sediments will be amended for truck transport but it is not stated what the amending agent would be. There are significant negative environmental and water quality impacts from certain amending agents. The use of amending agents must be fully disclosed to meet this subsection of the rule.

Further, the potential for the suspended solids to contain contaminants that are in the dredged materials, or are carried to the 45-acre area to be dredged with the stormwater and runoff pollutants or the groundwater base flow to the river and shallows from the Repauno Superfund site is not examined or discussed in any materials DRN has reviewed. Considering the long history of industrial use of the DuPont Repauno site and the use of the property for other industrial operations as well, there is a risk of stirring up and re-suspending contaminants through dredging and day-to-day operation at the berths and landside facilities that can in turn effect migrating finfish. This needs consideration and analysis prior to any approval from the Army Corps.

ii. The Project Threatens Submerged Vegetation Habitats and Fish that Depend on them.

Submerged Vegetation Habitat or Submerged Aquatic Vegetation (SAV) is protected under NJAC 7:7-9.6. SAV habitat is prohibited from being developed to protect these special habitats. A bed of submerged aquatic vegetation (American eelgrass) is located in the active project area but the applicant states it is being avoided. DRP's NJWFD Application Appendix C shows the extensive bed within the project area. A survey of the SAV bed immediately prior to the planned dredge operations must be done to accurately identify the SAV's location during the spring growing season. The applicant's consultant (Matrix) performed the survey in September 2018. Accurate location of the SAV bed is essential. The potential for damage to the SAV from shading from the trestle structure and ships is not explored in any materials DRN has seen concerning the proposed project thus far and must be.

iii. The Project Will Impact Endangered and Threatened Wildlife or Plant Species Habitats.

Under New Jersey Law, The Coastal Zone Management Act provides specific protections for endangered and threatened species under NJAC 7:7-9.36.

Development of endangered and threatened species (wildlife or plant) is prohibited unless an Impact Assessment demonstrates that there will be no direct or secondary adverse impacts *on the site or the surrounding area*. (Emphasis added) The materials reviewed by the DRN thus far does not demonstrate adequately that the Atlantic Sturgeon habitat will not be adversely impacted. Potential takes of the Atlantic Sturgeon and shortnose sturgeon is projected and can be expected.

The Delaware River Atlantic Sturgeon are currently being severely impacted by ship strikes along the Delaware River with the current level of shipping; any increase will have an adverse impact for both the Atlantic sturgeon and the shortnose sturgeon. The ramifications of increased ship traffic and ship strikes is serious and potentially catastrophic. The Delaware River population of Atlantic Sturgeon is genetically unique with a surviving population that includes less than 300 spawning adults.⁶ With numbers this precariously low, the responsibility for vigilant protection by our federal agencies could not be greater. The Delaware River population of Atlantic Sturgeon, along with the entire NY Bight Distinct Population Segment (DPS), of which the Delaware River population is a part, are designated as endangered pursuant to the Endangered Species Act. In addition, the Delaware River's population of Shortnose Sturgeon is listed as federally endangered and suffers low population figures. The endangered Atlantic and Shortnose Sturgeon and the designated Atlantic Sturgeon Critical Habitat will be impacted.

A study of mortality rates on Atlantic sturgeon in the Delaware River between 2005 and 2008 found that 50% of the mortalities were the result of vessel strikes. The remaining 50% were too

⁶ ASSRT (Atlantic Sturgeon Status Review Team) 2007. Status Review of Atlantic Sturgeon (*Acipenser oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

decomposed to determine if they were caused by vessel strikes but it is likely most were.⁷ According to a 2010 research article on vessel strikes, the majority (71%) of mortalities reported in spring during the months of May and June. The majority of vessel strikes appeared to result from interactions with large vessels, such as tankers, with a lower percentage likely resulting from interactions with small recreational or commercial fishing vessels equipped with outboard or inboard/outboard (stern drive) engines.

Atlantic sturgeon are demersal fishes and thus if the sturgeon are spending most of their time at the bottom of the water column, then they are most likely being impacted by larger vessels. Large vessels that transit the shipping channel typically draft close to the bottom of the channel, thereby posing a threat to sturgeon positioned close to the bottom of the channel.⁸ For small remnant populations of Atlantic sturgeon, such as that in the Delaware River, the loss of just a few individuals per year due to anthropogenic sources of mortality, such as vessel strikes, may continue to hamper restoration efforts.⁹

The report states, “Both the dredging to deepen the channel and the subsequent increase in large vessel traffic may further hamper the recovery of the Delaware River Atlantic sturgeon population.”¹⁰ Of critical importance, this study is concerned about the size of the vessels resulting from deepening as opposed to any increase in the volume of vessels. The larger size of the vessels from the deepened channel will likely increase the number of vessel strikes for both sturgeon species.¹¹ Between 2005 and 2008, there were 28 reported mortalities of sturgeon in the estuary. Half of those (14) were clearly from vessel strikes. If that is a constant trend, then around four or five sturgeon die every year in the estuary from vessel strikes. The potential for an increase in vessel strikes and Atlantic Sturgeon deaths is a critically important aspect of the Environmental Impact Statement that the Corps must conduct.

The continued dredging of new deep-water areas will further impact Atlantic sturgeon spawning by accelerating the intrusion of brackish water into the hard-bottom spawning grounds, and thus forcing Atlantic sturgeon to spawn further upstream in the zone of depressed dissolved oxygen. This shift then exposes the eggs and larvae of newly spawned Atlantic sturgeon to low oxygen conditions from which they may not survive. This “squeeze” between increased salt intrusion in the estuary downstream (exacerbated by channel deepening, new deep-dredged berthing areas, and rising sea levels) and the near-lethal dissolved oxygen levels upstream limits the ability of Atlantic sturgeon to successfully reproduce, and increases the likelihood of extinction. This project makes a significant contribution to such salt-intrusion by adding 45 acres of new deep-water channel and berthing to an estuary under siege.¹²

⁷ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁸ Brown, J.J., & Murphy, G.W. (2010). Atlantic Sturgeon Vessel-Strike Mortalities in the Delaware Estuary. *Fisheries*, Vol. 5, No. 2.

⁹ Ibid.

¹⁰ Ibid.

¹¹ Ibid.

¹² Moberg and DeLucia. 2016. Potential Impacts of Dissolved Oxygen, Salinity and Flow on the Successful Recruitment of Atlantic Sturgeon in the Delaware River. The Nature Conservancy. Harrisburg, PA. 69 pp.

The remobilization (and dewatering of dredged sediments) will create higher exposure to PCBs and other contaminants, and the Atlantic Sturgeon spawning and rearing that begins in June and extends the early-life-stages through July and August, with increasing evidence for high aggregations of young-of-year in the Proposed Project vicinity, means that elevated exposure will occur for larval and juvenile stages of this endangered species in the Delaware River. DRP's currently proposed BMPs methods such as avoidance, minimization, and mitigation and timing are insufficient to protect this endangered species habitat and the surrounding area, and further evidence and analysis is required regarding protection of the Atlantic Sturgeon and the shortnose sturgeon.

A report dated August 26, 2016 that was submitted to the New Jersey Department of Environmental Protection prepared by James Schmid and Company stated that bald eagles and ospreys nest on site.¹³ Further analysis is needed to ensure that the nearest bald eagle nest is on Monds Island, as DRP has stated in its materials thus far, and that the osprey nest on the relic piling at the Repauno site will not be disturbed by any environmental changes including noise, air emissions, construction, site activities and storage, shipping and related activities at Gibbstown Logistics Center. Additionally, other wildlife species and plant species have been identified over recent years at the Repauno site and further analysis is needed to accurately map all relevant habitat and the surrounding area that may be impacted by the Dock 2 activities and operations.

iv. The Project Will Impact State and Federally Protected Critical Wildlife Habitats.

The Coastal Zone Management Act provides specific protections for critical wildlife habitats under NJAC 7:7-9.37. Development that would negatively affect critical wildlife habitats is discouraged. In materials DRN has reviewed from the application, the applicant states that the NJ Natural Heritage Database and the NJ Landscape Project identified foraging habitat for the great blue heron. The applicant additionally states that a breeding colony of heron is located on Monds Island, one mile from the project site. Is this mile measured to the dock? Is the measurement from the Federal Navigation Channel where the ships would travel? It should be to accurately assess the impacts to these birds. The many species that may visit the site include the 26 bird species in the list provided by the applicant including the federally threatened Red Knot (*Calidris canutus rufa*), and Cooper's Hawk. Also identified for the site is the federally threatened bog turtle and a vernal pool habitat. It is stated that no critical habitat has been designated for Red Knot or the bog turtle. There must be field surveys to accurately identify habitat and individual species that are located on the site.

The applicant's NJWFD application Appendix B does not provide a comprehensive picture of the natural conditions on the larger property and the development site, to give context to the project area. The large contiguous acreage of the Repauno site and the area used by species has developed over approximately 30 years, as the former industrial Repauno site remained largely fallow. It is a 1,856-acre site located along the Delaware River in Gloucester County, NJ. The site is bounded to the north by the Delaware River, to the east by a former Hercules Chemical

¹³ Report to Delaware Riverkeeper Network from James A. Schmid, PhD. of Schmid and Company, Consulting Ecologists dated August 25, 2016.

manufacturing plant, to the south by the city of Gibbstown, and to the west by wetlands and Repauno Creek. The western half of the site consists almost entirely of surface water bodies and wetlands. The eastern half of the site also consists of some upland and wetland ecological communities.¹⁴ Altogether, the site contains approximately 1,500 acres of wetlands.¹⁵ The Logistics Center is planned to use 218 acres on the northeastern portion of the site. The largely natural area that had grown up on this property is ripe for the many species that could live here and must be fully investigated before the applicant can be considered in compliance.

C. The Project's Development Involves Special Hazards that must be Thoroughly Evaluated to Ensure Protection of Public Health and Safety.

During Army Corps' review of the project specific consideration must be given to these impacts as New Jersey Law provides specific protections for special hazard areas under NJAC 7:7-9.39. This subsection discourages development within or proximate to areas that pose special hazards. This subsection requires evaluation based on the LNG activities, including transloading, transporting into the site and shipping and the potential for hazards related to the transport into, loading, handling and storage of LHG, crude oil, and refined bulk liquids at the Gibbstown Logistics Center. Additionally, LNG poses many special hazards on its own discussed later in this comment. Finally, the former use of the site for munitions, the possible presence of hazardous residues or contaminants in the soil, sediment, materials on site, groundwater or surface water of the site must be evaluated for potential hazards.

This superfund site may pose a hazard. DuPont operated the site as an explosive manufacturing facility from 1880 to about 1950. In 1917, DuPont expanded operations to include the manufacturing of organic compounds, which continued until 1986. All explosive manufacturing and ammonia production were discontinued during the 1960s. Repauno is a Superfund site undergoing remediation.¹⁶ The area previously used by DuPont as a terminal location for anhydrous ammonia began being cleaned for reuse in 2002, according to the 2002 Annual Groundwater Progress report. One of the dangerous contaminants on the site is nitrobenzene, a highly toxic chemical classified by the Centers for Disease Control as "Immediately Dangerous to Life or Health" if people are exposed at specific concentrations. Nitrobenzene is a likely human carcinogen according to the US Environmental Protection Agency (EPA) and is linked to several carcinomas and cancers as well as other dangerous human health effects. The area where the logistics center would operate is the area most likely exposed to aniline, a toxic chemical with adverse health effects; aniline is involved with the processing of benzene to make nitrobenzene. The area where acids were used is also at least partly included in the logistics center active project area. Whether they are located in the areas adjacent to or effected by the Dock 2 activities needs to be evaluated through onsite sampling and mapping. These acids were most likely "mixed acids" associated with the nitrobenzene manufacturing process and are toxic.

¹⁴ EPA (2003). RCRA Corrective Action – DuPont Repauno Facility. *Documentation of Environmental Indicator Determination*. Retrieved from https://www3.epa.gov/region02/waste/dup_r750.pdf

¹⁵ Fichera, A. (2015). Land sale raises hopes for new South Jersey port. *Philly.com, March 22, 2015*. Retrieved from http://articles.philly.com/2015-03-22/news/60349872_1_port-facility-chemical-plant-gibbstown

¹⁶ See <https://cumulis.epa.gov/supercpad/CurSites/csinfo.cfm?id=0200783>.

In 1990, 8,500 tons of sediments were removed from the ditches in the former nitrobenzene and PMDA/DMT production areas.¹⁷ In the three rounds of site wide investigation completed in 1993, 1996, and 2000 respectively, DuPont screened all Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) for their investigation/remediation priorities and focused on the migration/flow of groundwater and the soils in former production areas. The currently ongoing fourth round of investigation is to complete the investigation of the remaining two SWMUs/AOCs and to conduct an ecological risk assessment for the wetlands, streams, and the ditch system.¹⁸

In 1985, DuPont installed a system to pump contaminated groundwater and to treat it. The groundwater interceptor system has been in operation since, in conjunction with a groundwater monitoring program, owned and operated by Chemours, DuPont's spinoff company, since 2015. Chemours is required to continue the groundwater interceptor system together with the site wide groundwater monitoring program to confirm that contaminated groundwater is under control. The current plans show that some monitoring wells that are located in areas planned for Logistics Center parking will be paved over, jeopardizing the continued use of these wells for monitoring the cleanup. This disruption of the sampling record must be avoided.

In addition, several different companies have leased areas at the Repauno facility. In 1998, Repauno Products LLC purchased the manufacturing operation that produced sodium nitrite and nitrosylsulfuric acid. In 1999, Spring AG purchased the industrial diamond refining operation, which ceased in late 2002. Industrial diamond processing may have used chemical vapor deposition or other dangerous processes that are used to manufacture industrial and synthetic diamonds, contributing additional contaminants to the site's environment that require investigation prior to use of the property. Furthermore, from reviewing numerous applications and materials concerning the project, DRN has seen claims that fill was placed on the property at some point. What was this fill and has it been fully tested and characterized? Has it been accurately mapped so sampling and analysis can be done? Additionally, there is fill being placed on the site currently. Contaminants in fill placed on the site from somewhere else, whether dredge spoils, imported material, or other fill, must be found, sampled for, and identified in order to fully answer the question of whether existing programs or plans for the site for Dock 2 will not pose a risk to public health and safety.

D. The Project Will Impact Local Historic, Cultural, Scenic and Recreational Values.

Army Corps must consider the projects impact to the local historic cultural and recreational values in its evaluation, 33 CFR 320.4(e):

(e) Historic, cultural, scenic, and recreational values:

Applications for DA permits may involve areas which possess recognized historic, cultural, scenic, conservation, recreational or similar values. Full evaluation of the general public interest requires that due consideration be given to the effect which the

¹⁷ EPA (2005). DuPont Company – Repauno Plant. *Region 2 RCRA Cleanup Fact Sheet*. Retrieved from <https://www3.epa.gov/region02/waste/fsdupont.htm>

¹⁸ Ibid.

proposed structure or activity may have on values such as those associated with wild and scenic rivers, historic properties and National Landmarks, National Rivers, National Wilderness Areas, National Seashores, National Recreation Areas, National Lakeshores, National Parks, National Monuments, estuarine and marine sanctuaries, archeological resources, including Indian religious or cultural sites, and such other areas as may be established under federal or state law for similar and related purposes. Recognition of those values is often reflected by state, regional, or local land use classifications, or by similar federal controls or policies. Action on permit applications should, insofar as possible, be consistent with, and avoid significant adverse effects on the values or purposes for which those classifications, controls, or policies were established.

The materials provided by the applicant to the various agencies so far fail to consider the important naturally restored condition of the Repauno property and adjacent, local and regional natural resources that would greatly benefit from preservation and protection. The loss of the natural condition, habitats, scenic values and quality of the Logistics Center site and the fragmentation of the natural systems in the surrounding area will be great. Fishing in the river is a popular recreational activity that may be negatively impacted or impinged upon. However, the applicant does not discuss, measure, or assess these impacts. The applicant simply relies on the 100-year historic use of the Repauno property prior to its abandonment as an industrial location. It has been decades since heavy industrial use of the property has occurred, and the natural environment has taken over the location and should be considered as a natural asset of great value. Fishing in the Delaware River and tributaries must be considered as a current recreational use of cultural importance. The current site and the river area is an amenity to the region, providing natural capital that contributes to the quality of life in the region. These assets and the impacts that would occur must be assessed.

The applicant's NJDEP Waterfront Development Application, Alternatives Analysis (Appendix E) does not consider the natural assets at the site. In fact, in the analysis, the applicant states in the Alternatives Analysis a circular justification for the project at this location stating that because the site is undergoing redevelopment as a marine terminal with Dock 1 and the associated landside development, it is "the most feasible alternative for the proposed project". Simply because the Gibbstown Logistics Center is being constructed does not provide justification or rationale for further impacting natural resources and assets for Dock 2.

i. Impacts to Archeological Resources Must Be Properly Accounted for.

Numerous documents DRN has reviewed including the NJWFD application, Appendix G Phase IA Historical & Archeological Resource Impact Survey and reports including the Phase I Underwater Archeological Investigations, Thompson Point, Repauno Site, Delaware River, Greenwich Township, Gloucester County, New Jersey and the Phase I Underwater Archeological Investigations, Thompson Point, Repauno Site, Delaware River, Greenwich Township, Gloucester County, New Jersey document historic and prehistoric resources at Thompson's Point which could be impacted by the proposed project. It is stated that there was a Native American archaeological site previously documented within the project site at Thompson Point, but that this location is not likely to yield significant Native American archaeological remains due to the changes in the environment over the years. One of the changes was the

potential location of an early historic site dating from the late 17th through the 19th century. Both of these archeological sites are expected to be too disturbed to be significant. However, only a Phase 1 survey has been done. The potential for finding important archeological resources at Thompson Point is great, due to previous findings. Sonar did yield some potential finds that are documented in these reports. DRN disagrees that further investigation under a Phase 2 study is not warranted. The cultural importance of prehistoric history is too great to be glossed over based on a guess that subsequent uses have destroyed the value of Thompson Point, which is famous in local lore as an important Native American site.

E. The Army Corps Must Evaluate the Project to Ensure Adequate Floodplain Management.

33 CFR 320.4 (l) Floodplain management.

(1) Floodplains possess significant natural values and carry out numerous functions important to the public interest. These include:

(i) Water resources values (natural moderation of floods, water quality maintenance, and groundwater recharge);

(ii) Living resource values (fish, wildlife, and plant resources);

(iii) Cultural resource values (open space, natural beauty, scientific study, outdoor education, and recreation); and

(iv) Cultivated resource values (agriculture, aquaculture, and forestry).

(2) Although a particular alteration to a floodplain may constitute a minor change, the cumulative impact of such changes may result in a significant degradation of floodplain values and functions and in increased potential for harm to upstream and downstream activities. In accordance with the requirements of Executive Order 11988, district engineers, as part of their public interest review, should avoid to the extent practicable, long and short term significant adverse impacts associated with the occupancy and modification of floodplains, as well as the direct and indirect support of floodplain development whenever there is a practicable alternative. For those activities which in the public interest must occur in or impact upon floodplains, the district engineer shall ensure, to the maximum extent practicable, that the impacts of potential flooding on human health, safety, and welfare are minimized, the risks of flood losses are minimized, and, whenever practicable the natural and beneficial values served by floodplains are restored and preserved.

(3) In accordance with Executive Order 11988, the district engineer should avoid authorizing floodplain developments whenever practicable alternatives exist outside the floodplain. If there are no such practicable alternatives, the district engineer shall consider, as a means of mitigation, alternatives within the floodplain which will lessen any significant adverse impact to the floodplain.

The entire Logistics Center is located within the Flood Hazard Area, as defined by New Jersey regulations. The infrastructure for the Dock and berths is located in the Delaware River and the dredging between the riverbank and Dock 2 will connect the Dock 2 to the federal navigation channel. The Department only approves activity in a channel under certain conditions. One key requirement of New Jersey Regulations pertaining to floodplain management, NJAC 7:13-11.1(b)4, is that there is enhancement of aquatic habitat where prevention is not possible. In materials DRN has seen from the application so far, the applicant addresses this requirement in a cavalier fashion, without any enhancements provided. The applicant simply states that some natural features were avoided and does not address the needed to replace the value of what is negatively impacted. One example is throughout the NJWFD application; the applicant is denying harm and promising avoidance and best management without fully assessing the natural resources, without on-the-ground analysis of natural conditions in the surrounding area and on the site, without acknowledging the natural resources and species in the region, and only choosing to examine the project as they envision it.

F. Public Review Process Must Account for All the Project's Environmental, Health and Safety Impacts.

Under 33 CFR 320.4(p) Army Corps must consider the environmental benefits and detriments of the project during its Public Interest Review, 33 CFR 320.4(p) states:

(p)Environmental benefits, states:. “Some activities that require Department of the Army permits result in beneficial effects to the quality of the environment. The district engineer will weigh these benefits as well as environmental detriments along with other factors of the public interest.”

The construction and operations of the Logistics Center have significant ramifications environmentally, for public safety, and for shipping on the Delaware River system. This comment has identified numerous environmental health and safety issues throughout it. Including but not limited to:

- Analysis of the unique risks and dangers presented by LNG transport, storage and handling;
- Accounting for the risks associated with increase truck traffic;
- Accounting for the risks associated with increase vessel traffic;
- Potential for leaks and accidents with the LNG materials;
- Threat of PCBs release; and
- Threats associated with construction and operation on a superfund site.

The National Environmental Policy Act Review Mandates that the Army Corps Create an Environmental Impact Statement for the Project.

Given the numerous issues with the project DRN is outlining in this comment, the US Army Corps of Engineers (Army Corps) must fulfill its legal obligations pursuant to the National Environmental Policy Act (NEPA) by undertaking the necessary review required by NEPA – issuing an Environmental Impact Statement (EIS). Issuing an Army Corps approval for the

Gibbstown Logistics Center (CENAP-OP-R-2016-0181-39), which now undeniably includes an LNG export operation, without a proper EIS would be a violation of federal law that will be subject to legal challenge.

NEPA is our “basic national charter for protection of the environment.”¹⁹ NEPA makes environmental protection a part of the mandate of every federal agency²⁰ by requiring that federal agencies take environmental considerations into account in their decision-making “to the fullest extent possible.”²¹ Pursuant to NEPA, federal agencies must consider environmental harms and the means of preventing them in a “detailed statement” before approving any “major federal action significantly affecting the quality of the human environment.”²² This required analysis serves to ensure that “the agency will not act on incomplete information, only to regret its decision after it is too late to correct.”²³ Approval of the LNG export facility proposed definitely meets the standard of requiring NEPA review.

A proper NEPA assessment must fully assess and disclose the complete range of environmental consequences of the proposed action, including “ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, [and] cultural” impacts, “whether direct, indirect, or cumulative.”²⁴ Direct effects are “caused by the action and occur at the same time and place.”²⁵ Indirect effects are those impacts that are caused by the action, but occur “later in time or farther removed in distance, but are still reasonably foreseeable,” and may include “growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.”²⁶ Cumulative impacts are “impact[s] on the environment which result[] from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.”²⁷ NEPA also prohibits segmentation in order to avoid full and fair review of the implications and impacts of a project or action.

LNG has significant ramifications environmentally, for public safety, and for shipping on the Delaware River system.

¹⁹ 40 C.F.R. § 1500.1(a)

²⁰ See 42 U.S.C. § 4332(1).

²¹ 42 U.S.C. § 4332.

²² Id. § 4332(2)(C).

²³ *Marsh v. Oregon Natural Res. Council*, 490 U.S. 360, 371 (1979).

²⁴ 40 C.F.R. §§ 1502.16(a), (b); 1508.8.

²⁵ 40 C.F.R. § 1508.8(a).

²⁶ 40 C.F.R. § 1508.8.

²⁷ 40 C.F.R. § 1508.7 (emphasis added).

Many of these ramifications have been included in this comment. However, we illustrate here some of the issues that must be addressed in an EIS pursuant to NEPA. The Army Corps must conduct a full analysis of a wide array of issues including but not limited to:

- the safety, pollution and health implications of trucking;
- the ramifications of storing LNG on a ship while it is slowly loaded over a period of at least 15 days; what LNG exports from Gibbstown means for shipping, ship traffic and the business operations of other shippers operating through Delaware River ports;
- the climate change and other environmental impacts of exporting LNG from this site including the onsite impacts, but also the ramifications from the gas extraction activities and greenhouse gas emissions that will be induced/supported by this operation and the downstream impacts from the use of the gas;
- the safety ramifications of having an LNG operation of this kind on the Delaware River including for the surrounding community;
- the implications for other shippers and port operations (there is anticipated to be at least 2 LNG export operations a month – 24 a year – from this site and additional LHG shipping events);
- the impacts on the endangered Atlantic and Shortnose Sturgeon or the designated Atlantic Sturgeon Critical Habitat in the Delaware River;
- the water quality and invasive species ramifications due to the release of ballast water from LNG ships;
- the air and other ramifications of flaring off of gas and/or the construction and operation of a small capacity liquefier on site;

It is notable that in a November 16, 2017 letter to the US Coast Guard (when only one Dock and berth was proposed), DRP states that there are limitations caused by having just a single-berth at this site while also accommodating an LNG operation there – i.e. that “LNG, LHG, or other hazardous or non-hazardous cargo operations will not run concurrently, as the single-berth wharf only permits one vessel to dock at a given time for a single commodity.” Clearly, the applicant and the agencies knew that LNG was an intended goal of this project whether it was a single-berth or two-berth design and so there is no excuse not to have considered the impacts that constructing and operating an LNG export facility at this site at the time of review of Stage 1 for Dock 1 (including the delivery of LNG by rail and truck) as well as during the current Stage 2 of this project and there is no excuse for not having notified the public of this intended use in the Army Corps’ April 4, 2019 Public Notice.

In addition, there must be full EIS consideration of the proposed Liquefied Hazardous Gas (LHG) handling facility proposed for the site. According to the November 2017 letter to the Coast Guard the LHG operation at that time was anticipated to include 24 vessels a year (2 a month) from Dock 1 creating additional potential pressures for Delaware River port traffic, particularly when considered along with the currently anticipated 24 vessels a year of LNG. In addition, there will be constructed ~100,000 BBL of onsite storage, the use of the underground cavern, and the additional employment of the shipping vessels for storage in order to increase the onsite storage capacity. LHG will be brought to the site via rail car and/or truck, the environmental and safety ramifications of which have not been analyzed. Furthermore, the environmental and safety ramifications of the volume of LHG to be delivered, stored, and

exported for sale; the frequency of deliveries; the details of off-loading and on-loading operations; and the full scope of the rail delivery system have not been analyzed in any documents reviewed by DRN. The project includes at least ~3 acres of storage tanks, including at least one sphere tank, a subsurface cavern and associated equipment as additional project elements that essentially turns the site into a storage facility or “tank farm”, which is discouraged by state regulations on riverfront lands. Mentioned in the 2017 Letter of Inquiry to the Coast Guard is a “small capacity” liquefier that consists of a “cold box”, compressor, N2 tank and a cold storage bullet tank (1430 BBL capacity), a flare, a gas separator, and a Thermal Oxidizer.²⁸ The placement, management, and operation of all of these facilities on the site must be fully analyzed in combination with the LNG/LHG activities at the site.

It is important to consider that the November 2017 letter to the Coast Guard was for only Dock 1; the expanded LHG activities related to Dock 2 are not divulged in any documents that DRN has reviewed. The LHG information requires a full analysis by the Army Corps, particularly the ramifications of the extensive storage of LHG at the site, the proximity of LHG storage to site operations, including the rail yard, and other ramifications of having both the proposed LNG and LHG at the same location.

Below DRN highlights the most pressing issues that must be addressed in the Environmental Impact Statement for the Project. In addition to the issues identified below, Army Corps should include the pressing issues identified in the previous section addressing Army Corps’ Public Interest Review.

A. Army Corps’ NEPA Review Must Include a Thorough Cumulative Impacts Analysis, Including the Impacts Associated with Climate Change.

As explained in an article about LNG-powered ships in Washington State, natural gas is composed mostly of methane, which is one of the four major greenhouse gases and a culprit in the global warming of our atmosphere, exacerbating climate change. Moreover, methane leaks throughout the entire gas development process, from fracking at the extraction well, through pipeline and compressor delivery systems, during storage and in end use such as power plants and gas processing and petrochemical facilities, including when it is used for fuel in shipping. The article states “The International Coalition for Clean Transportation estimates 2.2-4.6% of methane on ships escapes into the atmosphere after passing through the engine without combusting. This is known as methane slip and its rate depends on the type of engine.”²⁹ It explains further, that “Again, LNG is composed chiefly of methane, which is itself a nasty greenhouse gas – 86 times worse than CO2 over a 20 year span and 36 times worse over a 100 year span. New research actually suggests that those numbers may be underestimated by as much as 14%. This means that we don’t want to be adding any more methane to the atmosphere and, in fact, scientists point out that we can have more immediate impacts on lessening climate change by reducing methane since it doesn’t last as long in the atmosphere as CO2. Alarming,

²⁸ Letter to Captain Scott Anderson, Captain of the Port, USCG Sector Delaware Bay, from AcutTech, November 16, 2017.

²⁹ Villa, Daniel, *The Origins of LNG as a Maritime Fuel*, 350 Tacoma, June 21, 2018. Available at <https://www.350tacoma.org/the-origins-of-lng-as-a-maritime-fuel/>.

US methane emissions have risen 30% in the past decade thanks mostly to the central US, a hotbed of fracking.’³⁰

The impacts of greenhouse gas emissions that will be released by this project are substantial and can be minimized if gas products – LNG and NGL – are eliminated as cargo that will be handled at the Logistics Center. Methane and carbon are leaked, released or burned through the full life cycle of the hydraulically fractured (fracked) gas produced for this project – from extraction by fracking through delivery systems such as pipelines and compressors to the liquefaction plant, the processing at the LNG liquefaction plant, the transport by truck, rail, or pipeline to the export terminal, any interim storage, transloading of the material the storage in the ocean-going vessel and then the final re-gasification of the LNG and its end use.

This uncontrollable and inefficient process is also deadly in its effects on atmospheric warming and the climate crisis we are facing globally. It is irresponsible and shortsighted to support the further development of fracked gas projects. A climate change impact analysis must be done for this project to measure and then assess the potential effects of the **full life cycle** of LNG and NGL greenhouse gas emissions and climate change effects that would be produced for the Logistics Center.

B. The Public Safety Analysis Must Include and Account for all of the Known and Potential Threats to Environmental, Health and Safety Implicated by The Project.

i. The EIS Must Be Sure to Evaluate All Risks Associated with the Handling of LNG at this Site.

It is essential that the Army Corps’ review process include all relevant details about the LNG project. LNG has significant ramifications environmentally, for public safety, and for shipping on the Delaware River system.

DRN provides the following information about the unique dangers of LNG and its transport, storage, and handling, illustrating that LNG is a special product that needs specific conditions that DRN does not consider to be available at this site or within the Delaware River Watershed:

It is known that, upon release in a liquid state, LNG expands to a gas cloud that is 600 times larger than the amount of liquid. The gas cloud then moves across the surface, can travel many miles quickly and can also become trapped under spaces that confine the gas, providing the conditions that cause explosion and, if there is a point of ignition such as a spark or flame, fire will result.

New information has shown that LNG can cause a catastrophic BLEVE or Boiling Liquid Expanding Vapor Explosion if the vessel is exposed to high temperatures or a fire. The expansion of the liquid LNG in a vessel causes the pressurized liquid to boil, and the gas takes up more room than the liquid, stressing the container as pressure builds. Relief valves are only designed to release pressure slowly to keep equilibrium in the pressurized container. Exposed to high heat, the valve will fail to keep up and the metal will weaken, cracks will result in the

³⁰ Ibid.

container, causing LNG to be released with an explosion. The result is a BLEVE, a catastrophic failure of the container. There are many incidents over the years of BLEVE catastrophes, some as recent as 2019, but the fact that a BLEVE can occur with LNG has only recently been established.

When the gas or vapor cloud in the container is released, because it is flammable it is likely to ignite after the BLEVE, typically causing a fireball that burns fast, hot and wide. A fuel air explosion can also occur, known as a “vapor cloud explosion”. A vapor cloud explosion is the mechanism used in a thermobaric weapon that uses air to generate a high-temperature explosion, producing a long duration blast wave. These weapons are also termed a fuel-air bomb. This is the threat that LNG storage and transport brings to the Gibbstown region and to every traffic route used to carry the LNG to the Delaware River and on the river during export.

On dry land such as a terminal where LNG is stored or is contained in tankers on trucks or rail cars, a BLEVE where there is no liquid in the local environment to absorb the heat, can rupture even faster than a vessel on water. Truck transport regulations are being closely examined due to an increase in accidents involving truck transport of LNG. While it used to be assumed that truck transport had a low potential for explosion or fire, an accident in Spain changed that:

In 2002, an LNG truck in Spain flipped over, burned, then exploded into a 500-foot fireball that killed the driver and burned two others. ‘The severity of this kind of explosion is something people haven't usually considered applicable to LNG trucks,’ says Jerry Havens, former director of the Chemical Hazards Research Center at the University of Arkansas. ‘But what happened in Spain changes that picture. It shows you've got the potential for a massive explosion’.

In the accident in Spain, a BLEVE occurred, which resulted in death to the driver and burns to two people approximately 650 feet away, and threw large flaming debris, including the truck’s diesel engine, for 853 feet. A similar LNG truck accident with a catastrophic fire occurred in Spain in 2011, killing the driver. It was pointed out by an analyst in Savannah Georgia during debate over LNG truck transport that a pool fire and and/or explosion involving an LNG truck may have a low probability, but it has a high consequence with instant injuries or death for those within several hundred feet. The chances, according to the analyst, of an LNG truck accident are 200 to 1. This is a great risk for populated areas and truck routes through urban centers. The potential impacts of the transit of trucks to the site and the parking, movements, unloading and exit of the trucks must be fully examined for risk of accidents and resulting damage to people and the environment.

In the event of a release of LNG, the LNG must gas off naturally, as the container cannot be capped or interacted with, the area must be immediately evacuated and secured, ignition sources must be eliminated, and water cannot be used, as the release is cryogenic. Water can plug the valves of the container with ice and any cold air release can freeze skin in seconds and can even turn air to liquid or solid form, removing oxygen, an obvious disaster for anyone in the area.

These handling procedures apply to any container of LNG under pressure, including those used in transportation such as truck or rail containers or storage vessels at a terminal, ships, or at a

liquefaction facility.³¹ The dangers of an LNG release and fire from a tank accident are unique to LNG and require special handling due to the highly dangerous properties of the LNG and its gases. This is well illustrated in a report of an LNG tank truck accident in Belgium, which has been used as a “lessons learned” example by first response trainers.³²

When a fire erupts around or under a LNG container, it can cause a BLEVE quickly, in as little as 15 minutes for a large tank (2 ½ minutes for a small tank). Once a fire ignites around the container, the 2000 Department of Transportation (DOT) Emergency Response Guidebook (ERG) states that a 1,600-meter perimeter must be isolated around the container, as explained in the relevant text at Guide #112, the same as for explosives such as bombs and artillery. Since water cannot be used to cool the container or extinguish the fire, and the evacuation area is so large, the fire response is, especially if there are no lives at risk, for firefighters and first responders to evacuate the 1,600-meter area and let the fire burn out, similar to the response to crude oil derailments that risk explosion.

In fact, even removing the damaged container can be risky. An example of how firefighters in Utah decided to handle a train derailment with damaged propane tanks illustrates the risks – it was less dangerous to detonate the cars in place than move them.³³ Of course, this is not possible in a populated area, begging the question of how much risk for communities is involved with flammable liquid in rail cars.

This makes the transport of LNG in containers and the storage of containers of LNG inherently dangerous and inappropriate for populated areas. The proposed Logistics Center is located next to a residential area in Gibbstown. There is a day care center, public school and Little League athletic fields, public buildings, the U.S. Post Office, a Methodist Church, the local VFW Post, and housing in Gibbstown adjacent to the Block and Lot of this site. These residential and community uses are not compatible with the proposed activity, especially if the activity includes handling of hazardous substances such as LNG or LHG or other bulk liquids (crude oil is another liquid mentioned as a possible cargo). Prevention of exposure to toxics and hazardous materials is the only way to provide protection to the especially vulnerable population of children at a daycare center, school or out on an athletic field and to the workers, residents and families who are located adjacent to or who use the public buildings and government centers in the area around this the site.

The transport routes, not yet identified by New Fortress Energy, are through communities across Pennsylvania and New Jersey, from a proposed LNG processing plant that the parent company, New Fortress Energy, wants to build in Bradford County, PA (approximately 175 miles away by roadway). Has the proximity of the LNG activities to structures, receptors, and residences been

³¹ PHMSA, “Safe Transport of Energy Products”, <https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/research-and-development/hazmat/58176/day-1-pm-2.pdf>

³² Vollmacher, Kurt and Tom Van Esbroeck, “Accident Involving LNG Truck”, CTIF Commission for Extrication & New Technology, October 16, 2017, available at: <https://www.ctif.org/sites/default/files/2018-09/Retex%20LNG%202018%2006%2006%20ENG-reduced%20size.pdf>.

³³ Mikaulka, Justin, “Trump Order to Allow LNG by Rail Would Expand ‘Bomb Train’ Risks”, DeSmog Blog, April 17, 2019, available at <https://www.desmogblog.com/2019/04/17/trump-executive-order-lng-rail-bomb-train-risks>.

calculated and are there sufficient separation distances as required by U.S.DOT? US DOT has requirements for thermal radiation and vapor dispersion hazard-based exclusion distances around land based, fixed LNG terminals.³⁴ This is an essential analysis for the protection of Gibbstown, the transportation routes, and the region.

Another important consideration is the use of trucks to carry the LNG product will increase emissions of natural gas constituents, including methane, into the air and will emit hazardous air pollutants due to diesel exhaust. The emission of air pollutants to communities along the transport route unjustly exposes people to health hazards that they may be unaware of due to the transient nature of the vehicles. There should be an analysis of the truck route impacts on communities, environmental justice areas, and areas such as the Delaware River valley where the federal government has already declared a non-attainment area for ground level ozone under clean air regulations, causing smog and the resulting respiratory and other adverse health effects that accompany air pollution and the deposition of air pollutants on water, such as the Delaware River, the water supply for millions in the region. The venting of the trucks (or railcars) en route to avoid over-pressurization must be assessed.

Finally, there is not enough information to assure that LNG handling and transport can be done safely. It is important to err on the side of precaution and prevention of hazards by avoiding populated areas and areas with sensitive environments. The advice under current regulations that govern LNG activities is to avoid substantial risks by locating LNG activities in sparsely populated areas and areas without vulnerable environmental resources. These are not the conditions at the Logistics Center on the Repauno site.

The Pipeline and Hazardous Materials Safety Administration (PHMSA) has been researching LNG handling but their research is far from complete. Gas Technology Institute (GTI), the agency's chief consultant firm on risk analysis, outlined PHMSA's LNG facility "release-risk" research in two recent presentations. The GTI reports suggest what PHMSA should be doing to assess LNG transportation risks and regulatory standards. The GTI 2018 research program report summary shows a vigorous and worldwide search of the most relevant LNG facility failure data. Some of these, GTI noted, were "quite dated and not reflective of modern design practices."³⁵ The reports show how outdated many of the US LNG facility regulatory standards are and underscores the need for consistent national industry/agency approaches to the most basic standards concerning LNG facility Design Basis Accidents. GTI 2018 mentions no LNG or other refrigerated liquids transportation-related data except for potential failures of onsite LNG truck loading transfer line operations. The Corps should obtain and assess this data for the EIS for the Logistics Center.

GTI recommends a new updated US LNG facility survey of equipment failure every 5 years, given technological facility and operational changes, adding "but no industry or federal funding was made available for this purpose."³⁶ Without up to date and comprehensive data on fixed

³⁴ 49 CFR Part 193.

³⁵ Khalid Farrag, Ph.D., P.E., PMP, Senior Institute Engineer, R&D Manager, Gas Technology Inst., *PHMSA-Supported GTI LNG Research Program*, September 11-12, 2018.
<https://primis.phmsa.dot.gov/rd/mtgs/091118/GTI%20-%20Khalid%20Farrag.pdf>

³⁶ Gas Technology Institute, GTI PROJECT NUMBER 21873, *Statistical Review and Gap Analysis of LNG Failure Rate Table*, Jan. 11, 2017.

LNG facilities, how can transportation and transloading of LNG be accurately assessed in terms of setback distances from transportation and terminal activities, or safety and health issues? The Army Corps must assess setback distances and equipment safety in the EIS.

ii. The EIS Must Evaluate All Risks Associated with the Increase of Trucking and Traffic Due to the Project.

A proper EIS analysis includes but is not limited to the safety, pollution and health implications of trucking. The anticipated truck traffic created by the LNG facility for the local community has the likely potential of being quite massive. In the initial Letter of Intent to the Coast Guard in 2017, the applicant stated the truck rack that would directly transfer, or “transload”, the LNG from the trucks to the ships was being designed to handle 200 to 220 trucks per day with the potential for raiing in the significant volumes of LNG. This would presumably equal 400 to 440 truck trips per day (truck trip = in and out of the facility). The estimate for the annual volume of LNG that would be shipped out of the port was 1.5 million metric tons per year in the initial Letter of Intent to Coast Guard, which is now potentially tripled for LNG and LHG due to two additional berths. Neither the Army Corps Public Notice dated July 13, 2019 nor the Public Notice dated April 4, 2019 provide any estimate of the volume of LNG to be exported from the facility on a daily, monthly or annual basis.

There are varying estimates of truck and vehicle traffic that will be generated by the facility included in several documents DRN has reviewed. In the Army Corps of Engineers’ Public Notice dated July 13, 2019 the total number of truck trips is estimated to be 360, or 15 truck trips per hour, 13 of those exclusively for LNG. The Army Corps of Engineers’ Public Notice also states that a new access road will be built for the facility so that trucks will bypass the residential areas of Gibbstown and limit truck traffic impacts on the local community. The Corps states that it will review this component of the project due to “the single and complete/reasonable related nature of this component” even though this will not require any approvals from the Corps. The Public Notice states that the Truck Bypass (the “Route 44 Bypass”) will be built by Gloucester County.

The number of trucks estimated in the February 2019 McCormick Taylor Drainage and Storm Water Management Report for the Route 44 Truck Bypass³⁷ for the Logistics Center is starkly different and much greater than the number estimated in the Army Corps’ Public Notice. According to the stormwater report, the current average number of trucks on Route 44 is 143 trucks per day on the eastern end and 92 trucks per day on the western end. After the Logistics Center is completed, the facility will generate approximately 1,650 truck trips per day, according to the report. The report continues, “These land uses are expected to generate approximately 8,450 daily trips to-from the DuPont Repauno site, including nearly 1,650 truck trips.”³⁸

In a Technical Memo submitted to Greenwich Township by Langan Engineers in July 2019, it is stated that the approved Redevelopment Plan for the property limits traffic prior to the

³⁷ McCormick Taylor, “Drainage and Storm Water Management Report for the Route 44 Truck Bypass and DuPont Port Access”, Township of Greenwich, Gloucester County, February 13, 2019.

³⁸ Ibid. page 2.

completion of the Route 44 Bypass to 550 vehicle trips per day. The Memo gives estimates for various stages of construction related to Phase 1 of the project at startup of construction before the Route 44 Bypass. It covers construction and administrative traffic and operational traffic for cavern filling and sales of butane, the only current operational activity at the site. The total during the “Fill Import Phase”, which will be the placement of fill to raise the site, is estimated at 426 truck trips per day. The total during rail rack construction phase is estimated at 186 trips per day and the total after rail rack construction is estimated to be 94 trips per day. This is all prior to shipping from either Dock 1 or Dock 2 and prior to the use of the proposed Route 44 Bypass.³⁹

In its application to the New Jersey Department of Environmental Protection for a Waterfront Development Permit, the applicant states that there will be secondary impacts due to increases in truck traffic but that the Gloucester County Improvement Authority is going to construct a bypass road for traffic to be routed around downtown Gibbstown.⁴⁰ No details are provided about the “secondary” impacts.

In the Greenwich Township Zoning and Hearing Board meeting minutes of June 2019 the mayor stated that it would be 1 to 1.5 years before the Bypass would be completed. It was also stated in the minutes under “Kernan: His review letter dated 5/6/19”. that “The hope is that the Bypass will be completed before there is a traffic snarl. Time (*sic.*) asked that a trip generation would be a condition of approval for future applications”.⁴¹ (That trip generation memo has been produced by Langan Engineers as discussed above). Traffic, including truck traffic, is clearly a concern for the municipality, the County, and the region but it does not seem to be required that the Bypass be completed prior to use of the site. In fact, DRN understands that truck traffic for NGL operations is already traveling in and out of the site, delivering NGL, using local roads in the residential area. Of course, because Stage 1 of the project and Dock 1 are under construction now, construction traffic is using the local roads, including Rt. 44 and residential streets through Gibbstown’s residential and business areas. Timing of the Bypass and the use of local roads for the enormous increase of truck and vehicular traffic generated by the Logistics Center is a critical part of the analysis of the impacts of the activities and operations at the Logistics Center on the area.

The issue of conflicting and incomplete or partial estimates of truck traffic and other traffic in and out of the site remains an issue that must be accurately assessed. The Logistics Center is expected to generate extremely large increases in truck traffic and other motor vehicle traffic. The Corps has deferred assessing the impacts of rail traffic at this time due to the lack of approval by the federal government for the use of rail cars for the transport of LNG. However, rail is expected to be used for LHG (natural gas liquids) and rail track improvements are reportedly already underway at the site. The accompanying air, noise, and light pollution and health and safety threats are important aspects of the Corps’ EIS examining the truck and vehicle traffic. DRN considers it essential that potential rail impacts be considered at this time as well so

³⁹ Langan Engineers, *Technical Memorandum re. Trip Generation DR Partners, Repauno Port and Rail Terminal, LPG Transloading Facility Site Plan Application*, Greenwich Township, July 12, 2019.

⁴⁰ Ramboll, “Compliance Statement in Support of WFD Individual Permit Application Dock 2 – DRP Gibbstown Logistics Center, 1690000609-001”, February 2019, page 26.

⁴¹ Greenwich Township Planning & Zoning Board, June 3, 2019 MINUTES, page 3.

the environmental analysis does not to avoid the cumulative assessment needed for all modes of transportation.

iii. **The EIS Must Evaluate the Potential for Accidents and Other Risks Associated with LNG Leaks.**

The risks of handling LNG are discussed earlier in this comment. Leaks in containers can cause cracks that expand to allow leakage of LNG, which vaporizes on release and, as discussed, can cause explosion and/or fire with catastrophic consequences. In a technical paper presented at the Probabilistic Safety Assessment and Management PSAM 12 Conference, June 2014, the authors use a methodology for risk analysis of LNG carriers operations aiming at defining the most critical pieces of equipment for avoiding LNG leakage during loading and unloading operations.⁴² This is an important analysis because it examines the ways that the unloading and loading operations of LNG pose specific risks and require certain safety measures. It is critical that an assessment be performed by experts of the safety measures and equipment to be employed at the Gibbstown Logistics Center, especially considering that the transloading of LNG is dangerous and can result in significant damage and injury, depending on the part of the equipment that fails. The consequence categories that are examined in Table 4 show categories of harm from negligible, to Marginal, to Critical and to Catastrophic. In the Critical category, lesions of moderate severity in employees, contractors, and/or people from outside the facility and minor lesions in “third parts” are projected to occur. In the catastrophic category, death or serious injuries to one or more people are projected. These scenarios will also severely damage or irreparably damage equipment or in the facilities. The probability of these and other less damaging categories of consequences is based on the equipment that fails and the failure rate. The paper concludes that the method used to assess risk helps to determine the critical components of transloading operations and equipment and the importance of gas detection; low temperature monitoring, heat, and fire detection; and emergency shutdown systems. The paper shows that improving operational safety can be achieved through understanding reliability of equipment more fully and developing specific maintenance procedures for that equipment.

A paper examining what can occur during the transloading of LNG to a carrier employs a risk-based analysis method, applied to a LNG shipping operation terminal. The possible causes of leakage are identified and the consequences classified. Among other findings is that the “probability of accidents is greater during cargo loading and unloading operations due to the great number of systems and pieces of equipment involved in those operations.”⁴³

It is crucial that the transloading of LNG from trucks or rail to the ship is fully and comprehensively assessed in terms of safety and operations of equipment considering the inherent dangers and higher risk factors that come with loading the ships 24 hours per day, continuously filling the shipping vessel day in and day out. It is also essential that all containers

⁴² Arthur Henrique de Andrade Melania, Dennis Wilfredo, Roldán Silvaa, Gilberto Francisco, Martha Souza, “Use of Bayesian Network to Support Risk-Based Analysis of LNG Carrier Loading Operation”, University of São Paulo, São Paulo, Brazil, 2014, downloaded 7.2019 at http://meetingsandconferences.com/psam12/proceedings/paper/paper_112_1.pdf

⁴³ G. F. M. Souza, D. W. R. Silva “Risk-Based Analysis of LNG Carriers Loading and Unloading Operations”, Proceedings of the 22th International Offshore and Polar Engineering Conference, ISOPE, 2005, Rhodes, Greece.

including trucks containing LNG that are on the site for transloading be evaluated for the potential for leaks, cracks, and container failures. Setback distances based on “blast zone” probabilities must be set to prevent public health harms. The location of Dock 2 on the Delaware River near sensitive ecological resources, within 1 mile of residential neighborhoods in Gibbstown and the employment of workers at the Logistics Center must be assessed in light of the potential for accidents associated with LNG leaks.

iv. The EIS Must Evaluate the Safety Issues of Simultaneous Handling of LNG And Other Cargo.

Another question that must be answered is whether simultaneous handling of LNG and other cargoes, including dangerous NGLs, can be done safely. If the transloading to the ship from truck or railcar is considered similar to “truck to ship bunkering” when assessed by the U.S. Coast Guard, there are Coast Guard regulations that apply to these activities when there are SIMOPS or “simultaneous operations” planned in the same vicinity. The usual procedure is for a Policy Letter to be issued by the Coast Guard after the specific logistics are evaluated.⁴⁴ Similar to SIMOPS considerations, it is additionally important to evaluate the activities and storage planned for export of other products such as NGL from the terminal for compatibility with LNG activities. An informed decision needs to be made about timing, location, and proximity to the LNG facilities and activities. It may be that other activities planned for the terminal cannot occur under any circumstances at the same site that is handling LNG.

C. Impacts to Water Resources, Including Surface Water and Groundwater Impacts Must be Fully Considered.

The former use of the site for munitions, the possible presence of hazardous residues or contaminants in the soil, sediment, materials on site, groundwater or surface water of the site must be evaluated for potential hazards.

i. An EIS Must Evaluate the Threats to Groundwater from the Project.

This superfund site may pose a hazard to groundwater. As discussed in more detail earlier in this comment under D., groundwater has been contaminated by industrial activities at the property for more than 100 years, primarily by DuPont. The potential for changing the movement of pollutants through groundwater and disrupting environmental conditions that could result in the release of dangerous contaminants further into the environment through existing and new pathways is great due to the extensive construction and the operations associated with the Logistics Center. The Army Corps’ EIS must fully assess this complex issue.

The groundwater pumping remediation program initiated by DuPont in 1985 is operated since 2015 by Chemours, a spin-off company from DuPont. The groundwater interceptor system continuously pumps to attempt to keep the migration of pollutants in the groundwater in check. As mentioned previously in this comment, the monitoring wells that have been tracking the pollution are in jeopardy of being moved for the Logistics Center use of the site. This would

⁴⁴ CG-OES Policy Letter, No.01-17, JUN - 8 2017, Guidance for Evaluating Simultaneous Operations (SIMOPS) During Liquefied Natural Gas (LNG) Fuel Transfer Operations, Ref: (a) CG-OES Policy Letter No, 01-15.

disrupt the critical continuous sampling data collection that is so important to accurate and effective cleanup of the site. This mistake cannot be allowed to occur.

ii. Environmental Impacts of the Proposed Dredging Activities Must be Fully Evaluated.

The dredging of 665,000 cubic yards of sediment from the Delaware River to provide a channel to the Federal Navigation Channel would go to a depth of 43 feet below mean water lower low water over a 45-acre area. Allowed is a two-foot overdraft. This almost doubles the amount of material that will be dredged for the entire Logistics Center project, increasing greatly the adverse environmental footprint of the dredging from the originally proposed Dock 1. The sediment to be dredged is silt, fine sand, and trace gravel, according to the draft docket. DRN is very concerned about the impacts of the dredging on water quality, fish, and aquatic life. We do not agree that the prevention measures included in DRPs application materials so far for controlling the sediment will provide adequate protection to species in the area of the Center. DRN has commented in the past on the significant environmental impacts that dredging causes in this section of the Delaware River. First, deepening 45 acres of river area to a depth of -40 feet mean lower low water with a 2-foot overdraft will open this newly deepened area to the potential for an increased risk of harm if there is a catastrophic spill event. With a deepened area, ships will access the proposed deepwater port and, when filled for export will be heavily laden with LNG, natural gas liquids or other chemicals. Using the catastrophic experience of the Athos I oil spill of November 26, 2004, the volume of carried material available to leak and wreak havoc on the environment and our communities will be greater and therefore more dangerous with the added capacity of the proposed port's dredging of 45 acres.⁴⁵

The Athos I catastrophe exposed 115 miles of River, 280 miles of shoreline, 16,500 birds, as well as many species of fish, shellfish, and wildlife and a variety of important habitats to the heavy crude it dumped into the Delaware River.⁴⁶ Habitats, wildlife, water quality, air quality, industry, recreation, and communities were all significantly harmed by the spill. Any project that will increase the magnitude of such a tremendous level of damages in the event of a future catastrophe is a danger to all of these natural and human resources.

Adding LNG transport to the dangers of shipping on the river exponentially increases the potential for a far-reaching catastrophe. Considering that the zone of blast around a container release and/or fire is at least one mile and could be miles larger depending on how quickly the gas cloud created by the vaporizing LNG spreads, communities along the river, including metropolitan areas such as Philadelphia, Camden, Chester and other high density population centers), passing ships, bridges, facilities such as airports (the Logistics Center is across the river from the Philadelphia Airport), motor vehicle traffic and workers would all be exposed to potential life-threatening injury if an LNG marine vessel were to have an accident and release LNG. There is no discussion in the Docket about the shipping dangers that the dredging would

⁴⁵ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁴⁶ Final Restoration Plan and Environmental Assessment; for the November 26, 2004 M/T Athos I Oil Spill on the Delaware River Near the Citgo Refinery in Paulsboro, New Jersey, September 2009, http://www.darrp.noaa.gov/northeast/athos/pdf/Athos_Final_RP.pdf

enable. This is one reason why a comprehensive environmental analysis of this LNG project is required.

Dredge spoils significantly increase the amount of heavy metals and toxins that would be released into waterways and the environment,⁴⁷ especially with the amount of material that appears to be contaminated at this site. The impacts of the spoil disposal plans and potential pollution impacts could have significant community and environmental effects. The threat posed by dredged spoils is known to be a source of water pollution after on-land disposal.⁴⁸ In addition to polluting the water and land, there are likely to be air quality impacts including NOx emissions associated with the construction and associated traffic from this additional dock and dredging project that should be considered as well. This needs to be fully evaluated.

Maintenance dredging will be required once the project is in operation. The environmental impacts of future dredging for the operation of the project must be evaluated.

iii. The Threat of the Release of PCBs From the Site Must Be Accounted For.

DRN is very concerned about the release of PCBs from the site. EPA identified the Repauno site in 2003 as one of the largest PCB point sources in the Delaware Estuary (among the top 10). A TMDL was established for the Estuary to remediate the contamination. Dredging; construction in the water, riverbank and on uplands; and site disturbance and stormwater systems will disturb PCBs, which have been found in near-shore sediments and in runoff from the site. There is a zone of highly contaminated sediments immediately adjacent to the shore and port facility. DRBC's dedicated role in reducing PCBs in the Estuary and its role to ensure that PCB Pollution Minimization Plans (PMP) are effectively implemented is compromised by the plan to disturb, construct on, and dredge this site.

Past projects have seen regulatory agencies take a lax approach to this issue. The 2017 DRBC docket approved dredging and other disturbances that could significantly increase PCB loading to the already-impaired Delaware Estuary. DRBC did require in the current docket a PCB sampling program to be conducted by Delaware River Partners and stated that fill and capping to raise the site to a higher elevation would help to minimize PCB release. DRN has not seen any analysis that proves that statement. A NPDES permit was supposed to be required to assess PCB migration from the site and to possibly require a separate pollutant minimization plan to be conducted by Delaware River Partners. However, the project is currently under construction while no NPDES permit is in place that requires sampling and monitoring of the release of PCBs during this critical disturbance phase of the project.

There are several unaddressed questions regarding this PCB issue. First, the sampling and the controls should have gone into operation prior to dredging and land disturbance that could release PCBs but this apparently is not the case unless the NPDES permit has been issued without public disclosure. Second, Chemours claims that the site is "substantially remediated"

⁴⁷ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁴⁸ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

for PCBs yet there is no evidence that PCBs are remediated and the sampling as recently as 2018 shows otherwise. Third, Chemours currently operates the site remediation program, including a groundwater pumping system which is supposed to continue during the operation of the facility. It is important that an analysis is done about how these cleanup operations will reliably and safely operate while Dock 2 is being constructed, the river is being dredged, and while the Docks and on-land activities at the site are in operation.

iv. Impacts of Additional Traffic on the River Need to Be Evaluated and Accounted For.

As discussed earlier in more detail in this comment, the additional deepened 45 acres of river area that would provide access to the proposed deepwater port Dock 2 would result in larger and deeper draft vessels coming up the River. DRP's draft docket with the DRBC states ocean-going vessels up to 966 feet long with a draft of 39.7 feet will be accommodated at the two deep water berths. This triples the amount of vessel traffic that was originally planned for the facility. This additional traffic being layered on to the facility needs to be properly analyzed in the environmental assessment, particularly in terms of the amount of truck traffic, parking areas, turning radius areas and other related knock-on logistical needs that are available on this site, which had some non-specified areas but without an analysis showing that the additional traffic can be handled at the Center, it is unknown if the site is too small for this additional vessel traffic. The additional ship traffic and the specific types of ships required for LNG and NGL overseas transport will significantly increase.

v. Impacts from the Certain Increase of Ballast Water Must be Accounted For.

More shipping vessels mean more ballast water needs, discharges, and impacts. Impingement and entrainment of the variety of species discussed in this comment and beyond due to the intake and discharge of ballast water could be significant. The increased intake of ballast water from the River as a result of the commercial vessels coming into the River due to this project would entrain early life stages of commercially and recreationally important fish including American shad, alewife, blueback herring and striped bass.⁴⁹ The cumulative effects of this impingement and entrainment need to be considered in conjunction with the impingement and entrainment that already occurs at existing cooling water intakes operating in the Delaware Estuary and River, including the nearby Paulsboro and West Deptford Township facilities.

In addition, the concerns about invasive exotic species that may result from larger discharges of ballast water from larger vessels cannot be overstated in terms of either ecological or economic impacts. The invasion of such species into major ports and waterways of the U.S. have cost billions of dollars in control efforts and lost economic value from damage to important fish and wildlife species as well as the habitats that support them.⁵⁰ For more information see http://water.epa.gov/polwaste/vwd/ballastwater/invasive_species_index.cfm http://water.epa.gov/polwaste/vwd/ballastwater/invasive_species_bal_links.cfm

⁴⁹ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁵⁰ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

<http://www.invasivespecies.gov/index.html>

D. A Proper NEPA Analysis Must Include an Examination of All Potential Air Quality Issues and Consequences of Them.

The additional emissions of the truck traffic, impacts of rail traffic for the LHG deliveries, additional stormwater runoff (in terms of quantity and also quality due to the additional traffic and additional types of cargo, including LNG) and other related infrastructure need to handle and service the new shipping traffic, as discussed in more detail earlier in this comment. The transloading area needs to also be analyzed to be certain the potential air emissions that could come from the cargo, especially if it is hazardous material such as NGL or LNG or other bulk liquids that possess toxic properties are accounted for.

E. Impacts to Aquatic and Wildlife, Including Endangered and Threatened Animal and Plant Species Must be Thoroughly Catalogued and Considered.

i. Impacts to Atlantic Sturgeon Must be Thoroughly Evaluated.

As discussed earlier in this comment, Atlantic sturgeon will be directly negatively impacted by the development and operation of this site. The revised wharf design is under review by NMFS regarding two threatened and endangered sturgeon species, and the critical habitat for the Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). However, the applicant and agencies thus far have failed to acknowledge that the federal government established the Delaware Estuary as Critical Habitat for the New York Bight DPS of Atlantic Sturgeon in August 2017.

So far, DRN has witnessed one agency neglect this fact in their review of the project. DRBC's Water Quality Regulations at §4.30.5-B.1 acknowledge that the Commission must evaluate Critical Habitat, and that this evaluation must follow its Rules of Practice and Procedure. Despite the federal ruling, DRBC has yet to initiate its procedures for verifying the Critical Habitat established by the federal government, and the role that Critical Habitat will play in docket decisions. DRBC should not have approved any project that could directly and indirectly affect this Critical Habitat until it completed all necessary procedures in the Critical Habitat evaluation. DRN contends that to approve such activity was premature, undermined the required process for DRBC review and approvals, was unfair in terms of just application of its regulations, and jeopardizes the Critical Habitat of the Atlantic Sturgeon.

Both direct take and incidental take of sturgeon are a distinct possibility with a project of this nature. Both the Atlantic sturgeon and shortnose sturgeon are threatened and adversely affected by dredging and effects to water quality including dissolved oxygen (DO) levels, water temperature, and contaminants.⁵¹ The proposed project will entail significant levels of dredging as well as significant water quality effects and dramatic changes in important habitats including juvenile habitat and spawning grounds.

⁵¹ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

The dredging of river systems significantly impacts aquatic ecosystems in a number of ways that will harm both sturgeon species. Among the effects that the project will have on the Delaware River populations of both sturgeon species are:

- Deep-draft vessel traffic in the Delaware River has been cited as the biggest threat to the survival of the Delaware River population Atlantic sturgeon; the increased vessel traffic and increased area for deep-draft vessels to strike Atlantic sturgeon directly resulting from this project will significantly increase sturgeon vessel strikes and could accelerate the extinction of this endangered species population.⁵²
- Dredging activities remove, disturb, dispose of and re-suspend river sediments, modifying the river bottom substrate and impacting the community of benthic macrofauna;
- Dredging operations can remove or bury organisms and destroy benthic feeding areas;
- Dredging operations can create noise and disturbance, and can disrupt spawning migrations;
- Dredging activities can re-suspend contaminants, affect turbidity and siltation, and deposit fine sediments in spawning habitats; and
- Dredging activities alter the hydrodynamic regime, alter physical habitats, and create the loss of riparian habitat.⁵³

The act of dredging can entrain sturgeon, taking them up into the dredge drag-arms and impeller pumps and resulting in death.⁵⁴ New data from tagged Atlantic sturgeon continue to show their presence in or near the main navigation channel, making them vulnerable to direct take by dredging operations, as well as direct take from the larger vessels that will be using the channel.⁵⁵ These lethal takes are significant for a species that is at such low levels (fewer than 300, maybe even fewer than 100), and as genetically unique as the Atlantic sturgeon of the Delaware River are.⁵⁶

Dredging in the portions of the River near Philadelphia is likely to be detrimental to the successful spawning of sturgeon in the Delaware – not just because of the act of dredging but also because of the degradation of spawning habitat.⁵⁷ Dredging increases the level of suspended sediments and contaminants in the water. An increase in suspended sediments could be detrimental to egg survival of sturgeon – increasing the probability that eggs adhere to suspended

⁵² Brown and Murphy. 2010. Atlantic Sturgeon Vessel-Strike Mortalities in the Delaware Estuary. *Fisheries* 35(2): 72-83.

⁵³ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁵⁴ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁵⁵ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁵⁶ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁵⁷ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

solids and suffocate, increasing contaminant loads can alter growth and reproductive performance in sturgeon.⁵⁸

Dredging is a factor in the destruction, modification, or curtailment of the Atlantic sturgeon's habitat and range.⁵⁹ The environmental impacts of dredging include direct removal or burial of organisms, elevated turbidity or siltation, contaminant re-suspension, noise or disturbance, alterations to hydrodynamic regime and physical habitat, and loss of riparian habitat.⁶⁰ Furthermore, an increase in vessel traffic on the Delaware River resulting from the project would increase the likelihood of vessel strikes to sturgeon.²

A study of mortality rates on Atlantic sturgeon in the Delaware River between 2005 and 2008 found that 50% of the mortalities were the result of vessel strikes. The remaining 50% were too decomposed to determine if they were caused by vessel strikes but it is likely most were.² For small remnant populations of Atlantic sturgeon, such as that in the Delaware River, the loss of just a few individuals per year due to anthropogenic sources of mortality, such as vessel strikes, may continue to hamper restoration efforts.² According to a 2010 research article on vessel strikes, "Both the dredging to deepen the channel and the subsequent increase in large vessel traffic may further hamper the recovery of the Delaware River Atlantic sturgeon population."² Of critical importance, this study is concerned about the size of the vessels resulting from deepening as opposed to any increase in the volume of vessels. The larger size of the vessels from the deepened channel will likely increase the number of vessel strikes for both sturgeon species.²

The continued dredging of new deep-water areas will further impact Atlantic sturgeon spawning by accelerating the intrusion of brackish water into the hard-bottom spawning grounds, and thus forcing Atlantic sturgeon to spawn further upstream in the zone of depressed dissolved oxygen. This shift then exposes the eggs and larvae of newly spawned Atlantic sturgeon to low oxygen conditions from which they may not survive. This "squeeze" between increased salt intrusion in the estuary downstream (exacerbated by channel deepening, new deep-dredged berthing areas, and rising sea levels) and the near-lethal dissolved oxygen levels upstream limits the ability of Atlantic sturgeon to successfully reproduce and increases the likelihood of extinction. This project makes a significant contribution to such salt-intrusion by adding 45 acres of new deep-water channel and berthing to an estuary under siege.⁶¹

The remobilization (and dewatering of dredged sediments) will create higher exposure to PCBs and other contaminants, and the Atlantic Sturgeon spawning and rearing that begins in June and extends the early-life-stages through July and August, with increasing evidence for high aggregations of young-of-year in the Proposed Project vicinity, means that elevated exposure will occur for larval and juvenile stages of this endangered species in the Delaware River. The currently proposed methods and timing are insufficient to protect this endangered species, and

⁵⁸ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁵⁹ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁶⁰ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁶¹ Moberg and DeLucia. 2016. Potential Impacts of Dissolved Oxygen, Salinity and Flow on the Successful Recruitment of Atlantic Sturgeon in the Delaware River. The Nature Conservancy. Harrisburg, PA. 69 pp.

more evidence and analysis would be required in order to claim that the project does not impair NOAA Trust Resources, fish and wildlife, and the water resources of the Basin.

ii. Threats to Fresh Water Mussels Must be Accounted For.

In November of 2010, researchers discovered beds of freshwater mussels in the Delaware River between Chester, PA and Trenton, NJ.⁶² The species found included the alewife floater (*Anodonta implicata*) and the tidewater mucket (*Leptodea ochracea*), only found in New Jersey in the tidal Delaware River; the pond mussel (*Ligumia nasuta*) and the yellow lampmussel (*Lampsilis cariosa*), both considered critically-imperiled; and the creeper (*Strophitus undulatus*) and the eastern floater (*Pyganodon cataracta*) both considered vulnerable; as well as the eastern elliptio (*Elliptio complanata*), the only mussel known to be native to our Delaware River that is not considered to be in jeopardy.⁶³ Mussels are not mentioned in the application or in the applicant's Compliance Statement. Particularly because some of these estuarine species are state-listed and/or critically imperiled, the extent and composition of these mussel beds needs to be accurately surveyed prior to any in-water work at the site. Once the locations, abundance, and identify of these species are documented, a relocation plan would be needed to move individual mussels out of areas where direct mortality might occur.

Freshwater mussels can live 80 to 100 years old, and most species do not begin reproducing until they are 8 to 10 years old.⁶⁴ Because they are so slow growing and don't begin to reproduce until this older age, they are not able to quickly recover from disturbances and the population cannot recover quickly from impacts that result in death to individuals.⁶⁵ Freshwater mussels require a fish host, a specific species depending on the mussel, to complete their life cycle. Activities that damage the needed fish hosts in turn do direct harm to the freshwater mussel species they help serve in the life cycle.⁶⁶

Mussels are vital for filtering pollution and filling important habitat niches. Experts believe that revitalizing freshwater mussels in the Delaware River could improve water quality downstream and thereby benefit estuarine species.⁶⁷ All of the freshwater mussels in the Delaware River system, except for one (the Eastern elliptio, *Elliptio complanata*), are identified by one or more of the states as endangered, threatened, imperiled, vulnerable, critically impaired, very rare, extremely rare or extirpated.²

Freshwater mussels are very sensitive to water quality. Exposure to contaminants either directly via dissolved compounds or contaminants that are particle-mediated can have adverse

⁶² Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁶³ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁶⁴ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁶⁵ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁶⁶ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁶⁷ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

consequences.² Freshwater mussels are highly exposed to changes in water quality because of their filtering activities and the passage of large volumes of water across many thin tissue layers. Dissolved toxins, such as heavy metals, are rapidly taken up by direct absorption and indirectly via food.⁶⁸ Because this project will likely result in pollution both directly and through contaminants from spoil disposal, the implications of this pollution for the mussels in this area must be examined.

Stressed mussels require more oxygen. The dredging described for this project is a threat to any submerged aquatic vegetation in the area that is critical for providing oxygen in the Estuary, including the Philadelphia reach of the River, which includes the location of the proposed project. Although dissolved oxygen levels can become excessively low in this area even today, they have improved significantly compared to decades past. In fact, the DRBC is considering elevating their “Aquatic Life Designated Use” rule in this section of the Delaware River to maintain and protect dissolved oxygen levels.⁶⁴ Increased sedimentation from dredging activity inhibits mussels and their host fish species from taking in oxygen.⁶⁹ Additionally, invasive or exotic species resulting from interbasin transfers of water can be a very direct threat to freshwater mussels as well as many other species. Increased ballast water from deeper ships, and increased ship traffic, brought up the River by a deeper channel could heighten this risk.⁷⁰ The issue of invasive and exotic species and ballast water and their ecological and economic implications for freshwater mussels and other River fish and wildlife species must also be considered.

Identification of host fish needed for freshwater mussels is one of the least studied aspects of freshwater mussel life history. American eel are known to be hosts for *Elliptio complanata*; some believe they are in fact the preferred host.⁷¹ Some species of trout and yellow perch too can serve as hosts and data shows that some of the species found in the tidal estuary, *Strophitus undulatus*, can use pumpkinseed and yellow perch.⁷² Shad too are considered by some as possible host species.⁷³ The potential impacts to these host species are additional factors to consider when assessing the threats to mussels.

iii. Impacts to Wildlife from the Construction and Operation Must be Addressed.

There is evidence that the acoustic impacts from construction activities, such as those described for this project, can significantly harm fish.⁷⁴ The effects of underwater sounds created by pile

⁶⁸ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁶⁹ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁷⁰ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁷¹ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁷² Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁷³ Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁷⁴ Delaware Riverkeeper Network (2011). Supplemental Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

driving on fish may range from a brief acoustic annoyance to instantaneous lethal injury depending on many factors.⁷⁵ Even at non-lethal levels, low levels of acoustic damage may result in the fish not being able to swim normally, detect predators, stay oriented relative to other fish in the school, or feed or breed successfully.⁷⁶ This is a potential threat to all fish, including both sturgeon species as well as all the fish that serve as host species to mussels.

There are bald eagle (*Haliaeetus leucocephalus*) nests and osprey (*Pandion haliaetus*) nests near or within the project site.⁷⁷ Even with the best mitigation plan in place, there would inevitably be some level of disturbance to these nests versus the no-action alternative, which would leave the nests as they currently are. The nests are not even mentioned in the public notice and this is an issue that the public should be aware of. While formerly a highly-degraded site when DuPont owned and operated the property, the wetland and upland portions of the site have reverted to a natural state with a diverse ecosystem suitable as nesting habitat for these two imperiled bird species. Any disturbances or alterations to these nesting areas could be detrimental to the breeding success of these birds and therefore the future viability of their populations in this area.

F. Army Corps Must Require A Proper Alternative Analysis Section and Account For The Destruction To The Natural Restored Condition Of The Repauno Property, Including A No Action Alternative.

This analysis should include, but not be limited to, examining differences in impacts to wildlife species, wetlands and waterbodies, steep slope topography, land disturbance, forest reduction, re-vegetation potential, and health and safety risks from the impacts of different alternative actions.

In its application materials so far, DRP has failed to consider the important naturally restored condition of the Repauno property and adjacent, local and regional natural resources that would greatly benefit from preservation and protection. The loss of the natural condition, habitats and quality of the Gibbstown Logistics Center site and the fragmentation of the natural systems in the surrounding area will be great. However, the applicant does not discuss, measure, or assess this impact. The applicant simply relies on the 100-year historic use of the Repauno property prior to its abandonment as an industrial location. It has been decades since heavy industrial use of the property has occurred, and the natural environment has subsumed the location and should be considered as a natural asset of great value.

The natural assets at the site must be accounted for in determining the value of this project. In the materials DRN has reviewed so far the applicant has used a circular justification for the project at this location stating that because the site is undergoing redevelopment as a marine terminal with Dock 1 and the associated landside development, it is “the most feasible alternative for the proposed project”. Simply because the Gibbstown Logistics Center is being constructed does not provide justification or rationale for further impacting natural resources and assets for Dock 2.

⁷⁵ Delaware River Basin Commission (2017) Draft Resolution, February 23, 2017. Retrieved from http://www.nj.gov/drbc/library/documents/Res_EstuaryAquaticLifeUses_draft022317.pdf

⁷⁶ Delaware River Basin Commission (2017) Draft Resolution, February 23, 2017. Retrieved from http://www.nj.gov/drbc/library/documents/Res_EstuaryAquaticLifeUses_draft022317.pdf

⁷⁷ Ramboll Environ (2016). Compliance Statement in Support of Multiple Individual Permit Applications. Appendix E, Habitat Impact Assessment Report, July 2016.

G. The Army Corps Must Thoroughly Examine DRP’s Claims of Public Need for the Project.

NEPA requires that an environmental assessment “[s]hall include brief discussion of the need for the proposal, of alternatives as required by section 102(2)(E), of the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted.” 40 CFR 1508.9(b). This requires the Army Corps to consider energy needs on both local and national scales. As well as energy production, uses, and conservation.

Additionally, under New Jersey regulations, new dredging is considered acceptable only if certain conditions are met. Particularly important for this site is the condition that requires a demonstrated need that cannot be satisfied by existing facilities. DRP’s claims of public need must be assessed to ensure it is both valid and not self-serving.

H. The Current Proposal is a Clear Case of Illegal Segmentation - the Army Corps Must Remedy This Defect In Its EIS NEPA Review.

NEPA prohibits segmentation of projects for purposes of NEPA review. As stated by the DC Circuit in *Delaware Riverkeeper Network, et al. v. Federal Energy Regulatory Commission*, 753 F.3d 1304, 1307 (D.C. Cir. 2014):

“An agency impermissibly “segments” NEPA review when it divides connected, cumulative, or similar federal actions into separate projects and thereby fails to address the true scope and impact of the activities that should be under consideration. The justification for the rule against segmentation is obvious: it “prevent[s] agencies from dividing one project into multiple individual actions each of which individually has an insignificant environmental impact, but which collectively have a substantial impact.” *NRDC v. Hodel*, 865 F.2d 288, 297 (D.C. Cir. 1988)” The rule against segmentation requires the federal agency, in this case, to consider all connected and cumulative actions.”

It is clear to DRN that the prohibition against segmentation has in fact been violated. Not only was the expansion of the facility reasonably foreseeable, but it now appears that this expansion was planned all along and that expansion was documented by the company.

- In a July 24, 2016 Philadelphia Inquirer news article, the company admits that it had envisioned LNG for this site: “Although a company prospectus last year envisioned a liquefied natural gas (LNG) facility at Repauno - disconcerting some residents and environmental groups such as the Sierra Club and the Delaware Riverkeeper – ‘that is no longer in our designs,’ Lewis said.” As a result, having an LNG operation at this site was clearly considered and therefore it was reasonably foreseeable that LNG would become a serious component of this operation at some point. It now seems obvious that while Delaware River Partners removed the LNG prospect from its application materials in 2016, it had every intention to restore that component of the project at a future date, and simply removed it to lighten the level of agency and public scrutiny and review that

would be given to the project during the reviews that were taking place for stage 1 of the Gibbstown Logistics Center.

- A November 16, 2017 Letter of Intent was submitted to the US Coast Guard specifically describing the project as being an LNG facility. This letter was sent to the US Coast Guard before the Army Corps issued its approval for stage 1 of this project on December 21, 2017. And so, it is clear that Delaware River Partners knew, and the Army Corps should have known, that the ultimate goal of the project was to build an LNG facility at this site. The letter to the Coast Guard has significant detail, including the anticipated export capacity of the site (1.5 million metric tonnes). The failure to consider the full project, including the LNG component, is a clear case of segmentation in violation of federal law. It is clear, should have been clear to the Army Corps, and would have been clear to the Army Corps had it done its NEPA due diligence, that the two stages of the project were and are interdependent and are clearly two parts of the same whole. There is a clear violation of the prohibition against segmentation that has taken place/is taking place at this site.
- There is clearly a foreseeable expansion of the facility to accommodate additional LNG capacity in the future (i.e. a state 3 of the project) given that the November letter to the Coast Guard describes the current project as “proposing an LNG facility with an initial capacity of up to approximately 1.5 million MTPA of LNG (roughly 1,670,000 BBL per month).” The descriptive language of “initial capacity” makes clear that more LNG exports are to come, that there will be additional expansions, and that such expansions need consideration as part of this current project in order to avoid additional segmentation violations.

Further, NEPA requires consideration of all reasonably foreseeable impacts resulting from a proposed action, activity or project. The facts above make clear that the LNG component has always been reasonably foreseeable.

I. A Full Environmental Impact Statement Is Clearly Mandated.

Authorizing the Logistics Center to export LNG and to construct and operate LNG export facilities demands an Environmental Impact Statement (EIS) pursuant to NEPA because this project will clearly have significant effects on the human environment. Unquestionably, construction and operation of the export facilities, including the transportation of the liquefied natural gas (LNG) to the site via truck and rail will have significant effects that trigger the mandate for a full NEPA EIS. In addition, there will be upstream and downstream impacts with respect to the extraction and use of the source fracked gas that are related and reasonably foreseeable actions which must be considered. Export of LNG will induce additional shale gas extraction/production in upstream regions, result in increased downstream uses, increased domestic gas prices, and increased greenhouse gas emissions and global warming. Each of these effects has direct importance to the Army Corps’ consideration of the Gibbstown Logistics port expansion proposal which includes LNG export as a significant, if not primary, goal of the project.

LNG operations pose specific and adverse risks to surrounding neighborhoods as well as the local, regional and national environment. The inclusion of LNG operations is a significant

aspect of the Gibbstown Logistics Center expansion that must receive full NEPA EIS review. Further, the Applicant has already segmented its operations at Gibbstown into different projects, even though they all support each other. Continuing to permit such segmentation masks the environmental and health harms of Delaware River Partners' operations as a whole. The proposal to truck/rail in the LNG along with long offloading times resulting in at least 15 days of storage on vessels raises additional impacts that need to be assessed and addressed, in addition to the environmental (including climate change) and health consequences at the point of gas extraction and as the result of downstream use. There are also implications for port traffic along the Delaware River in need of meaningful consideration and review.

As noted throughout this letter, there are a wealth of environmental and public impacts that need to be fully assessed pursuant to NEPA. Issues that need to be considered in a NEPA EIS include, but are not limited to:

- The safety, pollution and health implications of truck and rail traffic necessary to support the LNG (and LHG) operations proposed for the site. It is anticipated that truck traffic will at least triple over current levels as a result of the LNG export portion of the proposal. Truck racks that will be used to transfer the LNG from truck to ship will be designed to accommodate 200 to 220 trucks per day; a clear indication of the massive volume of truck traffic that will be created by the proposed LNG operations at the site. This will result in tremendous air pollution, noise pollution, property value, quality of life, traffic impact and traffic safety concerns that must be assessed. LNG volumes anticipated for the site were 1.5 million metric tonnes per year when initially calculated; the volume currently planned is unknown. It is anticipated that offloading from truck to rail will take 15 days, using pipelines that connect directly to the ships. As discussed earlier in this comment, 1,650 trucks per day are expected for the Logistics Center and all vehicle trips to/from the Logistics Center are expected to total 8,450, a massive increase in truck and vehicle traffic.
- The ramifications, particularly safety ramifications, of storing LNG on a ship while it is slowly loaded over a period of at least 15 days.
- The ramifications of the proposed LNG exports for shipping, ship traffic and the business operations of other shippers operating through Delaware River ports, especially if certain other operations must be shut down or bridges must be closed while ships are passing.
- The onsite environmental impacts of exporting LNG from this site.
- The upstream climate and environmental ramifications of the gas extraction activities that will be induced/supported by this operation. Increased shale gas extraction, including drilling and fracking, is a related, connected and foreseeable outcome of the proposed Gibbstown LNG facility given that the facility is intended to secure and support increased shale gas development in order to supply the facility with shale gas for export. As such, NEPA requires consideration of the environmental and community impacts of shale gas development that will result in order to supply the Gibbstown LNG facility. Shale gas development is an extraordinarily land and water-intensive process that converts agricultural, forest, and range lands to industrial uses, consumes millions of gallons of water per well, and generates huge quantities of hazardous wastes, and results in

tremendous and harmful volumes of climate changing emissions as well as the release of other hazardous air pollutants.⁷⁸

- The downstream environmental and climate impacts from the use of the gas to be exported.
- The safety ramifications of having an LNG operation of this kind on the Delaware River including for the surrounding community.
- The implications for other shippers and port operations that will result from the LNG export use of the site at a rate of 2 LNG export vessels a month / 24 a year with additional shipping events for LHG, numbering 37 in total according to the NJWFD application.
- The impacts on the endangered Atlantic and Shortnose Sturgeon and the designated Atlantic Sturgeon Critical Habitat that will be impacted. The Delaware River population of Atlantic Sturgeon is genetically unique with a surviving population that includes less than 300 spawning adults.⁷⁹ With numbers this precariously low, the responsibility for vigilant protection by our federal agencies could not be greater. The Delaware River population of Atlantic Sturgeon, along with the entire NY Bight Distinct Population Segment (DPS), of which the Delaware River population is a part, are designated as endangered pursuant to the Endangered Species Act. The Delaware River Atlantic Sturgeon are being severely impacted by ship strikes along the Delaware. In addition, the Delaware River's population of Shortnose Sturgeon is also listed as federally endangered and suffers low population figures. The ramifications of increased ship traffic and ship strikes is serious and potentially catastrophic.
- The water quality ramifications due to the release of ballast water from LNG ships. The "... discharge of ballast water and sediment from ships during LNG terminal loading operations may result in the introduction of invasive aquatic species."⁸⁰
- The water quality ramifications due to dredging and the potential resuspension/reintroduction from CDF discharges of contaminants to the Delaware River, including PCBs. CDFs holding dredged sediments from Delaware River dredging projects have been a demonstrated source of toxic contamination to the River, inflicting serious water quality impacts.
- The air and other ramifications of flaring off of gas and/or the construction and operation of a small capacity liquefier on site as discussed in a letter sent on November 16, 2017 to the US Coast Guard.

⁷⁸ Shale gas extraction is also a significant source of hazardous air pollution, including methane, volatile organic chemicals (VOCs), and air toxics such as benzene and ethylbenzene. In July 2011, EPA proposed a suite of draft regulations under the Clean Air Act to set new source performance standards for VOCs and sulfur dioxide, an air toxics standard for oil and natural gas production, and an air toxics standard for natural gas transmission and storage. Final regulations are due by April 3, 2012. See <http://www.epa.gov/airquality/oilandgas/>The Department of Energy's advisory panel on shale gas has urged EPA to extend these rules to existing shale gas production sources and to adopt regulations addressing methane explicitly. Bridget DiCosmo, "DOE Panel Urges EPA to Strengthen Proposed Air Rules for 'Fracking,'" Nov. 10, 2010, <http://insideepa.com/201111102381935/EPA-Daily-News/Daily-News/doe-panel-urges-epa-to-strengthen-proposed-air-rules-for-fracking/menu-id-95.html>. Methane is twenty times more potent a greenhouse gas than carbon dioxide. See <http://www.climate-science.gov/infosheets/highlight1/default.htm>. The oil and gas industry is the single largest source of methane emissions in the US, accounting for nearly 40% of national methane emissions. See <http://epa.gov/airquality/oilandgas/pdfs/20110728factsheet.pdf>.

⁷⁹ ASSRT (Atlantic Sturgeon Status Review Team) 2007. Status Review of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

⁸⁰ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

- Releases, spills or leaks during storage, transfer and/or transport of LNG.⁸¹
- Risk of accidents, incidents, fire or explosion during transport storage and/or transfer of LNG.⁸² While it is asserted there will be no onsite storage of LNG, the process of loading each ship will take on the order of 15 days—this translates into 15 days of storage on the vessel while loading operations are taking place. The potential safety implications need to be examined and disclosed. “Natural gas is combustible, so an uncontrolled release of LNG poses a serious hazard of explosion or fire.”⁸³ The greatest LNG hazards include pool fires, flammable vapor clouds and flameless explosion.⁸⁴
 - A pool fire occurs if LNG spills near an ignition source and in fact ignites, “the evaporating gas in a combustible gas-air concentration” burns above the LNG pool, and then proceeds to spread as the LNG pool expands away from its source and continues evaporating.⁸⁵ Pool fires are intense and will burn more hotly and rapidly than oil or gasoline.⁸⁶ Pool fires cannot be extinguished – “all the LNG must be consumed before they go out.”⁸⁷
 - Flammable vapor clouds happen if there is an LNG spill that does not immediately ignite and instead evaporates forming a vapor cloud.⁸⁸ Vapor clouds can drift a distance from the site of the spill.⁸⁹ If the vapor cloud encounters an ignition source then “those portions of the cloud with a combustible gas-air concentration will burn.”⁹⁰ While a vapor cloud is not toxic, it can displace breathable air and as a result cause asphyxiation.⁹¹ Extremely cold LNG can injure through direct contact.⁹² It has been said that “environmental damage associated with an LNG spill would be confined to fire and freezing impacts near the spill since LNG dissipates completely and leaves no residue.”⁹³
 - “LNG spilled directly onto a warm surface (such as water) could result in a sudden phase change known as a Rapid Phase Transition (RPT).”⁹⁴ “If LNG spills

⁸¹ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

⁸² IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

⁸³ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁸⁴ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁸⁵ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁸⁶ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁸⁷ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁸⁸ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁸⁹ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁹⁰ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁹¹ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁹² CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁹³ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁹⁴ IFC, Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities, April 30, 2007.

on water, it could theoretically heat up and regasify almost instantly in a 'flameless explosion'.”⁹⁵

- Given the site’s history of industrial operations, the known contamination that has and still does exist on the site, and its superfund status, there is a need to consider the potential synergy of harm that could occur if there was a catastrophic release at the site. Known contaminants of concern at the site include: nitrobenzene, aniline and mixed acids, sodium nitrite and nitrosylsulfuric acid.
- The entire site is in the flood hazard area. What are the implications of a flood for the LNG operations and LHG operations if there were a flood during transfer operations or storage onsite? With climate changing increasing the frequency, duration and magnitude of floods, this is an obvious and serious consideration. The ramifications of catastrophic flooding due to climate change is compounded by the known flood and safety ramifications of storm surge in the Delaware Estuary.
- The Gibbstown Logistics Center is located next to a residential area. There is a day care center and housing in Gibbstown adjacent to the Block and Lot of this site. These residential and day care uses are not compatible with an LNG export operation. The safety issues of the trucking, rail transport, storage, and transfer of LNG is dangerous if there is an accident or incident, and is in need of careful consideration.
- The economic ramifications of the proposed LNG export. By causing an increase in shale gas prices here in the U.S., there is widespread concern that the export of shale gas to foreign countries will adversely impact a number of other industries and the economic benefits and jobs they provide.⁹⁶
- LNG infrastructure can be vulnerable to terrorist attack.⁹⁷ This threat needs serious consideration. While, according to a report prepared for Congress in 2003, it was reported that “No LNG tanker or land-based LNG facility has been attacked by terrorists ... similar natural gas and oil facilities have been favored terror targets internationally.”⁹⁸ Among the catastrophic events that can result from an accident or attack at an LNG facility are pool or vapor cloud fires.⁹⁹
- EPA identified the Repauno site in 2003 as one of the largest PCB point sources in the Delaware Estuary (among the top 10). Additional dredging, site disturbance and stormwater systems will disturb PCBs, which have been found in near-shore sediments and in runoff from the site. There is a zone of highly contaminated sediments immediately adjacent to the shore and port facility. The remobilization (and dewatering of dredged sediments) will create re-release of PCBs into the estuary, including in Atlantic Sturgeon spawning habitats. The ramifications for the reintroduction of PCBs into the environment needs careful assessment. Given that there is a reasonably foreseeable future expansion at this site to accommodate increased LNG operations, there

⁹⁵ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁹⁶ Unanswered Questions about the Economic Impact of Shale Gas Exports: Don't Jump to Conclusions, Comments on NERA Study, prepared by Jannette M. Barth, Ph.D., Economist, Pepecton Institute LLC, Dec 11, 2012.

⁹⁷ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁹⁸ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

⁹⁹ CRS Report for Congress, Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress, Sept 9, 2003.

needs to be consideration of this expansion for issues such as PCBs and other environmental effects.

- The job impacts of the proposal are in need of consideration and public disclosure. LNG exports, while creating some jobs in the gas industry, many temporary, creates a net job loss effect for the country. In fact, LNG exports could result in the net loss of as many as 270,000 jobs per year in our country.¹⁰⁰ The job implications must be assessed

In closing, we urge and request that the Army Corps begin by providing to the public more complete information about the full breadth of this project, undertake the completion of a full environmental impact statement review of all stages and phases of the Logistics Center without segmentation of the build-out as required under NEPA, and provide for abundant and broad public comment.

Given the numerous issues with the project DRN has outlined in this comment, the Army Corps must fulfill its legal obligations pursuant to NEP by undertaking the necessary review required by NEPA – issuing an Environmental Impact Statement (EIS). Issuing an Army Corps approval for the Gibbstown Logistics Center (CENAP-OP-R-2016-0181-39), which now undeniably includes an LNG export operation, without a proper EIS would be a violation of federal law that will be subject to legal challenge.

Respectfully & Urgently,



Maya K. van Rossum
the Delaware Riverkeeper
Delaware Riverkeeper Network

Tracy Carluccio
Deputy Director
Delaware Riverkeeper Network

Attachments:

Delaware Riverkeeper Network comment to Delaware River Basin Commission re. Delaware River Partners LLC, Gibbstown Logistics Center, Dock 2 , Greenwich Township, Gloucester County, New Jersey, June 7, 2019.

McCormick Taylor, “Drainage and Storm Water Management Report for the Route 44 Truck Bypass and DuPont Port Access”, Township of Greenwich, Gloucester County, February 13, 2019.

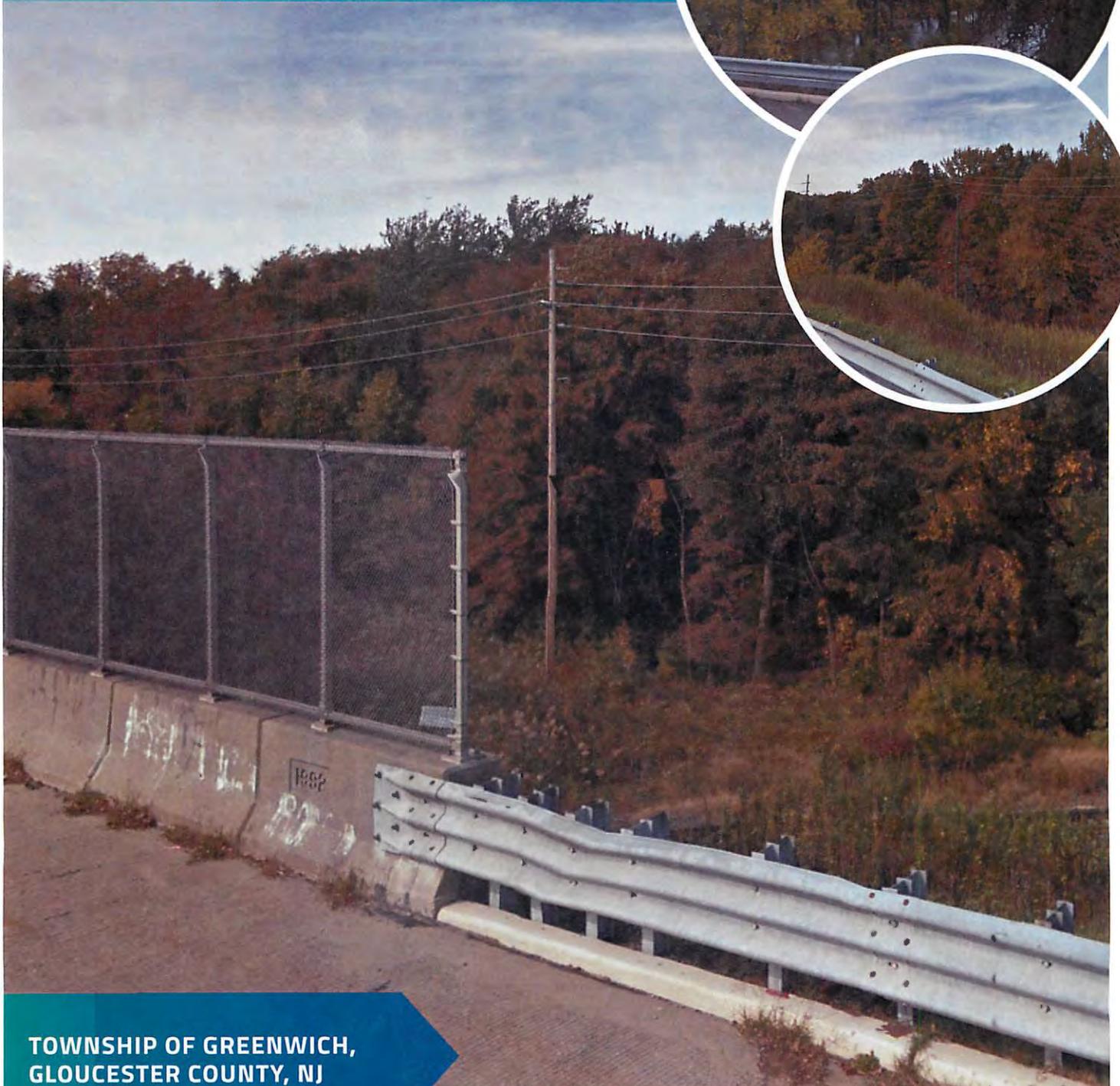
Langan Engineers, *Technical Memorandum re. Trip Generation DR Partners, Repauno Port and Rail Terminal, LPG Transloading Facility Site Plan Application*, Greenwich Township, July 12, 2019.

¹⁰⁰ Will LNG Exports Benefit the United States Economy, Synapse Energy Economics Inc., January 23, 2013



DRAINAGE & STORM WATER MANAGEMENT REPORT

FOR ROUTE 44 TRUCK BYPASS AND
DUPONT PORT ACCESS



TOWNSHIP OF GREENWICH,
GLOUCESTER COUNTY, NJ

GCIA & COUNTY OF GLOUCESTER

***DRAINAGE
&
STORM WATER MANAGEMENT
REPORT***

For

**ROUTE 44 TRUCK BYPASS
AND DUPONT PORT ACCESS
TOWNSHIP OF GREENWICH
GLOUCESTER COUNTY, NJ**

Prepared for:

**Gloucester County Improvement Authority
109 Budd Blvd.
Woodbury, NJ 08096**

Prepared by:

**McCormick Taylor, Inc.
700 East Gate Drive, Suite 201
Mt. Laurel, NJ 08054**

February 2019

**Route 44 Truck Bypass and DuPont Port Access
Greenwich Township (Gibbstown),
Gloucester County, New Jersey**

Drainage and Storm Water Management Report

Certification Page

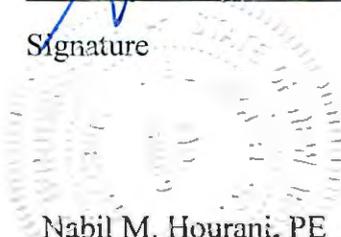
In accordance with N.J.A.C. 7:13-18.2 (j), I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining and preparing the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for knowingly submitting false information, including the possibility of fine and imprisonment.



Signature

02-13-19

Date



Nabil M. Hourani, PE
Printed Name

No. 24GE03888900

Professional License #

**DRAINAGE & SWM REPORT
FOR
ROUTE 44 TRUCK BYPASS
AND DUPONT PORT ACCESS**

TABLE OF CONTENTS

I. PROJECT DESCRIPTION.....	1
A. INTRODUCTION.....	1
B. PROJECT LOCATION.....	1
C. PROJECT PURPOSE AND NEED.....	1
D. GOALS AND OBJECTIVES.....	2
E. PROPOSED PROJECT.....	4
F. EXISTING DRAINAGE CONDITIONS.....	4
II. PROPOSED DRAINAGE CONDITIONS	4
A. PIPES AND INLETS DESIGN CRITERIA.....	5
B. MODELING METHODS	5
III. STORMWATER MANAGEMENT.....	5
A. NON-STRUCTURAL STORMWATER STRATEGIES EVALUATION	5
B. STORMWATER RUNOFF QUANTITY	7
C. SOIL CHARACTERISTICS AND GROUNDWATER RECHARGE.....	9
D. STORMWATER RUNOFF QUALITY	12
E. EROSION CONTROL.....	12
F. MAINTENANCE PLAN AND MAINTENANCE REQUIREMENTS	13
IV. UTILITY IMPACTS.....	14

LIST OF TABLES

Table 1 - Existing vs Proposed Peak Flows for Project Watershed.....	8
Table 2 - Existing vs Proposed Volumes for Project Watershed.....	8
Table 3 - Existing vs Proposed Water Surface Elevations.....	9
Table 4 - Water Quality Treatment.....	12

LIST OF FIGURES

FIGURE 1 – Project Location Map3
FIGURE 2 – Soil Map 10
FIGURE 3 – HUC-14 Map 11

LIST OF APPENDICES

APPENDIX A – CALCULATIONS REPORT

- 1-STORM SEWER SYSTEMS - PROPOSED CONDITIONS
- 2-FLOW AND VOLUME CALCULATIONS
- 3-WATER SURFACE ELEVATION CALCULATIONS
- 4-OUTFALL PROTECTION CALCULATIONS
- 5-VELOCITIES CALCULATIONS DOWNSTREAM OF OUTFALL

APPENDIX B – DRAINAGE AREAS MAPS

**APPENDIX C – RT 44-SOIL DETAILS AND ANNUAL GROUNDWATER RECHARGE ANALYSIS
SPREADSHEET**

I. PROJECT DESCRIPTION

A. INTRODUCTION

Through the small community of Gibbstown section of Greenwich Township, Route 44 services various residential, institutional, commercial and governmental land uses which create less than ideal conditions for truck traffic. A large planned redevelopment project at the Repauno site, located adjacent to Gibbstown, is projected to add significant truck activity to Route 44 and local roadways to provide access to/from higher order, limited access highways.

Route 44 was originally constructed in 1929, extending from Logan Township northward to I-295 in West Deptford. In 1969, Route 44 was widened to provide shoulders in both directions. The Route 44 Bridge over Conrail railroad tracks was replaced in 1991. Route 44 through the project area was resurfaced in 2001.

B. PROJECT LOCATION

Route 44 is a north-south corridor located entirely within Gloucester County. The southern limit of the study corridor crosses the White Sluice Race Creek at MP 2.42. The northern limit of the corridor crosses the Swedesboro Road (County Route 653) at MP 5.18. Route 44 (W. Broad Street) through Gibbstown contains a mixture of residential, commercial, institutional and governmental land uses. The Broad Street School and Greenwich Township Little League fields are both located within the project limits in the vicinity of N. School Street. Additionally, there is a local VFW Post, a Methodist Church, the Greenwich Township Municipal Building/Police Department and US Post Office all located along Route 44 within Gibbstown. The project limits have been identified on the attached Project Location Map illustrated as *Figure 1*.

C. PROJECT PURPOSE AND NEED

The purpose of this project is to provide a truck bypass of Route 44 within Gibbstown to reduce the negative impacts of trucks to this residential community and to facilitate access to the DuPont Repauno site.

Route 44 through the community of Gibbstown is a mixture of residential, commercial, institutional, and governmental land uses, which results in less than ideal conditions for truck traffic. The Broad Street School, Greenwich Township Little League fields, Municipal Building and US Post Office are all located along Route 44 between Repauno Avenue and Harmony Road. Average daily traffic (ADT) volumes on Route 44 range from 1,765 vehicles per day (vpd) near Veterans Drive to 5,850 vpd near Harmony Road. Average daily truck percentages range from 2% near Harmony Road to 5% near Veterans Drive. This translates to approximately 143 trucks per day along Route 44 at the eastern end and 92 trucks per day traveling along Route 44 at the western end of the project limits.

Gloucester County is considering restricting truck movements on Tomlin Station Road (CR 607) and Democrat Road (CR 673) between Route 44 and I-295 to help eliminate truck traffic through

Gibbstown. These potential restrictions would divert more than 310 trucks per day onto alternate county roadways such as Swedesboro Road (CR 653) and Harmony Road (CR 680). Additionally, proposed development at the DuPont Repauno site, located adjacent to Repauno Avenue north of Route 44, is expected to be completed by Year 2020 and includes warehousing, liquid storage, an auto storage terminal and a marine terminal. These land uses are expected to generate approximately 8,450 daily trips to/from the DuPont Repauno site, including nearly 1,650 truck trips. Conceptual development plans for other industrial sites are also being considered for redevelopment along the outskirts of Gibbstown, which could generate several hundred additional truck trips to the area. A bypass roadway would be required to accommodate traffic affected by the truck restrictions and allow truck traffic to enter/exit the DuPont Repauno site from Route 44 without traveling through Gibbstown.

D. GOALS AND OBJECTIVES

The goals and objectives of the project are identified below:

- Provide a bypass roadway to accommodate truck traffic that currently uses Route 44 through Gibbstown as well as future truck traffic that will be generated by redevelopment of the DuPont Repauno site.
- Eliminate/reduce truck traffic through residential neighborhoods and school zones along Route 44 in Gibbstown, thereby improving safety for drivers, pedestrians, bicyclists and school buses.
- Provide a bypass roadway that meets AASHTO and NJDOT geometric standards and provides safe connectivity to/from Route 44 for both cars and trucks.
- Provide a bypass roadway that can accommodate the forecasted travel demand at the DuPont Repauno site.
- Utilize existing infrastructure to the extent feasible to minimize the environmental impacts of the bypass roadway.
- Avoid impacts to the White Sluice Conservation Easement and Wiggin's Pond.
- Minimize social, noise, and economic impacts to the community of Gibbstown.
- Provide a bypass roadway that minimizes impacts to the redevelopment plans of the DuPont Repauno site and does not impede future development.



Project Location Map (USGS)

Route 44 Truck Bypass and DuPont Port Access
Greenwich Township, Gloucester County
New Jersey

Legend

- Project Location
- Municipality Boundaries

N
W E
S

0 600 1,200 2,400
Feet

**MCCORMICK
TAYLOR**

Figure 1

E. PROPOSED PROJECT

The Preliminary Preferred Alternative (PPA) was chosen after consideration and receiving input from GCIA and the Gloucester County Engineering Department, as this concept meets the Project Purpose and Need as well as many of the goals and objectives. This alternative consists of the construction of a two-lane truck bypass roadway extending from Route 44, just east of Sand Ditch, to 'A' Line Road. On- and off-ramps connect the bypass roadway to Route 44 just north of Sand Ditch, and acceleration and deceleration lanes are provided between the ramps and Route 44. The existing Route 44 Bridge over Conrail will be modified to accommodate the Route 44 off-ramp. This alternative does not require construction of a new crossing of Sand Ditch, although it will require minor modification of the existing Route 44 culvert headwall at Sand Ditch to accommodate widening of Route 44.

This alternative was favorably received as a result of having lesser environmental impacts than the other alternatives and a minimal impact to the existing residential community.

F. EXISTING DRAINAGE CONDITIONS

There is no existing drainage systems for this project

II. PROPOSED DRAINAGE CONDITIONS

The proposed drainage conditions are as follow:

- 1- System proposed on Route 44 that has 7 inlets, one Manhole, 18" RCPs, one MTD and 14" DIPs to connect to the MTD. This system outfalls at Sta.534+9.5(RT), RT 44 existing baseline.
- 2- System proposed on Route 44, NB Ramp and on SB Ramp, this system has 23 inlets, 1 manhole, 18" RCPs, 18" DIPs, two MTDs and 14" DIPs to connect to the MTD. This system outfalls at Sta.200+00(RT), SB Ramp baseline.
- 3- System proposed on RT 44 Bypass, it has 9 inlets, 18" RCPs and DIPs, one MTD and 14" DIPs to connect to the MTD. It outfalls at Sta.304+35.1(LT), RT 44 Bypass baseline.
- 4- System proposed on RT 44 Bypass, it has 7 inlets, 18" RCPs and DIPs, one MTD and 14" DIPs to connect to the MTD. It outfalls at Sta.310+72 (LT), RT 44 Bypass baseline.
- 5- An 18" DIP with zero slope crosses under NB and SB ramps to feed and connect the two sides of the wetland areas, two inlets are connected to this pipe. Another 18" DIP with zero slope crosses under RT 44 Bypass also to feed and connect the two sides of the wetland areas.
- 6- An additional MTD, two new inlets and 16" DIPs will be proposed on Route 44, 118' south of Veterans Dr. within the same HUC-14 watershed to provide the required water quality treatment.

A. PIPES AND INLETS DESIGN CRITERIA

The proposed storm drainage systems were designed to limit stormwater spread in the 10-year storm event to the shoulder on Route 44 and Route 44 Bypass, to the third of the lane on NB and SB Ramps and to the half of the acceleration and deceleration lanes. Inlets will be installed to collect stormwater runoff from the roadway wherever possible without a major utility conflict. The systems will have capacity to convey stormwater runoff in a 10-year storm event at Free Outfall Boundary Conditions.

B. MODELING METHODS

The Bentley StormCAD computer program was used to perform spread and hydraulic grade line calculations. StormCAD uses the Rational Method ($Q=CIA$) to calculate flow to each inlet or structure within the conveyance system. A minimum time of concentration (T_c) of ten (10) minutes was used for inlet entrance times. Input to the computer program was based on observed field conditions, field survey, and proposed roadway profiles and cross sections.

The Bentley PondPack computer program was used to perform calculations for the rating curves of the diverted flows to the Manufactured Treatment Devices and the by-pass flows. *Please See Appendix A – 1-Storm Sewer Systems – Proposed Conditions. See also Appendix B – Drainage Areas Maps.*

III. STORMWATER MANAGEMENT

The project area is located within one HUC-14 watershed #: 02040202140010. *Please See Figure 3 – HUC-14 Map.* Proposed improvements for the project will disturb approximately 5.60 acres of existing land and existing roadway, increase 3.48 acres of new impervious area and include 0.74 acre of full depth pavement reconstruction. Since the project disturbance is more than one acre, and the increase of impervious area is more than 0.25 acre, the project triggers the NJDEP Stormwater Management Rules (NJAC 7:8-1.2) as “major development”. The project will comply with N.J.A.C. 7:8-Subchapter 5 (Design and Performance Standards for Stormwater Management Measures) as follows:

A. NON-STRUCTURAL STORMWATER STRATEGIES EVALUATION

The SWM Rules require that nine non-structural SWM strategies (NJAC 7:8-5.3) be evaluated and maximized before designing structural SWM measures to achieve the standards below:

- 1. Protection of areas that provide water quality benefits or are susceptible to erosion and sediment loss.* The most significant natural features providing water quality benefits are the areas containing freshwater wetlands. As discussed in detail in the Freshwater Wetland Permit Application, the proposed project has been designed to avoid and minimize the impact of the project on freshwater wetlands, State open waters, and wetland transition areas. Riparian zones adjacent to watercourses also provide some water quality benefits, and these areas (near stream vegetation) been avoided and minimized in accordance with

Flood Hazard Area Control Act Rules at N.J.A.C. 7:13, as described in detail in the submitted Environmental Project.

2. *Minimize impervious surfaces and break up or disconnect the flow of runoff over impervious surfaces.* The proposed roadway improvements have been designed to meet minimum New Jersey Department of Transportation (NJDOT) and AASHTO roadway design standards. Lane and shoulder widths are the minimum permitted, and these widths are dictated by the needs for motorist safety and other geometric requirements. The non-vegetated surface provided under guiderail to prevent the growth of vegetation is typically constructed with asphalt.
3. *Maximize the protection of natural drainage features and vegetation.* Measures have been proposed to minimize disturbance to areas beyond the project limits during construction. Limits of disturbance will be minimized by the use of steel sheet piling walls on both sides of the proposed bypass which will minimize wetland/floodplain disturbance and the clearing of trees. Side slopes and berms will be topsoiled and seeded. Silt fence will be used at limits of disturbance and inlet filters will be used at all existing and proposed inlets within the project limits. Where appropriate, culverts will be installed to connect the wetland hydrology on both sides of the proposed bypass.
4. *Minimize the decrease in the time of concentration from pre-construction to post-construction.* The proposed project will not result in a decrease in the time of concentration for the watersheds in which the project is located. Such decreases are typically the result of changes in land cover, drainage patterns, or shortening of drainage flow paths. The proposed project will do none of these. However, in some areas, longitudinal drainage systems have been provided to direct runoff to MTDs for water quality treatment.
5. *Minimize land disturbance including clearing and the proposed.* All proposed land disturbance activity will occur within right-of-way (ROW). Since the proposed project involves new construction of roadway, the primary strategy used to minimize the need for ROW and easements is to locate all disturbance activities within and immediately adjacent to proposed ROW to the maximum extent practicable. Impacts to existing, adjacent vegetation will be prevented through the use of silt fence and orange snow fence to limit construction access only to the necessary work areas.
6. *Minimize soil compaction.* Soil compaction will be limited to the footprint of the proposed Route 44 bypass within the proposed steel sheet piling. Areas to be disturbed temporarily during construction will be scarified, topsoiled and seeded.
7. *Provide low-maintenance landscaping that encourages retention and planting of native vegetation and minimizes the use of lawns, fertilizers, and pesticides.* Due to the limited ROW, the project does not involve the creation of wide berm areas along the roadway that might be landscaped. However, landscaping with native, non-invasive vegetation will be performed within the project ROW wherever feasible. Non-vegetated surfaces will be provided under guiderail so that applications of herbicides will not be required for maintenance.

8. *Provide vegetated open-channel conveyance systems discharging into and through stable vegetated areas.* For this project, providing vegetated open channels are not practical mainly due to the use of steel sheet piling walls to limit the roadway disturbance area. However, two vegetated open channels were designed between Route 44 and the north and southbound ramps.
9. *Provide source controls to prevent or minimize the use or exposure of pollutants at the site.* Many of the roadway drainage systems will discharge into proposed stabilized outfalls. In addition, all curb-opening inlets will comply with the New Jersey Pollutant Discharge Elimination System (NJPDES) standards regarding maximum opening size to trap debris and large floatable, and will also provide storm drain labeling to discourage dumping of pollutants into the drainage system. Most of the inlets along the roadway will be located in median areas, and these inlets do not have curb openings at all; only grates which meet “bicycle-safe” standards and are, therefore, in compliance with the NJPDES standards. All roadway drainage systems will be connected to manufactured treatment devices (MTDs) before discharging into stable pre-formed scour holes that will be designed to minimize the outfall flow velocity to a non-erosive velocity.

B. STORMWATER RUNOFF QUANTITY

The installation of stormwater management basins would not be a prudent stormwater management solution since it would require the removal of substantial additional forested areas, including wetlands, in the tidal floodplain of the Delaware River. Providing stormwater discharges to stable forested areas adjacent to the retaining walls would be more ecologically beneficial than cutting trees to install stormwater basins. Therefore, stormwater management basins are not considered a prudent stormwater management solution for the proposed project. The use of wider preformed scour hole at the drainage system outfalls will reduce the velocity and will not erode the stable and vegetated area. The increase in volume and discharge due to the construction of the Route 44 bypass will not have any adverse impact below point of discharges.

Table 1 and *Table 2* summarize the peak flows and volumes at POI (O-1 in PondPack Calculations) in the existing and proposed conditions for the project watershed.

Table 1 - Existing vs Proposed Peak Flows for Project Watershed

Storm Event	Existing Peak Flow (cfs)	Proposed Peak Flow (cfs)	Flow Increase (cfs)
1-yr	14.97	16.91	1.94
2-yr	22.64	24.62	1.98
5-yr	38.26	40.01	1.75
10-yr	53.37	54.90	1.53
25-yr	77.39	78.55	1.16
50-yr	100.28	101.08	0.80

Table 2- Existing vs Proposed Volumes for Project Watershed

Storm Event	Existing Volume (ac-ft)	Proposed Volume (ac-ft)	Volume Increase (ac-ft)
1-yr	2.345	2.891	0.546
2-yr	3.367	3.97	0.603
5-yr	5.441	6.128	0.687
10-yr	7.469	8.215	0.746
25-yr	10.736	11.553	0.817
50-yr	13.898	14.765	0.867

Notes: The existing levee protect the project area up to 50-year tide elevation, 100-yr storm event is not included because it is tidal.

The increase in volume and peak flow will have no adverse impact below the point of discharges. FlowMaster software was used to calculate the water surface elevations (WSE) and the results are shown in **Table 3**:

Table 3 - Existing vs Proposed Water Surface Elevations

Storm Event	Existing WSE (ft)	Proposed WSE (ft)	WSE Increase (ft)
1-yr	-0.82	-0.80	0.02
2-yr	-0.76	-0.75	0.01
5-yr	-0.67	-0.66	0.01
10-yr	-0.60	-0.60	0
25-yr	-0.51	-0.51	0
50-yr	-0.43	-0.42	0.01

Please refer to **Appendix A** for calculations.

C. SOIL CHARACTERISTICS AND GROUNDWATER RECHARGE

The project is located on two types of soil: **Udorthents (UddcB)**, and **Fallsington (FamA)**:

1- Uddcb: Udorthents, dredged coarse materials, 0 to 8 percent slopes

2- FamA: Fallsington sandy loams, 0 to 2 percent slopes, Northern Coastal Plain

The Annual Groundwater Recharge Analysis Spreadsheet (AGRAS) shows that the Post-Development Annual Recharge Deficit is 0 cubic-feet. So, Groundwater Recharge is not required for this project.

*Please See **Figure 2 – Soil Map** and **Appendix C - RT 44-Soil Details and AGRAS**.*

989 Lenox Drive, Suite 124 Lawrenceville, NJ 08648 T: 609.282.8000 F: 609.282.8001

To: Greenwich Township Planning Board
Greenwich Township Police Department

From: Kevin J. Webb, PE

Date: July 12, 2019

Re: Trip Generation
Delaware River Partners, LLC
Repauno Port & Rail Terminal, LPG Transloading Facility Site Plan Application
Part of Block 8, Lots 3 and 4, Township of Greenwich, Gloucester County, NJ
Langan Project No.: 130088803

PB2019-08

In accordance with Item 4.4 of the Redevelopment Plan, we have prepared this assessment of anticipated site-wide traffic at the Repauno facility during the construction and operation of the proposed LPG Transloading Facility.

Item 4.4.1 of the Redevelopment Plan states that the site-wide trip generation shall be limited to a maximum of 550 vehicle trips per day prior to the construction of Phase 1 of the proposed Route 44 Bypass. Furthermore, the trip generation is clarified to include both vehicles and trucks used by site employees and visitors, but excludes traffic related to the ongoing site remediation by Chemours and construction traffic related to the proposed bypass road.

The number of trips generated by the operational and construction-related activities at the site will vary due to the seasonality of the existing butane cavern operations and phasing of construction. The component parts of the overall site-wide traffic are described and tallied below.

ADMINISTRATIVE SERVICES TRAFFIC

This category includes traffic associated with DRP's employees and visitors. The total number of DRP administrative and support staff employees is estimated at 14, including employees, 2 maintenance contractors, and 3 security contractors. Visitors, consultants, and delivery trucks historically account for 3 additional vehicles per day.

Each of these 17 vehicles would be expected to account for 2 trips: 1 entering and 1 exiting. Approximately 8 employees would be expected to leave the site and return during the workday for outside meetings or meals, thereby generating additional trips.

In summary, the administrative services traffic is estimated at 50 trips per day:

$$17 \text{ vehicles} \times 2 \text{ trips/day} + 8 \text{ vehicles} \times 2 \text{ additional trips/day} = 50 \text{ trips/day}$$

Technical Memorandum

Trip Generation
Repauno Port & Rail Terminal, LPG Transloading Facility Site Plan Application
Part of Block 8, Lots 3 and 4, Township of Greenwich, Gloucester County, NJ
Langan Project No.: 130088803
July 12, 2019- Page 2 of 4

OPERATIONAL TRAFFIC – EXISTING BUTANE CAVERN

The butane cavern operation is seasonal. During April through October, the cavern typically receives butane via railcar delivery or is idle, thereby generating no vehicle trips. During November through March, the cavern generally ships butane off-site by truck. The truck rack at the butane cavern can accommodate up to 2 trucks at one time or a theoretical maximum of 48 trucks in a 24-hour period. To date, no more than 16 trucks per day have served the cavern at peak operation during the shipping season, with a typical average of 8 trucks per day.

All trucks generate 2 trips: 1 entering and 1 exiting. Two operators support the butane cavern, thereby generating 4 trips/day. In summary, based on historical operations the existing butane cavern operation is estimated to generate 36 trips per day:

$$2 \text{ vehicles} \times 2 \text{ trips/day} + 16 \text{ trucks} \times 2 \text{ trips/day} = 36 \text{ trips/day}$$

OPERATIONAL TRAFFIC – FUTURE RAIL RACK

The only vehicle trips generated by the proposed rail rack operation are those associated with its operators. DRP estimates 4 operators will support the rail rack operation, thereby generating 8 trips/day.

$$4 \text{ vehicles} \times 2 \text{ trips/day} = 8 \text{ trips/day}$$

CONSTRUCTION TRAFFIC – FUTURE RAIL RACK

Construction traffic will be comprised of construction vehicles used by construction employees to arrive at the site, those supporting the on-site construction, and those used to import fill from off-site sources. The construction will be phased such that the fill import activities will precede the construction of the rail rack and its supporting infrastructure.

Fill Import Phase

The site-wide trip generation will peak during the fill import phase, as a portion of the fill will be imported via truck from an off-site source as coordinated with Gloucester County. It is expected that a maximum of 150 trucks per day will deliver fill to the site, thereby generating 300 total trips daily. *In addition*, we estimate a total of 20 construction vehicles will support this work, including 10 vehicles *used at the* construction site and 10 additional personal vehicles for employees who are transported to the work area using vans that do not otherwise leave the site. In total, we estimate 340 trips/day will be generated during the fill import phase.

$$150 \text{ trucks} \times 2 \text{ trips/day} + 20 \text{ vehicles} \times 2 \text{ trips/day} = 340 \text{ trips/day}$$

Technical Memorandum

Trip Generation
Repauno Port & Rail Terminal, LPG Transloading Facility Site Plan Application
Part of Block 8, Lots 3 and 4, Township of Greenwich, Gloucester County, NJ
Langan Project No.: 130088803
July 12, 2019- Page 3 of 4

Rail Rack Construction Phase

Once the fill has been imported, additional construction vehicles will be expected for the construction of the rail rack. We estimate a total of 50 construction vehicles will support this work, including 25 vehicles used at the construction site and 25 additional personal vehicles for employees who are transported to the work area using vans that do not otherwise leave the site. In total, we estimate 100 trips/day will be generated during the fill import phase.

$$50 \text{ vehicles} \times 2 \text{ trips/day} = 100 \text{ trips/day}$$

ANALYSIS

Using the figures calculated above, the current baseline administrative and operational activities generate 50 trips/day for the majority of the year and a total of 86 trips/day during the limited period when butane is being shipped off-site via truck. When the rail rack becomes operational, those figures will increase to 58 trips/day and 94 trips/day respectively.

During construction of the rail rack, the site-wide trip generation will increase above those baseline levels. During the fill import phase, the site-wide trip generation will peak at an estimated 426 trips/day. After completion of the fill import activities and during the construction of the rail rack, the site-wide trip generation is estimated to be 186 trips/day.

See Table A on page 4 for a summary of all calculations.

CONCLUSION

Even during peak trip generation conditions of the rail rack construction, the site-wide trip generation will be less than the maximum 550 trips/day specified in the Redevelopment Plan.

As specified during prior applications, operational and construction-related truck traffic shall use the entrance and exit routes shown on the attached Truck Traffic Routes plan, dated November 16, 2018, prepared by Langan.

Technical Memorandum

TABLE A - TRIP GENERATION CALCULATIONS

ADMINISTRATIVE SERVICES TRAFFIC

DRP employees	9 vehicles		
DRP maintenance contractors	2 vehicles		
DRP security contractors	3 vehicles		
Visitors	3 vehicles		
Additional workday trips	8 vehicles		
<hr/>			
Subtotal	25 vehicles	x 2 trips/day	= 50 trips/day

OPERATIONAL TRAFFIC - EXISTING BUTANE CAVERN

DRP cavern operators	2 vehicles		
Butane trucks	16 vehicles		
<hr/>			
Subtotal	18 vehicles	x 2 trips/day	= 36 trips/day

OPERATIONAL TRAFFIC - FUTURE RAIL RACK

DRP rail rack operators	4 vehicles		
<hr/>			
Subtotal	4 vehicles	x 2 trips/day	= 8 trips/day

CONSTRUCTION TRAFFIC - RAIL RACK

Fill Import Phase

Fill import trucks	150 vehicles		
Construction support vehicles	10 vehicles		
Construction employees	10 vehicles		
<hr/>			
Subtotal	170 vehicles	x 2 trips/day	= 340 trips/day

Rail Rack Construction Phase

Construction support vehicles	25 vehicles		
Construction employees	25 vehicles		
<hr/>			
Subtotal	50 vehicles	x 2 trips/day	= 100 trips/day

TOTAL DURING FILL IMPORT PHASE **426 trips/day**

TOTAL DURING RAIL RACK CONSTRUCTION PHASE **186 trips/day**

TOTAL AFTER RAIL RACK CONSTRUCTION **94 trips/day**



June 7, 2019

Delaware River Basin Commission
West Trenton, New Jersey

Re: DOCKET NO. D-2017-009-2 , DELAWARE RIVER BASIN COMMISSION , Delaware River Partners LLC, Gibbstown Logistics Center, Dock 2 , Greenwich Township, Gloucester County, New Jersey

Delaware Riverkeeper Network (DRN) submits this comment in opposition to the approval of Docket D-2017-009-2 on behalf of our approximately 20,000 members throughout the Delaware River Watershed including residents in the closest Gloucester County communities. The Delaware Riverkeeper Network (DRN) is a private non-profit membership organization, championing the rights of our communities to a Delaware River and tributary streams that are free flowing, clean, healthy, and abundant with a diversity of life.

DRN submits that, based on review of the materials submitted to Delaware River Basin Commission (DRBC) by the applicant, this project will have substantial negative impacts on the Delaware River, its water quality, its habitats, and the species that live, forage, shelter, migrate through and reproduce in the River, Estuary and Bay. DRN also submits that the application is substantially lacking in critical information for and assessment of described and yet-to-be described or assessed aspects of the proposed project. DRN requests that Docket approval be denied or, in the alternative, the Docket be withdrawn and specific reviews and analyses are conducted before further consideration of the project.

DRN points out that we commented on the last docket proposed and approved by DRBC in November 2017 for the Gibbstown Logistics Center (D-2017-009-1). Concerns we expressed about the incompleteness of the application materials, unfortunately, remain. We point out DRBC did not heed these concerns in 2017 and since it appears now that New Fortress Energy may have been planning LNG export from this site at that time but did not disclose that information, our concerns were well-founded and should have led to DRBC insisting that the missing information be provided before the first docket was approved. If that had been done, the public and the agencies may have learned of the planned export of LNG from the Center and a comprehensive analysis of the project would have been required.

As stated by DRN in our comment letter dated November 17, 2017:

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
drm@delawareriverkeeper.org
www.delawareriverkeeper.org

DRBC states its draft Docket is to approve dredging and the construction of a deepwater berth for the proposed Delaware River Partners (DRP) Gibbstown Logistics Center (“the Proposed Project”). However, the current draft docket, despite claiming to approve only the dredging and deep-water berth construction project, approves stormwater outfalls and land disturbances. Furthermore, the docket states that DRP “...is required to submit detailed site plans to the DRBC for the remainder of the Logistics Center, including the proposed: Automobile import area/parking lot; processing facilities; perishables, bulk-liquids and gases, and bulk cargo handling areas; warehouses and associated buildings; stormwater management system (including stormwater outfalls); and the associated infrastructure”.¹

Based on this lack of essential information, until all plans are completed, submitted to and assessed by DRBC, the draft docket for the Proposed Project should be put on hold. It is unreasonable to move ahead with an application that is so obviously incomplete and lacking in adequate assessment and review. It is impossible to accurately assess the potential impacts on the water resources of the Basin with the information made available for only a portion of the Proposed Project.

We point out that the condition (C.I.(c)) of the 2017 DRBC Docket, which requires the missing information to be provided, seems not to have been met by Delaware River Partners because in subsequent file reviews conducted by DRN through FOIA, we have not seen any written material in the files disclosing the plans of the applicant to include LNG as a cargo. This is despite repeated public statements by New Fortress Energy that LNG would be processed from Marcellus Shale gas in Bradford County, Pennsylvania, trucked to the Delaware River and exported out of the country through the Delaware River ports. The U.S. Army Corps of Engineers (ACE) Public Notice of April 4, 2019, listed various cargo to be transloaded at the Gibbstown Logistics Center. Included in the list was liquefied natural gas (LNG) and yet this was not added to this new draft docket for Dock 2. Obviously, the follow up information – site plans for handling of all cargo - that was to be provided by the applicant was either not supplied to DRBC or DRBC decided not to include LNG in the list of cargo published in the new draft docket. Either way, the public was deprived of this information and the missing information regarding the products to be handled at the Center, makes the application deficient based on incompleteness.

DRN points out that the exclusion of LNG from the cargo list is additionally important because of the dangers of handling and transloading LNG. LNG is arguably the most consequential and dangerous product to be handled at the Center, making it a glaring omission. We are including information regarding the potential impacts of LNG release and the special circumstances LNG requires at the end of this comment.

The additional dredging and deep-water berth construction project, named Dock 2, poses several unacceptable environmental hazards and potential pollution sources for the Delaware River and the region.

Environmental Impacts of the Proposed Activities Contained in the Draft Docket

Dredging: The dredging of 665,000 cubic yards of sediment from the Delaware River to provide a channel to the Federal Navigation Channel would go to a depth of 43 feet below mean water lower low water over a 45-acre area. Allowed is a two-foot overdraft. This almost doubles the amount of material that will be dredged for the entire Gibbstown Logistics Center project, increasing greatly the adverse environmental

¹ Docket No. D-2017-009-1, p. 3.

footprint of the dredging from the originally proposed Dock 1. The sediment to be dredged is silt, fine sand, and trace gravel, according to the draft docket. DRN is very concerned about the impacts of the dredging on water quality, fish, and aquatic life. We do not agree that the prevention measures included in the draft docket for controlling the sediment will provide adequate protection to species in the area of the Center.

The Delaware Riverkeeper Network has commented in the past on the significant environmental impacts that dredging causes in this section of the Delaware River. First, deepening 45 acres of river area to a depth of -40 feet mean lower low water with a 2-foot overdraft will open this newly deepened area to the potential for an increased risk of harm if there is a catastrophic spill event. With a deepened area, ships will access the proposed deepwater port and, when filled for export will be heavily laden with LNG, natural gas liquids or other chemicals. Using the catastrophic experience of the Athos I oil spill of November 26, 2004, the volume of carried material available to leak and wreak havoc on the environment and our communities will be greater and therefore more dangerous with the added capacity of the proposed port's dredging of 45 acres.²

The Athos I catastrophe exposed 115 miles of River, 280 miles of shoreline, 16,500 birds, as well as many species of fish, shellfish, and wildlife and a variety of important habitats to the heavy crude it dumped into the Delaware River.² Habitats, wildlife, water quality, air quality, industry, recreation, and communities were all significantly harmed by the spill. Any project that will increase the magnitude of such a tremendous level of damages in the event of a future catastrophe is a danger to all of these natural and human resources.

Adding LNG transport to the dangers of shipping on the river exponentially increases the potential for a far-reaching catastrophe. Considering that the zone of blast around a container release and/or fire is at least one mile and could be miles larger depending on how quickly the gas cloud created by the vaporizing LNG spreads, communities along the river, including metropolitan areas such as Philadelphia, Camden, Chester and other high density population centers), passing ships, bridges, facilities such as airports (the Gibbstown Logistics Center is across the river from the Philadelphia Airport), motor vehicle traffic and workers would all be exposed to potential life-threatening injury if an LNG marine vessel were to have an accident and release LNG. There is no discussion in the Docket about the shipping dangers that the dredging would enable. This is one reason why a comprehensive environmental analysis of this LNG project is required.

Dredge spoils significantly increase the amount of heavy metals and toxins that would be released into waterways and the environment², especially with the amount of material that appears to be contaminated at this site. The impacts of the spoil disposal plans and potential pollution impacts could have significant community and environmental effects. The threat posed by dredged spoils is known to be a source of water pollution after on-land disposal.² In addition to polluting the water and land, there are likely to be air quality impacts including NOx emissions associated with the construction and associated traffic from this additional dock and dredging project that should be considered as well. Yet there is no analysis of air pollution in the draft docket.

Atlantic sturgeon will be directly negatively impacted by the development and operation of this site. The draft docket states that the revised wharf design is under review currently by USACE in consultation with

² Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

NMFS regarding two threatened and endangered sturgeon species, and the critical habitat for the Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). However, the docket fails to acknowledge that the federal government established the Delaware Estuary as Critical Habitat for the New York Bight DPS of Atlantic Sturgeon in August 2017. DRBC's Water Quality Regulations at §4.30.5-B.1 acknowledge that the Commission must evaluate Critical Habitat, and that this evaluation must follow its Rules of Practice and Procedure. Despite the federal ruling, DRBC has yet to initiate its procedures for verifying the Critical Habitat established by the federal government, and the role that Critical Habitat will play in docket decisions. DRBC should not approve any project that could directly and indirectly affect this Critical Habitat until it has completed all necessary procedures in the Critical Habitat evaluation. To do so would be premature, would undermine the required process for DRBC review and approvals, would be unfair in terms of just application of its regulations, and jeopardizes the Critical Habitat of the Atlantic Sturgeon. The DRBC is not ready to grant approval to any project that involves the Critical Habitat of the Delaware Estuary for the New York Bight DPS of Atlantic Sturgeon.

Both direct take and incidental take of sturgeon are a distinct possibility with a project of this nature. Both the Atlantic sturgeon and shortnose sturgeon are threatened and adversely affected by dredging and effects to water quality including dissolved oxygen (DO) levels, water temperature, and contaminants.² The proposed project will entail significant levels of dredging as well as significant water quality effects and dramatic changes in important habitats including juvenile habitat and spawning grounds.

The dredging of river systems significantly impacts aquatic ecosystems in a number of ways that will harm both sturgeon species. Among the effects that the project will have on the Delaware River populations of both sturgeon species are:

- ✓ Deep-draft vessel traffic in the Delaware River has been cited as the biggest threat to the survival of the Delaware River population Atlantic sturgeon; the increased vessel traffic and increased area for deep-draft vessels to strike Atlantic sturgeon directly resulting from this project will significantly increase sturgeon vessel strikes and could accelerate the extinction of this endangered species population.³
- ✓ Dredging activities remove, disturb, dispose of and re-suspend river sediments, modifying the river bottom substrate and impacting the community of benthic macrofauna;
- ✓ Dredging operations can remove or bury organisms and destroy benthic feeding areas;
- ✓ Dredging operations can create noise and disturbance, and can disrupt spawning migrations;
- ✓ Dredging activities can re-suspend contaminants, affect turbidity and siltation, and deposit fine sediments in spawning habitats; and
- ✓ Dredging activities alter the hydrodynamic regime, alter physical habitats, and create the loss of riparian habitat.²

The act of dredging can entrain sturgeon, taking them up into the dredge drag-arms and impeller pumps and resulting in death.² New data from tagged Atlantic sturgeon continue to show their presence in or near the main navigation channel, making them vulnerable to direct take by dredging operations, as well as direct take from the larger vessels that will be using the channel.² These lethal takes are significant for a species

³ Brown and Murphy. 2010. Atlantic Sturgeon Vessel-Strike Mortalities in the Delaware Estuary. Fisheries 35(2): 72-83.

that is at such low levels (fewer than 300, maybe even fewer than 100), and as genetically unique as the Atlantic sturgeon of the Delaware River are.²

Dredging in the portions of the River near Philadelphia is likely to be detrimental to the successful spawning of sturgeon in the Delaware – not just because of the act of dredging but also because of the degradation of spawning habitat.² Dredging increases the level of suspended sediments and contaminants in the water. An increase in suspended sediments could be detrimental to egg survival of sturgeon – increasing the probability that eggs adhere to suspended solids and suffocate.² increasing contaminant loads can alter growth and reproductive performance in sturgeon.²

Dredging is a factor in the destruction, modification, or curtailment of the Atlantic sturgeon’s habitat and range.² The environmental impacts of dredging include direct removal or burial of organisms, elevated turbidity or siltation, contaminant re-suspension, noise or disturbance, alterations to hydrodynamic regime and physical habitat, and loss of riparian habitat.² Furthermore, an increase in vessel traffic on the Delaware River resulting from the project would increase the likelihood of vessel strikes to sturgeon.²

A study of mortality rates on Atlantic sturgeon in the Delaware River between 2005 and 2008 found that 50% of the mortalities were the result of vessel strikes. The remaining 50% were too decomposed to determine if they were caused by vessel strikes but it is likely most were.² For small remnant populations of Atlantic sturgeon, such as that in the Delaware River, the loss of just a few individuals per year due to anthropogenic sources of mortality, such as vessel strikes, may continue to hamper restoration efforts.² According to a 2010 research article on vessel strikes, “Both the dredging to deepen the channel and the subsequent increase in large vessel traffic may further hamper the recovery of the Delaware River Atlantic sturgeon population.”² Of critical importance, this study is concerned about the size of the vessels resulting from deepening as opposed to any increase in the volume of vessels. The larger size of the vessels from the deepened channel will likely increase the number of vessel strikes for both sturgeon species.²

The continued dredging of new deep-water areas will further impact Atlantic sturgeon spawning by accelerating the intrusion of brackish water into the hard-bottom spawning grounds, and thus forcing Atlantic sturgeon to spawn further upstream in the zone of depressed dissolved oxygen. This shift then exposes the eggs and larvae of newly spawned Atlantic sturgeon to low oxygen conditions from which they may not survive. This “squeeze” between increased salt intrusion in the estuary downstream (exacerbated by channel deepening, new deep-dredged berthing areas, and rising sea levels) and the near-lethal dissolved oxygen levels upstream limits the ability of Atlantic sturgeon to successfully reproduce, and increases the likelihood of extinction. This project makes a significant contribution to such salt-intrusion by adding 45 acres of new deep-water channel and berthing to an estuary under siege.⁴

The remobilization (and dewatering of dredged sediments) will create higher exposure to PCBs and other contaminants, and the Atlantic Sturgeon spawning and rearing that begins in June and extends the early-life-stages through July and August, with increasing evidence for high aggregations of young-of-year in the Proposed Project vicinity, means that elevated exposure will occur for larval and juvenile stages of this endangered species in the Delaware River. The currently proposed methods and timing are insufficient to

⁴ Moberg and DeLucia. 2016. Potential Impacts of Dissolved Oxygen, Salinity and Flow on the Successful Recruitment of Atlantic Sturgeon in the Delaware River. The Nature Conservancy. Harrisburg, PA. 69 pp.

protect this endangered species, and more evidence and analysis would be required in order to claim that the project does not impair NOAA Trust Resources, fish and wildlife, and the water resources of the Basin.

In November of 2010, researchers discovered beds of freshwater mussels in the Delaware River between Chester, PA and Trenton, NJ.² The species found included the alewife floater (*Anodonta implicata*) and the tidewater mucket (*Leptodea ochracea*), only found in New Jersey in the tidal Delaware River; the pond mussel (*Ligumia nasuta*) and the yellow lampmussel (*Lampsilis cariosa*), both considered critically-imperiled; and the creeper (*Strophitus undulatus*) and the eastern floater (*Pyganodon cataracta*) both considered vulnerable; as well as the eastern elliptio (*Elliptio complanata*), the only mussel known to be native to our Delaware River that is not considered to be in jeopardy.² Mussels are not mentioned in the application or in the applicant's Compliance Statement. Particularly because some of these estuarine species are state-listed and/or critically imperiled, the extent and composition of these mussel beds needs to be accurately surveyed prior to any in-water work at the site. Once the locations, abundance, and identify of these species are documented, a relocation plan would be needed to move individual mussels out of areas where direct mortality might occur.

Freshwater mussels can live 80 to 100 years old, and most species do not begin reproducing until they are 8 to 10 years old.² Because they are so slow growing and don't begin to reproduce until this older age, they are not able to quickly recover from disturbances and the population cannot recover quickly from impacts that result in death to individuals.² Freshwater mussels require a fish host, a specific species depending on the mussel, to complete their life cycle. Activities that damage the needed fish hosts in turn do direct harm to the freshwater mussel species they help serve in the life cycle.²

Mussels are vital for filtering pollution and filling important habitat niches. Experts believe that revitalizing freshwater mussels in the Delaware River could improve water quality downstream and thereby benefit estuarine species.² All of the freshwater mussels in the Delaware River system, except for one (the Eastern elliptio, *Elliptio complanata*), are identified by one or more of the states as endangered, threatened, imperiled, vulnerable, critically impaired, very rare, extremely rare or extirpated.²

Freshwater mussels are very sensitive to water quality. Exposure to contaminants either directly via dissolved compounds or contaminants that are particle-mediated can have adverse consequences.² Freshwater mussels are highly exposed to changes in water quality because of their filtering activities and the passage of large volumes of water across many thin tissue layers. Dissolved toxins, such as heavy metals, are rapidly taken up by direct absorption and indirectly via food.² Because this project will likely result in pollution both directly and through contaminants from spoil disposal, the implications of this pollution for the mussels in this area must be examined.

Stressed mussels require more oxygen. The dredging described for this project is a threat to any submerged aquatic vegetation in the area that is critical for providing oxygen in the Estuary, including the Philadelphia reach of the River, which includes the location of the proposed project. Although dissolved oxygen levels can become excessively low in this area even today, they have improved significantly compared to decades past. In fact, the DRBC is considering elevating their "Aquatic Life Designated Use" rule in this section of the Delaware River to maintain and protect dissolved oxygen levels.⁵ Increased sedimentation from

⁵ Delaware River Basin Commission (2017) Draft Resolution, February 23, 2017. Retrieved from http://www.nj.gov/drbc/library/documents/Res_EstuaryAquaticLifeUses_draft022317.pdf

dredging activity inhibits mussels and their host fish species from taking in oxygen.² Additionally, invasive or exotic species resulting from interbasin transfers of water can be a very direct threat to freshwater mussels as well as many other species. Increased ballast water from deeper ships, and increased ship traffic, brought up the River by a deeper channel could heighten this risk.² The issue of invasive and exotic species and ballast water and their ecological and economic implications for freshwater mussels and other River fish and wildlife species must also be considered.

Identification of host fish needed for freshwater mussels is one of the least studied aspects of freshwater mussel life history. American eel are known to be hosts for *Elliptio complanata*; some believe they are in fact the preferred host.² Some species of trout and yellow perch too can serve as hosts and data shows that some of the species found in the tidal estuary, *Strophitus undulatus*, can use pumpkinseed and yellow perch.² Shad too are considered by some as possible host species.² The potential impacts to these host species are additional factors to consider when assessing the threats to mussels.

There is evidence that the acoustic impacts from construction activities, such as those described for this project, can significantly harm fish.⁶ The effects of underwater sounds created by pile driving on fish may range from a brief acoustic annoyance to instantaneous lethal injury depending on many factors.⁵ Even at non-lethal levels, low levels of acoustic damage may result in the fish not being able to swim normally, detect predators, stay oriented relative to other fish in the school, or feed or breed successfully.⁵ This is a potential threat to all fish, including both sturgeon species as well as all the fish that serve as host species to mussels.

There are bald eagle (*Haliaeetus leucocephalus*) nests and osprey (*Pandion haliaetus*) nests near or within the project site.⁷ Even with the best mitigation plan in place, there would inevitably be some level of disturbance to these nests versus the no-action alternative, which would leave the nests as they currently are. The nests are not even mentioned in the public notice and this is an issue that the public should be aware of. While formerly a highly-degraded site when DuPont owned and operated the property, the wetland and upland portions of the site have reverted to a natural state with a diverse ecosystem suitable as nesting habitat for these two imperiled bird species. Any disturbances or alterations to these nesting areas could be detrimental to the breeding success of these birds and therefore the future viability of their populations in this area.

The additional deepened 45 acres of river area that would provide access to the proposed deepwater port Dock 2 would result in larger and deeper draft vessels coming up the River. The draft docket states ocean-going vessels up to 966 feet long with a draft of 39.7 feet will be accommodated at the two deep after berths. This triples the amount of vessel traffic that was originally planned for the facility. This additional traffic being layered on to the facility is not being analyzed in the draft docket in terms of the amount of truck traffic, parking areas, turning radius areas and other related knock-on logistical needs that are available on this site, which had some non-specified areas but without an analysis showing that the additional traffic can be handled at the Center, it is unknown if the site is too small for this additional vessel

⁶ Delaware Riverkeeper Network (2011). Supplemental Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁷ Ramboll Environ (2016). Compliance Statement in Support of Multiple Individual Permit Applications. Appendix E, Habitat Impact Assessment Report, July 2016.

traffic. The additional ship traffic and the specific types of ships required for LNG and NGL overseas transport will significantly increase. There is no discussion of this in the draft docket.

Additionally, the additional emissions of the truck traffic, impacts of rail traffic, and other related environmental impacts are not discussed in the docket, nor is any additional stormwater runoff (in terms of quantity and also quality due to the additional traffic and additional types of cargo, including LNG) and other related infrastructure need to handle and service the new shipping traffic. The transloading area needs to also be analyzed to be certain the additional cargo that will be transloaded, especially if it is hazardous material such as NGL or LNG or other bulk liquids that possess toxic properties can be safely handled with adequate environmental protections and that stormwater produced will not pollute receiving waterways?

Again, this is an example of partial review of the proposed Dock 2 that represents segmentation of the project since DRBC had included stormwater outfalls and systems on land in the 2017 docket but does not here address that infrastructure that now may need to be changed due to the additional activities Dock 2 will enable. When will these aspects of the expanded project be assessed and will DRBC consider these aspects as they have in the last docket? How can DRBC conclude that water resources will not be adversely impacted without this analysis? Furthermore, if LNG is the cargo that is being added with Dock 2, or is among the cargo being added, what special considerations and conditions will be required to assure the handling and transloading of the LNG can be safely accomplished? This is not discussed in the draft docket.

Another question that must be answered is whether simultaneous handling of LNG and other cargoes, including dangerous NGLs, can be done safely. If the transloading to the ship from truck or railcar is considered similar to “truck to ship bunkering” when assessed by the U.S. Coast Guard, there are Coast Guard regulations that apply to these activities when there are SIMOPS or “simultaneous operations” planned in the same vicinity. The usual procedure is for a Policy Letter to be issued by the Coast Guard after the specific logistics are evaluated.⁸ Similar to SIMOPS considerations, it is additionally important to evaluate the activities and storage planned for export of other products such as NGL from the terminal for compatibility with LNG activities. An informed decision needs to be made about timing, location, and proximity to the LNG facilities and activities. It may be that other activities planned for the terminal cannot occur at the same site that is handling LNG. This issue must be resolved prior to any further permitting for the Gibbstown Logistics Center facility.

More shipping vessels mean more ballast water needs, discharges, and impacts. Impingement and entrainment of the variety of species discussed in this comment and beyond due to the intake and discharge of ballast water could be significant. The increased intake of ballast water from the River as a result of the commercial vessels coming into the River due to this project would entrain early life stages of commercially and recreationally important fish including American shad, alewife, blueback herring and striped bass.² The cumulative effects of this impingement and entrainment need to be considered in conjunction with the impingement and entrainment that already occurs at existing cooling water intakes operating in the Delaware Estuary and River, including the nearby Paulsboro and West Deptford Township facilities.

⁸ CG-OES Policy Letter, No.01-17, JUN - 8 2017, GUIDANCE FOR EVALUATING SIMULTANEOUS OPERATIONS (SIMOPS) DURING LIQUEFIED NATURAL GAS (LNG) FUEL TRANSFER OPERATIONS, Ref: (a) CG-OES Policy Letter No, 01-15.

In addition, the concerns about invasive exotic species that may result from larger discharges of ballast water from larger vessels cannot be overstated in terms of either ecological or economic impacts. The invasion of such species into major ports and waterways of the U.S. have cost billions of dollars in control efforts and lost economic value from damage to important fish and wildlife species as well as the habitats that support them.² For more information see

http://water.epa.gov/polwaste/vwd/ballastwater/invasive_species_index.cfm

http://water.epa.gov/polwaste/vwd/ballastwater/invasive_species_bal_links.cfm

<http://www.invasivespecies.gov/index.html>

DRN is very concerned about the release of PCBs from the site. EPA identified the Repauno site in 2003 as one of the largest PCB point sources in the Delaware Estuary (among the top 10). A TMDL was established for the Estuary to remediate the contamination. Dredging; construction in the water, riverbank and on uplands; and site disturbance and stormwater systems will disturb PCBs, which have been found in near-shore sediments and in runoff from the site. There is a zone of highly contaminated sediments immediately adjacent to the shore and port facility. DRBC's dedicated role in reducing PCBs in the Estuary and its role to ensure that PCB Pollution Minimization Plans (PMP) are effectively implemented is compromised by the plan to disturb, construct on, and dredge this site.

The 2017 DRBC docket approved dredging and other disturbances that could significantly increase PCB loading to the already-impaired Delaware Estuary. DRBC did require in the current docket a PCB sampling program to be conducted by Delaware River Partners and stated that capping to raise the site to a higher elevation would help to minimize PCB release. We did not see any analysis that proves that statement. A NPDES permit was supposed to be required to assess PCB migration from the site and to possibly require a separate pollutant minimization plan to be conducted by Delaware River Partners. However, the project is currently under construction while no NPDES permit is in place that requires sampling and monitoring of the release of PCBs during this critical disturbance phase of the project.

There are several unaddressed questions regarding this PCB issue. First, the sampling and the controls should have gone into operation prior to dredging and land disturbance that could release PCBs but this apparently is not the case unless the NPDES permit has been issued without public disclosure. Second, Chemours claims that the site is "substantially remediated" for PCBs yet there is no evidence that PCBs are remediated and the sampling as recently as 2018 shows otherwise. Third, Chemours currently operates the site remediation program, including a groundwater pumping system which is supposed to continue during the operation of the facility. If the 2017 DRBC Docket condition is carried out, how will the Delaware River Partners operation of a separate PCB plan, possibly connected to the stormwater infrastructure, be coordinated physically, managerially, and legally in concert with the cleanup of the groundwater by Chemours?

DEP had informed DRBC during the last docket review that there would be a stormwater permit issued for the facility that would address the PCB issues through a DEP-issued NPDES permit. However, there was no stormwater permit issued after the DRBC Docket was approved. Instead, after a year of phone calls and file reviews, DRN finally got a copy of the stormwater permit in 2019 for the site – a permit DEP claimed did not exist since the time DRN filed an OPRA for the project. It was issued in 2017 but had no mention of PCBs. This permit was not even contained in the DRBC's files.

More perplexing is that the 2017 DRBC docket at C.(D)l. requires that when the DEP NPDES permit is issued “the docket holder shall perform an investigation of the site to assess the disposition of stormwater and the flow paths for the individual stormwater outfalls either directly or indirectly to the Delaware River in order to develop and implement a PCB stormwater sampling plan. Upon evaluation of the sampling results by the NJDEP in consultation with the DRBC, DRP may be required to develop and implement a separate PMP for PCBs in accordance with Section 4.30.9 of the Commission’s Water Code and Water Quality Regulations (18 CFR Part 410).”⁹

The draft docket has no mention of a NPDES permit and records obtained by DRN from DRBC through FOIA, show that the applicant stated that a NJPDES permit is pending in an email dated May 14, 2019. However, a week later an email from the applicant dated May 21, 2019 states, without any explanation, that the NJPDES permit is “not required”. The NPDES permit is not listed in Table B-1 in the draft docket. DRN asks why the NPDES permit was, suddenly, not required, who made that determination and why and how is a condition of the current (2017) docket summarily violated? How will the PCB sampling program be carried out, how will PCB be controlled from the site for the current development of the site and what precautionary measures are being taken by DRBC to ensure that the PCBs released from the activities required for Dock 2 do not contribute to PCB contamination of the Delaware River Estuary?

The Gibbstown Logistics Center is wholly compromised by its location on a highly contaminated property. Construction and operation of the Center can be expected to disturb and mobilize soil, sediment, surface water and groundwater pollution that is present on this Superfund site. This is a former industrial site that is under remediation known as the Repauno Plant. It is a 1,856-acre site located along the Delaware River in Gloucester County, NJ. The site is bounded to the north by the Delaware River, to the east by a former Hercules Chemical manufacturing plant, to the south by the city of Gibbstown, and to the west by wetlands and Repauno Creek. The western half of the site consists almost entirely of surface water bodies and wetlands. Former and current production operations are located in the northeastern part of the site. Several production areas have discontinued operations and structures have been razed. The eastern half of the site also consists of some upland and wetland ecological communities (EPA, 2003). Altogether, the site contains approximately 1,500 acres of wetlands (Fichera, 2015). The Gibbstown Logistics Center is planned to use 218 acres.

DuPont operated the site as an explosive manufacturing facility since 1880. In 1917, DuPont expanded operations to include the manufacturing of organic compounds, which continued until 1986. All explosive manufacturing and ammonia production were discontinued during the 1960s. Repauno is a CERCLA site undergoing remediation (<https://cumulis.epa.gov/supercpad/CurSites/calinfo.cfm?id=0200783>). The area previously used by DuPont as a terminal location for anhydrous ammonia began being cleaned for reuse in 2002, according to the 2002 Annual Groundwater Progress report (EPA, 2003).

One of the dangerous contaminants on the site is nitrobenzene, a highly toxic chemical classified by the Centers for Disease Control as “Immediately Dangerous to Life or Health” if people are exposed at specific concentrations. Nitrobenzene is a likely human carcinogen according to the United States EPA and is linked to several carcinomas and cancers as well as other dangerous human health effects. The area where the logistics center would operate is the area is most likely exposed to aniline, a toxic chemical with adverse health effects; aniline is involved with the processing of benzene to make nitrobenzene. The area where

⁹ Docket No. D-2017-009-1, p. 9.

acids were used is also at least partly included in the proposed site. These acids were most likely “mixed acids” associated with the nitrobenzene manufacturing process and are toxic. Redevelopment can disturb and distribute in unforeseen ways contaminants that remain on the property. DRN advocates that no disturbance of the contaminated site be allowed until all contaminants are removed from the soil, sediment, groundwater, surface water, wetlands and other related natural systems.

In addition, several different companies have leased areas at the Repauno facility. In 1998, Repauno Products LLC purchased the manufacturing operation that produced sodium nitrite and nitrosylsulfuric acid. In 1999, Spring AG purchased the industrial diamond refining operation, which ceased in late 2002. Industrial diamond processing may have used chemical vapor deposition or other dangerous processes that are used to manufacture industrial and synthetic diamonds, contributing additional contaminants to the site’s environment that require investigation prior to use of the property.

In 1990, 8,500 tons of sediments were removed from the ditches in the former Nitrobenzene and PMDA/DMT production areas (EPA, 2005). In the three rounds of sitewide investigation completed in 1993, 1996, and 2000 respectively, DuPont screened all Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) for their investigation/remediation priorities and focused on the migration/flow of groundwater and the soils in former production areas. The currently ongoing fourth round of investigation is to complete the investigation of the remaining two SWMUs/AOCs and to conduct an ecological risk assessment for the wetlands, streams, and the ditch system (EPA, 2005). In 1985, DuPont installed a system to pump contaminated groundwater and to treat it. The groundwater interceptor system has been in operation since, in conjunction with a groundwater-monitoring program, owned and operated by Chemours, DuPont’s spinoff company since 2015. Chemours is required to continue the groundwater interceptor system together with the sitewide groundwater monitoring program to confirm that contaminated groundwater is under control. How the operation of the Center and the remediation program will compatibly operate is difficult to understand and needs further analysis by EPA, DEP and other relevant agencies, including DRBC, due to the potential for negative impacts from pollution to the water resources of the Delaware River Basin.

DEP is supposed to impose restrictions on the use of groundwater for as long as it remains contaminated (EPA, 2005). The draft docket states that water and sewer for the Center will be provided by the local municipal facilities, which is important for public health and safety. Has there been an analysis that shows the local facilities have the capacity to add the Center? EPA claimed in 2005 that the site was no longer a risk for human exposure and groundwater contamination (Romalino, 2015). These new uses at the site should require a re-analysis of that conclusion. The site plans call for one or more of the monitoring wells being used to track remediation to be paved over for a parking lot. Baseline and years of data will be compromised if consistent sampling is lost. It is essential that the current monitoring wells remain.

Permits

As stated in the letter dated June 3, 2019 submitted by DRN to DRBC, there are several permits that have not been identified by the applicant that are needed for this project. Some permits that are still needed are listed in the letter but we also point out that other permits should have also been identified in the draft docket but were not. These include approvals from the United States Coast Guard under 18 CFR Parts 153 and 157? Has Delaware River Partners filed a Letter of Intent (LOI), which is due one year in advance? Has a Water Suitability Assessment been filed with the LOI as required at 33CFR 127.007 (f) and (g)? Has

the Coast Guard issued a Letter of Recommendation? These analyses are essential to the decisionmaking about this facility, which may not proceed without the Coast Guard reviews. There has been no determination that the Delaware River at this location is suitable for LNG marine traffic. Until there is a Coast Guard determination for the transport from this terminal, it is premature to consider other approvals. The application is deficient for not including this important permit, in addition to the other federal and state permits DRN has listed in our letter.

Environmental and Health and Safety Impacts Regarding LNG

DRN provides the following information about the unique dangers of LNG and its transport, storage, and handling, illustrating that LNG is a special product that needs specific conditions that DRN does not consider to be available at this site or within the Delaware River Watershed:

It is known that, upon release in a liquid state, LNG expands to a gas cloud that is 600 times larger than the amount of liquid. The gas cloud then moves across the surface, can travel many miles quickly and can also become trapped under spaces that confine the gas, providing the conditions that cause explosion and, if there is a point of ignition such as a spark or flame, fire will result.

New information has shown that LNG can cause a catastrophic BLEVE or Boiling Liquid Expanding Vapor Explosion if the vessel is exposed to high temperatures or a fire. The expansion of the liquid LNG in a vessel causes the pressurized liquid to boil, and the gas takes up more room than the liquid, stressing the container as pressure builds. Relief valves are only designed to release pressure slowly to keep equilibrium in the pressurized container. Exposed to high heat, the valve will fail to keep up and the metal will weaken, cracks will result in the container, causing LNG to be released with an explosion.¹⁰ The result is a BLEVE, a catastrophic failure of the container. There are many incidents over the years of BLEVE catastrophes¹¹, some as recent as 2019, but the fact that a BLEVE can occur with LNG has only recently been established.

When the gas or vapor cloud in the container is released because it is flammable, it is likely to ignite after the BLEVE, typically causing a fireball that burns fast, hot and wide. A fuel air explosion can also occur, known as a “vapor cloud explosion”. A vapor cloud explosion is the mechanism used in a thermobaric weapon that uses air to generate a high-temperature explosion, producing a long duration blast wave. These weapons are also termed a fuel-air bomb.¹² This is the threat that LNG storage and transport brings to the Gibbstown region and to every traffic route used to carry the LNG to the Delaware River and on the river during export.

On dry land such as a terminal where LNG is stored or is contained in tankers on trucks or rail cars, a BLEVE where there is no liquid in the local environment to absorb the heat, can rupture even faster than a vessel on water. Truck transport regulations are being closely examined due to an increase in accidents involving truck transport of LNG. While it used to be assumed that truck transport had a low potential for explosion or fire, an accident in Spain changed that:

“In 2002, an LNG truck in Spain flipped over, burned, then exploded into a 500-foot fireball that killed the driver and burned two others. ‘The severity of this kind of explosion is something people haven’t usually considered applicable to LNG trucks,” says Jerry Havens, former director of the

¹⁰ https://en.m.wikipedia.org/wiki/Boiling_liquid_expanding_vapor_explosion

¹¹ Ibid.

¹² https://en.m.wikipedia.org/wiki/Thermobaric_weapon

Chemical Hazards Research Center at the University of Arkansas. ‘But what happened in Spain changes that picture. It shows you've got the potential for a massive explosion.’”¹³

In the accident in Spain, a BLEVE occurred, which resulted in death to the driver and burns to two people approximately 650 feet away, and threw large flaming debris, including the truck’s diesel engine, for 853 feet. A similar LNG truck accident with a catastrophic fire occurred in Spain in 2011, killing the driver.¹⁴ It was pointed out by an analyst in Savannah Georgia during debate over LNG truck transport that a pool fire and and/or explosion involving an LNG truck may have a low probability but it has a high consequence with instant injuries or death for those within several hundred feet.¹⁵ The chances, according to the analyst, of an LNG truck accident are 200 to 1.¹⁶ This is a great risk for populated areas and truck routes through urban centers.

Regarding rail use, the U.S. Department of Transportation’s Federal Highway Administration (FRA) nor the Pipeline and Hazardous Materials Safety Administration (PHMSA) have not approved rail car regulations for the transport of LNG yet. There has been very limited use of rail so far, with only one approval in Alaska by the Obama Administration, local small use in Florida, and some use in Canada. Statistics that claim few accidents mean that trucking of LNG is safe are misleading because, similar to crude oil transported in unsafe train cars a few years ago before the Bakken crude phenomena, it has been rarely done. For Bakken oil trains, accidents increased 400% in one year once volume of traffic increased, creating the biggest jump in deadly and/or catastrophic train accidents in years.

The Trump Administration has provided a big push for the use of rail for LNG transport in April 2019 with President Donald Trump issuing an executive order directing federal regulators to create new rules allowing rail companies to transport LNG by rail in the next 13 months, or less.¹⁷ Considering the length of time it customarily takes PHMSA and the Federal Railroad Administration to develop new car specifications and use regulations, one year is a truncated period that fast-tracks the approval the President is seeking. The priority, according to LNG promoters, is a quick approval to meet the need for the industry to serve new markets. This does not inspire confidence in the results.

In the event of a release of LNG, the LNG must gas off naturally, as the container cannot be capped or interacted with, the area must be immediately evacuated and secured, ignition sources must be eliminated, and water cannot be used, as the release is cryogenic. Water can plug the valves of the container with ice and any cold air release can freeze skin in seconds and can even turn air to liquid or solid form, removing oxygen, an obvious disaster for anyone in the area. These handling procedures apply to any container of LNG under pressure, including those used in transportation such as truck or rail containers or storage vessels at a terminal, ships, or at a liquefaction facility.¹⁸ The dangers of an LNG release and fire from a tank accident are unique to LNG and require special handling due to the highly dangerous properties of the

¹³ <https://www.csmonitor.com/2006/0707/p02s01-usgn.html>

¹⁴ https://www.researchgate.net/publication/235976022_Explosion_of_a_road_tanker_containing_liquified_natural_gas

¹⁵ <https://www.savannahnow.com/article/20101006/NEWS/310069738>

¹⁶ Ibid.

¹⁷ <https://www.govinfo.gov/content/pkg/FR-2019-04-15/pdf/2019-07656.pdf>

¹⁸ PHMSA, “Safe Transport of Energy Products”, <https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/research-and-development/hazmat/58176/day-1-pm-2.pdf>

LNG and its gases. This is well illustrated in a report of an LNG tank truck accident in Belgium, which has been used as a “lessons learned” example by first response trainers ¹⁹

When a fire erupts around or under a LNG container, it can cause a BLEVE quickly, in as little as 15 minutes for a large tank (2 ½ minutes for a small tank). Once a fire ignites around the container, the 2000 Department of Transportation (DOT) Emergency Response Guidebook (ERG) states that a 1,600-meter perimeter must be isolated around the container, as explained in the relevant text at Guide #112, the same as for explosives such as bombs and artillery. Since water cannot be used to cool the container or extinguish the fire, and the evacuation area is so large, the fire response is, especially if there are no lives at risk, for firefighters and first responders to evacuate the 1,600-meter area and let the fire burn out, similar to the response to crude oil derailments that risk explosion. In fact, even removing the damaged container can be risky. An example of how firefighters in Utah decided to handle a train derailment with damaged propane tanks illustrates the risks – it was less dangerous to detonate the cars in place than move them.²⁰ Of course, this is not possible in a populated area, begging the question of how much risk for communities is involved with flammable liquid in rail cars.

This makes the transport of LNG in containers and the storage of containers of LNG inherently dangerous and inappropriate for populated areas. The proposed Logistics Center is located next to a residential area in Gibbstown. There is a day care center and housing in Gibbstown adjacent to the Block and Lot of this site. These residential and day care uses are not compatible with the proposed activity, especially if the activity includes handling of hazardous substances such as LNG or NGL or other bulk liquids. Prevention of exposure to toxics and hazardous materials is the only way to provide protection to the especially vulnerable population of children at a day care center and to the workers, residents and families who are located adjacent to the site.

The transport routes, not yet identified by New Fortress, are through communities across Pennsylvania and New Jersey. Has the proximity of the LNG activities to structures, receptors, and residences been calculated and are there sufficient separation distances as required by U.S.DOT? US DOT has requirements (in 49 CFR Part 193) for thermal radiation and vapor dispersion hazard-based exclusion distances around land based, fixed LNG terminals. This is an essential analysis for the protection of Gibbstown and the region.

Transportation safety issues, while previously not a large concern when truck and rail transport was rare, are emerging as an important concern across the nation as transport by truck increases and rail is expected to be used as a major means of transport for an expanding industry in the near future. The Marcellus Shale has made Pennsylvania the second largest producer of natural gas in the nation, and the industry is looking for new markets and new means of delivering gas products. So, transport is ramping up to substantially increase. However, the current anti-regulation climate at the federal level means that the safety measures required for safe transport are not likely to be enacted under the current Trump Administration. The US Department of Transportation’s upper management and policymakers are heavily influenced by or transferred directly into their positions from industry and have been actively carrying out a roll back of transportation regulations. According to an Associated Press investigative report, the rolling back of transportation regulations and the elimination of regulations that were in progress, has been and is increasingly a hallmark of the Trump Administration.

¹⁹ <https://www.ctif.org/sites/default/files/2018-09/Retex%20LNG%202018%2006%2006%20ENG-reduced%20size.pdf>

²⁰ <https://www.desmogblog.com/2019/04/17/trump-executive-order-lng-rail-bomb-train-risks>

“Industry’s influence on regulations generally “is probably more powerful than it has ever been,” said Neil Eisner, who was the DOT assistant general counsel in charge of overseeing the issuing of regulations for more than three decades. DOT says having industry insiders in leadership positions provides deep practical experience in how the transportation industry works.”²¹

The AP article goes on to use as an example the statement by USDOT DOT of its intention to repeal “a 2015 rule opposed by freight railroads requiring trains that haul highly flammable crude oil be fitted with advanced braking systems that stop all rail cars simultaneously instead of conventional brakes that stop cars one after the other”.²² Delaware Riverkeeper Network and many other organizations and safety groups when proposed by USDOT after the deadly Lac-Mégantic rail disaster in Canada where 47 people died and a town was destroyed, supported this rule.

“Trump has made reducing regulations a priority, seeing many rules as an unnecessary burden on industry. Last month he tweeted that his administration “has terminated more UNNECESSARY Regulations, in just 12 months, than any other Administration has terminated during their full term in office...”

The good news is,” he wrote, ‘THERE IS MUCH MORE TO COME!’²³

However, not every effected sector is supportive of the relaxation of regulations. Reflecting the concerns of workers:

“These rules have been written in blood,” said John Risch, national legislative director for the International Association of Sheet Metal, Air, Rail and Transportation Workers. “But we’re in a new era now of little-to-no new regulations no matter how beneficial they might be. The focus is what can we repeal and rescind.”²⁴

Additionally, it is unknown how the truck or rail-delivered LNG will be transloaded and what transfer systems will be employed. There is a cavern on the site that was presumably going to be used for natural gas liquids (NGL), although it was stated at the DRBC Hearing that there would be no storage on site of bulk liquids. Funds have been invested by the owner of the property in renovation of the cavern but whether it is expected to be enlarged and what is to be stored in it, is unknown but should be publicly disclosed and disclosed to all agencies, including DRBC. Storage conditions, even if kept in idling or parked trucks, are critical to avoid releases of the super-cooled LNG for safety as well as climate impact considerations. DRN asks why the site plans show a bulk liquid tank area, a sphere tank area and the on-site cavern for bulk liquids storage if, as stated by DRBC staff at the public hearing, there will be no bulk liquid storage on site and only truck or rail transloading directly to ships?

Another important consideration is the use of trucks to carry the LNG product will increase emissions of natural gas constituents, including methane, into the air and will emit hazardous air pollutants due to diesel exhaust. The emission of air pollutants to communities along the transport route unjustly exposes people to health hazards that they may be unaware of due to the transient nature of the vehicles. There should be an

²¹ <https://www.apnews.com/1936e77a11924c909880f1ef014c7ca7>

²² Ibid.

²³ Ibid.

²⁴ Ibid.

analysis of the truck route impacts on communities, environmental justice areas, and areas such as the Delaware River valley where there is already a non-attainment area for ozone, resulting in smog and the resulting respiratory and other adverse health effects that accompany air pollution and the deposition of air pollutants on water, such as the Delaware River, the water supply for millions in the region. The venting of the trucks (or railcars) is necessary en route to avoid over-pressurization, so those emissions are unavoidable but nonetheless, unacceptable.

As explained in an article about LNG-powered ships in Washington state, natural gas is composed mostly of methane, which is one of the four major greenhouse gases and a culprit in the the global warming of our atmosphere, exacerbating climate change. Moreover, methane leaks throughout the entire gas development process, from fracking at the extraction well, through pipeline and compressor delivery systems, during storage and in end use such as power plants and gas processing and petrochemical facilities, including when it is used for fuel in shipping. The article states “The International Coalition for Clean Transportation estimates [2.2-4.6% of methane on ships](#) escapes into the atmosphere after passing through the engine without combusting. This is known as methane slip and its rate depends on the type of engine.”²⁵

It explains further, that “Again, LNG is composed chiefly of methane, which is itself a nasty greenhouse gas – 86 times worse than CO₂ over a 20 year span and 36 times worse over a 100 year span. New research actually suggests that those numbers may be [underestimated by as much as 14%](#). This means that we don’t want to be adding any more methane to the atmosphere and, in fact, scientists point out that we can have [more immediate impacts on lessening climate change by reducing methane](#) since it doesn’t last as long in the atmosphere as CO₂. Alarming, US methane emissions [have risen 30%](#) in the past decade thanks mostly to the central US, a hotbed of fracking.”²⁶

The impacts of greenhouse gas emissions that will be released by this project are substantial and can be minimized if gas products – LNG and NGL -- are eliminated as cargo that will be handled at the Gibbstown Logistics Center. Methane and carbon are leaked, released or burned through the full life cycle of the hydraulically fractured (fracked) gas produced for this project – from extraction by fracking through delivery systems such as pipelines and compressors to the liquefaction plant, the processing at the LNG liquefaction plant, the transport by truck, rail, or pipeline to the export terminal, any interim storage, transloading of the material the storage in the ocean-going vessel and then the final re-gasification of the LNG and its end use. This uncontrollable and inefficient process is also deadly in its effects on atmospheric warming and the climate crisis we are facing globally. It is irresponsible and shortsighted to support the further development of fracked gas projects. At the very least, a climate change impact analysis must be done for this project to measure and then assess the potential effects of the full life cycle of LNG and NGL greenhouse gas emissions and climate change effects that would be produced for the Gibbstown Logistics Center.

This comment is submitted in addition to the two letters submitted by Delaware Riverkeeper Network to DRBC dated June 3, 2019 and May 28, 2019, and the verbal testimony of Tracy Carluccio at the public hearing of June 6, 2019.

Conclusion

²⁵ <https://www.350tacoma.org/the-origins-of-lng-as-a-maritime-fuel/>

²⁶ Ibid.

The draft docket is deficient and misleading. It lacks essential information and continues to obfuscate the major intended use of the facility, LNG export. DRN requests that the draft docket be held back from the DRBC's business meeting based on its incompleteness. We point out the lack of adequate time for the Commissioners to review the project to be a major obstacle for a full and fair review (only 2 days before the meeting when the usual review period for the Commissioners is 30 days).

If the docket is included on the agenda at the business meeting, we request the Commissioners either disapprove the draft docket based on the evidence presented showing substantial harm to Delaware River water resources or withdraw the draft docket from consideration until a comprehensive analysis by all relevant agencies is complete and permits have been subject to public review and input. If the DRBC considers this docket in the future, DRN requests that after all other permitting and exhaustive environmental reviews are complete, DRBC provide at least a 60 day comment period for the draft docket so the public can be afforded the time and information needed to assess and provide input into the decisionmaking.

Respectfully submitted,

Handwritten signatures in blue ink. The signature on the left is 'Maya van Rossum' and the signature on the right is 'Tracy Carluccio'.

Maya van Rossum
the Delaware Riverkeeper

Tracy Carluccio
Deputy Director

Exhibit F



August 7, 2019

Re: Proposed Special Permit SP 20534, Docket PHMSA-2019-0100

Delaware Riverkeeper Network (DRN) submits this comment in opposition to the proposed Special Permit (SP) that would allow rail cars to carry Liquefied Natural Gas (LNG) on the nation's railways. The Special Permit poses unacceptable dangers that cannot be justified. The proposed transport of LNG by DOT 113C120W tank cars is unsafe and the threats that result from the wholly inadequate review process and Environmental Assessment (EA) are completely avoidable by either rejecting the application for a Special Permit or by requiring the appropriate process to be completed – a full Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA). Approval of the SP without an EIS would violate NEPA because the substantial and complex impacts have not been adequately assessed in the EA and the potential for human and environmental harm are great. DRN advocates that the proposed SP be denied and, if PHMSA is to consider the allowance of rail transport of LNG, that a full EIS be conducted with the opportunity for robust and diverse public participation across the nation.

NEPA is our “basic national charter for protection of the environment.”¹ NEPA makes environmental protection a part of the mandate of every federal agency² by requiring that federal agencies take environmental considerations into account in their decision-making “to the fullest extent possible.”³ Pursuant to NEPA, federal agencies must consider environmental harms and the means of preventing them in a “detailed statement” before approving any “major federal action significantly affecting the quality of the human environment.”⁴ This required analysis serves to ensure that “the agency will not act on incomplete information, only to regret its decision after it is too late to correct.”⁵ Approval of the use of tank cars to transport LNG definitely meets the standard of requiring NEPA review.

The use of the DOT 113C120W tank cars for LNG transport requires testing, design specification analysis, regulations that govern conditions of use, and wide public review and input. The DOT 113C120W cars have not been proven safe for the extreme and unique requirements of LNG.

¹ 40 C.F.R. § 1500.1(a).

² See 42 U.S.C. § 4332(1).

³ 42 U.S.C. § 4332.

⁴ Id. § 4332(2)(C).

⁵ *Marsh v. Oregon Natural Res. Council*, 490 U.S. 360, 371 (1979).

The bulk transportation of LNG by rail tank car is prohibited today. A small number of special permits have been granted. DRN advocates that this prohibition continue to protect human health, safety, and the environment.

The SP would allow unit trains, up to 100 cars, to transport LNG, subjecting railways to long, heavy, hard-to-handle trains. These trains pose threats due to:

- *no stated limit on train length,*
- *no stated maximum allowable car weight,*
- *allowing a maximum speed of 50 mph with no empirical data to support that speed; it exceeds by 25 percent the maximum allowable speed of 40 miles per hour proposed by the Federal Railroad Administration for oil trains traveling near major population centers,*
- *no BLEVE (boiling liquid evaporating vapor explosion) modeling, and*
- *no analysis of “limited zone of hazard” beyond labeling it “significant”,*
- *complete lack of permit restriction to avoid routing through densely populated centers.*

Safety and human health issues:

LNG is inherently dangerous due to the nature of the product, which must be kept frozen at extremely low temperatures, ~260 degrees F, and, when released transforms into a gas that is at least 600 times greater in volume than the cryogenic material. PHMSA’s EA at pages 6 and 7 outline the safety and human health hazards associated with LNG and its release.

“LNG poses potential cryogenic temperature exposure hazards as well as fire and explosion hazards. Due to a large difference in temperature, the rapid transfer of heat from an object into the cryogenic liquid can cause burns if direct contact of liquid with skin occurs or if Personal Protective Equipment (PPE) is inadequate to prevent cold-temperature injury during an exposure. Additionally, large spills of the liquid onto metal structures can cause embrittlement and fracturing. Methane is odorless and LNG contains no odorant (unlike odorized residential natural gas supplies), making detection difficult without a flammable gas detector device.”

“Releases of LNG due to venting or to accidents involving either a MC-338 cargo tank or a DOT-113C120W have the potential to create flammable clouds of natural gas. Large releases of LNG due to the breach of the inner tank of a tank car could pose pool fire, vapor fire and explosion hazards, which pose the highest potential impacts when compared to localized cryogenic hazards.”
(EA, Pp. 6, 7)

Thus, catastrophic events can result from release of LNG. The dangers are well known to government regulatory agencies, which have advised that LNG facilities and storage areas be kept in remote areas, away from human populations, sensitive ecological systems and infrastructure. This alone should meet the requirements for the performance of an EIS.

DOT 113C120W rail tank cars are a 50-yr-old design, which has never before been authorized for LNG service. The comparison with current use of these cars is not valid due to the difference in properties of LNG. No rail tank car standards for transport of LNG have yet been established. The transport of LNG by rail should not be approved without specific design for LNG tank cars.

PHMSA's EA agrees that response to a broken cryogenic tank car is very difficult for first responders and fire companies and risks catastrophe due to the great potential for explosions and large fires. The response is essentially to evacuate the area since a methane gas-fueled fire cannot be extinguished. Certainly, the huge volume of a gas cloud (600 times greater than the liquid) released from a breached LNG tank as well as the instance where a tank car is engulfed in fire compounds the potential for catastrophe in populated areas and for communities that are along the transportation route. The result is not only fire but can also result in a bomb-like explosion that is similar to a thermogenic event - literally a bomb.

In case of an LNG-by-rail fire and/or an explosion, PHMSA appears unable to adequately define the hazard zone and the risk to nearby populations. PHMSA refers to a "limited zone of hazard" and labels it "significant." Neither term is defined, leaving first responders, health professionals, planners and concerned citizens in the dark as to how extensive that hazard zone is, and the nature and degree of risk posed within that zone. PHMSA does state, "...exposure to heat from an LNG pool fire or ignition of LNG vapors could result in fatalities, serious injuries, and property damage for those within the limited zone of hazard." PHMSA also states:

"Response and mitigation techniques beyond evacuation for breaches in cryogenic tank cars do not exist or are impractical during a derailment scenario. Breach of a cryogenic tank car will result in the loss of the entire volume of material in the tank car. Incidents are rare, though rail impacts can be high-consequence, given the quantity of hazardous materials in transportation." (EA, P. 7)

Unfortunately, there are instances of serious damage to DOT 113C120W rail tank cars during transportation, including instances where a DOT 113C120W car lost cargo due to breach of both its outer and its inner tanks. Should the outer and inner tanks of a car carrying LNG be breached, such as during derailment, the results could be a catastrophic explosion and fire, as discussed below. However, the record of use of the DOT 113C120W rail tank car is very limited nationally considering that in 2015 only about 13,000 were used, a tiny proportion of the 2.3 million railcars used annually according to Association of American Railroads estimates for all hazmat rail cargoes. Today, there are reportedly very few of the DOT 113C120W rail tank car are in service. Therefore, making reasonable estimates from the historical record of the DOT 113C120W rail tank car's likely performance in future derailments is not reasonable. It is known, however that a serious puncture of this rail car is likely to release the entire refrigerated cargo, risking disaster. This is one of the most compelling reasons that a thorough EIS is required to fully assess the potential for harm within specified distances of a release or accident.

New information has shown that LNG can cause a catastrophic BLEVE or Boiling Liquid Expanding Vapor Explosion if the vessel is exposed to high temperatures or a fire. The expansion of the liquid LNG in a vessel causes the pressurized liquid to boil, and the gas takes up more room than the liquid, stressing the container as pressure builds. Relief valves are only designed to release pressure slowly to keep equilibrium in the pressurized container. Exposed to high heat, the valve will fail to keep up and the metal will weaken, cracks will result in the container, causing LNG to be released with an explosion. The result is a BLEVE, a catastrophic failure of the container. There are many incidents over the years of BLEVE catastrophes, some as recent as 2019, but the fact that a BLEVE can occur with LNG has only recently been established.

When the gas or vapor cloud in the container is released, because it is flammable it is likely to ignite after the BLEVE, typically causing a fireball that burns fast, hot and wide. A fuel air explosion can also occur,

known as a “vapor cloud explosion”. A vapor cloud explosion is the mechanism used in a thermobaric weapon that uses air to generate a high-temperature explosion, producing a long duration blast wave. These weapons are also termed a fuel-air bomb. This is the threat that LNG storage and transport brings to the Gibbstown region and to every traffic route used to carry the LNG to the Delaware River and on the river during export.

On dry land such as a terminal where LNG is stored or is contained in tankers on trucks or rail cars, a BLEVE where there is no liquid in the local environment to absorb the heat, can rupture even faster than a vessel on water. Truck transport regulations are being closely examined due to an increase in accidents involving truck transport of LNG. While it used to be assumed that truck transport had a low potential for explosion or fire, an accident in Spain changed that:

In 2002, an LNG truck in Spain flipped over, burned, then exploded into a 500-foot fireball that killed the driver and burned two others. ‘The severity of this kind of explosion is something people haven’t usually considered applicable to LNG trucks,’ says Jerry Havens, former director of the Chemical Hazards Research Center at the University of Arkansas. ‘But what happened in Spain changes that picture. It shows you’ve got the potential for a massive explosion’.

In the accident in Spain, a BLEVE occurred, which resulted in death to the driver and burns to two people approximately 650 feet away, and threw large flaming debris, including the truck’s diesel engine, for 853 feet. A similar LNG truck accident with a catastrophic fire occurred in Spain in 2011, killing the driver. It was pointed out by an analyst in Savannah Georgia during debate over LNG truck transport that a pool fire and and/or explosion involving an LNG truck may have a low probability, but it has a high consequence with instant injuries or death for those within several hundred feet. The chances, according to the analyst, of an LNG truck accident are 200 to 1. This is a great risk for populated areas and truck routes through urban centers. The potential impacts of the transit of trucks to the site and the parking, movements, unloading and exit of the trucks must be fully examined for risk of accidents and resulting damage to people and the environment.

In the event of a release of LNG, the LNG must gas off naturally, as the container cannot be capped or interacted with, the area must be immediately evacuated and secured, ignition sources must be eliminated, and water cannot be used, as the release is cryogenic. Water can plug the valves of the container with ice and any cold air release can freeze skin in seconds and can even turn air to liquid or solid form, removing oxygen, an obvious disaster for anyone in the area. The potential for such explosion alone should require an EIS to be conducted.

Climate change issues:

The impacts of greenhouse gas emissions that will be released as a result of the upstream and downstream greenhouse gas emissions – cradle to grave – of methane are substantial must be considered by PHMSA. Methane is a highly potent greenhouse gas with a greater efficiency at warming the atmosphere than any other fossil fuel. It is 86 times more powerful than carbon on a 20-year time scale and over 100 times more potent on a 10-year time scale. These 10 and 20-year periods are those that are the most important today as we globally face tipping points from which our planet will not be able to recover. Already societies are suffering from the impacts of global climate change, with the worst of the impacts being borne by those already bearing the heavy price of dirty energy and other hazardous environmental impacts. Furthermore,

fracking is ruining communities and the environment where it is occurring today across the nation and in Pennsylvania, the second largest producer of natural gas and one of the Delaware River Watershed states. Harms are being experienced in the form of environmental degradation of water and air quality and adverse health effects of fracking, materializing as alarming public health trends and incidents.

(<https://bit.ly/30kqe4u> and <https://www.psr.org/blog/resource/compendium-of-scientific-medical-and-media-findings-demonstrating-risks-and-harms-of-fracking/>) These impacts must be fully considered in an EIS by PHMSA.

Methane and carbon are leaked, released or burned through the full life cycle of the hydraulically fractured (fracked) gas produced for transport by rail – from extraction by fracking through delivery systems such as pipelines and compressors to the liquefaction plant, the processing at the LNG liquefaction plant, the transport by rail to the export terminal, any interim storage, the transloading of the material and the storage in the ocean-going vessel and then the final re-gasification of the LNG and its end use.

As explained in an article about LNG-powered ships in Washington State, natural gas is composed mostly of methane, which is one of the four major greenhouse gases and a culprit in the global warming of our atmosphere, exacerbating climate change. Moreover, methane leaks throughout the entire gas development process, from fracking at the extraction well, through pipeline and compressor delivery systems, during storage and in end use such as power plants and gas processing and petrochemical facilities, including when it is used for fuel in shipping. The article states “The International Coalition for Clean Transportation estimates 2.2-4.6% of methane on ships escapes into the atmosphere after passing through the engine without combusting. This is known as methane slip and its rate depends on the type of engine.”⁶

It explains further, that “Again, LNG is composed chiefly of methane, which is itself a nasty greenhouse gas – 86 times worse than CO₂ over a 20 year span and 36 times worse over a 100 year span. New research actually suggests that those numbers may be underestimated by as much as 14%. This means that we don’t want to be adding any more methane to the atmosphere and, in fact, scientists point out that we can have more immediate impacts on lessening climate change by reducing methane since it doesn’t last as long in the atmosphere as CO₂. Alarming, US methane emissions have risen 30% in the past decade thanks mostly to the central US, a hotbed of fracking.”⁷

Energy Transport Solutions

Energy Transport Solutions (ETS), a subsidiary of New Fortress Energy, submitted an application for the transport of LNG by rail tank cars with a goal of exporting LNG for sale overseas. While the origins and the destinations of the LNG that would be transported by ETS were redacted from their application, DRN is aware of the plans for the delivery of LNG from a proposed LNG liquefaction plant in Wyalusing Township, Bradford County, PA to the Gibbstown Logistics Center, a deepwater port terminal in Gibbstown, Gloucester County, NJ on the Delaware River. We are opposed to this plan and to addition of LNG to the export cargo allowed at the Gibbstown facility. See

<https://www.delawareriverkeeper.org/sites/default/files/DRN%20Comment%20to%20ACE%20re%20Gibbstown%20LNG%20supmntl%20%282019-07-31%29.pdf> and

<https://www.delawareriverkeeper.org/sites/default/files/Fact%20Sheet%20Gibbstown%20Logistics%20LN>

⁶ Villa, Daniel, *The Origins of LNG as a Maritime Fuel*, 350 Tacoma, June 21, 2018. Available at <https://www.350tacoma.org/the-origins-of-lng-as-a-maritime-fuel/>.

⁷ Ibid.

[G%20ltrhd_0.pdf](#)). Permits are still outstanding but New Fortress Energy is very actively pursuing the necessary approvals. The communities that will be negatively impacted by the full life cycle of the fracked LNG that would be exported from the Delaware River Watershed include: the Pennsylvania shale field locations where the fracking would occur; Wyalusing Township, Bradford County, where the liquefaction plant would be built; the rail routes that would carry the LNG from Bradford County, at least 175 miles through Pennsylvania and New Jersey; the Gibbstown, NJ residents and Gloucester County residents where the Gibbstown Logistics Center Dock 2 would be built to ship LNG down the Delaware River; the Delaware River communities in Southeastern PA, in Delaware and in New Jersey where the LNG shipping vessels would travel; the current operations that occur on the Delaware River, Estuary and Bay that would be impacted by the dangerous transport of LNG; the ocean waters that would be traveled; the receiving ports such as Puerto Rico and Jamaica where New Fortress Energy now operates and other ports they have stated publicly where they will sell and finally burn the LNG. All of these human communities will be impacted and must be considered. Furthermore, the fish, wildlife, aquatic species, and other non-human communities as well as the environment and its ecological resources that will be impacted through this “cradle to grave” pathway must be considered in an EIS by PHMSA.

DRN opposes the SP and urges PHMSA to deny the permit and, if it moves ahead with considering LNG by rail, DRN states that under NEPA an EIS is required and must be performed by PHMSA.

Thank you for the opportunity to comment.



December 20, 2019

Re: Docket Number PHMSA–2018–0025 (HM–264)

Delaware Riverkeeper Network (DRN) submits this comment in opposition to the proposed rulemaking by the Pipeline and Hazardous Materials Safety Administration (PHMSA), with the Federal Railroad Administration (FRA), to change the Hazardous Materials Regulations to allow for the bulk transport of Methane, refrigerated liquid, commonly known as liquefied natural gas (LNG), in rail tank cars. The proposal would authorize the transportation of LNG by rail in the DOT-113C120W specification rail tank car. DRN opposes the proposed Hazardous Material Regulation changes and calls for the denial of the proposed rulemaking and the Proposed Alternative.

PHMSA received a Petition for rulemaking from the Association of American Railroads (AAR) and President Trump's April 10, 2019, "Executive Order on Promoting Energy Infrastructure and Economic Growth," which orders "The Secretary of Transportation shall propose for notice and comment a rule, no later than 100 days after the date of this order, that would treat LNG the same as other cryogenic liquids and permit LNG to be transported in approved rail tank cars."¹ According to the Executive Order (E.O.), the rulemaking is to be finalized within 13 months after April 10, 2019, the date of the E.O. (Sec. 4(b)).² DRN points out that neither the Petition nor the E.O. can violate current laws, rules, or regulations. Our nation's laws are in force to protect the public and the environment and the environmental rights of all, including generations yet to come.

PHMSA and the FRA jointly hold the mission "...to manage, and reduce, the risk to people and the environment by the transport of hazardous material by rail."³ The current prohibition of transport of bulk LNG by rail car is based on the lack of necessary provisions in current regulations to provide for the safe transport of LNG by rail car and a lack of perceived need for the use of the railways for LNG transport. Neither of these circumstances has changed. Therefore, DRN

¹ <https://www.whitehouse.gov/presidential-actions/executive-order-promoting-energy-infrastructure-economic-growth/>

² Ibid.

³ NJDOT, Pipeline and Hazardous Materials Safety Administration, Docket No. PHMSA-2018-0025 (HM-264) RIN 2137-AF40, Hazardous Materials: Liquefied Natural Gas by Rail, NPRM Preliminary Regulatory Impact Analysis, October 2019, Executive Summary.

concludes that LNG should not be allowed to be transported by rail car on the nation's railways; the proposed rulemaking and Proposed Alternative are unsubstantiated and must be rejected.

The rulemaking proposal is described by PHMSA as "deregulatory". PHMSA seems to use this description to avoid performing certain analyses, including those required by applicable environmental laws and regulations, such as a full Environmental Impact Statement under NEPA. In fact, PHMSA seems to bend over backwards to make no substantial changes to the current regulations such as operational controls for safety purposes and specific controls for the use of "unit trains" (20 rail cars or more of the same material), stating they lack information.⁴ They state that there is not enough data on the transport of LNG by tank cars to inform what additional safety controls should be imposed. They also state that they do not know when "unit trains" would be used and initially expect only a few tank cars as part of manifest trains. This is then used as an excuse for not requiring further testing and regulatory controls on LNG in DOT-113C120W specification rail tank cars, which are proposed by PHMSA to be used to transport LNG.⁵

In comment submitted to PHMSA December 5, 2019, the National Transportation Safety Board (NTSB) questions this rationale and PHMSA's lack of specific operational controls in the proposed rulemaking, such as those used for high-hazard flammable trains.⁶ NTSB states that President Trump's Executive Order suggests a need for a much greater deployment of LNG by rail than a few cars in manifest trains and references the application from Energy Transport Solutions (ETS) for PHMSA Special Permit SP 20534 that projects unit trains of 50-100 shipments (rail cars) per day.⁷

Additional evidence that unit trains would be employed as soon as possible is the economy of scale presented in PHMSA's Cambridge Systematics Risk Assessment ("Risk Assessment") issued in March 2019. In discussion of LNG Mode Choice, it is stated that rail delivery takes longer due to operational imperatives when rail cars are sorted into manifest trains. The Risk

⁴ Notice of Proposed Rulemaking, U.S. DEPARTMENT OF TRANSPORTATION, Pipeline and Hazardous Materials Safety Administration, 49 CFR Parts 172 and 173, [Docket No. PHMSA-2018-0025 (HM-264)], RIN 2137-AF40, Hazardous Materials: Liquefied Natural Gas by Rail, p. 21. "PHMSA recognizes that there may be other operational controls or combinations of controls to consider and encourages comments on such controls. However, for this rulemaking, PHMSA and FRA decided not to propose additional operational controls because there is not sufficient data about the potential movements of LNG by tank car."

⁵ Ibid, p. 21-22. "While PHMSA expects LNG will initially move in smaller quantities (i.e., a few tank cars) as part of manifest trains, it is uncertain whether LNG will continue to be transported in those quantities or if LNG by rail will shift to be transported using a unit train model of service, and if so, how quickly that shift will occur."

⁶ National Transportation Safety Board, letter to U.S.D.O.T., RE. Docket No. PHMSA -2018-0025 (HM-264), d. 12.5.2019.

⁷ Ibid, p. 4. "The urgency provided by the President's Executive Order suggests that LNG transportation by rail as a viable alternative to highway transportation is envisioned to entail greater amounts than mere incidental numbers of tank cars in manifest trains. Additionally, the August 21, 2017, ETS application for a special permit to transport methane, refrigerated liquid in DOT-113 tank cars (just one potential LNG by rail shipper), states that it anticipates operating two LNG unit trains, 50 to 100 tank cars, per day. Therefore, the NTSB disagrees with PHMSA's assertion that the number of LNG shipments would be minimal and that proposing additional operational controls in this NPRM is unnecessary".

Assessment states, “This would be different if unit trains were employed, in which only LNG railcars were transported from origin to destination without required railyard sorting”.⁸

DRN agrees with the conclusion by NTSB that the evidence does not support PHMSA’s assertion that the volume and frequency of LNG transport by rail would be minimal to start and therefore does not require operational controls. NTSB points out that even if there is a gradual increase in the transport of LNG by rail in these tank cars, the risk of catastrophe is too great to justify not imposing operational controls.⁹

The proposed rulemaking allows unit trains with no new required operational controls and since PHMSA imposes no limits on ramp-up, the deployment of unit trains and frequent, large rail shipments will be allowed to occur before adequate safety controls. Without any LNG-specific operational controls, public safety, worker safety, and the environment are put at great risk. Similar to the speedy ramp-up of the use of rail cars for the transport of crude oil, communities along the railways will be used as guinea pigs to test in real time if the DOT-113C120W is safe to carry LNG.

This is an outrageous circumstance and cannot be allowed. We only have to witness the catastrophic loss of 47 people’s lives, devastating environmental damage, and tremendous economic harm of the train derailment in Lac-Mégantic, Canada in 2013 to recognize the consequences of the lack of adequate safety controls. Additionally, numerous derailments and disastrous incidents occurred on the railways across the U.S. when the industry deployed crude oil trains without adequate safety controls.

NTSB questions PHMSA’s determination that DOT-113C120W specification rail tank cars are safe for LNG transport without a comprehensive review of the cars regarding the potential for release of LNG in an accident. NTSB points out that puncture and thermal exposure resistance of these tank cars needs to be evaluated if they are to be used for LNG transport. Furthermore, they question PHMSA’s reference to the information presented in the Exponent Report submitted by ETS for PHMSA Special Permit SP 20534 as sufficient, stating that it is only “anecdotal” and that Exponent states that there is no loss of containment probability data available. Drawing conclusions about these essential questions based on reference or proxy data from other types of hazardous substances without knowing how the properties of these substances compare with LNG is not defensible. PHMSA also does not offer any applicable data.

In fact, PHMSA’s Risk Assessment states “when the probability of LNG tank car derailment is understood, better decisions can be made regarding crashworthiness, placement, and operation

⁸ Cambridge Systematics, Inc. *with* MaineWay Services, LLC, Rutgers University, Transport Analytics, LLC., ScienceSmith LLC., “Risk Assessment of Surface Transport of Liquid Natural Gas”, *prepared for* U.S. DOT Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, 3.20.2019, p. ES-5.

⁹ *Ibid*, p. 4, “A gradual initial ramp-up of LNG rail transportation would likely occur because of the limited availability and high cost of DOT-113 tank cars. Nonetheless, we believe the risks of catastrophic LNG releases in accidents is too great not to have operational controls in place before large blocks of tank cars and unit trains proliferate.”

of rail cars and the potential consequences from an LNG release due to a derailment”.¹⁰ The National Association of State Fire Marshals (NASFM) has gone on the record with PHMSA opposing the Proposed Rulemaking based on “the lack of evidence and research that allowing such an action as proposed in the docket is safe either for America’s first responders or the public”.¹¹ Clearly, those who respond to incidents and events on the railways are in a position to know when safety is being adequately addressed and when it is not. Mr. Narva of the NASFM goes on to state, “The combination of a lack of information with no increased safety measures is a dangerous proposition. This only serves to put the public and our first responders at even greater risk.”¹²

It is inarguable that testing of DOT-113C120W specification rail tank cars for transport of LNG must be required prior to their use. PHMSA does not have sufficient information to assert any findings regarding safety of DOT-113C120W specification rail tank cars for transport of LNG. Without this research, the use of DOT-113C120W rail cars must be denied.

NTSB urges PHMSA to require train crew separation from potential LNG release locations due to the particular properties of LNG. Odorless and colorless, those close to the source of release could be unaware of a release and could lack sufficient warning to protect themselves. Asphyxiation, freeze burn, and exposure to a fire and explosion can occur quickly and be fatal.¹³ These properties mandate worker protections that cannot be ignored.

DRN points out that proximity to populations, occupied structures, sensitive environmental features and vulnerable operations/facilities must be considered based on LNG’s properties. PHMSA’s reference to some jurisdiction’s codes that occupied structures can be as close as 50 feet from a railroad track illustrates the lack of adequate separation.¹⁴ These features are all at risk due to the unique and highly dangerous properties of LNG releases, supporting the denial of the proposed rulemaking and PHMSA’s Proposed Alternative.

NTSB states that large quantities of LNG can be released in a rail car derailment, warning “...such a release could be more severe than releases from cargo tank motor vehicles. Recent history with unit train shipments of ethanol and crude oil demonstrate how unprepared federal regulators were

¹⁰ Cambridge Systematics, Inc. *with* MaineWay Services, LLC, Rutgers University, Transport Analytics, LLC., ScienceSmith LLC., “Risk Assessment of Surface Transport of Liquid Natural Gas”, *prepared for* U.S. DOT Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, 3.20.2019, p. ES-9.

¹¹ Comment submitted by James D. Narva, Executive Director, National Association of State Fire Marshals to PHMSA re. Docket Number PHMSA-2018-0025 (HM-264) – LNG by Rail.

¹² *Ibid.*

¹³ *Ibid.*, p. 6. “Given the potential hazards of LNG when released, as described in the Exponent, Inc. quantitative risk analysis report and the NPRM regulatory analysis as including fireballs, flash fire, and explosions from ground-level vapor clouds that may vigorously expand far beyond the point of release to an ignition source, cryogenic material thermal exposure hazards, and asphyxiation hazards for a colorless and odorless gas that lack sufficient warning properties, the NTSB urges PHMSA to implement appropriate train crew separation distance requirements...”

¹⁴ NJDOT, Pipeline and Hazardous Materials Safety Administration, Docket No. PHMSA-2018-0025 (HM-264) RIN 2137-AF40, Hazardous Materials: Liquefied Natural Gas by Rail, NPRM Preliminary Regulatory Impact Analysis, October 2019, p.43.

to address the spate of fiery flammable liquids accidents that occurred between 2009 and 2015 until regulations for HHFTs were published.”¹⁵

The NPRM, the Preliminary Regulatory Impact Analysis and PHMSA’s Risk Assessment discuss the known hazards of LNG, should the liquid be released from a container. Also examined are operational and material challenges such as the stress that containers undergo to hold the super-cooled LNG and the embrittlement of the materials holding it. It is well documented that catastrophic events can result from release of LNG.

One problem with these described potential disasters is the lack of acknowledgement of the potential for explosion of the vapor cloud even without an ignition source, if containment is present. The evidence of a BLEVE is also compelling but is not acknowledged. That type of incident must be assessed and taken into consideration by PHMSA.

New information has shown that LNG can cause a catastrophic BLEVE or Boiling Liquid Expanding Vapor Explosion if the vessel is exposed to high temperatures or a fire. The expansion of the liquid LNG in a vessel causes the pressurized liquid to boil, and the gas takes up more room than the liquid, stressing the container as pressure builds. Relief valves are only designed to release pressure slowly to keep equilibrium in the pressurized container. Exposed to high heat, the valve will fail to keep up and the metal will weaken, cracks will result in the container, causing LNG to be released with an explosion. The result is a BLEVE and a catastrophic failure of the container. There are many incidents over the years of BLEVE catastrophes, some as recent as 2019, but the fact that a BLEVE can occur with LNG has only recently been established.

When the gas or vapor cloud in the container is released, because it is flammable it is likely to ignite after the BLEVE, typically causing a fireball that burns fast, hot and wide. A fuel air explosion can also occur, known as a “vapor cloud explosion”. A vapor cloud explosion is the mechanism used in a thermobaric weapon that uses air to generate a high-temperature explosion, producing a long duration blast wave. These weapons are also termed a fuel-air bomb. A BLEVE where there is no liquid in the local environment to absorb the heat can rupture even faster than a vessel on water. This is the threat that transport brings, in a rail car, truck or other type of container.¹⁶ The potential impacts of a BLEVE resulting from a release of LNG during transport in DOT-113C120W specification rail tank cars must be fully assessed for this proposed rulemaking.

¹⁵National Transportation Safety Board, letter to U.S.D.O.T., RE. Docket No. PHMSA -2018-0025 (HM-264), d. 12.5.2019, p. 6.

¹⁶ In 2002, an LNG truck in Spain flipped over, burned, then exploded into a 500-foot fireball that killed the driver and burned two others. ‘The severity of this kind of explosion is something people haven’t usually considered applicable to LNG trucks,’ says Jerry Havens, former director of the Chemical Hazards Research Center at the University of Arkansas. ‘But what happened in Spain changes that picture. It shows you’ve got the potential for a massive explosion’. In the accident in Spain, a BLEVE occurred, which resulted in death to the driver and burns to two people approximately 650 feet away, and threw large flaming debris, including the truck’s diesel engine, for 853 feet. A similar LNG truck accident with a catastrophic fire occurred in Spain in 2011, killing the driver.

The DOT-113C120W rail tank car has a LNG capacity of ~30,680 gallons or up to 142,500 lbs. of LNG.¹⁷ A typical “semi-truck” tank car holds 9,000 gallons and 80,000 lb. gross weight.¹⁸ Tank trucks cars can hold up to 12,000 gallons of product.¹⁹ According to PHMSA’s Risk Assessment dated March 20, 2019, a truck with a cryogenic container can haul about 9,300 gallons of LNG; a rail car can hold approximately 30,000 gallons of LNG.²⁰ The Risk Assessment states in a different section of the report that a tank truck holds 10,943 gallons of LNG, which is equal to 0.9 million cubic feet of natural gas.²¹ LNG expands to a gas 600 times larger than the volume of liquid that is contained. The potential for a large release with greater impact is more likely from a rail car carrying LNG than a truck carrying LNG. DRN does not support either of these modes of transport due to unresolved and unknown safety risks but there is no evidence presented to support PHMSA’s conclusion that rail car transport is safer than truck transport.

One reason PHMSA offers for trucks being less safe is that there are reports made to PHMSA of truck accidents transporting LNG (8 reported between 2005 and 2017). PHMSA states, “While PHMSA understands there are limited rail shipments of Methane, refrigerated liquid, compared to highway transportation, PHMSA and FRA have no record of any reported incidents involving Methane, refrigerated liquid in portable tanks transported by rail since 2005.”²² It is patently ridiculous to conclude anything about the likelihood of derailments, accidents or releases of LNG transported by rail car without any meaningful statistical data. The fact is there is no data because there has been minimal transport of LNG by rail and no transport of LNG in DOT 113 rail cars is undeniable. The lack of data and research to support a conclusion that LNG can be safely transported by rail is a valid basis for denial of the proposed rulemaking and Proposed Alternative.

PHMSA has provided a look at the safety history of DOT 113 rail cars and discusses some incidents with other types of cargos or liquids. PHMSA concludes: “It is difficult to estimate the failure rate of the DOT-113 tank car in derailments because railroads are not required to report incidents to PHMSA or FRA unless they meet a baseline threshold. 49 CFR 171.16 and 225.19. Incident data suggests that incidents involving rail tank cars can lead to higher consequence incidents; however, PHMSA believes that rail transportation is advantageous considering the quantity transported compared to miles traveled.”²³ The history is, by PHMSA’s own admission, incomplete due to the threshold for reporting. PHMSA also admits higher consequence incidents can occur but dismisses that danger by saying less trips will be made. There is no factual basis presented for this conclusion, however.

¹⁷http://files.chartindustries.com/14722936_LNG_Railcars.pdf

¹⁸https://en.wikipedia.org/wiki/Tank_truck

¹⁹ CENAP-OP-R-2016-0181-39 -- Gibbstown Logistics Center Port Expansion, Supplemental Public Notice, 7.16.2019, p. 2.

²⁰ Cambridge Systematics, Inc. with MaineWay Services, LLC, Rutgers University, Transport Analytics, LLC., ScienceSmith LLC., “Risk Assessment of Surface Transport of Liquid Natural Gas”, prepared for U.S. DOT Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, 3.20.2019, p. 24.

²¹ Ibid, p. 40.

²² Notice of Proposed Rulemaking, U.S. DEPARTMENT OF TRANSPORTATION, Pipeline and Hazardous Materials Safety Administration, 49 CFR Parts 172 and 173, [Docket No. PHMSA-2018-0025 (HM-264)], RIN 2137-AF40, Hazardous Materials: Liquefied Natural Gas by Rail, p. 34.

²³ Ibid, p. 35-36.

In examining truck transport frequency and volume today, PHMSA's Risk Assessment states that there is "limited ability to capture current truck movements".²⁴ DRN points out that this once again calls into question the substantive data that proves a need for LNG to be transported by rail. Section 4 of the Risk Assessment analyzes the LNG supply chain, showing that of the 65.1 MMCF moved in 2016, trucks moved 0.004 percent.²⁵ Trucks are the mode of transport currently being used to deliver LNG domestically and much of the need is seasonal and dependent on very cold weather when regions such as New England need supplemental heating fuel. This is a very limited demand that cannot justify the risks posed by the large scale transport of LNG by rail cars that would be allowed under the Proposed Rulemaking and Proposed Alternative.

The information provided seems to show that this seasonal, occasional need is being adequately met by small truck movements, undermining the argument that there is need for quantities of LNG to be moved by rail. In discussion about the economic competitiveness of LNG using rail versus road, PHMSA's Risk Assessment states, "Over distances greater than 300 miles, rail transport of bulk materials becomes competitive with road, provided that the shipments are not time sensitive".²⁶ That is hardly a reasonable rationale for the huge investment that would need to be made by industry to manufacture the rail cars, make the investments necessary in operations and management, and gear up in myriad ways necessary to use rail cars for LNG transport, especially considering that the use of LNG domestically is usually time-sensitive, struggling to meet changing and labile weather conditions that dictate that market.

Further, the shipments overseas of domestic natural gas are very large volumes that do not, as a rule, use intermodal transport of truck or rail but are exported directly from the liquefaction plant to shipping vessels; most LNG liquefaction plants are located on waterfronts and coasts. DRN does not support LNG export facilities at any location due to public health, safety, and environmental considerations, but certainly, PHMSA fails to prove a need for rail transport from liquefaction plants across the nation. In the Risk Assessment, it is stated that LNG by rail "could provide duplication and redundancy".²⁷ Such cursory and limited purpose cannot justify the dangers involved.

This expansion of LNG surface transportation entails substantial and unwarranted threats. There is no evidence presented that there is stranded LNG waiting for rail transport, no unmet demand. The proposed rulemaking can be more accurately described as an attempt to assist an ailing natural gas industry looking for markets and a fresh *raison d'être*; another way to induce more gas drilling and natural gas development. Yet the favor being shown to the special interests who will profit imposes heavy burdens on the public and environment. These impacts are discussed later in this comment.

²⁴ Ibid, p. 38-39.

²⁵ Ibid, p. 38.

²⁶ Cambridge Systematics, Inc. *with* MaineWay Services, LLC, Rutgers University, Transport Analytics, LLC., ScienceSmith LLC., "Risk Assessment of Surface Transport of Liquid Natural Gas", *prepared for* U.S. DOT Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, 3.20.2019, p. 50.

²⁷ Ibid, p. ES-5.

DRN has compiled a history of LNG accidents, shared in this comment as **Appendix A**.

Lack of Need, Weak Demand, Negative Economics

PHMSA has not provided a case for bona fide need for transport of LNG by rail. For instance, the framing of the proposed rulemaking assumes unbridled exponential growth of natural gas in the coming years to meet electricity generation demand. While the U.S. Energy Information Administration forecasts an increase of natural gas power plants and states such as Pennsylvania are permitting dozens of new natural gas-fired electric facilities, these forecasts are in many ways self-fulfilling prophecies. Many of the sources cited in PHMSA's Risk Assessment are "industry", who are certainly not independent analysts.²⁸ It is assumed by PHMSA that as other fossil fuels and nuclear generation are phased out, natural gas is the preferred, even inevitable, choice.

This is simply not true. This biased narrative by PHMSA ignores several realities: the growth and displacement of fossil fuel and nuclear energy sources by renewable, clean, less risky, greenhouse gas-free sources of energy; the lack of stability and reliability of the natural gas industry due to poor economic footing; and the increasing awareness by communities and decisionmakers of the enormous negative public health, safety, and environmental burdens imposed by natural gas development, making its future trajectory tenuous. These issues are outlined in the following section of comments.

Furthermore, the assumption that LNG exports will be in demand is also unfounded in light of the fierce competition for markets with foreign LNG generators and global politics that make these markets uncertain. The fact that there is currently an LNG glut and prices are "underwater" does not bode well for LNG's future viability as an export commodity.

Again, PHMSA's proposed rulemaking and their Risk Assessment frame the LNG market as an ever-expanding market, ignoring that there are highly competitive world resources that have been in place and in use for decades. In fact, that is why the U.S., until recently, was a net importer of LNG; the production of LNG by foreign nations is well developed. PHMSA's Risk Assessment verifies exports from Qatar, Australia, Malaysia, Nigeria, and Indonesia as top exporters, with the U.S. third from the bottom in terms of LNG export volumes.²⁹ Additionally, the proximity of point of origin/production to point of use is much more economically advantageous when overseas shipping is avoided or reduced, such as within continents. This is further discussed in these comments below.

²⁸ For instance, The Cambridge Systematics Risk Assessment states, "Altogether, between exports and gas-fired generation, industry analysts predict just over 13 Bcf/d of new gas demand in 2022." Cambridge Systematics, Inc. *with* MaineWay Services, LLC, Rutgers University, Transport Analytics, LLC., ScienceSmith LLC., "Risk Assessment of Surface Transport of Liquid Natural Gas", *prepared for* U.S. DOT Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, 3.20.2019, p. 13.

²⁹ Cambridge Systematics, Inc. *with* MaineWay Services, LLC, Rutgers University, Transport Analytics, LLC., ScienceSmith LLC., "Risk Assessment of Surface Transport of Liquid Natural Gas", *prepared for* U.S. DOT Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, 3.20.2019, p. 20.

From OilPrice.com: Nick Cunningham, “Shale Pioneer: Fracking Is An ‘Unmitigated Disaster’, OilPrice.com, June 24, 2019.

“Fracking has been an ‘unmitigated disaster’ for shale companies themselves, according to a prominent former shale executive: ‘The shale gas revolution has frankly been an unmitigated disaster for any buy-and-hold investor in the shale gas industry with very few limited exceptions,’ Steve Schlotterbeck, former chief executive of EQT, a shale gas giant, [said](#) at a petrochemicals conference in Pittsburgh. ‘In fact, I’m not aware of another case of a disruptive technological change that has done so much harm to the industry that created the change.’³⁰

“The message is not a new one. The shale industry has been burning through capital for years, posting mountains of red ink. One estimate from [the Wall Street Journal](#) found that over the past decade, the top 40 independent U.S. shale companies burned through \$200 billion more than they earned. A 2017 [estimate](#) from the WSJ found \$280 billion in negative cash flow between 2010 and 2017. It’s incredible when you think about it – despite the record levels of oil and gas production, the industry is in the hole by roughly a quarter of a trillion dollars.

The [red ink](#) has continued right up to the present, and the most [recent downturn](#) in oil prices could lead to more losses in the second quarter.”³¹

“Meanwhile, as the financial scrutiny increases on the industry, so does the public health impact. A new [report](#) that studied over 1,700 articles from peer-reviewed journals found harmful impacts on health and the environment. Specifically, 69 percent of the studies found potential or actual evidence of water contamination associated with fracking; 87 percent found air quality problems; and 84 percent found harm or potential harm on human health.”³²

From Wall Street Journal: Bradley Olson and Rebecca Elliott, “Frackers Face Harsh Reality as Wall Street Backs Away”, Wall Street Journal, Feb. 24, 2019.

“But in 2016, federal regulators concerned about banks’ exposure to shale drillers tightened standards for lending to oil-and-gas companies after dozens went bankrupt amid the drop in commodity prices. The U.S. Treasury Department guidelines require lenders to regard loans as troubled if a company’s total debt reaches more than 3.5 times a producer’s earnings, excluding interest, taxes and other accounting items.

Many banks now prefer to keep operators below 2.5 times earnings, bankers and lawyers said. Still, 20 companies were at 2.5 times or higher in the third quarter, and the industry remained more indebted at that time than during the same period three years ago, according to S&P Global Market Intelligence.”³³

³⁰ <https://oilprice.com/Energy/General/Shale-Pioneer-Fracking-is-an-Unmitigated-Disaster.html>

³¹ Ibid.

³² Ibid.

³³ <https://www.wsj.com/articles/frackers-face-harsh-reality-as-wall-street-backs-away-11551009601>

An E and E News article quoted the Wall Street Journal and industry analysts saying that a glut of natural gas with few customers was causing a downturn in 2017. “Many investors were betting that new gas-fired power plants and a historic level of exports would help take care of excess supply. But that hasn’t been the case in a market whose main drivers are weather and massive new supplies of shale gas.”³⁴ This undermines the claim that the natural gas industry is economically viable and in need of expansion through the transport of LNG by rail.

From FreightWaves, American Shipper: Greg Miller, Senior Editor, “A massive floating LNG stockpile has just been unloaded”, Nov. 18, 2019.

The news article reported on weak demand for LNG and ships from the United States that have become “floating storage” sailing the seas, looking for a buyer. “Exceptionally weak demand for liquefied natural gas (LNG), coupled with a surge in U.S. exports, led to an unprecedented bottleneck in global shipping flows in late October, according to S&P Global Platts”.³⁵ 60% of the shipping vessels were from the United States.

“The massive liquid cargo logjam — which spawned a flotilla of fully laden vessels hunting for somewhere to unload — is a bearish sign for LNG demand, said Josh Zwass, managing director of LNG Analytics at S&P Global Platts, in an interview with FreightWaves.”³⁶ “For LNG shipping demand, it’s more of a mixed bag. On one hand, slow steaming and floating storage are positives for spot rates because they remove ships from the market. On the other hand, weak global demand for LNG is a bad omen for future shipping demand.”³⁷

The article goes on to discuss the reason for the weak demand for LNG, ending with, “Finally, numerous market prognosticators have pointed to [an oversupply of LNG that could last through at least 2020](#). This could fuel future floating LNG storage simply because there’s no place left to put the cargo. “A vessel is expensive but available [storage] capacity,’ said Zwass, who emphasized, ‘The global gas market is oversupplied and there’s a struggle to consume it.’”³⁸ This is evidence that the demand for LNG is being far outpaced by a glut of the product, undermining the claim that there is a need for rail transport of LNG for export. Certainly, it is clear there is no justification for PHMSA to rush to increase LNG shipments overseas.

From Bloomberg: Vanessa Dezem, Mathew Carr and Anna Shiryayevskaya, “A Natural Gas Glut Grows in Europe and Prices Hit 10-Year Low”, Bloomberg, Sept. 3, 2019

This article examines the falling price of natural gas in Europe and the over-abundance of LNG that is flooding the market. “Supplies continue to exceed demand. Inventories across northwest

³⁴ EENEWS, NATURAL GAS, “Supply glut reverses profitable gas trade”, March 15, 2017, <http://www.eenews.net/energywire/2017/03/15/stories/1060051489>

³⁵ Greg Miller, Senior Editor, “A massive floating LNG stockpile has just been unloaded”, FreightWaves, American Shipper, 11/18/2019. Retrieved from <https://www.freightwaves.com/news/a-massive-floating-lng-stockpile-has-just-been-unloaded?p=236598>.

³⁶ Ibid.

³⁷ Ibid.

³⁸ Ibid.

Europe, Italy and Austria hit 62.3 billion cubic meters, or 94% of capacity, on Aug. 28.”³⁹ “The only way for European prices to recover would be to scale back flows from Russia or Norway or halt more arrivals of cargoes liquefied natural gas, said Norbert Ruecker, head of economics at Julius Baer Group Ltd.”⁴⁰ Again, what’s the rush to push LNG for export without basic safety controls and rail car testing?

From the New England Journal of Medicine: Landrigan et al., “The False Promise of Natural Gas”, *The New England Journal of Medicine*. Massachusetts Medical Society, 2019.

Another fact that undermines the need for LNG transport by rail is the uncertainty of the industry’s economic future considering its rapidly growing costs, including immediate and long-term societal costs, and its liabilities due to the dangers and harms that fracking is delivering where it and its operations occur. In summarizing this paper, DRN points out that the authors state that production of natural gas has grown by nearly 400% in the United States since 1950, and gas is now the country’s second-largest energy source, mainly driven by fracking.⁴¹ This sets up reliance on a shaky energy source, rife with problems that are inherent in the fracking process.

The dangers of fracking have been well documented, including explosions and fires at natural gas pipelines. In addition, the paper states that many fracking chemicals are toxic: 25% are carcinogens; 75% are dermal, ocular, respiratory, and gastrointestinal toxins; 40 to 50% have toxic nervous, immune, cardiovascular, and renal effects; 30 to 40% are endocrine disrupters.⁴²

The paper states that the health effects from fracking impacts include lung cancer, asthma, COPD, cardiovascular disease, sleep disturbance, stress, and anxiety.⁴³ Fracking also exacerbates climate change. As much as 4% of all gas produced by fracking is lost to leakage, and these releases appear to have contributed to recent sharp increases in atmospheric methane. Methane is a potent contributor to global warming, with a heat-trapping potential 30 times greater than that of carbon dioxide over a 100-year span and 85 times greater over a 20-year span.⁴⁴

Despite these dangers, fracking is continuing and its liabilities are expanding. The authors state that it does not make sense economically to continue fracking, as the Energy Information Administration estimates that by 2023 it will cost \$36.60 per megawatt-hour to produce electricity from wind and \$37.60 to produce solar energy, versus \$40.20 to produce energy from gas.⁴⁵

³⁹ Vanessa Dezem, Mathew Carr and Anna Shiryayevskaya, “A Natural Gas Glut Grows in Europe and Prices Hit 10-Year Low”, Bloomberg, September 3, 2019. Retrieved from: <https://www.bloomberg.com/news/articles/2019-09-03/gas-prices-poised-to-fall-in-europe-as-producers-keep-taps-open>.

⁴⁰ Ibid.

⁴¹ Landrigan et al. (2019). The False Promise of Natural Gas. *The New England Journal of Medicine*. Massachusetts Medical Society. Retrieved from <https://www.nejm.org/doi/pdf/10.1056/NEJMp1913663?articleTools=true>

⁴² Ibid. page 2.

⁴³ Ibid, p. 2.

⁴⁴ Ibid, p. 3

⁴⁵ Ibid, p. 3

The authors also point out that a recent study recommends that state and federal subsidies for natural gas be reduced over the next 2 years and then eliminated.⁴⁶ This will remove current prop-ups that are helping to artificially keep the industry going. Additionally, they recommend new residential or commercial gas hookups should not be permitted, new gas appliances be should removed from the market, further gas exploration on federal lands should be banned, and all new or planned construction of gas infrastructure should be halted.⁴⁷ At the same time, they recommend the EPA proposal to roll back limits on methane pollution should be blocked.⁴⁸

Deregulation of the gas development industry (such as the removal of methane pollution limits) is a subsidy in itself, making it more profitable due to the removal of environmental requirements that do not make companies money. Today's federal administrative agencies and the President are catering to the industry to help make a case that it will expand and need to move LNG to fill growing demand. Extraordinary efforts are being made to force gas development and induce new markets to attempt to save a failing business model – a model that requires enormous resource consumption and leaves a legacy of pollution, environmental degradation and ruinous health effects. Deregulation and other “favors” to the gas industry unlevel the playing field amongst industrial sectors and give advantages to natural gas that are not enjoyed by most other industries or by competing renewable energy sources. Removal of subsidies and halting the rolling back of regulatory controls would bring the industry closer to reality and the economic hardships this resource-intensive and expensive endeavor requires.

The authors also call for the creation of new tax structures, subsidies, and incentives such as carbon pricing that favor wind, solar power, and other nonpolluting, renewable energy sources and policies that support energy conservation, clean vehicles, and expansion of public transit.⁴⁹ They state that other countries and even states such as New York and Idaho have existing models in place for effective climate action and it would be beneficial for the entire United States to do its part.⁵⁰

There are costs attached to natural gas development that are crippling to the industry and subvert the claim of need for LNG to be transported by rail car. The very future of natural gas is in question.

Climate change costs

The approval of the movement of LNG on the nation's railways will induce natural gas development, at least in the short term, and may also buoy the industry from economic collapse for a period of years. Unfortunately, even a short-term gas boom can have significant negative climate effects, especially when added to the years of emissions that have preceded; there is a price being paid now that will be exacerbated by more natural gas development. The potential consequences of this must be considered in this proposed rulemaking. PHMSA does not

⁴⁶ Ibid.

⁴⁷ Ibid.

⁴⁸ Ibid.

⁴⁹ Ibid.

⁵⁰ Ibid.

recognize any of the costs that will burden the public or the cumulative environmental costs that the Proposed Alternative will impose. Climate costs that accompany the Proposed Alternative must be fully assessed.

Of great importance to the nation's economic health and energy security are the costs of climate change. To effectively limit the devastating impacts of climate change, there must be a national-scale campaign to immediately take action. This means shifting from greenhouse gas-emitting energy sources – i.e. fossil fuels - to greenhouse gas-free energy sources – i.e. clean and renewable sources, energy efficiency and conservation - starting today. This is necessary to avoid the critical environmental tipping points that will not be able to be undone and to avoid and reduce the devastating impacts of climate change, including hazardous air pollution and disasters that routinely disproportionately harm poor, minority, and vulnerable populations across the nation and the globe.

Scientists in the most recent Intergovernmental Panel on Climate Change (IPCC) Report estimate that at least 45% - 50% reduction of greenhouse gases must be achieved by 2030 in order to effectively limit atmospheric warming. "Emissions need to be halved by 2030 to limit warming to 1.5 degrees Celsius but temperatures are on track to reach double that by the end of the century even if countries' current plans are fully implemented, research by scientists shows."⁵¹ The IPCC Report says limiting warming to 1.5 degrees C will require reducing greenhouse gases by 45% from 2010 levels by 2030 and that there can be no carbon emissions from energy production by about 2050.⁵²

We know the composition of natural gas is about 95% methane. Methane leaks or is vented or flared at all stages of the natural gas process (extraction/production, gathering, processing, transmission, storage, local distribution and consumption). Methane is 86 times more efficient than CO₂ at trapping heat over a 20-year period and 34 times more efficient over a 100-year period.⁵³

Natural gas is not a bridge fuel because methane is the most powerful greenhouse gas over the time scale during which reductions must be made – over the next two decades and particularly over the next 10 years. The proof of the ineffective strategy of replacing coal and oil with natural gas in terms of thwarting atmospheric warming can be found in recent tracking greenhouse gas reports: "However, energy-related carbon dioxide emissions were at a record high last year and new renewable power capacity has stalled after years of strong growth. At the same time,

⁵¹ <https://climateactiontracker.org/publications/warming-projections-global-update-dec-2018/>

⁵² *Intergovernmental Panel on Climate Change, Summary for Policymakers, Revised on January 2019 by the IPCC, Switzerland, ISBN 978-92-9169-151-7*, downloaded at: <https://www.ipcc.ch/sr15/>

⁵³ Myhre, G. et al. 2013. Anthropogenic and Natural Radiative Forcing. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Stocker, T.F., D. Quin, G.K. Plattner, M.Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P.M. Midglet (eds). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. and https://en.wikipedia.org/wiki/Global_warming_potential

methane, a more potent greenhouse gas than carbon dioxide, has risen in recent years due to oil and gas production, including fracking.”⁵⁴

To achieve accuracy in calculating the effect of methane on heating the atmosphere and subsequently feeding climate change, it is essential to consider the greenhouse gas impacts from methane from a full life cycle perspective. That means calculating the emissions from gas extraction wells, storage units, compressor stations, pipelines, gas processing facilities, including LNG processors, modes of transport such as truck, rail, and shipping vessels, transloading of natural gas, natural gas liquids, and LNG, and, finally end use. The planet’s atmosphere is receiving emissions from these sources and more (such as orphan and abandoned wells); to not count all sources would result in inaccurate conclusions of the contribution of natural gas development to climate change.

Atmospheric methane levels rose steadily during the last few decades of the 20th century before leveling off for the first decade of the 21st century.⁵⁵ Since 2008, however, methane concentrations have again been rising rapidly. This increase, if it continues in coming decades, will significantly increase global warming and undercut efforts to reach the COP21 target of < 2 degrees C above the pre-industrial baseline by 2021.⁵⁶ Limiting warming to 1.5 degrees C will be even more difficult, if not impossible.

30% to 60% of the global increase in atmospheric methane between 2010 and 2014 was due to emissions in the lower 48 U.S. states and 63% of the increase in gas production over the past decade has been from shale gas.⁵⁷ Natural gas systems emit more anthropogenic methane than any other source in the United States, and are the third highest source for carbon dioxide emissions nationally.⁵⁸ Natural gas, considered “clean” or a “bridge fuel” is, in fact, a bigger problem than other fossil fuels due to uncontrolled and uncontrollable leaks, intentional flaring and venting. “Methane is far more potent than carbon dioxide in contributing to climate change. That makes it particularly harmful to the environment when it is discharged into the atmosphere. In the U.S. alone, the methane that leaks or is released from oil and gas operations annually is equivalent to the greenhouse gas emissions from more than 69 million cars, according to a Wall Street Journal analysis using conversion formulas from the Environmental Protection Agency and emissions estimates for 2015 published last year in the journal *Science*.”⁵⁹

The damaging changes that are already occurring and can be expected to occur in the near term are extremely costly. As the nation looks to meeting our energy needs in a way that engenders

⁵⁴ <https://www.insurancejournal.com/news/international/2019/06/19/529839.htm>

⁵⁵ Howarth, R. (2019). Ideas and perspectives: is shale gas a major driver of recent increase in global atmospheric methane? *Biogeosciences* (16), 3033-3046. Retrieved from <https://www.biogeosciences.net/16/3033/2019/bg-16-3033-2019.pdf>

⁵⁶ Ibid.

⁵⁷ Dr. Robert Howarth, Cornell University, <https://www.youtube.com/watch?v=1NPuYr1LGMl>

⁵⁸ EPA 2016. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014.

<https://www.epa.gov/ghgemissions/us-greenhouse-gas-inventory-report-1990-2014>

⁵⁹ Wall Street Journal, *The Leaks That Threaten the Clean Image of Natural Gas*, <https://www.wsj.com/articles/the-leaks-that-threaten-the-clean-image-of-natural-gas-11565280375>

wealth and prosperity for the public, it becomes clear that avoiding the harms of natural gas development is essential. Switching to natural gas is counter-productive in terms of energy security and sustainability due to the unavoidable negative impacts that accompany methane emissions. Attempting to mitigate the harmful impacts of methane cannot be successful because the harms will always outpace the mitigation, especially in the 10 and 20-year time frame that is so critical.

Because of the potent global warming potential of methane, natural gas substitution for other fossil fuels does not avoid substantial damages to the economy, environment, and human health over the coming decades.⁶⁰ Rising air and water temperatures and changes in precipitation are intensifying droughts, increasing heavy downpours and flooding, reducing snowpack, and causing declines in surface water quality, with varying impacts across different regions of the country.⁴ Changes in temperature and precipitation are increasing air quality and health risks from wildfire and ground-level ozone pollution. These impacts include an increase in heat-related deaths, allergic illnesses like asthma and hay fever, and vector-borne diseases such as Lyme disease from ticks.⁶¹

Climate change has already had observable impacts on biodiversity, ecosystems, and the benefits they provide to society. These impacts include the migration of native species to new areas and the spread of invasive species, which will worsen and could affect the ecological balance in the long term.⁶² Yields from major U.S. crops are expected to decline as a consequence of increases in temperatures and possibly changes in water availability (drought conditions), soil erosion, and disease and pest outbreaks.⁶³ Expected increases in the severity and frequency of heavy precipitation events will exacerbate flooding and affect inland infrastructure in every region, including access to roads, the viability of bridges, and the safety of pipelines and other facilities.

The Fourth National Climate Assessment looks at the Northeast region climate impacts. These are among expected changes in the near term:

- Less distinct seasons with milder winter and earlier spring conditions are already altering ecosystems and environments in ways that adversely impact tourism, farming, forestry, and other economies.⁶⁴
- Warmer ocean temperatures, sea level rise, and ocean acidification threaten ocean habitats, ecosystem services, and livelihoods.⁶⁵

⁶⁰ USGCRP, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: Report-in-Brief* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 186 pp. Retrieved from <https://nca2018.globalchange.gov/> at 14.

⁶¹ Ibid, p. 15.

⁶² Ibid, p. 16.

⁶³ Ibid, p. 16.

⁶⁴ Ibid, p. 116.

⁶⁵ Ibid, p. 117.

- Major negative impacts on critical infrastructure, urban economies, and nationally significant historic sites are already occurring and will become more common with a changing climate.⁶⁶
- Changing climate threatens the health and well-being of people in the Northeast through more extreme weather, warmer temperatures, degradation of air and water quality, and sea level rise.⁶⁷

From Nature: Burke, M., Davis, W.M., & Diffenbaugh, N.S. (2018). Large potential reduction in economic damages under UN mitigation targets. *Nature*, Vol. 557, 549 – 557. Retrieved from <https://www.nature.com/articles/s41586-018-0071-9>.

The United Nations Paris Agreement increased the need for quantitative analysis of uncertainties in the costs and benefits of holding global warming to “well below 2 °C above pre-industrial levels” and pursuing a 1.5 °C target.⁶⁸ A 2018 Research Letter addresses this by examining the global and country-specific economic impacts of limiting warming to 1.5 °C relative to 2 °C, as well as the global impacts of projected warming under current mitigation commitments. The researchers used annual measurements of average temperature and growth in gross domestic product (GDP) per capita from 165 countries over the years 1960–2010.⁶⁹ Most response functions generated more negative global impacts at 2 °C than at 1.5 °C.

The results indicated that limiting warming to 1.5 °C instead of 2 °C by mid-century would lead to an increase in global GDP of 1.5%–2.0% and US \$7.7–11.1 trillion in discounted avoided damages under a 3% fixed annual discount rate.⁷⁰

The report states that meeting these targets at the end of the century was estimated to lead to median gains in global GDP per capita of 3.4% and discounted avoided damages of US \$36.4 trillion.⁷¹ Achieving the 1.5 °C target at mid-century (2046–2065) would lead to a 68%–76% chance of overall cumulative net benefit relative to 2 °C under a fixed 3% discount rate.⁷²

Under the same discount rate, there was a 43%–53% chance of discounted cumulative benefits exceeding US \$10 trillion and a 4%–8% chance of exceeding \$30 trillion, which is about 40% of current global GDP.⁷³ For the end of the century (2081–2100), there was a >75% chance of net gain in per capita global GDP, an approximately 38% chance that benefits would exceed US \$50 trillion, and an approximately 5% chance that benefits would exceed US \$100 trillion.⁷⁴

⁶⁶ Ibid, p. 117.

⁶⁷ Ibid, p. 117.

⁶⁸ Burke, M., Davis, W.M., & Diffenbaugh, N.S. (2018). Large potential reduction in economic damages under UN mitigation targets. *Nature*, Vol. 557, 549–557. Retrieved from <https://www.nature.com/articles/s41586-018-0071-9>.

⁶⁹ Ibid, p. 549.

⁷⁰ Ibid, p. 550.

⁷¹ Ibid, p. 550.

⁷² Ibid, p. 550.

⁷³ Ibid, p. 550.

⁷⁴ Ibid, p. 550.

On a country scale, the researchers found that 71% of countries (approximately 90% of the projected global population) exhibited a >75% chance of experiencing positive economic benefits at 1.5 °C relative to 2 °C , and 59% of countries exhibited a >99% chance.⁷⁵ These countries include the three largest economies (the USA has a 76% chance of positive benefits; China 85%; Japan 81%).⁷⁶

They also include a large fraction of the world's poorest countries, with the likelihood of economic gains rising rapidly at lower levels of GDP per capita.⁷⁷ In contrast, under current national global warming commitments (2.5 to 3 °C), there was a 15%–25% reduction in per capita output by 2100, and reductions of more than 30% for 4 °C warming.⁷⁸ These results therefore suggest that achieving the 1.5 °C target is likely to reduce aggregate damages and lessen global inequality, and that failing to meet the 2 °C target is likely to increase economic damages substantially.⁷⁹ The most vulnerable and poorest communities would suffer even more.

Health, community, and environmental costs

From ECONorthwest: “The Economic Costs of Fracking in Pennsylvania”, May 2019.

Available at: <https://bit.ly/2JCO7yz>

A study of the economic impacts of Unconventional Oil and Gas Development (UOGD) in Pennsylvania authored by ECONorthwest was published by Delaware Riverkeeper Network in May 2019. The report found annual costs of current fracking activity over \$1 billion, with cumulative costs given continued fracking activity over the next 20 years of over \$50 billion in net present value. This estimated annual cost is roughly equivalent to 0.3 percent of the state's Gross Domestic Product.⁸⁰ The report evaluated the health, community, and environmental costs of fracking in the state.

“UOGD in Pennsylvania has transformed the state in a relatively short amount of time. While this boom is creating economic activity in the state, it is doing so by imposing large and long-term costs on residents on the state. If fracking continues at current rates, the economic, social, and environmental costs for Pennsylvania are estimated to be at least \$54 billion over the next twenty years. Increases in the rates of fracking in the state will increase these costs.”⁸¹

In addition to mounting and devastating health impacts and costly impacts to communities and other industries such as tourism and agriculture, there are costs associated with the environmental resources used and impacted by UOGD. These include but are not limited to: land changes; wetland, vernal pool, stream and river degradation; air pollution; water consumed for

⁷⁵ Ibid, p. 552.

⁷⁶ Ibid, p. 552.

⁷⁷ Ibid, p. 552.

⁷⁸ Ibid, p. 549.

⁷⁹ Ibid, p. 549.

⁸⁰ ECONorthwest, “The Economic Costs of Fracking in Pennsylvania”, May 2019. Available at: <https://bit.ly/2JCO7yz>, E.S. p. vii.

⁸¹ Ibid, p. 61.

fracking; water and soil contamination; bioaccumulation of contamination; healthy habitat loss such as forests, natural vegetation, land forms, geologic features; and in-water habitats for species; noise, light, and traffic impacts; infrastructure construction and operation; wastewater discharged from fracked wells; and community and social costs.

The report explains that other costs result from violations by operators in the fracking industry. Violations of permits and management practices that are not protective of the environment nor public health and safety have come with the rise of UOGD. For instance, in 2017 in Pennsylvania there were 821 violations at unconventional wells and 3,273 violations at conventional wells. Almost all (92 percent) of the unconventional well violations were environmental health and safety-related.⁸² The number of unconventional well violations for all wells (821) exceed the number of unconventional wells drilled in Pennsylvania in 2017 (810) (Figure 11). Well violations occur for wells at all stages of its lifespan.⁸³

The researchers found that many of these costs can be monetized but some cannot be “bought and sold”. Nonetheless, these costs are real and paid for by those who are impacted, primarily the public. In many cases, there is no effort made to measure or limit the “externalized costs” of an activity and the costs are not included in a typical cost-benefit analysis but are nonetheless carried on the shoulders of the public - taxpayers, residents, workers, and generations yet to come. The report examines and evaluates all costs that can be accounted for, to provide a more accurate and unbiased view of the economic costs of UOGD, primarily “fracking” [“UOGD represent the activities involved with hydraulic fracturing, which allows access to “unconventional” oil and gas reserves that are not possible to extract without the horizontal drilling associated with hydraulic fracturing”]⁸⁴.

“In the United States, it is estimated that the annual ecological costs of fracking are over \$1.52 billion per year.^{85, 86} This value includes the economic value associated with “ecosystem services” that are damaged by UOGD. Ecosystem services are the benefits that natural capital provides to people, such as carbon sequestration, flood mitigation, food security, recreation, and genetic diversity. These benefits are not bought and sold in markets, but economists derive and measure their value using various methods, including estimating the cost to replace the service with built infrastructure, asking people about their willingness to pay to protect or enhance services, and revealed social preference based on regulatory costs and government spending to sustain and protect scarce resources. UOGD directly impacts water and air resources, producing many of the health and community effects described in previous sections. It also affects the integrity of ecological systems, which in turn reduces the quantity and quality of terrestrial and aquatic habitat. People derive value both from the species that depend on the habitat, and from its

⁸² Ibid, p. 14.

⁸³ Ibid, p. 14.

⁸⁴ Ibid, p. 1.

⁸⁵ The original 2015 values have been inflated to 2019 dollars.

⁸⁶ Moran, M. D., Taylor, N. T., Mullins, T. F., Sardar, S. S., & McClung, M. R. (2017). Land-use and ecosystem services costs of unconventional US oil and gas development. *Frontiers in Ecology and the Environment*, 15(5), 237–242. doi: 10.1002/fee.1492

aesthetic character. Greenhouse gas emissions impose costs on human communities now and in the future. Geologic destabilization produces increased risks to physical infrastructure.”⁸⁷

“The costs of fracking primarily affect vulnerable populations such as children, elderly, and low income people, due to economic inequities and health risks. If fracking in Pennsylvania increases, then the total costs will also increase since they are rooted in per-well estimates. If fracking in Pennsylvania decreases these costs will decline, although some impacts like the loss of habitat will take years to restore. Even if fracking in Pennsylvania were to cease today, legacy wells will continue to pose risks to local communities and the broader region from health, community, and environmental impacts.”⁸⁸

“In addition to the monetized costs, other economic costs should also be considered as resulting from UOGD in Pennsylvania. These non-monetized costs include:

- Increases in fatal traffic accidents, primarily in high well-density counties;
- Detrimental effects to the water resources of the state from the high volumes of fresh water and groundwater being used for extraction of natural gas;
- Long-term economic effects from lower educational attainment, primarily among men;
- Lack of economic resiliency from reliance on natural resource commodity subject to boom and bust economic cycles;
- Long-term health effects, including increased cancer rates;
- Environmental effects from the accumulation of chemicals and pollutants over time;
- Impacts to recreational hunters and fishermen due to declining wildlife populations;
- Fiscal risk to the state from inadequate bonding requirements which could transfer the costs of clean-up to the state;
- Loss of land for agriculture and recreation due to creation of well-pads and inadequate restoration once drilling is completed; and
- Perpetuation of reliance on U.S. energy on fossil fuels that delays and impedes transitions to renewable energy.”⁸⁹

“Hydraulic fracturing primarily impacts human health through the pathways of air quality, groundwater contamination, surface water contamination, occupational hazards, and soil/agricultural contamination. The drivers of this risk are the chemicals and materials used in the fracking process, as well as the subterranean materials brought to the surface through extraction. The support infrastructure to the fracking process including compressors, pipelines, and trucks also produces health impacts through air quality impacts, noise, and safety issues. The health effects of UOGD are exacerbated by leaks, improper storage, and negligence associated with natural gas infrastructure, as well as by the intensity of nearby operations.⁹⁰ Health effects that have been linked to fracking include

⁸⁷ ECONorthwest, “The Economic Costs of Fracking in Pennsylvania”, May 2019. Available at: <https://bit.ly/2JCO7yz>, p. 44.

⁸⁸ Ibid, E.S. p. ix.

⁸⁹ Ibid, E.S. p. x.

⁹⁰ ProPublica. (2009). *Officials in Three States Pin Water Woes on Gas Drilling*. ProPublica. Retrieved from www.propublica.org/article/officials-in-three-states-pin-water-woes-on-gas-drilling-426.

low birth weight, preterm births, infertility, asthma, respiratory diseases, cancer, liver damage, silicosis, cardiovascular diseases, migraines, anxiety, insomnia, depression, and other mental health problems.⁹¹ The most commonly reported health symptoms of people living within one kilometer of a well include sleep disruption, headache, throat irritation, stress or anxiety, cough, shortness of breath, sinus problems, fatigue, nausea, and wheezing.⁹²

Of the 685 papers published between 2008 and 2015 on fracking, 226 studies investigated the link between adverse health effects and fracking.⁹³ The exact causes of the illnesses are often unclear because of the unknown chemicals that are used in the fracking process.⁹⁴ In 2005, the U.S. Environmental Protection Agency (EPA) enacted regulations, commonly known as the Halliburton Loophole that exempts oil and gas companies from federal oversight under the Safe Water Drinking Act. This exemption means that oil and gas companies do not have to disclose the chemicals used in hydraulic fracturing production.”⁹⁵

The costs of climate change are examined in the report as well. These costs are directly relevant to the proposed rulemaking, even though some figures are calculated for Pennsylvania. Considering that Pennsylvania is the second largest producer of natural gas in the country and it is developing gas processing and end uses within its borders, its greenhouse gas emissions are substantial and contribute to the national problem of overproduction of greenhouse gases. The costs of climate change are directly relevant to the viability and security of the natural gas industry, undermining a false narrative of an energy source with a growing, beneficial future. The lack of benefits for the public and the environment thwart its expansion as problems multiply and compound and subvert the need for developing another mode of transport for LNG. The public and some regulators and policy makers are becoming more and more intolerant of the unmitigatable impacts. This is especially true for such a dangerous and untested Proposed Alternative, rushed through without LNG-specific controls and analyses.

“The EPA has estimates for the value of social costs of GHGs, which represent the long-term costs based on damages due to GHG-caused changes in agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs. The effects of climate change in Pennsylvania include changes in precipitation and

⁹¹ Concerned Health Professionals of New York & Physicians for Social Responsibility. (2018). *Compendium of scientific, medical, and media findings demonstrating risks and harms of fracking (unconventional gas and oil extraction)*.

⁹² Weinberger, B., Greiner, L. H., Walleigh, L., & Brown, D. (2017). Health symptoms in residents living near shale gas activity: A retrospective record review from the Environmental Health Project. *Preventive medicine reports*, 8, 112-115.

⁹³ FracTracker Alliance. (2019). *Categorical Review of Health Reports on Unconventional Oil and Gas Development; Impacts in Pennsylvania*. FracTracker Alliance Issue Paper.

⁹⁴ Hays, J., & Shonkoff, S. B. (2016). Toward an understanding of the environmental and public health impacts of unconventional natural gas development: a categorical assessment of the peer-reviewed scientific literature, 2009-2015. *PLoS one*, 11(4), e0154164.

⁹⁵ ECONorthwest, “The Economic Costs of Fracking in Pennsylvania”, May 2019. Available at: <https://bit.ly/2JCO7yz>, p. 18.

runoff that will increase flooding and drought, as well as increases in temperature and frequency of temperature extremes.²⁶⁴ Additionally, water resources will be impacted by sea level rise which could cause salt water intrusion to Delaware River Estuary water supplies, the drinking water source for millions of people. Salt water intrusion, floods, and droughts will also lead to loss of habitat and degradation of water quality. Agricultural costs and health costs are also anticipated to be large due to climate change in Pennsylvania. Using a three-percent discount rate, the social cost of carbon is \$39, and the social cost of methane is \$1,088.265.

Pennsylvania accounted for 19 percent of total U.S. marketed natural gas production in 2017. Applying that percentage to the total U.S. natural gas emissions for methane and carbon dioxide emitted in 2016 (the most recent data available).⁹⁶

“The estimated annual cost due to natural gas production in Pennsylvania are estimated as \$1.3 billion for methane and \$11.2 billion for carbon dioxide.”⁹⁷

“The EPA estimates that the social cost of GHGs will increase over time due to the cumulative effects. ***If Pennsylvania continues to produce a similar level of natural gas as in 2016, in twenty years that production is estimated to result in a social cost of methane of \$28.4 billion and a social cost of carbon dioxide of \$21.5 billion.***”

These estimates for the social costs of GHG emissions are lower bound estimates. Research suggests that by 2025 GHG emissions from Pennsylvania's natural gas sector will be at least three times higher than emissions in 2012. Social costs of GHG emissions also increase over time as the cumulative level of GHGs in the atmosphere increases.⁹⁸

Health Costs

The health costs of natural gas development are also jeopardizing the future viability of the industry. These cost are externalized costs that the public must bear even though they have not chosen to do so, in opposition to their and future generations' environmental rights. There is a growing recognition among health professionals, scientists and government agencies of the health impacts that are harming people who are exposed to natural gas development operations. PHMSA must consider these costs in its determination regarding the proposed rulemaking. The growing evidence of significant health costs that are demanding accountability from the industry cannot be swept under the rug. They must be realized in terms of the industry's future and its stability as a viable energy source.

From FracTracker Alliance: “Categorical Review of Health Reports on Unconventional Oil and Gas Development; Impacts in Pennsylvania”, authored by Kyle Ferrar, Erica Jackson, Samantha Malone, FracTracker Alliance, May 2019. Available at: <https://bit.ly/30kqe4u>

“This infrastructure is increasingly encroaching on communities and residential areas. The Oil and Gas Threat Map, a joint project of FracTracker Alliance, Clean Air Task Force, and

⁹⁶ Ibid, p. 54.

⁹⁷ Ibid, p. 54.

⁹⁸ Ibid, p. 54-55.

Earthworks, estimated that 12.6 million people live within the half-mile threat radius of active oil and gas wells, compressor stations, and/or processing stations.⁹⁹ The proximity of homes to development has raised significant public health concerns and community resistance since communities started raising concerns of exposure to groundwater and air contamination, beginning in 2007 and 2008.”¹⁰⁰

“Of the 142 studies in our sample population (including 5 published in 2019), a total of 127 reports (89.4%) indicated a positive relationship of UOGD with health impacts. There were a total of 106 articles that published new, original research, with 104 focused on health impacts. Of these 104 articles, 94 indicated a positive relationship with health impacts (90.3%).”¹⁰¹

“Important Health Impact Findings:

- Cancer outcomes, including Non-Hodgkins lymphoma [62], and urinary bladder cancer [61]
- Impacts on pregnancy and development, including association with early infant mortality, pre-term birth, and poor infant health [24, 35, 36, 58]
- Impacts on mental health and well-being, including depression, self-reported stress, worry about health, and sleep disturbances [20, 43, 44]
- Pneumonia hospitalizations rates in elderly populations [49]
- Increased risk of asthma exacerbations [31, 33]
- Skin-related hospitalizations [50]
- General health symptoms, such as headache, fatigue, nasal and sinus impacts, and throat irritation [51, 60]
- Impacts on sexual health, in particular gonorrhea and chlamydia rates, which may be driven by demographic and population changes where unconventional oil and gas development occurs [47, 59]
- A Delphi study to determine adequacy of current setback distances from unconventional oil and gas development found that current distances do not protect public health [10]
- Radon concentration at wellheads is strongly correlated with production rate, and poses hazard to the public and environment [67]
- Risk assessment of residential exposure to contaminated drinking water from a modeled spill of flowback water poses cancer risk from radionuclide exposure and non-cancer risk from barium and thallium exposure [63]
- Risk assessment of exposure of contaminated drinking water from a spill of flowback water poses excess lifetime cancer risk and exposure to barium and lithium in drinking water pose non-cancer risk [64]
- Exposure to contaminants in unconventional oil and gas wastewater spread on roads, poses a health risk from release of salt, radioactivity and organic contaminants into the environment, at concentrations above drinking water

⁹⁹ *Oil and Gas Threat Map*. FracTracker Alliance, Clean Air Task Force, Earthworks.

¹⁰⁰ FracTracker Alliance, “Categorical Review of Health Reports on Unconventional Oil and Gas Development; Impacts in Pennsylvania”, May 2019. <https://bit.ly/30kqe4u> p. 3.

¹⁰¹ *Ibid*, p. 7.

standards. Toxicological studies indicated that the organic micropollutants in wastewater caused toxicity to aquatic organisms like *Daphnia magna* [65]

- Chemical characterization and toxicologic research of fracking fluids and wastewater pose the possibility of “toxicity to human organs, sensitization, irritation, developmental effects, and tumor promotion” [66]
- A modeled scenario of exposure patterns of volatile organic compounds (VOCs), particulate matter (PM) and diesel found periods of extreme exposure which correlate with the documented peaks in reported health complaints [68]¹⁰²

“Well pads and infrastructure degrade air quality, surface water quality, have the potential and have already contaminated groundwater sources as well. From the primary research conducted in the Marcellus Shale and specifically in Pennsylvania, we find that impacts are not just anecdotal or segregated to a particular region. Wherever there is a dense concentration of UOGD in the shale play, public health assessments are documenting community and environmental health impacts.”¹⁰³

“The sources of pollution are not limited to just oil and gas well pads either. Expansive infrastructure is necessary to support the transmission, processing and even petrochemical manufacturing that constitute the fossil fuel extraction economy. In addition to natural gas liquids (NGL) pipelines, cryogenic plants, and fractionation facilities in shale plays, plans for ethylene cracker projects are also in the works.

The international shale boom has depressed both oil and gas prices, but the decrease in natural gas prices has been most substantial domestically. As the price of natural gas continues to fall operators are looking for ways to balance profits. What materials were once considered production by-products – the longer chain hydrocarbon condensates, have become valuable raw materials for ethane production. Major operators such as Shell, Exxon, and BP have the capacity to make use of these byproducts. The Ohio River Valley is becoming a hot bed for new ethane “cracker” facilities, starting in Pennsylvania, leading to the development of a new major industrial corridor on the Ohio River¹⁰⁴.¹⁰⁵

“The results of this study indicate that a variety of health impacts in every major organ system are being experienced by individuals living near UOGD. Furthermore, these impacted communities clearly attribute declines in health to the presence of the oil and gas industry. Additionally, the epidemiologic studies with a longitudinal aspect that tracked the inclement growth of the industry show a response to increased development and additional drilling.”¹⁰⁶

¹⁰² Ibid, p. 9.

¹⁰³ Ibid, p. 16.

¹⁰⁴ Jackson, E., *Ethane Cracker Project: Risks of Bringing Plastic Manufacturing to Ohio*. 2018: FracTracker Alliance. <https://www.fractracker.org/2013/09/swpa-preta/>.

¹⁰⁵ Ibid, p. 16.

¹⁰⁶ Ibid, p. 17.

From: Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking (Unconventional Gas and Oil Extraction) Sixth Edition, June 19, 2019

The *Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking* (the Compendium) is a fully referenced compilation of evidence outlining the risks and harms of fracking.

“In our review of the data, seventeen compelling themes emerged; these serve as the organizational structure of the Compendium. Readers will notice the ongoing upsurge in reported problems and health impacts, making each section top-heavy with recent data. The Compendium focuses on topics most closely related to the public health and safety impacts of fracking. These include risks from fracking infrastructure, including compressor stations, pipelines, silica sand mining operations, natural gas storage facilities, the manufacture and transportation of liquefied natural gas (LNG), and, for the first time, gas-fired power plants.”¹⁰⁷

From: *Nature Sustainability*. Mayfield et al., (2019). “Cumulative environmental and employment impacts of the shale gas boom”, 2019.

“The cumulative impacts over the boom-and-bust nature of the natural gas supply chain are still largely unexplored and unaccounted for in public and private decision-making. A new study analyzed the shale gas boom (and decline) in the Appalachian basin with respect to both reserves and production.”¹⁰⁸

Impacts across the regional supply chain from preproduction to end use from 2004 to 2016 were modeled. It was estimated that 1,200 to 4,600 premature mortalities were associated with air pollutant emissions from shale gas activity between 2004 and 2016.¹⁰⁹ Annual mortalities (439) and damages (\$3.7 billion) peaked in 2014, and air pollution damages from natural gas electricity generation are around 5% that of coal.¹¹⁰

Methane emissions from natural gas-related sources within Pennsylvania, Ohio, and West Virginia (1.25 million tonnes in 2015) accounted for 10% of U.S. emissions, while carbon dioxide in these states (134 million tonnes in 2016) accounted for 9% of all emissions in the country.³

End use processes contributed most CO₂ (85%) emissions across the supply chain, with remaining emissions attributable to well development (2%) and fuel consumption for production, processing, transmission and distribution (13%).³ Cumulative climate damages from natural gas activity over the period 2004 to 2016 range from \$12 billion to 94 billion, depending on assumptions regarding social costs.”¹¹¹

¹⁰⁷ Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking (Unconventional Gas and Oil Extraction) Sixth Edition, June 19, 2019. <http://concernedhealthny.org/compendium/>

¹⁰⁸ Mayfield et al. (2019). Cumulative environmental and employment impacts of the shale gas boom. *Nature Sustainability*.

¹⁰⁹ Ibid, p. 2.

¹¹⁰ Ibid, p. 3.

¹¹¹ Ibid, p. 4.

From: Pittsburgh Post-Gazette. The Southwest Pennsylvania Environmental Health Project. The Editorial Board, “Fear and frustration: Fuel for solving the Ewing sarcoma mystery”, Pittsburgh Post-Gazette, 11.10.2019. The Southwest Pennsylvania Environmental Health Project, “EHP Addresses Childhood Cancer Issue in SWPA”, THE YEAR IN REVIEW Term: Winter, Issue 5, Dec. 2019.

There is emerging evidence of childhood cancers in southwestern Pennsylvania, one of the most active and concentrated Marcellus Shale development regions in Pennsylvania. A shocking expose by the Pittsburgh Post-Gazette (PG) revealed an aggregation of childhood cancers in the region, many concentrated in one school district. The area has a concentration of natural gas extraction wells that employed fracking.

From the paper’s Editorial: “In March, the PG documented six Ewing sarcoma cases within Canon-McMillan (comprising Cecil and North Strabane townships and Canonsburg) as well as an additional nine Canon-McMillan preschoolers and students who during the 2018-2019 school year had cancer. Those cases include two cases each of osteosarcoma (bones) and leukemia (blood), and one case each of liposarcoma (connective tissue), rhabdomyosarcoma (soft tissue), neuroblastoma (nerve cells), liver cancer and Wilms (kidney) tumor. Additionally, a teenage student died in February from astrocytoma, a brain and spinal cord cancer.”¹¹²

The Southwest Pennsylvania Environmental Health Project YEAR IN REVIEW newsletter reported on the childhood cancer cases and the ongoing investigations, including Pennsylvania government-funded study. “In 2019, EHP found itself on the front line of a disturbing controversy surrounding the rise in childhood cancers in SWPA. According to a series published in the Pittsburgh Post-Gazette, there have been a total of 67 rare childhood cancers from 2008-2018 in 4 SWPA counties, including a total of 27 cases of a rare bone cancer, Ewing sarcoma (ES). In the last decade, 6 children in the Canon-McMillan School District alone have been diagnosed with ES. At least 10 additional children attending this school district have been diagnosed with other rare cancers during the same time period.”¹¹³

The fallout from the investigation that is now underway may impact the region that is one of two most productive natural gas producing areas in the Commonwealth. Obviously, the tragedy that is unfolding in this part of the shale play will have far-reaching effects should a connection be found between the cancers and fracking and natural gas operations. These findings directly affect the viability of natural gas as an energy source.

¹¹² The Editorial Board, “Fear and frustration: Fuel for solving the Ewing sarcoma mystery”, Pittsburgh Post-Gazette, 11.10.2019. Retrieved from: <https://www.post-gazette.com/opinion/editorials/2019/11/10/Ewing-sarcoma-cancer-mystery-fear-frustration/stories/201910240049>. Further information at: <https://newsinteractive.post-gazette.com/ewing-sarcoma-cancer-cluster-pittsburgh-washington-westmoreland/>

¹¹³ The Southwest Pennsylvania Environmental Health Project, “EHP Addresses Childhood Cancer Issue in SWPA”, THE YEAR IN REVIEW Term: Winter, Issue 5, December 2019. Retrieved from: <https://www.environmentalhealthproject.org/sites/default/files/assets/resources/winter-2019-newsletter.pdf>.

In conclusion, Delaware Riverkeeper Network disagrees with PHMSA's proposed finding that the proposed regulations allowing the transport of LNG via DOT-113C120W tank car will not result in a significant environmental impact. There are significant environmental, public health, and safety impacts that will occur if the proposed regulations and the Proposed Alternative are adopted.

For this reason, DRN opposes the proposed Hazardous Material Regulation changes and calls for the denial of the proposed rulemaking and the Proposed Alternative.

Thank you for the opportunity to comment.

Respectfully submitted,

Handwritten signatures in blue ink. The signature on the left is 'Maya van Rossum' and the signature on the right is 'Tracy Carluccio'.

Maya van Rossum
the Delaware Riverkeeper

Tracy Carluccio
Deputy Director

Imbedded Attachment: DRN Appendix A

APPENDIX A

History of LNG Incidents December 2019

1. History of LNG Accidents¹¹⁴

- *The Cleveland Disaster, U.S. 1944.* The very first commercial LNG facility built in the United States in 1941, caused a major industrial accident known as the "The Cleveland Disaster." Where, in 1944, according to the U.S. Bureau of Mines report, LNG holding tanks failed and released their contents into the streets and sewers and their vaporous cloud ignited and fire engulfed the nearby residents and commercial establishments. LNG destroyed 79 Homes, 2 Factories, 217 Cars, 7 Trailers, Left 680 Homeless, Injured 225 and Killed 131. The fiery LNG inferno devastated one square mile of Cleveland, Ohio.
- *Methane Princess Spill, 1965.* The LNG discharging arms on a vessel which were disconnected before the liquid lines had been completely drained – caused another LNG accident
- *Jules Verne Spill, May 1965.* Failure of the liquid level instrumentation – caused another LNG accident
- *La Spezia, Italy, 1971.* Phenomenon called rollover, where two layers of LNG having different densities and heat content are allowed to form back flow of natural gas from the compressor to the nitrogen line – caused another LNG accident
- *Montreal East, Quebec, Canada, 1972.* Explosion occurred in the LNG liquefaction and peak shaving plant of Gaz Metropolitan in Montreal East, Quebec. The accident occurred in the control room due to a back flow of natural gas from the compressor to the nitrogen line.
- *Staten Island Tank Fire, USA, 1973.* A fire erupted at an out-of-service LNG tank that was being repaired. Forty workers then inside the tank were killed. LNG, which had leaked through the liner during previous fillings, had accumulated in the soil below and around the concrete tank wall berm. It has been assumed that an electrical spark in one of the irons or vacuum cleaners ignited the flammable gas reentering the tank.
- *Massachusetts Barge Spill, July 1974.* After a power failure and the automatic closure of the main liquid line valves, a small amount of LNG leaked from a 1-inch nitrogen-purge globe valve on the vessel's liquid header - pressure surge caused by the valve closure induced the leakage of LNG – caused another LNG accident
- *Aquarius Spill, September 1977.* Difficulties in the liquid level gauge system – caused another LNG accident
- *Das Island, United Arab Emirates, March 1978.* Failure of a bottom pipe connection of a LNG tank– caused another LNG accident
- *Cove Point, Maryland, 1979.* LNG leak from a high-pressure pump found its way into an electrical conduit – caused another LNG accident
- *Mostafa Ben Bouliad Spill, April 1979.* A check valve in the piping system of a 125,000 cubic meter vessel failed – caused another LNG accident
- *Pollenger Spill, April 1979.* Leaking from a valve gland – caused another LNG accident

¹¹⁴ <https://www.timrileylaw.com/LNG.htm>

- Bontang, Indonesia, 1983. Rupture of a heat exchanger in an LNG plant and resultant explosion – caused another LNG accident
- Nevada Test Site, Mercury, NV, 1987. An accidental ignition of an LNG vapor cloud occurred at the US Department of Energy (DOE) Nevada Test Site in August 1987.
- *Bachir Chihani*, Hull Cracking, 1990. Inner hull fracture occurred in a 130,000 cubic meter vessel at a part of the ship's structure that is prone to the high stresses that accompany the complex deflections that the hull encounters on the high seas – caused another LNG accident
- *Mediterranean Off Gibraltar, Minor LNG Carrier "Collision," November 13, 2002*. LNG carrier Norman Lady was struck off Gibraltar by the USS Oklahoma City, a Navy nuclear submarine. Minor damage to both vessels was caused by submarine periscope. The company said the vessel, had already unloaded its LNG cargo in Barcelona, Spain.
- *Algeria, LNG Facility Explosion, January 19, 2004*. LNG port facility designed to load only small LNG Tankers for short distances exploded; death toll: 27; workers injured: 74; blast felt miles away; facility destroyed; fires raged for 8 hours; property damage: approx. \$ 1 Billion; cause: (initially believed: "defective boiler" which had earlier received "superficial repairs;"); insurance investigation determined cause: liquefied natural gas leak in pipe
- *Trinidad Tobago, June 13, 2004*. LNG turbine explodes, workers evacuated. Scores of workers had to be evacuated after a gas turbine at Atlantic LNG's Train 3 facility exploded. *Details Still Unfolding...*
- *Belgium, July 31, 2004*. Fluxy's LNG gas pipeline explosion kills 15 in Belgium. It was the deadliest gas blast in Belgium since 1967, when a tanker truck carrying liquid gas blew up, killing 22 people. ["Debris from the initial explosion was found up to four miles away"](#) (BBC video)
- *Norway, September 20, 2004*. LNG tanker adrift north of Bergen. A fully loaded LNG tanker with a crew of 14 was adrift west of Fedje, on the west coast of Norway, north of Bergen. The ship's engines had stopped, and the anchors were useless in the stormy weather. Tugboats could not get the tanker undertow until the ship was only 30 yards from hitting rocks. There was strong wind and bad weather conditions in the area, and preparations were made to evacuate the 800 persons living on the island of Fedje, for fear that the tanker would explode if it grounded, NRK reports.
- *USA, March 2005*. [LNG Causes Pipeline Leaks](#) and house explosion. On July 7, 2005, a company-sponsored study, launched after a District Heights house exploded in late March, found that subtle molecular differences in the imported liquefied natural gas the utility began using in August 2003 were drying the rubber seals of aging metal couplings that link sections of pipe. The breakdown of seals in the couplings of gas pipelines led to about 1,400 gas leaks during the past two years, and has required the company to launch a \$144 million project to replace lines and equipment. Two other house explosions in the area are now under investigation.
- *Nigeria, August 2005*. 28-inch Liquefied Natural Gas underground pipeline exploded - Wild inferno engulfed an estimated 27 square kilometers. Eleven persons are feared missing and aquatic life completely destroyed when a 28-inch Liquefied Natural Gas underground pipeline exploded at Kalakama, an Ogoloma fishing community in Okrika Local Government Area of Rivers State. The incident, which occurred at the weekend, resulted in a wild inferno that engulfed an estimated 27 square kilometers of the once rich Kalakama

mangrove, killing seafoods and cash crops. So huge, the impact of the explosion was felt on the Okrika Island and the Borikiri area of Port Harcourt where, residents were forced into a stampede for safety. [Nigeria LNG pipeline explosion](#)

- *India, September 17, 2005.* Winds just over a mere 40 knots led to an accident at Petronet LNG Ltd.'s terminal at Dahej when the tugboats of LNG carrier "Disha" hit Dolphin Piles of the jetty. The LNG ship was casting off after unloading the cargo. Petronet LNG Ltd.'s is evaluating the extent of damage. [Mishap at Dahej LNG unit, supply hit](#)
- *Savannah, GA March 14, 2006.* A potentially disastrous spill was averted early Tuesday morning when the liquefied natural gas tanker Golar Freeze discharging its load at the Southern LNG terminal on Elba Island broke from its moorings and pulled away from the pier. The dock was shut down for about 36 hours while representatives from the Coast Guard and an LNG engineer from the Federal Energy Regulatory Commission investigated the incident. [Near-miss shuts down LNG imports on Elba](#)
- *Trinidad & Tobago May 18 & May 21 & June 6, 2006.* Fire at LNG Plant - "YET another blowout has occurred at Atlantic LNG in Point Fortin. On Tuesday, fire broke out at the base of a Flame Pole when a seal broke loose. The incident that occurred around 8.30 pm did not result in any injuries to employees or damage to the plant. According to a report from the Point Fortin sub-fire station, the seal popped and fire shot out. An employee nearby alerted a safety officer who quickly extinguished the fire. On May 21, Atlantic LNG employees had to evacuate the plant after a plug blew out and struck an employee in the chest. Three days before that incident, Train 11 plant had to be shut down for six hours when a natural gas leak was discovered in a two-inch pipeline." [FIRE AT LNG PLANT](#) Trinidad News, Trinidad and Tobago
- [Ship carrying liquid gas burns off Jordan](#) *July 13, 2006.* "AMMAN, Jordan -- A tanker carrying liquefied natural gas caught fire as it unloaded Thursday in Aqaba, injuring 12 people, the manager of the Jordanian Port Said. Four of the injured were firefighters, who needed an hour to bring the blaze under control, said Awwad al-Maaytah, the director general of Aqaba Port Authority. The other injured were crewmembers. The ship was promptly evacuated and towed away from the pier in the Red Sea port having unloaded only half of its cargo. Al-Maaytah said the cause of the fire was under investigation." Seattle Post Intelligencer. [Jordan Liquid-Gas Ship Mishap Injures 19](#)
- [LNG Tanker Adrift Off Cape Cod Needs Rescue](#) *February 11, 2008.* Coast Guard and tugboat crews rescued a liquefied natural gas tanker crippled off Cape Cod after many hours of drifting at sea at the mercy of powerful winds and high waves. Just 5-years-old, the fully laden LNG carrier was corralled by four tugboats about 25 miles east of Provincetown. Apparently, about 3 a.m. Monday its propulsion system shut down because of a computer malfunction according to the Coast Guard. The 933-foot Spanish-flagged LNG tanker Catalunya Spirit was heading from Trinidad to the LNG facility in Everett. 2/15/08. After several days of troubleshooting, repair specialists determined a malfunctioning boiler feed pump, which supplies water to the main propulsion boilers, caused the Catalunya Spirit's loss of power and propulsion. Captain of the Port of Boston reviewed and approved the final repair certification presented by Lloyd's Register and Teekay Corporation. The LNG delivery through Boston Harbor was cancelled.
- *Washington, March 31, 2014* U.S. LNG Explosion "Early Monday, a "processing vessel" at the Williams facility near the small town of Plymouth, Washington, exploded, spraying

chunks of shrapnel as heavy as 250 pounds as far as 300 yards, according to local emergency responders.

- The flying debris pierced the double walls of a 134-foot LNG tank on site, causing leaks. Five workers were injured, and local responders warned that vapors from the leaks could trigger a more devastating, second explosion. A county fire department spokesperson said authorities were concerned a second blast could level a 0.75-mile 'lethal zone' around the plant.
- Everyone within a two-mile radius of the site was evacuated...”

2. On June 21, 1970 in Crescent City, IL, 16 railcars derailed and 10 of them contained 34,000 gallons of liquid propane. As a result of the derailment, one of the propane tank cars was punctured by a coupler of another car, causing a leak that ignited almost immediately, engulfing the other nine derailed propane cars. Flame impingement on the uninsulated tank cars caused an increase in pressure inside the tank cars from impingement on the liquid space. Impingement on the vapor space caused weakening of the steel that resulted in the BLEVEs (boiling liquid expanding vapor explosions) that occurred. Flames reached several hundred feet into the air and a nearby house and business were set on fire by radiant heat. The heat from the incident could be felt from three blocks away. A total of 66 people (fire, police and press personnel) were injured by the explosions and 11 required hospitalization.¹¹⁵

3. On June 22, 2002, an LNG tanker truck near Tivissa, Spain lost control on downhill section of the road, probably due to speeding. The truck flipped over on its left side and immediately ignited in flames. The flames grew and burned for 20 minutes before the tank violently exploded. The explosion broke the tank and the truck into several pieces, distorting some of them considerably, ejecting them over considerable distances and causing a pressure wave. The driver died and two people 200 meters away were burned.¹¹⁶

4. On January 19, 2004, the Skikda LNG plant in Algeria exploded and set off a chain reaction that damaged surrounding structures and facilities — including a nearby power plant, one of the berths at the Skikda harbor, and numerous homes and other buildings in the community. At least six people died instantly in the explosion. The shockwave leveled the maintenance, security and administrative buildings nearby, trapping workers under the debris. The force of the blast overturned security vehicles and ambulances that were parked near the facilities, and the heat was so intense that it melted the vehicles' metal structures. Several people died in the ensuing fire, with some reportedly trapped by a chain-link fence that surrounded a fire-engulfed area.¹¹⁷

5. On June 29, 2009, a 14-car train carrying liquefied petroleum gas (butane, propane) derailed and crashed into nearby neighborhood in Viareggio, Italy. The train exploded, collapsing five

¹¹⁵ <https://www.firehouse.com/home/article/10467137/crescent-city-train-derailment-40-years-later>

¹¹⁶ https://www.academia.edu/7741565/Explosion_of_a_road_tanker_containing_liquified_natural_gas

¹¹⁷ <https://us.evershedssutherland.com/mobile/portalresource/lookup/poid/Z1tOI9NP1uKPtDNIqLMRV56Pab6TfzcRXncKbDtRr9tObDdEuW3Cu0!/fileUpload.name=/PGJLNG.pdf>

buildings and setting fire to the surrounding area. At least 12 people were killed on 50 injured in the blast.¹¹⁸

6. On October 20, 2011, an LNG tanker truck in Murica, Spain, collided with another vehicle that was stationary on the side of the road. A fire started immediately, igniting plastic and rubber materials and the fuel tank that which finally engulfed the cargo tank. The cargo tank was of a single wall construction with polyurethane insulation and aluminum cladding. The inlet and outlet pipes for both liquid and gas were fitted with valves flush with the tank wall but there were other connections from the tank leading to the exterior. One of these connections was broken as a result of the accident and this allowed the tank contents to leak and feed the fire. The fire was burning for 71 minutes at which time the tank exploded and collapsed. The fireball that resulted was ~100 meters high with a radius of ~75 meters. Further damage was caused by thermal radiation, a pressure wave (broken windows at a nearby gas station) and debris being thrown over a distance of 200 meters. The driver of the tanker was killed in the explosion.¹¹⁹

7. On March 31, 2014, gas processing equipment at Plymouth LNG in Washington exploded into a towering, mushroom-shaped cloud. Nearby residents saw flames shoot into the air, and people living three to six miles from the plant could feel the explosion. The blast sent 250 pounds of debris and shrapnel flying as far as 300 yards, damaging buildings and equipment and puncturing one of the large LNG storage tanks. Shrapnel injured four of the fourteen employees on duty, and a fifth worker was hospitalized for burns.¹²⁰

8. In 2018, about 0.6 Bcf of U.S. LNG exports were by truck to Canada and Mexico, with 97% going to Mexico.¹²¹

9. The rail incident rate per mile is approximately five times higher than the rate for road tankers.¹²²

10. There have been two accidental releases of cryogenic liquids approved for U.S. rail transport in DOT-113 tank cars in the past 16 years.¹²³

11. However, there is a low quantity DOT-113 tank cars carrying LNG, which lowers the accident rate. In 2015, there were under 13,000 carloads of product moved using DOT-113 tank cars. To put that in perspective, according to a 2014 [AAR document](#), U.S. railroads were transporting 9,500 carloads of crude oil in 2008 but by 2013, that number skyrocketed to 407,761 carloads.¹²⁴

¹¹⁸ <https://www.theguardian.com/world/2009/jun/30/train-crash-viareggio-lucca>

¹¹⁹ https://www.gti.energy/wp-content/uploads/2018/12/Safety-4-Juan_M_Bonilla-LNG17-Poster.pdf

¹²⁰ <https://www.sightline.org/2016/02/08/how-industry-and-regulators-kept-public-in-the-dark-after-2014-lng-explosion-in-washington/>

¹²¹ <https://www.eia.gov/energyexplained/natural-gas/liquefied-natural-gas.php>

¹²² <https://www.exponent.com/knowledge/alerts/2015/08/bulktransportation/~media/03b73782ec76446798c70f6ac403ef84.ashx>

¹²³ <https://fortune.com/2019/04/11/trump-natural-gas-ship-rail/>

¹²⁴ <https://www.desmogblog.com/2019/04/17/trump-executive-order-lng-rail-bomb-train-risks>

12. Derailments involving DOT-113 tank cars can result in large quantities of hazardous materials released, which can result from venting or breach of the inner tank shell.¹²⁵

13. A “roll-over” in an LNG tank can occur if the liquid at the bottom becomes lighter than that at the top, and rapidly rises to the surface. The liquid that moves to the top of the container experiences a drop in pressure equal, to a first approximation, to the head of liquid. It may therefore be above its boiling point at that pressure. In such an event, the vapor pressure within the tank may be as high as the liquid pressure at the bottom of the tank, whence the liquid came, and so the resulting pressure spike might overwhelm the pressure relief systems in place and if pipe work is not designed, constructed and maintained to cope with these, then they might fail.¹²⁶

14. There were 73 incidents involving cryogenic ethylene DOT-113 tank cars between 1977 and 2015 reported by PHMSA. Of these 73 incidents, only 5 were listed as “HMS Serious Incident.” Of the 5, 3 included one incident in Moran, KS in which three DOT-113 tank cars containing liquid ethylene derailed and burned. The incident in Brunswick, MD was due to a broken line in the piping cabinet. Another incident resulted from loss of vacuum in the annular space, due to a failure in the outer tank. After reviewing the description of each incident, several are related to venting from residue cars. In these cases, a 15 psi (20 percent) increase in the start-to-discharge pressure of the main safety relief valve could have a significant benefit by reducing the number of times cars vent and the amount they vent. There are no reports of inner vessel punctures. In some cases, railcars may be delayed in transit or on a siding or at a plant location. In these situations, there is a chance of venting or the need to flare gas to maintain vapor pressures within acceptable limits.¹²⁷

15. On May 23, 2011, three DOT-113 tank cars containing liquid ethylene derailed and caught fire near Moran, KS. No injuries were reported.¹²⁸

¹²⁵ <https://www.federalregister.gov/documents/2019/10/24/2019-22949/hazardous-materials-liquefied-natural-gas-by-rail>

¹²⁶ https://publications.jrc.ec.europa.eu/repository/bitstream/JRC106029/jrc106029_online.pdf

¹²⁷ <https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/research-and-development/hazmat/reports/71651/fr2-phmsa-hmtrns16-oncall-20mar2019-v3.pdf>

¹²⁸ <https://kansaspublishradio.org/kpr-news/train-derailment-sparks-grass-fire-allen-county>



Re: Re: Docket Number PHMSA–2018–0025 (HM–264)

Delaware Riverkeeper Network (DRN) submits this comment, in addition to other comments submitted by our organization to the above referenced PHMSA docket, in opposition to the proposed rulemaking by the Pipeline and Hazardous Materials Safety Administration (PHMSA), with the Federal Railroad Administration (FRA), to change the Hazardous Materials Regulations to allow for the bulk transport of Methane, refrigerated liquid, commonly known as liquefied natural gas (LNG), in rail tank cars. The proposal would authorize the transportation of LNG by rail in the DOT-113C120W specification rail tank car. DRN opposes the proposed Hazardous Material Regulation changes and calls for the denial of the proposed rulemaking and the Proposed Alternative.

**COMMENTS ON THE WEAK INDUSTRY/AGENCY CASE
FOR A MARKET NEED FOR APPROVING NATIONWIDE
US TRANSPORT OF LNG IN RAIL TANK CARS/UNIT TRAINS**

- I. The Railroads’ Petition and information from other industry proponents for a new federal de-regulation of LNG on nationwide rail in tank cars offer nearly no evidence of any market need for such a regulation, nor do federal agency documents or the historical record of only minimal federal safety research on the “unique safety risks” of LNG on Rail.

The Pipeline and Hazardous Materials Safety Administration [PHMSA] and the Federal Railroad Administration [FRA] have jointly produced a sweeping Notice of Proposed Rulemaking [NPRM] proposing to allow liquefied natural gas [LNG] to be transported nationwide in railroad tank cars. The NPRM has findings on market need and on public safety, officially published in the Federal Register: <https://www.federalregister.gov/documents/2019/10/24/2019-22949/hazardous-materials-liquefied-natural-gas-by-rail>

There is only one new short 24-pp technical document on the PHMSA docket at www.regulations.gov [PHMSA-2018-0025], namely, the Preliminary Regulatory Impact Analysis [PRIA] .

FRA and PHMSA are collaborating agencies on what they term this whole “deregulatory” NPRM effort, “needed to eliminate an unnecessary regulatory burden” – the longtime ban on LNG tank car rail transportation [PRIA, p. 5] . The agencies also state they consulted with the Federal

Highway Transportation Administration, but do not mention consulting with the other main LNG safety regulatory agencies, the Federal Energy Regulatory Commission and the US Coast Guard, which deal with LNG facilities and LNG port activities, respectively.

The NPRM was set in motion in response, as PHMSA's PRIA outlines [pp. 4-5] to the American Association of Railroads [AAR] 2017 Petition [Docket No. PHMSA-2017-0020] and to "a comment received" in the Trump Administration's Regulatory Review [Docket No. DOT-OST-2017-0069-0001], later seen to be from "Interested Parties", an ad hoc group of hazmat producers, shippers and carriers with no website, no office, no staff, and no return address or contact information on the letterhead. **[See ATTACHMENT ONE]**

The AAR was said to have noted that LNG was already allowed by truck in the US and "expressed the opinion" that rail transportation is safer than truck in comparison.

The 5-pp. AAR Petition number P-1697 is extraordinarily slim with its unsubstantiated suggestions of a real world market need for LNG in rail tank cars:

This petition is filed by the Association of American Railroads ("AAR"), on behalf of itself and its member railroads, pursuant to 49 C.F.R. § 106.100.1. AAR petitions for rulemaking to authorize the transportation of methane, refrigerated liquid ("LNG"), by rail in DOT-113C120W and DOT-113C140W tank cars.² LNG should be authorized for rail transportation because it is a safe method of transporting this commodity [and] LNG shippers have indicated a desire to use rail to transport it... [p. 1]

... The current and expected future demand for transportation of LNG by rail warrant prompt authorization by the Pipeline and Hazardous Materials Safety ("PHMSA").³

There Is A Commercial Interest In Transporting LNG by Rail.

Currently, the only way to transport LNG is by obtaining special approval from PHMSA for rail transport, or by transporting it via highway.⁴

Notwithstanding the requirement for a special approval, customers have expressed interest in shipping LNG by rail from Pennsylvania to New England, and between the U.S. and Mexico. Authorizing transportation of LNG by rail likely would stimulate more interest. In addition, several railroads are actively exploring LNG as a locomotive fuel. If railroads are to use LNG-powered locomotives, they would need to supply LNG along their networks. Transporting LNG in tank cars would be an optimal, if not essential, way to transport LNG to those locations.

AAR mentions [note 3] that "Notably, Transport Canada authorizes the transportation of LNG in DOT-113 cars. There is no reason for DOT and Transport Canada to have different regulations with respect to rail transport of LNG." But AAR fails to mention that the Canadian approval was followed by not a single rail tank car shipment up to the present, a stunning hint that the current hasty push for regulatory approval of LNG on rail is similarly based on only dubious hopes for a future market need in North America.

See the similar vague and baldly unsupported market assertions also in the AAR letter from 2017 on the respective dockets.

10 13 17 Letter re ETS Special Permit 20534: “Recent advances in natural gas production and storage have made rail transportation of LNG increasingly attractive, and PHMSA’s grant of authorization will remove an outdated regulatory barrier to this commercial opportunity”.

[The more recent 7 8 19 AAR letter has no mention of any market demand, and is only about safety issues.]

From the AAR’s official 10 27 16 slide presentation “Getting LNG onto US Rail Lines” [pp. 6 ff]

The Need

- *There is a huge increase in the production of methane in the US as a result of fracking*
- *The price of natural gas is low*
- *Shippers are starting to pursue transportation of LNG by rail*
- *Car builders are receiving requests for quotes to build new cars to transport LNG*
- *There is a shortage of pipeline capacity in certain areas of the country*
- *As a result, the need to transport*

October 27, 2016 © ASSOCIATION OF AMERICAN RAILROADS p. 6

LNG as a Possible Fuel Source

- *Railroads are exploring the use of LNG as a locomotive fuel*
- *Until infrastructure can be built, there will be a need to get LNG to railroad fueling points*
- *Tank car transportation is a good alternative to the movement of that LNG [p. 8]*

When DOT-113 tank cars were developed for the transportation of cryogenic liquids, there was no contemplated demand for the transportation of LNG, and as a result, it was not included in the list of authorized commodities.

The only context in which any real interest can be found in rushing approval for LNG by Rail in tank cars is the overall Trump Administration deregulatory campaign that produced this deregulation push by the rail industry along with other risk-imposing industries seeking deregulation in their own contexts. See the “Interested Parties” appeal to PHMSA of 11 15 17 with a list of desired prompt agency de-regulations on hazardous materials safety issues, of which LNG is a minor part, on their page 5. **[ATTACHMENT TWO]**

Neither before nor currently outside this deregulatory effort [with former top railroad executives now at the head of both PHMSA and FRA] can any other significant evidence of keen and sustained interest, much less “market demand”, be found. This contrasts, for example, with:

- not only the documented evidence preceding and sustaining the surging industry momentum, federal approvals, local tax breaks, and construction of the major new US LNG export facilities

- but also with the Congressional bills introduced in recent years to allow and expedite US LNG export to all interested buyers in foreign nations.

By contrast, for the promotion of US LNG by Rail in tank cars [“LNG Rail”], there are, to our knowledge:

- No bills introduced in Congress
- No extensive long-distance railroad trials [only a few limited trials since 2013 with LNG-fueled locomotives in various nations, which new and cheaper power technology does not entail LNG Rail. [See, e.g., the FERC experiment with 24 locomotives transporting LNG by smaller ISO intermodal containers, and not a whisper of need for LNG Rail in tank cars.]
- No visible demand for LNG Rail during the US LNG import era, roughly 2000-2012 when up to 50 new North American LNG import facilities were planned and in the approvals process at FERC. The Everett MA facility, e.g., served by LNG trucks the communities within 150 miles underserved by natural gas pipelines. An entrepreneur who wished in 2010 to load LNG trucks at the Elba Island GA LNG import facility and to truck up to 58 truckloads per day through Savannah residential streets to the Southeast US met fierce resistance and eventually lost interest as the import era faded.
- Now in the US LNG export era, no railroad loading or unloading facilities at the new major LNG export facilities, all of whom receive natural gas by pipeline and export LNG by ship.
- No evidence of demand for, or historical shipments of, LNG Rail in any of the foreign nations surveyed by PHMSA in this rulemaking process, even in Canada and Japan where LNG Rail is approved.
- No significant federal or expert R&D efforts specifically on the market viability or release disaster safety risks of LNG Rail.
- The US federal agencies certainly have felt no significant market demand for LNG in rail tank cars that would drive them to conduct the necessary market and safety research for promulgating a new regulation. The LNG Rail research desert on the safety side features:
 - No field tests of survivability of an LNG-loaded tank car [using the AAR and NPRM-proposed DOT-113 design tank car not yet approved for LNG service]
 - Nor of even generic tests of the DOT-113 tank car loaded with ethylene or other cryogenic flammable cargo.
 - Nor simulation of tank car hulls using metal plates by expert firms or government agencies on the survivability of LNG-filled tank cars [only one wind-blown botched open-air field fire test by FRA in 2017 – by analogy using a single ISO container filled with nitrogen on a rail flat car.] FRA could not get the budget for 2018 to re-do testing with a better design.
 - No computer modeling of survivability events.
 - Not even any publicly available key safety data from the analogous rail LNG shipment demonstration projects in FL and AL beginning in 2015/2016.

- No publicly available modeling estimates by PHMSA or private consultants on the downwind distances an LNG Rail release can travel into trackside communities [needed for candid emergency event training materials for rail workers and local emergency responders]

In recent years PHMSA national audience slide presentations have candidly outlined many LNG safety “research gaps” [including as one part the consequences and probabilities of the future risks in LNG Rail transportation] that PHMSA implicitly feels should be filled before a respectable rulemaking could be undertaken. [cf. our later discussion e.g., of the 2019 Willauer Report, etc.]

The agency in its NPRM documents including PRIA does not reiterate the 2016 statement by FRA top safety official Dr. Karl Alexy in his [2015?] approval letter for Florida East Coast Railroad regional pilot for LNG by rail using intermodal containers. Alexy’s letter underscored that LNG on US rail lines poses “unique safety risks” and that thus FRA would impose special safety conditions on FECR’s time-limited pilot project – [later extended to 2020]. The much larger LNG tank cars in similar transportation environs would no doubt pose even more serious multi-car derailment risks.

II. Instead of a reaction to real market demand, the push for LNG by rail tank cars is clearly part of the current overall federal rail safety deregulatory effort for various aspects of rail safety regulation:

1. Early in the Trump Presidency, PHMSA responded to industry and Administration pressures by providing a formal “Regulatory Review” process in which “public” commenters [likely most often industry groupings] could seek de-regulatory actions from federal transportation safety agencies pursuant to Trump Admin E.O 13771 dated 10 2 17.

This Regulatory Review overhaul selects and aims to cripple several major rail safety initiatives underway in recent years, especially from the Obama Administration years. Aims included reversing the longstanding federal ban on LNG by Rail using the standard size 30,000-gallon tank cars [it seems no Special Permit was ever before either requested or granted]. [Previously some smaller LNG rail transport was allowed by special permits, e.g., granted to Union Pacific and other railroads for their episodic experiments with using some smaller LNG storage tanks [“tenders”] hauled behind a very few new design LNG-fueled locomotives, testing the feasibility of this new mode of powering locomotives.]

The NPRM cites a document from rail industry firms, the “Interested Parties” 11 15 17 memo that attaches a long list of industry-desired deregulatory priorities involving hazardous materials transportation [hazmat] safety regulations. The industry groupings also ask for new additional regulatory language underscoring federal preemption over state and local officials in hazmat matters. [ATTACHMENT TWO]

2. Next PHMSA proposed, over thousands of objections filed on the docket, to issue a Special Permit to an individual shipper, and produced a slim 23-pp. Environmental Assessment [EA] that accompanied the Special Permit 20534 proposal -- see that docket at www.Regulations.gov PHMSA 2019-0100. PHMSA did in fact in December 2019 promptly issue Special Permit 20534 for ETS logistics company, connected with New Fortress Energy, to make shipments of LNG by railroad tank car DOT-113s, but only on a

specific short route from Wyalusing PA to Gibbstown NJ. Issued for a renewable period of ten years, the permit had no costly or onerous new safety conditions, only some monitoring and reporting requirements regarding ETS plans to move from single car shipments to unit trains. And the permit took pains to underscore that no methane life cycle climate change implications had been considered:

b. The safety analyses performed in the development of this special permit only considered the hazards and risks associated with the transportation in commerce.

3. Finally, the current PHMSA/FRA NPRM, which features some of the same basic arguable assertions as the earlier [and ongoing] Special Permit 20534 proposal, but the NPRM would promulgate a much more important and sweeping and permanent opening for all shippers of the whole US rail system to ship LNG in tank cars.

The PHMSA NPRM documents [dubiously] assert a Finding of No Significant Impact [FONSI] that means PHMSA says it does not have to do an EA or EIS.

The NPRM is accompanied on the docket by a supporting document, a 24-pp. Preliminary Regulatory Impact Analysis [PRIA] dated October 2019.

- III. The overall challenge for PHMSA, of course, is rationally to justify the NPRM not only on safety grounds, but also on the market need for the regulation, and the regulatory documents try to argue that, but with little success.

In the current PHMSA docket's NPRM and PRIA assertions:

- The evidence presented in the PRIA include several features not present in the earlier EA for Special Permit 20534, most of which new evidence actually undermines the arguments PHMSA is trying to make in justifying the present NPRM effort.
- There are various current developments in LNG infrastructure growth, public safety and politics which PHMSA documents are remiss in ignoring or misinterpreting.

For example, numerous media reports indicate clearly that the Trump Administration is pressing nations in Europe and Asia to buy US LNG exported by ship, as a way of countering Russian geopolitical influence based on Russia's ability to provide relatively cheap Russian natural gas by pipelines which are significantly expanding apace. Even such developments are not sufficient to predict confidently that LNG by Rail in tank cars and unit trains will be needed to facilitate such exports, since the new major US LNG export facilities can all export to the significant new overseas markets by ship. **[ATTACHMENT THREE]**

- A. Regarding evidence for any [real world energy market] need for the proposed regulation, PHMSA in the NPRM documents can manage only to speculate weakly on a possible future market demand for LNG by Rail. While reaching widely for evidence, PHMSA provides hardly any ringing endorsement of its own case, saying "there may

be a demand" [p. 5] and that some industry sectors have shown "interest" in LNG by Rail [p. 6] . Unsurprisingly, in the de-regulation environment, PHMSA is determined nevertheless that it should make the LNG Rail opportunity available if and when some real-world energy industry market demand actually materializes.

The NPRM's PRIA Executive Summary suggests how speculative and biased this whole rulemaking is:

"This proposed rulemaking does not impose new compliance costs [on the regulated industry], since it would merely enable the transportation of LNG by an alternative mode. The potential benefits include transportation efficiency; market impacts; emissions reductions; and safety impacts. This proposed rule is expected to expand production opportunities to the industry by allowing LNG transportation by rail. PHMSA evaluated the benefits categories and expected cost savings qualitatively rather than quantitatively because this is an enabling rule and there is limited information about the potential market for the transportation of LNG by rail." [PRIA, p. 3]

There is no discussion of imposing additional costs on local and state emergency response agencies.

- B. Recent industry comprehensive future market prediction surveys of LNG developments mention not even a hint of any need for or industry demand for LNG bulk transport by rail:

[Market Report Gazette](#)

Technology News, Latest Technology News, Trending Market News

<http://www.marketreportgazette.com/2019/11/massive-growth-of-oil-and-gas-logistics-market-2019-and-share-size-estimation-demand-overview-leading-key-company-analysis-and-industry-outlook-2026-with-gulf-agency-company-ltd-agility-p-2/> November 11, 2019 Robin

- C. PHMSA's own most recent [2019] consultant report "Risk Assessment of Surface Transport of Liquid Natural Gas", by David Willauer, [which we will discuss more fully below] assesses modestly that:

- "North American railroads" are for now only experimenting with "pilot" LNG-fueled locomotives, "running [them] across the country to assess their durability in diverse climates", while also testing Compressed Natural Gas-fueled locomotives. [p. 23]
- Even in a "fast developing" small scale US LNG market, LNG by Rail Transport is only "on the horizon."
<https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/research-and-development/hazmat/reports/71651/fr2-phmsa-hmtrns16-oncall-20mar2019-v3.pdf>

[For a fuller discussion of the weak market need case in the Willauer Report, see ATTACHMENT SIX.]

D. PHMSA correctly notes the large growth in LNG facilities between 2012 and 2018 [PRIA pp. 6-7] and industry momentum in adding new large facilities, a “thriving” export market and export by foreign-flagged maritime carrier vessels [the US has none]. But the PHMSA-cited industry “interest” argument does not offer a single concrete or plausible business plan for use of bulk LNG by Rail for any current or near-future market demand in the US or in Mexico [except perhaps to transport LNG to the railroads’ own far-flung potential future LNG locomotive re-fueling stations – even this is an uncertain prospect] . PHMSA relies abstractly on US LNG growth “trends” [p. 8] and on the “interest” expressed by some for LNG fueled rail locomotives and for exporting LNG to Mexico [p. 10] PRIA notes the lack of data on highway shipments of LNG or other hazmat cargoes [p. 7] and studiously ignores throughout the question of why US truck LNG shipments cannot continue to suffice for foreseeable domestic needs.

E. An egregious NPRM omission is any evidence that there are any real-world North American market demands that could not be served adequately by the current or somewhat higher numbers of LNG truck shipments that have long served small markets not near natural gas pipelines, often remote mining and greenhouse operations in the US and Mexico. PHMSA has offered no showing that rail LNG is needed for such locations, nor that it could reach those locations economically.

LNG truck shipments have been adequate for such small scale markets, using LNG tank truck or ISO containers that are much smaller than a rail tank car. PHMSA's PRIA admits that LNG supply is needed to supply natural gas to such remote locations, but does not provide evidence that LNG by Rail on current rail lines could reach a significant number of such locations, nor even a single concrete industry or agency planning document aimed at assessing this potential.

PHMSA NPRM without evidence simply repeats the unsubstantiated assertions from some industry groups [such as the original AAR petitioners for this rulemaking and a group calling themselves “Interested Parties”] that the lack of prior US authorization for LNG by Rail tank cars was due to “lack of demand” in the US, and PHMSA fails to show any significant change in that lack of demand situation.

F. As far as the NPRM’s assertions that the US LNG growth will be impacted by “international market trends” [p. 8] e.g., being stimulated by rising LNG demand from Europe and/or Asia, this is a big gamble given the demonstrated ability for these nations to import LNG from many suppliers besides the US. Leaders in Germany and the Netherlands, for example, just approved a new big Russian gas pipeline Nord 2 expansion, displeasing the Trump Administration.

Trade analysts and media reports say European leaders state that imports of US LNG ship-borne gas will have to compete on price with other suppliers. So the future of US [expensive ship-borne] export of LNG may depend on the success of US non-economic muscling in on current suppliers’ market share [especially Russia’s] for [relatively cheap] natural gas by pipeline to Europe and Asia.

G. The weakness of the NPRM market need argument is underscored by the thin evidence overhyped by pro-LNG Rail Railway Age magazine’s recent Nov 2019 regulatory hurry-up demand article by Contributing Editor Jim Blaze:

- a single LNG rail contract arrangement in Europe [an area well served by rail lines overall] and
- the tiny and unique regional LNG Rail experiment in Florida – not even using LNG rail tank cars in a clever corporate vertical integration scheme to avoid any market competition [discussed further later in this statement].

[ATTACHMENT FOUR – RAILWAY AGE ARTICLE EXCERPTS]

H. Tellingly, PHMSA’s PRIA [p. 8] cites the extremely weak examples of Canada, Europe and Japan [since 2000] regarding already existing approvals in national regulations allowing bulk LNG by rail tank cars, but PRIA admits it cannot cite a single rail tank car shipment in any of these nations.

Neither the Railway Age articles nor PHMSA/s NPRM mention any positive results from Russia’s early experimentation with LNG-fueled locomotives, beginning with field trials of the world’s first such locomotive in 2013. Even given Russian agencies’ penchant for secrecy, if the trials had led to widespread adoption on the massive Russian railway system, some publicity or information leaks may have resulted. The Railway Technology February 23 2015 article on this does not even hint that LNG would be transported in bulk on Russian railways, only that LNG locomotive fuel would be cheaper than diesel. [See Attachment]

And the FRA documentation of the Japanese experience are being withheld, and recent US trade press reports describe a recent 2018 European 2-nation trip of LNG ISOs as a “pilot journey”. It was in fact a very basic level LNG promotional demonstration, co-funded by the European Commission, by 42 partners from European logistics industry and port officials of the intermodal flexibility of ISO containers to move between nations using three modes of travel: train, truck and ship. The shortest leg of the trip was by rail.

<https://www.railfreight.com/intermodal/2018/12/13/lng-transport-by-road-rail-and-sea-in-pilot-journey/>

I. PHMSA cites the enormous “growth” of the US LNG industry’s facility infrastructure, with many now being planned, federally approved for siting and for export to almost all nations, and constructed with maritime docks for liquefied export of the (over-optimistic public relations-driven) “prodigious” volumes of North American fracked natural gas. PHMSA neglects to mention, however, that the vast majority of the future transportation movements of gas in the US will by necessity continue to be in the ever-expanding number of natural gas pipelines to coastal LNG liquefaction export facilities that are being rushed to completion -- so they can then transport their product by [increasingly huge] maritime vessels to the major LNG markets emerging in Europe and Asia [only some of which would be served by US LNG].

Also not mentioned is that this would require a marked increase in new fracked gas wells in already-overburdened communities in shale plays. Not only is the reliability of a steady shale gas supply stream economically weak, it is also questionable if the public and decisionmakers will continue to tolerate the enormous and virtually permanent environmental and public health costs and losses that accompany fracking. See Delaware

Riverkeeper Network's NPRM comment submitted to PHMSA December 20, 2019. Additionally, it ignores that some analysts consider future shale gas supply to be severely limited due to overly effusive estimates of how much gas is actually recoverable. (See Professor Anthony Ingraffea discuss the limited nature of shale gas and the overblown predictions of reserves <https://www.youtube.com/watch?v=ZQdLA-6Y8LA>).

PHMSA cites no reports of any of the new export facilities building rail unloading terminal infrastructure in anticipation of future reliance on bulk LNG Rail instead of pipelines or even as a supplemental supply.

J. The well-known underlying LNG market volatility may in any case dash the hopes of ever-expanding LNG industry growth. The petrochemical trade press reports that with recurring market uncertainties [including predictions of milder winters ahead], many LNG projects are being delayed and some well-heeled companies are backing out of investment commitments.

K. PHMSA's PRIA neglects to cite whatever economic [and safety] lessons the agencies learned from the experimental LNG by Rail pilot projects that FRA approved beginning in 2016 in Alaska and Florida regional railroads. Both projects used not rail tank cars [since no approved tank cars exist] but intermodal ISO T-75 standard containers [one-third the quantity of rail tank cars] tied down [experimentally] on rail flat cars.

The Alaska project reportedly "ran only a couple of LNG trains" of undetermined length, and then reportedly abruptly "stopped for lack of a market" [personal communication with Alaska Railroad Corporation official]. The Florida project is ongoing, as it is designed to supply and is supplying a small energy market demand in the Caribbean islands by loading individual ISO containers on to normal freight vessels. [Although the New Fortress Energy shippers may aspire to enlarge their reach domestically from their current very small scale LNG liquefaction facility [quietly sited on a tiny 13-acre site in the middle of Miami] to markets in Europe and perhaps elsewhere.]

In both the Florida and Alaska small regional railroad LNG Rail pilot project cases, the DOT agencies have withheld from public scrutiny both:

- the agency-possessed project data on economic lessons learned from the project operations and
- the public safety and rail crew risk documents regarding the key factors on which one could assess the safety lessons of the LNG rail shipments, sometimes by agency citing of "commercial or business privacy" exemptions to FOIA requests.

L. Finally, any PHMSA bullish predictions of a growing market need for LNG by rail tank car must be assessed cautiously by industry investors and government regulators alike. Even the use of LNG to fuel rail locomotives [a relatively minor market matter at best] is dubious, given the simultaneous rail industry and governments' interest in exploring more eco-friendly alternative means for that purpose, including the use of hydrogen as fuel and battery/electric power. See numerous Railway Technology journal articles in their archives at <https://www.railway-technology.com/?s=LNG>

Also, see DRN 12.20.12019 NPRM PHMSA comment on climate change impacts of the continued development of shale gas and the urgent need to reduce greenhouse gas-emitting energy sources, including methane, the worst of all fossil fuels in terms of global warming potential over the all-important, highly consequential 20-year period.

A much fuller overall story on the European picture regarding the use of LNG-fueled locomotives emerges in the illuminating January 26 2017 Railway Technology article [uncited by NPRM or Railway Age] which cites numerous technical developments which undercut the PHMSA and Railway Age arguments for LNG as the most likely railroad fuel even for the near-term future. e.g., <https://www.railway-technology.com/features/featurepowering-the-trains-of-tomorrow-5723499/>

M. A homegrown US cautionary analogous tale also may be seen in the recent 2018 decision of the extensive and well-used Washington State Ferries System to abandon their early enthusiasm and extensive planning to switch their passenger ferries from diesel to LNG fuel, which would have entailed weekly LNG re-fueling of each vessel from some infrastructure yet to be developed. Safety and climate change factors played a big part of the state agency decision instead to pursue less dangerous and non-fossil fuel opportunities for future vessel fuel conversions away from diesel fueling. The first three vessel conversions will be to hybrid-electric power:

Study backs plan to shift Washington ferries to hybrid-electric power By [Workboat Staff](#) on SEPTEMBER 4, 2018 <https://www.workboat.com/news/passenger-vessels/study-backs-shift-wsf-ferries-hydro-electric-power/>

<http://www.tacomadailyindex.com/blog/washingtons-ferries-are-going-electric/2444534/>

Given the existential need for rapid progress on limiting disastrous climate change, prudent investors will challenge assertions like those in the NPRM that predict the likely future use of massive quantities of fossil fuel LNG for other bulk energy purposes such as in power plants. Just as worldwide railroads are experimenting with alternatives to LNG, so are those responsible for developing more climate-friendly sources of energy in other, more significant market sectors.

[See ATTACHMENT FIVE Railway Technology article]

DRN appreciates the opportunity to comment on the PHMSA docket PHMSA-2018-0025 for the Notice of Proposed Rulemaking **regarding the market need for the regulation.**

Finally, DRN opposes the proposed rulemaking and the Proposed Alternative. If this proposal moves any further towards approval, DRN states that current regulations require a comprehensive Environmental Impact Statement under the National Environmental Policy Act must be completed.

In closing, DRN also urges that the NPRM should not rely, in any way, on the flawed PHMSA approval of Special Permit SP 20534. DRN considers the approved Special Permit SP 20534 to Energy Transport Solutions, a subsidiary of New Fortress Energy, a mistake that must be corrected. Reliance on any materials used by PHMSA to support the Special Permit SP 20534 approval is likewise flawed. DRN urges in the strongest terms possible that SP 20534 be rescinded, based on the threat to public safety and health of the communities being exposed to life-threatening risk from the LNG transport in DOT 113 rail cars from its inception in Wyalusing,

PA, to its destination in Gibbstown NJ and the millions who will be exposed along the railroad corridor. We consider the approved use of rail cars to transport LNG on rail lines uses Pennsylvania and New Jersey communities as “guinea pigs” because of the untested circumstances. This is unjust and completely unacceptable. As outlined in DRN’s comments submitted to PHMSA on 8.7.2019, DRN considers the approval of SP 20534 to only serve special interests without basis, at the expense of jeopardizing public health, the environment and the nation’s economy.

This comment is submitted by Delaware Riverkeeper Network in addition to DRN comments submitted to this NPRM PHMSA Docket on December 20, 2019 and in comments submitted by Earthjustice in which DRN is represented.

Respectfully submitted,

Handwritten signatures in blue ink. The signature on the left is 'Maya van Rossum' and the signature on the right is 'Tracy Carluccio'.

Maya van Rossum
the Delaware Riverkeeper

Tracy Carluccio
Deputy Director

Imbedded Attachments: Att. 1, 2, 3, 4, 5, 6.

ATTACHMENT ONE: "INTERESTED PARTIES" members 10 12 07 2 of 5p

INTERESTED PARTIES FOR HAZARDOUS MATERIALS TRANSPORTATION

October 12, 2007

Susan E. Dudley
Administrator
Office of Information and Regulatory Affairs
Office of Management and Budget
725 - 17th Street, NW
Washington, DC 20503

VIA Facsimile: 202-395-3888

DEPT. OF TRANSPORTATION
EMERGENCY
2007 OCT 23 A 9:55

RE: Request to Modify the Hazardous Materials Public Sector Training and Planning Grants Application
(OMB Control Number 2137-0586)

Dear Administrator Dudley:

On behalf of the Interested Parties for Hazardous Materials Transportation, the undersigned organizations write in regard to the matter noted above. We have written previously regarding the Pipeline and Hazardous Materials Administration's (PHMSA) submission for a three-year renewal and extension of its Information Collection Request to authorize Hazardous Materials Public Sector Training and Planning Grants (PTGP); we urged the Administrator to provide only a one-year extension. We have also written PHMSA to express our support for the agency's pursuit of additional information from Hazardous Materials Emergency Preparedness (HMEP) grant recipients.¹

As representatives of companies that actually provide the program's funding that has resulted in \$152 million in grants since its inception in 1992,² we are not arguing to discontinue it or to deny funding for any entities that can properly demonstrate eligibility for grants. Instead, we seek to improve upon the program and to help PHMSA meet its frequently stated goals of collecting reliable data that enables the agency to address risks. Toward that end, we have urged PHMSA to focus on distributing grant funds to States and Indian tribes that are capable of demonstrating needs, as Congress required.

Our purpose for writing is to support the July PHMSA proposal to revise its information collection requirements under the HMEP grant program² by responding to commenters' objections. We note that the comments opposing PHMSA's proposal were submitted by individuals representing or serving on State or local emergency planning organizations currently receiving HMEP grants under the PTPG program. Despite the number of comments filed by opponents to the Interested Parties' petition, the filings are clearly form letters or variations thereof. While they may lend to the docket the appearance of a sizable objection, most are actually coordinated variations on the same point.

We address commenters' key points, below.

¹ 72 Federal Register 36754 (July 5, 2007)

² EPGP data, PHMSA, 2006.

³ 72 Federal Register at 36754.

and met. State disclosure of the information PHMSA has requested together with an objective assessment of existing State programs and permits is the only means by which to do so.

We continue to believe safe transportation of hazardous cargoes is of paramount importance, and we support emergency responders' planning and training efforts aimed at preventing injury or loss of life arising out of hazardous materials transportation incidents. Where non-federal fees are applied and enforced in accordance with the HMTA, we do not object to their existence. However, because a State's or Indian tribe's hazardous materials transportation fee must be allocated to planning and training for purposes related to hazardous materials transportation, we support PHMSA's proposal to ensure that HMEP grant funds only go to States or tribes that demonstrate real need.

We believe that PHMSA's proposal will aid the agency's risk-based approach while ensuring that legislative intent is achieved.

Respectfully,

Agricultural Retailers Association
 American Chemistry Council
 American Pyrotechnics Association
 American Trucking Associations, Inc.
 Association of Hazmat Shippers
 The Chlorine Institute, Inc.
 Compressed Gas Association
 Council on Radionuclides and Radiopharmaceuticals,
 Inc.
 Council on Safe Transportation of Hazardous Articles
 Dangerous Goods Advisory Council
 The Fertilizer Institute
 Gamma Industry Processing Alliance
 Industrial Packaging Alliance of North America
 Institute of Makers of Explosives

International Vessel Operators Hazardous Materials
 Association, Inc.
 International Warehouse Logistics Association
 National Association of Chemical Distributors
 National Association of Shell Distributors
 National Paint & Coatings Association
 National Private Truck Council
 National Propane Gas Association
 National Tank Truck Carriers, Inc.
 Nuclear Energy Institute
 Petroleum Marketers Association of America
 Petroleum Transportation and Storage Association
 Radiopharmaceutical Shippers & Carriers Conference
 Reusable Industrial Packaging Association
 Steel Shipping Container Institute
 Truckload Carriers Association

cc: Ted Willke, Associate Administrator for Hazardous Materials Safety, DOT

ATTACHMENT TWO: INTERESTED PARTIES WISH LIST FOR DE-REGS, BRIEF MENTION OF LNG, NOT LISTED AS FINANCIALLY SIGNIFICANT

INTER. PARTIES - 2017- DEREG RAIL ASKS -

INTERESTED PARTIES FOR HAZARDOUS MATERIALS TRANSPORTATION

~~November 15, 2017~~

(No Website)

Docket Management Facility
U.S. Department of Transportation
1200 New Jersey Ave., SE
Washington, DC 20590

- 9
6

Re: Docket Number DOT-OST-2017-0069¹

On behalf of the Interested Parties for Hazardous Materials Transportation (Interested Parties)², I am submitting comments on the above referenced docket issued by the Office of the Secretary of Transportation (OST) to review and evaluate existing regulations and agency actions to determine their continued necessity, and whether they are crafted effectively to solve current problems. Further, OST asks specifically whether any of these rules or agency actions are "good candidates for repeal, replacement, suspension, or modification."

Interest of the Interested Parties

Hazardous materials are ubiquitous in our society and essential to maintain the quality of life we enjoy. The value of hazardous materials in commerce is estimated to be greater than two trillion dollars annually, and the transportation of these materials supports over 1.5 million jobs. At the same time, the quantity of hazmat transported in the United States is increasing. According to the most recent Economic Census of the United States, hazmat transportation increased nearly 16 percent from 2.2 to 2.6 billion tons between 2007 and 2012.

As representatives of businesses that produce, store, transport and distribute hazardous materials, we are committed to ensuring the safety and security of the products we transport, and we strongly support a robust and efficient hazardous materials transportation regulatory program within the Department of Transportation (DOT) focused on these goals. At the same time, we agree that policies and regulations can become dated or otherwise unnecessary burdens on commerce, and we support the OST initiative to identify such regulations with a goal to minimize regulatory burdens without impairing safety.

In this context, we believe certain regulations could be improved, and agency actions could be taken to better support industry efforts to ensure that hazardous materials are efficiently transported in a safe and secure manner.

¹ 82 FR 45750 (October 2, 2017).

² The Interested Parties is a volunteer-run coalition of organizations that share an interest in legislative and regulatory issues related to the safe and secure domestic and international transportation of hazardous materials. Interested Parties members include associations representing hazardous materials shippers, carriers, packaging manufacturers and other related groups. The following Interested Parties participants have approved these comments: Agricultural Retailers Association; American Chemistry Council; American Fuel & Petrochemical Manufacturers; American Trucking Associations; American Pyrotechnics Association; Association of HazMat Shippers; The Compressed Gas Association; Council on the Safe Transportation of Hazardous Articles; Dangerous Goods Advisory Council; The Petroleum Institute; Gases and Welding Distributors Association; Institute of Makers of Explosives; International Liquid Terminals Association; International Vessel Operators Dangerous Goods Association; Medical Device Battery Transport Council; National Association of Chemical Transporters; National Private Truck Council; National Tank Truck Carriers; Plastics Industry Association; Petroleum Marketers Association of America; Radioactive Pharmaceutical Shippers & Carriers Conference; Railway Supply Institute, Inc.; Responsible Industrial Packaging Association; Sporting Arms Ammunition Manufacturers Institute; The Sulphur Institute; Utility Solid Waste Activities Group.

[Handwritten bracket on the left side of the footnote]

[Handwritten arrow pointing up on the right side of the footnote]

51 Monroe Street, Suite 812 ~ Rockville, MD ~ 20850 ~ 301-577-3780

10 23 17

Role of the Office of Hazardous Materials Safety (OHMS)

The Secretary of Transportation (Secretary) has delegated authority for regulating the commercial transportation of hazardous materials to the Pipeline and Hazardous Materials Safety Administration (PHMSA). PHMSA so closely controls hazmat transportation that these materials may only be transported if authorized by a regulation, special permit or approval.³ Within PHMSA, the responsibility to promulgate the Department's hazardous materials regulations (HMR), which include rules for obtaining special permits and approvals, rests with the OHMS.⁴ This level of regulatory control is necessary to facilitate domestic and international movements of hazardous materials.

Impact of E.O. 13771

According to the preamble to this docket, E.O. 13771 directs "an executive department or agency" to repeal "at least two existing regulations" whenever a new regulation is proposed or promulgated.⁵ (Emphasis added.) This statement is confusing because E.O. 13771 defines "a cabinet department" as "a single agency." Please clarify, for purposes of DOT, whether PHMSA would follow this E.O. if the "two existing regulations" to be repealed were Department regulations other than those promulgated by PHMSA.

Clarification of which "agency" rules may be repealed is important because, as noted above, the regulation of hazardous materials transportation is structured to be comprehensive to ensure that these materials move seamlessly from one jurisdiction to another. In 2003, for example, PHMSA's predecessor agency, the Research and Special Programs Administration (RSPA) finalized a rulemaking withdrawing agency jurisdiction over aspects of loading, unloading and storage incident to the transportation of hazardous materials. The action left open the door for the Environmental Protection Agency, the Occupational Safety and Health Administration, and non-federal entities to attempt to regulate in this space. DOT's process to update and repeal unnecessarily burdensome regulations must ensure that there are no gaps or omissions in PHMSA's hazmat regulatory framework, and ensure that its rules are promptly harmonized with international standards.

Exercise of Preemption Authority Essential

OST asks whether "existing regulation could be better handled fully by the states without Federal regulations." Regarding hazardous materials transportation, the short answer is "no." Federal law grants the Secretary express authority to preempt state or local regulations that conflict with, present an obstacle to, or, in some areas, are not substantively the same as, a federal rule. The purpose of this authority is to promote safety by ensuring that myriad state and/or local regulations do not impede commerce or enable the export of transportation risks to other jurisdictions.

The hazardous materials industry and the public rely upon uniform regulation, both domestic and international, to ensure the safe, secure and expedited transportation of hazardous materials. Uniform regulation has the added benefit of promoting effective hazmat employee training, which is crucial because the safe transportation of hazardous materials begins with well-trained employees. The Secretary has delegated this authority to PHMSA, and the agency has exercised it numerous times over the years to overturn various permit, inspection and local fee programs that delay hazardous materials movements and/or unnecessarily increase the cost of transportation. The Interested Parties strongly support PHMSA's exercise of

³ We are disappointed that the Department's summary of its responsibilities did not specifically mention this pervasive regulatory role.

⁴ The DOT Operating Administrations have limited authority to promulgate hazmat regulations specific to their modes.

⁵ 82 FR 45751 (October 2, 2017)

this authority. If anything, PHMSA should be encouraged to reach determinations of preemption more promptly following the receipt of petitions.

Rules Deserving to be Repealed, Replaced, Suspended, or Modified

OST invites recommendations of rules or agency actions that are "good candidates for repeal, replacement, suspension, or modification." The Interested Parties recommend the following actions in no order of priority:

- Suspension and Modification of Standards of Fitness – 49 CFR 107 Subpart B and H

As noted above, hazardous materials may only be transported if appropriately authorized. Regulatory flexibility is needed for such activities as authorizing one-time movements of hazardous materials and facilitating the emergence of new and innovative technologies or packagings. Special permits and approvals are the regulatory mechanisms that PHMSA uses for these purposes. PHMSA processes thousands of special permits and approvals requests annually.

Since 1996, PHMSA has had authority to determine the fitness of applicants for special permits and approvals.⁶ The agency sought this authority to enable it to deny or revoke special permits or approvals requested by or issued to those who had violated the HMR. In 2009, PHMSA rewrote the administrative procedures used to determine the fitness of applicants for special permits and approvals without public notice and comment.⁷ The new procedures instituted a three-tier, multi-signoff approach to process special permit and approval applications.

At the time, the Interested Parties were deeply concerned that the standards of fitness used by the agency to trigger the need for greater scrutiny of the applicant at higher tier levels was not publicly disclosed. Consequently, the regulated community faced uncertainty about what actions would result in a denial. Congress directed PHMSA to initiate a rulemaking on this subject, which was issued in 2015.⁸ However, the rule "[did] not change previously established policies." Regarding fitness standards at the final third-level of review, the agency retained subjective standards of performance based on whether an applicant has "implemented sufficient corrective actions for prior violations, or is at risk of being unable to comply with the terms of an application for or an existing special permit, approval, or the HMR."⁹

Moreover, this final assessment of "fitness" is delegated to field enforcement staff (or, in some cases, other DOT Operating Administrations), who, after an onsite visit, decide whether an applicant has met or not these subjective standards. In short, the criteria used by field enforcement staff are still subjective, and their decisions at this final level of review may, therefore, be based on minor compliance issues having nothing to do with the activity covered by the special permit or approval.

When PHMSA promulgated its final rule establishing fitness criteria, it committed "to investigate opportunities to improve its special permit and approval application review processes in the future, as these opportunities become available to the agency." We believe this rulemaking presents an opportunity to direct PHMSA to establish clear performance standards that will give companies certainty that they will be found "fit" to be granted requested special permits and approvals. Applicants should be deemed "fit" unless the agency has

⁶ HM-207C (May 9, 1996).

⁷ <https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/Special%20Permits%20Standard%20Operating%20Procedures%20Version%201.0.pdf> and https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/Approvals%20Program%20SOP_6.30.2011.pdf.

⁸ HM-233E (September 10, 2015).

⁹ Additionally, a finding of "unfit" for one application, could jeopardize other special permits or approvals held by the company.

evidence of HMR violations that are factually relevant to the application. Open-ended onsite investigations should be the exception, not the rule.

- Storage and Unloading of Tank Cars

By statute, “transports” or “transportation” of hazardous materials means “the movement of property and loading, unloading, or storage incidental to the movement.”¹⁰ Congress understood the need for such a comprehensive definition of DOT’s authority to ensure uniformity of regulation that is essential to safety. Yet, as noted above, DOT chose to restrict the scope of this statutory authority when, in 2003, it limited its regulatory authority over to the storage and unloading of bulk transportation equipment.¹¹ These functions would no longer be covered by DOT’s regulations unless they were performed by or in the presence of carrier personnel. Because motor carrier personnel are present in most instances of transportation-related cargo tank storage and unloading, the primary impact of this retraction of the scope of DOT regulations has been on the storage of tank cars incidental to transportation and the unloading of those cars by non-carrier personnel. See, for example, 49 CFR 171.1(c)(2) and (d)(2).

This change by DOT, adopted in the face of nearly unanimous industry opposition, has opened the storage and unloading of tank cars to varying restrictions and practices in each jurisdiction where these activities occur. Safety is impaired by variations that fall within the statutory jurisdiction of DOT, but not the scope of its regulatory authority. For these reasons, we believe the Department’s 2003 regulatory decision must be reopened for further comment and consideration.

- Routine Incorporation of Proven Special Permits into the HMR – 49 CFR 107.113(i)

As noted above, special permits authorize specific hazmat transportation activities when no clear regulatory authority exists. Special permits, however, were never intended to become a default means of regulation. The HMR provide that rulemaking should be initiated to incorporate the provisions of proven, widely-used or long-standing special permits into regulation. The value of such incorporation is that the regulated community has immediate access to the regulatory flexibility offered by proven special permits, thus facilitating commerce while maintaining an appropriate level of safety. Incorporation also eliminates the paperwork burden associated with repeated renewal requests.

PHMSA’s failure to actively seek to incorporate proven special permits into the HMR prompted Congress, in 2012, to require that the agency conduct a review and analysis of special permits that have been in effect for a 10-year period to determine whether the permit should be converted into the HMR.¹² PHMSA initiated such a review, and in 2016 promulgated a final rule that incorporated 96 of more than 1,000 permits that met the review criteria.¹³ Given the directive from Congress, the regulated community anticipated that PHMSA would annualize this review. At the time, however, PHMSA declined to commit to an annual review, stating that all special permits leading up to the 2016 final rule had been reviewed and that another review would not be necessary for 10-years. The Interested Parties disagree with this assessment, particularly given the relatively few special permits that were incorporated in the agency’s initial rulemaking. The Interested Parties recommend that 49 CFR 107.113(i) be modified to reflect the desire of Congress that PHMSA provide, at least annually, an opportunity for the regulated community to nominate proven special permits for incorporation into the HMR.

¹⁰ 49 U.S.C. 5101(i)(2).

¹¹ HM-223, rulemaking initiated by RSPA.

¹² 49 U.S.C. 5117(f).

¹³ HM-233F (January 21, 2016).

INDUSTRY - LNG by RAIL -

5

- Incident Reporting – 49 CFR 171.16

PHMSA's hazardous materials transportation safety program relies upon DOT Form F 5800.1, *Hazardous Materials Incident Report*, to gather basic information on hazmat incidents that meet specified criteria listed in Section 171.16 of the HMR. PHMSA uses the data and information reported to evaluate the effectiveness of the existing regulations and industry operating procedures, ascertain the need for regulatory changes, and to identify major safety issues that should receive priority attention. This data is also used by both the government and industry to chart trends, identify acute transportation safety problems and training inadequacies, evaluate packaging performance, and assess ways to reduce releases. Therefore, ensuring the integrity and quality of the data and related information is extremely important.

The Interested Parties believe that the incident data ~~now being~~ collected on Form 5800.1 is not as comprehensive, consistent or robust as it could and should be to meet the laudable goals of the program. To this end, the Interested Parties urge PHMSA to ~~revise the data collection~~ form to eliminate inconsistencies and limit the opportunity for subjective and non-specific responses. The descriptive portions of the Form should be limited to purely factual accounts of incidents. The Interested Parties also recommend that the codes indicating the type of packaging that failed, how it failed, and the cause of failure be ~~evaluated for~~ accuracy and relevance, and that PHMSA be encouraged to focus on the collection of essential incident data that can guide the development of future hazardous materials transportation practices that limit the risk of harming people, property or the environment.

- Authorize LNG for Rail Transport

Liquefied Natural Gas (LNG) is currently missing from the list of commodities authorized for rail transportation in the United States. For the following reasons, we believe LNG should be authorized for transportation by rail in the United States

LNG is similar in all relevant properties to other cryogenic materials authorized by rail and has been moved in the United States safely under a special permit. This material is authorized for transportation by rail in DOT-113 rail cars by Transport Canada, and the safety record in that nation is excellent. Importantly, there is now commercial demand for rail transport within the U.S. and ~~between~~ the U.S. and Mexico.

- Petitions for Rulemaking – 49 CFR 106.95

The HMR provide opportunity for the public to petition PHMSA to add, amend, or delete a regulation. Currently, PHMSA has accepted 51 petitions for rulemaking which are pending at the agency.¹⁴ The majority of these petitions have been filed by the regulated community, and the oldest dates to 2006. We urge OST to consider these petitions as recommendations consistent with the goals of this rulemaking. Further, the Interested Parties urge PHMSA to institute procedures to expedite, within 180 days of the receipt of a petition, action to accept, deny or further review petitions; and to prioritize petitions based on their potential to reduce incidents, improve enforcement, and reduce unnecessary burdens. Such administrative procedures are like those Congress directed the Federal Motor Carrier Safety Administration to implement when enacting the "FAST" Act.

- Public Meeting

OST states that it may hold a public meeting to discuss and consider comments from members of the public related to this docket. The Interested Parties urge OST to host such a meeting with a goal to benchmark

¹⁴ <https://www.phmsa.dot.gov/hazmat/rulemakings/hazardous-materials-petitions> [October 22, 2017].

agency actions implementing regulatory reform recommendations. As noted in the preamble to this docket, PHMSA conducts 10-year cyclical reviews under section 610 of the Regulatory Flexibility Act. However, there is little evidence that these reviews have resulted in substantive regulatory reforms.

Conclusion

The Interested Parties appreciate this opportunity to comment on Docket No. DOT-OST-2017-0069. We are available to respond to any questions regarding our recommendations or matters affecting hazardous materials transportation. Meanwhile, we look forward to the opportunity for a public meeting to advance regulatory reform initiatives.

Sincerely,



Paul W. Rankin, Chair

RIPA - see its website for my scans?

ATTACHMENT THREE: US-RUSSIA CONFLICTS REGARDING MARKET SHARE OF LNG EXPORTS TO EUROPE AND ASIA

CRS study 2013 *Europe's Energy Security: Options and Challenges to Natural Gas Supply Diversification* <https://fas.org/sgp/crs/row/R42405.pdf>

[Columbia | SIPA Center on Global Energy Policy](#) *The Impact of US LNG on Russian Natural Gas Export Policy* DECEMBER 17, 2018 BY [DR. TATIANA MITROVA](#) AND [DR. TIM BOERSMA](#)

<https://energypolicy.columbia.edu/research/report/impact-us-lng-russian-natural-gas-export-policy>

Let's not exaggerate: Southern Gas Corridor prospects to 2030 Oxford Institute for Energy Studies <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2018/07/Lets-not-exaggerate-Southern-Gas-Corridor-prospects-to-2030-NG-135.pdf>

Bloomberg Politics

U.S. Concedes Defeat on Nord Stream 2 Project, Officials Say By [Jennifer Jacobs](#), [Nick Wadhams](#), and [Lars Paulsson](#) December 17, 2019, 9:22 PM EST *Updated on December 18, 2019*

<https://www.bloomberg.com/news/articles/2019-12-18/u-s-concedes-defeat-on-nord-stream-2-pipeline-officials-say>

Trump Team Wants to Bring Zelensky to US Natural Gas Posts 12 13 19

<https://www.thedailybeast.com/trump-team-wants-to-bring-zelensky-to-us-natural-gas-posts>

ATTACHMENT FOUR:

Railway Age Nov 2019 on need to hurry new regs on LNG by Rail

<https://www.railwayage.com/regulatory/assessing-lng-by-rail-safety/?RChannel=home>

Assessing LNG-By-Rail Safety Written by [Jim Blaze](#), Contributing Editor

Chart Industries teamed up with VTG to develop cryogenic tank cars for the European rail network. Chart Industries photo.

*“...Safety is important. Yet, we can do safety research and development a lot faster. It’s timely to ask why the regulatory process takes so long... **While** awaiting additional safety studies, here are two market examples of how railroad movement of LNG is proceeding on a commercial basis....*

In Europe, Germany-based VTG Aktiengesellschaft ([whose U.S. subsidiary is VTG Rail](#)) signed a contract in 2015 with Norway-based Skangass AS to haul LNG by rail. The operation involves leasing up to 20 LNG tank cars that can move as much as ~1,500 cubic meters of LNG per trip. That would replace use of over-the-highway tank trucks.

An LNG European disruptive force is Czech Republic-based Chart Ferox, a division of U.S.-based [Chart Industries](#).

Translation: European railway regulatory agencies now have three or more years of actual operational performance with which to determine the safety aspects of transporting LNG by rail.

*A second disruptive commercial example comes from the Florida East Coast Railway (FEC). Operating freight trains over more than 300 miles of track between Jacksonville and Miami, FEC introduced LNG-fueled locomotives in 2017. **FEC is part of Grupo Mexico Transportes.**”*

ATTACHMENT FIVE: Railway Technology article 1 26 17 on new technologies emerging to ditch dirty fossil fuels

<https://www.railway-technology.com/features/featurepowering-the-trains-of-tomorrow-5723499/> 26 JANUARY 2017 *Railway Technology*

Powering the trains of tomorrow

While diesel still plays a major part on many routes in many countries, rail is experimenting with new forms of power, including hydrogen fuel cells and batteries, while making old, dirty locomotives more efficient.

[*Alstom's Coradia iLint combines hydrogen and oxygen in an onboard fuel cell.*](#)

[*Photo: courtesy of Alstom.*](#)



[*The Talent 3 EMU has a battery system that can be recharged by overhead wires. Photo: courtesy of Bombardier.*](#)

[*In 2015, the UK's Network Rail trialled the first battery-powered passenger train to run on Britain's rail network in more than half a century. Photo: courtesy of Hugh Llewelyn.*](#)

Globally, there's a trend toward greener forms of transport. Backed by new regulations and a steely resolve from environmental groups, this trend is forcing a whole host of industries to confront some difficult, but necessary, questions. For example, how do we ensure the rail industry's growth over the past decade continues uninterrupted while limiting damage to the environment?

It would be wrong to suggest that this is a completely new dilemma, as for many years large sections of track have been electrified; however, in recent times there has been a stronger effort to rid rail of diesel, or at least make diesel engines less harmful.

Still, the European Commission claims that 20% of Europe's current rail traffic is hauled by diesel locomotives, with the UK, Greece, Estonia, Latvia and Lithuania high up on the list. In late December, a report from market research firm Technavio suggested that the worldwide diesel locomotive market will grow steadily, with a compound annual growth rate of nearly 3% in 2020.

In addition, a 2015 study by the University of Cambridge, University of Minnesota, and Minnesota State University Mankato, found that enclosed railway stations where diesel trains are present are a health risk. Researchers discovered that London Paddington train station was in breach of European limits regarding nitrogen dioxide (NO₂) for outdoor air quality over a period of five days.

So there is progress to be made, but just what is the industry doing?

Hydrogen fuel cells in trains

If you're interested in hydrogen fuel cells, then look towards Germany. The European nation is playing host to Alstom's Coradia iLint train, which works by combining hydrogen and oxygen in an onboard fuel cell to generate electricity.

In 2014, Alstom signed letters of intent with the German regions of Lower Saxony, North Rhine-Westphalia and Baden-Württemberg, to act as a testing ground before passenger trains enter service in 2018.

"The Coradia iLint combines hydrogen and oxygen in an onboard fuel cell."

As well as this, Hydrail, an umbrella term for all rail vehicles that use onboard hydrogen for energy, has gone from strength to strength, with projects in Germany, the UK and China, where in 2015 a hydrogen-powered tram opened in Qingdao.

On a slightly smaller scale, students from the University of Birmingham built a working locomotive powered by fuel cells in 2012. Lead researcher Stephen Kent was quoted by Wired explaining that hydrogen could be ideal for rural, quieter routes. He said: "It is highly unlikely they [the routes] will ever be electrified," he

said. "At some point diesel is going to become too scarce and too expensive to carry on using. Hydrogen appears to be an ideal alternative."

All eyes will be on Germany and the success, or otherwise, of the iLint.

Battery-powered locomotives

In 2015, the UK's Network Rail trialled the first battery-powered passenger train to run on Britain's rail network in more than half a century.

Travelling between Harwich International and Manningtree, with the words 'Batteries Included' splashed on the side, the Class 379 Electrostar could one day be operating across the network. "[They are] quieter and more efficient than diesel-powered trains," said a Network Rail spokesperson.

Furthermore, in January, Bombardier announced it had signed a \$1.9bn contract with the Austrian Federal Railways (OBB) to provide 300 Talent 3 trains for regional and suburban rail, with services expected to begin sometime in 2019.

Talent 3's electric multiple unit (EMU) has a battery system that can be recharged by overhead wires on electrified tracks or by charging stations on non-electrified routes.

LNG for cleaner railways

Liquefied natural gas (LNG) is being used in the rail industry as an option for dual-fuel locomotives. In July, Russian Railways, Gazprom, Transmashholding and Sinara Group signed an agreement to develop the necessary infrastructure to support the use of LNG to power locomotives.

Russia was also in the headlines back in 2015, when it unveiled what it called the world's first LNG-generated locomotive, the TEM19.

Also late last year, Spanish operator RENFE announced it was to replace a diesel engine in a Class 2600 DMU with a LNG equivalent, and test it against a diesel version in the same locomotive. The LNG DMU will run on a 20km section of track in northern Spain.

According to Railway Gazette, RENFE wants to cut emissions to below 20g of CO₂ per passenger-km by 2020, and has reduced the use of diesel fuel from 41% in 1990 to 32% in the present day.

GE Transportation also runs a natural gas retrofit kit, which it claims can convert its Evolution series locomotives to operate on as much as 80% natural gas. But, is LNG the way forward? GE CEO Jeffrey Immelt said in 2014: “[The] age of natural gas is upon us. This is an economic story that has environmental impact.”

GE's Evolution Tier 4

Sticking with GE and its Evolution series, the company developed the Tier 4 diesel engine, designed to meet US Environmental Protection Agency (EPA) regulations on emissions.

GE completed the first production test on the Tier 4 back in April 2015, and the company claims it can reduce nitrogen oxides (NO_x) and particular matter (PM) emissions by at least 70%.

"The Tier 4 engine meets US EPA regulations."

In the same year, Ed Hall, GE senior general manager for engine engineering, told Wired: “We looked very hard at what it would take to reduce [pollutants]. How we manipulate the fuel, manipulate the air, control the whole combustion process. We were able to do it. This will be our crown jewel product for the next eight years.”

Last year, GE celebrated producing the 1,000th Tier 4 locomotive, to be used by the Canadian National Railway Company.

The Prima family

The Alstom Prima H3 and H4 locomotives, designed for shunting purposes, come in a number of versions.

They can be operated in single or double-engine modes: either one 1,000KW diesel generator or two 350KW diesel generators, or in hybrid and battery configurations.

The H3 hybrid can reduce fuel use by 30% to 50% as it incorporates a battery alongside the diesel generator. The full battery mode, designed for more populated areas or in tunnels, can operate emission-free.

As for the H4, its hybrid setting is suited for use on non-electrified track, while a bi-mode battery version couples a battery and catenary system. Alstom claims the H4 double engine can cut diesel fuel consumption by up to 15%.

In October, German operator Deutsche Bahn introduced five H3 hybrids to its fleet. Daniel Croonen, director of service for Alstom Germany and Austria, said at the time: “[The] Prima H3 locomotive is paving the way to the new reality of zero-emission freight transport in Europe.”

ATTACHMENT SIX:

The Weak Market Need Case in the 2019 Willauer Report

A key indicator of how thin and speculative is the PHMSA market need case for LNG by railroad tank cars is PHMSA's own 150-pp. report by a Cambridge Systematics team headed by consultant David Willauer, "Risk Assessment of Surface Transport of Liquid Natural Gas" ["the Willauer Report" or "Report"], final report dated March 20 2019.

In its Part A, the Willauer Report provided much valuable information on basic natural gas and LNG transportation patterns, in part to suggest possible growing market interest in LNG by Rail tank cars and the geographical shape of any future LNG Rail transportation network, and to outline the beginnings of a thorough risk assessment. Given his broad and detailed knowledge of the US natural gas industry, however, it is notable that his report provides no set of specific cases of business plans, final investment decisions, etc. having been held up by lack of availability of the huge quantities of LNG [3 million gallons per 100-car unit train] for which the current rail industry Petition seeks federal approval.

[The railroads have consistently maintained that the longstanding current ban on LNG by rail tank car is because of a historic, decades-long lack of market demand, not because LNG is inherently less safe than other cryogenic cargoes allowed for rail tank car shipments.]

The Willauer report also reported significant data gaps that limit the validity of all analytical efforts, and the report's overall conclusions are notably and appropriately modest and tentative – see much use throughout the Report of "could" statements:

p. ES-3: LNG by Rail LNG is not shipped by rail in the U.S. because it is not authorized by the Federal Railroad Administration (FRA), except by special permit. The code of Federal regulations, 49 C.F.R. § 172.101 Hazardous Materials Table lists natural gas with high methane content as forbidden to be transported by rail. The FRA has granted special permits [for LNG rail by intermodal containers only] to the Florida East Coast Railroad and to the Alaska Railroad. While several Class I railroads have piloted LNG propulsion programs, the comparatively low price of diesel fuel has delayed such programs. [Another factor is the lack of a North American infrastructure for re-fueling LNG locomotives, the solution of which gap is perhaps the single most important reason railroads are now supporting future approved LNG by rail tank cars.]

Nevertheless, authorizing LNG rail shipments could change existing demand patterns; demand of LNG transport by rail could appropriate market share from either trucking or pipeline, depending on the network characteristics and other factors. In the case of New England, for example, the railroad network could supplement the existing pipeline network. In addition, availability of LNG transport by rail could affect the market share of other energy sources.

The otherwise thorough Report provides none of what it alleges as the “evidence that a market demand exists for shipping LNG by rail”, while prefacing its safety case section by admitting that the public safety implications for such transport have not been researched:

[p. ES-9]: ...With this increased [US] demand for natural gas, LNG transportation complements the distribution of natural gas by pipeline, providing access to areas that are not sufficiently supplied by the pipeline network. While surface transportation of LNG currently is only allowed by truck, and by rail with special permit, modal choice for LNG delivery would increase the opportunity for energy consumers to make competitive choices about their energy supply. There is evidence that a demand exists for shipping LNG by rail, and that rail shipments of LNG can be both competitive and complementary to the truck and pipeline networks. Since railroads have unique advantages and disadvantages compared to trucks, and the public safety implications are not fully developed, [future] risk assessments provide additional insight into the shipment of LNG by rail...

Without any evidence that the current truck delivery system for LNG in North America has failed to serve even a single market demand in some remote area, the Report’s comparison of natural gas and LNG transportation delivery modes is summarized also with modest and tentative conclusions. It strains to imagine hypothetical situations including national emergencies, that could favor LNG by rail tank car trains instead of more flexible truck deliveries:

[p. ES-5]: LNG Mode Choice

Rail and truck delivery of goods complement and compete with each other; this could be the same for LNG.

For intermodal deliveries, trucks complement the rail network by providing consignees and shippers not directly served by rail lines access to rail terminals. For heavy loads and long hauls, rail delivery is more efficient than truck. One tank car can replace almost three truck cargo tank trailers. However, rail delivery of LNG has limitations particular to the railway network. In addition, rail delivery operationally takes longer than truck delivery because rail

loads in manifest trains must be consolidated and sorted onto trains at rail yards, whereas truck delivery is a direct point-to-point delivery. This would be different if unit trains were employed, in which only LNG railcars were transported from origin to destination without requiring railyard sorting. Rail routing also is circuitous because rail companies prefer to stay on their own tracks to avoid interchange fees.

There are certain origin and destination pairs that would make rail delivery of LNG more attractive than truck delivery, but since LNG supply points are spread out across the country, the overall distance that LNG would have to travel from the origin is limited, and this could favor truck delivery.

Rail delivery of LNG could replace or supplement the pipeline delivery of natural gas, such as during a supply disruption, where the rail option could provide duplication and redundancy. If a pipeline had to close due to immediate or planned maintenance work, or due to a pipeline malfunction, railroads could move large supplies of LNG to the demand regions. In addition, railroads could supply natural gas via LNG to destinations that the pipeline would not be able to service. For regions not currently served by pipeline, the demand for large volumes of natural gas on a consistent basis triggers the justification process for building a pipeline, which leaves several years for non-pipeline demand and delivery that could be replaced by pipelines if approved for construction.

Rail delivery could reach areas of the U.S. that currently do not use natural gas because it is too expensive to source and other sources are more accessible. If rail delivery of LNG is cheaper than truck delivery, then the LNG could travel longer distances from the supply source, to compete with other energy sources in areas previously out of reach. These are some of the factors to consider comparing LNG transport by truck and by rail.

The potential origins of LNG are facilities that liquefy natural gas or store LNG. These would include peak shaving facilities, export facilities, merchant plants, natural gas processing facilities, market hubs, and market centers that have liquefaction capabilities. Generally, there would be a large number of facilities that currently supply LNG for truck transport that could potentially supply LNG for rail transport to a single destination. For most destinations, that number can be reduced to a much smaller number by considering the alternative modes of trucking and pipeline, and using the costs of those modes to limit the potential rail origins.

The 2019 Willauer report's national map and discussion of the existing truck routes [p. 42] and combined volumes from several major LNG shipper companies did usefully suggest that LNG truck shipments, not without accidents but without major disaster, were already

reaching widely to many areas of the US, e.g., in New England areas and in western states presumably not adequately served by current natural gas pipelines.

[Cf. Cambridge Systematics Willauer Slide 15 of 73 slides QRA LNG transport May 2018 PHMSA event <https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/research-and-development/hazmat/58176/day-1-pm-2.pdf>]

[The Willauer Report's aggregated "gross" US LNG truck routes map, while suggestively useful, is not a compilation of any state or federal tracking reports of such shipments, which do not exist. So the map in Figure 4.11 seems a rough estimate somehow combining some public EIA information with private data from some shippers, the completeness of which is unknown and unknowable.]

An interesting Report observation was that *"the majority of the [LNG truck] movements are within the [EIA-designated] natural gas regions, but some of the LNG movements do move more than 1,000miles."* [p. 42] This would seem to raise the question of whether some US LNG shippers might have considered many years ago a move from truck to slightly less costly [per energy unit delivered – see p. ES-7 chart] rail tank car shipment, and pressed for federal approval of an LNG tank car.

But the Willauer Report cites not a single industry effort to do so, and suggests no Rail by LNG tank car push until the two very modest and preliminary regional AK and FL experimental LNG by rail ISO container movements in the current era [2014-present] and the current hurry-up LNG Rail tank car push in the context of the Trump Administration's across the board federal rail safety deregulation moves on LNG and other safety issues.

The market need/safety tradeoff question here is whether the US current and future LNG market demands would be likely to support shipping much larger rail tank car quantities [possibly in long manifest train consists or even in unit trains] to the identified LNG-using locations, especially given the much larger release disaster risks especially to urban populations. One answer to that question was already suggested in the useful analogous case of the Alaska Railroad Corporation's very short-lived LNG Rail experiment in transporting to LNG-using locations in Alaska using the much smaller ISOs: the dismissive phone interview comment from one top ARRC official: "We only sent a couple of LNG trains... but there was no market, so we stopped." [Detailed volumes, safety risk, and emergency response training information on this effort has been withheld by FRA from FOIA requestors.]

Another market/safety tradeoff question is raised by the Willauer Report's modest conclusion that LNG might find a market to some locations, *"if shipments do not need to be*

time-sensitive” [p. 50] -- the author’s diplomatic allusion to the US freight railroads’ frequent issues with slow delivery and many long system delays [compared with truck]. [p.42] Overall the Willauer Report compiles a valuable but thin batch of available data, inadequate for basing a respectable national rulemaking on LNG by rail tank car/unit trains.

The corresponding Report analysis of the potential routing of rail LNG [p. 50], for example, did not include any realistic routes, but instead used abstract state centroids, and did not consider the most basic question of what major cities might be traversed by LNG Rail.

If approved, rail tank car transport would be an alternative to truck for surface transport of LNG, and Figure 4.18 shows the routes that might be used if volumes of LNG similar to those currently moved by truck were moved by rail, to supplement or replace existing truck shipments should rail shipments of LNG be allowed in the HMR. [Cf. pp. 40-43]

The key safety-related contribution from the Willauer Report’s market demand section is the revelation that the LNG trucking industry [both with ISOs and tank trucks] is so extensive, both geographically and in infrastructure. The US FMCSA data accessed October 2017 shows 18 US motor carriers utilizing a total of 3056 trucks [“units”] and with an impressive safety record. [Willauer Report, p. F-5]

By comparison, the Report indicates that the LNG Rail history anywhere in the world is very thin. Even in Japan, cited by recent federal and industry documents as having approved LNG by rail, Willauer Report says the effort is only experimental.

The Report outlines how the comparative economics of various LNG modal delivery options is complicated by many factors:

[p. 59] Natural gas movements are a function of price and delivery convenience. Truck and rail delivery are a “flexible and competitive complement to traditional pipeline transportation” for the transport to market from “remote locations not adequately served by pipelines.” Natural gas delivered by rail would be slower than truck delivery, unless enough natural gas were delivered at once to build a unit train. Unit trains are treated with higher priority than manifest trains. This comes with additional risk, which will be discussed in Part 2. Natural gas delivered by rail and trucks provide more flexibility in their networks ability to access multiple delivery destinations across the country—pipelines are constrained in their access and delivery points. Different than the development of non-pipeline crude oil rail deliveries, natural gas comes from many sources. Natural gas comes from many suppliers, and goes to even more users. There is enough natural gas supply and demand spread out across the country, and nearly all of it is transported by pipeline. It is hard to predict if rail delivery can compete with the convenience and speed of truck delivery.

Here Willauer cites[only] one oil and gas industry energy expert's 2015 book [Rusty Braziel's "The Domino Effect"] which looks back comprehensively on the recent history of all the moving pieces in energy markets [including the rail industry's massive move into shipping crude oil in unit trains in a notoriously puncture-prone 50-year old design rail tank car, the DOT-113]. The Report cites Braziel's brief speculation on the future, a grandiose generalization:

"Whenever production exceeds pipeline capacity, the railroads can step in. Whenever new production has to wait for a pipe, it will travel by rail. Whenever markets are disrupted by pipeline congestion, railroads will step in to bypass the tangle. In remote plays where there are no pipelines at all, railroads will be the primary transportation mode." 41 [Willaur adds, without citing any evidence:] This is true except if rail delivery is not allowed. In that case, truck or vessel is the only other option.

The 2019 Willauer report [the most recent and comprehensive research document on the market case for LNG by rail tank cars] tries to hype the LNG tank car developments in other nations, but can only show very tentative beginnings, speculative hopes, and no ongoing commercially viable rail transportation of LNG anywhere. For example, see regarding Europe:

[p. F-9:] The first LNG Tank Car in Europe was a project between Chart Industries and VTG AG. 127 VTG invested in the rail tank cars "to create a so-called rolling pipeline to deliver LNG to industries that have sizeable energy requirements. It plans to work with Brunsbüttel to use LNG tank cars to supply Baltic Sea ports." 128]

[END]

Exhibit G



November 20, 2017

Delaware River Basin Commission
P.O. Box 7360
West Trenton, New Jersey 08628

Re: COMMENT on Docket No. D-2017-009-1 Delaware River Partners LLC – Gibbstown Logistics Center, Greenwich Township, Gloucester County, New Jersey

This comment is submitted by Delaware Riverkeeper Network (DRN) on behalf of our approximately 20,000 members throughout the Delaware River Watershed including residents in the closest Gloucester County communities. DRN is a private non-profit membership organization, championing the rights of our communities to a Delaware River and tributary streams that are free-flowing, clean, healthy, and abundant with a diversity of life.

DRN submits that, based on review of the materials submitted to Delaware River Basin Commission (DRBC) by the applicant, this project will have substantial negative impacts on the Delaware River, its water quality, its habitats, and the species that live, forage, shelter, migrate through and reproduce in the River, Estuary and Bay. DRN also submits that the application is substantially lacking in critical information for and assessment of described and yet-to-be described or assessed aspects of the proposed project. DRN requests that Docket approval be denied or, in the alternative, the draft docket be withdrawn and specific reviews and analyses are conducted before further consideration of the project.

Attached to this comment is a copy of DRN's April 5, 2017 comment filed with the Army Corps of Engineers on Public Notice CENAP-OP-R-2016-0181-39 for the SRP Gibbstown Logistics Center; those comments are included as part of DRN's comment on the draft docket.

General Comment

DRBC states its draft Docket is to approve dredging and the construction of a deepwater berth for the proposed Delaware River Partners (DRP) Gibbstown Logistics Center ("the Proposed Project"). However, the current draft docket, despite claiming to approve only the dredging and deep-water berth construction project, approves stormwater outfalls and land disturbances. Furthermore, the docket states that DRP "...is required to submit detailed site plans to the DRBC for the remainder of the Logistics Center, including the proposed: Automobile import area/parking lot; processing facilities; perishables, bulk-liquids and gases, and

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
drm@delawariverkeeper.org
www.delawariverkeeper.org

bulk cargo handling areas; warehouses and associated buildings; stormwater management system (including stormwater outfalls); and the associated infrastructure”.¹

This is a huge omission of information about the activities and infrastructure that this project would entail. Based on this lack of essential information, until all plans are completed, submitted to and assessed by DRBC, the draft docket for the Proposed Project should be put on hold. It is unreasonable to move ahead with an application that is so obviously incomplete and lacking in adequate assessment and review. It is impossible to fully assess the potential impacts that this project would have on the water resources of the Basin with the information made available for only a portion of the Proposed Project and its activities.

Essential Environmental Issues

PCB contamination in upland and river sediments

Despite the fact that this former DuPont site (now Chemours) remains among the top-10 biggest PCB loading point-source facilities in the Delaware Estuary, and the near-shore sediments show a pattern of contamination consistent with sources on-site, DRBC appears ready to approve this docket and allow the expansion of PCB contamination in the Delaware Estuary. This is unacceptable and counter to DRBC’s dedicated role in reducing PCBs in the Estuary and its role to ensure that PCB Pollution Minimization Plans (PMP) are effectively implemented.

The draft docket approves stormwater outfalls and land disturbances that will significantly increase PCB loading to the already-impaired Delaware Estuary (a TMDL exists for PCBs) but without any plan to monitor or control these elevated PCBs flowing to the Estuary. Instead, the docket defers review of these significant effects until a later time through a New Jersey Department of Environmental Protection (NJDEP) permitting process. DRBC should not approve the draft docket until it reviews all plans and fully assesses potential impacts from the movement of PCBs.

The draft docket acknowledges that DRBC has neither received nor reviewed critical documents about the larger project, including the stormwater management system, and yet seeks to approve the project and the stormwater outfalls without knowing the source of the runoff, the composition of that runoff, and the extent to which already-known PCB contamination on-site will be mobilized and discharged into the Delaware Estuary because of the activities allowed in the draft docket.

The pattern of sediment contamination clearly shows local sources of material, but there is no effort to address these local sources and prevent further contamination of the near-shore environment. The area adjacent to and just to the north of the proposed wharf is a known “hot spot” outfall for PCBs. DRP offers an unsubstantiated conclusion that Dupont and Chemours “has substantially remediated the site”² through their redevelopment of the Repauno site since the 2005 Pollution Minimization Plan (PMP).

There is no evidence shown in the application materials of soil or water sampling of the upland areas that contribute to the runoff of PCBs from the site that would support a conclusion that the area to be impacted has been fully remediated and will not release PCBs to the Estuary. There is also no data that demonstrates that the areas to be disturbed by the dredging of 27 acres, for the construction of the wharf and the

¹ Docket No. D-2017-009-1, p. 3.

² Ibid., p. 5.

construction of other components of the Proposed Project, as well as areas that will continue to be disturbed by the operation of the channel and activities at the Proposed Project site, have been fully remediated and will not release PCBs to the Estuary. Furthermore, there are areas discussed above that are planned by DRP to be built out as part of the Logistics Center but are not yet reviewed by DRBC; in these areas there is likewise no evidence or sampling results shown in the application materials that would support a conclusion that the area to be impacted has been fully remediated and will not release PCBs to the Estuary. It is wholly inappropriate for DRBC to issue a docket without this information and, based on the information that is available to DRBC, PCB contamination can reasonably be expected to expand into the Estuary if the Docket is approved and the Proposed Project is constructed.

In fact, the draft docket states that an estimated 72,000 cubic yards of “fine grained” sediments that are planned to be dredged are so contaminated that they don’t meet the standards for disposal at the White Basin CDF. The dredging activities themselves will mobilize and increase exposure to these highly contaminated near-shore sediments. The dredging exclusion between March 15 and July 15 does not eliminate exposure to critical early life stages of the federally-endangered Atlantic Sturgeon. Figure 2-2 from the DRBC docket application shows the zone of highly contaminated sediments immediately adjacent to the shore and port facility. The remobilization (and dewatering of dredged sediments) will create higher exposure to PCBs and other contaminants, and the Atlantic Sturgeon spawning and rearing that begins in June and extends the early-life-stages through July and August, with increasing evidence for high aggregations of young-of-year in the Proposed Project vicinity, means that elevated exposure will occur for larval and juvenile stages of this endangered species in the Delaware River. There is no evidence offered that it would be otherwise. The currently proposed methods and timing are insufficient to protect this endangered species, and more evidence and analysis would be required in order to claim that the project does not impair NOAA Trust Resources, fish and wildlife, and the water resources of the Basin.

Atlantic Sturgeon Critical Habitat

The DRBC draft docket fails to acknowledge that the federal government established the Delaware Estuary as Critical Habitat for the New York Bight DPS of Atlantic Sturgeon in August 2017, after the submission of the docket application to DRBC.

DRBC’s Water Quality Regulations at §4.30.5-B.1 acknowledge that the Commission must evaluate Critical Habitat, and that this evaluation must follow its Rules of Practice and Procedure. Despite the federal ruling, DRBC has yet to initiate its procedures for verifying the Critical Habitat established by the federal government, and the role that Critical Habitat will play in docket decisions.

DRBC should not approve any project that could directly and indirectly affect this Critical Habitat until such time as it has completed all necessary procedures in the Critical Habitat evaluation. To do so would be premature, would undermine the required process for DRBC review and approvals, would be unfair in terms of just application of its regulations, and jeopardizes the Critical Habitat of the Atlantic Sturgeon. The DRBC is not ready to grant approval to any project that involves the Critical Habitat of the Delaware Estuary for the New York Bight DPS of Atlantic Sturgeon.

The U.S. Army Corps of Engineers' Biological Assessment also acknowledges that the increased ship traffic is estimated to result in 3.3 Atlantic Sturgeon and 0.4 Shortnose Sturgeon deaths in the next 30 years.³ If every port facility results in 3 or more deaths of Atlantic Sturgeon in the next 30 years, its long-term persistence is clearly in danger. DRBC, National Marine Fisheries Service (NMFS), NJDEP, and the Army Corps of Engineers have failed in their duty to protect this endangered species if they accept this continued and increasing rate of ship-strike mortality (see attached paper; Brown & Murphy 2010 say that ship strikes may doom the species).

The substantial harm that will result to the species of concern and its Critical Habitat and the death of 3.3 Atlantic Sturgeon is unacceptable and should not be tolerated. Considering the evidence of the low population of Atlantic Sturgeon in the Delaware, these lethal takes are significant (fewer than 300, maybe even fewer than 100 individuals are left). These takes could be a substantial percent of this genetically unique population; it is reasonable that these losses could represent a death blow to the species in the Delaware River, especially when considered cumulatively with other port facilities and dredging operations that are occurring in the same area. For instance, the new Paulsboro Marine Terminal is extremely close to the Proposed Project site. Atlantic Sturgeon takes from that terminal and other operations should be considered by DRBC cumulatively in terms of impacts to Critical Habitat and Estuary conditions.

Submerged Aquatic Vegetation

NJDEP has accepted DRP's proposed mitigation, but US Fish and Wildlife Service (USFWS) has continued to comment on the risks to the larger bed of Submerged Aquatic Vegetation (SAV) identified as wild celery (*Vallisneria Americana*) to the east of the port/berth. There is ample evidence to suggest that re-establishment of *Vallisneria* is non-trivial, and that higher ratios of mitigation should be part of the request.

USFWS states that there needs to be careful monitoring of the larger eastern SAV bed because there are numerous risks to its long-term survival and persistence given the significant changes to the surrounding bathymetry and to the local ship traffic. During dredging, NMFS points out that 0.06 acres of *Vallisneria Americana* will be lost and that it is important forage and refuge habitat for several local fish species, including striped bass, American shad, alewife, and blueback herring.⁴ However, even after construction is complete, the increase in vessels in the area would continuously churn up the water and increase turbidity, degrading SAV habitat, and the 0.06 acres that DRP will create or enhance as mitigation under NJDEP permitting will likely not be enough. Without monitoring as USFWS proposes, further losses of the larger bed will not be accounted for. This monitoring should be required by DRBC.

Incomplete Information and Erroneous, Unsubstantiated Conclusions

DRBC reliance on reports from DRP and its consultants for information in the draft docket is not supportable. Many of the measures proposed by DRP and its consultants to "minimize" dredging impacts are not measurable or enforceable. Following are several examples of incomplete information, and unsupported or erroneous conclusions.

³ U.S. Army Corp of Engineers, "Biological Assessment For Potential Impacts To Species Listed Under The Endangered Species Act Resulting From The Proposed DRP Gibbstown Logistics Center, Gibbstown, NJ", August 2017, page 110.

⁴ National Marine Fisheries Service (2017). Comment Letter to the U.S. Army Corps of Engineers on Gibbstown Logistics Center. May 5, 2017.

- One of the proposed measures is “Controlling the “bite” of the bucket to: (a) minimize the total number of passes needed to dredge the required sediment volume.”⁵ How will this be measured and controlled in real time? If there is some means of measurement, what will be the enforcement mechanism should this proposed minimization be unsuccessful?
- Regarding TSS concentrations and its effects on NOAA Trust Resources, DRP assumes that the effects from suspended sediment would be too small to measure and this assumption automatically makes the effects insignificant. This is a baseless conclusion to jump to and there is no evidence presented to verify this conclusion. In fact the evidence that is available, as discussed above, contradicts this conclusion.
- The DRBC draft docket states that approximately 10.6 acres of the dredging is “new dredging” and the rest of the 27 acres of dredged area are “...areas of the Delaware River that have previously been dredged or otherwise modified”. It is unclear from the documents available if there will be any disturbance of the portions of the river “previously been dredged or otherwise modified”. This information should be made clear. Any disturbance of the river should be addressed by this draft docket, even if the area was previously modified, because the disturbance has impacts that must be considered and accounted for.
- Regarding noise during construction, it is dismissed by DRP as disrupting sturgeon. DRP claims that that sturgeon would avoid going near the noisy areas and therefore there is no impact⁶. However, avoidance is a behavior alteration due to the construction activity and can therefore be considered a form of disturbance. Furthermore, DRP indicates that underwater noise levels would be less than 150 dBRMs at distances greater than 289 ft. However, they go on to say that anadromous fish are expected to begin avoidance behavior at 282 ft. To insinuate that there would be no impact or disturbance, even if it is avoidance behavior, is grossly inaccurate.
- Regarding the projected increase in connectivity of the floodplain to the river, DRP claims the increase in connectivity would not have a significant effect on the transport of contamination or TSS from the site to NOAA Trust Resources but provides no basis for this conclusion. In fact the evidence that is available, as discussed above, contradicts this conclusion.
- In questioning the need for the Proposed Project and all its proposed components, NMFS asks if elimination of one or more components would minimize the adverse impacts of the project. The applicant states in response that there needs to be a wide range of cargoes to be “attractive to end-users now and in the future”⁷. But economic viability and attractiveness to end-users are not genuine needs for the project. These are desires by the applicant, but they do not demonstrate a purpose and need for the project that outweighs the environmental impacts. In fact, because of the close proximity of a competing terminal that is now complete, the Paulsboro Marine Terminal, and other planned and ongoing terminals in this region (i.e., Gloucester City and Philadelphia), there is no demonstrated need for the Proposed Project, removing the justification for any adverse impacts to the Estuary and Delaware River water resources.
- Regarding the Proposed Project’s design and location’s impact on SAV, DRP states they changed the outfall location outside the SAV and designed a berth cutoff wall⁸ but these modifications do

⁵ George, L. (2017). Responses to National Marine Fisheries Comments CENAP-OP-R-2016-0181-39 Delaware River Partners, LLC. Ramboll Environmental.

⁶ Ibid.

⁷ Ibid.

⁸ Ibid.

nothing to address the increase in vessels and the dredging activities, one of the most important impacts with which NMFS was clearly concerned.

- DRP admits the proposed inshore berth would permanently shade 1.9 acres and that “shading may reduce photosynthesis in these areas and may reduce prey biomass in the shaded area”⁹ but concludes it will not have any measurable effect on NOAA Trust Resources. However, a permanent area of reduced photosynthesis and prey biomass is still a negative impact to NOAA Trust Resources and there is no evidence presented to the contrary and information that substantiates that this will not have a measurable negative impact.
- Regarding the adverse impacts of ships moving in and out of the port is DRP’s claim that the slow speed of vessels will not increase turbidity beneath the wharf. The speed of the vessel is only one factor that affects how much water it disturbs as it moves (and increases turbidity). Other factors include vessel size, draft, hull shape, depth, current, and wind. Most of these vessels are very large and would certainly increase turbidity regardless of slow speed. Yet these important factors are not even mentioned or considered.
- The conclusion that DRP draws that the “...Project activities including construction, dredging, and operations of the port and upland Marine Terminal are not expected to have a significant adverse effect on NOAA Trust Resource species”¹⁰ and that the proposed mitigation will be sufficient is not supportable by the evidence in the record. DRP jumps to the conclusion that because they have certain expectations (such as expected sediment level thresholds) that they can say that there will be no impacts. Is someone going to measure sediment thresholds to make sure they don’t exceed their expected amount? Is someone going to study the impacts to prey species? On May 17, 2017, DRP submitted a modification of the Proposed Project design to the Army Corps of Engineers which described shifting the pile-supported open wharf structure 50 feet channelward. As a result of this modification, the dredging footprint has been reduced from 29 acres to 27 acres. This response is not nearly enough to address all of the concerns raised by NMFS, there is no evidence presented to show that it does sufficiently reduce negative impacts and certainly this mitigation is not enough to support the approval of this draft docket by DRBC.

“Existing Uses” Not Captured

DRP fails to recognize that fish “propagation” is an Existing Use and instead defers to “Designated Use”, which is not protective enough. Even though DRBC and other agencies also do not recognize the validity of the “Existing Use” designation, it doesn’t make this miss-classification right. Rather, it highlights a continued failing at DRBC and across the regulatory community to correctly recognize required “existing Uses” of the Estuary, resulting in inadequate protection for species and habitat.

Rush to Judgment

DRBC has moved the Proposed Project through to a draft docket at an accelerated pace. This draft docket should never have been considered ready for consideration due to the lack of information and the many erroneous, poorly reasoned, and faulty conclusions put forward by DRP. And it never should have been considered at this time because DRBC has not developed the regulations that will assess and implement the Critical Habitat of the Delaware Estuary for the New York Bight DPS of Atlantic Sturgeon.

⁹ Ibid.

¹⁰ Ibid.

Conclusion

DRN requests that DRBC disapprove the draft docket based on the evidence presented showing substantial harm to Delaware River water resources. If DRBC does not disapprove the draft docket, DRBC should at least remove it from consideration until NJDEP reviews and issues the required NJPDES permit for the stormwater discharge system; until sampling can be done and a decision is made regarding the need for a new Pollution Minimization Plan; and until there is enough evidence to demonstrate that the Proposed Project will not have the adverse impacts that it can be expected to have on the water resources of the Delaware River, Estuary and Bay. If using only the available information, DRBC should deny approval based on the reasonable likelihood that the project will cause harm to the water resources of the Basin and a lack of demonstration to the contrary and because there is not a demonstrated need for the Proposed Project and all its components that justifies the adverse environmental impacts.

Thank you for the opportunity to comment.

Sincerely,



Maya van Rossum
the Delaware Riverkeeper



Tracy Carluccio
Deputy Director

Attachments:

1. Delaware Riverkeeper Network April 5, 2017 comment filed with the Army Corps of Engineers on Public Notice CENAP-OP-R-2016-0181-39 for the SRP Gibbstown Logistics Center
2. J. Jed Brown and Gregory W. Murphy, "Atlantic Sturgeon Vessel-Strike Mortalities in the Delaware Estuary" Fisheries, vol 35 no 2, February 2010, www.fisheries.org



April 5, 2017

Submitted by Fed Ex Overnight

District Engineer, U.S. Army Corps of Engineers
Philadelphia District, Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Re: Comment on Public Notice CENAP-OP-R-2016-0181-39 for the SRP Gibbstown Logistics Center

Dear District Engineer of the U.S. Army Corps of Engineers,

The Delaware Riverkeeper Network has reviewed Public Notice CENAP-OP-R-2016-0181-39 for the SRP Gibbstown Logistics Center located in the Township of Greenwich, Gloucester County, New Jersey. The Delaware Riverkeeper Network submits this comment in response to this Public Notice.

It is our position that in accordance with 33 CFR parts 327.4 that this letter serve as a written request for the US Army Corps of Engineers to hold a **Public Hearing** to hear the public's concerns regarding this application including the reasons identified below:

1. Environmental Impacts of Dredging

The proposed Gibbstown Logistics Center in Greenwich Township, Gloucester County, NJ would have a substantial impact on the natural resources in this part of the Delaware River and there is no indication that this project is needed by the public. The stated purpose in the application is,

*"... to redevelop (the) site and create a deep water marine terminal that can accommodate vessels with a maximum length of 870 feet with a maximum of a 40-foot draft."*¹

In order to achieve this goal, the application further states that,

*"An area approximately 29 acres in size would be dredged to a depth of -40 feet mean lower low water ± 1 foot overdraft."*¹

¹ U.S. Army Corps of Engineers (2017). Public Notice CENAP-OP-R-2016-0181-39. March 7, 2017.

Retrieved from

http://www.nap.usace.army.mil/Portals/39/docs/regulatory/publicnotices/Public_Note_2016-0181-39.pdf

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
dm@delawariverkeeper.org
www.delawariverkeeper.org

*“Approximately 1264 square feet of open water habitat would be filled between the proposed sheet pile and the existing earthen berm.”*¹

*“457,000 cubic yards of material would be removed from the waterway.”*¹

The Delaware Riverkeeper Network has commented in the past on the significant environmental impacts that dredging causes in this section of the Delaware River. First, deepening 29 acres of river area to a depth of -40 feet mean lower low water \pm 1 foot overdraft will open this newly deepened area to the potential for an increased risk of harm if there is a catastrophic spill event. With a deepened area, ships will access the proposed deepwater port and, when filled for export will be heavily laden with natural gas liquids or other chemicals. Using the catastrophic experience of the Athos I oil spill of November 26, 2004, the volume of carried material available to leak and wreak havoc on the environment and our communities will be greater and therefore more dangerous with the added capacity of the proposed port’s dredging of 29 acres.²

The Athos I catastrophe exposed 115 miles of River, 280 miles of shoreline, 16,500 birds, as well as many species of fish, shellfish, and wildlife and a variety of important habitats to the heavy crude it dumped into the Delaware River.² Habitats, wildlife, water quality, air quality, industry, recreation, and communities were all significantly harmed by the spill. Any project that will increase the magnitude of such a tremendous level of damages in the event of a future catastrophe is a danger to all of these natural and human resources.

2. Contaminated Dredge Spoils

The dredge spoils from this proposed activity would clearly not be clean. According to the application,

*“...based on initial testing, approximately 106,000 cubic yards of the material proposed to be dredged appears to be contaminated.”*¹

*“The material would then be dried on-site or at the Camden facility and then deposited on the adjoining uplands.”*¹

Dredge spoils significantly increase the amount of heavy metals and toxins that would be released into waterways and the environment², especially with the amount of material that appears to be contaminated at this site. The impacts of the spoil disposal plans and potential pollution impacts could have significant community and environmental effects. The threat posed by dredged spoils is known to be a source of water pollution after on-land disposal.² In addition to polluting the water and land, there are likely to be air quality impacts including NOx emissions associated with the construction and associated traffic from this project that should be considered as well.

3. Impacts to Sturgeon

This project would also adversely affect both species of sturgeon found in the Delaware River. From the application:

“A preliminary review of this application indicates that the proposed work may impact 2 fish species listed on the Endangered Species List pursuant to Section 7 of the Endangered Species Act as amended. The first

² Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

would be the Short-nose Sturgeon (*Acipenser brevirostrum*) and the second would be Atlantic Sturgeon (*Acipenser oxyrinchus*) and its proposed critical habitat.”¹

Both direct take and incidental take of sturgeon are a distinct possibility with a project of this nature. Both the Atlantic sturgeon and shortnose sturgeon are threatened and adversely affected by dredging and effects to water quality including dissolved oxygen (DO) levels, water temperature, and contaminants.² The proposed project will entail significant levels of dredging as well as significant water quality effects and dramatic changes in important habitats including juvenile habitat and spawning grounds.

The dredging of river systems significantly impacts aquatic ecosystems in a number of ways that will harm both sturgeon species. Among the effects that the project will have on the Delaware River populations of both sturgeon species are:

- ✓ Deep-draft vessel traffic in the Delaware River has been cited as the biggest threat to the survival of the Delaware River population Atlantic sturgeon; the increased vessel traffic and increased area for deep-draft vessels to strike Atlantic sturgeon directly resulting from this project will significantly increase sturgeon vessel strikes and could accelerate the extinction of this endangered species population.³
- ✓ Dredging activities remove, disturb, dispose of and re-suspend river sediments, modifying the river bottom substrate and impacting the community of benthic macrofauna;
- ✓ Dredging operations can remove or bury organisms and destroy benthic feeding areas;
- ✓ Dredging operations can create noise and disturbance, and can disrupt spawning migrations;
- ✓ Dredging activities can re-suspend contaminants, affect turbidity and siltation, and deposit fine sediments in spawning habitats; and
- ✓ Dredging activities alter the hydrodynamic regime, alter physical habitats, and create the loss of riparian habitat.²

The act of dredging can entrain sturgeon, taking them up into the dredge drag-arms and impeller pumps and resulting in death.² New data from tagged Atlantic sturgeon continue to show their presence in or near the main navigation channel, making them vulnerable to direct take by dredging operations, as well as direct take from the larger vessels that will be using the channel.² These lethal takes are significant for a species that is at such low levels (fewer than 300, maybe even fewer than 100), and as genetically unique as the Atlantic sturgeon of the Delaware River are.²

Dredging in the portions of the River near Philadelphia is likely to be detrimental to the successful spawning of sturgeon in the Delaware – not just because of the act of dredging but also because of the degradation of spawning habitat.² Dredging increases the level of suspended sediments and contaminants in the water. An increase in suspended sediments could be detrimental to egg survival of sturgeon – increasing the probability that eggs adhere to suspended solids and suffocate.² Increasing contaminant loads can alter growth and reproductive performance in sturgeon.²

³ Brown and Murphy. 2010. Atlantic Sturgeon Vessel-Strike Mortalities in the Delaware Estuary. Fisheries 35(2): 72-83.

Dredging is a factor in the destruction, modification, or curtailment of the Atlantic sturgeon's habitat and range.² The environmental impacts of dredging include direct removal or burial of organisms, elevated turbidity or siltation, contaminant re-suspension, noise or disturbance, alterations to hydrodynamic regime and physical habitat, and loss of riparian habitat.² Furthermore, an increase in vessel traffic on the Delaware River resulting from the project would increase the likelihood of vessel strikes to sturgeon.²

A study of mortality rates on Atlantic sturgeon in the Delaware River between 2005 and 2008 found that 50% of the mortalities were the result of vessel strikes. The remaining 50% were too decomposed to determine if they were caused by vessel strikes but it is likely most were.² For small remnant populations of Atlantic sturgeon, such as that in the Delaware River, the loss of just a few individuals per year due to anthropogenic sources of mortality, such as vessel strikes, may continue to hamper restoration efforts.² According to a 2010 research article on vessel strikes, "Both the dredging to deepen the channel and the subsequent increase in large vessel traffic may further hamper the recovery of the Delaware River Atlantic sturgeon population."² Of critical importance, this study is concerned about the size of the vessels resulting from deepening as opposed to any increase in the volume of vessels. The larger size of the vessels from the deepened channel will likely increase the number of vessel strikes for both sturgeon species.²

The continued dredging of new deep-water areas will further impact Atlantic sturgeon spawning by accelerating the intrusion of brackish water into the hard-bottom spawning grounds, and thus forcing Atlantic sturgeon to spawn further upstream in the zone of depressed dissolved oxygen. This shift then exposes the eggs and larvae of newly spawned Atlantic sturgeon to low oxygen conditions from which they may not survive. This "squeeze" between increased salt intrusion in the estuary downstream (exacerbated by channel deepening, new deep-dredged berthing areas, and rising sea levels) and the near-lethal dissolved oxygen levels upstream limits the ability of Atlantic sturgeon to successfully reproduce, and increases the likelihood of extinction. This project makes a significant contribution to such salt-intrusion by adding 29 acres of new deep-water channel and berthing to an estuary under siege.⁴

4. Mussel Impacts

In November of 2010, researchers discovered beds of freshwater mussels in the Delaware River between Chester, PA and Trenton, NJ.² The species found included the alewife floater (*Anodonta implicata*) and the tidewater mucket (*Leptodea ochracea*), only found in New Jersey in the tidal Delaware River; the pond mussel (*Ligumia nasuta*) and the yellow lampmussel (*Lampsilis cariosa*), both considered critically-imperiled; and the creeper (*Strophitus undulatus*) and the eastern floater (*Pyganodon cataracta*) both considered vulnerable; as well as the eastern elliptio (*Elliptio complanata*), the only mussel known to be native to our Delaware River that is not considered to be in jeopardy.² Mussels are not mentioned in the application or in the applicant's Compliance Statement. Particularly because some of these estuarine species are state-listed and/or critically imperiled, the extent and composition of these mussel beds needs to be accurately surveyed prior to any in-water work at the site. Once the locations, abundance, and identify of these species are documented, a relocation plan would be needed to move individual mussels out of areas where direct mortality might occur.

⁴ Moberg and DeLucia. 2016. Potential Impacts of Dissolved Oxygen, Salinity and Flow on the Successful Recruitment of Atlantic Sturgeon in the Delaware River. The Nature Conservancy. Harrisburg, PA. 69 pp.

Freshwater mussels can live 80 to 100 years old, and most species do not begin reproducing until they are 8 to 10 years old.² Because they are so slow growing and don't begin to reproduce until this older age, they are not able to quickly recover from disturbances and the population cannot recover quickly from impacts that result in death to individuals.² Freshwater mussels require a fish host, a specific species depending on the mussel, to complete their life cycle. Activities that damage the needed fish hosts in turn do direct harm to the freshwater mussel species they help serve in the life cycle.²

Mussels are vital for filtering pollution and filling important habitat niches. Experts believe that revitalizing freshwater mussels in the Delaware River could improve water quality downstream and thereby benefit estuarine species.² All of the freshwater mussels in the Delaware River system, except for one (the Eastern elliptio, *Elliptio complanata*), are identified by one or more of the states as endangered, threatened, imperiled, vulnerable, critically impaired, very rare, extremely rare or extirpated.²

Freshwater mussels are very sensitive to water quality. Exposure to contaminants either directly via dissolved compounds or contaminants that are particle-mediated can have adverse consequences.² Freshwater mussels are highly exposed to changes in water quality because of their filtering activities and the passage of large volumes of water across many thin tissue layers. Dissolved toxins, such as heavy metals, are rapidly taken up by direct absorption and indirectly via food.² Because this project will likely result in pollution both directly and through contaminants from spoil disposal, the implications of this pollution for the mussels in this area must be examined.

Stressed mussels require more oxygen. The dredging described for this project is a threat to any submerged aquatic vegetation in the area that is critical for providing oxygen in the Estuary, including the Philadelphia reach of the River, which includes the location of the proposed project. Although dissolved oxygen levels can become excessively low in this area even today, they have improved significantly compared to decades past. In fact, the DRBC is considering elevating their "Aquatic Life Designated Use" rule in this section of the Delaware River to maintain and protect dissolved oxygen levels.⁵ Increased sedimentation from dredging activity inhibits mussels and their host fish species from taking in oxygen.² Additionally, invasive or exotic species resulting from interbasin transfers of water can be a very direct threat to freshwater mussels as well as many other species. Increased ballast water from deeper ships, and increased ship traffic, brought up the River by a deeper channel could heighten this risk.² The issue of invasive and exotic species and ballast water and their ecological and economic implications for freshwater mussels and other River fish and wildlife species must also be considered.

Identification of host fish needed for freshwater mussels is one of the least studied aspects of freshwater mussel life history. American eel are known to be hosts for *Elliptio complanata*; some believe they are in fact the preferred host.² Some species of trout and yellow perch too can serve as hosts and data shows that some of the species found in the tidal estuary, *Strophitus undulatus*, can use pumpkinseed and yellow perch.² Shad too are considered by some as possible host species.² The potential impacts to these host species are additional factors to consider when assessing the threats to mussels.

5. Additional Fish and Wildlife Impacts

⁵ Delaware River Basin Commission (2017) Draft Resolution, February 23, 2017. Retrieved from http://www.nj.gov/drbc/library/documents/Res_EstuaryAquaticLifeUses_draft022317.pdf

As indicated in Appendix E of Ramboll Environ's Compliance Statement, there are bald eagle (*Haliaeetus leucocephalus*) nests and osprey (*Pandion haliaetus*) nests near or within the project site.⁶ From the Compliance Statement:

*"There are currently two (2) active bald eagle nests located within 1 km of the Project Site: one located on Mond's land and a second located east of the Project Site near Clonmell Creek."*⁴

*"Field observations have confirmed that four osprey nests were established on the Project Site on man-made structures including utility poles and a loading arm located at the wharf."*⁴

Even with the best mitigation plan in place, there would inevitably be some level of disturbance to these nests versus the no-action alternative which would leave the nests as they currently are. The nests are not even mentioned in the public notice and this is an issue that the public should be aware of. While formerly a highly-degraded site when DuPont owned and operated the property, the wetland and upland portions of the site have reverted to a natural state with a diverse ecosystem suitable as nesting habitat for these two imperiled bird species. Any disturbances or alterations to these nesting areas could be detrimental to the breeding success of these birds and therefore the future viability of their populations in this area.

Additionally, there is evidence that the acoustic impacts from construction activities, such as those described for this project, can significantly harm fish.⁷ The effects of underwater sounds created by pile driving on fish may range from a brief acoustic annoyance to instantaneous lethal injury depending on many factors.⁵ Even at non-lethal levels, low levels of acoustic damage may result in the fish not being able to swim normally, detect predators, stay oriented relative to other fish in the school, or feed or breed successfully.⁵ This is a potential threat to all fish, including both sturgeon species as well as all the fish that serve as host species to mussels.

6. Increased Ballast Water Needs and Discharge

The deepened 29 acres of river area that would provide access to the proposed deepwater port would result in larger and deeper draft vessels coming up the River which means more ballast water needs, discharges, and impacts. Impingement and entrainment of the variety of species discussed in this comment and beyond due to the intake and discharge of ballast water could be significant. The increased intake of ballast water from the River as a result of the commercial vessels coming into the River due to this project would entrain early life stages of commercially and recreationally important fish including American shad, alewife, blueback herring and striped bass.² The cumulative effects of this impingement and entrainment need to be considered in conjunction with the impingement and entrainment that already occurs at existing cooling water intakes operating in the Delaware Estuary and River, including the nearby Paulsboro and West Deptford Township facilities.

⁶ Ramboll Environ (2016). Compliance Statement in Support of Multiple Individual Permit Applications. Appendix E, Habitat Impact Assessment Report, July 2016.

⁷ Delaware Riverkeeper Network (2011). Supplemental Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

In addition, the concerns about invasive exotic species that may result from larger discharges of ballast water from larger vessels cannot be overstated in terms of either ecological or economic impacts. The invasion of such species into major ports and waterways of the U.S. have cost billions of dollars in control efforts and lost economic value from damage to important fish and wildlife species as well as the habitats that support them.² For more information see

http://water.epa.gov/polwaste/vwd/ballastwater/invasive_species_index.cfm

http://water.epa.gov/polwaste/vwd/ballastwater/invasive_species_bal_links.cfm

<http://www.invasivespecies.gov/index.html>

7. Submerged Aquatic Vegetation

As with mussels, there is lack of survey information by the applicant regarding the presence of any submerged aquatic vegetation (SAV) in the project area and it is not even mentioned anywhere in the application or in their Compliance Statement. SAV is vital habitat for many of the life stages of prey base, young-of-the-year striped bass, and river herring.² It functions as a substrate for macroinvertebrates and as cover for small fish as well as a source of dissolved oxygen for the water.² For the Delaware Estuary, the current high levels of dredging and industrial shipping limit the extent and abundance of this vital habitat, necessitating the protection and preservation of each SAV bed. If present in the project area, the resulting implications for water quality and species require careful consideration.

8. Recreational Impacts

This project would likely introduce toxic contaminants into the River and food chain. The Delaware River and Estuary are major destination points for recreational fishing. Exacerbating the already contaminated conditions of the fish, subjecting them to extended fish advisories due to the addition of more contaminants into the River system, or resulting in new advisories, are potential harms to this major recreational use of the River. Spending in the Delaware River and Estuary region by recreational anglers is valued at \$62 to \$100 per angler per day.² NOAA reported in 1991 that roughly 155,000 people spent almost \$60 million fishing in Delaware's waters resulting in \$29 million in earnings, and supporting 1,605 jobs.²

In that same year, 950,000 people spent more than \$630 million fishing in New Jersey's waters, resulting in \$400 million in earnings, and supporting 16,750 jobs.² While the Delaware Estuary is not responsible for all of this fishing and related jobs and income, it is responsible for a fair share of it. Further contamination and/or even the perception of additional contamination from this project could create significant recreational and economic harms.

9. Economic Costs

In addition to the numerous environmental costs of this project, there would also be extensive economic costs. There are potentially hundreds of millions of dollars a year that could be lost in river jobs and economic returns (present and future) associated with the environmental resources put at risk from the project.² The project puts at risk the fish, shellfish, wildlife, and habitats that are critical for providing hundreds of millions of dollars of income and jobs in the present and future. Finally, there is no demonstrated public benefit that outweighs the level of public, economic, and environmental harms that will result from implementing this project.

10. Secondary Impacts

The proposed project does not appear to sufficiently address compliance with the Clean Water Act's Section 404(b)(1) guidelines for consideration of alternatives. The fundamental objective of these guidelines was to ensure that discharges of dredged or fill materials into waters of the US, including wetlands, should not occur unless it can be demonstrated that such discharges either individually or cumulatively, will not result in unacceptable adverse effects on the aquatic ecosystem (40 CFR 230.10(a)). As such, the applicant is required to evaluate opportunities for use of non-aquatic areas and other aquatic sites that would result in less adverse impacts of the ecosystem.

It is not clear from the public notice how secondary impacts to the aquatic ecosystem were evaluated by the applicant. In many cases the secondary impacts result in significant impacts to the environment including impacts to delegated wetlands and waters. The overall project contemplates impacts to 7.22 acres of riparian zone as well as 8 acres of freshwater wetlands, 6 acres of coastal wetland, 0.39 acres of open water and approximately 47 acres of freshwater and coastal wetland buffer areas. The applicant has not satisfied its obligation to show that it exhausted attempts to avoid and then minimize of impacts to regulated resources such as riparian zones, coastal and freshwater wetlands and wetland transition area. Compliance with the 404(b)1 guidelines has not been seriously attempted or any effort to adequately illustrate compliance. The project proposed before the Army Corps should not be reviewed as approval of the waterfront portion in isolation of all other impacts of this project as these impacts are inextricably associated with other significant impacts situated outside of the Corps' jurisdiction.

11. EPA Review

Section 404(q) of the Clean Water Act establishes a requirement that the Secretary of the Army and the Administrator of the EPA enter into an agreement assuring that delays in the issuance of permits under Section 404 are minimized. In August 1992, a Memorandum of Agreement (MOA) was created and the EPA may request that certain permit applications receive a higher level of review within the Department of Army. This project clearly demonstrates that there is the potential for adverse impacts to aquatic resources, as such, this project should receive a higher level of review. Has communication with the US Environmental Protection Agency occurred with regards to this project? If not, it is requested that the EPA be made aware of this project and initiate a higher level of review.

12. Compensatory Mitigation

In 2008, EPA and the US Army Corps of Engineers jointly promulgated regulations revising and clarifying requirements regarding compensatory mitigation. According to these regulations, compensatory mitigation means the restoration, establishment, enhancement and/or in certain circumstances preservation of wetlands, streams and other aquatic resources for the purpose of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved. The public notice states that the applicant has

“avoided/minimized impacts to the aquatic environment by incorporating engineering/construction procedures into the process that will substantially reduce impacts to aquatic resources. Additionally, the applicant states that the amount of fill in open water has been minimized by designing a portion of the multi-purpose pier as an open deck structure and by removing existing deteriorated and unnecessary

marine structures. Due to the large area and volume of existing structures to be removed, there is an overall decrease in the area and volume of fill in open water compared to previous conditions. Therefore, it is the opinion of the applicant that the new fill is more than offset by the removal of existing structures and fill, no compensatory mitigation is being offered.

The applicant does not provide any factual basis in their alternatives analysis to support this claim. As such, compensatory mitigation should be provided in accordance with 40 CFR Chapter 1 – Subpart J to address the losses of aquatic resources.

Delaware Riverkeeper Network opposes the approval by the Corps of the proposed permit that is being considered under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) and Section 404 of the Clean Water Act (33 U.S.C. 1344) for the reasons discussed herein and because the proposed permit does not serve the public interest, would have a substantial impact on the natural resources of the Delaware River and because there is no indication that this project is needed by the public.

Respectfully submitted,

Handwritten signatures in blue ink. The signature on the left is 'Maya van Rossum' and the signature on the right is 'Tracy Carluccio'.

Maya van Rossum
the Delaware Riverkeeper

Tracy Carluccio
Deputy Director

Atlantic Sturgeon Vessel-Strike Mortalities in the Delaware Estuary

ABSTRACT: The Atlantic Sturgeon Status Review Team has recommended that the Secretary of Commerce list the New York Bight distinct population segment of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), which includes the Delaware River and Hudson River populations, as threatened under the federal Endangered Species Act. Between 2005 and 2008, a total of 28 Atlantic sturgeon mortalities were reported in the Delaware Estuary. Sixty-one percent of the mortalities reported were of adult size and 50% of the mortalities resulted from apparent vessel strikes. The remainder of the mortalities were too decomposed to ascertain the cause of death, but the majority were likely the result of vessel strikes. For small remnant populations of Atlantic sturgeon, such as that in the Delaware River, the loss of just a few individuals per year due to anthropogenic sources of mortality, such as vessel strikes, may continue to hamper restoration efforts. An egg-per-recruit analysis demonstrated that vessel-strike mortalities could be detrimental to the population if more than 2.5% of the female sturgeon are killed annually. We report on our observations of vessel-strike mortalities in the Delaware Estuary, discuss the possible implications for the Delaware River population, and recommend further research.

Mortalidad del esturión del Atlántico en el estuario Delaware por colisión con embarcaciones

RESUMEN: El grupo de trabajo que revisa el estado del esturión del Atlántico recomendó que la Secretaría de Comercio enliste al segmento distintivo de la población de esturión del Atlántico (*Acipenser oxyrinchus oxyrinchus*) que habita en la Bahía de Nueva York, la cual incluye a las poblaciones de los ríos Delaware y Hudson, como especie amenazada dentro del Acta Federal de Especies en Peligro. Entre 2005 y 2008, se reportó un total de 28 esturiones muertos en el estuario Delaware. Sesenta y un por ciento de dichos animales eran de talla adulta y 50% de las mortalidades parecen haber sido resultado de colisiones con embarcaciones. El resto de los individuos muertos se encontraban en un estado de descomposición tan avanzado que no fue posible determinar la causa de muerte, sin embargo la mayoría de ellos muy probablemente perecieron como resultado de una colisión. Para las pocas poblaciones remanentes del esturión del Atlántico, como aquellas que habitan el río Delaware, la pérdida anual de algunos pocos individuos por mortalidad antropogénica, como la provocada por las colisiones con embarcaciones, pueden entorpecer los esfuerzos de restauración. Mediante un análisis de huevos por recluta se demostró que las mortalidades causadas por impacto con embarcaciones pueden ir en detrimento de la población, si perecen más de 2.5 por ciento de las hembras por año. En la presente contribución reportamos nuestras observaciones sobre la mortalidad de esturiones el estuario Delaware causadas por colisión con embarcaciones, se discuten las posibles implicaciones para la población del río Delaware y se recomiendan futuras líneas de investigación.

J. Jed Brown and Gregory W. Murphy

Brown is assistant director, U.S. Virgin Islands Division of Fish and Wildlife, St. Croix. He can be contacted at jed.brown@dpr.gov.vi. Murphy is a senior scientist with the URS Corporation, Fort Washington, Pennsylvania.

INTRODUCTION

The Atlantic Sturgeon Status Review Team (ASSRT), a group comprised of federal agency biologists, recently reviewed the status of Atlantic sturgeon (*Acipenser oxyrinchus*) populations in the United States and recommended that several distinct population segments (DPS) be listed as threatened under the federal Endangered Species Act. The ASSRT concluded that the Delaware River population had a moderately high risk (> 50% chance) of becoming endangered in the next 20 years (ASSRT 2007). The ASSRT grouped the Delaware River and Hudson River populations into a single New York Bight DPS and made a recommendation to the Secretary of Commerce that this DPS be listed as threatened under the Endangered Species Act. The states of Delaware and Pennsylvania, which border sections of the Delaware Estuary, have already placed Atlantic sturgeon on their respective state endangered species lists, and New Jersey lists this species as a "species of special concern" and its Endangered and Nongame Species Advisory Committee recommended an endangered status listing.

Given the long generation time and slow rate of population growth of Atlantic sturgeon, any anthropogenic sources of mortality may continue to hamper restoration efforts (Boreman

1997; Secor and Waldman 1999; Gross et al. 2002). Many factors including historical overfishing, habitat degradation, and the construction of dams have been implicated in the decline of Atlantic sturgeon populations. Due to the decline of populations along the Atlantic Coast, the Atlantic States Marine Fisheries Commission instituted a coastwide moratorium on the harvest of Atlantic sturgeon in 1998, which is designed to remain in effect until there are at least 20 protected year classes in each spawning stock. Collins et al. (1996) and Stein et al. (2004) detailed the impact of bycatch mortality on Atlantic sturgeon. We report here on another anthropogenic source of mortality that has not been widely considered—mortality from vessel strikes, and examine how these vessel strikes may be affecting the population of Atlantic sturgeon in the Delaware River. We use the term “vessel strike” to indicate mortality caused by entrainment through the propellers of vessels and direct collisions with vessel hulls.

The Atlantic sturgeon is one of nine species/subspecies within the family Acipenseridae present in North American waters (Cech and Doroshov 2004). Although intensely studied since the 1970s, many aspects of Atlantic sturgeon life history remain unknown (Murawski and Pacheco 1977; Bain 1997; Bemis and Kynard 1997; Smith and Clugston 1997; Kynard and Horgan 2002; ASSRT 2007). Specific life history characteristics vary latitudinally along the Atlantic Coast, but the Atlantic sturgeon is generally characterized as a long-lived, late-maturing, estuarine-dependent, anadromous species (ASSRT 2007). Anadromous species are those that spend the majority of their life cycle in marine environments but reproduce in freshwater habitats. The historic range of Atlantic sturgeon included major estuarine and riverine systems spanning from the Saint Johns River, Florida, to Hamilton Inlet on the coast of Labrador (Murawski and Pacheco 1977; Smith and Clugston 1997; ASSRT 2007), with the Delaware River historically supporting the largest population along the Atlantic Coast (Secor and Waldman 1999; ASSRT 2007).

Atlantic sturgeon are slow maturing, with females typically reaching sexual maturity at 16 years or older and males at least 12 years in mid-Atlantic systems (Van Eenennaam et al. 1996). Spawning is not believed to occur every year, with spawning intervals ranging from 2 to 5 years for females (Vladykov and Greeley 1963; Van Eenennaam et al. 1996; Stevenson and Secor 1999; ASSRT 2007). Fecundity has been correlated with age and body size and typically ranges between 400,000 and 8 million eggs per female (Smith et al. 1982; VanEenennaam and Doroshov 1998; Dadswell 2006; ASSRT 2007).

Spawning adults are generally thought to migrate upriver in their natal systems during April and May in mid-Atlantic systems (Murawski and Pacheco 1977; ASSRT 2007), with recent studies suggesting that spawning may occur as late as mid to late June in the Delaware River (Simpson and Fox 2007). Spawning is believed to occur in flowing water between the salt wedge and fall line of large tidal rivers, where optimal flows are between 46 and 76 cm/s and depths are between 11 and 27 m (Borodin 1925; Crance 1987; Bain et al. 2000; ASSRT 2007). The highly adhesive eggs are deposited on hard-bottom substrates and fertilized externally (Smith et al. 1980; Gilbert 1989; Smith and Clugston 1997; ASSRT 2007).

Spawning locations in the Delaware Estuary were historically reported between river kilometer (rkm) 75 and rkm 130,

with locations such as Pea Patch Island near Delaware City, Delaware, and Penn's Grove, New Jersey (rkm 85–110), noted as likely spawning areas. However, these conclusions were based primarily on fishery dependent information from the caviar fishery (Ryder 1890; Cobb 1900; Borodin 1925). Recent information from the movements of telemetered adult Atlantic sturgeon coupled with substrate and water quality information suggests that present day spawning may occur between north Philadelphia, Pennsylvania (rkm 176), and Trenton, New Jersey (rkm 211), in the Delaware River (Simpson and Fox 2007). However, the area between Marcus Hook, Pennsylvania (rkm 125), and Trenton could be considered potential spawning habitat based on substrate and water quality information (Simpson and Fox 2007). The majority of hard-bottom substrates, particularly coarse-grained substrates, occurring at depths suitable for Atlantic sturgeon spawning between Marcus Hook and Tinicum Island (rkm 136) either neighbor or are located within the shipping channel (Sommerfield and Madsen 2003).

After hatching, juvenile sturgeon move downstream into brackish waters, and eventually become residents in estuarine waters for months or years (Smith and Clugston 1997; ASSRT 2007). Upon reaching sizes of approximately 76 to 92 cm, the juveniles may emigrate to coastal waters (Murawski and Pacheco 1977; Smith 1985; ASSRT 2007), where they may travel widely, undertaking long range migrations and wandering among coastal and estuarine habitats (Dovel and Berggren 1983; Bain 1997; ASSRT 2007). Studies on the movements of telemetered juvenile and adult Atlantic sturgeon tracked manually in the Delaware Estuary indicate that sturgeon commonly utilize the shipping channel for upriver and downriver movements. These studies also identified three riverine concentration areas for juveniles during the summer months located at Artificial Island (rkm 89), Cherry Island Flats (rkm 110), and the Marcus Hook Anchorage (Shirey et al. 1999; Simpson and Fox 2007). Genetic studies and tagging programs indicate that a large percentage of the juveniles utilizing these concentration areas originated in other systems, mainly the Hudson River (King et al. 2001; ASSRT 2007; Wirgin et al. 2007).

Although the Delaware River once supported the largest population of Atlantic sturgeon along the Atlantic Coast (Secor and Waldman 1999; ASSRT 2007), overfishing, beginning in the 1880s and continuing throughout the early 1900s, led to recruitment failure and stock collapse. Habitat degradation and continued fishing prevented the population from recovering, and thus the population has apparently maintained itself at a very low level since the early 1900s. Currently, it is believed that Atlantic sturgeon are still reproducing in the Delaware River based on the capture of sexually mature adults during the historic spawning season (Simpson and Fox 2007). Genetic analyses from nuclear (King et al. 2001) and mitochondrial DNA (Wirgin et al. 2007) indicate that the Delaware River population is distinct from others on the Atlantic Coast. However, the ASSRT found that the Delaware River population was not sufficiently distinct to stand as its own DPS, and was grouped together with the Hudson River population as part of the New York Bight DPS.

The ASSRT speculated that the current population size of the Delaware River population is probably less than 300

spawning adults (ASSRT 2007). Although the ASSRT did not provide any empirical data to justify this population size, their rationale for using this figure was that the river systems for which adult population size estimates were available, the Hudson and the Altamaha, had approximate population sizes of 860 and 350 spawning adults, respectively. They speculated that these two populations are the largest populations in the United States and assumed that the other U.S. populations would be smaller than these two systems, hence the 300 spawning adults figure (ASSRT 2007). Rigorous estimates of the size of the Delaware River population are not available due to the difficulties associated with capturing a sufficient number of fish for study, particularly adults, the vast size of the Delaware Estuary, and the long-range migrations and coastal wandering behavior of juveniles and adults.

STUDY AREA

The Delaware Estuary, the tidal portion of the Delaware River, stretches from Trenton, New Jersey, and Morrisville, Pennsylvania (rkm 217), south to Cape May, New Jersey, and Cape Henlopen, Delaware, and includes all of Delaware Bay (Figure 1). It encompasses approximately 17,600 km² and is bordered by the states of New Jersey, Delaware, and Pennsylvania. The estuary is highly industrialized and hosts one of the largest petrochemical port complexes in the United States. Many large commercial vessels transit the estuary to reach these ports in the Wilmington, Delaware; Camden, New Jersey; and Philadelphia, Pennsylvania areas. The Maritime Administration of the U.S. Department of Transportation groups 17 ports in the Philadelphia, Pennsylvania, area together as Philadelphia/Delaware River Ports. These ports stretch from Salem, New Jersey, and Delaware City, Delaware, at rkm 97 to the ports of southern Bucks County, Pennsylvania, at rkm 203. In 2007, a total of 3,148 ocean-going vessels greater than 10,000 dead-weight tons (DWT) visited the Philadelphia/Delaware River Port Complex, making it the fifth busiest port complex in the United States, following Houston, Los Angeles/Long Beach, New York, New Orleans, and San Francisco (USDOT 2008). Within the port complex, the Port of Philadelphia at rkm 159 handles the greatest volume of cargo (USACOE 2006).

Vessels transit the estuary through a shipping channel, the depth of which is maintained by the U.S. Army Corps of Engineers. The lower portion of the shipping channel, which extends 203 rkm from the mouth of Delaware Bay to the south of Bordentown, New Jersey (approximately 24 rkm upriver of the northern boundary of the city of Philadelphia), is currently maintained at a depth of 12.2 m (40 ft). The width of the channel varies from 122 m to 305 m, with the channel being wider in the lower estuary and narrower upriver. North of Bordentown to the southern boundary of Trenton, a distance of 8.6 km, the channel depth is maintained at 7.6 m (25 feet). Through the city of Trenton, a distance of 2 km where there is a small port, the channel depth is maintained at a depth of 3.7 m (12 feet). The Delaware River is non-navigable by large vessels above Trenton. The relatively long distance vessels need to travel from the sea through the estuary to reach their ports is unusual; most of the other major Atlantic Coast ports such as New York and Norfolk, Virginia, are located close to the sea. The long distance that vessels transit through

the Delaware Estuary allows for a greater chance of interaction with sturgeon. In addition to commercial vessels, many recreational and commercial fishing vessels also traverse the Delaware Estuary.

METHODS

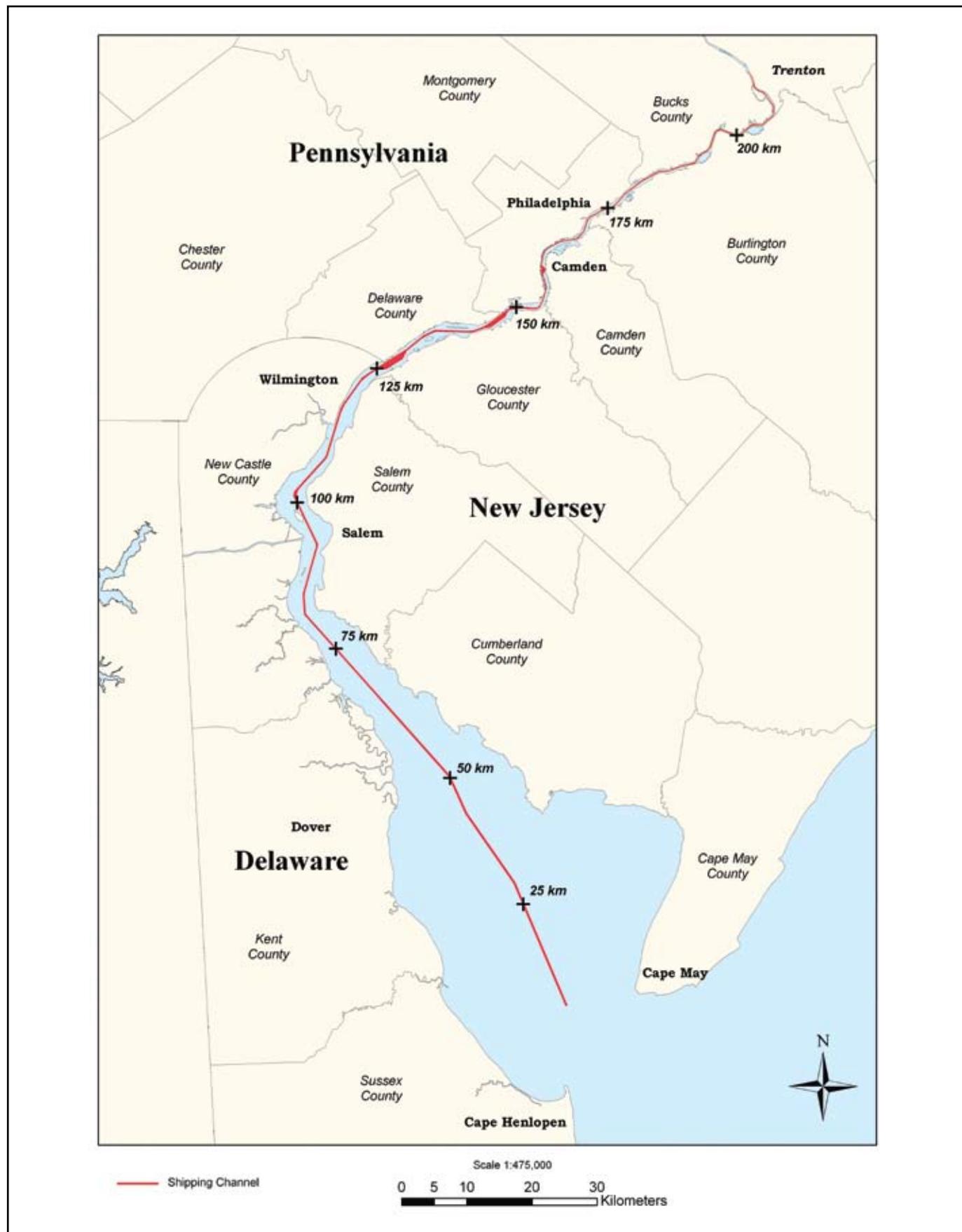
To evaluate the occurrence of Atlantic sturgeon vessel-strike mortalities in the Delaware Estuary, the Delaware Division of Fish and Wildlife (DEDFW) began tracking reports of sturgeon mortalities in 2005. The DEDFW received several reports of Atlantic sturgeon mortalities annually prior to 2005 but the reports were not formally documented. All of the sturgeon mortalities were reported by interested citizens or directly by agency biologists who encountered the carcasses while conducting surveys on other species. A dedicated survey program has not been implemented by DEDFW. However, the DEDFW Natural Heritage and Endangered Species Program has integrated logbooks and contact information into their shorebird monitoring program training guide. The shorebird monitoring program surveys a large portion of the beaches along Delaware Bay during spring and typically accounts for several of the sturgeon mortality reports annually. The majority of sturgeon reported were measured for total length (or length of portion found), scanned for internal and external tags, sexed when practical, examined for injuries, photo documented, and marked prior to being buried to eliminate double reporting. Tissue samples were taken and archived for future genetic stock analysis and a subset for contaminant analysis depending on the stage of decomposition.

To explore the effect of vessel-strike mortalities on the Delaware River Atlantic sturgeon population, we conducted an egg-per-recruit (EPR) analysis (Boreman 1997) to examine the impact on lifetime fecundity. The equation of the EPR is:

$$EPR = \sum_{i=2}^n \lambda_i \phi_i \prod_{t=1}^{i-1} e^{-(VS_t + M)}$$

where n is the oldest spawning age, λ is the proportion of females that are mature at age i , ϕ_i is the mean fecundity of a female at age i , VS is the instantaneous rate of vessel-strike mortality during the period t , and M is the instantaneous natural mortality rate. All maturity and fecundity schedules were taken from Kahnle et al. (2007). We evaluated a range of VS values from 0 to 0.25 at intervals of 0.01. We assumed a maximum age of 60 years, a constant M equal to 0.07 over all ages, fishing and bycatch mortality rates equal to zero, and that sturgeon become fully vulnerable to vessel strikes starting at age 3 (assuming knife-edge recruitment). We assumed that sturgeon become vulnerable to vessel strikes at age 3 because this age corresponds approximately to the length of the smaller sturgeon carcasses that were observed (Stevenson and Secor 1999). Vessel-strike mortality rates that result in EPRs of 50% or more of the EPR from an unexploited population were considered sustainable based on Kahnle et al. (2007).

Figure 1. Map of the Delaware Estuary, the tidal portion of the Delaware River, which stretches from Trenton, New Jersey, and Morrisville, Pennsylvania, south to Cape May, New Jersey, and Cape Henlopen, Delaware, and includes all of Delaware Bay. The estuary encompasses approximately 17,600 km² and is bordered by the states of New Jersey, Delaware, and Pennsylvania. The shipping channel is shown and rkm points are indicated.



RESULTS

A total of 28 Atlantic sturgeon mortalities were reported in the Delaware Estuary between 2005 and 2008 (Table 1). The locations of reports ranged from Little Tinicum Island on the Delaware River near Chester, Pennsylvania, to Cape Henlopen near the mouth of Delaware Bay (Figure 2). Sixty-one percent of the sturgeon reported were of adult size, which was defined as sturgeon exceeding or likely to exceed 150 cm total length if not severed, with the majority (71%) of mortalities reported in spring during the months of May and June. Only one carcass was reported from the New Jersey side of the estuary.

Fifty percent of the sturgeon reported had injuries consistent with being struck by a vessel, while the remaining sturgeon reported were too decomposed to definitively determine the cause of death. Of the carcasses that had injuries consistent with being struck by a vessel, 71% were severed through the torso or head region (Figures 3 and 4), which is consistent with being entrained through the propeller of a large vessel. A few sturgeon had injuries that were consistent with a strike from the propeller of a small vessel, such as a recreational or com-

mercial fishing vessel (Figure 5). Field observations indicate that it is unlikely that the injuries are occurring post-mortem. For instance, a DEDFW marine patrol officer encountered an adult Atlantic sturgeon that surfaced in the wash of a large vessel navigating upstream in the Delaware River in May 2005. The sturgeon was bleeding and moribund from a laceration near the dorsal fin described as a propeller strike (T. Penuel, DEDFW, pers. comm.). In addition, a Delaware commercial crabber reported hitting an adult-size Atlantic sturgeon with his outboard motor during late spring while moving through a shallow section of the lower Delaware River (C. Shirey, DEDFW, pers. comm.).

Results from the EPR analysis are shown graphically in Figure 6. We plotted the percentage of female sturgeon killed annually by vessel strikes versus the percent reduction in maximum EPR. Eggs per recruit declined rapidly from the maximum of 7.1 million eggs, if the only source of mortality was natural mortality, to less than 10% of this amount if the annual percentage of female sturgeon mortalities exceeded 9% of the population. The $VS_{50\%}$, or the vessel-strike mortality rate that results in a 50% reduction of the maximum EPR, occurs when

Table 1. Summary of Atlantic sturgeon carcasses reported in the Delaware Estuary between 2005 and 2008. Adults were defined as sturgeon exceeding or likely to exceed 150 cm total length if not severed. The dates and locations reported are the dates and locations where the carcasses were found and are not necessarily the dates and locations where the vessel strikes occurred.

Date reported	Location found	Life stage	Apparent cause of death	Injuries noted
5/7/2005	Artificial Island, NJ	Adult	Vessel strike	Severed at anal fins, blunt force trauma to head
5/17/2005	Woodland Beach, DE	Adult	Vessel strike	Severed through torso, crushed scutes, anterior section only
5/18/2005	Woodland Beach, DE	Adult	Vessel strike	Laceration through mid torso
5/19/2005	Slaughter Beach, DE	Adult	Unknown	Badly decomposed, head region missing,
5/23/2005	Conch Bar, DE	Adult	Unknown	Badly decomposed, head region missing
7/5/2005	Woodland Beach, DE	Juvenile	Vessel strike	Laceration near caudal peduncle
5/2/2006	Augustine Beach, DE	Adult female	Vessel strike	Severed through lower torso at anal fins, anterior section only
5/9/2006	South Bowers Beach, DE	Juvenile	Unknown	Badly decomposed, head region missing
5/15/2006	Port Mahon, DE	Juvenile	Unknown	Badly decomposed, head region missing
5/16/2006	Brockonbridge Gut, DE	Adult	Unknown	Badly decomposed, severed through lower torso at anal fins, anterior section only
5/17/2006	Kitts Hummock, DE	Adult	Unknown	Badly decomposed
5/17/2006	Little Tinicum Island, PA	Adult	Vessel strike	Severed through lower torso at anal fins, anterior section only
6/1/2006	Bay View Beach, DE	Juvenile	Vessel strike	Severed through mid torso region, anterior section only
8/15/2006	New Castle, DE	Adult	Unknown	Badly decomposed
8/17/2006	Augustine Beach, DE	Juvenile	Vessel strike	Laceration to head region
5/11/2007	Collins Beach, DE	Adult	Vessel strike	Severed through torso, posterior section only
5/13/2007	Pea Patch Island, DE	Adult	Unknown	Unreported
5/14/2007	Pickering Beach, DE	Juvenile	Vessel strike	Severed through torso, posterior section only
5/25/2007	Pea Patch Island, DE	Juvenile	Vessel strike	Severed through torso, posterior section only
6/11/2007	Bay View Beach, DE	Adult	Unknown	Badly decomposed
5/29/2008	Cape Henlopen, DE	Juvenile	Unknown	Badly decomposed, head region missing
6/23/2008	Marcus Hook, PA	Adult	Vessel strike	Severed head and crushed scutes
6/29/2008	Augustine Beach, DE	Juvenile	Vessel strike	Laceration posterior to head region and side of torso
7/10/2008	Port Mahon, DE	Juvenile	Unknown	Badly decomposed
7/12/2008	South Bowers Beach, DE	Adult	Unknown	Badly decomposed
10/21/2008	Ship John Shoal, DE Bay	Adult	Vessel strike	Head region severed
10/27/2008	Cape Henlopen, DE	Juvenile	Unknown	None observed
11/3/2008	Woodland Beach, DE	Adult	Unknown	None observed

Figure 2. Locations of Atlantic sturgeon carcasses reported in the Delaware Estuary between 2005 and 2008. The locations shown are where the carcasses were found and are not necessarily the locations where the vessel strikes occurred.

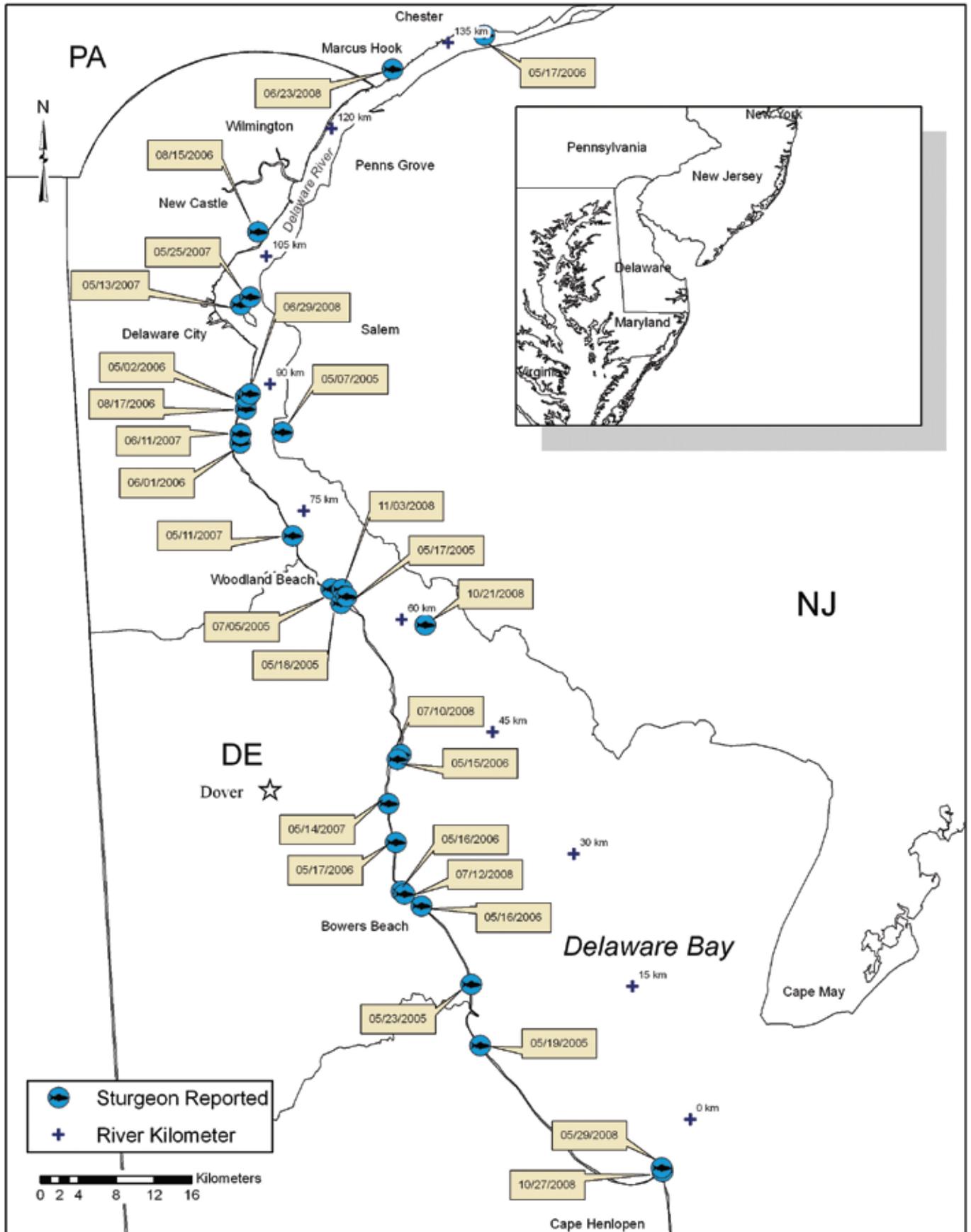


Figure 3. Gravid female Atlantic sturgeon found at Augustine Beach, Delaware, on 2 May 2006. This sturgeon appeared to have been struck by the propeller of a large vessel and was severed through the torso region near the anal fins. The anterior portion found measured 145 cm in length.



JARED JACOBINI, DEDFW

Figure 5. Juvenile Atlantic sturgeon found at Augustine Beach, Delaware on 29 June 2008. The injuries were consistent with a strike from the propeller of a small vessel. This sturgeon measured 75 cm total length.



GREG MURPHY, URS CORPORATION

approximately 2.5% of the female Atlantic sturgeon in the Delaware River population are struck by vessels and killed annually.

DISCUSSION

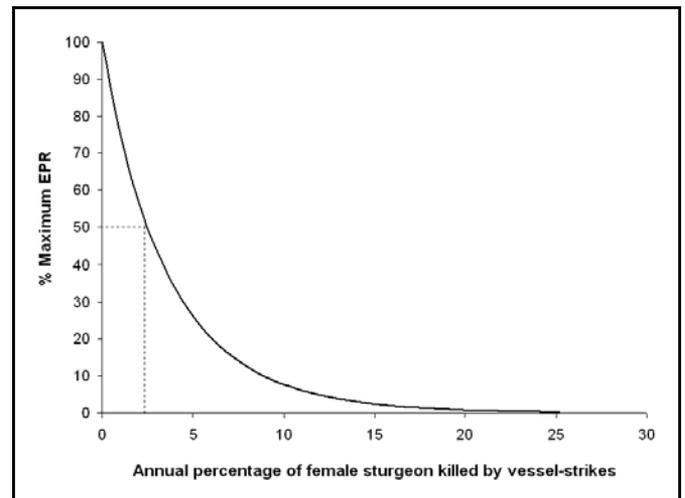
The presence of gravid Atlantic sturgeon in the Delaware River during the historical spawning season is strong evidence that a remnant population continues to persist. However, the number of sturgeon being killed by vessel strikes may be detrimental to the long-term viability of the population. Because juvenile sturgeon inhabiting the Delaware Estuary are composed of mixed stocks, predominantly fish of Hudson River origin foraging in the Delaware River (King 2001; ASSRT 2007; Wirgin et al. 2007), the vessel strikes occurring in the estuary may be adversely affecting sturgeon populations from

Figure 4. Large adult Atlantic sturgeon found at Woodland Beach on 17 May 2005. This sturgeon appeared to have been severed by the propeller of a large vessel. Greg Murphy of URS Corporation shown in photo examining the carcass.



JARED JACOBINI, DEDFW

Figure 6. The percent of maximum eggs per recruit (EPR) versus the annual percentage of female Atlantic sturgeon in the Delaware River population killed by vessel strikes.



other systems as well. The impact of these mortalities on the viability of the Delaware River population would be better understood if population estimates were available. Therefore, it may be useful to assess estimates of adult spawning populations from other Atlantic Coast systems. Peterson et al. (2008) estimated the size of the spawning run population in the Altamaha River, which is thought to be one of the largest populations in the United States, to be about 350 fish. Kahnle et al. (2007) estimated that the size of the Hudson River population, purportedly the largest population on the Atlantic Coast, is approximately 860 adults. Neither of these studies estimated the total Atlantic sturgeon population (all age classes) for these rivers. Relative abundance estimates from gillnet surveys conducted by DEDFW indicate that the current Delaware River sturgeon population is much smaller

by comparison than that of the Hudson or Altamaha rivers (Shirey et al. 1999).

Some studies have recommended harvest strategies using $F_{40\%}$ as the basis for formulating risk-adverse harvest strategies (Clark 1993; Mace 1994), that is, the harvest strategy that consists of fishing at a rate that reduces spawning biomass per recruit (equivalent to lifetime egg production per recruit) to 40% of the unfished value. However, other studies have indicated that using $F_{50\%}$ may be more prudent for long-lived stocks with low resiliency and for those stocks targeted for rebuilding (Boreman 1997; Clark 2002; Kahnle et al. 2007). Based upon the vulnerability schedule assumed in the EPR, a small increase in annual mortality due to vessel strikes can have a large impact on the lifetime fecundity of sturgeon. Our EPR analysis showed that the $VS_{50\%}$ (analogous to $F_{50\%}$) occurred at a vessel-strike mortality rate of approximately 2.5% per year. For example, if the Atlantic sturgeon population in the Delaware River is 100 female fish, then probably not more than 2 females could be struck and killed annually without having an adverse effect on the population. Similarly, if the Atlantic sturgeon population is 1,000 females, then probably not more than 25 females could be killed annually without negatively impacting the population.

There are very few beaches or access areas along the length of the Delaware Bay. Much of the shoreline consists of dense marsh vegetation limiting public access and reducing the likelihood that a carcass would be encountered and reported. Thus, only some fraction of the total vessel-strike mortalities that have occurred probably are reported. Another reason to suspect that the data reported here underestimate the total number of vessel-strike mortalities is that the data are derived primarily from reports received by DEDFW, and not from any agencies on the New Jersey side of the estuary. The New Jersey Division of Fish and Wildlife (NJDFW) does not have a program that tracks sturgeon mortalities in the Delaware Estuary and their biologists have not found carcasses on the New Jersey side of the estuary (R. Allen, NJDFW, pers. comm.).

Aside from the fact that the data reported here were primarily collected by DEDFW, physical oceanographic processes are probably responsible for the fact that most sturgeon carcasses were found on the Delaware side of the estuary. In the Delaware Estuary, dense, high salinity water flows into the estuary via the deep channel and the light low salinity water flows out along the surface of the Delaware and New Jersey shores. However, because the Coriolis force deflects the light, low salinity water flowing out of the estuary against the Delaware shore, the buoyant outflow is much stronger along the Delaware shore than the New Jersey shore (Wong and Munchow 1995).

In 2006, nine sturgeon mortalities were found in the Delaware Estuary. In the unlikely scenario that these mortalities represented 100% of the total sturgeon mortalities in the Delaware Estuary (and were all female), then the sturgeon population would need to exceed 360 female fish to avoid adverse population impacts. In the more likely scenario that the nine mortalities that were reported represented only 10 or 50% of the total sturgeon vessel-strike mortalities (and were all female), then the sturgeon population would need to be larger than 3,600 or 720 female fish, respectively, to avoid adverse impacts. Gutreuter et al. (2003) noted that entrainment kills

are rarely observed even in abundant species, but that if vessel traffic is large, even low kill rates that are extremely difficult to detect have the potential to adversely affect the production of certain species.

Fifty percent of the sturgeon carcasses found were too decomposed to definitively ascribe the cause of death to vessel-strikes. It is possible that these sturgeon were killed in gillnets, partially preyed upon by large predators, or died from disease. However, because these sturgeon were found in the same general area as the less decomposed carcasses and 36% were missing their head region, it is not unreasonable to assume that the majority of these sturgeon were also vessel-strike mortalities. We are unaware of any large predators such as large sharks that would move up the Delaware Estuary and consume only a portion of a sturgeon. Seals are occasional visitors to the Delaware Estuary, but they tend to visit in the late fall and winter and for the most part are localized in the lower Delaware Bay (www.ocean.udel.edu/oilspill/wildlifeimpacts.html). Similarly, we are unaware of any epizootics targeting sturgeon. There is a gillnet fishery for American shad (*Alosa sapidissima*) and striped bass (*Morone saxatilis*) in the lower Delaware Estuary, which is mostly prosecuted on the Delaware side of the estuary (New Jersey prohibits the commercial harvest of striped bass and Delaware's jurisdiction extends to the New Jersey shoreline of the Delaware River north of Delaware Bay). None of the carcasses found showed any indication of being entangled in gillnet mesh, i.e., none of the carcasses were enmeshed in netting, and none showed any indications of gillnet scars. Additionally, many of the commercial fishermen in the gillnet fishery report releasing the vast majority of the sturgeon they catch alive in good condition, which has been substantiated by tag returns months after being caught as bycatch in Delaware Bay (C. Shirey, DEDFW, pers. comm.). Similarly, many of the sturgeon carcasses reported here were found upriver of the northern limit of the anchored gillnet fishery (Liston Point, Delaware, rkm 77). Because of the nature of the currents in the estuary, it is unlikely that these carcasses drifted upriver. Finally, the striped bass gillnet fishery in Delaware, which is the primary gillnet fishery in the estuary, is open only from 15 February to 31 May and then, depending on the amount of quota harvested in the spring, can be opened again from 15 November to 31 December. Yet 50 % of the carcasses were found from 1 June to 14 November, outside of the striped bass gillnet season window.

The Philadelphia/Delaware River port complex differs from most of the other major ports in the United States in that the port facilities are located far up in the estuary. This poses an additional liability for sturgeon. The port's distant location from the Atlantic Ocean requires that vessels navigate through most of the estuary into potential Atlantic sturgeon habitat, thereby increasing the possibility of interactions with sturgeon. Additionally, above the Salem, New Jersey, and Delaware City, Delaware area, the estuary narrows significantly. Therefore, there is less habitat outside of the shipping channel for sturgeon to inhabit, and consequently sturgeon may be more likely to be struck by a vessel in the upper estuary.

Currently, the U.S. Army Corps of Engineers is planning to deepen the main channel of the Delaware River by 1.5 m (5 feet), from 12.2 m (40 feet) to 13.7 m (45 feet), from the Philadelphia Harbor, Pennsylvania, and Beckett Street

Terminal, New Jersey, to the mouth of the Delaware Bay, a distance of 165 km, to allow larger vessels to enter the river (www.nap.usace.army.mil/cenap-pl/drmcdp/overview.html).

Both the dredging to deepen the channel and the subsequent increase in large vessel traffic may further hamper the recovery of the Delaware River Atlantic sturgeon population.

The majority of vessel strikes appeared to result from interactions with large vessels, such as tankers, with a lower percentage likely resulting from interactions with small recreational or commercial fishing vessels equipped with outboard or inboard/outboard (stern drive) engines. Atlantic sturgeon are demersal fishes and thus if the sturgeon are spending most of their time at the bottom of the water column, then they are most likely being impacted by larger vessels. Large vessels that transit the shipping channel typically draft close to the bottom of the channel, thereby posing a threat to sturgeon positioned close to the bottom of the channel. Other species of sturgeon, such as the white sturgeon (*A. transmontanus*) are primarily found in the lower portion of the water column. Paragamian and Duehr (2005) tagged white sturgeon with depth-sensitive radio transmitters during prespawn and spawning periods in the Kootenai River, Idaho, located in the upper Columbia River basin, and found the sturgeon in the bottom one-third of the water column during 75% of the relocations. Fisher and Jacobini (2007) reported that Atlantic sturgeon surgically implanted with depth-sensing acoustic transmitters in the Delaware River were recorded at depths of 6.1 to 15.5 m and averaged 9.0 m in depth during manual relocations. Additional data on movements in the water column are still being collected and analyzed (Fisher and Jacobini 2007). Similarly, some of the sturgeon carcasses reported appeared to be too large to be severed by a small outboard propeller. Alternatively, sturgeon are known to frequently jump out of the water (Sulak et al. 2002). During jumping episodes, when sturgeon are located at or near the surface of the water, they may be more vulnerable to strikes from smaller vessels powered by outboards.

The problem of vessels striking and killing Atlantic sturgeon may be common in other estuaries and rivers as well. For example, five Atlantic sturgeon were reported to have been struck and killed by vessels in the James River, Virginia, in 2005, three in 2006, seven in 2007, and eight mortalities were reported in 2008. Most of the carcasses were found in a small area upstream of Hopewell, Virginia, where there is a significant narrowing of the shipping channel (A. Spells, U.S. Fish and Wildlife Service, pers. comm.). The James River is similar to the Delaware River in that commercial vessels transit long distances upriver to reach the ports. In the James River, vessels need to transit over 140 km to reach ports in Richmond, Virginia (www.nao.usace.army.mil/Partnerships/James%20River/homepage.asp).

Vessel-strike mortalities have also been noted in other sturgeon species. Gutreuter et al. (2003) examined mortality rates in adult fish entrained through the propellers of river towboats on the Upper Mississippi River and Illinois Waterway and found that a variety of fish were killed by towboat propellers, including shovelnose sturgeon (*Scaphirhynchus platyrhynchus*). They estimated that an average of 0.53 shovelnose sturgeon were killed per km of towboat travel. Partially or completely severed adult lake sturgeon (*A. fulvescens*) have also been

recovered from the Upper Mississippi River (S. Gutreuter, U.S. Geological Survey, pers. comm.).

The only reports we were able to find of marine fish mortalities related to vessel strikes were for whale sharks (*Rhincodon typus*; Gudger 1938a, 1938b, 1940). The whale shark mortalities reported by Gudger were all rammings by the bow of vessels. There have been reports of marine mammals such as whales (Laist et al. 2001; Kraus et al. 2005; Panigada et al. 2006), dolphins (Wells and Scott 1997) and manatees (Marmontel et al. 1997; Laist and Shaw 2006) being struck by vessels. Additionally, there have been reports of sea turtle vessel strikes, e.g., from 1994–1999, 30% of the 109 sea turtles found dead in the Delaware Estuary were victims of vessel strikes (Stetzar 2002). To our knowledge, this represents the first reported account of Atlantic sturgeon being struck and killed by vessels.

Finally, vessel strikes in conjunction with other anthropogenic impacts may further impede the recovery of Atlantic sturgeon populations. Factors such as poor water quality, low dissolved oxygen levels (although dissolved oxygen levels in the Delaware Estuary have improved dramatically over the past 50 years; Sutton et al. 1996), habitat modification, and bycatch mortality may be affecting the Atlantic sturgeon populations. For example, under scenarios of low recruitment in the Hudson River, it was estimated that bycatch mortality of Atlantic sturgeon would exceed levels that would result in stable or growing populations, and it was noted that populations smaller than that of the Hudson River, such as the Delaware River population, would be expected to be disproportionately affected by bycatch as proportional removals have larger negative effects on less productive populations (ASMFC 2007).

RECOMMENDATIONS

Further research to quantify the extent of vessel-strike mortalities in the Delaware Estuary could include directed ground or aerial surveys, and a public outreach campaign to request public assistance in reporting Atlantic sturgeon carcasses to the relevant agency. The 2009 Delaware Fishing Guide, which lists the fishing regulations of the DEDFW, added a section which requests the public's assistance in reporting dead sturgeon to the agency (www.fw.delaware.gov/Fisheries/Documents/2009fishingguideweb.pdf). This approach could be adopted by other states. Creation of a centralized database to allow scientists to report vessel strikes on a coastwide basis would aid in gaining an understanding of the magnitude of the problem along the Atlantic coast. In an effort to evaluate the depth and area in the water column that Atlantic sturgeon utilize, DEDFW is currently tagging sturgeon in the Delaware River with depth-sensing ultrasonic transmitters, which will provide valuable information related to vessel strikes, perhaps identifying the depths at which sturgeon are being struck by propellers. Additionally, more sophisticated approaches to quantify sturgeon mortality could be considered, such as trawling behind vessels (Gutreuter et al. 2003).

Possible mitigation measures could include recommending reduced vessel speed during the Atlantic sturgeon spawning season for vessels transiting through known concentration or spawning areas in the Delaware Estuary or other rivers with Atlantic sturgeon populations. This strategy has proven effective

tive for marine mammals (Laist and Shaw 2006). For marine mammals, it is thought that slower vessel speeds reduce vessel-strike mortalities by reducing the force of collision impacts and by allowing animals more time to detect and avoid oncoming vessels (Laist and Shaw 2006). Although reducing vessel speed to reduce mortalities from the force of collision may be important for large whales (Vanderlaan and Taggart 2007), which can survive collisions due their large body size, we expect that the primary benefit of reduced vessel speeds would be to allow sturgeon additional time to detect and avoid approaching vessels.

Alternatively, it may be useful to investigate the possibility of using underwater sound, light, or odor to divert sturgeon from the shipping channel and/or attract them to areas outside of the shipping channel. Ultrasound has been found to be effective in controlling the behavior of clupeid species (Gibson and Myers 2002; Plachta and Popper 2003; Popper et al. 2004) but findings from studies on other species using a variety of frequencies have been ambiguous (Popper and Carlson 1998). Studies to date have not shown any indication that sturgeon would be capable of detecting ultrasound (Lovell et al. 2005; Popper 2005). Similarly, studies on using light to divert fish have demonstrated that mercury and strobe lights can be used to attract some species and divert others (Popper and Carlson 1998). Other research has demonstrated that scent is used to attract sturgeon for feeding (Bardi Jr. et al. 1986) and for reproduction (Kynard and Horgan 2002), and therefore it may be

worthwhile to investigate using odors to divert sturgeon from areas with heavy vessel traffic. However, if sturgeon require the channel habitat to spawn, then continually diverting them from the channel may be problematic.

ACKNOWLEDGMENTS

We thank Gary Nelson of the Massachusetts Division of Marine Fisheries for his assistance with developing the EPR model. We thank Jim Eggers of the Public Service Enterprise Group (PSEG), Kevin Kalasz of DEDFW Natural Heritage and Endangered Species Program, Matt Fisher of DEDFW, Tom Magge of the Pennsylvania Soil and Water Department, and the various citizens who assisted with reporting the Delaware Estuary Atlantic sturgeon mortalities discussed in this article. We thank Craig Shirey of DEDFW, Steve Gutreuter of the U.S. Geological Survey, Michaela Meyers of the University of Maryland, and John Boreman of the National Oceanic and Atmospheric Administration for their review of the manuscript and Jared Jacobini of DEDFW and Gregory Breese of the U.S. Fish and Wildlife Service for their assistance with the figures. We thank the U.S. Fish and Wildlife Service Virginia Fisheries Coordinator's Office, Virginia Sea Grant, Virginia Commonwealth University, especially Matt Balazik, and the James River Association for the information on vessel strikes in the James River.

Photo Contest

Send us your pictures...
Winner gets a free
Garmin etrex
GPS.



**HT-2000 Battery Backpack
Electrofisher**





The HT-2000 meets and exceeds all aspects of the Electrofishing Guidelines for Safety and Functionality.

Contact us to find out why so many Federal, State and Local Authorities are choosing the HT-2000 for their Fisheries Research Monitoring and Stream Assessments.

Halltech services all makes and models of Electrofishing equipment. Send your equipment in now and receive 10% off until March 1, 2010!

Toll Free: 1-866-425-5832 Ext.24

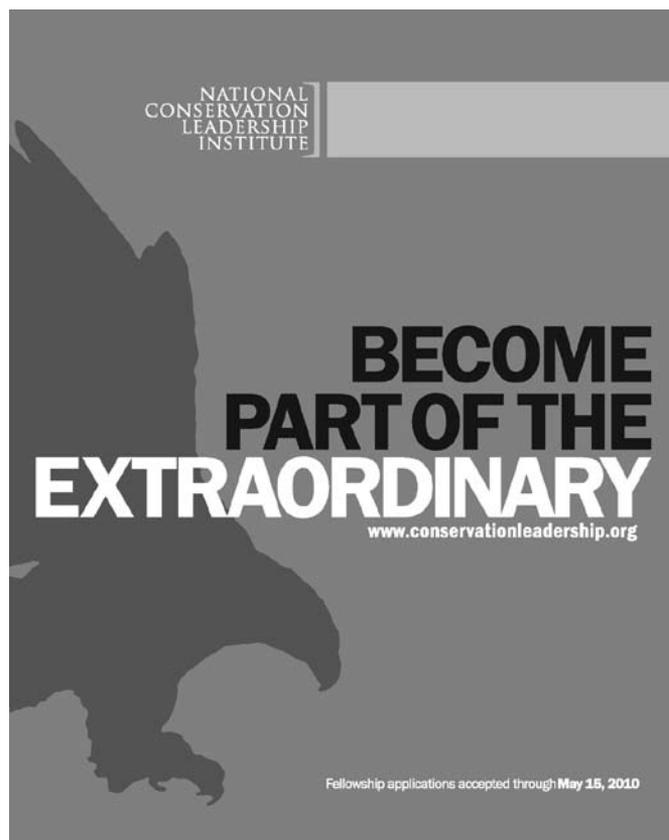
email: fish@halltechaquatic.com web: www.halltechaquatic.com

Visit www.htex.com for Rugged Data Collection Systems, GPS Solutions & more Field Research Products

REFERENCES

- ASMFC (Atlantic States Marine Fisheries Commission). 2007. Special report to the ASMFC Atlantic Sturgeon Management Board: estimation of Atlantic sturgeon bycatch in coastal Atlantic commercial fisheries of New England and the Mid-Atlantic. ASMFC, Washington, DC.
- ASSRT (Atlantic Sturgeon Status Review Team). 2007. Status review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office, Gloucester, Massachusetts.
- Bain, M. B. 1997. Atlantic and shortnose sturgeons of the Hudson River: common and divergent life history attributes. *Environmental Biology of Fishes* 48:347-358.
- Bain, M. B., N. Haley, D. Peterson, J. R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic sturgeon *Acipenser oxyrinchus* Mitchell, 1815, in the Hudson River Estuary: lessons for sturgeon conservation. *Instituto Espanol de Oceanografia. Boletin* 16:43-53.
- Bardi, Jr., R. W., F. A. Chapman, and F. T. Barrows. 1986. Feeding trials with hatchery-produced Gulf of Mexico sturgeon larvae. *The Progressive Fish-Culturist* 60(1):25-31.
- Bemis, W. E., and B. Kynard. 1997. Sturgeon rivers: an introduction to Acipenseriform biogeography and life history. *Environmental Biology of Fishes* 48:167-183.
- Boreman, J. 1997. Sensitivity of North American sturgeons and paddlefish to fishing mortality. *Environmental Biology of Fishes* 48(1):399-405.
- Borodin, N. 1925. Biological observations on the Atlantic sturgeon, *Acipenser sturio*. *Transactions of the American Fisheries Society* 55:184-190.
- Cech, J. J., and S. I. Doroshov. 2004. Environmental requirements, preferences, and tolerance limits of North American sturgeons. Page 73-86 in *Sturgeons and paddlefish of North America*. Springer, Netherlands.
- Clark, W. G. 1993. The effect of recruitment variability on the choice of a target level of spawning biomass per recruit. Pages 233-246 in G. Kruse, R. J. Marasco, C. Pautzke, and T. J. Quinn II, eds. *Proceedings of the international symposium on management strategies for exploited fish populations*. University of Alaska Sea Grant College Program Report 93-02. Fairbanks.
- Clark, W. G. 2002. $F_{35\%}$ revisited ten years later. *North American Journal of Fisheries Management* 22:251-257.
- Cobb, J. N. 1900. The sturgeon fishery of Delaware River and Bay. Report of the Commissioner, U.S. Commission of Fish and Fisheries 25:369-381.
- Collins, M. R., S. G. Rogers, and T. I. J. Smith. 1996. Bycatch of sturgeons along the southern Atlantic coast of the USA. *North American Journal of Fisheries Management* 16:24-29.
- Crance, J. H. 1987. Habitat suitability index curves for anadromous fishes. Page 554 in M. J. Dadswell, ed. *Common strategies of anadromous and catadromous fishes*. American Fisheries Society Symposium 1, Bethesda, Maryland.
- Dadswell, M. 2006. A review of the status of Atlantic sturgeon in Canada, with comparisons to populations in the United States and Europe. *Fisheries* 31(5):218-229.
- Dovel, W. L., and T. J. Berggren. 1983. Atlantic sturgeon of the Hudson Estuary, New York. *New York Fish and Game Journal* 30:140-172.
- Fisher, M., and J. Jacobini. 2007. Atlantic sturgeon progress report. State Wildlife Grant Project T-4-1. Delaware Division of Fish and Wildlife, Dover.
- Gibson, A. J. F., and R. A. Myers. 2002. Effectiveness of a high-frequency-sound fish diversion system at the Annapolis Tidal Hydroelectric Generating Station, Nova Scotia. *North American Journal of Fisheries Management* 22(3):770-784.
- Gilbert, C. R. 1989. Atlantic and shortnose sturgeons. U.S. Department of Interior Biological Report 82.
- Gudger, E. W. 1938a. Four whale sharks rammed by steamers in the Red Sea region. *Copeia* 1938(4):170-173.
- _____. 1938b. Whale sharks struck by fishing boats off the coast of lower California. *California Fish and Game* 24:420-421.
- _____. 1940. Whale sharks rammed by ocean vessels: how these sluggish leviathans aid in their own destruction. *New England Naturalist* 7:1-10.
- Gross, M. R., J. Repka, C. T. Robertson, D. H. Secor, and W. Van Winkle. 2002. Sturgeon conservation: insights from elasticity analysis. *American Fisheries Society Symposium* 28:13-30.
- Gutreuter, S., J. M. Dettmers, and D. H. Wahl. 2003. Estimating mortality rates of adult fish from entrainment through the propellers of river towboats. *Transactions of the American Fisheries Society* 132(4):646-661.
- Kahnle, A. W., K. A. Hattala, and K. A. McKown. 2007. Status of Atlantic sturgeon of the Hudson River Estuary, New York, USA. *American Fisheries Society Symposium* 56: 347-363.
- King, T. L., Lubinski, B. A., and A. P. Spidle. 2001. Microsatellite DNA variation in Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and cross-species amplification in the Acipenseridae. *Conservation Genetics* 2:103-119.
- Kraus, S. D., and fifteen co-authors. 2005. North Atlantic right whales in crisis. *Science* 309(5734):561-562.
- Kynard, B., and M. Horgan. 2002. Attraction of prespawning male shortnose sturgeon *Acipenser brevirostrum* to the odor of prespawning females. *Journal of Ichthyology C/J of Voprosy Ikhtiologii* 42(2):205-209.
- Laist, D. W., A. R. Knowlton, J. G. Mead, A. S. Collet, and M. Podesta. 2001. Collisions between ships and whales. *Marine Mammal Science* 17(1):35-75.
- Laist, D. W., and C. Shaw. 2006. Preliminary evidence that boat speed restrictions reduce deaths of Florida manatees. *Marine Mammal Science* 22(2):472-479.
- Lovell, J. M., M. M. Findlay, R. M. Moate, J. R. Nedwell, and M. A. Pegg. 2005. The inner ear morphology and hearing abilities of the paddlefish (*Polyodon spathula*) and the lake sturgeon (*Acipenser fulvescens*). *Comparative Biochemistry and Physiology A: Molecular and Integrative Physiology* 142(3):286-96.
- Mace, P. M. 1994. Relationships between common biological reference points used as thresholds and targets of fisheries management strategies. *Canadian Journal of Fisheries and Aquatic Sciences* 51:110-122.
- Marmontel, M., S. R. Humphrey, and T. J. O'Shea. 1997. Population viability analysis of the Florida manatee (*Trichechus manatus latirostris*), 1976-1991. *Conservation Biology* 11(2):467-481.
- Murawski, S. A., and A. L. Pacheco. 1977. Biological and fisheries data on Atlantic sturgeon, *Acipenser oxyrinchus* (Mitchell). NOAA (National Oceanic and Atmospheric Administration) NMFS (National Marine Fisheries Service), Highlands, New Jersey.
- Panigada, S., G. Pesante, M. Zanardelli, F. Capoulade, A. Gannier and M. T. Weinrich. 2006. Mediterranean fin whales at risk from fatal ship strikes. *Marine Pollution Bulletin* 52(10):1287-1298.
- Paragamian, V. L., and J. P. Duehr. 2005. Variations in vertical location of Kootenai River white sturgeon during the prespawn and spawning periods. *Transactions of the American Fisheries Society* 134:261-266.
- Peterson, D. L., P. Schueller, R. DeVries, J. Fleming, C. Grunwald and I. Wirgin. 2008. Annual run size and genetic characteristics of

- Atlantic sturgeon in the Altamaha River, Georgia. Transactions of the American Fisheries Society 137:393-401.
- Plachta, D. T. T., and A. N. Popper.** 2003. Evasive responses of American shad (*Alosa sapidissima*) to ultrasonic stimuli. Acoustics Research Letters Online 4:25.
- Popper, A. N.** 2005. A review of hearing by sturgeon and lamprey. Submitted to the U.S. Army Corps of Engineers, Portland District.
- Popper, A. N., and T. J. Carlson.** 1998. Application of sound and other stimuli to control fish behavior. Transactions of the American Fisheries Society 127:673-707.
- Popper, A. N., D. T. T. Plachta, D. A. Mann, and D. Higgs.** 2004. Response of clupeid fish to ultrasound: a review. ICES Journal of Marine Science 61(7):1057.
- Ryder, J. A.** 1890. The sturgeons and sturgeon industries of the eastern coast of the United States, with an account of experiments bearing upon sturgeon culture. Bulletin of U.S. Fish Commission 8:231-329.
- Secor, D. H., and J. R. Waldman.** 1999. Historical abundance of Delaware Bay Atlantic sturgeon and potential rate of recovery. American Fisheries Society Symposium 23:203-216.
- Shirey, C. A., C. C. Martin, and E. J. Stetzar.** 1999. Atlantic sturgeon abundance and movement in the lower Delaware River. Final Report. NOAA Project AGC-9N. Grant A86FAO315. Delaware Division of Fish and Wildlife, Dover.
- Simpson, P. C., and D. A. Fox.** 2007. Atlantic sturgeon in the Delaware River: contemporary population status and identification of spawning areas. Completion Report: Award NA05NMF4051093, Dover, Delaware.
- Smith, T. I. J.** 1985. The fishery, biology and management of Atlantic sturgeon, *Acipenser oxyrinchus*, in North America. Environmental Biology of Fishes 14:61-72.
- Smith, T. I. J., and J. P. Clugston.** 1997. Status and management of Atlantic sturgeon, *Acipenser oxyrinchus*, in North America. Environmental Biology of Fishes 48:335-346.
- Smith, T. I. J., E. K. Dingley, and E.E. Marchette.** 1980. Induced spawning and culture of Atlantic sturgeon. Progressive Fish Culturist 42:147-151.
- Smith, T. I. J., D. E. Marchette and R. A. Smiley.** 1982. Life history, ecology, culture and management of Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, Mitchell, in South Carolina. Final Report to U.S. Fish and Wildlife Service. South Carolina Wildlife and Marine Resources Department, Columbia.
- Sommerfield, C. K. and J. A. Madsen.** 2003. Sedimentological and geophysical survey of the upper Delaware Estuary. Final Report to the Delaware River Basin Commission, West Trenton, New Jersey.
- Stein, A. B., K. D. Friedland, and M. Sutherland.** 2004. Atlantic sturgeon bycatch and mortality on the continental shelf of the Northeast United States. North American Journal of Fisheries Management 24:171-183.
- Stetzar, E. J.** 2002. Population characterization of sea turtles that seasonally inhabit the Delaware Estuary. Masters thesis. Delaware State University, Dover.
- Stevenson, J. T., and D. H. Secor.** 1999. Age determination and growth of Hudson River Atlantic sturgeon, *Acipenser oxyrinchus*. Fishery Bulletin 97:153-166.
- Sulak, K. J., R. E. Edwards, G. W. Hill and M. T. Randall.** 2002. Why do sturgeons jump? Insights from acoustic investigations of the Gulf sturgeon in the Suwannee River, Florida, USA. Journal of Applied Ichthyology 18:617-620.
- Sutton, C.J., J. C. O'Herron, II, and R. T. Zappalorti.** 1996. The scientific characterization of the Delaware Estuary. The Delaware Estuary Program (DRBC Project 93.21; HA File 93.21), Wilmington, Delaware.
- U.S. Army Corps of Engineers (USACOE).** 2006. Waterborne commerce of the United States Calendar Year—2006, Part 5, National Summaries. USACOE, Alexandria, Virginia.
- U.S. Department of Transportation, Maritime Administration (USDOT).** 2008. Vessel calls at U.S. ports snapshot, 2007. USDOT, Washington, DC.
- Vanderlaan, A. S. M., and C. T. Taggart.** 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science 23(1):144-156.
- Van Eenennaam, J. P., and S. I. Doroshov.** 1998. Effects of age and body size on gonadal development of Atlantic sturgeon. Journal of Fish Biology 53:624-637.
- Van Eenennaam, J. P., S. I. Doroshov, G. P. Moberg, J. G. Watson, D. S. Moore, and J. Linares.** 1996. Reproductive conditions of the Atlantic sturgeon (*Acipenser oxyrinchus*) in the Hudson River. Estuaries 19(4):769-777.
- Vladykov, V. D. and J. R. Greeley.** 1963. Fishes of the Western North Atlantic. Memoir of the Sears Foundation for Marine Research. 1:24-60.
- Wells, R. S., and M. D. Scott.** 1997. Seasonal incidence of boat strikes on bottlenose dolphins near Sarasota, Florida. Marine Mammal Science 13(3):475-480.
- Wirgin, I. C. Grunwald, J. Stabile, and J. Waldman.** 2007. Genetic evidence for relict Atlantic sturgeon stocks along the Mid-Atlantic Coast of the United States. North American Journal of Fisheries Management 27:1214-1229.
- Wong, K. C., and A. Munchow.** 1995. Buoyancy forced interaction between estuary and inner shelf: observation. Continental Shelf Research 15:59-88.





June 7, 2019

Delaware River Basin Commission
West Trenton, New Jersey

Re: DOCKET NO. D-2017-009-2 , DELAWARE RIVER BASIN COMMISSION , Delaware River Partners LLC, Gibbstown Logistics Center, Dock 2 , Greenwich Township, Gloucester County, New Jersey

Delaware Riverkeeper Network (DRN) submits this comment in opposition to the approval of Docket D-2017-009-2 on behalf of our approximately 20,000 members throughout the Delaware River Watershed including residents in the closest Gloucester County communities. The Delaware Riverkeeper Network (DRN) is a private non-profit membership organization, championing the rights of our communities to a Delaware River and tributary streams that are free flowing, clean, healthy, and abundant with a diversity of life.

DRN submits that, based on review of the materials submitted to Delaware River Basin Commission (DRBC) by the applicant, this project will have substantial negative impacts on the Delaware River, its water quality, its habitats, and the species that live, forage, shelter, migrate through and reproduce in the River, Estuary and Bay. DRN also submits that the application is substantially lacking in critical information for and assessment of described and yet-to-be described or assessed aspects of the proposed project. DRN requests that Docket approval be denied or, in the alternative, the Docket be withdrawn and specific reviews and analyses are conducted before further consideration of the project.

DRN points out that we commented on the last docket proposed and approved by DRBC in November 2017 for the Gibbstown Logistics Center (D-2017-009-1). Concerns we expressed about the incompleteness of the application materials, unfortunately, remain. We point out DRBC did not heed these concerns in 2017 and since it appears now that New Fortress Energy may have been planning LNG export from this site at that time but did not disclose that information, our concerns were well-founded and should have led to DRBC insisting that the missing information be provided before the first docket was approved. If that had been done, the public and the agencies may have learned of the planned export of LNG from the Center and a comprehensive analysis of the project would have been required.

As stated by DRN in our comment letter dated November 17, 2017:

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215) 369-1181
drm@delawariverkeeper.org
www.delawariverkeeper.org

DRBC states its draft Docket is to approve dredging and the construction of a deepwater berth for the proposed Delaware River Partners (DRP) Gibbstown Logistics Center (“the Proposed Project”). However, the current draft docket, despite claiming to approve only the dredging and deep-water berth construction project, approves stormwater outfalls and land disturbances. Furthermore, the docket states that DRP “...is required to submit detailed site plans to the DRBC for the remainder of the Logistics Center, including the proposed: Automobile import area/parking lot; processing facilities; perishables, bulk-liquids and gases, and bulk cargo handling areas; warehouses and associated buildings; stormwater management system (including stormwater outfalls); and the associated infrastructure”.¹

Based on this lack of essential information, until all plans are completed, submitted to and assessed by DRBC, the draft docket for the Proposed Project should be put on hold. It is unreasonable to move ahead with an application that is so obviously incomplete and lacking in adequate assessment and review. It is impossible to accurately assess the potential impacts on the water resources of the Basin with the information made available for only a portion of the Proposed Project.

We point out that the condition (C.I.(c)) of the 2017 DRBC Docket, which requires the missing information to be provided, seems not to have been met by Delaware River Partners because in subsequent file reviews conducted by DRN through FOIA, we have not seen any written material in the files disclosing the plans of the applicant to include LNG as a cargo. This is despite repeated public statements by New Fortress Energy that LNG would be processed from Marcellus Shale gas in Bradford County, Pennsylvania, trucked to the Delaware River and exported out of the country through the Delaware River ports. The U.S. Army Corps of Engineers (ACE) Public Notice of April 4, 2019, listed various cargo to be transloaded at the Gibbstown Logistics Center. Included in the list was liquefied natural gas (LNG) and yet this was not added to this new draft docket for Dock 2. Obviously, the follow up information – site plans for handling of all cargo - that was to be provided by the applicant was either not supplied to DRBC or DRBC decided not to include LNG in the list of cargo published in the new draft docket. Either way, the public was deprived of this information and the missing information regarding the products to be handled at the Center, makes the application deficient based on incompleteness.

DRN points out that the exclusion of LNG from the cargo list is additionally important because of the dangers of handling and transloading LNG. LNG is arguably the most consequential and dangerous product to be handled at the Center, making it a glaring omission. We are including information regarding the potential impacts of LNG release and the special circumstances LNG requires at the end of this comment.

The additional dredging and deep-water berth construction project, named Dock 2, poses several unacceptable environmental hazards and potential pollution sources for the Delaware River and the region.

Environmental Impacts of the Proposed Activities Contained in the Draft Docket

Dredging: The dredging of 665,000 cubic yards of sediment from the Delaware River to provide a channel to the Federal Navigation Channel would go to a depth of 43 feet below mean water lower low water over a 45-acre area. Allowed is a two-foot overdraft. This almost doubles the amount of material that will be dredged for the entire Gibbstown Logistics Center project, increasing greatly the adverse environmental

¹ Docket No. D-2017-009-1, p. 3.

footprint of the dredging from the originally proposed Dock 1. The sediment to be dredged is silt, fine sand, and trace gravel, according to the draft docket. DRN is very concerned about the impacts of the dredging on water quality, fish, and aquatic life. We do not agree that the prevention measures included in the draft docket for controlling the sediment will provide adequate protection to species in the area of the Center.

The Delaware Riverkeeper Network has commented in the past on the significant environmental impacts that dredging causes in this section of the Delaware River. First, deepening 45 acres of river area to a depth of -40 feet mean lower low water with a 2-foot overdraft will open this newly deepened area to the potential for an increased risk of harm if there is a catastrophic spill event. With a deepened area, ships will access the proposed deepwater port and, when filled for export will be heavily laden with LNG, natural gas liquids or other chemicals. Using the catastrophic experience of the Athos I oil spill of November 26, 2004, the volume of carried material available to leak and wreak havoc on the environment and our communities will be greater and therefore more dangerous with the added capacity of the proposed port's dredging of 45 acres.²

The Athos I catastrophe exposed 115 miles of River, 280 miles of shoreline, 16,500 birds, as well as many species of fish, shellfish, and wildlife and a variety of important habitats to the heavy crude it dumped into the Delaware River.² Habitats, wildlife, water quality, air quality, industry, recreation, and communities were all significantly harmed by the spill. Any project that will increase the magnitude of such a tremendous level of damages in the event of a future catastrophe is a danger to all of these natural and human resources.

Adding LNG transport to the dangers of shipping on the river exponentially increases the potential for a far-reaching catastrophe. Considering that the zone of blast around a container release and/or fire is at least one mile and could be miles larger depending on how quickly the gas cloud created by the vaporizing LNG spreads, communities along the river, including metropolitan areas such as Philadelphia, Camden, Chester and other high density population centers), passing ships, bridges, facilities such as airports (the Gibbstown Logistics Center is across the river from the Philadelphia Airport), motor vehicle traffic and workers would all be exposed to potential life-threatening injury if an LNG marine vessel were to have an accident and release LNG. There is no discussion in the Docket about the shipping dangers that the dredging would enable. This is one reason why a comprehensive environmental analysis of this LNG project is required.

Dredge spoils significantly increase the amount of heavy metals and toxins that would be released into waterways and the environment², especially with the amount of material that appears to be contaminated at this site. The impacts of the spoil disposal plans and potential pollution impacts could have significant community and environmental effects. The threat posed by dredged spoils is known to be a source of water pollution after on-land disposal.² In addition to polluting the water and land, there are likely to be air quality impacts including NOx emissions associated with the construction and associated traffic from this additional dock and dredging project that should be considered as well. Yet there is no analysis of air pollution in the draft docket.

Atlantic sturgeon will be directly negatively impacted by the development and operation of this site. The draft docket states that the revised wharf design is under review currently by USACE in consultation with

² Delaware Riverkeeper Network (2011). Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

NMFS regarding two threatened and endangered sturgeon species, and the critical habitat for the Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). However, the docket fails to acknowledge that the federal government established the Delaware Estuary as Critical Habitat for the New York Bight DPS of Atlantic Sturgeon in August 2017. DRBC's Water Quality Regulations at §4.30.5-B.1 acknowledge that the Commission must evaluate Critical Habitat, and that this evaluation must follow its Rules of Practice and Procedure. Despite the federal ruling, DRBC has yet to initiate its procedures for verifying the Critical Habitat established by the federal government, and the role that Critical Habitat will play in docket decisions. DRBC should not approve any project that could directly and indirectly affect this Critical Habitat until it has completed all necessary procedures in the Critical Habitat evaluation. To do so would be premature, would undermine the required process for DRBC review and approvals, would be unfair in terms of just application of its regulations, and jeopardizes the Critical Habitat of the Atlantic Sturgeon. The DRBC is not ready to grant approval to any project that involves the Critical Habitat of the Delaware Estuary for the New York Bight DPS of Atlantic Sturgeon.

Both direct take and incidental take of sturgeon are a distinct possibility with a project of this nature. Both the Atlantic sturgeon and shortnose sturgeon are threatened and adversely affected by dredging and effects to water quality including dissolved oxygen (DO) levels, water temperature, and contaminants.² The proposed project will entail significant levels of dredging as well as significant water quality effects and dramatic changes in important habitats including juvenile habitat and spawning grounds.

The dredging of river systems significantly impacts aquatic ecosystems in a number of ways that will harm both sturgeon species. Among the effects that the project will have on the Delaware River populations of both sturgeon species are:

- ✓ Deep-draft vessel traffic in the Delaware River has been cited as the biggest threat to the survival of the Delaware River population Atlantic sturgeon; the increased vessel traffic and increased area for deep-draft vessels to strike Atlantic sturgeon directly resulting from this project will significantly increase sturgeon vessel strikes and could accelerate the extinction of this endangered species population.³
- ✓ Dredging activities remove, disturb, dispose of and re-suspend river sediments, modifying the river bottom substrate and impacting the community of benthic macrofauna;
- ✓ Dredging operations can remove or bury organisms and destroy benthic feeding areas;
- ✓ Dredging operations can create noise and disturbance, and can disrupt spawning migrations;
- ✓ Dredging activities can re-suspend contaminants, affect turbidity and siltation, and deposit fine sediments in spawning habitats; and
- ✓ Dredging activities alter the hydrodynamic regime, alter physical habitats, and create the loss of riparian habitat.²

The act of dredging can entrain sturgeon, taking them up into the dredge drag-arms and impeller pumps and resulting in death.² New data from tagged Atlantic sturgeon continue to show their presence in or near the main navigation channel, making them vulnerable to direct take by dredging operations, as well as direct take from the larger vessels that will be using the channel.² These lethal takes are significant for a species

³ Brown and Murphy. 2010. Atlantic Sturgeon Vessel-Strike Mortalities in the Delaware Estuary. Fisheries 35(2): 72-83.

that is at such low levels (fewer than 300, maybe even fewer than 100), and as genetically unique as the Atlantic sturgeon of the Delaware River are.²

Dredging in the portions of the River near Philadelphia is likely to be detrimental to the successful spawning of sturgeon in the Delaware – not just because of the act of dredging but also because of the degradation of spawning habitat.² Dredging increases the level of suspended sediments and contaminants in the water. An increase in suspended sediments could be detrimental to egg survival of sturgeon – increasing the probability that eggs adhere to suspended solids and suffocate.² increasing contaminant loads can alter growth and reproductive performance in sturgeon.²

Dredging is a factor in the destruction, modification, or curtailment of the Atlantic sturgeon’s habitat and range.² The environmental impacts of dredging include direct removal or burial of organisms, elevated turbidity or siltation, contaminant re-suspension, noise or disturbance, alterations to hydrodynamic regime and physical habitat, and loss of riparian habitat.² Furthermore, an increase in vessel traffic on the Delaware River resulting from the project would increase the likelihood of vessel strikes to sturgeon.²

A study of mortality rates on Atlantic sturgeon in the Delaware River between 2005 and 2008 found that 50% of the mortalities were the result of vessel strikes. The remaining 50% were too decomposed to determine if they were caused by vessel strikes but it is likely most were.² For small remnant populations of Atlantic sturgeon, such as that in the Delaware River, the loss of just a few individuals per year due to anthropogenic sources of mortality, such as vessel strikes, may continue to hamper restoration efforts.² According to a 2010 research article on vessel strikes, “Both the dredging to deepen the channel and the subsequent increase in large vessel traffic may further hamper the recovery of the Delaware River Atlantic sturgeon population.”² Of critical importance, this study is concerned about the size of the vessels resulting from deepening as opposed to any increase in the volume of vessels. The larger size of the vessels from the deepened channel will likely increase the number of vessel strikes for both sturgeon species.²

The continued dredging of new deep-water areas will further impact Atlantic sturgeon spawning by accelerating the intrusion of brackish water into the hard-bottom spawning grounds, and thus forcing Atlantic sturgeon to spawn further upstream in the zone of depressed dissolved oxygen. This shift then exposes the eggs and larvae of newly spawned Atlantic sturgeon to low oxygen conditions from which they may not survive. This “squeeze” between increased salt intrusion in the estuary downstream (exacerbated by channel deepening, new deep-dredged berthing areas, and rising sea levels) and the near-lethal dissolved oxygen levels upstream limits the ability of Atlantic sturgeon to successfully reproduce, and increases the likelihood of extinction. This project makes a significant contribution to such salt-intrusion by adding 45 acres of new deep-water channel and berthing to an estuary under siege.⁴

The remobilization (and dewatering of dredged sediments) will create higher exposure to PCBs and other contaminants, and the Atlantic Sturgeon spawning and rearing that begins in June and extends the early-life-stages through July and August, with increasing evidence for high aggregations of young-of-year in the Proposed Project vicinity, means that elevated exposure will occur for larval and juvenile stages of this endangered species in the Delaware River. The currently proposed methods and timing are insufficient to

⁴ Moberg and DeLucia. 2016. Potential Impacts of Dissolved Oxygen, Salinity and Flow on the Successful Recruitment of Atlantic Sturgeon in the Delaware River. The Nature Conservancy. Harrisburg, PA. 69 pp.

protect this endangered species, and more evidence and analysis would be required in order to claim that the project does not impair NOAA Trust Resources, fish and wildlife, and the water resources of the Basin.

In November of 2010, researchers discovered beds of freshwater mussels in the Delaware River between Chester, PA and Trenton, NJ.² The species found included the alewife floater (*Anodonta implicata*) and the tidewater mucket (*Leptodea ochracea*), only found in New Jersey in the tidal Delaware River; the pond mussel (*Ligumia nasuta*) and the yellow lampmussel (*Lampsilis cariosa*), both considered critically-imperiled; and the creeper (*Strophitus undulatus*) and the eastern floater (*Pyganodon cataracta*) both considered vulnerable; as well as the eastern elliptio (*Elliptio complanata*), the only mussel known to be native to our Delaware River that is not considered to be in jeopardy.² Mussels are not mentioned in the application or in the applicant's Compliance Statement. Particularly because some of these estuarine species are state-listed and/or critically imperiled, the extent and composition of these mussel beds needs to be accurately surveyed prior to any in-water work at the site. Once the locations, abundance, and identify of these species are documented, a relocation plan would be needed to move individual mussels out of areas where direct mortality might occur.

Freshwater mussels can live 80 to 100 years old, and most species do not begin reproducing until they are 8 to 10 years old.² Because they are so slow growing and don't begin to reproduce until this older age, they are not able to quickly recover from disturbances and the population cannot recover quickly from impacts that result in death to individuals.² Freshwater mussels require a fish host, a specific species depending on the mussel, to complete their life cycle. Activities that damage the needed fish hosts in turn do direct harm to the freshwater mussel species they help serve in the life cycle.²

Mussels are vital for filtering pollution and filling important habitat niches. Experts believe that revitalizing freshwater mussels in the Delaware River could improve water quality downstream and thereby benefit estuarine species.² All of the freshwater mussels in the Delaware River system, except for one (the Eastern elliptio, *Elliptio complanata*), are identified by one or more of the states as endangered, threatened, imperiled, vulnerable, critically impaired, very rare, extremely rare or extirpated.²

Freshwater mussels are very sensitive to water quality. Exposure to contaminants either directly via dissolved compounds or contaminants that are particle-mediated can have adverse consequences.² Freshwater mussels are highly exposed to changes in water quality because of their filtering activities and the passage of large volumes of water across many thin tissue layers. Dissolved toxins, such as heavy metals, are rapidly taken up by direct absorption and indirectly via food.² Because this project will likely result in pollution both directly and through contaminants from spoil disposal, the implications of this pollution for the mussels in this area must be examined.

Stressed mussels require more oxygen. The dredging described for this project is a threat to any submerged aquatic vegetation in the area that is critical for providing oxygen in the Estuary, including the Philadelphia reach of the River, which includes the location of the proposed project. Although dissolved oxygen levels can become excessively low in this area even today, they have improved significantly compared to decades past. In fact, the DRBC is considering elevating their "Aquatic Life Designated Use" rule in this section of the Delaware River to maintain and protect dissolved oxygen levels.⁵ Increased sedimentation from

⁵ Delaware River Basin Commission (2017) Draft Resolution, February 23, 2017. Retrieved from http://www.nj.gov/drbc/library/documents/Res_EstuaryAquaticLifeUses_draft022317.pdf

dredging activity inhibits mussels and their host fish species from taking in oxygen.² Additionally, invasive or exotic species resulting from interbasin transfers of water can be a very direct threat to freshwater mussels as well as many other species. Increased ballast water from deeper ships, and increased ship traffic, brought up the River by a deeper channel could heighten this risk.² The issue of invasive and exotic species and ballast water and their ecological and economic implications for freshwater mussels and other River fish and wildlife species must also be considered.

Identification of host fish needed for freshwater mussels is one of the least studied aspects of freshwater mussel life history. American eel are known to be hosts for *Elliptio complanata*; some believe they are in fact the preferred host.² Some species of trout and yellow perch too can serve as hosts and data shows that some of the species found in the tidal estuary, *Strophitus undulatus*, can use pumpkinseed and yellow perch.² Shad too are considered by some as possible host species.² The potential impacts to these host species are additional factors to consider when assessing the threats to mussels.

There is evidence that the acoustic impacts from construction activities, such as those described for this project, can significantly harm fish.⁶ The effects of underwater sounds created by pile driving on fish may range from a brief acoustic annoyance to instantaneous lethal injury depending on many factors.⁵ Even at non-lethal levels, low levels of acoustic damage may result in the fish not being able to swim normally, detect predators, stay oriented relative to other fish in the school, or feed or breed successfully.⁵ This is a potential threat to all fish, including both sturgeon species as well as all the fish that serve as host species to mussels.

There are bald eagle (*Haliaeetus leucocephalus*) nests and osprey (*Pandion haliaetus*) nests near or within the project site.⁷ Even with the best mitigation plan in place, there would inevitably be some level of disturbance to these nests versus the no-action alternative, which would leave the nests as they currently are. The nests are not even mentioned in the public notice and this is an issue that the public should be aware of. While formerly a highly-degraded site when DuPont owned and operated the property, the wetland and upland portions of the site have reverted to a natural state with a diverse ecosystem suitable as nesting habitat for these two imperiled bird species. Any disturbances or alterations to these nesting areas could be detrimental to the breeding success of these birds and therefore the future viability of their populations in this area.

The additional deepened 45 acres of river area that would provide access to the proposed deepwater port Dock 2 would result in larger and deeper draft vessels coming up the River. The draft docket states ocean-going vessels up to 966 feet long with a draft of 39.7 feet will be accommodated at the two deep after berths. This triples the amount of vessel traffic that was originally planned for the facility. This additional traffic being layered on to the facility is not being analyzed in the draft docket in terms of the amount of truck traffic, parking areas, turning radius areas and other related knock-on logistical needs that are available on this site, which had some non-specified areas but without an analysis showing that the additional traffic can be handled at the Center, it is unknown if the site is too small for this additional vessel

⁶ Delaware Riverkeeper Network (2011). Supplemental Comment Re: 2011 Draft EA for Delaware River Main Channel Deepening Project Philadelphia. Submitted to U.S. Army Corps of Engineers on July 6, 2011.

⁷ Ramboll Environ (2016). Compliance Statement in Support of Multiple Individual Permit Applications. Appendix E, Habitat Impact Assessment Report, July 2016.

traffic. The additional ship traffic and the specific types of ships required for LNG and NGL overseas transport will significantly increase. There is no discussion of this in the draft docket.

Additionally, the additional emissions of the truck traffic, impacts of rail traffic, and other related environmental impacts are not discussed in the docket, nor is any additional stormwater runoff (in terms of quantity and also quality due to the additional traffic and additional types of cargo, including LNG) and other related infrastructure need to handle and service the new shipping traffic. The transloading area needs to also be analyzed to be certain the additional cargo that will be transloaded, especially if it is hazardous material such as NGL or LNG or other bulk liquids that possess toxic properties can be safely handled with adequate environmental protections and that stormwater produced will not pollute receiving waterways?

Again, this is an example of partial review of the proposed Dock 2 that represents segmentation of the project since DRBC had included stormwater outfalls and systems on land in the 2017 docket but does not here address that infrastructure that now may need to be changed due to the additional activities Dock 2 will enable. When will these aspects of the expanded project be assessed and will DRBC consider these aspects as they have in the last docket? How can DRBC conclude that water resources will not be adversely impacted without this analysis? Furthermore, if LNG is the cargo that is being added with Dock 2, or is among the cargo being added, what special considerations and conditions will be required to assure the handling and transloading of the LNG can be safely accomplished? This is not discussed in the draft docket.

Another question that must be answered is whether simultaneous handling of LNG and other cargoes, including dangerous NGLs, can be done safely. If the transloading to the ship from truck or railcar is considered similar to “truck to ship bunkering” when assessed by the U.S. Coast Guard, there are Coast Guard regulations that apply to these activities when there are SIMOPS or “simultaneous operations” planned in the same vicinity. The usual procedure is for a Policy Letter to be issued by the Coast Guard after the specific logistics are evaluated.⁸ Similar to SIMOPS considerations, it is additionally important to evaluate the activities and storage planned for export of other products such as NGL from the terminal for compatibility with LNG activities. An informed decision needs to be made about timing, location, and proximity to the LNG facilities and activities. It may be that other activities planned for the terminal cannot occur at the same site that is handling LNG. This issue must be resolved prior to any further permitting for the Gibbstown Logistics Center facility.

More shipping vessels mean more ballast water needs, discharges, and impacts. Impingement and entrainment of the variety of species discussed in this comment and beyond due to the intake and discharge of ballast water could be significant. The increased intake of ballast water from the River as a result of the commercial vessels coming into the River due to this project would entrain early life stages of commercially and recreationally important fish including American shad, alewife, blueback herring and striped bass.² The cumulative effects of this impingement and entrainment need to be considered in conjunction with the impingement and entrainment that already occurs at existing cooling water intakes operating in the Delaware Estuary and River, including the nearby Paulsboro and West Deptford Township facilities.

⁸ CG-OES Policy Letter, No.01-17, JUN - 8 2017, GUIDANCE FOR EVALUATING SIMULTANEOUS OPERATIONS (SIMOPS) DURING LIQUEFIED NATURAL GAS (LNG) FUEL TRANSFER OPERATIONS, Ref: (a) CG-OES Policy Letter No, 01-15.

In addition, the concerns about invasive exotic species that may result from larger discharges of ballast water from larger vessels cannot be overstated in terms of either ecological or economic impacts. The invasion of such species into major ports and waterways of the U.S. have cost billions of dollars in control efforts and lost economic value from damage to important fish and wildlife species as well as the habitats that support them.² For more information see

http://water.epa.gov/polwaste/vwd/ballastwater/invasive_species_index.cfm

http://water.epa.gov/polwaste/vwd/ballastwater/invasive_species_bal_links.cfm

<http://www.invasivespecies.gov/index.html>

DRN is very concerned about the release of PCBs from the site. EPA identified the Repauno site in 2003 as one of the largest PCB point sources in the Delaware Estuary (among the top 10). A TMDL was established for the Estuary to remediate the contamination. Dredging; construction in the water, riverbank and on uplands; and site disturbance and stormwater systems will disturb PCBs, which have been found in near-shore sediments and in runoff from the site. There is a zone of highly contaminated sediments immediately adjacent to the shore and port facility. DRBC's dedicated role in reducing PCBs in the Estuary and its role to ensure that PCB Pollution Minimization Plans (PMP) are effectively implemented is compromised by the plan to disturb, construct on, and dredge this site.

The 2017 DRBC docket approved dredging and other disturbances that could significantly increase PCB loading to the already-impaired Delaware Estuary. DRBC did require in the current docket a PCB sampling program to be conducted by Delaware River Partners and stated that capping to raise the site to a higher elevation would help to minimize PCB release. We did not see any analysis that proves that statement. A NPDES permit was supposed to be required to assess PCB migration from the site and to possibly require a separate pollutant minimization plan to be conducted by Delaware River Partners. However, the project is currently under construction while no NPDES permit is in place that requires sampling and monitoring of the release of PCBs during this critical disturbance phase of the project.

There are several unaddressed questions regarding this PCB issue. First, the sampling and the controls should have gone into operation prior to dredging and land disturbance that could release PCBs but this apparently is not the case unless the NPDES permit has been issued without public disclosure. Second, Chemours claims that the site is "substantially remediated" for PCBs yet there is no evidence that PCBs are remediated and the sampling as recently as 2018 shows otherwise. Third, Chemours currently operates the site remediation program, including a groundwater pumping system which is supposed to continue during the operation of the facility. If the 2017 DRBC Docket condition is carried out, how will the Delaware River Partners operation of a separate PCB plan, possibly connected to the stormwater infrastructure, be coordinated physically, managerially, and legally in concert with the cleanup of the groundwater by Chemours?

DEP had informed DRBC during the last docket review that there would be a stormwater permit issued for the facility that would address the PCB issues through a DEP-issued NPDES permit. However, there was no stormwater permit issued after the DRBC Docket was approved. Instead, after a year of phone calls and file reviews, DRN finally got a copy of the stormwater permit in 2019 for the site – a permit DEP claimed did not exist since the time DRN filed an OPRA for the project. It was issued in 2017 but had no mention of PCBs. This permit was not even contained in the DRBC's files.

More perplexing is that the 2017 DRBC docket at C.(I)l. requires that when the DEP NPDES permit is issued “the docket holder shall perform an investigation of the site to assess the disposition of stormwater and the flow paths for the individual stormwater outfalls either directly or indirectly to the Delaware River in order to develop and implement a PCB stormwater sampling plan. Upon evaluation of the sampling results by the NJDEP in consultation with the DRBC, DRP may be required to develop and implement a separate PMP for PCBs in accordance with Section 4.30.9 of the Commission’s Water Code and Water Quality Regulations (18 CFR Part 410).”⁹

The draft docket has no mention of a NPDES permit and records obtained by DRN from DRBC through FOIA, show that the applicant stated that a NJPDES permit is pending in an email dated May 14, 2019. However, a week later an email from the applicant dated May 21, 2019 states, without any explanation, that the NJPDES permit is “not required”. The NPDES permit is not listed in Table B-1 in the draft docket. DRN asks why the NPDES permit was, suddenly, not required, who made that determination and why and how is a condition of the current (2017) docket summarily violated? How will the PCB sampling program be carried out, how will PCB be controlled from the site for the current development of the site and what precautionary measures are being taken by DRBC to ensure that the PCBs released from the activities required for Dock 2 do not contribute to PCB contamination of the Delaware River Estuary?

The Gibbstown Logistics Center is wholly compromised by its location on a highly contaminated property. Construction and operation of the Center can be expected to disturb and mobilize soil, sediment, surface water and groundwater pollution that is present on this Superfund site. This is a former industrial site that is under remediation known as the Repauno Plant. It is a 1,856-acre site located along the Delaware River in Gloucester County, NJ. The site is bounded to the north by the Delaware River, to the east by a former Hercules Chemical manufacturing plant, to the south by the city of Gibbstown, and to the west by wetlands and Repauno Creek. The western half of the site consists almost entirely of surface water bodies and wetlands. Former and current production operations are located in the northeastern part of the site. Several production areas have discontinued operations and structures have been razed. The eastern half of the site also consists of some upland and wetland ecological communities (EPA, 2003). Altogether, the site contains approximately 1,500 acres of wetlands (Fichera, 2015). The Gibbstown Logistics Center is planned to use 218 acres.

DuPont operated the site as an explosive manufacturing facility since 1880. In 1917, DuPont expanded operations to include the manufacturing of organic compounds, which continued until 1986. All explosive manufacturing and ammonia production were discontinued during the 1960s. Repauno is a CERCLA site undergoing remediation (<https://cumulis.epa.gov/supercpad/CurSites/calinfo.cfm?id=0200783>). The area previously used by DuPont as a terminal location for anhydrous ammonia began being cleaned for reuse in 2002, according to the 2002 Annual Groundwater Progress report (EPA, 2003).

One of the dangerous contaminants on the site is nitrobenzene, a highly toxic chemical classified by the Centers for Disease Control as “Immediately Dangerous to Life or Health” if people are exposed at specific concentrations. Nitrobenzene is a likely human carcinogen according to the United States EPA and is linked to several carcinomas and cancers as well as other dangerous human health effects. The area where the logistics center would operate is the area is most likely exposed to aniline, a toxic chemical with adverse health effects; aniline is involved with the processing of benzene to make nitrobenzene. The area where

⁹ Docket No. D-2017-009-1, p. 9.

acids were used is also at least partly included in the proposed site. These acids were most likely “mixed acids” associated with the nitrobenzene manufacturing process and are toxic. Redevelopment can disturb and distribute in unforeseen ways contaminants that remain on the property. DRN advocates that no disturbance of the contaminated site be allowed until all contaminants are removed from the soil, sediment, groundwater, surface water, wetlands and other related natural systems.

In addition, several different companies have leased areas at the Repauno facility. In 1998, Repauno Products LLC purchased the manufacturing operation that produced sodium nitrite and nitrosylsulfuric acid. In 1999, Spring AG purchased the industrial diamond refining operation, which ceased in late 2002. Industrial diamond processing may have used chemical vapor deposition or other dangerous processes that are used to manufacture industrial and synthetic diamonds, contributing additional contaminants to the site’s environment that require investigation prior to use of the property.

In 1990, 8,500 tons of sediments were removed from the ditches in the former Nitrobenzene and PMDA/DMT production areas (EPA, 2005). In the three rounds of sitewide investigation completed in 1993, 1996, and 2000 respectively, DuPont screened all Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) for their investigation/remediation priorities and focused on the migration/flow of groundwater and the soils in former production areas. The currently ongoing fourth round of investigation is to complete the investigation of the remaining two SWMUs/AOCs and to conduct an ecological risk assessment for the wetlands, streams, and the ditch system (EPA, 2005). In 1985, DuPont installed a system to pump contaminated groundwater and to treat it. The groundwater interceptor system has been in operation since, in conjunction with a groundwater-monitoring program, owned and operated by Chemours, DuPont’s spinoff company since 2015. Chemours is required to continue the groundwater interceptor system together with the sitewide groundwater monitoring program to confirm that contaminated groundwater is under control. How the operation of the Center and the remediation program will compatibly operate is difficult to understand and needs further analysis by EPA, DEP and other relevant agencies, including DRBC, due to the potential for negative impacts from pollution to the water resources of the Delaware River Basin.

DEP is supposed to impose restrictions on the use of groundwater for as long as it remains contaminated (EPA, 2005). The draft docket states that water and sewer for the Center will be provided by the local municipal facilities, which is important for public health and safety. Has there been an analysis that shows the local facilities have the capacity to add the Center? EPA claimed in 2005 that the site was no longer a risk for human exposure and groundwater contamination (Romalino, 2015). These new uses at the site should require a re-analysis of that conclusion. The site plans call for one or more of the monitoring wells being used to track remediation to be paved over for a parking lot. Baseline and years of data will be compromised if consistent sampling is lost. It is essential that the current monitoring wells remain.

Permits

As stated in the letter dated June 3, 2019 submitted by DRN to DRBC, there are several permits that have not been identified by the applicant that are needed for this project. Some permits that are still needed are listed in the letter but we also point out that other permits should have also been identified in the draft docket but were not. These include approvals from the United States Coast Guard under 18 CFR Parts 153 and 157? Has Delaware River Partners filed a Letter of Intent (LOI), which is due one year in advance? Has a Water Suitability Assessment been filed with the LOI as required at 33CFR 127.007 (f) and (g)? Has

the Coast Guard issued a Letter of Recommendation? These analyses are essential to the decisionmaking about this facility, which may not proceed without the Coast Guard reviews. There has been no determination that the Delaware River at this location is suitable for LNG marine traffic. Until there is a Coast Guard determination for the transport from this terminal, it is premature to consider other approvals. The application is deficient for not including this important permit, in addition to the other federal and state permits DRN has listed in our letter.

Environmental and Health and Safety Impacts Regarding LNG

DRN provides the following information about the unique dangers of LNG and its transport, storage, and handling, illustrating that LNG is a special product that needs specific conditions that DRN does not consider to be available at this site or within the Delaware River Watershed:

It is known that, upon release in a liquid state, LNG expands to a gas cloud that is 600 times larger than the amount of liquid. The gas cloud then moves across the surface, can travel many miles quickly and can also become trapped under spaces that confine the gas, providing the conditions that cause explosion and, if there is a point of ignition such as a spark or flame, fire will result.

New information has shown that LNG can cause a catastrophic BLEVE or Boiling Liquid Expanding Vapor Explosion if the vessel is exposed to high temperatures or a fire. The expansion of the liquid LNG in a vessel causes the pressurized liquid to boil, and the gas takes up more room than the liquid, stressing the container as pressure builds. Relief valves are only designed to release pressure slowly to keep equilibrium in the pressurized container. Exposed to high heat, the valve will fail to keep up and the metal will weaken, cracks will result in the container, causing LNG to be released with an explosion.¹⁰ The result is a BLEVE, a catastrophic failure of the container. There are many incidents over the years of BLEVE catastrophes¹¹, some as recent as 2019, but the fact that a BLEVE can occur with LNG has only recently been established.

When the gas or vapor cloud in the container is released because it is flammable, it is likely to ignite after the BLEVE, typically causing a fireball that burns fast, hot and wide. A fuel air explosion can also occur, known as a “vapor cloud explosion”. A vapor cloud explosion is the mechanism used in a thermobaric weapon that uses air to generate a high-temperature explosion, producing a long duration blast wave. These weapons are also termed a fuel-air bomb.¹² This is the threat that LNG storage and transport brings to the Gibbstown region and to every traffic route used to carry the LNG to the Delaware River and on the river during export.

On dry land such as a terminal where LNG is stored or is contained in tankers on trucks or rail cars, a BLEVE where there is no liquid in the local environment to absorb the heat, can rupture even faster than a vessel on water. Truck transport regulations are being closely examined due to an increase in accidents involving truck transport of LNG. While it used to be assumed that truck transport had a low potential for explosion or fire, an accident in Spain changed that:

“In 2002, an LNG truck in Spain flipped over, burned, then exploded into a 500-foot fireball that killed the driver and burned two others. ‘The severity of this kind of explosion is something people haven’t usually considered applicable to LNG trucks,” says Jerry Havens, former director of the

¹⁰ https://en.m.wikipedia.org/wiki/Boiling_liquid_expanding_vapor_explosion

¹¹ Ibid.

¹² https://en.m.wikipedia.org/wiki/Thermobaric_weapon

Chemical Hazards Research Center at the University of Arkansas. ‘But what happened in Spain changes that picture. It shows you've got the potential for a massive explosion.’”¹³

In the accident in Spain, a BLEVE occurred, which resulted in death to the driver and burns to two people approximately 650 feet away, and threw large flaming debris, including the truck’s diesel engine, for 853 feet. A similar LNG truck accident with a catastrophic fire occurred in Spain in 2011, killing the driver.¹⁴ It was pointed out by an analyst in Savannah Georgia during debate over LNG truck transport that a pool fire and and/or explosion involving an LNG truck may have a low probability but it has a high consequence with instant injuries or death for those within several hundred feet.¹⁵ The chances, according to the analyst, of an LNG truck accident are 200 to 1.¹⁶ This is a great risk for populated areas and truck routes through urban centers.

Regarding rail use, the U.S. Department of Transportation’s Federal Highway Administration (FRA) nor the Pipeline and Hazardous Materials Safety Administration (PHMSA) have not approved rail car regulations for the transport of LNG yet. There has been very limited use of rail so far, with only one approval in Alaska by the Obama Administration, local small use in Florida, and some use in Canada. Statistics that claim few accidents mean that trucking of LNG is safe are misleading because, similar to crude oil transported in unsafe train cars a few years ago before the Bakken crude phenomena, it has been rarely done. For Bakken oil trains, accidents increased 400% in one year once volume of traffic increased, creating the biggest jump in deadly and/or catastrophic train accidents in years.

The Trump Administration has provided a big push for the use of rail for LNG transport in April 2019 with President Donald Trump issuing an executive order directing federal regulators to create new rules allowing rail companies to transport LNG by rail in the next 13 months, or less.¹⁷ Considering the length of time it customarily takes PHMSA and the Federal Railroad Administration to develop new car specifications and use regulations, one year is a truncated period that fast-tracks the approval the President is seeking. The priority, according to LNG promoters, is a quick approval to meet the need for the industry to serve new markets. This does not inspire confidence in the results.

In the event of a release of LNG, the LNG must gas off naturally, as the container cannot be capped or interacted with, the area must be immediately evacuated and secured, ignition sources must be eliminated, and water cannot be used, as the release is cryogenic. Water can plug the valves of the container with ice and any cold air release can freeze skin in seconds and can even turn air to liquid or solid form, removing oxygen, an obvious disaster for anyone in the area. These handling procedures apply to any container of LNG under pressure, including those used in transportation such as truck or rail containers or storage vessels at a terminal, ships, or at a liquefaction facility.¹⁸ The dangers of an LNG release and fire from a tank accident are unique to LNG and require special handling due to the highly dangerous properties of the

¹³ <https://www.csmonitor.com/2006/0707/p02s01-usgn.html>

¹⁴ https://www.researchgate.net/publication/235976022_Explosion_of_a_road_tanker_containing_liquified_natural_gas

¹⁵ <https://www.savannahnow.com/article/20101006/NEWS/310069738>

¹⁶ Ibid.

¹⁷ <https://www.govinfo.gov/content/pkg/FR-2019-04-15/pdf/2019-07656.pdf>

¹⁸ PHMSA, “Safe Transport of Energy Products”, <https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/research-and-development/hazmat/58176/day-1-pm-2.pdf>

LNG and its gases. This is well illustrated in a report of an LNG tank truck accident in Belgium, which has been used as a “lessons learned” example by first response trainers ¹⁹

When a fire erupts around or under a LNG container, it can cause a BLEVE quickly, in as little as 15 minutes for a large tank (2 ½ minutes for a small tank). Once a fire ignites around the container, the 2000 Department of Transportation (DOT) Emergency Response Guidebook (ERG) states that a 1,600-meter perimeter must be isolated around the container, as explained in the relevant text at Guide #112, the same as for explosives such as bombs and artillery. Since water cannot be used to cool the container or extinguish the fire, and the evacuation area is so large, the fire response is, especially if there are no lives at risk, for firefighters and first responders to evacuate the 1,600-meter area and let the fire burn out, similar to the response to crude oil derailments that risk explosion. In fact, even removing the damaged container can be risky. An example of how firefighters in Utah decided to handle a train derailment with damaged propane tanks illustrates the risks – it was less dangerous to detonate the cars in place than move them.²⁰ Of course, this is not possible in a populated area, begging the question of how much risk for communities is involved with flammable liquid in rail cars.

This makes the transport of LNG in containers and the storage of containers of LNG inherently dangerous and inappropriate for populated areas. The proposed Logistics Center is located next to a residential area in Gibbstown. There is a day care center and housing in Gibbstown adjacent to the Block and Lot of this site. These residential and day care uses are not compatible with the proposed activity, especially if the activity includes handling of hazardous substances such as LNG or NGL or other bulk liquids. Prevention of exposure to toxics and hazardous materials is the only way to provide protection to the especially vulnerable population of children at a day care center and to the workers, residents and families who are located adjacent to the site.

The transport routes, not yet identified by New Fortress, are through communities across Pennsylvania and New Jersey. Has the proximity of the LNG activities to structures, receptors, and residences been calculated and are there sufficient separation distances as required by U.S.DOT? US DOT has requirements (in 49 CFR Part 193) for thermal radiation and vapor dispersion hazard-based exclusion distances around land based, fixed LNG terminals. This is an essential analysis for the protection of Gibbstown and the region.

Transportation safety issues, while previously not a large concern when truck and rail transport was rare, are emerging as an important concern across the nation as transport by truck increases and rail is expected to be used as a major means of transport for an expanding industry in the near future. The Marcellus Shale has made Pennsylvania the second largest producer of natural gas in the nation, and the industry is looking for new markets and new means of delivering gas products. So, transport is ramping up to substantially increase. However, the current anti-regulation climate at the federal level means that the safety measures required for safe transport are not likely to be enacted under the current Trump Administration. The US Department of Transportation’s upper management and policymakers are heavily influenced by or transferred directly into their positions from industry and have been actively carrying out a roll back of transportation regulations. According to an Associated Press investigative report, the rolling back of transportation regulations and the elimination of regulations that were in progress, has been and is increasingly a hallmark of the Trump Administration.

¹⁹ <https://www.ctif.org/sites/default/files/2018-09/Retex%20LNG%202018%2006%2006%20ENG-reduced%20size.pdf>

²⁰ <https://www.desmogblog.com/2019/04/17/trump-executive-order-lng-rail-bomb-train-risks>

“Industry’s influence on regulations generally “is probably more powerful than it has ever been,” said Neil Eisner, who was the DOT assistant general counsel in charge of overseeing the issuing of regulations for more than three decades. DOT says having industry insiders in leadership positions provides deep practical experience in how the transportation industry works.”²¹

The AP article goes on to use as an example the statement by USDOT DOT of its intention to repeal “a 2015 rule opposed by freight railroads requiring trains that haul highly flammable crude oil be fitted with advanced braking systems that stop all rail cars simultaneously instead of conventional brakes that stop cars one after the other”.²² Delaware Riverkeeper Network and many other organizations and safety groups when proposed by USDOT after the deadly Lac-Mégantic rail disaster in Canada where 47 people died and a town was destroyed, supported this rule.

“Trump has made reducing regulations a priority, seeing many rules as an unnecessary burden on industry. Last month he tweeted that his administration “has terminated more UNNECESSARY Regulations, in just 12 months, than any other Administration has terminated during their full term in office...”

The good news is,” he wrote, ‘THERE IS MUCH MORE TO COME!’²³

However, not every effected sector is supportive of the relaxation of regulations. Reflecting the concerns of workers:

“These rules have been written in blood,” said John Risch, national legislative director for the International Association of Sheet Metal, Air, Rail and Transportation Workers. “But we’re in a new era now of little-to-no new regulations no matter how beneficial they might be. The focus is what can we repeal and rescind.”²⁴

Additionally, it is unknown how the truck or rail-delivered LNG will be transloaded and what transfer systems will be employed. There is a cavern on the site that was presumably going to be used for natural gas liquids (NGL), although it was stated at the DRBC Hearing that there would be no storage on site of bulk liquids. Funds have been invested by the owner of the property in renovation of the cavern but whether it is expected to be enlarged and what is to be stored in it, is unknown but should be publicly disclosed and disclosed to all agencies, including DRBC. Storage conditions, even if kept in idling or parked trucks, are critical to avoid releases of the super-cooled LNG for safety as well as climate impact considerations. DRN asks why the site plans show a bulk liquid tank area, a sphere tank area and the on-site cavern for bulk liquids storage if, as stated by DRBC staff at the public hearing, there will be no bulk liquid storage on site and only truck or rail transloading directly to ships?

Another important consideration is the use of trucks to carry the LNG product will increase emissions of natural gas constituents, including methane, into the air and will emit hazardous air pollutants due to diesel exhaust. The emission of air pollutants to communities along the transport route unjustly exposes people to health hazards that they may be unaware of due to the transient nature of the vehicles. There should be an

²¹ <https://www.apnews.com/1936e77a11924c909880f1ef014c7ca7>

²² Ibid.

²³ Ibid.

²⁴ Ibid.

analysis of the truck route impacts on communities, environmental justice areas, and areas such as the Delaware River valley where there is already a non-attainment area for ozone, resulting in smog and the resulting respiratory and other adverse health effects that accompany air pollution and the deposition of air pollutants on water, such as the Delaware River, the water supply for millions in the region. The venting of the trucks (or railcars) is necessary en route to avoid over-pressurization, so those emissions are unavoidable but nonetheless, unacceptable.

As explained in an article about LNG-powered ships in Washington state, natural gas is composed mostly of methane, which is one of the four major greenhouse gases and a culprit in the the global warming of our atmosphere, exacerbating climate change. Moreover, methane leaks throughout the entire gas development process, from fracking at the extraction well, through pipeline and compressor delivery systems, during storage and in end use such as power plants and gas processing and petrochemical facilities, including when it is used for fuel in shipping. The article states “The International Coalition for Clean Transportation estimates [2.2-4.6% of methane on ships](#) escapes into the atmosphere after passing through the engine without combusting. This is known as methane slip and its rate depends on the type of engine.”²⁵

It explains further, that “Again, LNG is composed chiefly of methane, which is itself a nasty greenhouse gas – 86 times worse than CO₂ over a 20 year span and 36 times worse over a 100 year span. New research actually suggests that those numbers may be [underestimated by as much as 14%](#). This means that we don’t want to be adding any more methane to the atmosphere and, in fact, scientists point out that we can have [more immediate impacts on lessening climate change by reducing methane](#) since it doesn’t last as long in the atmosphere as CO₂. Alarming, US methane emissions [have risen 30%](#) in the past decade thanks mostly to the central US, a hotbed of fracking.”²⁶

The impacts of greenhouse gas emissions that will be released by this project are substantial and can be minimized if gas products – LNG and NGL -- are eliminated as cargo that will be handled at the Gibbstown Logistics Center. Methane and carbon are leaked, released or burned through the full life cycle of the hydraulically fractured (fracked) gas produced for this project – from extraction by fracking through delivery systems such as pipelines and compressors to the liquefaction plant, the processing at the LNG liquefaction plant, the transport by truck, rail, or pipeline to the export terminal, any interim storage, transloading of the material the storage in the ocean-going vessel and then the final re-gasification of the LNG and its end use. This uncontrollable and inefficient process is also deadly in its effects on atmospheric warming and the climate crisis we are facing globally. It is irresponsible and shortsighted to support the further development of fracked gas projects. At the very least, a climate change impact analysis must be done for this project to measure and then assess the potential effects of the full life cycle of LNG and NGL greenhouse gas emissions and climate change effects that would be produced for the Gibbstown Logistics Center.

This comment is submitted in addition to the two letters submitted by Delaware Riverkeeper Network to DRBC dated June 3, 2019 and May 28, 2019, and the verbal testimony of Tracy Carluccio at the public hearing of June 6, 2019.

Conclusion

²⁵ <https://www.350tacoma.org/the-origins-of-lng-as-a-maritime-fuel/>

²⁶ Ibid.

The draft docket is deficient and misleading. It lacks essential information and continues to obfuscate the major intended use of the facility, LNG export. DRN requests that the draft docket be held back from the DRBC's business meeting based on its incompleteness. We point out the lack of adequate time for the Commissioners to review the project to be a major obstacle for a full and fair review (only 2 days before the meeting when the usual review period for the Commissioners is 30 days).

If the docket is included on the agenda at the business meeting, we request the Commissioners either disapprove the draft docket based on the evidence presented showing substantial harm to Delaware River water resources or withdraw the draft docket from consideration until a comprehensive analysis by all relevant agencies is complete and permits have been subject to public review and input. If the DRBC considers this docket in the future, DRN requests that after all other permitting and exhaustive environmental reviews are complete, DRBC provide at least a 60 day comment period for the draft docket so the public can be afforded the time and information needed to assess and provide input into the decisionmaking.

Respectfully submitted,

Handwritten signatures in blue ink. The signature on the left is 'Maya van Rossum' and the signature on the right is 'Tracy Carluccio'.

Maya van Rossum
the Delaware Riverkeeper

Tracy Carluccio
Deputy Director

Exhibit H



June 1, 2020

VIA FEDERAL RULEMAKING PORTAL

Office of NEPA Policy and Compliance
U.S. Department of Energy
1000 Independence Avenue SW
Washington, DC 20585

Re: DOE NEPA/NG Procedures, RIN 1990-AA49

To Whom it May Concern:

The United States Department of Energy (“DOE”) proposes to update its National Environmental Policy Act (“NEPA”),¹ implementing procedures regarding authorizations issued under Section 3 of the Natural Gas Act (“NGA”).² This update would categorically exclude all approvals and disapprovals of new authorizations or amendments of existing authorizations to export natural gas as well as any associated transportation of natural gas by marine vessel.

DOE invited public comments on the proposed changes on May 1, 2020, with a commenting deadline of June 1, 2020.³ The Delaware Riverkeeper Network and Maya van Rossum, the Delaware Riverkeeper (collectively, “DRN”), submit the following comments for DOE’s consideration.

As an initial matter, DRN requests that DOE extend the public comment period an addition sixty (60) days, to close on Friday, July 31, 2020. DOE should take into account the devastating effects of the coronavirus pandemic on the public’s ability to fully and fairly engage in the rulemaking process. Hardships endured by members of the public affect their access to time and resources that had been previously freely available. This rulemaking must not be rushed without adequate input from the public, which can only be provided if accommodations are made during this unprecedented global pandemic.

¹ 42 U.S.C. §§ 4321–4370h.

² 15 U.S.C. § 717b.

³ National Environmental Policy Act Implementing Procedures, 85 Fed. Reg. 25,340 (proposed May 1, 2020) (to be codified at 10 C.F.R. Part 1021).

I. DOE's NGA Authority

The NGA provides that DOE “shall” authorize exports to non-Free Trade Agreement countries “unless . . . it finds that the proposed exportation . . . will not be consistent with the public interest.”⁴ The NGA thus charges DOE with “assur[ing] the public a reliable supply of gas at reasonable prices,”⁵ while simultaneously granting DOE the “authority to consider conservation, environmental, and antitrust questions.”⁶

At the same time, the Federal Energy Regulatory Commission (“FERC”) has the “exclusive authority to approve or deny an application for the siting, construction, expansion, or operation of an LNG terminal.”⁷ An LNG terminal “includes all natural gas facilities located onshore or in State waters that are used to receive, unload, load, store, transport, gasify, liquefy, or process natural gas that is . . . exported to a foreign country from the United States”⁸ Based on its interpretation of Supreme Court precedent regarding the purposes of the NGA, FERC has exercised its Section 3 authority only as to LNG facilities that “have pipelines connecting the facility with either the interstate or an intrastate grid.”⁹

II. NEPA's Requirements

NEPA has two primary aims: (1) it obligates an agency to “consider every significant aspect of the environmental impact of a proposed action”; and (2) it “ensures that the agency will inform the public that it has indeed considered environmental concerns in its decisionmaking process.”¹⁰ The “action-forcing” portion of NEPA relevant to this proposed rulemaking is Section 102:

The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this chapter, and (2) all agencies of the Federal Government shall—

....

(C) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on—

(i) the environmental impact of the proposed action,

⁴ 15 U.S.C. § 717b(a).

⁵ *United Gas Pipe Line Co. v. McCombs*, 442 U.S. 529 (1979).

⁶ *NAACP v. Fed. Power Comm'n*, 425 U.S. 662, 670 n.4, n.6 (1976); see also *Sierra Club v. U.S. Dep't of Energy (Freeport II)*, 867 F.3d 189, 202–03 (D.C. Cir. 2017).

⁷ 15 U.S.C. § 717b(e)(1).

⁸ 15 U.S.C. § 717a(11).

⁹ *Shell U.S. Gas & Power, LLC*, 148 FERC ¶ 61,163 (Sept. 4, 2014), *Emera CNG, LLC*, 148 FERC ¶ 61,219 (Sept. 19, 2014); see also *FPC v. Hope Nat. Gas Co.*, 320 U.S. 591, 610 (1944), and *Phillips Petroleum Co. v. Fed. Power Comm'n*, 347 U.S. 672 (1954).

¹⁰ *Baltimore Gas & Elec. Co. v. Nat. Res. Def. Council, Inc.*, 462 U.S. 87, 97 (1983) (first quoting *Vermont Yankee Nuclear Power Corp. v. Nat. Res. Def. Council, Inc.*, 465 U.S. 519, 553 (1978), and then citing *Weinberger v. Catholic Action of Haw.*, 454 U.S. 139, 143 (1981)).

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.¹¹

"[B]y focusing the agency's attention on the environmental consequences of a proposed project, NEPA ensures that important effects will not be overlooked or underestimated, only to be discovered after resources have been committed or the die otherwise cast."¹²

"Major Federal actions" requiring preparation of an EIS include projects and programs entirely or partly financed, assisted, conducted, regulated, or approved by Federal agencies.¹³ The Council on Environmental Quality ("CEQ") is an agency within the Executive Office of the President and has promulgated regulations implementing NEPA.¹⁴ CEQ regulations direct Federal agencies to adopt their own regulatory procedures to supplement CEQ regulations.¹⁵ DOE's NEPA regulations are found at 10 C.F.R. Part 1021. CEQ regulations describe the process by which a Federal agency must decide whether to prepare an EIS.¹⁶ First, a Federal agency must determine whether the proposed action is one which normally requires an EIS or whether the proposed action is categorically excluded by the Federal agency's supplemental NEPA regulations.¹⁷ If the proposed action does not belong in either category, CEQ regulations direct the Federal agency to "prepare an environmental assessment [{"EA"}]" and to "involve environmental agencies, applicants, and the public, to the extent practicable, in preparing" the EA.¹⁸ CEQ regulations direct the Federal agency to "make its determination whether to prepare an [EIS]" based on the EA.¹⁹ If the Federal agency "determines on the basis of the environmental assessment not to prepare an [EIS]," then it should "[p]repare a finding of no significant impact," also known as a FONSI.²⁰

In this proposed rulemaking, DOE seeks to categorically exclude all "[a]pprovals or disapprovals of new authorizations or amendments of existing authorizations to export natural gas under section 3 of the Natural Gas Act and any associated transportation of natural gas by marine vessel" from the requirement to prepare an EA or EIS.²¹ A categorical exclusion ("CE") is a "category of actions which do not individually or cumulatively have a significant effect on the human environment and which have been found to have no such effect in procedures adopted by a Federal agency in implementation of these regulations...and for which, therefore, neither an environmental assessment nor an

¹¹ 42 U.S.C. § 4332. See also *Robertson v. Methow Valley Citizens*, 490 U.S. 332, 348-49 (1989).

¹² *Id.* at 349.

¹³ 40 C.F.R. § 1508.18(a).

¹⁴ 40 C.F.R. §§ 1500-1508.

¹⁵ 40 C.F.R. § 1507.3.

¹⁶ 40 C.F.R. § 1501.4.

¹⁷ 40 C.F.R. § 1501.4(a).

¹⁸ 40 C.F.R. § 1501.4(b).

¹⁹ 40 C.F.R. § 1501.4(c).

²⁰ 40 C.F.R. § 1501.4(e).

²¹ *Tracked Proposed Revisions*, DOE-HQ-2020-0017, RIN 1990-AA49.

environmental impact statement is required.”²² “Categorical exclusions, by definition, are limited to situations where there is an insignificant or minor effect on the environment.”²³ In deciding whether an action meets this definition, an agency should consider “the unique characteristics of the applicable geographic areas, the degree to which effects on the quality of the environment [are] controversial or the risks were unknown, the degree to which the CEs might establish a precedent for future actions with significant effects or represent[] a decision in principle about future considerations, the degree to which the actions might affect endangered species, and whether there exist[] cumulative impacts from other related actions.”²⁴

DOE justifies this proposed CE by improperly narrowing the scope of approvals and disapprovals of new authorizations and amendments of existing authorizations to export natural gas under section 3 of the Natural Gas Act. It does this by relying on the Supreme Court’s decision in *Department of Transportation v. Public Citizen*,²⁵ and the D.C. Circuit’s decision in *Sierra Club v. Federal Energy Regulatory Commission (Freeport I)*.²⁶ In *Public Citizen*, the Supreme Court held that “where an agency has no ability to prevent a certain effect due to its limited statutory authority over the relevant actions, the agency cannot be considered a legally relevant ‘cause’ of the effect.”²⁷ In *Freeport I*, the D.C. Circuit held that FERC’s NEPA analysis of the redesign of a liquefied natural gas (“LNG”) facility did not need to include an evaluation of the environmental consequences of exporting natural gas because “the Department of Energy, not the Commission, has sole authority to license the export of any natural gas going through” the facility.²⁸

Based on these cases, DOE asserts that it “need not review potential environmental impacts associated with the construction or operation of natural gas export facilities because DOE lacks authority to approve the construction or operation of those facilities.”²⁹ DOE also states that the only potential environmental impacts resulting from the exercise of its NGA Section 3 authority “occur at or after the point of export.”³⁰ DOE’s conclusions are wrong for two reasons: (1) DOE is required to consider the direct and indirect effects of natural gas export authorizations because it has the statutory authority to deny such authorizations on the basis that the authorization would pose too great a harm to the environment; and (2) DOE’s view of the environmental impacts of natural gas export is too narrow and excludes the indirect effects of such action.

A. DOE Section 3 Authority and its Effect on the Scope of DOE’s NEPA Analysis

The environmental effects of increased production of natural gas due to a NGA Section 3 authorization to export a specified amount of natural gas from a specified location fall within the scope of the required NEPA analysis. Because these effects are typically significant and vary from application to application, DOE’s proposal to categorically exclude authorizations to export natural gas under NGA Section 3 is improper.

²² 40 C.F.R. § 1508.4.

²³ *Sierra Club v. Bosworth*, 510 F.3d 1016, 1027 (9th Cir. 2007) (quoting *Alaska Ctr. For Env’t v. U.S. Forest Serv.*, 189 F.3d 851, 859 (9th Cir. 1999)).

²⁴ *Id.* (citing 40 C.F.R. § 1508.27(b)).

²⁵ 541 U.S. 752 (2004).

²⁶ 827 F.3d 36 (D.C. Cir. 2016).

²⁷ 541 U.S. at 770.

²⁸ 827 F.3d at 47.

²⁹ National Environmental Policy Act Implementing Procedures, 85 Fed. Reg. 25,340, 25,341–42 (proposed May 1, 2020) (to be codified at 10 C.F.R. Part 1021).

³⁰ *Id.* at 25,342.

In a companion case to *Freeport I*, the D.C. Circuit rejected petitioners' argument that FERC should have considered the increased production of gas for export and the increased cost of domestic gas that could prompt greater reliance on coal in its NEPA analysis of a liquefied natural gas terminal.³¹ The court reasoned that these effects could not occur "unless a greater volume of liquefied natural gas is shipped from the Terminal and enters the international marketplace" which "the Department of Energy alone has the legal authority to authorize."³² Accordingly, petitioner "remain[ed] free to raise these issues in a challenge to the Energy Department's NEPA review of its export decision."³³ Later, the petitioner in that case *did* challenge DOE's NEPA review of its export decision.³⁴ In *Freeport II*, the D.C. Circuit considered DOE's Addendum to Environmental Review Documents Concerning Exports of Natural Gas from the United States ("Addendum")³⁵ and its Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States ("Life Cycle Report")³⁶ as a part of DOE's "hard look" NEPA analysis of its Section 3 export authorization for the Freeport LNG Terminal in Texas.³⁷

In a third D.C. Circuit case, *Sierra Club v. Federal Energy Regulatory Commission (Sabal Trail)*,³⁸ the court clarified that "the fact that a second agency's approval was necessary before the environmental effect at issue could occur" was not sufficient to break the causal chain between an agency action and an environmental effect, but rather an agency must have "no legal authority to prevent the adverse environmental effects . . ."³⁹ This means that, for an environmental effect to be outside the scope of DOE's NEPA analysis, DOE must be "forbidden to rely on" the potential harm of those effects "as a justification for denying" an export authorization.⁴⁰ The question is not "What activities does [DOE] regulate?" but rather "What factors can [DOE] consider when regulating in its proper sphere?"⁴¹ In evaluating FERC's NGA Section 7 authority to approve applications to construct and operate interstate pipelines, the D.C. Circuit held that "[b]ecause FERC could deny a pipeline certificate on the ground that the pipeline would be too harmful to the environment, the agency is a 'legally relevant cause' of the direct and indirect environmental effects of pipelines it approves."⁴² Similarly, here, because DOE can deny an export authorization on the ground that the export of a certain amount of natural gas would be too harmful to the environment, it is a legally relevant cause of the direct and indirect environmental effects of pipelines it approves.

B. Environmental Effects of Natural Gas Export

Direct effects of natural gas export include the environmental impacts at or after the point of export. With regard to an LNG terminal, FERC typically evaluates the upland operations in its own NEPA analysis, which it completes as the "lead agency" for a natural gas export operation.⁴³ However, FERC has made clear that not all points of export will be subject to its Section 3 jurisdiction, specifically when

³¹ *Sierra Club v. Fed. Energy Regulatory Comm'n*, 827 F.3d 59, 68 (D.C. Cir. 2016).

³² *Id.*

³³ *Id.* at 68–69.

³⁴ See *Sierra Club v. U.S. Dep't of Energy (Freeport II)*, 867 F.3d 189 (D.C. Cir. 2007).

³⁵ 79 Fed. Reg. 48,132 (Aug. 15, 2014).

³⁶ 79 Fed. Reg. 32,260 (June 4, 2014).

³⁷ *Id.* at 197.

³⁸ 867 F.3d 1357 (D.C. Cir. 2017).

³⁹ *Id.* at 1373.

⁴⁰ *Id.*

⁴¹ *Id.*

⁴² *Id.*

⁴³ 15 U.S.C. § 717n(b)(1); see also *Freeport I*, 827 F.3d at 41.

those facilities do not connect to a pipeline.⁴⁴ Accordingly, when an export facility does not meet FERC's interpretation of an "LNG terminal," DOE must evaluate the direct environmental impacts of that facility, as it is located "at" the point of export. Each of these facilities will be unique and may have a substantial effect on the environment. A failure to analyze the impacts of such a facility in the absence of FERC jurisdiction will result in a regulatory gap. Thus, a categorical exclusion for all NGA Section 3 export authorizations is inappropriate.

DOE in its proposed rule also neglects to consider the indirect effects of authorizing natural gas exports. Indirect impacts caused by "reasonably foreseeable" future actions are recognizable under NEPA and must be considered throughout the NEPA process. Natural gas exports will increase U.S. gas production.⁴⁵ Thus, an approval for export of a specified amount of natural gas has a measurable impact on production, and is a legally-relevant cause of that increased production. As the D.C. Circuit explained in the context of a Section 7 pipeline approval, "[b]ecause FERC could deny a pipeline certificate on the ground that the pipeline would be too harmful to the environment, the agency is a 'legally relevant cause' of the direct and indirect environmental effects of pipelines it approves."⁴⁶ Here, too, because DOE could deny an application for authorization to export natural gas based on environmental concerns, DOE's approval is a legally-relevant cause of upstream gas production. In this respect, the approval for export from a specific site is similar to the construction of a logging road in *Thomas v. Peterson*,⁴⁷ a case that discussed the appropriate scope of a NEPA analysis. In that case, the Ninth Circuit reasoned:

The location, the timing, or other aspects of the timber sales, or even the decision whether to sell any timber at all affects the location, routing, construction techniques, and other aspects of the road, or even the need for construction.

....

The Forest Service argues that the sales are too uncertain and too far in the future for their impacts to be analyzed along with that of the road. This comes close to saying that building the road now is itself irrational. We decline to accept that conclusion. Rather, we believe that if the sales are sufficiently certain to justify construction of the road, then they are sufficiently certain for their environmental impacts to be analyzed along with those of the road.⁴⁸

In sum, if the production of natural gas is sufficiently certain to justify an export authorization, then it is sufficiently certain for DOE to analyze its environmental impacts, as required by NEPA.

That an export authorization for an increased amount of natural gas will necessarily lead to additional demand for natural gas, with consequences for its price, production, and use, is eminently

⁴⁴ See *Shell U.S. Gas & Power, LLC*, 148 FERC ¶ 61,163 (Sept. 4, 2014), *Emera CNG, LLC*, 148 FERC ¶ 61,219 (Sept. 19, 2014); see also Congressional Research Service, *Liquefied Natural Gas by Rail: Policy Issues* (Nov. 18, 2019) (describing "virtual pipelines" created by transporting LNG via trucks and rail cars) (attached).

⁴⁵ See NERA Economic Consulting, *Macroeconomic Impacts of LNG Exports from the United States* ("NERA Study") 51–52, fig. 30 (2012).

⁴⁶ *Sabal Trail*, 867 F.3d at 1373.

⁴⁷ 753 F.2d 754 (9th Cir. 1985).

⁴⁸ *Id.* at 760.

foreseeable. The D.C. Circuit has recently held that such “generally applicable economic principles,” as the relationship between the price of a good and its production and consumption, are “sufficiently ‘self-evident’” to “require ‘no evidence outside the administrative record.’”⁴⁹ The results of generally applicable economics are all the more foreseeable here, as DOE performed an export study in 2012.⁵⁰

The Council on Environmental Quality’s (“CEQ’s”) regulations implementing NEPA provide illustrations of indirect effects that are closely analogous to those at issue here: “growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate[.]”⁵¹ Like impacts on gas production and use, growth-inducing effects and induced changes in the pattern of land use reflect responses—generally market-based—to changes in the supply of, and demand for, various resources. Further reflecting the need to consider such impacts, the regulations include economic as well as environmental impacts among those that an agency must consider.⁵²

For that reason, courts have consistently required that agencies extend the ambit of their analysis to include effects akin to upstream production and downstream consumption. The Eighth Circuit has addressed circumstances that closely parallel those here, holding that when an agency approves a rail-line extension that would result in “an increase in availability and a decrease in price” of coal, NEPA demands that the agency examine the environmental “effects that may occur as a result of the reasonably foreseeable increase in coal consumption.”⁵³ In *Mid-States*, the agency’s decision enabled an increase in the supply of coal to the domestic market; here, as described below, DOE’s Section 3 authorizations will cause an increase in demand for natural gas. In *Mid-States*, that decision had foreseeable effects on the price of coal, its production, and its use.

DOE’s Section 3 authorizations have foreseeable impacts on natural gas’s price, production, and use. In *Mid-States*, the Eighth Circuit held that the agency could not responsibly or lawfully ignore those effects under NEPA.⁵⁴ Likewise, neither could DOE do so here. Other Circuits have reached similar conclusions. When authorizing a runway that would expand capacity and “spur demand,” the Ninth Circuit has held that the Department of Transportation must examine the increased usage that will result from that demand.⁵⁵ The First Circuit has refused to let an agency construct a causeway and port without examining the “industrial development” that would be enabled by that construction.⁵⁶ Those cases establish that when an agency takes an action that will increase demand for a resource, it cannot ignore the effects of that increased demand.

Additionally, DOE must consider the cumulative effects of actions similar to the proposed action, whether existing or reasonably foreseeable. Cumulative impacts include “impact[s] on the environment which result from the incremental impact of the action *when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such*

⁴⁹ *Airlines for Am. v. Transp. Sec. Admin.*, 780 F.3d 409, 410-11 (D.C. Cir. 2015) (finding standing based on “basic proposition that ‘increasing the price of an activity . . . will decrease the quantity of that activity demanded in the market’” (alteration in original) (quoting *Branton v. FCC*, 993 F.2d 906 (D.C. Cir. 1993))).

⁵⁰ 2012 LNG Export Study, 77 Fed. Reg. 73,627 (Dec. 11, 2012).

⁵¹ 40 C.F.R. § 1508.8(b) (2019).

⁵² *Id.*

⁵³ *Mid-States Coal. for Progress v. Surface Transp. Bd.*, 345 F.3d 520, 549-50 (8th Cir. 2003) (requiring that agency address air pollution resulting from increased coal use).

⁵⁴ *Id.*

⁵⁵ *Barnes v. U.S. Dep’t of Transp.*, 655 F.3d 1124, 1138-9 (9th Cir. 2011).

⁵⁶ *Sierra Club v. Marsh*, 769 F.2d 868, 877-79 (1st Cir. 1985). *See also Friends of the Earth v. U.S. Army Corps of Eng’rs*, 109 F. Supp. 2d 30, 39-40 (D.D.C. 2000) (invalidating agency decision approving casino, without considering economic development that would result).

*other actions.*⁵⁷ “Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.”⁵⁸ Cumulative impacts include “coincident effects (adverse or beneficial) on specific resources, ecosystems, and human communities of all related activities, not just the proposed project or alternatives that initiate the assessment process.”⁵⁹ A cumulative effects analysis focuses on resource sustainability, and has expanded geographic and time boundaries. In the specific context of Section 3 natural gas export authorizations, DOE should consider all pending natural gas export authorization applications before it in order to appropriately assess the cumulative impacts of its actions.

While DOE created an Addendum to Environmental Review Documents Concerning Exports of Natural Gas from the United States,⁶⁰ that document did not “specifically project where or to what extent the impacts of increased production might occur in response to any particular amount of exports.”⁶¹ NEPA does not allow agencies to consider only those effects whose specifics are known and certain. As the Eighth Circuit held, “when the *nature* of the effect is reasonably foreseeable but its *extent* is not . . . [an] agency may not simply ignore the effect.”⁶² Indeed, where an action’s effects are not precisely known, the Council on Environmental Quality’s regulations suggest that the action is more—not less—likely to warrant an environmental impact statement.⁶³

NEPA’s implementing regulations provide detailed instructions as to how such uncertainty is to be addressed in an environmental impact statement.⁶⁴ That the precise location of natural gas production is unknown, therefore, does not render such production unforeseeable, or allow DOE to dismiss its effects as insignificant. “It is well recognized that a lack of certainty concerning prospective environmental impacts cannot relieve an agency of responsibility for considering reasonably foreseeable contingencies.”⁶⁵ Rather, “[a]t the threshold stage of the NEPA inquiry . . . an agency must determine, to the extent feasible, whether the sum of all reasonably foreseeable effects, discounted by the probability of their occurrence, represent a ‘significant’ effect on the environment.”⁶⁶ If so, the “agency must issue an EIS analyzing the probabilistic facets of the prospective environmental impact.”⁶⁷

Analysts, experts, and modelers use the location of interstate transmission gas lines as a predictor of where gas production will take place. The reality of the industry is that there is a direct relationship between the siting and construction of well pads and the location of existing or proposed interstate pipelines. These pipelines then lead to natural gas liquefaction facilities, where the gas is

⁵⁷ 40 C.F.R. § 1508.7 (emphasis added).

⁵⁸ 40 C.F.R. § 1508.7.

⁵⁹ COUNCIL ON ENVIRONMENTAL QUALITY, EXECUTIVE OFFICE OF THE PRESIDENT, CONSIDERING CUMULATIVE EFFECTS UNDER THE NATIONAL ENVIRONMENTAL POLICY ACT at v (Jan. 1997).

⁶⁰ 79 Fed. Reg. 48,132 (Aug. 15, 2014).

⁶¹ *Freeport II*, 867 F.3d at 195.

⁶² *Mid-States Coal. for Progress*, 345 F.3d at 549-50 (when agency permits rail extension that will increase “availability of coal,” it may not ignore “the construction of additional [coal-fired] power plants” that may result merely because agency does not “know where those plants will be built, and how much coal these new unnamed power plants would use”).

⁶³ See 40 C.F.R. § 1508.27(b)(5) (intensity depends upon “[t]he degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks”); see also *Found. on Econ. Trends*, 756 F.2d at 154-55 (It is not “sufficient for the agency merely to state that the environmental effects are currently unknown,” because uncertainty is “one of the specific criteria for deciding whether an [environmental impact statement] is necessary”).

⁶⁴ 40 C.F.R. § 1502.22(b) (specifying how the agency should proceed when “the information relevant to reasonably foreseeable significant adverse impacts cannot be obtained because the overall costs of obtaining it are exorbitant or the means to obtain it are not known”).

⁶⁵ *Potomac Alliance v. U.S. Nuclear Reg. Comm’n*, 682 F.2d 1030, 1036-37 (D.C. Cir. 1982).

⁶⁶ *Id.*

⁶⁷ *Id.*

liquefied for export. DOE could use this information to determine the probable location of upstream environmental impacts. As an example, DRN attaches a region-wide analysis of the impacts of natural gas development in the Marcellus Shale formation, as well as a more specific watershed-based analysis of the potential impacts of natural gas development in the Delaware River Basin.^{68,69}

Accordingly, the scope of environmental impacts caused by a DOE Section 3 approval includes existing and reasonably foreseeable shale development/production that would be advanced, induced and supported if a specific amount of natural gas was authorized for export. The reasonably foreseeable actions—the environmental and community impacts of which must be considered—include the construction, operation and maintenance of the shale gas wells that will be the source of the gas ultimately exported—both the new wells that would be constructed and the production that would be induced at pre-existing wells by the proposed export. The analysis of impact for these gas wells must include the associated access roads, gathering lines, compressor stations, water quality effects, water pipelines, water consumption and water disposal, truck traffic, and other supporting infrastructure which is necessary for the construction, development, and operation of these wells.

IV. Conclusion

DOE should not promulgate the proposed rule categorically excluding approvals or disapprovals of new authorizations or amendments of existing authorizations to export natural gas under Section 3 of the NGA. Not only is it contrary to NEPA and governing case law, it runs the risk of creating a void in the review of environmental harms of LNG export facilities where FERC does not exercise jurisdiction. Instead, it should continue to evaluate NGA Section 3 export authorizations on a case-by-case basis to determine whether an EIS or EA is appropriate in accordance with NEPA.

Maya K. van Rossum



the Delaware Riverkeeper

Delaware Riverkeeper Network

Enclosures

⁶⁸ CNA Analysis & Solutions, Potential Environmental Impacts of Full-development of the Marcellus Shale in Pennsylvania (Sept. 2016).

⁶⁹ CNA Analysis & Solutions, The Potential Environmental Impact from Fracking in the Delaware River Basin (Aug. 2015).



Liquefied Natural Gas by Rail: Policy Issues

November 18, 2019

On October 24, 2019, the Pipeline and Hazardous Materials Safety Administration (PHMSA), in coordination with the Federal Railroad Administration (FRA), published a proposed rule to authorize the transportation of liquefied natural gas (LNG) in rail tank cars. This publication was the latest federal action intended to provide “greater flexibility in the modes of transportation” of LNG to serve domestic and export markets. The proposed rule could conflict with legislation approved by the House of Representatives earlier this year.

Natural gas cooled below -260° F at normal atmospheric conditions condenses into a liquid with 1/600th of its gaseous volume. In this form, it can be economically transported in insulated tanks. When LNG is warmed it “regasifies” and is used the same way as natural gas supplied by pipeline. Like other gaseous or vaporized fuels, natural gas is combustible, so an uncontrolled release of LNG poses a risk of fire or, in confined spaces, explosion. Due to its low temperature, LNG also could injure people or damage facilities through direct contact. Partly because of these safety risks, LNG shipment and the development of related facilities have been controversial in some communities.

Virtual Pipelines

Domestic transportation of natural gas occurs mainly by pipeline. However, not all parts of the United States have sufficient pipeline capacity to meet expected growth in demand. Furthermore, proposed pipelines in New England, New York, and the Mid-Atlantic have encountered legal and regulatory challenges. These challenges have prompted proposals to ship LNG by rail to markets with constrained pipeline capacity. The Federal Energy Regulatory Commission has determined that such “virtual pipelines” are not an economically practical alternative to a major pipeline project “based on the number of ... rail cars that would be needed to transport the project volumes and the facilities, time, and cost necessary to process and deliver these volumes.” Nonetheless, some in the energy sector believe LNG by rail may be economic in specific markets or at specific times, such as peak heating season in the Northeast. Consequently, certain natural gas market participants and trade groups assert LNG shipment by rail presents “a growing opportunity.”

LNG has been shipped between U.S. and overseas ports in large marine vessels for over 60 years. LNG also has been transported domestically by road in specialized tanker trucks since the 1970s. However, domestic shipment of LNG by rail is relatively new. Federal Hazardous Materials Regulations prohibit rail shipment of LNG except by PHMSA special permit or with FRA approval. The FRA granted the first

Congressional Research Service

<https://crsreports.congress.gov>

IN11202

such approval in 2015 to the Alaska Railroad Corporation, which has subsequently transported LNG by rail in multi-modal tank containers (**Figure 1**) from Anchorage to Fairbanks. The FRA issued a second approval in 2017 to the Florida East Coast Railroad, which is using LNG as a locomotive fuel and is testing LNG transport in tank containers from Jacksonville to Miami for export to the Caribbean.

Figure 1. Alaska LNG Shipment on Flatbed Rail Cars



Source: Federal Railroad Administration, Office of Technical Oversight, slide presentation.

PHMSA's proposed rule could expand rail shipment of LNG well beyond what the FRA has allowed. The agency's rule aligns with an April 10, 2019, executive order directing the Secretary of Transportation to propose a rule that would "permit LNG to be transported in approved rail tank cars" to be issued by May 2020. It also responds to a 2017 petition from the Association of American Railroads (a trade group) and a 2019 special permit application from Energy Transport Solutions, a prospective LNG shipper.

PHMSA's draft environmental assessment for the special permit states that the applicant intends to ship LNG in "unit trains," which carry one commodity in as many as 100 rail cars. Unit trains are already used in the United States for the shipment by tank car of other energy commodities such as propane and crude oil. However, the FRA has stated that "the transportation of large quantities of LNG in a single train presents unique safety risks." For similar reasons, a 2014 study for the Maritime Administration examining LNG as a maritime fuel recommended that prospective shippers of LNG by rail (to ports) "perform a detailed study of potential routes for LNG transportation ... that avoid densely populated areas and identify emergency response capabilities." PHMSA's rulemaking is examining potential limitations for routes and train length specifically for LNG shipments in rail tank cars. Speed restrictions and advanced braking devices are also under consideration.

PHMSA's proposed rule would allow LNG to be carried in DOT-113C120W specification tank cars (**Figure 2**), which are designed to carry liquefied ethylene, "another flammable cryogenic liquid which shares similar chemical and operating characteristics with LNG." The proposed rule does not discuss specific tank car features designed to reduce the chances of tank car punctures during derailment, such as those newly required of cars carrying crude oil. The proposed rule also does not specifically indicate whether LNG would be restricted to routes equipped with positive train control, an advanced signaling system designed to avert collisions due to conflicting train movements, although it does reference an industry standard that implies this requirement.

Figure 2. Insulated Rail Cars Proposed for LNG

Source: Courtesy of Chart Industries.

On June 24, 2019, the House approved an appropriations bill amendment (H.Amdt. 468 to H.R. 3055) to prohibit the Secretary of Transportation from using appropriated funds to carry out the LNG by rail provisions of the April 10 executive order. It also would prohibit the Secretary from using appropriated funds to authorize LNG transportation in rail tank cars by issuance of a special permit or approval. On September 12, 2019, the Chairman of the House Committee on Transportation and Infrastructure introduced the Protecting Communities from Liquefied Natural Gas Trains Act (H.R. 4306), which would require the FRA and PHMSA “to conduct an evaluation of the safety, security, and environmental risks of transporting liquefied natural gas by rail.” To what extent large rail shipments of LNG materialize, and where, will be determined by market factors as well as regulation.

Author Information

Paul W. Parfomak
Specialist in Energy and Infrastructure Policy

John Frittelli
Specialist in Transportation Policy

Disclaimer

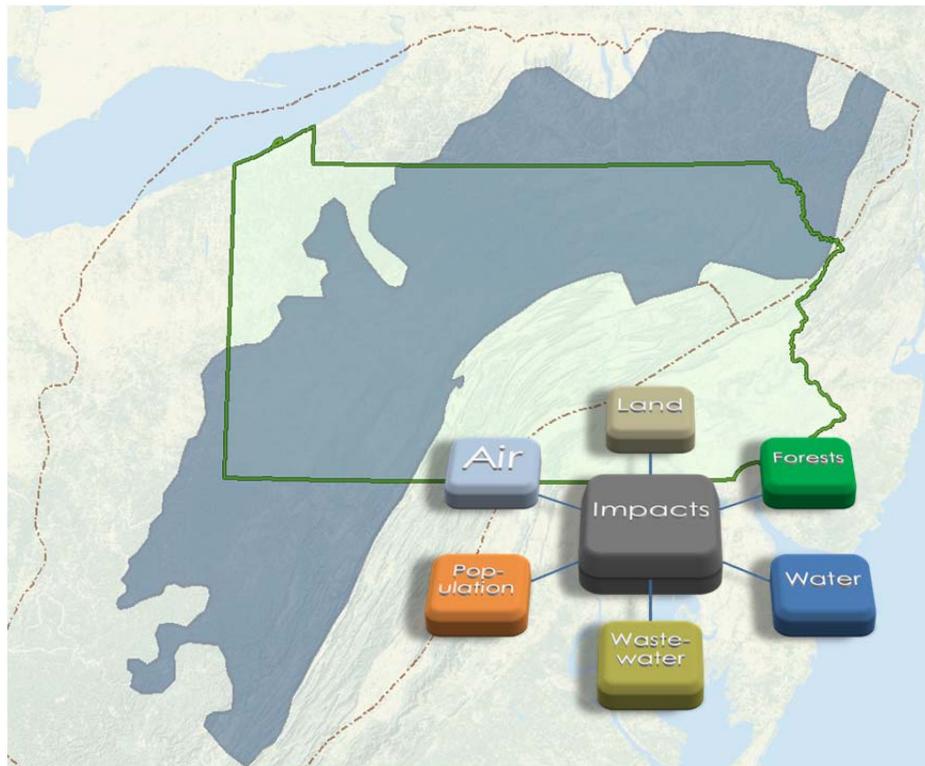
This document was prepared by the Congressional Research Service (CRS). CRS serves as nonpartisan shared staff to congressional committees and Members of Congress. It operates solely at the behest of and under the direction of Congress. Information in a CRS Report should not be relied upon for purposes other than public understanding of information that has been provided by CRS to Members of Congress in connection with CRS’s institutional role. CRS Reports, as a work of the United States Government, are not subject to copyright protection in the United

States. Any CRS Report may be reproduced and distributed in its entirety without permission from CRS. However, as a CRS Report may include copyrighted images or material from a third party, you may need to obtain the permission of the copyright holder if you wish to copy or otherwise use copyrighted material.

Potential Environmental Impacts of Full-development of the Marcellus Shale in Pennsylvania

Lars Hanson, Steven Habicht, and Paul Faeth

September 2016





Acknowledgements: The authors of this report would like to recognize the study's reviewers including Gerald Shapiro (CNA), Kim Deal (CNA), and Dr. John Stolz (Duquesne University) who completed an independent external review. Any errors that remain are our own responsibility. We would also like to recognize our editor, Maurine Dahlberg.

The Delaware Riverkeeper Network funded this research effort, and we would like to express our thanks for their support.

Authors: Lars Hanson, Steven Habicht, PhD, and Paul Faeth

Document Number: IRM-2016-U-013695

This document represents the best opinion of CNA at the time of release. It does not necessarily represent the opinion of the sponsor. CNA operates on the principle of conducting honest, objective, accurate, usable research to inform the important work of public policy decision makers.

Note: This document contains *projections* of potential impacts that are subject to assumptions and conditions which are documented in the report. Changes to the assumptions could change the results. This report does not constitute a prediction of future conditions, and should not be used to make investment decisions or for commercial purposes.

Distribution:

Unlimited Distribution

Image Credit: CNA

Approved by:

July 2016

A handwritten signature in black ink, appearing to read 'DK', with a long horizontal line extending to the right.

David Kaufman, Director
Safety and Security
Institute for Public Research

Abstract

Unconventional natural gas development using hydraulic fracturing has spurred a rapid expansion of natural gas extraction in Pennsylvania from the Marcellus Shale formation in particular. Further, the gas reserves in the Marcellus Shale could support significantly more gas development. We did a conditional analysis investigating the potential impacts to Pennsylvania's land, forests, water, air, and population *if* development of the Marcellus Shale should continue until all of the technically recoverable reserves are exhausted. We developed a geospatial analysis methodology to identify the most likely future well locations, and derived impacts per well or well pad from published literature or data sets. Our primary output is an *atlas*: a set of maps that puts the potential impacts of the projected natural gas development into useful spatial context. The maps cover several categories of impacts including land use changes, forest fragmentation, population living in proximity to well pads, air emissions, water withdrawals, and wastewater generation. These maps, and the data developed to generate them, will be useful to policy-makers, decision-makers, and others concerned about managing the impacts of Marcellus shale gas extraction in Pennsylvania.

This page intentionally left blank.

Executive Summary

Unconventional natural gas development using hydraulic fracturing has spurred a rapid expansion of natural gas extraction in Pennsylvania especially in the Marcellus Shale formation. Through the almost nine years of unconventional gas development in Pennsylvania, the Commonwealth has witnessed significant changes to energy costs, employment, communities, and the environment. While the price of natural gas has led to fluctuations in the rate of development, the significant quantity of gas reserves in the Marcellus Shale could support significantly more gas development in coming years.

The activities associated with unconventional natural gas development including drilling, land disturbance, water withdrawals, material handling and waste management, and operation of equipment have clear potential impacts to environmental resources and human health. The actual impacts and outcomes of these activities can vary considerably depending on industry practices, technology changes, and regulation, but in general they are proportional to the level of development. Improved practices, regulation, and monitoring can assist in managing impacts as they are occurring, but the overall level of impact will depend on the total amount of development that will occur. While many studies have investigated environmental impacts of gas development as it happens, relatively few consider the long range impacts of what might happen as development continues. In this study, we ask:

What would be the potential environmental impacts from natural gas development activities in Pennsylvania if the Interior Marcellus Shale resources were fully developed?

To answer this question, we developed a geospatial analysis methodology to identify the most likely future well locations based on the locations of existing wells relative to spatial data layers describing the shale characteristics, terrain, infrastructure, and hydrology of the region. We combined the probability surface generated from this analysis with recent estimates of total recoverable reserves and average production per well to determine how many wells could be developed and their most likely locations. We computed potential impacts based on the well (or well pad) numbers in a given geographic unit, and we derived impacts per well or well pad from published literature or data sets. With information on well locations and level of impact per well, we analyzed the spatial characteristics of impacts of natural gas development.

The scope of this study is limited to investigating potential impacts of additional well development in Pennsylvania in the Interior Marcellus¹ shale play. It does not consider other shale plays such as the Utica Shale. This study does not examine the full range of potential impacts from all activities associated with the natural gas sector², does not consider all potential impact pathways (e.g. accidental wastewater discharges), and it does not project possible environmental and human health *outcomes* based on the impacts.

For the Commonwealth of Pennsylvania, we estimated the following potential impacts associated with this study's projections of well development of the Marcellus Interior Shale formation:

- **Well development** - We estimated that 47,600 additional wells could be developed on 5,950 well pads over the next 30 years *if* the Interior Marcellus's technically recoverable resources were fully developed.
- **Land use change** - The construction of natural gas infrastructure (well pads, gathering pipelines, and access roads) to support projected well development would result in about 94,000 acres of land disturbance. Over half (about 51,000 acres) of the land disturbance would impact agricultural land, while about 28,000 acres would constitute the clearing of forest cover.
- **Forest change** - Of the 28,000 acres of forest that would be cleared, we found that 12,700 acres were core forest areas (over 100 meters from the nearest forest edge). Additionally, over 88,000 acres of core forest would be fragmented by road and pipeline development and converted to edge forest. Thus, over 100,000 acres of core forest would be lost due to the combined effect of clearing and fragmentation.
- **Population in proximity to well pads** - We estimated that the current population in Pennsylvania living within one-half mile of a well pad is about 100,000, and, based on our projections, this number could increase to 639,000. Similarly, we estimate that the population living within one mile of a well pad could increase from about 311,000 today to over 1.8 million at full build-out.

¹ The Interior Marcellus is the primary gas-producing portion of the Marcellus formation, with over 95 percent of its gas reserves.

² For example, this study does not consider the impacts associated with construction and operation of interstate gas transmission pipelines. Other potential impacts such as road traffic or groundwater contamination are not well suited to analysis using the methods employed for this study.

- **Air emissions** - The additional well development would result in greater emissions of NO_x, VOCs, and CH₄ from activities related to well pre-production and production, and compressor stations for moving gas through gathering lines. When the play nears full development (i.e., ongoing emissions from producing wells reach their peak), the annual average air emissions could reach 37,000 tons per year for NO_x, 22,500 tons per year for VOCs, and 388,000 tons per year for methane.
- **Water use, withdrawal, and consumptive use** - We determined that the projected natural gas development in the Marcellus would require 242 billion gallons of water in total, in order to mix frac fluid for the hydraulic fracturing process. Averaged over 30 years, this is a water use rate of 34 cubic feet per second or 22 million gallons per day. We found that roughly 200 billion gallons of fresh surface water would be withdrawn to support this development, and that 167 billion gallons would be used consumptively and would not re-join the hydrologic cycle after hydraulic fracturing injection.
- **Wastewater generated** - We estimated that 84 billion gallons of wastewater would be generated from projected natural gas development in Pennsylvania. Wastewater includes drilling fluid waste, plus flowback and produced water/brine recovered from the shale after frac fluid injection and during gas production.

These metrics offer a sense of the scale of the total statewide impacts of natural gas development through full development of the Interior Marcellus Shale. But these aggregated metrics do not tell the full story of the impacts, which have important geographic variations. Thus, the primary output of this research is an *atlas*: a set of maps that puts the impacts of the projected natural gas development into useful spatial context. These maps, and the data developed to generate them, present useful information to policy-makers, decision-makers, and other researchers concerned about managing the range of impacts of shale gas extraction in Pennsylvania.

The maps can be downloaded in sets corresponding to each chapter of this report at: www.cna.org/PA-Marcellus

Section Break.

Contents

Introduction.....	1
Understanding this report.....	2
Projected Natural Gas Development.....	7
Methods, data sources, and assumptions	7
Well location modeling	7
Infrastructure modeling	12
Results	12
Discussion.....	13
Map 1.1 - Probability surface for well pad development in the Interior Marcellus.....	13
Map 1.2 - Projected well pad development locations	14
Map 1.3 - Projected well development by county	14
Map 1.4 - Projected well development by watershed.....	14
Map 1.5 - Projected well development density.....	14
Map 1.6 - Projected natural gas infrastructure by county	15
General discussion.....	15
Impact on Land Cover.....	19
Methods, data sources, and assumptions	20
Results	22
Discussion.....	23
Map 2.1 - Land disturbance by county.....	23
Map 2.2 - Land disturbance by watershed	24
Map 2.3 - Forest clearing by watershed	24
Map 2.4 - Core forest loss by watershed	24
Map 2.5 - Existing developed area versus new clearing for gas infrastructure construction	25
Map 2.6 - Stream crossings by watershed	25
General discussion.....	25
Impact on Population	27
Methods, data sources, and assumptions	27

Results	28
Discussion.....	30
Map 3.1 – Area within 0.5 mile of well pads	30
Map 3.2 – Area within 1 mile of well pads.....	30
Map 3.3 – Population within 0.5 mile of well pads	30
Map 3.4 – Population within 1 mile of well pads	31
General discussion.....	31
Impact on Air Emissions	33
Methods, data sources, and assumptions	33
Results	36
Discussion.....	40
Map 4.1 – NOx emissions from projected development.....	40
Map 4.2 – VOC emissions from projected development.....	40
Map 4.3 – Methane emissions from projected development	40
General discussion.....	41
Water and Wastewater Impact	43
Methods, data sources, and assumptions	44
Water use per well.....	45
Water withdrawal, consumptive use, and wastewater	46
Results	48
Discussion.....	50
Map 5.1 – Water use by watershed	50
Map 5.2 – Water withdrawal by watershed	50
Map 5.3 – Consumptive use by watershed.....	51
Map 5.4 – Wastewater generation by watershed	51
Map 5.5 – Specific water use.....	51
Map 5.6 – Specific water withdrawal.....	52
Map 5.7 – Cumulative water use	52
Map 5.8 – Cumulative consumptive use.....	53
Map 5.9 – Consumptive use by watershed relative to existing consumptive uses	54
General discussion.....	54
Conclusion	57
Key findings.....	58
References.....	60

List of Figures

Figure 1.	This analysis and environmental burdens, impacts, and outcomes.....	3
Figure 2.	The Marcellus Shale formation and Pennsylvania counties (top), and watersheds (bottom). This analysis focuses on potential future development within the Interior Marcellus portion of the formation only.....	5
Figure 3.	Average number of wells drilled per well pad in the Marcellus Shale from 2005 to 2013.....	10
Figure 4.	Resource categories for various gas-in-place estimates used in industry.....	11
Figure 5.	Pennsylvania statewide land cover impacts from natural gas development including land disturbance by initial land cover type and core forest loss due to land disturbance and core to edge forest transition due to fragmentation.....	22
Figure 6.	Pennsylvania statewide population within 0.5 and 1 mile of current or projected Marcellus well pad locations at full development.	29
Figure 7.	Cumulative NOx, VOC, and methane emissions from projected natural gas development over a 30-year build-out.....	37
Figure 8.	Pennsylvania annual statewide emissions from projected natural gas development activities	39
Figure 9.	Uncertainty in statewide Marcellus annual NOx emissions due to emissions factor used for natural gas gathering compressor stations.	42
Figure 10.	Estimates of per well water use by HUC-8 watershed.....	46
Figure 11.	Total water and wastewater impacts for Pennsylvania associated with hydraulic fracturing of projected wells through full development of the Marcellus Shale.....	48

List of Tables

Table 1.	Well Projections Map Index.	13
Table 2.	Land Cover Impacts Map Index.....	23
Table 3.	Land cover groupings by 2011 National Land Cover Dataset classifications.	24
Table 4.	Population Impacts Map Index.....	30
Table 5.	Emissions factors used in this study to evaluate air quality impacts from projected natural gas development	35
Table 6.	Air Emissions Impact Map Index.	40
Table 7.	Water and wastewater maps by metric and category.	49
Table 8.	Water and Wastewater Impacts Map Index.	50

Glossary

Abbreviations

DRB	Delaware River Basin
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
NLCD	National Land Cover Dataset
PA	Pennsylvania
PA DEP	Pennsylvania Department of Environmental Protection
USGS	United States Geological Survey
CH ₄	methane (gas)
EUR	Expected ultimate recovery
HF, HVHF	Hydraulic fracturing, High-volume hydraulic fracturing
HUC	Hydrologic Unit Code
NOx	Nitrogen oxides (including NO ₂ , NO ₃)
TRR	Technically recoverable resources
UNGD	Unconventional natural gas development
VOC	Volatile organic compound
ac	acres
cf/ Bcf/ Tcf	cubic feet / Billion cubic feet / Trillion cubic feet
cfs	cubic feet per second
ft	feet
gal	gallons
gpd	gallons per day
mi	miles
mi ²	square miles
MG	million gallons
MGD/MGY	million gallons per day / million gallons per year

Key terms

brine/produced water	Wastewater recovered during gas production consisting of frac fluid and contaminants from the shale formation.
consumptive use	The portion of water use for fracking that is not recovered from shale.
core forest	Forest of high ecological value more than 100 meters from other land use types, or infrastructure such as roads
edge forest	Forest adjacent to (less than 100 meters) other land use types, or infrastructure such as roads
flowback	Wastewater consisting primarily of frac fluid recovered in the first few weeks after hydraulic fracturing
frac fluid	Fluid composed of water, sand, and chemicals injected at high volume into wells during the hydraulic fracturing process in order fracture gas-bearing shale
gathering pipeline	Type of pipeline used to move gas from producing wells to the gas transmission pipeline network
hydraulic fracturing	The process used to open fissures in gas bearing rock (esp. shale) using high-pressure injection of liquid.
lateral	The horizontal portion of the well drilled in the shale formation.
Maxent	Maximum Entropy (geospatial analysis technique)
play	Layer of rock of similar age/type that contain petroleum products such as natural gas
unconventional natural gas development	General term for the combination of industry practices and technologies (e.g., hydraulic fracturing, horizontal drilling, multiple wells per well pad) used to extract natural gas from shale formations such as the Marcellus
water withdrawal	The portion of the water used for fracking that is withdrawn directly from surface water sources.
well pad	The location from which wells are drilled

Introduction

Since 2007, Pennsylvania has become a major natural gas producing hub due to technology advances that have facilitated gas extraction from the Marcellus Shale play, which underlies portions of Pennsylvania, West Virginia, New York, Maryland, and Ohio. The unconventional natural gas development (UNGD) technology that has enabled this shift is high-volume hydraulic fracturing (HVHF) paired with horizontal drilling on well pads with multiple wells per pad. Hydraulic fracturing uses a high-volume injection of “frac” fluid (water, sand, and added chemicals) to fracture the shale formation, which generally holds gas tightly. Horizontal drilling has allowed each well to travel along the shale layer for several thousand feet, and the ability to drill multiple wells per well pad has increased the speed and efficiency of gas extraction. The net result is that the Marcellus play, which as recently as 2006 was a small player in gas production, now accounts for over 20 percent of total U.S. dry gas production [1].

Unlike several declining shale plays in other parts of the country, the Marcellus Shale play still has a large portion of its reserves available, and can support continuing development [2]. The pace of development will largely be tied to economic factors. The price of natural gas has a significant effect on development activity, as demonstrated by the recent declines in drilling activity in 2015 due to low gas prices. So does the marginal cost of production, which varies regionally across the Marcellus by a factor of three or more [1]. Economic factors in Pennsylvania (such as workforce development) and the role of the natural gas industry in the Pennsylvania economy will also influence development going forward. Over the long term, these economic forces will significantly influence the pace and timing of development, but the ultimate determinant of the amount of gas that could be developed is set by the amount of gas reserves and the technology available to recover the gas (subject to applicable restrictions and regulations pertaining to gas development).

According to the U.S. Energy Information Administration’s (EIA) estimates, the Marcellus Shale contains over 144 trillion cubic feet (Tcf) of technically recoverable reserves, of which over 65 Tcf are considered proven reserves [3], and of which most are in Pennsylvania. Over 11 Tcf has been produced in Pennsylvania through the end of 2014, and over 8,800 wells have already been drilled. Taken together, these statistics indicate that tens of thousands more wells would be needed to fully develop the Marcellus Shale resources in Pennsylvania.

Inevitably, UNGD results in some potential impacts to the environment across the landscape of development due to the activities needed to support the phases of development. Land must be cleared and developed in order to build the well pads, roads, and pipelines necessary to access the gas. During production, HVHF requires water to mix frac fluid, and produces volumes of wastewater along with gas that must be handled. Equipment that is necessary to run gas development operations (drilling rigs, pumps, trucks, compressors, and other equipment) produces air emissions, dust, and noise. All of these activities necessary for UNGD have impacts to land cover (including forests), watersheds, air, and human populations [4-22]. Some of these impacts can be mitigated more easily than others, and regulations, industry practices, and simple probability (large variations well-to-well) can have a large effect on the level of impact, or the risk of certain impacts occurring. The outcomes associated with these impacts are largely tied to the density and pace of natural gas development, and the underlying conditions and vulnerability of the affected areas' resources. But in order to understand these impacts, it is first necessary to understand the activities that cause them.

This analysis begins to answer the question: What happens if the Marcellus Shale is fully developed?

Understanding this report

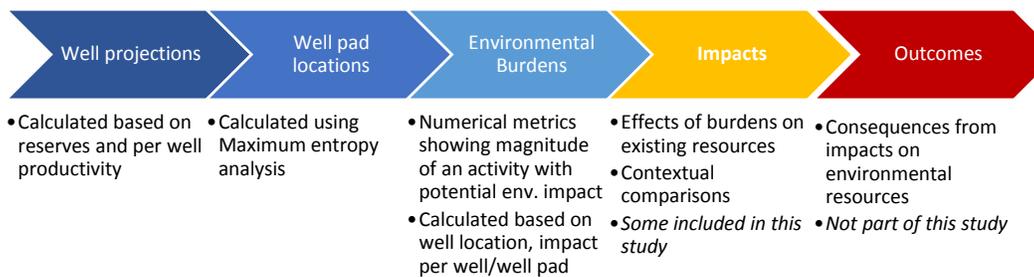
We present this analysis as one projection of what the impacts of full development of the Marcellus Shale may look like across the landscape of Pennsylvania. This study is not intended to be a comprehensive examination of all potential impacts of gas development, but rather is meant to be a starting point and useful guide that can help identify impact categories where more in-depth analysis may be warranted. The geographic breadth of this study limits the depth of the impact analysis.

Our methodology is relatively straightforward: Determine the number of wells required to fully develop the technically recoverable shale resources in the Interior Marcellus, and estimate the most likely well pad locations associated with this level of development. Then, using the projected numbers and locations of the wells and well pads, estimate the level of impacts using available data and scientific literature. In general, we multiply data on “per well pad” impact by projected number of well pads to estimate overall impact, and disaggregate results using useful geographic delineations (counties and watershed boundaries).

The metrics used to evaluate the impacts of gas development can be most easily explained by using the *Burdens > Impacts > Outcomes* framework advanced by Krupnick et al. [23] to discuss potential environmental impacts of fracking. *Burdens* are the numeric quantification of different activities that may have a potential impact. *Impacts* are the resulting effects of these activities on an environmental

resource. *Outcomes* refer to the secondary or indirect impacts on measures of environmental health that are generally not solely tied to a given impact (i.e. they depend on other factors such as the current condition of the resource). Figure 1 shows how this research effort fits within this framework. The foundation of this analysis is the well projections and associated well pad locations calculated for the full development of Interior Marcellus Shale. From this basis, the environmental burdens, impacts, and outcomes may be computed.

Figure 1. This analysis and environmental burdens, impacts, and outcomes.



This report is best understood as primarily a calculation of the location and magnitude of *environmental burdens* associated with gas development. That is, the metrics used relate primarily to activities (e.g., land disturbance, water withdrawal, air emissions), but not necessarily to the direct impacts or outcomes that may result from these activities.

Where possible, we investigate the *impacts* of these burdens on applicable resources—for example, forest cover lost as a portion of existing forest cover. In this study, we do not evaluate the *potential outcomes* associated with the impacts. For example, the loss of forest cover could potentially reduce the population of a particular bird species, or air emissions could increase the prevalence of respiratory illness. While burdens (and some impacts) can be calculated in a relatively straightforward manner based on the well and well pad projections, assessing outcomes requires a much greater understanding of the current state of environmental resources and potentially affected communities, and the mechanisms by which stressors (burdens and impacts) may influence outcomes. These types of evaluations are not within the scope of this study. Though we do note there is a growing body of literature investigating connections between gas development and these types of outcomes (see, for example [5, 8, 12-13]).

The burdens and impacts examined in this report are also not a comprehensive list of potential impacts. The impacts investigated are those that can be reasonably calculated in a straightforward manner based on the well projections. We aim to present a set of useful impact metrics that can support decision-making and more detailed future analyses, potentially including investigations of probable outcomes.

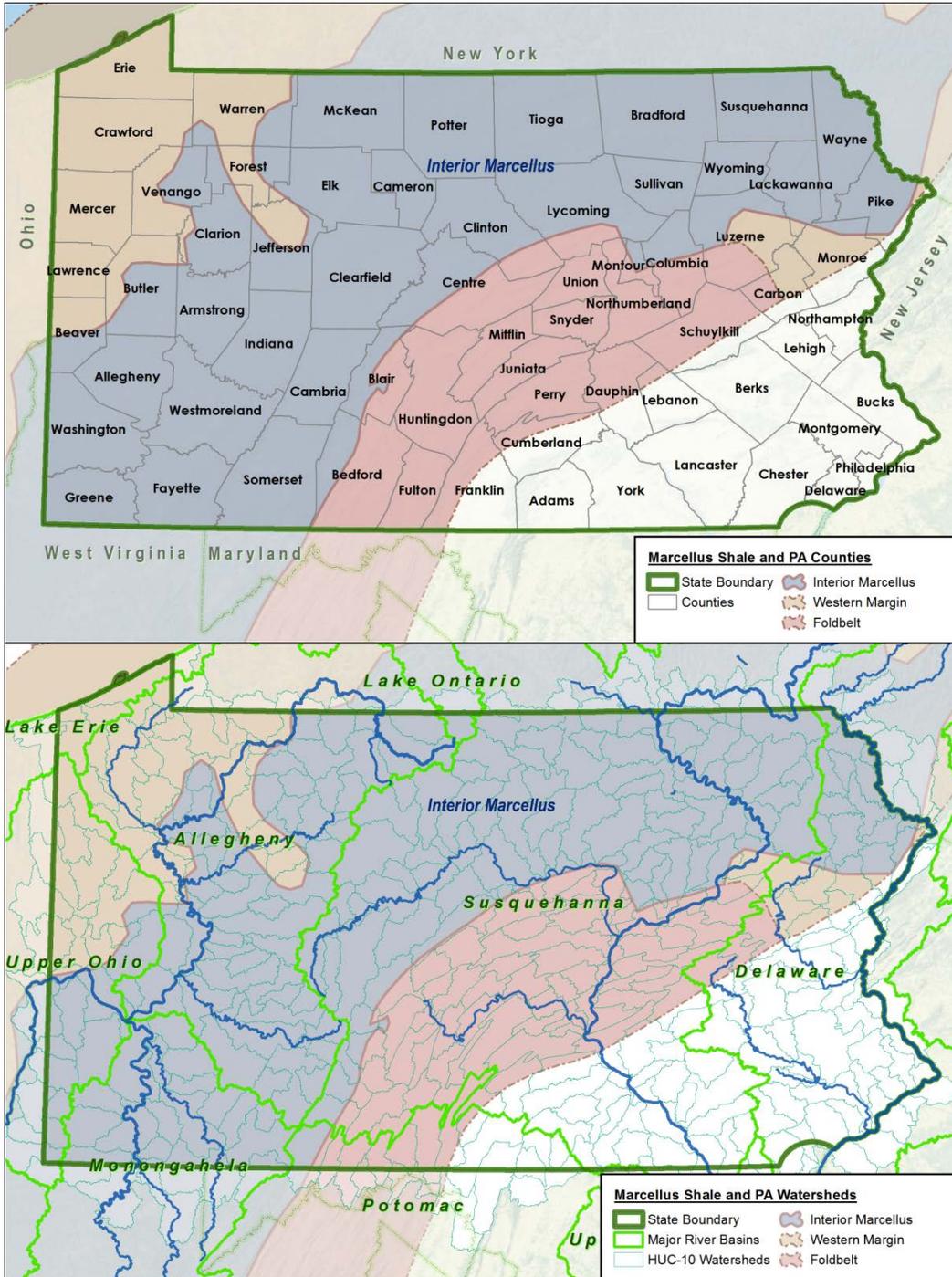
Specifically, we ask: What will be the approximate level of environmental burdens to land resources, forests, water, air, and the population of Pennsylvania that can be reasonably expected based on projections of the numbers of wells and well pads needed to fully develop the Marcellus Shale? We investigate particular impact metrics such as land area needed for infrastructure, forest and core forest loss, water withdrawals, wastewater generated, populations living in close proximity to wells, and air emissions. The impacts investigated tend to be those that can be reasonably estimated based on the well development numbers and locations using average per-well factors (from peer-reviewed literature or publicly available data sources), or additional geospatial analysis or modeling. In general, these impacts reflect average conditions for activities necessary for well development (e.g., building well pads, water withdrawals to mix frac fluid, or running compressors to pump natural gas).

This analysis does not investigate some other potential impacts often associated with gas development, because of data limitations or difficulty assessing impacts at such a large spatial scale. Some impacts such as groundwater contamination (associated with well-casing failures, surface spills of wastewater fluids, etc.) are difficult to investigate because the probabilistic nature of the impact cannot be directly tied to well locations without overly simplistic assumptions. Other impacts such as wastewater treatment and discharge, and community impacts such as truck traffic cannot be investigated easily because they require knowing information about natural gas operations (e.g., wastewater disposal method and location, preferred routes) that cannot easily be determined for long-range projections of well development. Finally, some impacts such as erosion and pollutant loading impacts associated with land development are not investigated because the analysis required is too complex and time-consuming to be completed at this geographic scale.

The primary output of this analysis is a series of maps displaying potential impact from a full development of the shale in several impact categories. We present the information in relevant geospatial context, recognizing that the impacts do vary considerably across Pennsylvania in relation to the relative intensity of gas development and existing condition of local resources. Specifically, we map the impacts by county or watershed (see Figure 2) depending on the nature of the impact. For instance, air emissions and population data are collected at the county level, while water withdrawal impacts are associated with watersheds. For mapping watershed impacts, we use Hydrologic Unit Code 10 (HUC-10) watershed boundaries from the United States' Geological Survey's (USGS's) Watershed Boundary dataset. In Pennsylvania, there about 330 HUC-10s, with an average size of 162 square miles.

The maps can be downloaded in sets corresponding to each chapter of this report at: www.cna.org/PA-Marcellus.

Figure 2. The Marcellus Shale formation and Pennsylvania counties (top), and watersheds (bottom). This analysis focuses on potential future development within the Interior Marcellus portion of the formation only.



This page intentionally left blank.

Projected Natural Gas Development

This chapter presents the current landscape of the Marcellus Shale play in order to predict how it may change in the future in response to the expansion of natural gas extraction. In particular, we focus on the potential development in the Interior Marcellus Shale Assessment Unit, since 95 percent of the shale's reserves are estimated to fall within this boundary [24], and 98 percent of the new wells developed in the region since 2011 have been within this boundary.³

For this report, we focused our analysis to determine where this development would most likely occur through Pennsylvania to realize full extraction of natural gas reserves. We then modeled the extent of potential infrastructure (gathering pipelines and access roads) necessary to support these well pads in the DRB. We did not assess impacts from additional infrastructure needed to support natural gas extraction that is not directly tied to individual well pads.⁴ Additionally, we did not assess other types of pipeline infrastructure (e.g., interstate and intrastate transmission pipelines, or intermediate collector pipelines to connect to several gathering pipelines) that may be developed beyond the gathering lines that bring the gas from the well pad to the nearest connection to the existing pipeline network.

Methods, data sources, and assumptions

Well location modeling

To predict the most likely locations for the placement of future wells in Pennsylvania, we used the same approach as in our previous analysis of the Delaware River Basin [4], which is based on methodology employed by Johnson et al. (2010)

³ The other assessment units (Western Margin and Foldbelt) are generally thinner and less rich in gas. Additionally, there were not a sufficient number of existing wells in these areas to complete the geospatial analysis necessary for well location modeling.

⁴ For example, equipment storage sites, industrial wastewater treatment plants, centralized wastewater impoundments, quarries, water withdrawal sites, and other supporting infrastructure not associated with individual well pads.

[18]. Briefly, we combined geospatial analysis and maximum entropy (Maxent) modeling using historical well location data and geological and environmental data layers for the Marcellus Shale. This method produced a probability surface in which each pixel contained a value that denoted the likelihood for development. We then determined the projected well pads' locations across the surface by using spatial averaging to center the locations on the highest Maxent value neighborhoods, and used exclusion distances to ensure adequate average well pad spacing.⁵ While a full description of the methodology can be found in our previous report [4], we present below the assumptions, data sources, and updates that we used for this analysis:

- Well development will occur at eight wells per well pad on average, based on recent trends of development in the state. New well pads would be built to accommodate each new set of wells. All wells drilled are horizontal wells.
- Development continues until all technically recoverable reserves for the Interior Marcellus (144 trillion cubic feet) are exhausted, at an estimate of 1.9 Billion cubic feet (Bcf) estimated ultimate recovery (EUR) per well. Both values are based on EIA estimates for the Marcellus Shale. We did not include development outside of the Interior Marcellus (e.g., in the Foldbelt or Western Margin Marcellus) or in other shale plays such as the Utica.
- For this analysis, “build-out” or “full development” are terms that refer to the condition when the EIA estimate of technically recoverable reserves in the Interior Marcellus play has been exhausted. We assume that build-out will occur over 30 years. We do not explicitly factor in economics (natural gas price projections, costs of development, etc.) in determining extent of development.
- Well spacing was based on an average lateral length of 5,000 feet and lateral spacing of 600 feet with eight horizontal wells per well pad, consistent with average Marcellus wells in 2014 [26].
- Well pad location exclusions followed PA regulations [27]:
 - Buildings — 500 ft (GIS address points [28]);
 - Streams and Wetlands — 300 ft; (NHDPlus v2 flowlines, NHDPlus v2 waterbodies [29]);
 - Outside 100-year floodplains (FEMA flood hazard layer [30]);

⁵ This methodology differs from that of a previous analysis [25], which used fixed or grid spacing for estimating well pad locations. The spatial averaging of Maxent values helps place the well pad in the center of a favorable development zone.

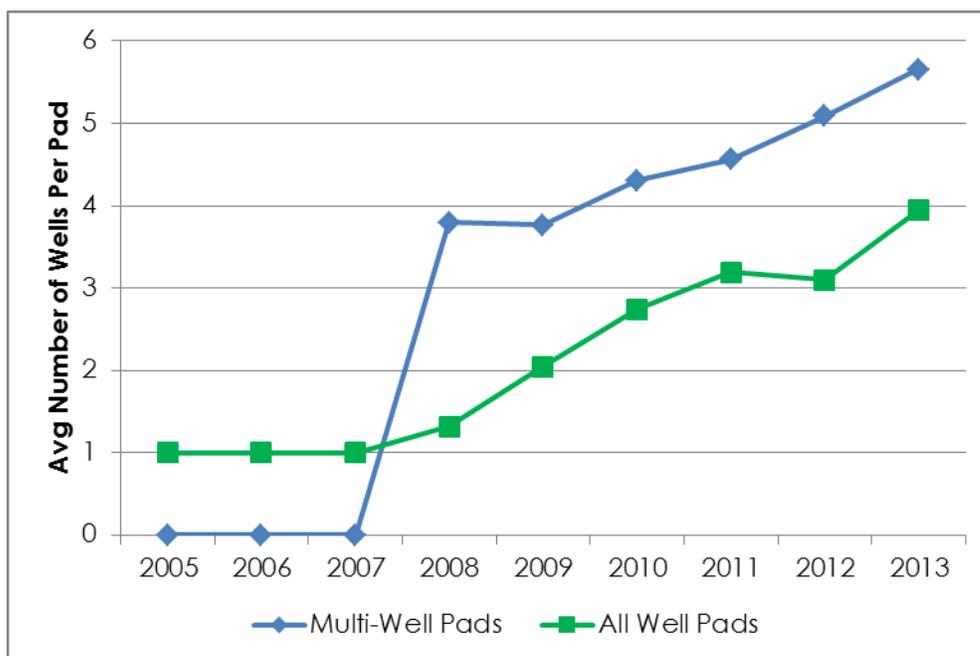
- Protected areas (USGS Gap Analysis Program Protected Areas Database, class 1 and 2 [31]).
- UNGD development with HVHF is not currently permitted in the portion of Pennsylvania within the Delaware River Basin (primarily affecting Wayne and Pike counties). For this analysis, we assumed that development *would be permitted* in this area, in order to analyze potential impacts to the Delaware River Basin.

Key parameters

The projections of the ultimate number of wells and well pads across the Marcellus are sensitive to several key assumptions. Notably, the number of wells per well pad, the estimated EUR per well, overall reserves estimate, and the number of horizontal versus vertical or directional wells drilled all affect the overall well numbers. Average well pad spacing (a function of lateral length and wells per pad), and exclusion areas will impact well locations. We also assume that all future well development will use HVHF with horizontally drilled wells. Although vertical and directional wells are still drilled in the Marcellus, nearly all new Marcellus wells in Pennsylvania are drilled with horizontal drilling [2].

We used an assumption of eight wells per well pad on average as reflective of typical development practice over the time horizon of this study (roughly 30 years). This is higher than the current average, but there is a clear upward trend in both the number of well pads with multiple well drilling, and the number of wells drilled on multi-well pads [32]. Also, recent analysis has found that nearly all new development is completed with multiple wells per pad [2]. Figure 3 presents the trend of well pad development in the Marcellus Shale and shows that the average number of wells on a multi-well pad has increased from fewer than three wells per pad in 2008 to almost six wells per pad in 2013. Further, there are already instances of well pads with 16 or more wells drilled. The number of wells per pad can have a significant influence on the level of impacts for several impact categories (e.g., land disturbance, forest fragmentation, population affected), and less influence for others (e.g., water withdrawal, air emissions). With more wells per pad, fewer well pads get developed across the landscape, given the same total number of wells. Previous studies [4, 18] have investigated how impacts differ depending on the number of wells per pad.

Figure 3. Average number of wells drilled per well pad in the Marcellus Shale from 2005 to 2013. After UNGD with hydraulic fracturing started in PA in 2007, drilling multiple wells per pad has become common, and the trend is still increasing.



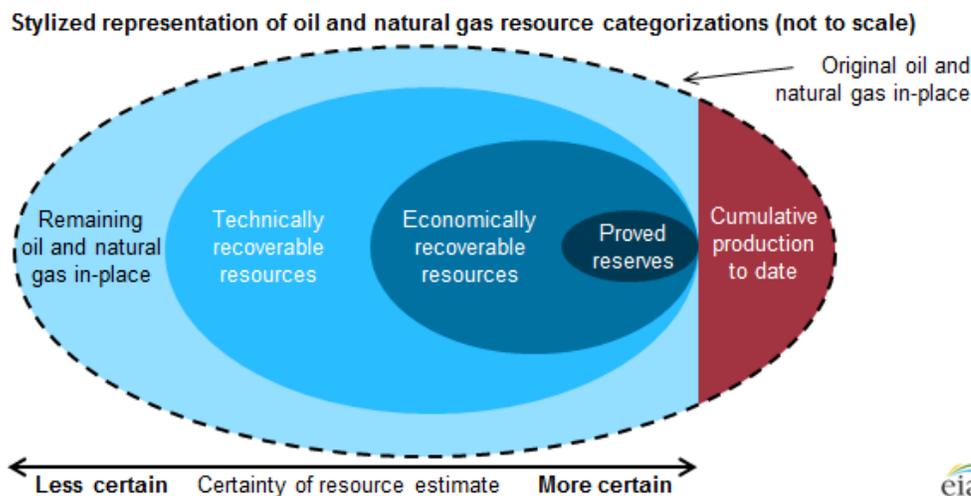
Source: Based on data from [32].

Based on recent EIA estimates [24], we assumed an average EUR per well of 1.9 Bcf. This value is lower than current average EUR estimates for wells drilled in the past few years, which range from approximately 4 to over 6 Bcf per well [3, 33].⁶ But the current wells are drilled in some of the most favorable locations, and this analysis, which takes a longer-term view, includes projected drilling in the future when many of the most productive areas would have been fully developed. Development outside of these “sweet-spot” areas currently targeted has a lower expected per-well productivity (by initial production, and correspondingly, EUR) [34]. In any case, the EUR estimate is used only to project number of wells that would be needed to exhaust the current estimate of technically recoverable resources. (We do not project expected gas production by county or watershed in this report.)

⁶ In some ‘sweet spot’ areas, there are reports of much higher per well recovery (over 10 Bcf). Additionally, some wells are being drilled with much longer laterals (over 9,000 ft), which also increases per well recovery.

We also use EIA estimates for assumed technically recoverable resources as 144 Tcf for the entire Interior Marcellus (including areas outside Pennsylvania, but only where drilling is permitted). Technically recoverable resources are unproven, and represent an estimate of the portion of total gas in place (excluding production to date) that can be extracted with current technology. As shown in Figure 4, the technically recoverable resources are larger than the economically recoverable resources and the proven reserves (which EIA estimates at 65 Tcf of gas for the Marcellus). Resource estimates can and do change in response to better information about production from across the shale, more geological data, and changes in technology that allow more recovery (HVHF is an example). And, economically recoverable resources can expand as technology improves over time (lowering development costs), or in response to gas price changes. Since both economics and technology may change over time, it is reasonable to use technically recoverable resources as an estimate for this type of full development or build-out analysis.

Figure 4. Resource categories for various gas-in-place estimates used in industry



Source: US Energy Information Administration, 2014 [35].

There may be considerable debate about the “best” EUR or reserves estimates to use for this type of analysis, and many organizations have their own values they use to support their own analyses. We have selected the EIA estimates of these values because they are the most widely accepted, are publicly available, and are transparent with respect to methodology and limitations. We recognize that changing the estimates could significantly change outcomes. Of course, our well placement methodology is flexible enough that it would be a relatively simple change to increase or decrease the estimate of total wells projections, and investigate the differences in potential impacts.

Infrastructure modeling

In addition to well pads, we considered other natural gas infrastructure required to support development, which at a minimum includes roads to move equipment and materials to and from the well pad, and gathering pipelines which move gas produced at the well pad to market. To model the roads and gathering lines, we used the least-cost path-optimization approach, which is a common approach for siting and analyzing linear infrastructure. This methodology was used in our earlier study of the DRB, and we provide further detail in that report. [4] Briefly, to perform this modeling, we first developed a cost surface for Pennsylvania by combining a variety of geospatial layers⁷ relevant to routing, and assigning a cost to the values associated with each layer. We used this cost surface with the “Least Cost Path” tool in ArcGIS 10.2 to determine the most efficient route from each of the projected well pads to the existing infrastructure.⁸

Results

Based on the EIA estimate of technically recoverable resources divided by the EIA average total production per well, and subtracting the number of existing Marcellus wells, we get the number of new wells expected, which is over 66,000 for the entire Interior Marcellus. In our modeling, Pennsylvania accounts for 72 percent of these expected wells (47,600). Based on a scenario of 8 wells per pads, this amounts to 5,950 well pads that may be developed throughout the Commonwealth to accommodate these new wells.

Based on our infrastructure modeling, we found that 5,832 miles of gathering pipeline and 1,342 miles of road would be developed to support full build-out of the Marcellus Shale in Pennsylvania based on our projections of well pad locations. The infrastructure modeled only includes roads/pipelines needed to connect well pads to

⁷ These geospatial layers, including slope, land use, roadways, streams, floodplains, and protected lands, are used in least-cost optimization to reflect the *relative* difficulty of building infrastructure through or across these landscape features. For example, building on flat land is easier than building on steep slopes, and crossing wetlands is more difficult than crossing pastures. In general, the least-cost “path” will be the most efficient path to minimize distance while avoiding terrain features that are difficult to cross.

⁸ We modeled the least-cost path for each well pad independently, but in (the many) cases where pipeline or road infrastructure followed the same path, we assumed they could share a road/pipeline (i.e., we did not double count this length). Modeling the infrastructure build-out in sequence, well pad by well pad, or centralized planning of intermediate collector lines could result in slightly lower distances per well pad, but likely would not change results significantly.

the nearest (or least costly to reach) point in the existing road or pipeline network. The analysis does not consider additional infrastructure needed to support increasing gas production on regional or statewide basis such as interstate or intrastate gas transmission pipelines. Note that these projections are intended to illustrate the potential scale of infrastructure with a reasonable estimation of spatial extent and are not meant to predict exact locations.

We have developed a variety of maps to present the statewide results of projected natural gas development, in order to provide spatial context for our discussions. Table 1 gives an overview of these maps. The discussion section provides descriptions and information that will help readers understand each map.

Table 1. Well Projections Map Index.
 Access maps at www.cna.org/PA-Marcellus

Map	Title
1.1	Probability surface for well pad development in the Interior Marcellus
1.2	Projected well pad development locations
1.3	Projected well development by county
1.4	Projected well development by watershed
1.5	Projected well development density
1.6	Projected natural gas infrastructure by county

Discussion

Map 1.1 – Probability surface for well pad development in the Interior Marcellus

This map shows the probability surface generated by the Maxent program based on existing well locations, and ‘environmental variables’ including shale characteristics, existing infrastructure, land use, and terrain. The surface has 30-meter resolution and uses a color scheme to depict the relative likelihood of development (i.e., Maxent value) based on the environmental variables, with “cooler” colors denoting areas with a lower probability of development, and “warmer” colors denoting those with a higher probability of development. These probabilities are based on the characteristics of the underlying geospatial layers at existing Marcellus wells developed from 2007 to 2013. The Maxent surface was developed for the Interior Marcellus play only. We have also included the boundaries of the full extent of the Marcellus formation. These boundaries will be included in all maps generated from this analysis for spatial context. The two major hotspots for existing drilling are in the southwest and northeast portions of the Marcellus Shale in Pennsylvania.

Map 1.2 – Projected well pad development locations

This map shows the location of projected additional well pads that would be developed in the Pennsylvania portion of the Interior Marcellus Shale through full development of EIA technically recoverable resources. We determined the projected well pad locations from the probability surface by using spatial averaging to center the locations on high Maxent value “neighborhoods” instead of particular individual pixels with high probability scores. The 5,950 well pads are divided into color-coded quintiles based on their Maxent value, to illustrate the relative suitability of each location. The existing Marcellus wells in the state are also depicted on the map, in grey, for reference.

Map 1.3 – Projected well development by county

This map shows the number of projected additional wells that would be developed in the Pennsylvania portion of the Interior Marcellus Shale through build-out by county. We developed well projections based on the projected well pad locations (see Map 1.2) with an average of eight wells per pad. The bars show the number of horizontally drilled to date, and then the projected number of additional wells broken into five groups (quintiles) ranging from most likely (red) to least likely (blue) as determined from the Maxent probability score.

Map 1.4 – Projected well development by watershed

This map shows the number of projected additional wells that would be developed in the Pennsylvania portion of the Interior Marcellus Shale through build-out by HUC10 watershed. We developed well projections based on the projected well pad locations (see Map 1.2) with an average of eight wells per pad.

Map 1.5 – Projected well development density

This map, like Map 1.4, shows the number of additional wells to be developed in each watershed based on the projections in this study. In this case, the map shading shows the additional wells normalized to watershed area in terms of wells per square mile. This map shows the relative density of well development independent of watershed size. (Large watersheds can accommodate more well pads, which might skew the perception of where development is most intense, absent this correction.)

Map 1.6 – Projected natural gas infrastructure by county

This map shows the amount of projected road and gathering pipeline infrastructure, in miles, that would be developed in Pennsylvania to support natural gas development to build-out. We used least-cost path optimization to model the gathering pipelines and access roads that could be developed to connect the projected well pads to existing infrastructure in the state. The map includes the existing pipeline infrastructure in the state, in red, for reference and context (the existing road infrastructure is too dense to provide meaningful information). Within each county, we also present the average miles of infrastructure developed to support a well pad in the county, which is a function of the proximity or density of existing infrastructure. The values show first the average miles of pipeline per well pad, and then the average miles of road per well pad.

General discussion

To begin the study, we examined potential well development across the full extent of the Interior Marcellus. Evaluation of the probability surface shows two distinct areas with a concentrated high probability of development: one in the northeast region of Pennsylvania (around Tioga, Bradford, and Susquehanna counties), and the other in the southwest region of the state (around the Pittsburgh area). These two areas are consistent with a majority of the existing shale gas development seen in the Marcellus region. There are several other smaller hotspots, and large regions with somewhat lower potential for development.

The probability surface and well projection estimates are subject to several important caveats. By necessity, the reserves estimates represent a snapshot in time; they are constantly changing based on new information collected from drilling productivity and geological review. It is likely these estimates will continue to change, but we have elected to use the most recent EIA data available at the time of the study. Since this a long-range analysis, we also assume no regulatory constraints (other than those listed in the methods section)⁹ or economic constraints when developing the probability surface.

Our projections show that 12 counties could each see development of over 2,000 new wells to support full extraction of the resources in the Interior Marcellus. Many of these counties are located within the current hot spots, but a few, such as Potter,

⁹ For example, this analysis does allow development in the Delaware River Basin, and in state forests, which are locations that currently have moratoriums on new development.

Elk, and Armstrong counties, are not experiencing as much development today and thus would see larger increases in development, albeit possibly not until the current hot-spots are nearly fully developed. Even with the updated assumptions used in the modeling for this analysis, it is worth noting that our results for Wayne County (2,328 potential wells) are still very consistent with those from our previous analysis (2,424 potential wells) that focused on the Delaware River Basin.

We project well pad locations to support the calculation of impacts, but they should *not* be interpreted as explicit *predictions* of where wells will actually go. Although high-resolution spatial data allows fairly precise well pad siting, this analysis is most useful for identifying which portions of the Marcellus Shale may be most suitable for development (relative to all the others). Actual locations of wells depend on many site-specific factors, not the least of which is a legal lease contract to perform drilling on a property. Furthermore, the projected well pad locations should not be used to estimate impacts at small scales, such as for individual parcels or neighborhoods. Further, our modeling of the natural gas infrastructure was based on a standard GIS approach to provide a representative picture of this development, and carries the same caveat as the well pad locations. The actual routes could depend on additional site-specific factors, such as lease holds and applicable laws and regulations.

We found that the average length of pipeline developed to support well pads varied widely across the state, owing to the extent of existing infrastructure in place. Counties in northeast Pennsylvania showed an average length of about 1.5 miles of pipeline per pad, which is consistent with previous studies on pipeline development [36-37]. However, the counties in the southwestern part of the state showed much lower averages of a half-mile or less per pipeline. Examination of the existing pipeline infrastructure supports these results, as the pipeline network is much denser in southwest Pennsylvania, reducing average distance needed to connect to it. This produced a statewide average of pipeline length per pad of around 1 mile. The average length of road per well pad was much more consistent across the state, not deviating much from about 0.2 miles per pad, likely owing to the dense network of road infrastructure already in place.

Of course, there are several caveats to keep in mind related to the infrastructure modeling. The infrastructure modeled only includes the well pads, gathering pipelines, and roads that are necessary, at minimum, for unconventional gas development. In the next section, land cover impacts are limited to these infrastructure types, and do not include other facilities such as equipment storage, or centralized waste processing facilities. The routes selected by the least cost path analysis do not consider the suitability of the existing roads or pipelines for handling the traffic or gas volume from the new wells. Rather they consider the most efficient route to the nearest (or least costly to reach) existing road or pipeline. A longer path could be necessary if there are access, capacity, or usage issues with the nearest road/pipeline. Also note that the roads and especially pipeline data may not be

completely up to date if they are available at all [38], so shorter paths could exist in areas that have had recent road or pipeline construction. Finally, planning pipeline or road layouts for several well pads at a time (if a single company operated them, for instance) could result in different infrastructure development patterns (total length could be shorter or longer).

In general, our estimates for gathering pipeline length are lower than some other estimates such as the 25,000 miles estimated by former PA Department of Environmental Protection (DEP) secretary John Quigley [38], or the 10,000 miles estimated by the Nature Conservancy for a similar number of well pads (based on an average of 1.65 miles per well pad) [36]. One potential explanation is that our infrastructure modeling reflects regional differences in existing pipeline density. Further, the other estimates may include some other intermediate gathering and transmission pipeline infrastructure beyond the immediate gathering pipelines.

There are several ways this analysis could be revised and extended in the future. The maximum entropy analysis in particular is flexible, and can be updated to include more recent data, and additional data layers not included in this study. Simply repeating the analysis with a larger set of existing wells to ‘seed’ the model should result in improved projections. Similarly, updated maps of underlying layers such as gas pipeline infrastructure, and roads could affect the relative probability of development where there has been rapid change in the past few years.

There are several possibilities for other data layers to include in the maximum entropy modeling. As more Marcellus wells are drilled, improved maps of shale richness (e.g., total gas in place) and well productivity are being generated by the gas industry and academics. These could be helpful to add additional weight to development in known hot-spots. We did not include such maps as a data input to the maximum entropy analysis, as there was no authoritative data source, the maps available (e.g., investor presentations from the gas industry) vary widely in their estimates, and the geospatial data sets are either not publicly accessible or not well-documented. We also did not consider the presence of other shale plays in the region (e.g., the Utica), but it is likely the ability to access multiple plays influences the likelihood of drilling. Finally, leasehold data could be included in the maximum entropy analysis to identify areas with particular likelihood for drilling.

While these data sets could improve the projections, we intentionally limited the maximum entropy analysis to layers reflecting physical parameters of the shale, land surface, and infrastructure that are *publicly available* and *not subject to rapid change*. In general, the marginal information gained for Maxent analysis decreases as more input layers are added. As the available data sets improve, and become more widely accessible, these additional factors plus economic and regulatory considerations could be explicitly included in follow-on studies.

This page intentionally left blank.

Impact on Land Cover

When assessing the environmental impacts of natural gas development, one of the most unavoidable aspects of such development is the impact on land cover. A typical well pad may cover three to five acres of land to support the well-drilling and hydraulic process, which includes the well site and room for supporting equipment, onsite water and wastewater storage (impoundments and/or closed tanks), and adjacent disturbed areas (e.g., land for regrading and leveling the well pad). In addition to the well pad, development of land to support natural gas extraction requires access roads to the site and gathering or feeder pipelines to transport the extracted gas from the site to the existing transmission infrastructure [14, 36-37, 39]. The resulting land disturbance from this development can present both short- and long-term risks to the use of the land, depending on the remediation and reclamation procedures used [40-41].

One issue associated with the development activities from natural gas extraction in the Marcellus Shale is the impact on forests [14, 18, 39-40]. Pennsylvania's dense forest cover provides the region with a variety of ecosystem services, such as carbon sequestration, clean air, aquifer recharge, and recreation/eco-tourism [42]. Furthermore, forest cover in the region is home to a variety of different plant and animal species that rely on the forest for their habitat. The edge transition from non-forest to forest area creates a habitat that tends to favor generalist species over rare or vulnerable species, and an increase of edge forest can promote the spread of invasive species [40].

Another issue of interest focuses on the relationship between land and water. Clearing of forests and other natural land cover for natural gas infrastructure and subsequent conversion to impervious cover or compaction of soil in construction right-of-way can change the hydrologic behavior of the landscape, leading to more runoff and erosion and less groundwater infiltration. Impervious cover (or more broadly, changes in the perviousness of the landscape) can be used to assess impacts on water quality, since it represents how much water can infiltrate the soil versus how much will run off into nearby streams [43]. Stream quality in a watershed will generally become impacted once impervious cover reaches above 10 percent, though some studies have shown impacts to streams above as little as 2 percent [44]. Stream crossings by road and pipeline infrastructure can also have an impact on flow characteristics in the stream, sediment loads, and water quality, and on the health and movement of aquatic species [45-48].

To assess the potential impacts of natural gas development on land cover in Pennsylvania, we combined our projections of natural gas well and infrastructure development in the state with a suite of GIS tools and methodology. We used the projected well pad locations and supporting infrastructure to survey the impacts to current land cover, and the potential for forest fragmentation. Then, to give context to the amount of area impacted, we compared the total disturbance area to the amount of existing developed land.

Methods, data sources, and assumptions

Before the infrastructure to support natural gas extraction—e.g., well pads, gathering pipelines, and access roads—can be constructed, the land must be cleared. In the previous chapter, we documented how the natural gas infrastructure locations were modeled as points for well pads, and linear features for roads and pipelines. To determine the land area affected by disturbance from these activities, we used the “Buffer” tool in ArcGIS to map the spatial extent of the well pads and pipeline and road rights-of-way.

We then used this footprint to extract the impacted land cover values from the 2011 National Land Cover Dataset (NLCD) raster. “Land disturbance” refers to all land that falls within this footprint. By contrast, for the purpose of this study, “new clearing” refers to all land cover types within this footprint except for developed land (open space, low density, medium density, or high density), which has already been cleared. For this analysis, we considered the land necessary for initial development of the infrastructure including the construction rights-of-way necessary for equipment access to build the roads and pipelines.

Given the prevalence of forest cover in Pennsylvania (approximately 60 percent of total land cover) and the potential for impact, we extended our land cover analysis to focus on the extent of potential forest fragmentation caused by this disturbance. To assess this impact, we generated a baseline core forest raster from the NLCD raster using the Landscape Fragmentation Tool v2.0 [49] and applied a forest edge width of 100 meters. After we generated the baseline condition, we assessed the potential impact from natural gas development by applying an additional 100-meter buffer to the projected spatial footprint of gas infrastructure (i.e., well pads and road and pipeline rights-of-way) to determine the changes in core and edge forest due to new edge effects.

We also performed an analysis to compare the total new land cleared for gas infrastructure to existing developed land, in order to put the area of development into context. We estimated existing developed area from 2011 NLCD by computing the total of the developed land cover categories for low-, medium-, and high-density

development (NLCD codes 22, 23, and 24), which represent most urban and suburban development areas (though not transportation or open cleared land).

To evaluate land cover burdens associated with Marcellus gas infrastructure development, we used the following assumptions:

- Each well must be located on a well pad, and each well pad must be connected via road to an existing road, and via gathering pipeline to the existing natural gas pipeline network in PA (exclusive of distribution or “downstream” pipelines that bring natural gas directly to homes and businesses).
- Each well pad occupies 3.5 acres.
- Each gathering pipeline requires a 30-meter right-of-way, and each access road requires a 10-meter right-of-way.
- Core forest represents forest patches that lie 100 meters inward from the nearest non-forest land cover (i.e., the forest edge).
- Potential new stream crossings were identified as intersection points between the modeled gathering pipeline and access road routes and Pennsylvania streams in the National Hydrography Dataset Plus version 2 (NHDPlus v2) database [29].

The baseline results are presented using both the county and HUC10 watershed boundaries, but the impacts on forest and stream crossings are presented only for watershed boundaries.

The assumptions for development area reflect the area generally needed for *initial construction* of infrastructure. After construction, some of this area may be partially returned to existing uses during operation, or at the conclusion of development. This report does not examine the evolution of the landscape through the development period as it responds to varying rates of development and varying remediation and reclamation practices. Instead, this report focuses on the direct area impacted by construction of well pads, gathering pipelines and roads.

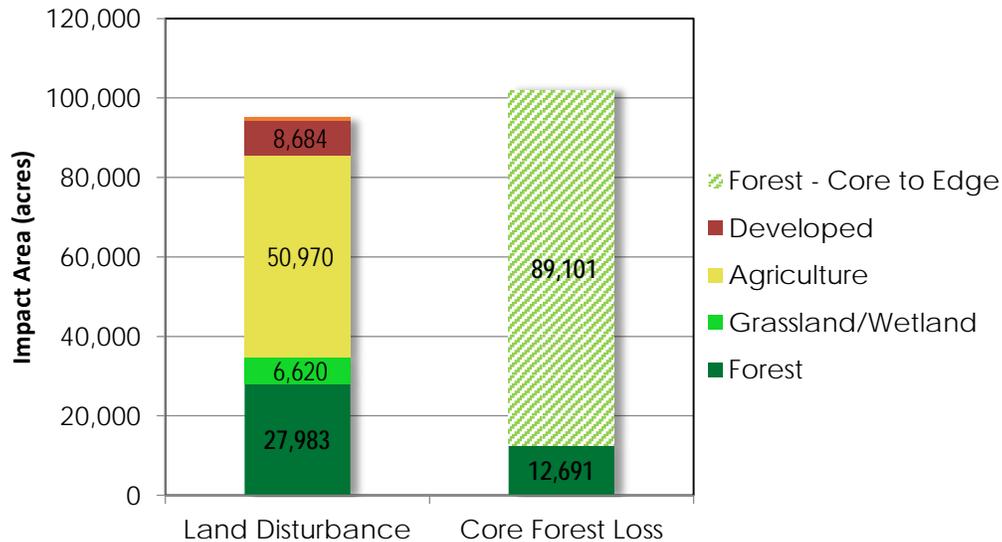
It is important to note that many of these infrastructure types do not cover the full range of land development activities associated with gas development, and they do not consider the estimates of additional area needed for equipment storage, centralized impoundments, wastewater treatment facilities, mining and quarry areas for soil/sand/gravel, earth moving (cut and fill) outside of the rights-of-way, landfill areas, or other areas needed to otherwise support natural gas development.

Results

Based on our projections of well pad development and associated supporting infrastructure, we generated Pennsylvania-wide estimates of land cover burdens. Figure 5 shows the results of our analysis at the statewide level. We found that just under 95,000 acres of land could be disturbed by construction of natural gas infrastructure in the state, about 28,000 acres of which would constitute the clearing of forest cover. However, over 100,000 acres of core forest could be lost as a result of the combined effect of clearing and fragmentation due to the creation of new forest edges.

These estimates are similar to, but slightly lower than previous Pennsylvania estimates of forest disturbance. The *Pennsylvania Energy Impacts Assessment* [18] completed by the Nature Conservancy found that for 60,000 wells, direct forest clearing would be between 38,000 acres (10 wells per pad) and 61,000 acres (six wells per pad). They estimated that additional core forest loss from fragmentation would be between 91,000 acres (10 wells per pad) and 147,000 acres (six wells per pad).

Figure 5. Pennsylvania statewide land cover impacts from natural gas development including land disturbance by initial land cover type and core forest loss due to land disturbance and core to edge forest transition due to fragmentation.



While these figures are informative for comparisons to other shale gas basins or across industries, the importance of the impacts within Pennsylvania is difficult to

discern from the statewide figures. For example, the 28,000 acres of forest cleared only represents 0.2 percent of the total forest cover in Pennsylvania. Breaking these impacts down to the county or HUC10 watershed level offers a more informative picture of where these impacts may be concentrated. Table 2 gives an overview of the maps generated for this impact category. The discussion section provides descriptions and useful information for understanding each map.

We also found that in many counties affected by natural gas development, the construction of new gas infrastructure could affect an area comparable to or larger than all existing developed land (e.g., residential, commercial, industrial land uses).¹⁰

Table 2. Land Cover Impacts Map Index.
Access maps at www.cna.org/PA-Marcellus

Map	Title
2.1	Land disturbance by county
2.2	Land disturbance by watershed
2.3	Forest cleared by watershed
2.4	Core forest loss by watershed
2.5	Existing developed area versus new clearing for gas infrastructure
2.6	Stream crossings by watershed

Discussion

Map 2.1 – Land disturbance by county

This map shows the total amount of land disturbed from natural gas development by county. This metric represents the total area of land, in acres, that would underlie well pads or rights of way for pipelines or roads. In this map, we use pie charts to represent the breakdown of the land cover impacted from natural gas development in each county. For visibility on the map, we combined the 11 land cover classifications from the NCLD dataset into broader groups, as shown in Table 3.

¹⁰ We excluded Developed Open Space (NLCD code 21), which primarily includes undeveloped parcels and transportation.

Table 3. Land cover groupings by 2011 National Land Cover Dataset classifications.

Grouping	NLCD Classifications
Forest	41 – Deciduous Forest; 42 – Evergreen Forest; 43 – Mixed Forest
Grassland/ Wetland	71 – Grassland Herbaceous; 52- Shrub/Scrub; 90 – Woody Wetlands; 95 – Emergent Herbaceous Wetlands
Agriculture	81 – Pasture/Hay; 82 – Cultivated Crops
Developed	21 – Developed Open Space; 22 – Developed Low Intensity; 23- Developed Medium Intensity; 24 – Developed High Intensity; 31 – Barren Land

Map 2.2 – Land disturbance by watershed

This map shows the total amount of land disturbed from natural gas infrastructure development by HUC10 watershed. This metric (shown in shading on the map) represents the total area of land, in acres, that would underlie well pads or rights of way for pipelines or roads at the time of initial construction. In this map, we also use bar charts to represent the breakdown of the impacted area by land cover type (according to the 2011 NLCD) in each watershed with over 100 acres of disturbance.

Map 2.3 – Forest clearing by watershed

This map shows the total amount of forest projected to be cleared from natural gas infrastructure development by HUC10 watershed. This metric represents the total area of forest, in acres, that would underlie well pads or rights-of-way for pipelines or roads at the time of initial construction. We presented this impact at the HUC10 watershed level due to the role that forest cover plays in preserving water quality.

Map 2.4 – Core forest loss by watershed

This map shows the impact of forest fragmentation as core forest lost from natural gas development by HUC10 watershed. This metric, shown in the shading, represents the total area of core forest, in acres, that could be lost due to construction of well pads or rights-of-way for pipelines or roads. Within each watershed on the map we also label the percentage of total pre-development core forest that would be impacted (for cases where this value exceed 1 percent). Note that this loss in core forest area comprises both forest that is cleared for infrastructure (i.e., direct losses shown in Map 2.3) and the indirect losses resulting from core to edge forest conversion along the road and gathering pipeline rights-of-way.

Map 2.5 – Existing developed area versus new clearing for gas infrastructure construction

This map puts the land disturbance area associated with gas infrastructure development in context relative to total existing urban and suburban developed area by watershed. We computed the existing developed area in each watershed by summing the developed low-density, medium-density, and high-density land cover areas (NLCD codes 22, 23, 24) from the 2011 NLCD dataset. These estimates include most urban and suburban developed area in residential, commercial, and industrial land uses, but exclude most undeveloped open space and land use for transportation. The map compares the total land needed for initial construction of natural gas infrastructure with these existing developed areas.¹¹ Yellow bars indicate the relative amount of land clearing for initial gas infrastructure construction by watersheds. The shading indicates the ratio of new gas infrastructure clearing area compared to existing developed area; a value of 1 indicates that the new infrastructure for gas development will occupy an area equal to all existing development in the watershed.

Map 2.6 – Stream crossings by watershed

This map shows the projected number of new stream crossings associated with construction of road and pipeline infrastructure. Each stream crossing represents the intersection of the modeled gathering pipeline or road routes and streams in the USGS NHDPlus v2 database. Stream crossings within 250 feet of each other were treated as one crossing. On the map, the blue bars show the relative numbers of crossings by watershed, and the shading indicates the density of new stream crossings in units of crossings per 100 square miles. (The average watershed area of 162 square miles is on the same order of magnitude.)

General discussion

Our results showed that the construction of well pads and associated infrastructure to support shale gas development would have an impact on the land cover of Pennsylvania of over 100,000 acres, affecting primarily agricultural land (54 percent

¹¹ This is purely to give context to the scale of impacted area on a watershed basis, and is not meant to imply that the land use types for gas infrastructure are similar in character to general urban/suburban development.

of disturbed land) and forest land (30 percent). This assessment of land disturbance only accounts for the well pad and rights-of-way for gathering pipelines and access roads to support those well pads. It does not account for additional construction that could occur to support natural gas development, such as new transmission pipelines that may be needed to help move gas to market, or new compressor stations to support gas transmission through the pipeline network. This construction could be expected to add to the footprint of development and cause additional land cover impacts to the state.

Land-cover change from shale gas development is unavoidable, and disturbance can be significant at build-out. The loss of forest cover, in particular, can have significant impacts at the watershed level, such as degraded water quality and a loss of biodiversity from disappearing flora and fauna that cannot tolerate “edge effects.” For instance, we found that some Pennsylvania watersheds could lose over 5 percent of the existing core forest. Furthermore, remediation procedures to restore vegetation on the impacted land often do not replace mature forest cover, both because of the need to maintain access to gathering lines and use roads, and because mature forests take a long time to grow.

Many of the environmental impacts and outcomes related to land cover changes are difficult to understand at this level of analysis because they are highly dependent on how the changes occur over time, something we did not investigate in this study. It is relevant to note that the land cover changes will not occur all at once, but build over time as development continues. This analysis only considers total area within

Further study related to these impacts could include:

- Investigating effects of timing or rate of development and remediation and reclamation practices used on land cover over time
- Estimating potential erosion and sediment loadings associated with land clearing and infrastructure development over time, subject to varying assumptions of development rate and management practices
- Assessing vulnerability of species to the changes in forest area, loss of core forests, or potential water quality effects.

Impact on Population

The distance from active well pads has been shown to correlate with certain health and environmental risk factors. Distance from activity is often used as a primary discriminator for determining dose intensity in public health studies. As a result, knowing the potential population within several distances of the proposed well pads is useful for evaluating potential impacts to Pennsylvania residents. In this study, we do not assess the likelihood of particular health outcomes occurring for populations within the specified distances.

We report the populations living within two distances of well pads: one-half mile and one mile. These distances represent a close to moderate distance from well pads, and a moderate to farther distance, respectively. Several health studies have used similar distances to divide experimental groups when investigating variations in health risk factors related to natural gas extraction [13, 19, 50-52].

The maps in this section should be read only as reporting the population (based on the 2010 Census) within the specified distances from well pads through full development of the Interior Marcellus play. These maps do not account for potential or projected population growth, or population living within the specified distance of other gas infrastructure such as roads, pipelines, equipment yards, compressor stations, or wastewater treatment facilities.

Methods, data sources, and assumptions

We evaluate the population within two distances of Marcellus Shale well pads, one mile and one-half mile, using 2010 census block data for Pennsylvania [53]. Unlike our previous analysis for the DRB ([4]), which has a moratorium on natural gas development, there are existing Marcellus well pads in many parts of the Commonwealth. We analyzed the population within each county within the specified distance for “Current” Marcellus well pads, for “Additional” well pads developed through build-out, and population “Outside” the specified distance.

We used a buffer method in ArcGIS to compute the areas within the specified distances, and intersected these areas with the Census population blocks to determine population affected. Our previous report, *The Potential Environmental Impact from Fracking in the Delaware River Basin* [4], has a full description of

methodology associated with computing the population living within a given distance of projected well pad locations. In brief, the following assumptions and data sources were used.

- Population estimates were computed from 2010 census, census block data (2010 Census Bureau – SF1 data [53]), which is the finest resolution available. Population is assumed to be distributed with constant density within each census block to make population estimates where a portion of the census block falls outside the designated distance from a well pad location.
- Existing well pad locations were computed based on commercially available well location data (IHS, 2014 [54]) through September 2014.¹²
- Projected well pad locations from this analysis were used to determine “Additional” area. We only counted new area affected, and did not double-count area within the specified distances of existing well pads.
- Total population estimates reflect the sum of “Current” and “Additional” population within the designated distances.

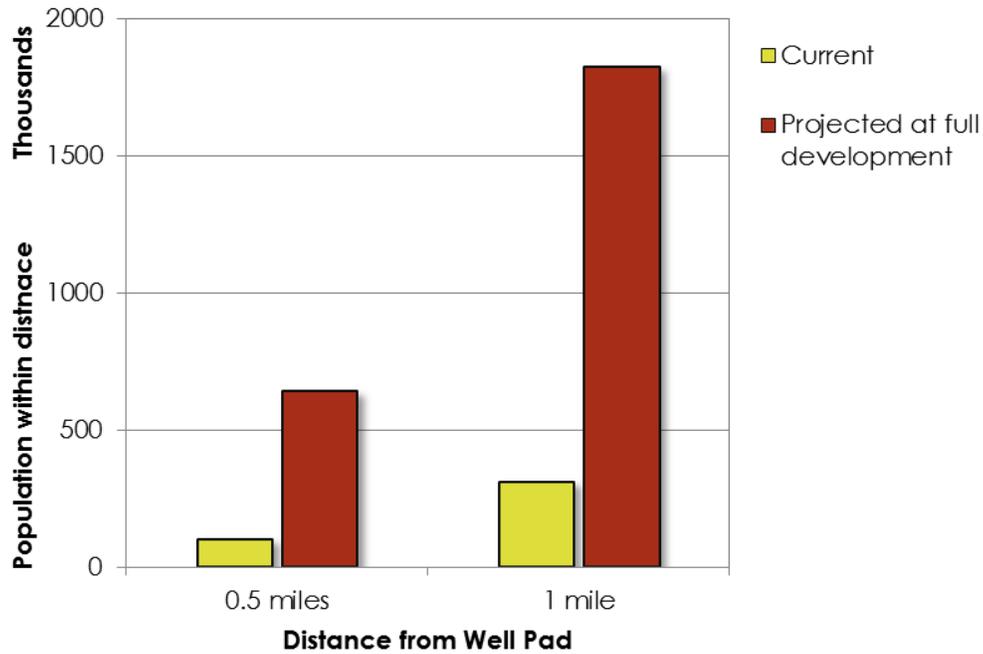
Results

Based on the well pad locations generated for this analysis, and county-level data on population in U.S. census blocks, we estimated Pennsylvania-wide impact estimates for area and population within one-half and one mile of well pads. For area, we found 1,813 square miles within one-half mile of existing wells, and 6,354 square miles after all projected wells are included. The corresponding values are 4,680 and 14,450 square miles for the one-mile distance from well pads.

Figure 6 shows the Pennsylvania population estimated to be living within these distances both currently and at our projection of full development.

¹² Only wells designated as being drilled in the Marcellus play and having a status of “Active” or “Inactive” (not “Abandoned”) were used.

Figure 6. Pennsylvania statewide population within 0.5 and 1 mile of current or projected Marcellus well pad locations at full development. Roughly six times more people will be within these distances by full development relative to the current numbers.



On a statewide basis, the population living within one-half mile of a well pad would increase from 100,600 to 639,000. The population living within one mile would increase from 311,000 to 1.8 million. These calculations are based on 2010 census data. For context, Pennsylvania's population in the 2010 census was 12.7 million, and its estimated 2015 population is 12.8 million [55].

The scale of the affected population is difficult to discern from the statewide figures alone. Mapping these impacts on a county basis offers a much clearer picture of where the populations near gas development live. Table 4 gives an overview of the maps generated for this impact category. The discussion section after Table 4 provides descriptions and useful information for understanding each map.

Table 4. Population Impacts Map Index.
 Access maps at www.cna.org/PA-Marcellus

Map	Title
3.1	Area within 0.5 mile of well pads
3.2	Area within 1 mile of well pads
3.3	Population within 0.5 mile of well pads
3.4	Population within 1 mile of well pads

Discussion

Map 3.1 – Area within 0.5 mile of well pads

This map shows the portion of county area within one-half mile of existing and projected well pads by county. The brown shading indicates counties that have existing or projected well development. The light tan overlay shading indicates the areas within a half mile of existing or projected well pad locations. The area of each county with existing or projected Marcellus Shale development is represented as a pie chart, broken into three categories. First, in yellow, is the portion of the county area within one-half mile of an existing well pad, labeled “Current” in the legend. Second, in dark red, is the additional area that will fall within one-half mile of projected well pads built through build-out. This is additional area that does not double-count any area within the half-mile distance of existing well pads, and is labeled “Additional” in the legend. The sum of the yellow and red sections represents the total percentage of the county area within one-half mile of well pads. Finally, the light blue section of the pie charts is the remaining portion of county area that is outside the one-half-mile distance through the end of development. It is labeled “Outside” in the legend.

Map 3.2 – Area within 1 mile of well pads

This map shows the portion of county area within one mile of existing and projected well pads by county. The legend and pie charts are the same as in Map 3.1 to enable comparisons, except that in all cases, the relevant distance is one mile.

Map 3.3 – Population within 0.5 mile of well pads

This map shows the 2010 population within one-half mile of existing and projected well pads by county. The shading indicates the raw population total by county living within one-half mile at build-out. The population of each county with existing or

projected Marcellus Shale development is shown with a pie chart, indicating the percentage of the county population in three categories. First, in yellow, is the portion of the population living within one-half mile of an existing well pad, labeled “Current” in the legend. Second, in dark red, is the additional portion of the population that will fall within one-half mile of projected well pads built through build-out. This is “Additional” population, and does not double-count any population within the half-mile distance of existing well pads. Finally, the remaining portion of the population, shown in light blue, is that which is “Outside” of the one-half-mile distance all the way through build-out condition.

Map 3.4 – Population within 1 mile of well pads

This map shows the 2010 population within one mile of existing and projected well pads by county. The shading by county is scaled identically to Map 3.3 in order to allow comparisons between the maps. The definitions for the pie chart are also the same as in Map 3.3, except that in all cases, the relevant distance is one mile instead of one-half mile.

General discussion

These results present an estimate of population within certain radii of well pad locations. These population estimates are based on 2010 U.S. census data [53], and do not account for future population change. Further, this assessment only considers distance from well pads—the primary location for most natural gas development activity—and not other types of gas infrastructure.

This analysis is best interpreted as a way to understand the number of Pennsylvania residents that will experience natural gas development first-hand close to their residences. We can conclude that the number of Pennsylvania residents within these one-half-mile and one-mile radii of well pads will increase significantly—roughly six-fold—over the population currently living within this proximity of existing well pads.

We also see regional patterns in the impacts on population. The largest such impacts in terms of pure numbers are in the southwest portion of the state, an area that already has significant existing gas development and, importantly, has a relatively high population density. By contrast, the counties in the northeast portion of the Commonwealth project tend to have most “coverage” of the county’s land area within the specified distances. For instance, in Map 3.1, almost all of Bradford, Susquehanna, Washington, Greene, and Armstrong counties could be within one mile of a well pad at some point during the development period. As a result, the portion of these county’s populations living within the specified distances is extremely high. Due to the lower population density of these counties, the raw total population

affected in the northeast portion of the state is lower than that in the southwest region of Pennsylvania.

This information could be useful for several types of follow-on analysis, including economics and public health. In terms of economics, proximity to well pads may indicate how much of the population could be affected by economic impacts from development (e.g., property value change, royalties).

While many studies show some correlation between distance from well pads and certain health risk factors, we did not attempt to connect these results to potential health impacts. Some potential follow-on health-related risk analyses could include, for example, potential groundwater contamination, or exposure to particular air pollutants. Or, public health studies could be used to estimate how incidence of certain health outcomes might change. We note that doing so would require a fuller, more detailed understanding of the specific nature of various gas development activities and facilities, and the intensity, duration, and frequency of potential health risk stressors associated with each. .

Impact on Air Emissions

Unconventional natural gas development is an industrial process that involves a host of machinery and operations to extract natural gas from shale deposits. Shale gas operations release a variety of criteria pollutants that can degrade local air quality, including nitrogen oxides (NO_x); sulfur oxides (SO_x); particulate matter (PM); and volatile organic compounds (VOCs), such as formaldehyde, benzene, toluene, ethylbenzene, and xylene (BTEX) [51-52, 56-58]. These emissions stem from diesel-powered equipment used for the well pad construction, drilling, hydraulic fracturing, and production processes. In addition, significant emissions can also arise from combustion-powered compressor stations that compress natural gas to keep it flowing through the pipeline system. Further, these activities could contribute to climate change due to greenhouse gas (GHG) emissions from shale gas development, which stem from the leakage of natural gas (i.e., methane, or CH_4) at various points throughout the development cycle, from extraction to processing and transmission.

For this analysis, we calculated the potential contributions to NO_x , VOC, and methane emissions from projected natural gas development in Pennsylvania. We used the data from the Marcellus Shale Air Emissions Inventory [59] from the PA DEP to develop per-well emissions factors to apply to our projections. We also use DEP data to estimate the emissions contributions from additional compressor stations needed to support this development. We then present the emissions estimates from projected development at the county level across the state, along with the relative increase from emissions in the state today. We did not analyze the potential for any more localized impacts on air quality, as this was beyond the scope of the study.

Methods, data sources, and assumptions

To assess the impacts to air quality, we applied relevant values from the PA DEP 2014 natural gas emissions inventory and professional literature to our build-out scenarios in order to calculate the emissions associated with natural gas development at the county level. We used an average development rate scenario to illustrate the impacts of development on air quality. This provides the average pace of development and shows the potential variation in emissions that could be expected from natural gas development activities in each county. We do note that in reality there would likely be considerable yearly variations in development per

county as operators focus on the more favorable locations first. We then developed a final year emissions estimate to represent the cumulative impact of ongoing emissions from natural gas production and the compression needed in order to bring it to market.

To estimate the number of new compressor stations required to support our projected natural gas development, we used a data extract from the PA DEP listing of the midstream compressor stations in their 2014 inventory [59]. This extract included 509 facilities, which, PA DEP explained, included both gathering and transmission compressor stations. We used GIS analysis to classify any stations within 0.1 mile of a transmission pipeline as a transmission station and eliminate it from the list. This resulted in 320 gathering stations, or 1 compressor station for about every 9 well pads in Pennsylvania. Applying this ratio to our well pad projections, we estimate that 661 compressor stations will be developed to support natural gas development.

We developed emission factors to apply to our projected natural gas development based on either the 2014 PA DEP natural gas emissions inventory or values from scientific literature. We classified development into three phases: pre-production, production, and gathering. Table 5 shows the emissions factors for NO_x, VOC, and methane for each of these phases. Pre-production represents the emissions from drilling, hydraulic fracturing, and completion of the well. We developed this factor using the reported emissions from “drill rigs” and “completions” in the natural gas emissions inventory. Production represents the ongoing production of natural gas from the well. We developed this factor for NO_x and VOC based on the study by Livovitz et al. [60]. For methane emissions, we used a recent study by Goetz et al. [61]. Finally, gathering represents the collection of natural gas from multiple well pads and compression of this gas to deliver it to transmission pipelines. We developed this factor based on the average emissions from the gathering stations in the seven counties within Pennsylvania that are most representative of UNGD: Bradford, Butler Greene, Lycoming, Susquehanna, Tioga, and Washington. These counties contain 75 percent of the UNGD in Pennsylvania through 2014, and would be most representative of the facilities used to support development moving forward.

Table 5. Emissions factors used in this study to evaluate air quality impacts from projected natural gas development

Development Phase	Emissions Factor (tons/yr)		
	NOx	VOC	Methane
Pre-production (per well)	6.97	0.37	1.08
Production (per well)	0.59	0.62	8.44
Gas gathering and compression (per compressor station)	18.03	6.83	170.09

Source: Pre-production [59], Production [60-61], Gathering [59].

^a. Pre-production includes drilling, hydraulic fracturing, and completion of the well.

For the air quality analysis, we assumed the following to generate the annual emissions:

- Well development occurs at a constant rate over a 30-year build-out within each county. Overall, this amounts to a statewide development of 1,587 wells per year.
- Compressor station development also occurs at a constant rate over a 30-year build-out, which amounts to development of 22 compressor stations per year. We apportioned these compressor stations geographically based on the total expected development in each county.
- First-year emissions from new well development equal pre-production emissions plus one half of production emissions (to simulate development over the course of the year).
- First-year emissions from new compressor stations equal one half of average annual gathering emissions to simulate development over the course of the year.
- Annual emissions from existing infrastructure equal production emissions from existing wells plus gathering emissions from existing compressor stations
- Wells have a 20-year lifetime for production¹³ and compressor stations go offline in conjunction with and in proportion to well retirement.

¹³ Although most gas production of Marcellus wells tends to be in the first three to five years, the lifetime of the well can extend further and depends on a variety of factors. For example, data from the PA DEP show that over half of the unconventional wells drilled in 2007 are still active, and over 80 percent of those drilled in 2008 are still active.

- Total annual emissions equal pre-production plus production plus gathering and compression emissions.

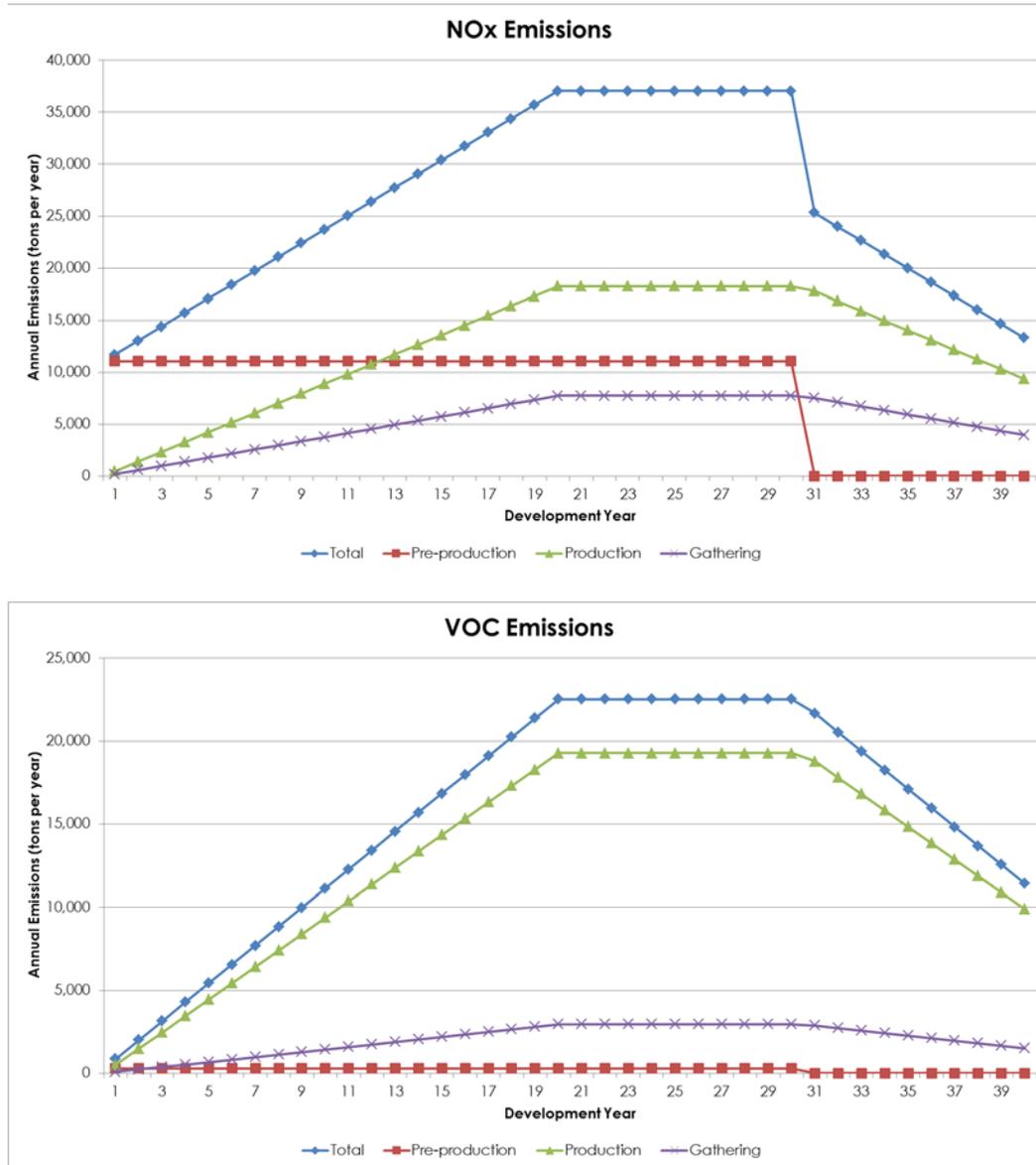
Results

Using our projections of wells and compressor stations, we generated estimates of annual emissions of NO_x, VOC, and methane from projected natural gas development in Pennsylvania. The contributions to these emissions from the different phases of natural gas development will change over time, as shown in Figure 7. Based on our 30-year build-out scenario, the pre-production phase contributes the majority of NO_x emissions for the first 12 years, after which emissions from the production phase become the primary contributor. However, the pre-production phase contributes very little to the overall VOC and methane emissions from development. These graphs also illustrate the cumulative impact that ongoing emissions from production and gathering contribute to overall emissions from development.

We find that given constant development rate, emissions tend to “peak” and plateau for several years. We use these “peak” annual emissions rates as the primary metric for mapping analysis, as they reflect the highest combination of pre-production, production and gathering emissions during the development period.¹⁴

¹⁴ This peak will likely be lower than true peak emissions during the development period, as yearly development will not occur at a constant rate. Individual county peaks may be even higher if development is particularly concentrated over a short time period.

Figure 7. Cumulative NOx, VOC, and methane emissions from projected natural gas development over a 30-year build-out. Pre-production is the largest contributor to NOx emissions until Year 13, when ongoing emissions overtake it. Production is the largest contributor to VOC and methane emissions from the onset of development.



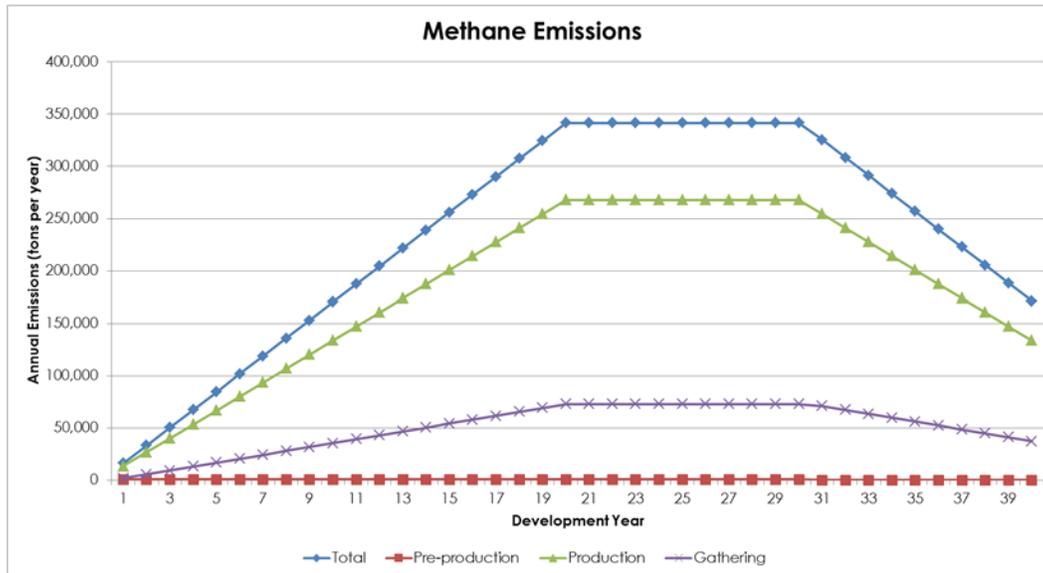
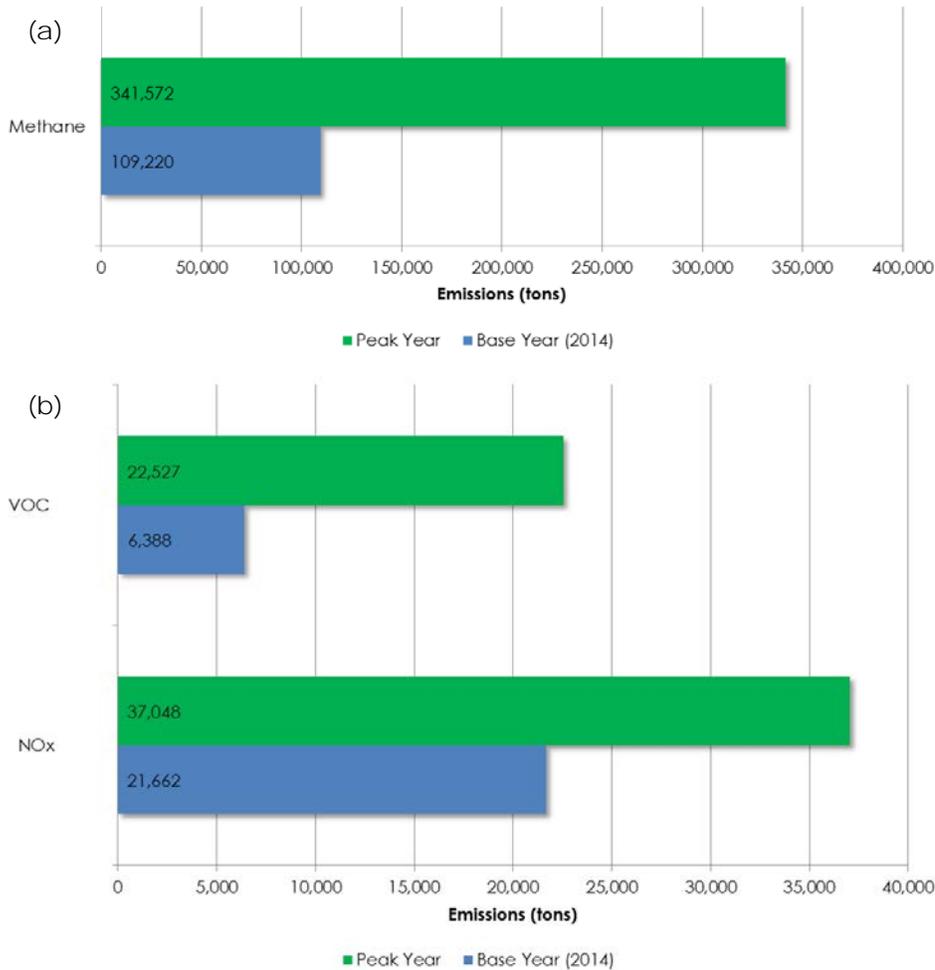


Figure 8 shows the statewide results from the peak emissions years against the emissions from the 2014 PA DEP natural gas emissions inventory. Based on our analysis, during the peak emissions years, annual NOx emissions will have increased by 1.5 times, VOC emissions will have increased by 3.6 times, and methane emissions will have increased 3.1 times relative to the reported emissions data from the natural gas sector in Pennsylvania in 2014.

Figure 8. Pennsylvania annual statewide emissions from projected natural gas development activities (when ongoing production and compressor emissions reach their peak): (a) Methane, (b) VOC and NOx.



Source: Baseline: PA DEP (2014) [59]; Projected: CNA.

For additional context, we have generated a series of maps that depict how the average year of development and final year of development would impact emissions at the county level. Table 6 gives an overview of the maps generated for this impact category. The discussion section provides descriptions and useful information for understanding each map.

Table 6. Air Emissions Impact Map Index.
Access maps at www.cna.org/PA-Marcellus

Map	Title
4.1	NOx emissions from projected development
4.2	VOC emissions from projected development
4.3	Methane emissions from projected development

Discussion

Map 4.1– NOx emissions from projected development

This map shows a peak year of NOx emissions from projected natural gas development by county. This metric represents the NOx emissions from new development plus the cumulative emissions from ongoing natural gas production and compressor stations to support this production. We compared the projected NOx emissions for each county to the current county NOx emissions from the 2014 PA DEP natural gas emissions inventory, and the result is depicted by the shading on the map. Bar charts also indicate the yearly emissions for 2014, and the projected values in order to compare both current and projected future emissions regionally.

Map 4.2 – VOC emissions from projected development

This map shows a peak year of VOC emissions from projected natural gas development by county. The layout of the map is the same as Map 4.1, with all values now depicting VOC emissions.

Map 4.3 – Methane emissions from projected development

This map shows a peak year of methane emissions from projected natural gas development by county. The layout of the map is the same as Map 4.1, with all values now depicting methane emissions.

General discussion

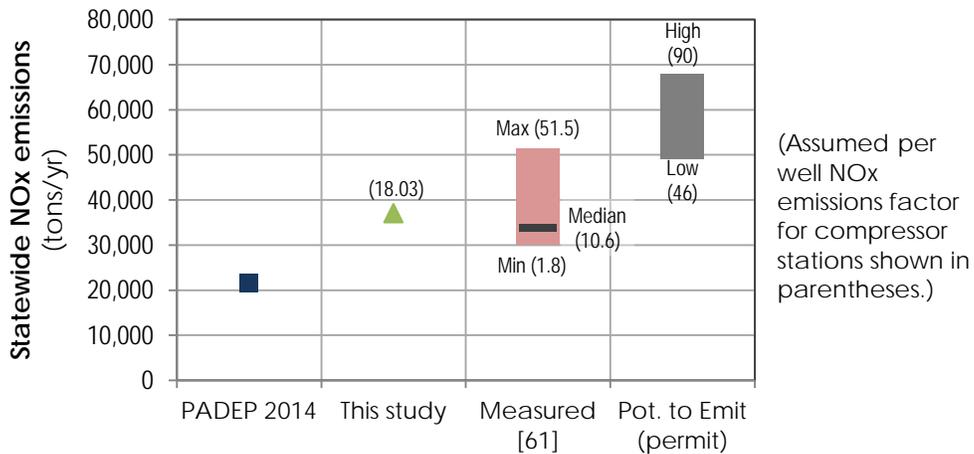
Overall, we found that projected natural gas development could lead to significant increases in NO_x, VOC, and methane emissions across the state. We found that of the counties currently experiencing natural gas development, 25 would increase their NO_x, VOC, and methane emissions profile compared to the 2014 emissions inventory. Further, five counties that did not report natural gas sector emissions in 2014 would have new emissions. Although we focused only on the county-level impacts for this study, it should be noted that more localized or concentrated development in subsections of each county could present a larger potential for reduction in air quality than what is presented here. Recent studies have attributed this localized development to a variety of airborne health risk factors [13, 51-52, 62].

One interesting result from this analysis compared to our previous look at the Delaware River Basin [4] is the contribution to NO_x emissions from compressor stations. In the DRB analysis, the cumulative effect of compressor station build-out accounted for a majority of the overall emissions profile from natural gas development. In this analysis, however, ongoing production represents a larger cumulative contribution than compressor stations. The explanation for this finding lies in the emission factors used to represent compressor stations. In our previous work, we relied on literature values for NO_x emissions from compressor stations that were based on the facility's permitted "potential to emit" value, which indicate the maximum amount of emissions the facility is permitted to emit by the PA DEP. Those values ranged from 46 to 90 tons per year of NO_x. For this study, we obtained the list of compressor stations and actual emissions inventory data collected by the PA DEP to produce the emission factor based on the average observed NO_x emissions, which were not available to us for the DRB study [4]. The emission factor used for this study was 18.03 tons per year. While the potential to emit values still represents an upper bound of emissions, these results should provide a more accurate representation of projected emissions in Pennsylvania.¹⁵

Figure 9 shows the effect that the emissions rate assumption has on total annual emissions. The annual emissions data reported to PADEP in 2014 are compared to the projected annual emissions using three different emissions rate data sources. First, the emissions factor used in this study. Then, the potential ranges of values are shown for the measured data by Goetz et al. [61], and for the potential to emit values in the permits.

¹⁵ It is worth noting that a recent study using a mobile laboratory to measure emissions from Marcellus Shale facilities in Pennsylvania obtained a median value of 10.6 tons per year, with a maximum observed value of 51.5 tons per year, for NO_x emissions from eight compressor stations [61].

Figure 9. Uncertainty in statewide Marcellus annual NOx emissions due to emissions factor used for natural gas gathering compressor stations. Annual emissions reported to PADEP for 2014 are shown for comparison. (Emissions attributed to pre-production and production are the same for all cases at 29,300 tons.)



Source: CNA, based on data from: PA DEP [59], Goetz et al., 2015 [61]

Given that NOx and VOC are the precursors to ozone formation, a potential by-product of increased development is an increase in ozone formation for the impacted counties. A recent study found that natural gas development in the Barnett Shale contributed to an increase in ozone pollution in the Dallas-Fort Worth area [63]. Ground-level ozone is a primary component of smog, which can cause respiratory illness and other decreases in lung function. Due to its potential to cause harm to human health, the EPA monitors ozone, and this pollutant is subject to national ambient air-quality standards (NAAQS). The Pittsburgh-Beaver Valley region (i.e., Allegheny County and the surrounding counties) has struggled in the past with air quality issues related to ozone and even received a non-attainment status for ozone [64]. Projected development in this area could further contribute to these air quality issues.

Some potential follow-on analysis possibilities include scenario or contextual analysis. For example, a study could investigate effects of timing or rate of development in order to refine and evaluate the air quality impacts in each county over time. Or, a different study could compare the projected air quality impacts from gas development to air quality impacts from other sectors in order to determine the impact on total emissions in each county and state-wide.

Water and Wastewater Impact

Water and wastewater management is a significant part of the unconventional natural gas extraction process. Hydraulic fracturing requires a significant amount of water to mix the “frac fluid” that is pumped into the horizontal wells at high pressure in order to fracture the shale and release gas. Most of the water needed to mix the frac fluid is withdrawn from nearby surface water resources, though some of the water needs are met through recycling of wastewater, groundwater, and other sources (e.g., purchase from municipal water providers).

After injection, most of the frac fluid remains in the shale formation, but some returns to the surface along with the gas. The early portion of the water that returns in the first 10-30 days is known as flowback. Later, additional wastewater known as “produced water” or “brine” returns with the gas for as long as the gas well is producing, and roughly in proportion with gas production. Both flowback and produced water are types of wastewater with high concentrations of dissolved solids (salts), metals, volatile organic compounds, and, in some cases, radioactive materials. Some of these contaminants may originate as additives in frac fluid, but many are picked up from the shale formation itself. The final type of wastewater is drilling fluid recovered after drilling the wells. (There are also several types of solid waste, including drill cuttings, and solids settled out from flowback or produced water, but they are not part of this analysis.)

In this analysis, we analyze the volumes of water and wastewater associated with the projected development of gas wells in the Interior Marcellus. Notably, we focus on four key metrics related to natural gas water management:

- **Water use:** the total volume of water used for mixing the frac fluid that is injected into the shale during hydraulic fracturing
- **Water withdrawal:** the volume of water used to mix frac fluid that is withdrawn from surface water resources
- **Consumptive use:** the volume of water in the frac fluid that remains in the shale after injection
- **Wastewater generation:** the volume of wastewater produced from the wells as either flowback or produced water plus used drilling fluid.

All of these metrics are important as they can be used for different impact assessments. *Water use* is important to report, as it is the total volume of water needed for hydraulic fracturing regardless of source. In theory, all of this water could be taken from local streams, but in many cases, other water sources are used including groundwater and recycled wastewater (either from the natural gas industry or from municipal or industrial wastewater sources). For this reason, *water withdrawal* is reported as the average quantity that would be taken from local streams. After frac fluid injection, some portion of the water used for fracking comes back as wastewater, and can potentially return to the watershed (after some level of wastewater treatment). But the consumptive use - or the portion of frac fluid does not return - is important to understand as it indicates the (minimum) amount flow is reduced in the watershed. Finally, it is important to understand the volume of *wastewater generated* that must be managed due to the potential risks associated with the high concentrations of water pollutants in natural gas wastewaters[4].

All of these metrics refer to water volumes, but considering the large number of wells involved, and the long period of well development, reporting volumes for these metrics would result in very large numbers that are difficult to put into context. Instead, we report these metrics in terms of average flow rate—that is, volume per unit of time. We assume a 30-year development period as the unit of time, so all of the metrics are expressed as the average volume over that period. We use the U.S. Geological Survey’s preferred unit of flow, cubic feet per second (cfs) to report these metrics in the results. We also report the 30-year statewide total volume in billions of gallons. (1 cubic foot equals 7.48 gallons.)

Methods, data sources, and assumptions

In this report, we use four major metrics for water use for fracking. They relate to the major water management stages for unconventional gas development with hydraulic fracturing.

For calculation of water and wastewater impacts, we assume that:

- Well development will occur at eight wells per well pad on average. Each well is fracked once, and there is no-re-stimulation.¹⁶
- All wells within a HUC-8 have the same water use.

¹⁶ Some wells can be re-stimulated (or-refracked) to boost or prolong gas recovery. There has been limited re-fracking to date, and few data exist on the amount of water needed. We have not included re-fracking in this analysis.

- Well development occurs at a constant average rate over a 30-year development period. We report water use as an average flow rate for each HUC-10 watershed. The volume is estimated based on the number of wells and the water use per well, and the rate is calculated by dividing the time associated with development—in this case, 30 years. This rate shows the average pace of development, but there may be considerable yearly and monthly variations in water use.
- Eighty percent of water use is met by surface water withdrawals, and 20 percent of water use is met by water reuse, including recycled frac fluid, and other sources.
- All surface water withdrawals for wells are taken from the same HUC-10 as the well pad location.
- Sixty-nine percent of frac fluid water volume remains in the shale, and is considered consumptive use.
- Thirty-one percent of frac fluid water volume returns to the surface as wastewater.

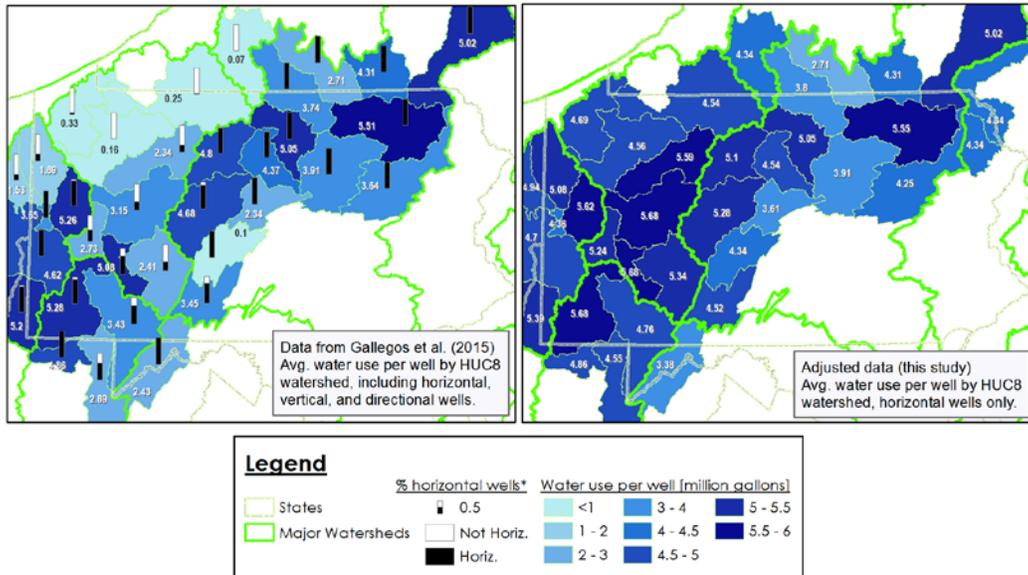
Water use per well

We estimated water use from Gallegos et al. (2015) [65], who analyzed water use for fracking by HUC-8 watershed for major U.S. shale plays including the Marcellus. The data were reported as average water use per well, including horizontal, vertical, and directional wells. Because of this averaging, these data under-estimate average usage for horizontal wells [66], which use much more water than vertical wells. Gallegos et al. do report the number of horizontal, vertical, and directional wells in each HUC-8 watershed, and we used these data to estimate ‘adjusted’ water use for horizontal wells only.¹⁷

¹⁷ We adjusted the average water use per well based on Gallegos et al.’s reported averages of 300 m³ for vertical wells and 2,000 m³ for directional wells. For HUC8 watersheds with fewer than 50 percent horizontal wells, we averaged the adjusted horizontal well estimate with the Marcellus average per well reported by Kondash and Vengosh [66], using the percentage of horizontal wells as the weighting factor. (e.g., if 37 percent of wells were horizontal, we used 63 percent as the weight for the Marcellus average reported by Kondash and Vengosh). To avoid overestimates, we also limited the maximum water use per well for the adjusted values to the maximum value for HUC-8s with at least 90 percent horizontal wells (roughly 5.6 million gallons).

Figure 10 shows side-by-side comparison of the unadjusted and adjusted Gallegos et al. data by HUC-8, on a per well basis.

Figure 10. Estimates of per well water use by HUC-8 watershed. Gallegos et al. (2015) estimates (left), and adjusted (right) to consider only horizontal wells.



Source: Data from Gallegos et al. (2015); Maps created by CNA.

We note that Figure 10 shows that the adjusted data are much more consistent per across the formation once the vertical and directional wells are excluded. The overall average water use for the projected wells is 4.9 million gallons, which is near or slightly above the reported average water use for some previous studies [67-69]. We believe that this is reasonable, considering that water use per well has been trending upward slightly, mostly because lateral length is increasing. Kondash and Vengosh also reported on data from Chesapeake Energy, which indicated average use of 5.6 million gallons; this closely matches several of the highest HUC-8 averages in terms of water use per horizontal well (see Figure 10). The range is 2.7 to 5.7 million gallons

Water withdrawal, consumptive use, and wastewater

We base our estimates of water withdrawal, consumptive use, and wastewater generation on literature values for these figures in relation to total water use for fracking. Specifically, we gathered the most recent estimates [66] for the portion of total water use met by new water withdrawals from fresh surface water, and the

relative proportion of injected frac fluid that remains in the shale (consumptive use) versus returns as flowback or brine wastewater.

We assume that most of the water demand for hydraulic fracturing will be met by surface water withdrawals. Trends in the industry are towards more reuse of natural gas wastewaters for water supply, and there has been some interest in non-traditional sources such as municipal wastewater treatment plant effluent or mine drainage waters. For this study, consistent with the previous CNA study for the Delaware River Basin, we assume that 80 percent of the total water use for fracking is met by surface water withdrawals, which accounts account for wider availability of recycled wastewater as more wells are developed. This percentage is slightly below figures by other research on the topic [68-69], though comparable to recent data published by the Susquehanna River Basin Commission [70]. Transporting water is a significant cost, so we assume that all wells will be supplied by surface water withdrawals from within the same watershed (i.e., HUC-10) as the well pad site. At this level of analysis, we make no assumption about the stream order within the watershed from which the withdrawal is taken. Finally, we assume that the 80 percent factor is constant across the study area.

For determining the fate of the injected water in the frac fluid, we used recent research by Kondash and Vengosh (2015) [66]. Early analysis of unconventional drilling in the Marcellus Shale had indicated that only a small portion, perhaps 10-15 percent, of water injected as frac fluid would return to the surface as natural gas wastewater. But these analyses were mostly focused on the flowback fluid, which can be measured easily as it returns over the first 30 days after hydraulic fracturing. Kondash and Vengosh, by contrast, accounted for more of the produced water which comes up the well in small quantities along with produced gas for 10 years or longer. Taking this longer view, Kondash and Vengosh calculated that 31 percent of the average injected frac fluid volume would return as wastewater. The remaining 69 percent is “consumptive use” as it is not recovered from the shale. Since our study covers a long time horizon, we use these figures to calculate consumptive use and volume of wastewater generated. We assume that these percentages remain constant across the study area.¹⁸

¹⁸ We did investigate Pennsylvania Oil and Gas wastewater reporting data for geographic trends in wastewater volume, but we found insufficient data to clearly indicate geographic differences. In many cases, we could not connect water use per well from FracFocus with wastewater records. Additionally, the wastewater reporting data were often incomplete due to omissions or, more likely, because not enough time had passed since drilling and fracking to collect, process, and report wastewater volumes.

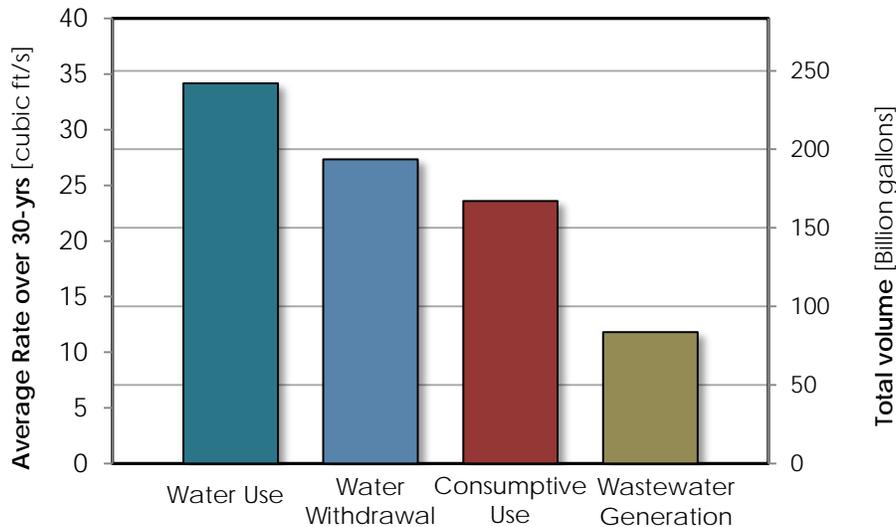
Results

The results for this chapter are focused on four key water and wastewater metrics, including water use, water withdrawal, consumptive use, and wastewater generation.

As mentioned previously, we report these water impacts both in terms of total statewide volumes, but also in terms of average flow rates over the development period. We use cubic feet per second for all water metrics to allow comparisons with streamflow, and thousands of gallons per day for wastewater.

Statewide, we determined that the development of the roughly 48,000 additional wells in the Marcellus would result in an average water use rate of 34 cfs over 30 years, or 242 billion gallons in total. Figure 11 shows the corresponding values for water withdrawal (200 billion gallons), consumptive use (167 billion gallons), and wastewater generation (84 billion gallons).

Figure 11. Total water and wastewater impacts for Pennsylvania associated with hydraulic fracturing of projected wells through full development of the Marcellus Shale. The average rates and total volume are shown on the left and right axes, respectively, for water use, surface water withdrawals, consumptive use, and wastewater generation.



As in previous chapters, the statewide totals do not present the full picture of these impacts. For water-related impacts, it is most appropriate to analyze the impacts by watershed. But since water flows from one watershed to another, it is not sufficient to simply assess the impacts of natural gas development solely within the watershed

the development occurs. We have generated four categories of maps to give greater understanding and context to this analysis.

- **Volume/Flow-rate** - Standard analysis of water-related impacts in each HUC-10 watershed based only on development within the watershed, expressed as average-flow over the development period.
- **Specific or Area-averaged flow** - measures the ‘intensity’ of water use by dividing the flow computed for each watershed by watershed area. This will show where development will be most concentrated.
- **Cumulative flow** - presents a more comprehensive view of the water impacts by including both the impacts within each watershed and the total impact from all watersheds upstream. This is particularly relevant to consumptive use.
- **Contextual analysis** - compares the flow-rates calculated in this analysis to existing water usage.

Table 7 presents an overview of the water and wastewater maps by metric and category. Not all categories of map are relevant for all of the metrics. Maps 5.1-5.4 present the water use, withdrawal, consumptive use, and wastewater generation by HUC-10 watershed in terms of average flow rate. Maps 5.5 and 5.6 present area-averaged or “specific” flow rates for water use and water withdrawal. Since assessing the water use in each watershed individually does not present the full picture of how water flows between watersheds, we created Maps 5.7 and 5.8 to show cumulative water use and consumptive use for each watershed including the upstream usage. Finally, in Map 5.9, we compare consumptive use for hydraulic fracturing relative to all other consumptive uses, this time at the larger HUC-8 watershed scale.

Table 7. Water and wastewater maps by metric and category.

Metric	Volume/ Flow-rate	Area-averaged flow	Cumulative flow	Contextual analysis
Water Use	Map 5.1	Map 5.5	Map 5.7	
Water Withdrawal	Map 5.2	Map 5.6		
Consumptive Use	Map 5.3		Map 5.8	Map 5.9
Wastewater Generated	Map 5.4			

Table 8 introduces the maps generated for this category. The following discussion section offers commentary on how to read and interpret each map.

Table 8. Water and Wastewater Impacts Map Index.
 Access maps at www.cna.org/PA-Marcellus

Map	Title
5.1	Water use by watershed
5.2	Water withdrawal by watershed
5.3	Consumptive water use by watershed
5.4	Wastewater generation by watershed
5.5	Specific water use
5.6	Specific water withdrawal
5.7	Cumulative water use
5.8	Cumulative consumptive use
5.9	Consumptive use relative to existing consumptive uses

Discussion

Map 5.1 – Water use by watershed

This map shows projected water use for hydraulic fracturing by HUC-10 watershed. The water use metric represents total water use volume for hydraulic fracturing by all projected wells within each HUC-10 through build-out, expressed as flow rate in cubic feet per second (cfs). The rate represents the average water use rate over the full build-out time frame, assumed to be 30 years. This metric does not include water uses for anything other than fracking (e.g., for drilling fluid or site preparation).

To generate this map, we used well projection numbers on a HUC-10 basis and the adjusted estimates of water use per well, which are computed from Gallegos et al. [65] on a HUC-8 basis. Therefore, the differences in the results by HUC-10 reflect differences in projected number of wells developed, and geographic differences in the average amount of water used for hydraulic fracturing.

Map 5.2 – Water withdrawal by watershed

This map shows the projected freshwater withdrawal for hydraulic fracturing through build-out by HUC-10 watershed. This metric represents total freshwater withdrawal volume for hydraulic fracturing by all projected wells within each HUC-10 through build-out, expressed as flow rate in cubic feet per second. The freshwater withdrawal rate is less than total water use rate because we assume that 20 percent

of the total water use for hydraulic fracturing is met by other water sources, primarily wastewater reuse, instead of freshwater withdrawal.

Map 5.3 – Consumptive use by watershed

This map shows the projected consumptive use associated with hydraulic fracturing through build-out by HUC-10 watershed. This metric represents the volume of hydraulic fracturing fluid left within the shale for all projected wells within each HUC-10 through build-out, expressed as flow rate in cubic feet per second. The consumptive water use rate is less than total water use rate because a portion of the injected fluid returns to the surface as wastewater.

We assume a standard fixed relationship across the Marcellus for percentage of the total water used for hydraulic fracturing that is left in the shale as consumptive use. Based on figures from Kondash and Vengosh [66], we assume that consumptive use is, on average, 69 percent of total water use for hydraulic fracturing.

Map 5.4 – Wastewater generation by watershed

This map shows the projected wastewater generation associated with hydraulic fracturing through build-out by HUC-10 watershed. This metric represents the volume of natural gas wastewaters returning from the shale after fracking for all projected wells plus drilling fluid wastewater within each HUC-10 through build-out, expressed in thousands of gallons per day. The wastewater generation rate for flowback and produced water is equal to total water use rate minus the consumptive use rate (water from the injected fluid left in the shale), or simply 31 percent of the total water use rate. We added another 185,000 gallons per well for drilling wastewater, slightly higher than the amount in previous research [71] to account for increasing lateral length.

This metric indicates the total volume of wastewater that must be handled within each HUC-10 watershed. This analysis does not consider how the wastewater is managed, treated, recycled, transported, or discharged. Separate analyses would be needed to determine how different wastewater treatment or disposal methods may affect water quality, human health, or ecological outcomes. The map does show currently (as of April 2016) permitted facilities for handling oil and gas wastewaters, for context.

Map 5.5 – Specific water use

This map, similar to Map 5.1, shows water use for hydraulic fracturing by HUC-10 watershed. The water use metric is identical to the one in Map 5.1, but is normalized

to the area of the watershed. The metric is presented as water withdrawal in cubic feet per second per 100 square miles. We use 100 square miles to make the numbers easier to comprehend, and because HUC-10 watersheds are on the order of 100 square miles in area. We could also present this metric as a depth over the watershed. For conversion, 1 cfs per 100 square miles (for a year) is equivalent to a depth on the watershed of 0.136 inches, or 3.45 millimeters, per year.

In Map 5.1, the largest watersheds typically also show the highest water use because they contain more well pads due to their size. Normalizing by watershed area removes this issue, and Map 5.5 shows the watersheds with high water use because they have a high relative density of development.

Map 5.6 – Specific water withdrawal

This map, similar to Map 5.2, shows freshwater withdrawal associated with hydraulic fracturing by HUC-10 watershed. The water withdrawal metric is identical to the one in Map 5.2, but is normalized to the area of the watershed. The metric is presented as water withdrawal in cubic feet per second per 100 square miles.

In Map 5.2, the largest watersheds typically also show the highest water withdrawal because they contain more well pads due to their size. Normalizing by watershed area removes this issue, and Map 5.6 shows the watersheds with high water withdrawal because they have a high relative density of development.

(Note: We do not show similar maps for consumptive use or wastewater generation because the relationship between the direct flow rate map and area-averaged map is similar to those for water use and water withdrawal.)

Map 5.7 – Cumulative water use

This map shows cumulative projected water use for hydraulic fracturing by HUC-10 watershed. The water use metric represents total water use volume for hydraulic fracturing by all projected wells within each HUC-10 through build-out plus the water use for all upstream HUC-10s, expressed as flow rate in cubic feet per second (cfs). This metric shows the cumulative upstream water use on an average basis through build-out.

This map is similar to Map 5.1, but adds all of the upstream water use to the water use for each HUC-10. This map shows water use in more HUC-10 watersheds than Map 5.1 because the water use is traced farther downstream until all water use for hydraulic fracturing is captured. In some cases, the watersheds are outside of Pennsylvania. This metric does show total upstream water use for hydraulic fracturing on an average basis, but the metric may not be meaningful with respect to

streamflow because alternate water sources and return flow (after wastewater treatment) are not taken into account. A more physically meaningful cumulative water use metric is the consumptive use, which is shown in Map 5.8.

The map also labels the average daily water use by major river basin. (Note that the Upper Ohio includes the cumulative flow from both the Allegheny and Monongahela.) Based on current data, these estimates appear reasonable; the Susquehanna River Basin Commission reported total water use of 15.4 cfs for 2012, and 13.2 cfs for 2013 [70], closely matching the 13.9 cfs reported for this study.

Map 5.8 – Cumulative consumptive use

This map shows cumulative projected consumptive use associated with hydraulic fracturing by HUC-10 watershed. This metric represents total consumptive water use volume associated with hydraulic fracturing by all projected wells within each HUC-10 through build-out plus the consumptive use for all upstream HUC-10s, expressed as an average flow rate in cfs.

This map is similar to Map 5.3, but adds all of the upstream consumptive use to the consumptive use for each HUC-10. It shows, on an average basis, the potential reduction in streamflow at the outlet point of each HUC-10 watershed. This map shows consumptive use in more HUC-10 watersheds than Map 5.3 because the water use is traced farther downstream until all water use for hydraulic fracturing in the Marcellus formation in Pennsylvania is captured. In some cases, the watersheds are outside of Pennsylvania due to the flow of rivers across state boundaries. Actual consumptive use could be higher or lower depending on how water is sourced and how wastewater is handled (recycling versus treatment with effluent disposal versus deep well injection). The consumptive use will also vary considerably over time and space due to variations in development rate.

For context, the total cumulative consumptive use for gas development at Pittsburgh is roughly 10.9 cfs (Allegheny plus Monogahela). Pittsburgh's municipal water supplier, PWSA, treats roughly 70 million gallons per day, or 108 cfs of potable water supply. Assuming a typical consumptive use rate of 10 percent for municipal supply, Pittsburgh's consumptive use for water supply is roughly 10.8 cfs (i.e., almost exactly equal to the average consumptive use for hydraulic fracturing upstream of Pittsburgh). Map 5.9 shows similar comparisons statewide, but for all existing consumptive water uses including agricultural and industrial use.

(Note: We did not generate similar maps to Maps 5.7 and 5.8 for water withdrawal or wastewater generation. The water withdrawal map would be similar to Map 5.7, and would not account for possible return flow after wastewater treatment. A cumulative wastewater generation map would not be especially instructive unless we assumed

that all wastewater is returned to the same watershed in which it was produced, and is not reused or transported to other watersheds for treatment.)

Map 5.9 – Consumptive use by watershed relative to existing consumptive uses

This map shows projected consumptive use for hydraulic fracturing on a HUC-8 basis, and relative to all other existing consumptive uses. We acquired the baseline consumptive use data by HUC-8 from Caldwell et al. (2013) [72], which is based on 2005 USGS water use data disaggregated to HUC-8 scale, and accounts for end use specific and geographically specific consumptive use factors relative to reported water use. These data would predate water usage related to UNGD with HVHF, but also do not account for changes in water use over the past decade.

The map shading indicates the total volume of consumptive water use associated with hydraulic fracturing by all projected wells within each HUC-8 through build-out, expressed as an average rate over 30 years. Using the vertical bars, we indicate the ratio of this consumptive use associated with fracking over the total estimated consumptive use for each HUC-8 as a percentage. This metric can be read as either the ratio of UNGD consumptive use to existing (2005) consumptive use, or the amount by which consumptive use would increase over existing usage in the HUC-8 due to UNGD.

This map puts the consumptive use for hydraulic fracturing in context with existing consumptive uses. In some areas of Pennsylvania, water use for fracking could dramatically increase overall consumptive use. In other areas (even with similar average usage for fracking), the existing consumptive use is much higher and the ratio is lower.

General discussion

The analysis presented considers four primary volumetric water and wastewater metrics presented on an average basis over a 30-year development period. This analysis considers only the total volumes of water and wastewater associated with hydraulic fracturing, presented as an average rate over a 30-year development horizon.

For at least four reasons, this analysis does not capture the full potential impacts of water and waste management associated with natural gas development. First, there are additional water uses and wastes that are not included in this analysis. Some additional water use is associated with indirect uses such as site preparation, materials processing and quarrying, and equipment washing. [68] Other waste

streams including spent lubricants and solid wastes such as drilling cuttings are not considered in this report. [16]

Secondly, the well development rate, and by extension the water use rate will vary geographically and temporally. The pace of development will likely correlate with energy prices, ability to sign leases, ability to permit and construct natural gas infrastructure, and other factors. The pace of development in turn affects flow rates associated with all phases of water management. The freshwater withdrawal rate could be several times higher than the average rate during peak periods [4], which can increase potential impacts on streams. Likewise, the consumption rate and wastewater generation rate will increase.

Thirdly, there may be variability in the water use rates from well to well¹⁹, and there may be changes over time due to evolving industry practices and regional development characteristics. Recently, water use per well has been increasing as average lateral length and the number of fractures per well has increased [70] (though primarily in “hotspot” areas with especially rich gas deposits). In addition, seasonal variations in drilling and hydraulic fracturing activity may play a large role in timing of withdrawals. Also, as development continues, more wastewater will be available for reuse, which could lower the portion of water use met by freshwater withdrawal for wells developed later. Finally, re-fracking is not included in this analysis, but could raise water usage in some areas of the play. Capturing these temporal aspects of water management is beyond the scope of this study, and would require a methodology for projecting well development on a year-by-year (or even month-by-month) basis.

Fourth, there is potential for movement of water and wastewater across watersheds. We assume that the demand for water withdrawal is met within the same HUC-10 as the well pad. This is generally a reasonable assumption, but in some cases may not be correct. Given costs to permit and develop new water withdrawals, it is possible that an existing, permitted water withdrawal location in an adjacent HUC-10 may make more sense for a particular well pad or operator. Our analysis focuses only on wastewater generation by watershed, as significant quantities of natural gas wastewaters (and other wastes) are routinely transported even across major river basin boundaries [16], and a full examination of wastewater disposal scenarios was beyond the scope of this study.

¹⁹ The data we used had a range of per well water use (averaged over each HUC-8) from 2.7 to 5.7 million gallons per well, an average of 4.9, and a median of 5.0. The total water use we computed for the projected 47,600 wells is 242 billion gallons based on the average computed for each HUC-8. If *all* wells used water at the highest end of the range, the total water use would be 270 billion gallons, an 11 percent increase.

Overall, this analysis generates projections of water and wastewater volumes, but does not investigate the context of the source (or receiving waters). That is, this is an analysis of environmental “burdens”, but not “impacts”. We present the water volumes in terms of flow rates, which is useful for supporting additional research. Specifically, this analysis does not put the magnitude of withdrawals and wastewater volumes into context by comparing them to the available streamflow in the watershed. Just as there can be significant variations in the rates of water use and wastewater generation, the actual impacts of water withdrawals on stream flow are highly dependent on the location of withdrawal, and the natural variability in the flow of the source waters. Withdrawing water in the spring from the mainstem of the Susquehanna River may have a negligible impact on flow, while withdrawing from a small headwater stream during late summer could have a substantial impact.

Similarly, we report only the wastewater volumes associated with development, and do not investigate potential impacts on water quality. Disposal of treated natural gas wastewaters can raise the concentration of certain pollutants (e.g., dissolved solids, barium, strontium, bromide) with potential ecological and human health effects. Our previous report on the Delaware River basin [4] investigated the potential impacts of water usage on available flow, and disposal of treated wastewater on the in-stream concentrations of pollutants for three case study watersheds, and found that the level of impact did vary (often by an order of magnitude) with development rate, in-stream flow, and stream order.

There are several ways this analysis could support additional studies. Examining the effects of water withdrawals on available flow is a logical extension. The wastewater impacts, however, may be of particular concern, especially given the potential risks to drinking water supplies. [5, 73-78] The method of wastewater management (e.g., on-site reuse of wastewater, treatment at a centralized wastewater facility, or exporting wastewater for disposal via deep well injection) is important; each has very different consequences for water quality. Investigating potential water quality impacts and key vulnerabilities (ecosystem and human health) for various wastewater management scenarios could be a useful topic for future analysis, and informing policy.

Conclusion

Unconventional natural gas development using hydraulic fracturing has spurred a rapid expansion of natural gas extraction in Pennsylvania due to the presence of the Marcellus Shale—which, though rich in gas, could not be economically developed with traditional drilling methods. Through the almost nine years of unconventional gas development in Pennsylvania, the Commonwealth has witnessed significant changes to energy costs, employment, communities, and the environment. While the price of natural gas has led to fluctuations in the amount of development, the quantity of remaining gas reserves in the Marcellus Shale could support significantly more gas development in coming years.

In this study, we ask, “What would be the environmental burdens associated with natural gas development activities in Pennsylvania if the Interior Marcellus Shale resources were fully developed?”

Specifically, we investigate the potential impacts to Pennsylvania’s land, forests, water, air, and population if development of the Marcellus Shale were to continue until all of the technically recoverable reserves were exhausted.

One significant difficulty with investigating potential future impacts of gas development is determining where those impacts may occur. To address this challenge, we developed a geospatial analysis methodology to identify the most likely locations of potential future wells, based on finding geologic, environmental, and land use conditions similar to where wells have already been drilled. Using the probability surface generated from this analysis and recent estimates of total recoverable reserves and average production per well, we determined how many wells would be developed until reserves are depleted, and their most likely locations. That is, we developed one set of “projections” of well numbers and locations through (what is currently estimated) as build-out condition. These are not formal *predictions* of wells and their locations, just one possible configuration identified as likely based on current information on gas development in the Interior Marcellus Shale.

With information on well locations and level of impact per well, we analyze the spatial characteristics of impacts of natural gas development. For the most part, we compute these impacts based on the well (or well pad) numbers in a given geographic unit, and impacts per well or well pad derived from published literature or data sets. We also apply additional geospatial and mathematical analysis techniques to estimate several of the impacts, as appropriate.

The primary output of this research is an *atlas*: a set of maps that puts the impacts of the projected natural gas development in useful spatial context. These maps, and the data developed to generate them, present useful information to policy-makers, decision-makers, and other researchers concerned about managing the range of impacts of shale gas extraction in Pennsylvania. We strive to present the impacts using straightforward, relevant metrics useful for comprehension and supportive of follow-on analysis. At this time, the metrics are focused on environmental burdens and impacts (e.g., land areas, emissions, volumes, and flow rates) that can be reasonably and directly estimated from the well and well pad projections. This analysis does not address the potential “outcomes” resulting from the impacts (e.g., endangered species populations, water pollutant concentrations, and human health outcomes).

Key findings

For the Commonwealth of Pennsylvania, the key impacts we determined to be associated with the full development of the Marcellus Interior shale formation include:

- **Well development** – We estimated that 47,600 additional wells could be developed on 5,950 well pads over the next 30 years *if* the Interior Marcellus’s technically recoverable resources were fully developed.
- **Land use change** – The construction of natural gas infrastructure (well pads, gathering pipelines, and access roads) to support projected well development would result in almost 100,000 acres of land disturbance. Over half (about 51,000 acres) of the land disturbance would impact agricultural land, while about 28,000 acres would constitute the clearing of forest cover.
- **Forest change** – Of the 28,000 acres of forest that would be cleared, we found that nearly 13,000 acres were core forest (patches of forest at least 300 feet from a forest edge). An additional 89,000 acres of core forest would be fragmented by the projected gas infrastructure development, resulting in a conversion to edge forest.
- **Population in proximity to well pads** – We estimated that the current population in Pennsylvania living within one-half mile of a well pad is about 100,000, and this number could increase to 639,000 based on our projections. Similarly, we estimate that the population living within one mile of a well pad could increase from about 311,000 today to over 1.8 million at full build-out.

- **Air emissions** – The additional well development would result in greater emissions of NO_x, VOCs, and CH₄ from activities related to well pre-production, and production, and compressor stations for moving gas through gathering lines. When the play nears full development (i.e., ongoing emissions from producing wells reach their peak), the average air emissions per year could reach 37,000 tons for NO_x, 22,500 tons for VOCs, and 342,000 tons for methane.
- **Water use, withdrawal, and consumptive use** – We determined that the projected natural gas development in the Marcellus would result in an average water use rate of 34 cfs over about 30 years, or 242 billion gallons in total in order to mix frac fluid for the hydraulic fracturing process. We found that roughly 200 billion gallons of fresh surface water would be withdrawn to support this development, and that 167 billion gallons would be used consumptively and would not re-join the hydrologic cycle after injection.
- **Wastewater generated** – We estimated that 84 billion gallons of wastewater would be generated from projected natural gas development in Pennsylvania. Wastewater includes drilling fluid waste, plus flowback and produced water/brine recovered from the shale after frac fluid injection and during gas production.

All of these metrics offer a sense of the scale of the total statewide impacts of natural gas development through full development of the Marcellus Shale. But these aggregated metrics do not tell the full story of the impacts, which have important geographic variations. The maps accompanying this work show these variations and can help identify areas of comparatively higher and lower impacts. Readers are encouraged to view and download these maps at: www.cna.org/PA-Marcellus

We do not provide an opinion on the overall significance of these impacts—we leave that to policy-makers and decision-makers with local knowledge of the impacted areas to decide. But this analysis takes the initial step of looking at the long-term future of natural gas development in Pennsylvania. Development appears likely to continue over the coming years, and will continue to have some level of environmental impact wherever development occurs. Tolerance for and management of these impacts will be a continuing area of debate among policy-makers, regulators, land owners, the natural gas industry, and the general public. This analysis provides information that any of the relevant stakeholders—especially policy-makers—may consider as they decide how gas development is to be managed and regulated over the coming decades.

References

- [1] Hanson, Mark P. 2014. "Shale Shock - How the Marcellus Shale Transformed the Domestic Natural Gas Landscape and What It Means for Supply in the Years Ahead." *Morningstar Energy Observer*. February 2014.
- [2] Hughes, J. David. 2014. *Drilling Deeper - A reality check on U.S. government forecasts for a lasting tight oil & shale gas boom*. Post Carbon Institute. <http://www.postcarbon.org/publications/drillingdeeper/>.
- [3] Staub, John. 2015. "The Growth of U.S. Natural Gas: An Uncertain Outlook for U.S. and World Supply." 2015 EIA Energy Conference, Washington, DC, June 15, 2015. <http://www.eia.gov/conference/2015/pdf/presentations/staub.pdf>.
- [4] Habicht, S., L. Hanson, and P. Faeth. 2015. *The Potential Environmental Impact from Fracking in the Delaware River Basin*. https://www.cna.org/cna_files/pdf/IRM-2015-U-011300.pdf.
- [5] Brantley, Susan L., Dave Yoxtheimer, Sina Arjmand, Paul Grieve, Radisav Vidic, Jon Pollak, Garth T. Llewellyn, Jorge Abad, and Cesar Simon. 2014. "Water resource impacts during unconventional shale gas development: The Pennsylvania experience." *International Journal of Coal Geology* 126: 140-156. doi: 10.1016/j.coal.2013.12.017.
- [6] Vidic, R. D., S. L. Brantley, J. M. Vandenbossche, D. Yoxtheimer, and J. D. Abad. 2013. "Impact of Shale Gas Development on Regional Water Quality." *Science* 340 (6134). doi: 10.1126/science.1235009.
- [7] Krupnick, A. J., H. Gordon, and S. M. Olmstead. 2013. *Pathways to Dialogue: What the Experts Say about the Environmental Risks of Shale Gas Development*. Resources for the Future. www.rff.org/shaleexpertsurvey.
- [8] Olmstead, Sheila M., Lucija A. Muehlenbachs, Jih-Shyang Shih, Ziyang Chu, and Alan J. Krupnick. 2013. "Shale gas development impacts on surface water quality in Pennsylvania." *Proceedings of the National Academy of Sciences* 110 (13): 4962-4967. doi: 10.1073/pnas.1213871110.
- [9] Evans, J. S., and J. M. Kiesecker. 2014. "Shale gas, wind and water: assessing the potential cumulative impacts of energy development on ecosystem services within the Marcellus play." *PLoS One* 3929665 9 (2): e89210. doi: 10.1371/journal.pone.0089210. <http://www.ncbi.nlm.nih.gov/pubmed/24586599>.
- [10] New York Department of Environmental Conservation. 2011. *Revised Draft Supplemental Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program: Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs*. Accessed Jan. 13, 2015. <http://www.dec.ny.gov/energy/75370.html>.
- [11] NYS DOH. 2014. *A Public Health Review of High Volume Hydraulic Fracturing for Shale Gas Development*. New York State Department of Health.
- [12] Penningroth, S. M., M. M. Yarrow, A. X. Figueroa, R. J. Bowen, and S. Delgado. 2013. "Community-based risk assessment of water contamination from high-volume horizontal hydraulic fracturing." *New Solut* 23 (1): 137-66. doi: 10.2190/NS.23.1.i. <http://www.ncbi.nlm.nih.gov/pubmed/23552652>.

- [13] Rabinowitz, P. M., I. B. Slizovskiy, V. Lamers, S. J. Trufan, T. R. Holford, J. D. Dziura, P. N. Peduzzi, M. J. Kane, J. S. Reif, T. R. Weiss, and M. H. Stowe. 2014. "Proximity to Natural Gas Wells and Reported Health Status: Results of a Household Survey in Washington County, Pennsylvania." *Environmental Health Perspectives*. doi: 10.1289/ehp.1307732. <http://www.ncbi.nlm.nih.gov/pubmed/25204871>.
- [14] Racicot, A., V. Babin-Roussel, J. F. Dauphinais, J. S. Joly, P. Noël, and C. Lavoie. 2014. "A Framework to Predict the Impacts of Shale Gas Infrastructures on the Forest Fragmentation of an Agroforest Region." *Environmental Management* 53 (5): 1023-1033. <http://link.springer.com/article/10.1007%2Fs00267-014-0250-x>.
- [15] Brittingham, Margaret C., Kelly O. Maloney, Aida M. Farag, David D. Harper, and Zachary H. Bowen. 2014. "Ecological Risks of Shale Oil and Gas Development to Wildlife, Aquatic Resources and their Habitats." *Environmental Science & Technology*. Accessed 2014/09/15. doi: 10.1021/es5020482. <http://pubs.acs.org/doi/abs/10.1021/es5020482>.
- [16] Maloney, K. O., and D. A. Yoxtheimer. 2012. "Production and Disposal of Waste Materials from Gas and Oil Extraction from the Marcellus Shale Play in Pennsylvania." *Environ. Pract.* 14 (04): 278-287.
- [17] Entrekin, S., M. Evans-White, B. Johnson, and E. Hagenbuch. 2011. "Rapid expansion of natural gas development poses a threat to surface waters." *Front. Ecol. Environ.* 9 (9): 503.
- [18] Johnson, N. 2010. *Pennsylvania Energy Impacts Assessment Report 1: Marcellus Shale Natural Gas and Wind*.
- [19] Hays, J., and S.B.C. Shonkoff. 2016. "Toward an understanding of the environmental and public health impacts of shale gas development: an analysis of the peer-reviewed scientific literature, 2009-2014." *PLOS One*. doi: 10.1371/journal.pone.0154164.
- [20] Moore, C.W., B. Zielinska, G. Petron, and R.B. Jackson. 2014. "Air Impacts of Increased Natural Gas Acquisition, Processing, and Use: A Critical Review." *Environ. Sci. Technol.* 48 (15): 8349-8359.
- [21] Vengosh, Avner, Robert B. Jackson, Nathaniel Warner, Thomas H. Darrah, and Andrew Kondash. 2014. "A Critical Review of the Risks to Water Resources from Unconventional Shale Gas Development and Hydraulic Fracturing in the United States." *Environmental Science & Technology* 48 (15): 8334-8348. Accessed 2014/09/15. doi: 10.1021/es405118y. <http://pubs.acs.org/doi/abs/10.1021/es405118y>.
- [22] Werner, A. K., S. Vink, K. Watt, and P. Jagals. 2015. "Environmental health impacts of unconventional natural gas development: A review of the current strength of evidence." *Sci Total Environ* 505C: 1127-1141. doi: 10.1016/j.scitotenv.2014.10.084. <http://www.ncbi.nlm.nih.gov/pubmed/25461113>.
- [23] Krupnick, Alan, and Sheila Olmstead. 2013. "Cumulative Risks of Shale Gas Development." Resources For the Future, Washington, DC, May 31, 2013. http://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_083435.pdf.
- [24] US Energy Information Administration. 2015. *Assumptions from the 2015 Annual Energy Outlook*.
- [25] Bearer, S., E. Nicholas, T. Gagnolet, M. Dephilib, T. Moberg, and N. Johnson. 2012. *Environ. Pract.* 14 (04): 308.
- [26] Cabot Oil & Gas Corporation. 2014. "Investor Presentation: Barclays' 2014 CEO Energy-Power Conference." September 2-3, 2014.
- [27] Brannon, Travis L., Walton C. Shepherd, and James M. Van Nostrand. 2012. *Marcellus Shale Drilling Comparative White Paper: The Regulatory Approaches of New York, Ohio, Pennsylvania, and West Virginia*.

- [28] PAMAP Program. 03/08/2007. Geographic Information Systems dataset. *PAMAP - Building/Address (Points)*. vector digital data. PAMAP Program, PA Department of Conservation and Natural Resources, Bureau of Topographic and Geologic Survey.
- [29] McKay, L., T. Bondelid, T. Dewald, J. Johnston, R. Moore, and A. Rea. 2012. Geographic Information Systems dataset. *NHDPlus Version 2*. U.S. Environmental Protection Agency (USEPA) and the U.S. Geological Survey (USGS).http://www.horizon-systems.com/nhdplus/NHDPlusV2_documentation.php.
- [30] FEMA. 2015. Geographic Information Systems dataset. *FEMA National Flood Hazard Layer (NFHL)*. Federal Emergency Management Agency.<https://hazards.fema.gov/femaportal/wps/portal/NFHLWMS>.
- [31] Gergely, K.J., and A. McKerrow. Geographic Information Systems dataset. *PAD- US - National inventory of protected areas*. US Geological Survey.<http://gapanalysis.usgs.gov/padus/data/>.
- [32] Manda, Alex K., Jamie L. Heath, Wendy A. Klein, Michael T. Griffin, and Burrell E. Montz. 2014. "Evolution of multi-well pad development and influence of well pads on environmental violations and wastewater volumes in the Marcellus shale (USA)." *Journal of Environmental Management* 142: 36-45.
- [33] International, ICF. 2014. *Detailed Production Report*.
<http://www.icfi.com/news/2014/06/icf-detailed-production-report-second-quarter>.
- [34] Berman, Arthur, and Lyndon Pittinger. 2014. *Resource Assessment of Potentially Producible Natural Gas Volumes From the Marcellus Shale, State of New York*.
- [35] US Energy Information Administration. 2014. "Oil and natural gas resource categories reflect varying degrees of certainty." Today in Energy - US Energy Information Administration. July 17, 2014.
<http://www.eia.gov/todayinenergy/detail.cfm?id=17151>.
- [36] Johnson, N., T. Gagnolet, R. Ralls, and J. Stevens. 2011. *Natural Gas Pipelines: Excerpt from Report 2 of the Pennsylvania Energy Impacts Assessment*.
- [37] Slonecker, E.T., L.E. Milheim, C.M. Roig-Silva, A.R. Malizia, D.A. Marr, and G.B. Fisher. 2012. *Landscape consequences of natural gas extraction in Bradford and Washington Counties, Pennsylvania, 2004-2010*. USGS Open-File Report 2012-1154.<http://pubs.usgs.gov/of/2012/1154/>.
- [38] Philips, Susan. 2015. "Unmapped, unregulated maze of rural pipelines poses hidden risks." *State Impact: A reporting project of NPR member stations*. Aug 04, 2015<https://stateimpact.npr.org/pennsylvania/2015/08/04/unmapped-unregulated-maze-of-rural-pipelines-poses-hidden-risks/>.
- [39] Kiviat, E. 2013. "Risks to biodiversity from hydraulic fracturing for natural gas in the Marcellus and Utica shales." *Ann. N.Y. Acad. Sci.* 1286: 1-14.
- [40] Souther, S., M. W. Tingley, V. D. Popescu, D. T. S. Hayman, M. E. Ryan, T. A. Graves, B. Hartl, and K. Terrell. 2014. "Biotic Impacts of energy development from shale: research priorities and knowledge gaps." *Front. Ecol. Environ.* 12 (6): 330-338.
- [41] Drohan, P., and M. Brittingham. 2012. "Topographic and Soil Constraints to Shale-Gas Development in the Northcentral Appalachians." *Soil Sci. Soc. Am. J.* 76 (5): 1696.
- [42] Kauffman, Gerald. 2011. *Socioeconomic Value of the Delaware River Basin in Delaware, New Jersey, New York, and Pennsylvania* University of Delaware.
<http://www.nj.gov/drbc/library/documents/SocioeconomicValueDRB-UDEL-FinalRpt.pdf>.
- [43] Schueler, Thomas R., Lisa Fraley-McNeal, and K. Cappiella. 2009. "Is Impervious Cover Still Important? Review of Recent Research." *Journal of Hydrologic Engineering* 14 (4): 309-15.
- [44] King, R.S., M.E. Baker, P.F. Kazzyak, and D.E. Weller. 2011. "How novel is too novel? Stream community thresholds at exceptionally low levels of catchment urbanization." *Ecol. Appl.* 21 (5): 1659-78.

- [45] Kidd, K. R., and W.M. Aust. 2014. "Recreational Stream Crossing Effects on Sediment Delivery and Macroinvertebrates in Southwestern Virginia, USA." *Environmental Management* 54: 505-516. doi: 10.1007/s00267-014-0328-5. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3846828.pdf.
- [46] Aust, W.M., M.B. Carroll, M.C. Bolding, and C.A. Dolloff. 2011. "Operational Forest Stream Crossings Effects on Water Quality in the Virginia Piedmont." *South. J. Appl. For.* 35 (3): 123-130. http://www.srs.fs.usda.gov/pubs/ja/2011/ja_2011_aust_001.pdf.
- [47] Vaughan, D.M. 2002. *Potential Impact of Road-Stream Crossings (Culverts) on the Upstream Passage of Aquatic Macroinvertebrates*. The Xerces Society. US Forest Service Report. http://www.fs.fed.us/t-d/programs/eng/projects/aopxing/pdfPubs/xerces_7-02_invert.pdf.
- [48] The Nature Conservancy. 2015. *Reducing Ecological Impacts of Shale Development: Recommended Practices for the Appalachians: Stream Crossings*. <http://www.nature.org/ourinitiatives/regions/northamerica/areas/centralappalachians/recommended-shale-practices-stream-crossings.pdf>.
- [49] Vogt, Peter, Kurt H. Riitters, Christine Estreguil, Jacek Kozak, Timothy G. Wade, and James D. Wickham. 2007. "Mapping spatial patterns with morphological image processing." *Landscape Ecology* 22: 171-177. ArcGIS tool downloaded from: <http://clear.uconn.edu/tools/1ft/1ft2/>.
- [50] Colborn, Theo, Carol Kwiatkowski, Kim Schultz, and Mary Bachran. 2011. "Natural Gas Operations from a Public Health Perspective." *Human and Ecological Risk Assessment: An International Journal* 17 (5): 1039-1056. Accessed 2014/09/15. doi: 10.1080/10807039.2011.605662. <http://dx.doi.org/10.1080/10807039.2011.605662>.
- [51] Macey, G.P., R. Breech, M. Chernaik, C. Cox, D. Larson, D. Thomas, and D.O. Carpenter. 2014. "Air concentrations of volatile compounds near oil and gas production: a community-based exploratory study." *Environmental Health* 13 (82): 1-18.
- [52] McKenzie, Lisa M., Roxana Z. Witter, Lee S. Newman, and John L. Adgate. 2012. "Human health risk assessment of air emissions from development of unconventional natural gas resources." *Science of The Total Environment* 424 (0): 79-87. doi: <http://dx.doi.org/10.1016/j.scitotenv.2012.02.018>.
- [53] US Census Bureau. 2010. Census block data by county. *SF1 100% Data - Profile of General Population and Housing Characteristics*. Spreadsheet document. US Census Bureau, Department of Commerce. <http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t>.
- [54] IHS. Dec 31 2014. Geographic Information Systems Geodatabase. *"US Oil and Gas Pipeline and Facilities Data."*
- [55] US Census Bureau. 2016. "Quick Facts: Pennsylvania." <https://www.census.gov/quickfacts/table/PST045215/42>.
- [56] Colborn, Theo, Kim Schultz, Lucille Herrick, and Carol Kwiatkowski. 2012. "An Exploratory Study of Air Quality Near Natural Gas Operations." *Human and Ecological Risk Assessment: An International Journal* 20 (1): 86-105. Accessed 2014/09/15. doi: 10.1080/10807039.2012.749447.
- [57] Eastern Research Group, and Sage Environmental Consulting. 2011. *City of Fort Worth Natural Gas Air Quality Study*. City of Fort Worth, TX.
- [58] Olague, Eduardo P. 2012. "The potential near-source ozone impacts of upstream oil and gas industry emissions." *Journal of the Air & Waste Management Association* 62 (8): 966-977. doi: 10.1080/10962247.2012.688923.
- [59] Pennsylvania Department of Environmental Protection. "Air Emissions Data from Natural Gas Operations." http://www.dep.pa.gov/Business/Air/BAO/BusinessTopics/Emission/Pages/Marcellus-Inventory.aspx#VtOgu_krLIV.

- [60] Litovitz, A., A. Curtright, S. Abramzon, N. Burger, and C. Samaras. 2013. "Estimation of regional air-quality damages from Marcellus Shale natural gas extraction in Pennsylvania." *Environ. Res. Lett.* 8: 014017.
- [61] Goetz, J. Douglas, Cody Floerchinger, Edward C. Fortner, Joda Wormhoudt, Paola Massoli, W. Berk Knighton, Scott C. Herndon, Charles E. Kolb, Eladio Knipping, Stephanie L. Shaw, and Peter F. DeCarlo. 2015. "Atmospheric Emission Characterization of Marcellus Shale Natural Gas Development Sites." *Environmental Science & Technology* 49 (11): 7012-20.
- [62] Jemielita, T., G.L. Gerton, M. Neidell, S. Chillrud, B. Yan, M. Stute, M. Howarth, P. Saberi, N. Fausti, T.M. Penning, J. Roy, K.J. Propert, and R.A. Panettieri Jr. 2015. "Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates." *PLoS One* 10 (7). doi: 10.1371/journal.pone.0131093. <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0131093>.
- [63] Ahmadi, Mahdi, and Kuruvilla John. 2015. "Statistical evaluation of the impact of shale gas activities on ozone pollution in North Texas." *Sci Total Environ* 536: 457-467.
- [64] Environmental Protection Agency. 2008. "8-Hour Ozone Area Information (2008 Standard)." Green Book Nonattainment Areas. <https://www3.epa.gov/airquality/greenbook/hindex.html>.
- [65] Gallegos, T.J., B.A. Varela, S.S. Haines, and M.A. Engle. 2015. "Hydraulic fracturing water use variability in the United States and potential environmental implications." *Water Resour. Res.* 51 (7): 5839.
- [66] Kondash, A., and A. Vengosh. 2015. "Water Footprint of Hydraulic Fracturing." *Environmental Science & Technology Letters*. doi: <http://dx.doi.org/10.1021/acs.estlett.5b00211>.
- [67] Mantell, M.E. 2011. "Produced water reuse and recycling challenges and opportunities across major shale plays." Unclassified. EPA hydraulic fracturing study technical workshop #4 - water resources management, March 29, 2011. Accessed November 27, 2014. http://www2.epa.gov/sites/production/files/documents/09_Mantell_-_Reuse_508.pdf.
- [68] Jiang, Mohan, Chris T. Hendrickson, and Jeanne M. VanBriesen. 2014. "Life Cycle Water Consumption and Wastewater Generation Impacts of a Marcellus Shale Gas Well." *Environmental Science & Technology* 48: 1911-1920. doi: 10.1021/es4047654.
- [69] Hansen, E., D. Mulvaney, and M. Betcher. 2013. *Water Resource Reporting and Water Footprint from Marcellus Shale Development in West Virginia and Pennsylvania*. Downstream Strategies.
- [70] Richenderfer, J.L., B. Wagner, M.K. Shank, J. Balay, D. Hintz, J. Hoffman, P.B. Ballaron, S. McFeaters, and J. Zimmerman. 2016. *Water Use Associated with Natural Gas Shale Development: An Assessment of Activities Managed by the Susquehanna River Basin Commission July 2008 through December 2013*. Susquehanna River Basin Commission. Publication No. 299.
- [71] Lutz, B. D., A. N. Lewis, and M. W. Doyle. 2013. "Generation, transport, and disposal of wastewater associated with Marcellus Shale gas development." *Water Resour. Res.* 49 (2): 647.
- [72] Caldwell, P., G. Sun, S. McNulty, J.M. Myers, E. Cohen, R. Herring, and E. Martinez. 2013. *WaSSI Ecosystem Services Model Version 2.1 User Guide*. United States Forest Service. <http://www.wassimap.sgcp.ncsu.edu/help/wassiuserguide.pdf>.
- [73] Ferrar, K. J., D. R. Michanowicz, C. L. Christen, N. Mulcahy, S. L. Malone, and R. K. Sharma. 2013. "Assessment of Effluent Contaminants from Three Facilities Discharging Marcellus Shale Wastewater to Surface Waters in Pennsylvania." *Environmental Science & Technology* 47 (7): 3472. <http://pubs.acs.org/doi/abs/10.1021/es301411q>.

- [74] Hammer, R., Jeanne VanBriesen, and L. Levine. 2012. *In Fracking's Wake: New Rules are Needed to Protect Our Health and Environment from Contaminated Wastewater*. Natural Resources Defense Council. 12-05-A.
- [75] Harkness, J., G.S. Dwyer, N. Warner, K.M. Parker, W.A. Mitch, and A. Vengosh. 2015. "Iodide, Bromide, and Ammonium in Hydraulic Fracturing and Oil and Gas Wastewaters: Environmental Implications." *Environmental Science & Technology*. doi: 10.1021/es504654n. <http://pubs.acs.org/doi/abs/10.1021/es504654n>.
- [76] Hladik, M.L., M.J. Focazio, and M. Engle. 2014. "Discharges of produced waters from oil and gas extraction via wastewater treatment plants are sources of disinfection by-products to receiving streams." *Science of the Total Environment* 466-467: 1085-1093. doi: 10.1016/j.scitotenv.2013.08.008.
- [77] Parker, K.M., T. Zeng, J. Harkness, A. Vengosh, and W.A. Mitch. 2014. "Enhanced Formation of Disinfection Byproducts in Shale Gas Wastewater-Impacted Drinking Water Supplies." *Environmental Science & Technology* 48 (19): 11161-11169. doi: 10.1021/es5028184. <http://pubs.acs.org/doi/abs/10.1021/es5028184>.
- [78] Warner, N. R., C. A. Christie, R. B. Jackson, and A. Vengosh. 2013. "Impacts of Shale Gas Wastewater Disposal on Water Quality in Western Pennsylvania." *Environ. Sci. Technol.* 47 (20): 11849. doi: 10.1021/es402165b. <http://pubs.acs.org/doi/abs/10.1021/es402165b>.



CNA

This report was written by CNA's Energy, Water, and Climate (EWC) group within the Safety and Security (SAS) division of the Institute for Public Research (IPR).

EWC provides integrated analysis of energy, water, and climate to gain a better understanding of the implications of their interrelationships and to help develop sound policies and programs to improve energy security, foster efficiency, and increase the likelihood of a secure, climate-friendly energy future.

CNA's Institute for Public Research provides research and analysis to a diverse array of federal, state, and local government agencies, and non-governmental organizations. At CNA, we take a systematic, evidence-based approach to problem solving. We define the problem, collect data through observation and experiment, and formulate and test hypotheses, to deliver *impartial* answers grounded in a thorough understanding of the issues. Read more about our research principles, and see our recent publications at:

<https://www.cna.org/research/>





CNA is a not-for-profit research organization that serves the public interest by providing in-depth analysis and result-oriented solutions to help government leaders choose the best course of action in setting policy and managing operations.

*Nobody gets closer—
to the people, to the data, to the problem.*

The Potential Environmental Impact from Fracking in the Delaware River Basin

Steven Habicht, Lars Hanson and Paul Faeth

August 2015





Acknowledgements: This report was extensively reviewed, so we have quite a few people to thank. They include Michele Adams, Art Berman, Don Cymrot, Kim Deal, Peter Demicco, Kevin Heatley, Robert Howarth, Anthony Ingraffea, Katherine McGrady, Paul Rubin, Gerald Shapiro, and David Vordick. Any errors that remain are our own responsibility. We would also like to recognize our editors, Peter Pavilionis and Andrea Wiltse, as well as our colleagues who helped with production, Veronica Hoban and Cynthia Roberson.

The Delaware Riverkeeper Network provided the funding for this research and we would like to express our thanks for their support.

Authors: Steven Habicht, Lars Hanson and Paul Faeth

This document represents the best opinion of CNA at the time of issue.

Distribution unlimited

Approved by:

August 2015

A handwritten signature in black ink, consisting of a large, stylized initial 'D' followed by a series of loops and a long horizontal stroke extending to the right.

David J. Kaufman, Vice President and Director
Institute for Public Research
Safety and Security Division

Abstract

This study aims to model the landscape of the Marcellus Shale region to predict how it may change in the future in response to the expansion of natural gas extraction, and, in particular, what impact this may have on the Delaware River Basin (DRB). Our approach combined geospatial analysis and statistical modeling to create a probability surface that predicts the most favorable locations for the placement of future wells based on the location of existing wells. Using the probability surface and an estimate of the number of wells that would be needed to fully exploit the shale resource, we estimated the future landscape of development in the Interior Marcellus Shale and DRB. Using affected subwatersheds and counties as study areas, we then investigated potential impacts associated with land cover, water and wastewater management, water quality due to changes in land cover, air emissions, and health risk factors. The results are intended to help decision-makers and the public understand the scale of the potential impacts.

This page intentionally left blank.

Executive Summary

Hydraulic fracturing, or “fracking,” combined with horizontal drilling, has opened up natural gas fields that were previously thought to be inaccessible; however, this activity has the potential to impact the regional environment. To date, there has been no systematic analysis to evaluate multiple impacts of fracking in an integrated way. Published research has predominantly looked at individual environmental impacts associated with fracking in a subset of wells. Few studies have considered multiple impacts, and no study has provided a reasonably complete, integrated regional environmental assessment of fracking. We aim to help fill this knowledge gap and inform the public debate concerning fracking by providing comprehensive, long-term estimates of a set of environmental impacts of natural gas fracking in the Interior Marcellus Shale. This play, which covers parts of Pennsylvania, New York, West Virginia, Maryland, and Ohio, is now considered to be the second-largest gas field in the world.

This research project models the potential natural gas development of the Marcellus Shale to predict what environmental impacts this expansion may have on the Delaware River Basin (DRB). The DRB—which spans Pennsylvania, Delaware, New Jersey, and New York—contains one part of the Interior Marcellus Shale play where fracking has been under a moratorium, by the Delaware River Basin Commission. (The State of New York has separately banned hydraulic fracturing after implementing a five-year moratorium). For this reason, the DRB is a good candidate for a prospective analysis of potential impacts.

Our approach combines geospatial analysis and statistical modeling to create a probability surface that predicts the most favorable locations for the placement of future wells based on the locations of existing wells. Using the probability surface and an estimate of the number of wells that would be needed to fully develop the shale resource, we estimated the future landscape of development across the Interior Marcellus Shale.

We then investigated the potential impacts of this development on land cover, water and wastewater management, water quality, air emissions, and health risk factors in three DRB sub-watersheds. Our calculations were designed to give reasonable upper bounds on each of these potential impacts. Based on our analysis, we offer the following key points to help stakeholders and decision-makers evaluate the potential impacts of natural gas development:

- If the moratoriums on fracking were lifted, there could be as many as 4,000 **wells** fracked in the Interior Marcellus within the DRB in future years, requiring between 500 – 1,000 **well pads**.
- Development of natural gas infrastructure including well pads, and rights-of-way for access roads and natural gas gathering lines, results in 17-23 acres of **land cover disturbance** per well pad. In watersheds we studied, this land cover disturbance could reduce forest cover directly by 1-2 percent, and result in a 5-10 percent reduction in **core forest area**.
- **Water withdrawals** during periods of maximum well development could remove up to 70 percent of water if taken from small streams during low-flow conditions, and less than 3 percent during normal flow conditions.
- Discharge of **wastewater effluent** from fracking could raise in-stream concentrations of some key contaminants (notably barium and strontium) up to 500 percent above reference values during maximum development periods at low-flow conditions, if all wastewater were treated to Pennsylvania effluent standards.
- Land cover conversions could increase **erosion rates** up to 150 percent during the initial development phase and up to 15 percent in a post-development state, despite affecting less than 3 percent of land cover in affected watersheds we studied.
- The installation of multiple **compressor stations** (needed to transport gas away from wells through pipelines) in the DRB could as much as double nitrogen oxide emissions in the impacted counties (compared to present-day, county-wide emissions).
- In the DRB, roughly 45,000 people would live within one mile of the projected well pad locations, a distance that has been related to **health risk factors** in scientific literature. This population would predominantly reside in Wayne County, PA, where nearly 60 percent of the county's population (over 30,000 people) may be affected.

Of these risks, changes to land cover and associated impacts to area forests, hydrology, and water quality appear the most likely to occur and most difficult to mitigate completely. The water and wastewater and air quality risks pose some significant management challenges, but the actual level of impact is uncertain and highly influenced by potential regulation and policy. The health risks require more study because a significant number of people in the Upper Delaware River Basin live in areas that are close to potential well locations.

This report presents an estimate of full natural gas development based on technically recoverable resources in the Interior Marcellus Shale play, and focuses on some of the locations where concentrated development can reasonably be expected in the DRB portion of the play (if development were allowed). As such, the well development projections and associated impact calculations likely would be a conservative (high-end) estimate of potential development or impacts. Actual development will ultimately depend on laws and regulations, ability to sign leases, ability to recover gas, and economics (price of gas, cost of production, well productivity, etc.). While regulatory, economic, and other factors may limit the actual level of development, policymakers should be prepared to handle the impacts from a scenario in which the shale resources could be fully developed.

This study only investigates the Interior Marcellus shale play, and does not consider other shale plays underlying the DRB such as the Utica Shale. This study does not examine the full range of potential impact categories that the region may experience, does not consider all potential impact pathways (e.g. accidental wastewater discharges), and it does not project possible environmental and human health outcomes based on the impacts.

This page intentionally left blank.

Contents

Introduction.....	1
Understanding this report.....	3
Potential Natural Gas Development in the Marcellus Shale	7
Key Findings	7
Model Variables	8
Well-Location Modeling.....	9
Development Scenarios.....	10
Results and Study Area Selection	13
Discussion.....	15
Impacts on Land Cover.....	17
Key Findings	17
Methodology.....	19
Results	20
Infrastructure Modeling.....	20
Land Cover Disturbance	22
Forest Fragmentation.....	24
Discussion.....	25
Impacts on Water and Wastewater Management.....	27
Key Findings	27
Methodology.....	29
Results	31
Water Use and Wastewater Generated.....	31
Wastewater Pollutant Loadings	37
Discussion.....	42
Impacts on Water Quality due to Changes in Land Cover	45
Key Findings	45
Methodology.....	46
Results	48

Discussion.....	51
Impacts on Air Quality	53
Key Findings	53
Methodology.....	54
Results	56
Criteria Pollutant Emissions	56
Methane Emissions	59
Discussion.....	60
Health Risks and Affected Population.....	63
Key Findings	63
Methodology.....	67
Results	69
Discussion.....	71
Conclusions	73
Appendix A: Chemicals in Natural Gas Wastewaters	77
Appendix B: Stream Gages	81
References.....	84

List of Figures

Figure 1.	The extent of the Marcellus Shale play and the Delaware River Basin	3
Figure 2.	Map depicting the Maxent probability surface for the Interior Marcellus Shale.....	10
Figure 3.	Map depicting the number of <i>new</i> well pads that could be developed in each county based on the “dispersed” scenario (15,853) if fracking were allowed across the whole Marcellus.....	12
Figure 4.	Potential locations for new well pads in the DRB, based on the “dispersed” scenario.	14
Figure 5.	Imagery depicting several existing well pads and associated infrastructure rights-of-way in Susquehanna County, PA.....	18
Figure 6.	Projected gathering pipeline and access road development needed to support well pad development..	21
Figure 7.	Breakdown of potential land cover disturbance from natural gas development in each DRB study area, broken out by scenario (“dispersed” or “concentrated”).....	23
Figure 8.	Percent-change in forest cover and type (core vs. edge) from infrastructure development in the DRB study areas, broken out by scenario (“dispersed” and “concentrated”).	24
Figure 9.	The fracking water cycle.	28
Figure 10.	Sankey diagram of water volumes for the fracking water and wastewater management cycle estimated for this study, on a per well basis.	31
Figure 11.	Flow schematic for the Upper DRB, showing locations of study areas and reference gages.....	34
Figure 12.	Withdrawals as percent of available streamflow for selected flow metrics, maximum-year development scenario.....	35
Figure 13.	Withdrawals as percent of available streamflow versus flow percentile, small stream gages, maximum-year development scenario.....	36
Figure 14.	Barium concentration increase versus flow percentile at time of effluent discharge.....	42
Figure 15.	Total upland erosion plus sediment loading, as percent of the baseline loading.	49
Figure 16.	Monthly variation in erosion relative to the baseline condition for both the Initial Infrastructure and Post-Development condition.....	50

Figure 17.	Pollutant emissions from well development (and one compressor station) for average-year (left) and maximum-year (right) scenarios, relative to total county emissions from the 2011 NEI	57
Figure 18.	Pollutant emissions from well development (and 22 compressor stations) for average-year (left) and maximum-year (right) scenarios, relative to total county emissions from 2011 NEI.....	59
Figure 19.	Map of the 0.5-mile and 1-mile buffers around well pads superimposed on county and study area boundaries.....	68
Figure 20.	Population within several radii common to health-assessment literature.....	70
Figure 21.	Wayne County residential structures within x distance (ft) of a well pad (total and percent of all county residential structures).....	71

List of Tables

Table 1.	Chapter breakdowns of analysis in this report.....	5
Table 2.	Scenarios used to project well pad development in the Marcellus Shale.	11
Table 3.	Projected natural gas development in the DRB, broken down by development scenario and assessment units	15
Table 4.	Projected infrastructure (gathering pipelines and access roads) needed to support natural gas development in the three study areas.	22
Table 5.	Projected rates of well development, water use, withdrawal, wastewater generation, and effluent for disposal, by study area and scenario.....	33
Table 6.	Wastewater concentrations of key contaminants in flowback and brine wastewater.....	38
Table 7.	Potential average daily loadings of key contaminants from all flowback and brine wastewater and from treated effluent	39
Table 8.	Increase in concentration of pollutants caused by maximum-year effluent discharge during the 20 percent-flow condition	41
Table 9.	Changes in hydrology and loadings for each scenario.....	48
Table 10.	Annual emissions estimates for projected natural gas development by county (and for one compressor station) in the DRB.	56
Table 11.	Potential methane emissions from projected development in the DRB, based on methane leakage rates reported from field measurement (top-down) studies.....	60
Table 12.	Health risk factors and impacts cited in literature, versus distance from gas development activities.	66
Table 13.	Area within 0.5 mile and 1 mile well pad buffer, by county.	69
Table 14.	Pollutants measured in natural gas wastewaters.....	78
Table 15.	USGS stream gages used in this study.	81
Table 16.	Daily flow statistics for the stream gages used in this study	82

This page intentionally left blank.

Glossary

Ba	Barium
Bcf	billion cubic feet
BMP	Best Management Practice
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CO ₂	carbon dioxide
Cl	Chloride
DRB	Delaware River Basin
DRBC	Delaware River Basin Commission
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
ESRI	Environmental Systems Research Institute
EUR	Estimated Ultimate Recovery
GIS	geographic information system
GW	groundwater
HUC	hydrologic unit code
JAS	July-August-September
Maxent	maximum entropy (modeling technique)
MGD	million gallons per day
NEI	National Emissions Inventory
NLCD	National Land Cover Dataset
NO _x	nitrogen oxides
PADEP	Pennsylvania Department of Environmental Protection
PAH	polycyclic aromatic hydrocarbon
PM	particulate matter
SO _x	sulfur oxides
SO ₄	sulfate
Sr	Strontium
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
TN	Total Nitrogen
TP	Total Phosphorus
UNGD	unconventional natural gas development
USGS	U.S. Geological Survey
VOC	volatile organic compound
WW	wastewater

This page intentionally left blank.

Introduction

Hydraulic fracturing, or “fracking,” combined with horizontal drilling, has allowed access to natural gas in shale deposits previously thought to be inaccessible. This type of unconventional natural gas development (UNGD) has significant implications for energy supplies and fuel choice in the American economy. For the first time in 30 years, coal’s share of power generation dipped below 40 percent in 2012, while gas’s share increased. Leading this charge is the Marcellus Shale play, which currently accounts for almost 40 percent of U.S. natural gas production and is projected to increase [1]. This play, which covers parts of Pennsylvania, New York, West Virginia, Maryland, and Ohio, is now considered to be the second-largest gas field in the world.

While these newly accessible resources are transforming the nation’s energy economy, the fracking process carries a potential environmental burden in the nature and scale of the extraction activities involved—particularly well development [2-7]. The amount of water required to fracture a well typically varies from one to five million gallons (but can be more depending on well-specific conditions). Much of the water that is tapped to inject into the wells contains a variety of chemicals and additives to aid in fracturing the shale rock. About 80 percent of the injected water is consumed by the process (i.e., remains underground), and the “produced water” that returns to the surface must be handled as required by environmental law. The nature of well pad development has raised concerns over soil erosion, sedimentation/siltation, and eutrophication of nearby streams, as well as ecosystem fragmentation. Local air quality could suffer from increased ozone creation, the release of volatile organic compounds and toxic chemicals, greenhouse gas emissions from fugitive methane releases, and increased airborne particulates from extensive diesel engine use. These are potential environmentally hazardous byproducts of the fracking process itself.

While recent years have seen a significant increase in the peer-reviewed literature on the various impacts of fracking, substantive data gaps remain [8]. To date, there has been no systematic analysis to evaluate the multiple, integrated impacts of fracking. Published research has looked predominantly at individual environmental impacts associated with fracking in a subset of wells. Few studies have considered multiple impacts, and no study has provided a reasonably complete, regionally integrated environmental assessment of fracking, or developed the methodology to do so. Thus, even with more information, regulators are left attempting to extrapolate study

results to their region to assess impacts—and at a time of shrinking government budgets and resources.

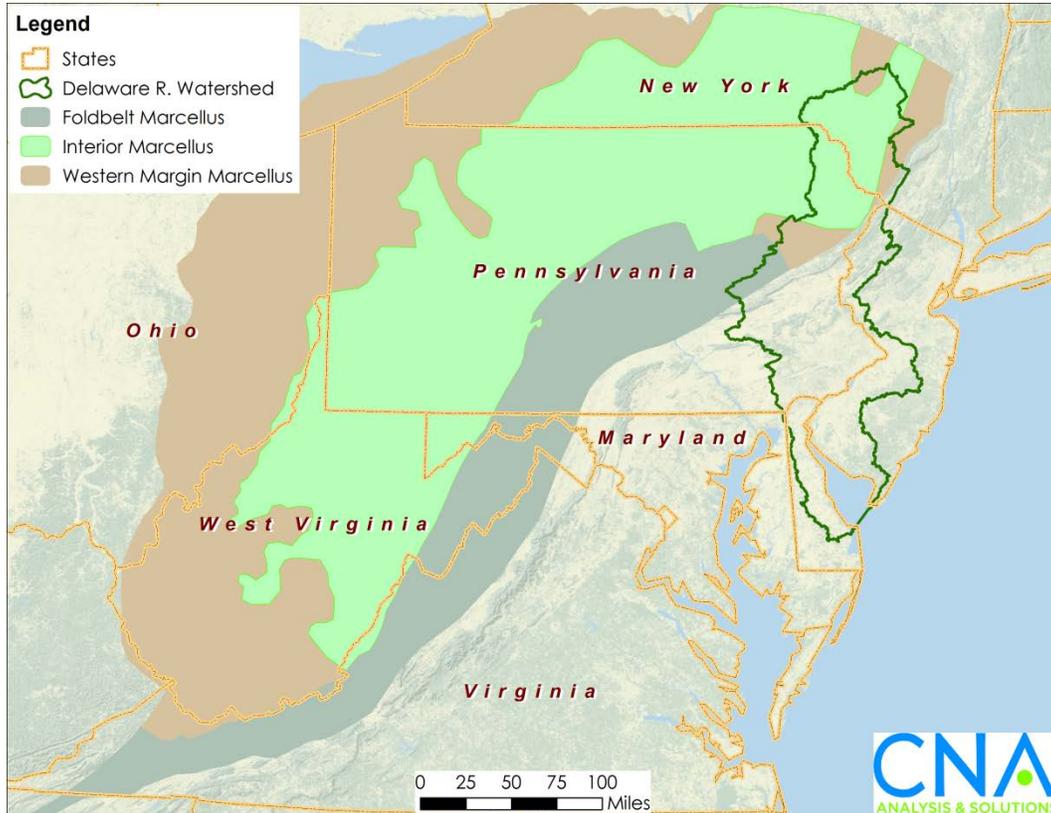
One of the primary barriers to conducting this type of research is the difficulty in predicting where future natural gas wells will be located. For example, in a recent report to Congress, the U.S. Government Accountability Office stated, “The risks identified in the studies and publications we reviewed cannot, at present, be quantified, and the magnitude of potential adverse effects or likelihood of occurrence cannot be determined for several reasons. First, it is difficult to predict how many and where shale oil and gas wells may be constructed” [9]. With this report, our objective is to correct this critical deficiency in the research.

The Delaware River Basin (DRB)—which spans Pennsylvania, Delaware, New Jersey, and New York—contains one part of the Marcellus Shale play that has not been developed (see Figure 1 on the following page); therefore, it is a good candidate for a prospective analysis of potential impacts. Due to state and regional regulation, gas development is currently limited in the DRB. The State of New York recently announced a ban on hydraulic fracturing after investigating its impacts during a five-year moratorium on the practice. Similarly, in the Pennsylvania portion of the basin, no hydraulic fracturing has occurred because the Delaware River Basin Commission (DRBC) has had a moratorium in place on the practice for some years. In this analysis, we investigate a hypothetical case where no moratorium prevents development.

Furthermore, this analysis focuses on the Interior Marcellus, which is most suitable for gas development with hydraulic fracturing. The Western Margin Marcellus is generally less than 50 feet thick, and the Foldbelt Marcellus shows the extent of the shale formation, but is generally not thought to be deep enough or thick enough for development.

In this report, we summarize the methodology to identify the probable placement and extent of future wells in the DRB region of the Interior Marcellus Shale through the statistical evaluation of existing well locations in the play. We then demonstrate the utility of the well-development projections to evaluate a variety of potential environmental impacts to some subwatersheds of the DRB. These impacts include land cover disturbance, including forest fragmentation; issues related to water and wastewater management; water quality issues resulting from changes to land cover; air quality issues; and affected population. Each chapter of the report examines one of these impacts in the context of existing basin conditions, as well as relevant activities where appropriate, for framing of results.

Figure 1. The extent of the Marcellus Shale play and the Delaware River Basin. This study focuses on the Interior Marcellus.



Source: U.S. Geological Survey (Marcellus, DRB), U.S. National Park Service (Terrain Basemap)

Understanding this report

This report presents an estimate of full natural gas development (based on technically recoverable resources) in the Marcellus Shale play, and focuses on some of the locations where concentrated development can reasonably be expected in the Delaware River Basin portion of the play. As such, the development projections and associated impact calculations likely would be a conservative (high-end) estimate of potential development or impacts. Actual development will ultimately depend on laws and regulations, ability to sign leases, ability to recover gas, and economics (price of gas, cost of production, well productivity, etc.). Like the projections for well pad development, we calculated potential impacts using several scenarios to give reasonable upper bounds of potential impacts. While regulatory, economic, and other factors may limit the actual level of development, policymakers should be prepared

to handle the impacts from a scenario in which the shale resources could be fully developed.

We project locations to calculate impacts, but they should *not* be interpreted as explicit *predictions* of where wells will actually go. Although high-resolution spatial data allows fairly precise well pad siting, this analysis is most useful for identifying which portions of the Marcellus Shale may be most suitable for development (relative to all the others). Actual locations of wells depend on many site-specific factors, not the least of which is a legal lease contract to perform drilling on a property. Furthermore, the projected well pad locations should not be used to estimate impacts at small scales, such as for individual parcels or neighborhoods.

Instead, the level of impacts estimated in this report should be viewed as a first iteration of investigating a range of potential impacts. While the impacts selected cover a broad range of topics, there are other potential impacts that are not covered here (e.g. truck traffic, long-range transmission pipelines, or induced seismicity). The selected impacts in this report are suited to analysis using the well pad projections; are documented in peer-reviewed literature; and are likely to occur, given current trends in the development of the gas sector. We present each potential impact in its own chapter with its own analysis, though all depend on the projections of wells and well pads. Furthermore, this report only examined the potential for development of wells and well pads in the portion of the Marcellus Shale play that underlies the DRB; there are other shale formations (e.g., the Utica Shale and Newark Basin) that lie beneath that DRB that were not considered in our projections.

We selected study areas, scenarios, and analysis methods to investigate the range of outcomes associated with each impact category. Table 1 outlines the assessment unit, development scenarios, and additional analysis scenarios for each section. The assessment unit is the geographic area under consideration. For land- and water-related impacts, we used the drainage areas of defined subwatersheds in the basin with extensive projected gas development. For impacts to air quality and human health, we used counties as study areas.

We generated projections for well development for two well pad-density scenarios: a *concentrated* scenario (eight wells per pad = fewer well pads) and a *dispersed* scenario (four wells per pad = more well pads). The land cover changes, water quality issues from land cover changes, and health risk are all related to the development of well pads (and associated infrastructure). By contrast, the water/wastewater and air quality impacts depend primarily on the number of wells. Since the number of wells is approximately equal for the scenarios, the well pad density is not important when analyzing these impacts and only one scenario was selected. The water and wastewater management chapter used the “concentrated” scenario because slightly more wells were developed in the assessment units being considered than for the “dispersed” scenario.

Furthermore, each chapter’s topic required additional analysis dimensions particular to the impact to capture the potential consequences. For example, water/wastewater and air quality results depend on the rate of well development per year, so we investigated scenarios for average yearly development and for maximum development within a year. The water quality impacts associated with land cover disturbance vary over time, such as during initial infrastructure construction or after infrastructure is built and the gas wells are in production. Finally, we investigated the affected population affected at six different distances from the nearest well pad, which academic literature uses in evaluating certain health risk factors as a function of distance from the well pad.

Table 1. Chapter breakdowns of analysis in this report. Land cover and water impacts were considered at the drainage basin level; air and health impacts were considered at the county level.

Report Chapter Topic	Assessment Unit	Development Scenarios	Additional Analysis Dimensions
Land Cover Changes	Drainage basin 	Both	<ul style="list-style-type: none"> • Direct Conversion • Forest Fragmentation
Water and Wastewater Management	Drainage basin 	<i>Concentrated</i>	<ul style="list-style-type: none"> • Average Dev. • Maximum-Year Dev. • Wastewater reuse
Water Quality	Drainage basin 	Both	<ul style="list-style-type: none"> • Initial Infrastructure • Post-Development
Air Quality	County 	<i>Dispersed</i>	<ul style="list-style-type: none"> • Average Dev. • Maximum-Year Dev.
Health Risks and Affected Population	County 	Both	<ul style="list-style-type: none"> • Six distances from well pad

This page intentionally left blank.

Potential Natural Gas Development in the Marcellus Shale

Key Findings

- Based on Energy Information Administration resource estimates for technically recoverable reserves, the Interior Marcellus could see an additional 63,000 wells developed in the future. Our analysis did not include other portions of the Marcellus, or other shale plays in the region.
- Most of the future development in the Interior Marcellus would be expected in Pennsylvania (74 percent), followed by West Virginia (19 percent), New York (4 percent), Ohio (2 percent), and Maryland (1 percent), assuming no moratoriums throughout the Marcellus region.
- Eleven counties in Pennsylvania could each see development of over 2,000 additional new wells, including Wayne County in the DRB.
- Were the moratoriums in the DRB lifted, there could be approximately 4,000 wells at full development of the Interior Marcellus. This number of wells would require 500 – 1,000 well pads depending on the number of wells per well pad.

This chapter presents the current landscape of the Marcellus Shale play in order to predict how the landscape may change in the future in response to the expansion of natural gas extraction. In particular, we focus on the potential development in the Interior Marcellus Shale Assessment Unit (see Figure 1 on page 3), since 95 percent of the shale's reserves are estimated to fall within this boundary [10], and 98 percent of the new wells developed in the region since 2011 have been within this boundary. We then focus our analysis to determine where this development would most likely extend into the Delaware River Basin if the moratoriums on drilling were lifted.

To predict the most likely locations for the placement of future wells, we used an approach combining geospatial analysis and maximum entropy (Maxent) modeling. This approach is commonly used in ecological sciences to predict the most probable

distribution of species based on the environmental conditions of their known habitat [11-13]. This approach has also been used previously to predict the location of future well pad sites in Pennsylvania's Marcellus Shale play [14] to assess the impacts of habitat disturbance. We expand the use of this model here to the entire Interior Marcellus Shale region to project where natural gas development may occur at full development of the shale play.

Model Variables

For this research, we used geographic information system (GIS) tools (Environmental Systems Research Institute [ESRI] ArcGIS 10.2) to process a variety of environmental variable layers that are known to be relevant in the siting of natural gas well pads [15]. These layers are based on the best available data and include characteristics of the shale, itself, and characteristics of the states' landscapes, such as the terrain and infrastructure:

- **Shale characteristics** provide insight into the amount of natural gas that may be present. The layers depicting the depth and thickness of the Marcellus Shale we used for this analysis were developed by the Penn State Marcellus Center for Outreach and Research [16]. Shale thermal maturity was based on the work of Wrightstone [15] and was obtained from Rystad Energy [17].
- **Land cover and slope variables**, which outline the terrain of the region, can help to gauge the relative effort required when developing a well pad. We used the National Land Cover Dataset (NLCD) [18] as the land cover variable layer. We created the slope layer from the USGS 30-meter national elevation dataset [19] using the "Slope" tool in ArcGIS.
- **Distance variables** represent the importance of a well pad's proximity to critical infrastructure that supports the extraction process. We used geospatial pipeline data from IHS Energy [20] and geospatial road data (primary and secondary roads only) from the U.S. Census Bureau [21] to represent infrastructure. We then used the Distance tools in ArcGIS to create the distance variable layers.

All layers were sampled to 30 meters and formatted for the Maxent application by using the "Extract by Mask" tool in ArcGIS to align all layers to the Interior Marcellus boundary.

We used the coordinates for wells drilled in the Marcellus Shale between 2005 and 2013 (from Rystad Energy [17]) as inputs for the model, amounting to about 8,000 well locations. We then used the well locations to estimate the number of unique well pad locations as inputs for the Maxent model, since multiple wells can be drilled on a

single well pad. We accomplished this by placing a 50-meter buffer around each well and taking the center point of any overlapping buffers as the pad location, resulting in approximately 3,600 unique pad locations.

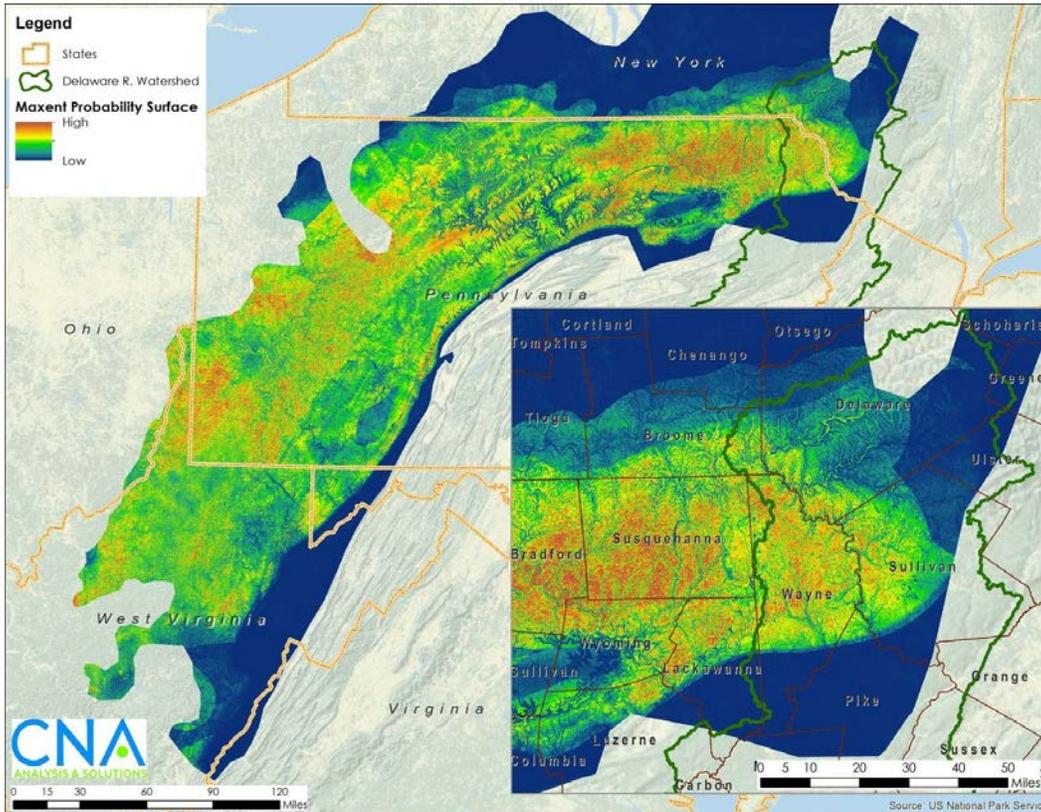
Well-Location Modeling

We input the well pad locations and environmental layers into the Maxent modeling application (Version 3.3.3k [22]) to evaluate the layer values at each of the locations. Maxent uses the characteristics of the environmental layers at existing well locations to develop a scoring model, which translates these layer characteristics into a probability model for future locations. From the 3,600 locations that we input into the program, about 2,900 were randomly chosen to build the model; the remaining locations were used to validate the model. The program produced a probability surface that depicted the most probable locations for well pads. We analyzed the probability surface using ArcGIS to evaluate the extent of potential natural gas development in the region.

To begin the study, we examined the full extent of the Interior Marcellus. There are other shale plays in the region, but we did not consider them in this analysis. Figure 2 shows the probability surface generated by the Maxent program. This analysis is based on physical parameters only and assumes no regulatory or economic constraints. The surface has 30-meter resolution and uses a color scheme to depict the suitability of the region for development based on the environmental variables, with “cooler” colors denoting areas with a lower probability of development, and “warmer” colors denoting those with a higher probability of development. Evaluation of the surface shows two distinct areas with a concentrated high probability of development: one in the northeast region of Pennsylvania (around Tioga, Bradford, and Susquehanna Counties), and the other in the southwest region of the state (around the Pittsburgh area). These two areas are consistent with a majority of the shale gas development seen in the region.

The probability surface also shows potential in Wayne County in northeast Pennsylvania, as well as some parts of Broome, Delaware, and Sullivan Counties in New York along the NY-PA border. No development has occurred in these areas, as they are under moratoriums put in place by the DRBC and New York State. Following examination of the full probability surface, we focused on these areas of the Interior Marcellus Shale that fall within the Delaware River Basin (Figure 2, inset).

Figure 2. Map depicting the Maxent probability surface for the Interior Marcellus Shale. The northeastern and the southwestern parts of Pennsylvania have the highest probability of future development. Some drilling could occur within the Delaware River Basin if the moratoriums were lifted.



Source: U.S. National Park Service (Terrain Basemap)

Development Scenarios

To determine the number of wells that would be needed to fully develop the Marcellus Shale, we used the U.S. Energy Information Administration’s (EIA’s) estimate [10] of technically recoverable resources: 113.9 trillion cubic feet for the Interior Marcellus, divided by the EIA average total production per well (Estimated Ultimate Recovery [EUR] of 1.6 billion cubic feet [Bcf] per well). We subtracted the number of existing Marcellus wells from this total to get the number of new wells expected, which is over 63,000. We then developed two scenarios to model how well pads may be developed throughout the region to accommodate these new wells. The scenario names, referring to well pad distribution across the landscape, are as follows:

- **Dispersed:** Development of four wells per pad (more well pads built)
- **Concentrated:** Development of eight wells per pad (fewer well pads built)

Table 2 shows the number of well pads associated with each scenario. For this research, we assumed that new well pads would be built to accommodate each new set of wells. These scenarios and estimates are in line with trends in the industry. Currently, Marcellus Shale well pads average a bit less than three wells, though the trend in this region is toward more wells per pad, and there have been pads here with up to 19 wells drilled. These scenarios likely bracket the expected range of average wells per pad in the future.

Table 2. Scenarios used to project well pad development in the Marcellus Shale. Each scenario has the same number of wells, but the “concentrated” scenario has half as many well pads and twice the spacing between the pads.

Scenario	Total Wells	Wells Per Pad	Well Pads	Spacing ^a
Dispersed	63,412	4	15,853	367 acres
Concentrated	63,412	8	7,926	735 acres

^a Spacing was based on an estimated drainage area for each well pad and calculated by extending half of the well laterals in one direction, and the other half 180 degrees in the opposite direction. We assumed a 4,000-foot lateral length and 500 feet of spacing between laterals.

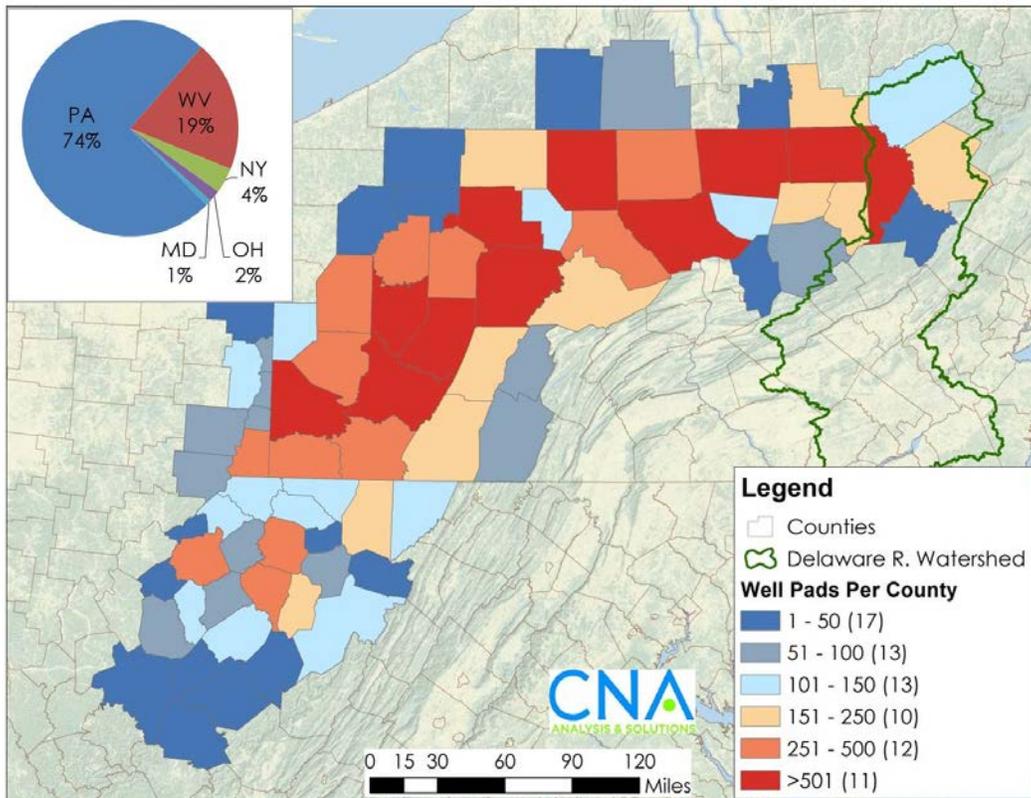
After developing the probability surface and scenarios, we devised a methodology to analyze the probability surface and choose the most likely locations for natural gas well pads. First, we used GIS tools to exclude areas in the probability map that would most likely be prohibited from development (e.g., existing well pad locations, wetlands, flood plains, and additional areas based on setbacks from streams, reservoirs, and buildings).

Next, we used a combination of spatial averaging and exclusion techniques in ArcGIS to ensure that well pads were sited over “hotspots” on the Maxent surface, and that well pads had adequate spacing (see Table 2) to prevent overlapping laterals. When completed, this analysis produced a distribution of unique cells on the Maxent best suited to well pads across the Marcellus Shale. For example, for the “dispersed” scenario, we selected the top 15,853 well pad locations as measured by Maxent values. These locations were converted to a set of points representing well pad locations across the Marcellus Shale that could be used for further analysis. By focusing on the locations within the DRB, we can begin to understand the scope of shale gas development if the moratoriums were lifted.

Based on the “dispersed” scenario, Figure 3 shows a breakdown of the number of well pads projected from future development in each county throughout the

Marcellus Shale. The inset for this figure also shows the aggregate percent total of well pads expected in each state overlaying the Marcellus. As expected, we see a majority of potential future development (74 percent) occurring in Pennsylvania, based on both the favorable conditions for development and the fact that a majority of the Marcellus Shale is found under the state. Furthermore, all 11 of the highest developed counties (>500 well pads) are located within Pennsylvania. The highest number of wells we found in a county is about 2,900 in Washington County.

Figure 3. Map depicting the number of *new* well pads that could be developed in each county based on the “dispersed” scenario (15,853) if fracking were allowed across the whole Marcellus. Inset shows the breakdown of new well pads by state. Eleven counties in Pennsylvania are likely to experience the most shale gas development, including Wayne County, PA, in the DRB.



Source: U.S. National Park Service (Terrain Basemap)

Results and Study Area Selection

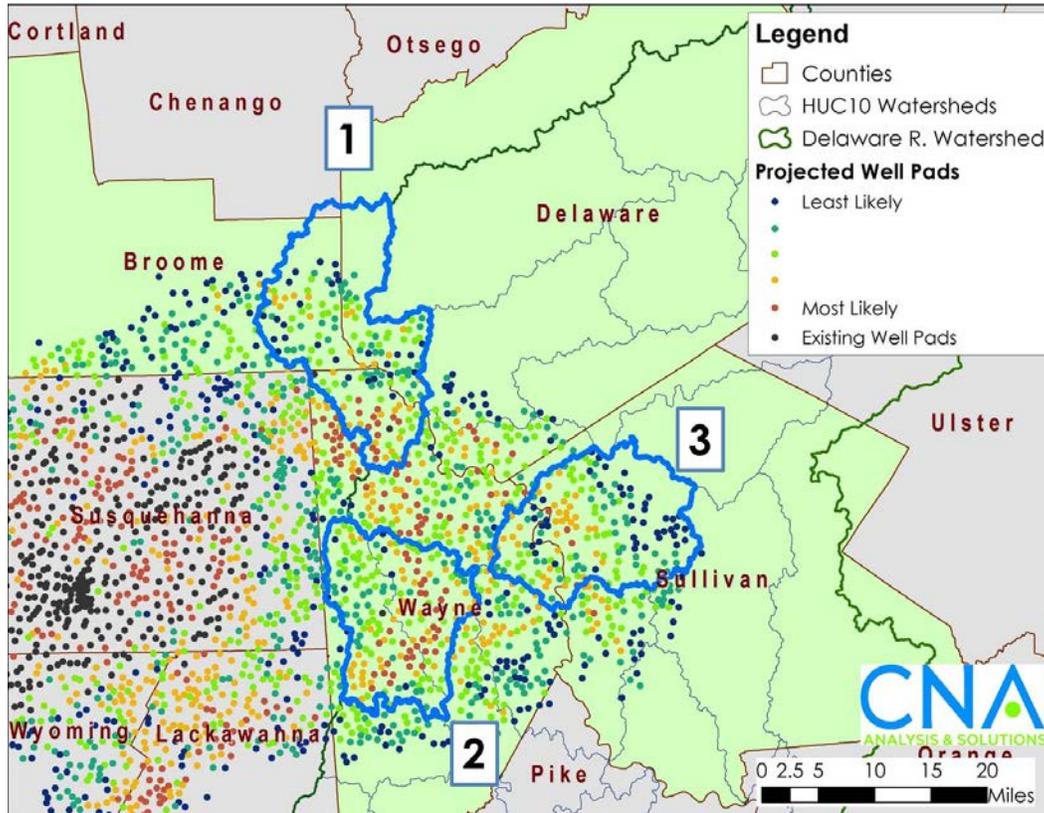
Figure 4 shows an expanded view of the potential landscape of natural gas development in the DRB, based on our development projection using the “dispersed” scenario. The well pads are color-coded according to their potential for development, again using the warm-to-cool scale to indicate most to least likely. Based on this modeling, the DRB potentially could see 500 (“concentrated” scenario) to 1,000 (“dispersed” scenario) well pads (or about 4,000 wells) developed were the moratoriums to be lifted. In either scenario, we expect that a majority of the development within the DRB would occur in Wayne County, PA.

We chose three study areas within the DRB to localize our assessment of potential water-related impacts to the environment. Each study area is based on the USGS hydrologic unit code (HUC)-10 watershed boundaries and is approximately 160-210 square miles in size. (For reference, the city limits of Philadelphia cover an area of 143 square miles.) The study areas are highlighted in Figure 4 and cover areas in both New York and Pennsylvania that would most likely be impacted by development. We will reference these study areas throughout the following chapters when evaluating each of the different impacts. Study Area 1 includes portions of Broome (NY), Delaware (NY), and Wayne Counties (PA), and is just downstream of the Cannonsville Dam. Study Area 2 includes two adjacent HUC-10s in Wayne County. Study Area 3 is primarily in Sullivan County, NY.¹

¹ The USGS 10-digit Hydrologic Unit Codes for these areas are as follows:

Study Area 1 - 0204010103; Study Area 2 - 0204010301 and 0204010302;
Study Area 3 - 0204010105.

Figure 4. Potential locations for new well pads in the DRB, based on the “dispersed” scenario. We chose from three study areas (blue outline) or four counties (green fill) as assessment units for further analysis.



For each of the following chapters, we chose assessment units (i.e., drainage areas or counties) best suited to quantify and describe the extent of impacts that may be expected (see Table 1). For land- and water-related impacts, we used the drainage areas of defined subwatersheds in the DRB. For impacts to air quality and human health, we used county boundaries. Table 3 shows the extent of natural gas development in the DRB that our methodology projects, broken down by these different assessment units for reference throughout the report.

Table 3. Projected natural gas development in the DRB, broken down by development scenario and assessment units. Of the four impacted counties in the DRB, Wayne County, PA is projected to experience the most development.

Assessment Unit	Area (sq mi)	Dispersed Scenario		Concentrated Scenario	
		Well Pads	Wells	Well Pads	Wells
Study Area 1	212	162	648	90	720
Study Area 2	162	191	764	93	744
Study Area 3	178	170	680	79	632
Wayne Co., PA ^a	751	590	2,360	303	2,424
Broome Co., NY ^a	715	58	232	34	272
Delaware Co., NY	1,468	204	816	93	744
Sullivan Co., NY	997	123	492	67	536
DRB Total	3,150 ^b	975	3,900	497	3,976

^a These numbers reflect only the portion of expected development that would fall within the DRB; Wayne Co., PA, and Broome Co., NY, could see development outside of the DRB.

^b This area represents the portion of the DRB that lies above the Interior Marcellus. Roughly one-third of this area has projected well pad development.

Discussion

Our results depict a model of potential development in the Interior Marcellus Shale—and particularly in the DRB—assuming full exploitation of the Shale’s technically recoverable resources (as estimated by the EIA). Our goal with this model was to provide a projection and spatial context to this development in order to evaluate what environmental impacts it could have on the basin (assuming drilling was allowed to proceed). Given the importance of shale characteristics to the model, the use of additional variables (e.g., total organic carbon, or the inclusion of potentially more-accurate proprietary data) could lead to a different projection.

We estimate that about 4,000 wells could be drilled in the Marcellus Shale within the DRB. This projection falls within a wide range of other published and unpublished estimates of well development in this region. For example, the National Park Service used the overlap of the Marcellus Shale and DRB boundaries with some spacing and exclusion assumptions to arrive at an estimate of 16,000 to 32,000 wells that could be drilled in the DRB [23]. Kaufman and Homsey estimated the amount of gas that could be produced in the DRB by using estimates of reserves and excluding lands based on proposed regulations to assess the economic value of shale gas development in the region [24]. Their results indicate an estimate of approximately 2,500 wells drilled in the DRB (based on their production estimates for the DRB and applying our assumption that wells have an EUR of 1.6 Bcf), a number in fair agreement with our projections. The Nature Conservancy used a similar methodology to ours to project the location of potential wells in Pennsylvania, which we estimate

from their report includes approximately 350 wells drilled in Wayne County, PA [14]. While this estimate is noticeably lower than ours (we project approximately 2,600 wells in Wayne County), the authors did add a caveat that their results may have underestimated Wayne County, based on comments from reviewers. Berman and Pittinger recently estimated potential development in New York based on well production data in Pennsylvania [25]. Their results indicate that although Broome County could see the most development in New York, this development would be focused mostly on the western to central portion of the county, with little apparent development in the DRB portion. The study also estimates no development in Delaware and Sullivan Counties (NY), in contrast with our results. The authors do state that the lack of well-production data in New York (due to the moratorium) does add uncertainty to this area. These studies demonstrate the variation in potential for well development in the region, and the results of our study fall within the range of well development that the previous studies have found .

Impacts on Land Cover

Key Findings

- We analyzed land cover changes in three study watersheds with extensive projected gas development. Land converted for each well pad, including the pad itself, access roads and the rights-of-way for gathering pipelines, would directly impact 17-23 acres per well pad. Gathering pipelines account for 75 percent of this area.
- Gas infrastructure could directly convert 2–3 percent of the land in areas affected by fracking, with most of the impacted area made up of agricultural land and forests.
- Shale gas development could lead to a 1–2 percent loss of total forest land in impacted DRB watersheds that we studied, and between 5 and 10-percent loss of core forest.
- The total area of land disturbed in the DRB at the completion of gas development in the Interior Marcellus could be 18 – 26 square miles. This is about the same area as 570 to 840 Wal-Mart Supercenters including their parking lots.

When assessing the environmental impacts of natural gas development, one of the most unavoidable aspects of such development is the impact to land cover. A typical well pad may cover 3–5 acres of land to support the fracking process, which includes the well site, itself, and room for supporting equipment, such as drilling equipment, water impoundments, quarries, temporary construction areas, and truck parking [2, 14, 26]. The well pad site is typically cleared of any previous land cover to produce a barren surface to support the extraction activities. In addition to the well pad, development of land to support natural gas extraction requires access roads to the site and gathering or feeder pipelines to transport the extracted gas from the site to the existing transmission infrastructure [27-30]. Figure 5 shows an example of this development in Susquehanna County, PA. Development of this supporting infrastructure requires clearing land not only for the infrastructure, itself, but also

for the accompanying right-of-way to accommodate construction equipment and future maintenance. The resulting land disturbance from this development can present both short- and long-term risks to the use of the land, depending on the remediation and reclamation procedures used [26, 31]. Furthermore, the design and practices used by pipelines and roads to cross streams and wetlands can adversely impact the health of these ecosystems by altering channel geomorphology and restricting the movement of fish and wildlife [32-33].

Figure 5. Imagery depicting several existing well pads and associated infrastructure rights-of-way in Susquehanna County, PA. This provides an example of the potential footprint associated with natural gas development.



Source: ESRI World Imagery Layer from ArcGIS Online (ESRI, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community)

One particular issue associated with the development activities from natural gas extraction in the Marcellus Shale is the impact on forests [14, 27-28, 31]. The portion of the DRB that lies above the Marcellus Shale includes over two million acres of forest, and forested land is the dominant land cover in each of our three study areas (approximately 65,000–110,000 acres each, which is more than 50 percent of each study area). This dense forest cover provides the region with a variety of ecosystem

services, such as carbon sequestration, clean air, aquifer recharge, and recreation/eco-tourism. These services are in addition to the key role that forests play in maintaining the water quality of the Delaware River, which supplies drinking water to over 17 million people [24].

Furthermore, forest cover in the region is home to a variety of different plant and animal species that rely on the forest for their habitat. Forest habitats are divided into two primary classes: edge and core forest. Edge forest is generally described as the area that is adjacent to the non-forest area, extending inward approximately 300 feet (or 100 meters) [27-28]. The edge transition from non-forest to forest area creates a habitat that tends to favor generalist species over rare or vulnerable species, and an increase of edge forest can promote the spread of invasive species [31].

To assess the potential land cover impacts on the DRB from natural gas development, we combined our above projections of natural gas development in the watershed with a suite of GIS tools and methodology. We first used least-cost path-optimization to model the extent of potential infrastructure (gathering pipelines and access roads) that could be developed to support these well pads in the DRB. We did not account for additional potential construction that could occur to support natural gas development (e.g., new transmission pipelines or compressor stations), which was beyond the scope of this study. We then performed a buffer analysis using the projected well pad locations and supporting infrastructure to survey the impacts to current land cover (and further the potential for forest fragmentation) that could be expected from development in these areas. Finally, we compared the projected land cover impacts to other recognizable development activities to provide context to the scale of these impacts.

Methodology

To model the infrastructure required to support our projections of natural gas development, we used the least cost path optimization approach, which is a common approach for siting and analyzing roads and pipelines. To perform this modeling, we first developed a cost surface for each study area by combining a variety of geospatial layers relevant to routing, and assigning a cost to the values associated with each layer. “Cost” in this sense refers to a penalty for following a less-efficient route, and we assigned costs to the layers based primarily on the ESRI Pipeline Optimization Route Interface [34], with additional input from industry methods and reports [35-37]. These layers covered a variety of factors that can impact infrastructure route design, such as topography, affected population, and environmentally sensitive areas. For example, we assigned a higher cost for development on terrain with steep slopes, compared to relatively flat areas. We used

this cost surface with the “Least Cost Path” tool in ArcGIS to determine the most efficient route from the projected well pads to the existing infrastructure.

The construction of well pads, gathering pipelines, and access roads to support natural gas extraction requires the clearing of land to accommodate this infrastructure. To assess both the area and type of land that may be disturbed from these activities, we used GIS tools to map the spatial extent of the well pads and associated infrastructure. We estimated that each well pad occupies 3.5 acres, each pipeline requires a 30-meter right-of-way, and each road requires a 15-meter right-of-way, based on studies that examined aerial imagery depicting areas with shale gas development [14, 29-30]. We used these values to buffer the appropriate features to create the spatial footprint of development in each study area. We then used this footprint to extract the impacted land values from the NLCD. Furthermore, to determine the number of stream and wetland crossings that could occur from pipeline and road development, we used the “Intersect” tool in ArcGIS to count the number of intersections between the new infrastructure and the stream and wetland networks in each of the study areas.

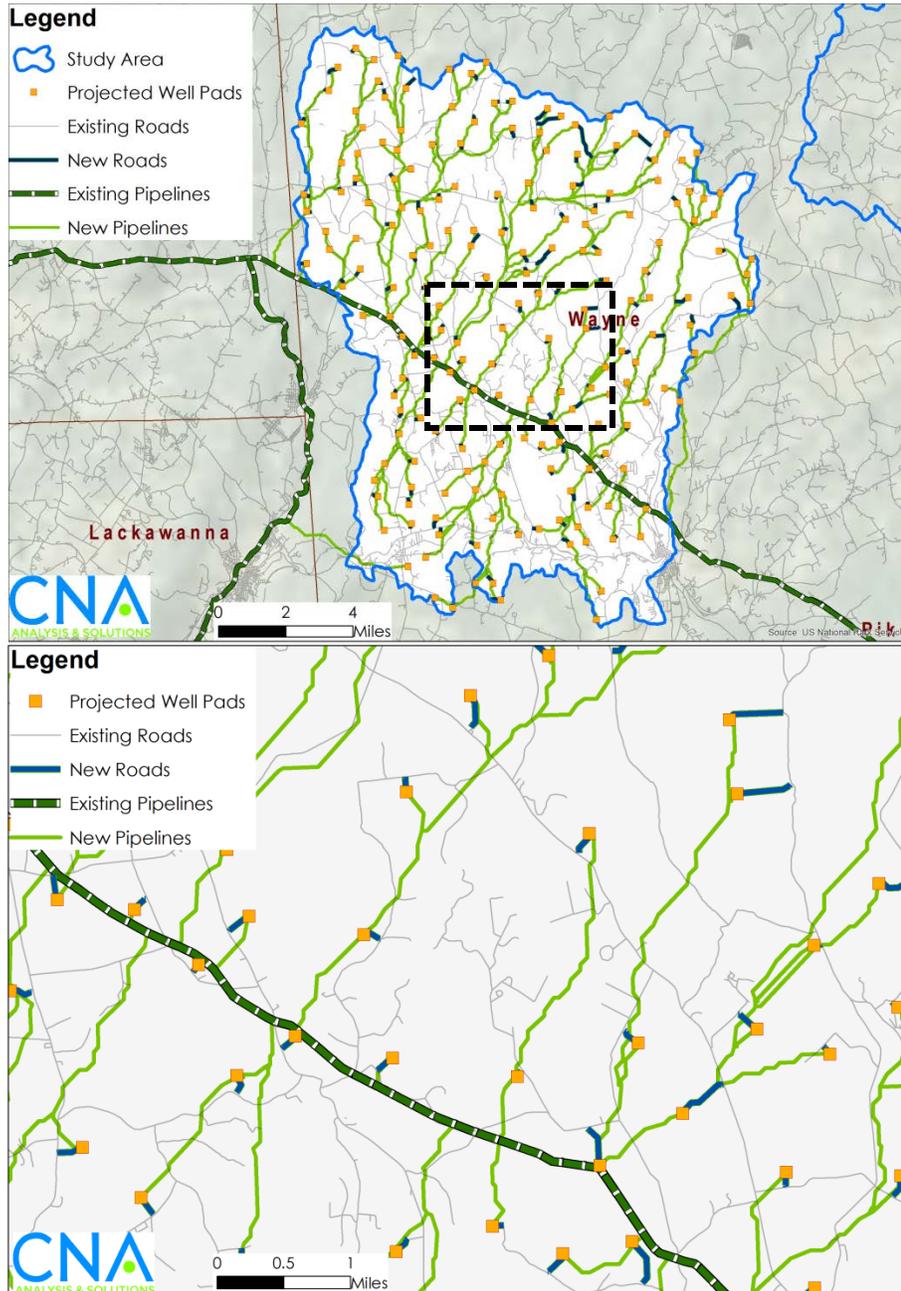
Given the prevalence of forest cover in the DRB and the potential for impact, we extended our land cover analysis to focus on the extent of forest fragmentation caused by this disturbance. To assess this impact, we calculated the baseline total area of forest in each study area through GIS analysis of the NLCD. We updated this dataset with rights-of-way from the existing road, pipeline, and rail networks to more accurately depict the baseline condition. To calculate core forest, we used GIS tools to generate a 100-meter buffer into the baseline forest from the edges. We refer to this 100-meter buffer as “edge forest.” After we generated the baseline condition, we assessed the potential impact from natural gas development by applying the same spatial footprint as above. We then generated a 100-meter buffer into the forest from all new forest edges (i.e., from well pads and along the road and pipeline rights-of-way) to represent the changes in core and edge forest.

Results

Infrastructure Modeling

Using least-cost path-optimization, we modeled the gathering pipelines and access roads that could be expected to support the new well pads in the three study areas. Figure 6 shows an example of these results from Study Area 2 (“dispersed” scenario), and Table 4 lists the results of all modeling. Note that these projections are intended to illustrate the potential scale of infrastructure with a reasonable estimation of spatial extent and are not meant to predict exact locations.

Figure 6. Projected gathering pipeline and access road development in Study Area 2 to support 191 well pads under the “dispersed” scenario. The installation of new gathering pipelines would be the primary driver of land disturbance from natural gas development.



Source: National Park Service (background)

Table 4. Projected infrastructure (gathering pipelines and access roads) needed to support natural gas development in the three study areas. Units = miles.

Scenario	Study Area	Well Pads	Pipelines		Roads	
			Total Length	Avg. Length Per Pad	Total Length	Avg. Length Per Pad
Dispersed	1	162	184	1.13	30.8	0.19
	2	191	235	1.23	35.6	0.19
	3	170	250	1.47	25.0	0.15
Concentrated	1	90	130	1.44	21.3	0.24
	2	93	163	1.75	20.5	0.22
	3	79	162	2.05	12.1	0.15

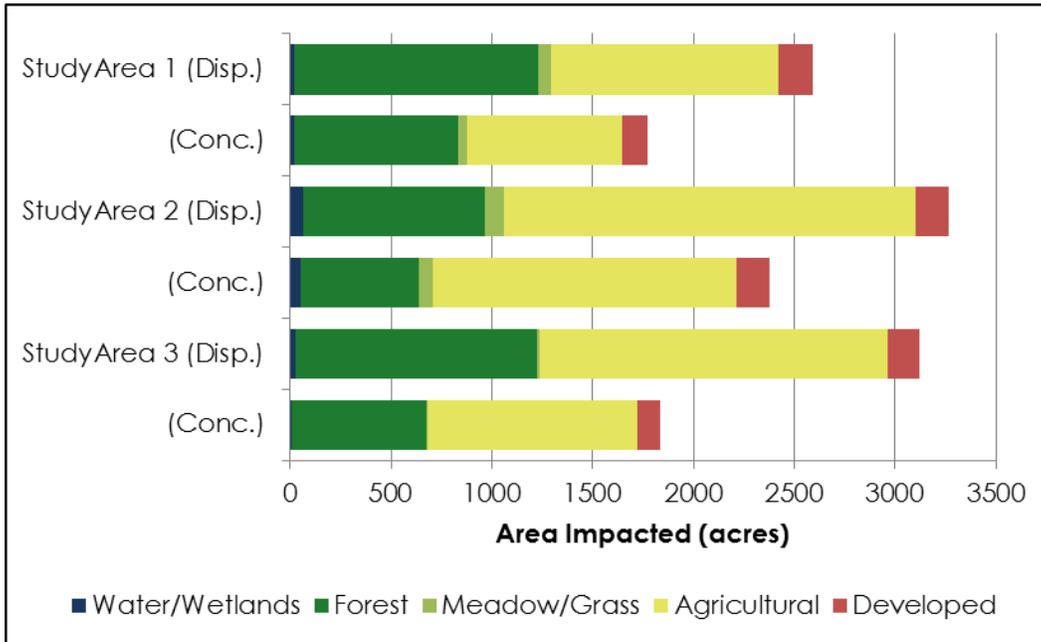
Our infrastructure modeling results compare favorably to recent retrospective studies on Marcellus Shale infrastructure development in Bradford County, PA [29-30]. For pipelines, the average length to support a well pad dropped by 26 percent from the “concentrated” to “dispersed” scenarios, which may be attributed to the location of the existing pipelines within the study areas and the relative spread of well pad locations. The well pad locations under the “concentrated” scenario are already spread out across the study areas, so many of the longest pipelines were modeled in this scenario, and the addition of more well pads under the “dispersed” scenario served to fill in the area. The average length of road developed per well pad was fairly consistent, at about 0.2 miles per pad among the study areas and scenarios, likely owing to the network of road infrastructure already in place throughout the study areas.

Land Cover Disturbance

Using our projections of potential well pads and supporting infrastructure within the DRB, we assessed the extent and form of land disturbance that would be observed from natural gas development. Figure 7 shows the breakdown of impacted land for each study area from natural gas development under the two build-out scenarios.

We project that each study area could see between 2,500 and 3,300 acres of impacted area in the “dispersed” scenario, and between 1,700 and 2,400 acres of impacted area in the “concentrated” scenario at well build-out. On average, these impacts represent 2 to 3 percent of the land area of the study areas. Although a large majority of the baseline land cover (more than 59 percent) in each study area is classified as forest cover, only Study Area 1 shows forest cover as the most impacted land area (and, even then, only slightly more impacted than agricultural land). This finding most likely is due to the higher cost associated with developing forest land versus agricultural land based on the method that we used to model infrastructure. However, a significant amount (28–47 percent) of the impacted land in each study area is forested.

Figure 7. Breakdown of total potential land cover disturbance from natural gas development in each DRB study area, broken out by scenario (“dispersed” or “concentrated”). A majority of the impacted area in each study area is agricultural or forested.



Our modeling revealed that a majority of the land disturbance associated with natural gas development would be attributed to gathering pipeline development (74 percent of the impacted land was due to new pipelines, versus 21 percent from well pads and 5 percent from new roads). This makes sense, considering that each new well pad would average 1.28 (“dispersed” scenario) to 1.75 (“concentrated” scenario) miles of gathering pipeline development, which would directly impact about 15 to 21 acres of land, respectively, versus 3.5 acres for the well pad, itself. This result also explains why, even though the “concentrated” scenario contains only about half as many well pads as the “dispersed” scenario, the concentrated scenario shows closer to two-thirds as much land cover impact as the dispersed scenario.

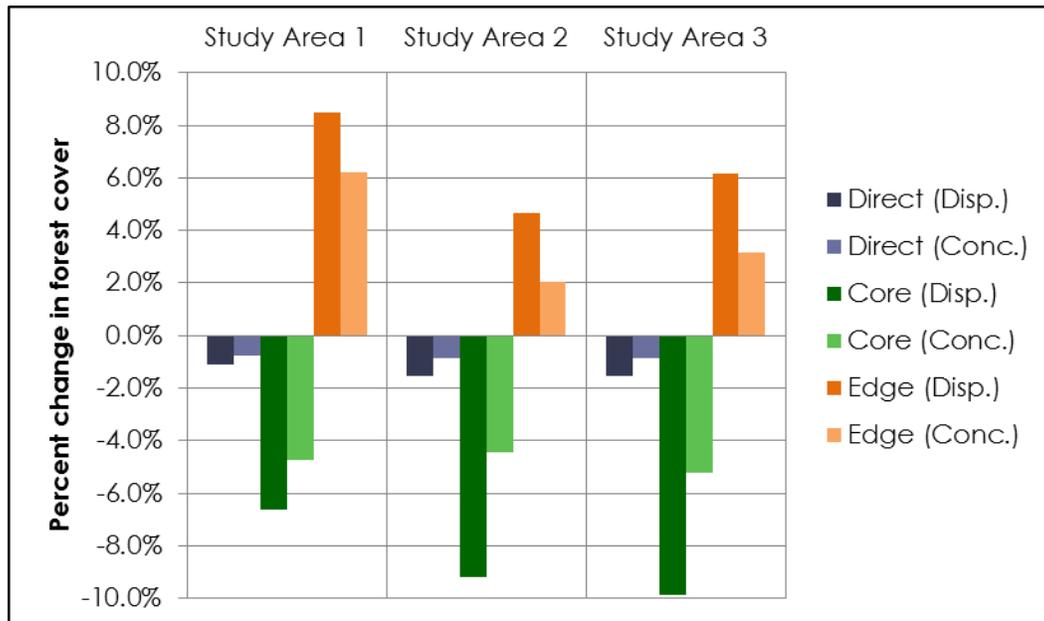
We also determined the number of stream and wetland crossings that could be encountered from development of supporting infrastructure. From our GIS analysis, we found an average of 115 stream crossings and 130 wetland crossings from new pipelines in each study area, and an average of 12 stream and 10 wetland crossings from new roads in each study area. We generated these results using the “dispersed” scenario; the “concentrated” scenario resulted in about 30–40 percent fewer

crossings, due to the reduction in total infrastructure needed to support fewer well pads.

Forest Fragmentation

The results of our land cover analysis showed that development of natural gas well pads and supporting infrastructure would directly impact the extensive forest cover present in the DRB. Deforestation activities can also present a variety of indirect impacts to a forest’s ecosystem that extend beyond the actual trees that are cleared. To evaluate the extent of these additional impacts, we performed a second buffer analysis to represent the baseline and impacted core forest in each DRB study area. Figure 8 shows the results of this analysis.

Figure 8. Percent-change in forest cover and type (core vs. edge) from infrastructure development in the DRB study areas, broken out by scenario (“dispersed” and “concentrated”). Results show direct conversion of about 1-2 percent of total forest, and indirect effects (a shift from core to edge forest) of 4–10 percent.



From Figure 8, we see that site and infrastructure development can have significant impacts on the core forest of the DRB. In the “dispersed” scenario, we found that the total forest area cleared for this development amounts to a loss of about 1 to 2 percent for each study area. This same development could amount to upwards of almost 10-percent loss in core forest area. Note that this loss in core forest area comprises both forest that is cleared for infrastructure and the resulting conversion

from core to edge forest along these rights-of-way (the latter results appearing as the net gain of edge forest in Figure 8).

Discussion

Our results showed that the construction of well pads and associated infrastructure to support shale gas development would have an impact on the land cover of the DRB, affecting primarily agricultural and forest lands. Our modeling of the natural gas infrastructure was based on a standard GIS approach to provide a representative picture of this development. Thus, just as was stated for our projected well pad locations, the projected infrastructure is used for calculating impacts, but should *not* be interpreted as explicit *predictions* of where this infrastructure will actually go. The actual locations could depend on additional site-specific factors, such as lease holds and applicable laws and regulations.

Our assessment of land disturbance only accounts for the well pad and rights-of-way for gathering pipelines and access roads to support those well pads. We did not account for additional construction that could occur to support natural gas development, such as new transmission pipelines that may be needed to help move gas to market, or new compressor stations to support gas transmission through the pipeline network. This construction could be expected to add to the footprint of development and cause additional land cover impacts to the area.

To provide context to the scale of the projected land cover disturbance from natural gas development, we compared the impacted land area to other large construction projects that have been completed in the region. The projected amount of land cleared for development in Study Area 2 could be comparable to building 58 King of Prussia Malls, which is one of the largest malls in the United States. The projected amount of land cleared for development in Study Area 3 could be comparable in area to building 155 Wal-Mart Supercenters with parking lots (about 20 acres each).

If we assume that land cover impact stays constant on a per well pad basis, we can roughly project the total land cover change for the entire DRB. Based on the average of the results for the three study areas, the total land cover impact is 17-23 acres, depending on the development scenario. Based on these per-well pad numbers, and the number of well pads projected in the DRB, we estimate the total area of DRB land cover change as between 18 and 26 square miles. This makes up 0.5 to 0.8 percent of the total Interior Marcellus area within the DRB (3150 square miles), but within the portion with well pad development projected (950 -1000 square miles), the total land cover conversion percentage should be roughly in line with the study area results at about 2 percent. Or, to use a prior example, the total land cover change would be equal in area to between 570 and 840 Wal-Mart Supercenters including parking lots.

Land-cover change from shale gas development is unavoidable, and disturbance can be significant at build-out. The loss of forest cover, in particular, can have significant impacts on the watershed, such as degraded water quality (for more details, see the “Impacts on Water Quality due to Changes in Land Cover” chapter of this report) and a loss of biodiversity from disappearing flora and fauna that cannot tolerate “edge effects.” Furthermore, remediation procedures to restore vegetation on the impacted land often do not replace mature forest cover, in part because of the need to maintain access to gathering lines and use roads, and because mature forests take a long time to grow.

Impacts on Water and Wastewater Management

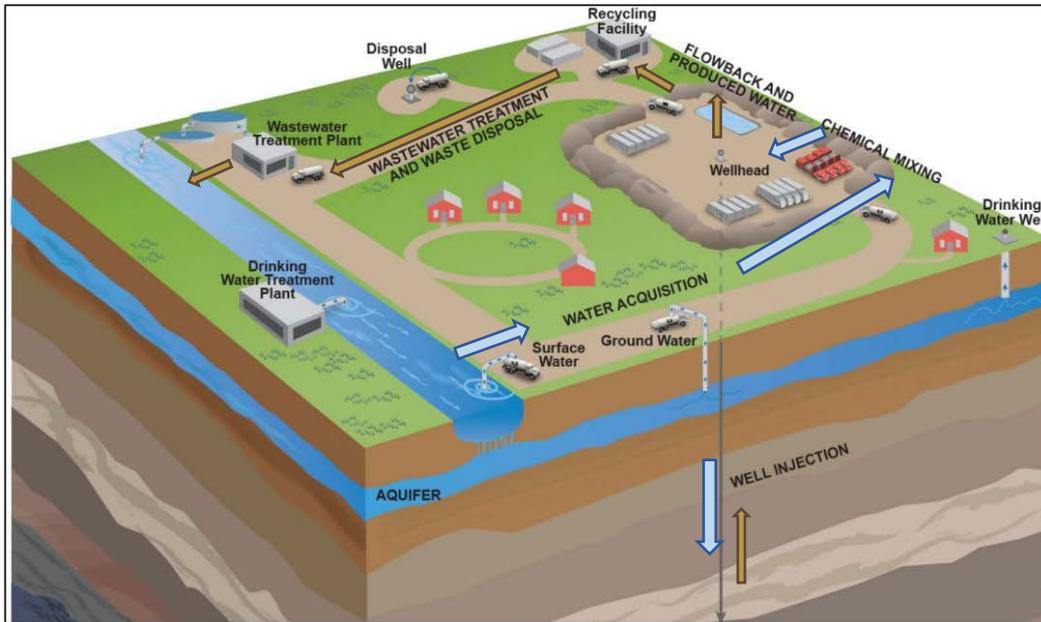
Key Findings

- Unconventional natural gas development requires about 4.5 million gallons per well, mostly to mix the “frac” fluid injected into the shale during hydraulic fracturing. Most of this water does not return from the shale after injection during the fracturing process and is a consumptive use.
- The impacts of water withdrawal on streamflow vary widely, depending on location, development rate, and flow conditions. During maximum periods of well development, the percentage reduction in streamflow ranges from over 70 percent during low-flow conditions to less than 3 percent during median or average flow conditions if withdrawals are taken from small streams.
- Natural gas wastewaters (flowback and brine) are concentrated, carrying high loads of dissolved solids, salts, some metals, hydrocarbons, and radioactive materials.
- If all wastewater were treated to meet Pennsylvania’s effluent standards and discharged in the study areas, the amount effluent produced during maximum-development periods could raise in-stream concentrations of some contaminants (notably barium and strontium) up to 500 percent above background levels during low-flow conditions.

One of the principal ways that unconventional gas drilling differs from conventional gas drilling is in its use of water for the extraction process and the amount of wastewater produced. There are two primary water uses in the process (drilling fluids and “frac” fluid), and three primary types of wastewater generated (waste drilling fluid, “flowback,” and brine wastewaters) that must be treated and either

recycled or disposed. Figure 9 illustrates the flows of water and wastewater (WW) during the fracking and gas-extraction process.

Figure 9. The fracking water cycle. This cycle includes water acquisition (withdrawal), mixing into “frac” fluid, injection into the well, recovery of wastewater (flowback and produced water) from the well, wastewater reuse (recycling), and then wastewater treatment and disposal.



Source: Environmental Protection Agency [38]

Water plays a key role in hydraulic fracturing as the base of the frac fluids that are injected at high volume into the shale to fracture it and release tightly held gas. A smaller quantity of water is used for drilling the wells before fracking. The bulk of the water use is consumptive, because most the frac fluid remains in the ground (and wastewater is often reused or sent outside the basin for treatment).

The main wastewaters include drilling fluids recovered after drilling and frac fluid that returns from the shale after hydraulic fracturing. The drilling wastewater is often recycled and reused as new drilling fluids or is disposed (in injection wells, among other disposal methods). The flowback is composed primarily of frac fluid that returns back up the well bore due to the high pressures in the fractured shale in the 10-14 days (up to 30+ days) after fracking and before gas production. Following the flowback period, as the well is producing natural gas, a smaller amount of wastewater continues flowing along with the gas. This wastewater is composed mainly of frac fluid, but also picks up pollutants from the shale, notably salts, which

earns it the name “brine” (also called “produced water”). After collecting flowback and brine, the wastewater can be reused in making new frac fluid, disposed via deep groundwater injection, or treated at special wastewater treatment plants.

Disposal of this flowback and brine wastewater is a significant concern due to the high concentrations of dissolved solids (mostly salts), metals, hydrocarbons, and radioactive materials [39]. Some particular contaminants of concern include ions such as chloride, sulfate, ammonium, and iodide; metals such as barium and strontium; solvents and aromatic hydrocarbons such as benzene and formaldehyde, and radioactive elements such as radium. Appendix A contains an expanded list of chemicals that have been detected in flowback and brine wastewaters, including approximate concentrations at which they are found. Even with treatment, concentrations of pollutants (especially dissolved solids, salts, and ammonium) in wastewater effluent have often been measured at concentrations exceeding water quality standards [40]. In addition to potentially harming aquatic life [41], some of these chemicals are difficult to remove in drinking water-treatment plants [42] and can lead to enhanced formation of disinfection byproducts [43-44] in drinking water, which can increase risk of some health effects (including cancer) [45]. Industrial wastewater treatment has improved since UNGD started in Pennsylvania, as have regulations that now limit Total Dissolved Solids (TDS) effluent concentrations to 500 mg/L, equivalent to current DRBC discharge regulations [46], yet these limits are many times higher than existing water quality in the basin’s special protection waters (50-100 mg/L TDS) [47].

The rest of this chapter investigates the impacts of the hydraulic fracturing water cycle for both water and wastewater. First, we computed the volumes of water and wastewater for the study areas, and we examined the withdrawal rates in the context of the available streamflow. The second portion of the results focuses on the pollutant loadings in the hydraulic fracturing wastewater, which we contextualize with the ambient loadings of these pollutants carried by the nearby streams.

Methodology

UNGD water and wastewater processes are linked, though their environmental impacts are manifested rather differently. In this analysis, we compute a median estimate of water use and wastewater production on a per-well basis, and then multiply by the number of projected wells for each case study area to determine the volumes of water withdrawals needed and wastewater generated in each. We estimate water usage; wastewater generation and recovery; and reuse rates from publicly available databases and peer-reviewed literature. Since the “concentrated” and “dispersed” scenarios result in a similar number of wells developed, we consider only the “concentrated” scenario in this chapter (as it has slightly more wells).

To estimate the impact of the water acquisition, we compare the withdrawal to available freshwater flow in the study areas. The water-related impacts are more easily judged using expected flow rates than overall volume. Well development is not likely to occur at a constant rate, and impacts are magnified during periods of rapid development, so we considered two scenarios to explore the range of impact the well development rate may have on water availability:

- **Average Development Year:** Assumes that development occurs at a constant rate over a 30-year build-out.
- **Maximum Development Year:** Assumes that 20 percent of well development build-out in each study area occurs in one year.²

The average- and maximum-year scenarios show the range in flow rates for water withdrawal and wastewater generation—and, by extension, the watershed impacts.

To estimate wastewater impacts, we investigated how discharge of treated wastewater effluent according to Pennsylvania regulations would raise concentrations of five key pollutants in streams. We only consider the flowback and brine wastewaters, as the drilling fluids and cuttings are generally disposed as solid waste. We multiplied the wastewater flow rates by concentrations of pollutants reported in the literature to calculate pollutant loads. The total loading rate of contaminants of concern in the various types of wastewater (flowback and brine) is estimated after treatment of wastewater (i.e., in wastewater treatment effluent), and for cases with and without reuse of wastewater.

Using local streamflow statistics, we developed an initial estimate of how much these loadings would raise concentrations of five key pollutants in the runoff coming from each study area, and compared this change to reference concentrations in the basin. Since these estimates lack the context of actual location and method of treatment, and cover a limited set of pollutants, we recommend future studies with more specific scenarios. Furthermore, this study considers only the most likely pollutant pathway (wastewater effluent) for water quality impacts [5], but other pathways such as spills from trucks or at the drilling site may have impacts [5, 49-50], though often at more localized scales.

² The maximum-year scenario represents an estimate of maximum development that may occur in one study area. Based on observations of Baker Hughes rig count data [48], the maximum rig densities appear to be about one rig per 20 square miles, or 6-10 per study area. If we assume an average completion time of 20 days for wells, then rigs may be able to drill 18 wells per year. This would be sufficient to drill about 20 percent of the wells in a study area. For consistency, we applied this 20-percent assumption to all of the study areas.

Results

Water Use and Wastewater Generated

Water needs and wastewater generation are significant for natural gas operations, but must be properly compared to overall water availability and put into context by existing water uses in the DRB. Figure 10 shows the average per-well volumes of water and wastewater expected for projected well development in the DRB.

Reuse of drilling fluid, flowback, and brine plays an important role in reducing both freshwater demand and the volume of wastewater that must be disposed. After accounting for reuse, the remaining freshwater withdrawal and wastewater disposal volumes are the most important metrics for planning.

Figure 10. Sankey diagram of water volumes for the fracking water and wastewater management cycle estimated for this study, on a per well basis. "Frac" fluid dominates water use, and most is not recovered. Units = million gallons per well.

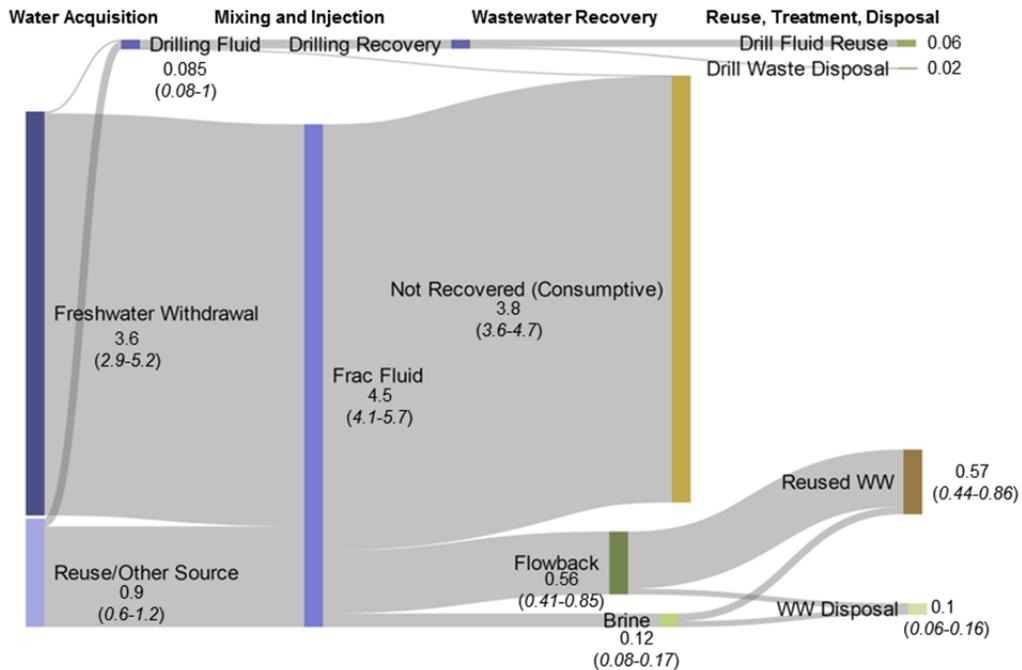


Figure by CNA via *SankeyMATIC*

^a Numbers show expected value. Expected range in parentheses.

We estimated water use based on FracFocus database records [51] of frac fluid water use per well across the Marcellus Shale. We calculated the per-well average water use based on 2012 and 2013 data for six counties in northeast Pennsylvania (Bradford, Lycoming, Sullivan, Susquehanna, Tioga, and Wyoming). The range represents the highest and lowest county average. Adding the water use for drilling fluid (about 85,000 gallons [52-53]), we compute the average water demand at 4.5 million gallons per well. Mantell estimated that alternative sources (such as recycling and reuse of flowback) reduce freshwater needs by 10-30 percent [52], and we assumed a median of 20 percent. We assumed that this reused water could come from reuse of flowback and brine within the study area or other sources (e.g., wastewater treatment plant effluent, groundwater, or purchases from public supply) within the DRB.

Flowback wastewater is generated at a rate of 10-15 percent of the volume of frac fluid injected [53-55], while brine production is about 50-100 million gallons per million cubic feet of gas produced [52]. The reuse rates of these wastewaters based on current industry practices are estimated to be about 90-95 percent for flowback and 56 percent for brine [53]. Though we do not include indirect uses in our analysis, Jiang et al. [53] estimated that indirect water consumption for well pad preparation might account for an additional 0.5 million gallons of water per well, and total indirect uses might account for as much as 2 million gallons per well.

Table 5 displays average daily rates of water use, withdrawal, wastewater generation, and wastewater effluent disposal for each study area, based on the per-well factors in Figure 10 and the number of wells developed. Note that the DRB total at the bottom includes wells not in the three study areas.

We account for reuse of wastewater (based on literature values of recent industry averages) in two ways. “Withdrawal” reflects remaining freshwater need after accounting for reuse and alternate sourcing. “Wastewater Generated” includes all flowback and brine recovered, but “Effluent Disposal” includes only the remaining portion of wastewater that is sent for treatment at industrial wastewater treatment facilities. We assume that the disposal volume is treated at wastewater treatment plants in the basin (instead of disposed through deep well injection or transported outside the basin), so this “disposal” volume can be called wastewater “effluent.” To establish the full potential range of impacts, we also consider the case where all wastewater is treated and disposed later in this chapter (i.e. no reuse).

Table 5. Projected rates of well development, water use, withdrawal, wastewater generation, and effluent for disposal, by study area and scenario. Units = 1,000 gallons per day, except wells per year.

Study Area	Scenario	Wells Per Year	Water Use	Withdrawal (Freshwater)	Wastewater Generated	Effluent Disposal
1	Average	22	270	210	40	6
2	Average	25	320	250	50	7
3	Average	23	280	230	50	6
1	Max.-Year	130	1,610	2,570	270	36
2	Max.-Year	153	1,900	3,040	320	43
3	Max.-Year	136	1,690	2,700	280	38
DRB	Average	133	1,650	1,320	270	37

Since water withdrawals are often not constant over a development period, we developed a reasonably high-withdrawal scenario. In the maximum-year scenario (20 percent of wells developed), we further assumed that water withdrawal occurs over a limited time window during the well-development process, equal to half of the well completion time (roughly 20 days). This doubles the effective withdrawal rate because the same amount of water is collected over 50 percent fewer days. Actual peak withdrawal rates could be higher if the water needed for each well fracturing is collected in only a few days to minimize water storage time onsite.

The withdrawals are highest in the maximum-year scenario, and it is these rates of withdrawal that may have the highest potential impact on flows in the DRB. The wastewater flow generated, as expected, is small relative to water use (but at 50,000–300,000 gallons per day in the study areas, it is still a large volume that must be managed).

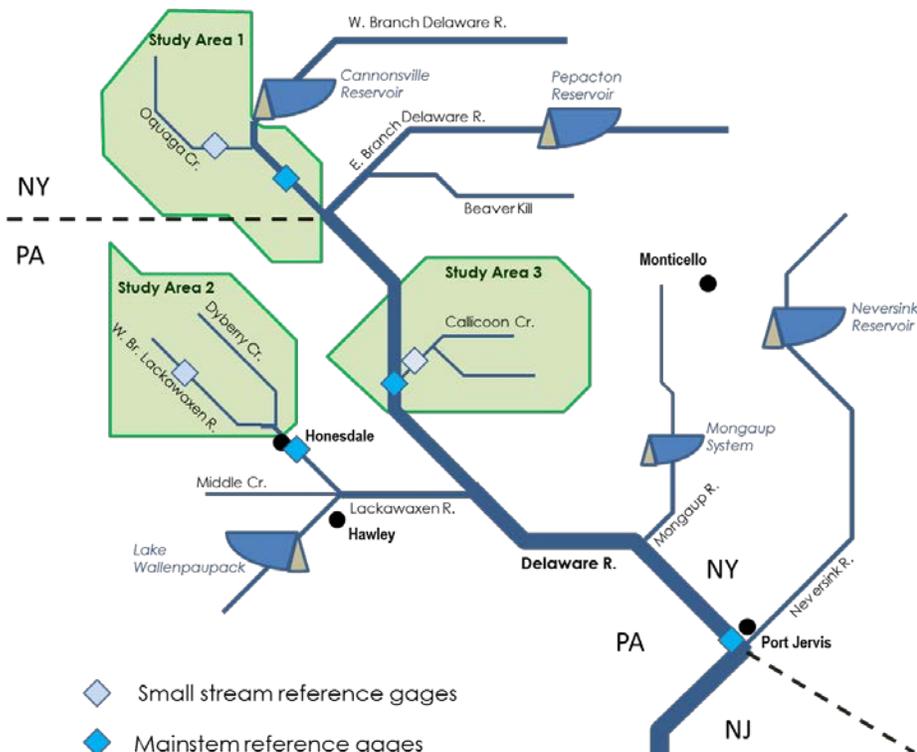
Impacts from Water Withdrawal

The impact of water withdrawals for fracking depends on the rate of extraction and the available water resources in the study area. This withdrawal rate is roughly 2.6–3.0 million gallons per day (MGD) for each study area. To determine the impact of these extractions on water availability in the study areas, we compared the water-extraction rate to water availability using two types of reference stream gages: “small stream” and “mainstem.” We obtained all stream gage records from the USGS Surface Water Daily Data database [56-57] (see Appendix B for details on the gages used).

The schematic in Figure 11 shows the relative locations of the two types of reference gages. Conveniently, all projected wells are upstream of the stream gage at Port Jervis, NY, which is useful for assessing basin-wide impacts. The small stream gages

represent smaller headwater drainage basins whose flow depends almost entirely on rainfall within the study area. The mainstem gages measure larger rivers flowing through the study area that have a significant portion of flow coming from upstream of the study area. Notably, the mainstem of the Delaware River flows through Study Areas 1 and 3, and water availability is influenced by upstream flows, including releases from the Cannonsville and Pepacton Reservoirs. Study Area 2 is different than 1 and 3 because it is entirely a headwater area and has no upstream drainage area to boost flow to the mainstem gage.

Figure 11. Flow schematic for the Upper DRB, showing locations of study areas and reference gages.



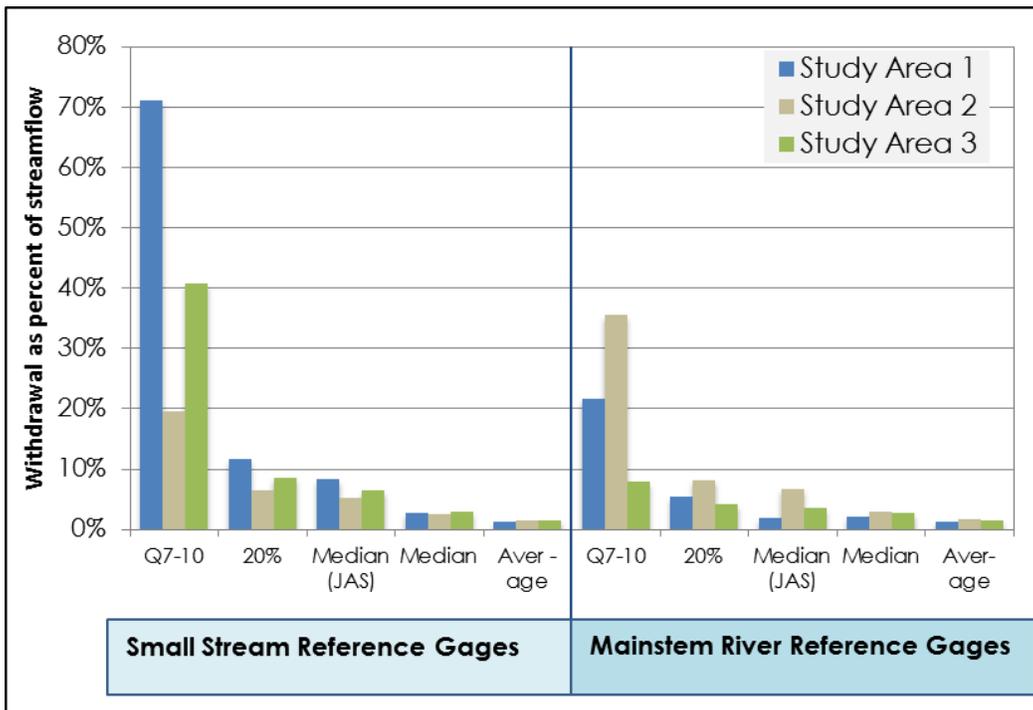
Note: The schematic is not to scale. Source: CNA.

For all gages, streamflow statistics were calculated including the Q7-10 (lowest seven-day average flow expected to occur once every 10 years), the 20th-percentile flow (sometimes called the Q80), median flow for the summer months (July–August–September [JAS]), median flow, and average flow per square mile (using the stream gages' contributing area). See Appendix B for these flow metric values. We divide the projected water withdrawal by the study area size to put demand on a per-square-mile basis, allowing a comparison.

We calculated water availability by dividing the maximum-year water demand for UNGD by the flow metric and expressing the result as a percentage. This is the percentage by which flow would be reduced under the listed flow conditions on days with water withdrawal (roughly half of days). Figure 12 shows the percentage of flow reduction for several flow metrics for both the small stream and mainstem reference gages.

The water availability analysis in the figure suggests that water withdrawals would reduce median or average flows by 1-3 percent, but the withdrawals may reduce flows 5-70 percent during summer and low-flow periods. Mainstem withdrawals would have a less-noticeable effect on flows under a range of flow conditions. By contrast, during periods of low-flow, withdrawal rates may noticeably reduce in-stream flow on small streams.

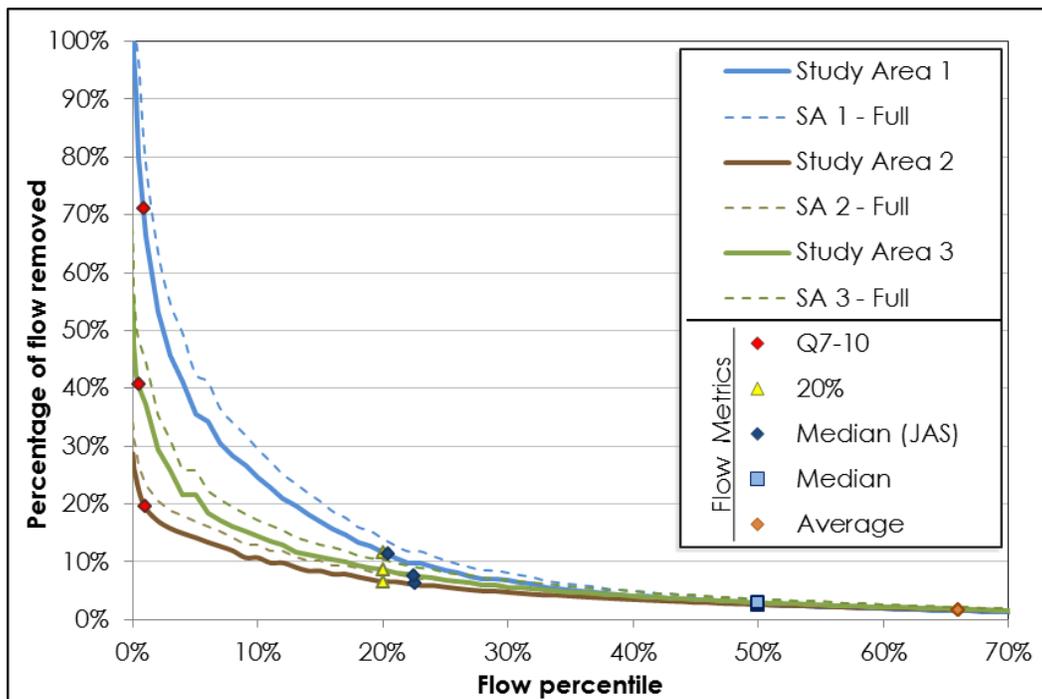
Figure 12. Withdrawals as percent of available streamflow for maximum-year development scenario. Shown for several flow metrics for both the small stream and mainstem gages. Withdrawals can take a high percentage of flow during low flow, when taken from small streams, and a lower percentage during average flow or when taken from mainstem rivers. (Units = percentage of flow removed.)



Notes: Q7-10 is lowest 7-day average flow experienced on average every ten years. 20% is the 20th percentile of daily streamflow. Median (JAS) is the 50th percentile daily flow for the months of July, August and September. Median is the 50th percentile of all daily flows. Average is the daily average flow.

For completeness, we also display the results over the full-flow distribution for the small stream gages. In Figure 13, lines show the percentage that flow would be reduced versus the flow percentile. The same flow metrics are shown as points along the line. The dashed lines represent an additional scenario if the full water demand were met with freshwater withdrawal (versus a combination of freshwater and reused water as depicted in Figure 10).

Figure 13. Withdrawal as percent of available flow versus flow percentile, small stream gages, maximum-year withdrawal scenario. At lower flows, the percentage of flow removed is higher. Dashed lines show the difference if all water needed for hydraulic fracturing were supplied by the streams.



Actual impacts would depend on the specific withdrawal location, withdrawal rates, and flow at the time of the withdrawal. Some ecosystems are highly sensitive to changes in flow regime, including changes to the low-flow magnitude, timing, and duration, which this study indicates may be a risk for smaller streams in the study areas. Several reviews of environmental flow literature have found that decreased magnitudes of low flows can lead to a range of effects on water quality and ecosystems, including decreased richness of species, increased densities of predators, increased abundance of generalist and highly mobile species, and decreased abundance of specialist and cold-water obligate species, among many others [58-59].

The total water volume needed to develop all 4,000 wells in the DRB is roughly 14 billion gallons, which, spread evenly over 30 years, is 1.3 million gallons per day. This average daily withdrawal amount would be sufficient to meet the domestic water needs³ for more than 17,000 people. Of course, the water withdrawals for fracking would be roughly 80-percent consumptive, versus about 20-percent consumptive for domestic water use.

Relative to existing water demands in the study areas' watersheds [61], the UNGD water demands would increase water use in the three study areas by a factor of 5 to 12.

Wastewater Pollutant Loadings

Table 6 shows expected concentrations (derived from literature values) of some of the key regulated contaminants in the flowback and brine wastewater [41, 43, 62-68] and industrial wastewater effluent [40, 43], compared to the effluent discharge limits [69] and the reference conditions in the watershed's streams [41]. The natural gas wastewaters contain dozens of pollutants, including salts, metals, hydrocarbons, volatile organic compounds, and radioactive compounds, among others[70]. This study focuses on five pollutants whose effluent concentrations are regulated from treatment plants treating oil and gas wastewater in Pennsylvania. These pollutants include Total Dissolved Solids, Chloride, Sulfate, Barium, and Strontium.

³ The average for Delaware, New Jersey, New York, and Pennsylvania is 75 gallons per day, per capita [60].

Table 6. Wastewater concentrations of key contaminants in flowback and brine wastewater. Discharge regulations on effluent concentrations, and reference conditions for surface water in the upper DRB are shown for context. Units = mg/L.

Pollutant	Flowback	Brine	Range	Discharge Regulations	DRB Reference
Total Diss. Solids (TDS)	73,000	205,600	38,500–261,000	500	46.5
Chloride (Cl)	54,600	99,600	19,600–174,700	250	5.8
Sulfate (SO ₄)	51	55	2.4–300	250	5.1
Barium (Ba)	1,020	33,630	4–84,300	10	0.021
Strontium (Sr)	1,190	5,230	350–4,800	10	0.025

Since 2010, Pennsylvania regulations [69] require new wastewater treatment facilities treating Marcellus Shale wastewater to meet additional standards for TDS, salts, and some metals before discharging to streams or conventional treatment plants. The newer industrial treatment facilities will have to more-effectively remove salts, metals, and other contaminants through advanced treatment technologies (e.g., desalination and distillation; reverse osmosis and other membrane processes; capacitive deionization [39]) to meet the newer regulations. The reference conditions reflect an average for four sites in the Upper DRB measured in 2012 [41].

These pollutant measures show the concentrated nature of the wastewaters being generated relative to the regulatory effluent discharge standards, many of which are equivalent to U.S. Environmental Protection Agency (EPA) maximum contaminant levels for drinking water. The low concentrations in the reference conditions indicate how susceptible the surface waters in the study area are to even small discharges of wastewater. The potential environmental effects depend on the loadings of the contaminants to surface water in addition to the location and flow conditions at point of discharge. Different measures of loading may be appropriate, depending on the planning objective.

The total loading of contaminants in flowback and brine wastewater sets an upper bound for the mass of contaminants that must be treated. For the five regulated contaminants in Table 6, we calculate the total contaminant loading in wastewaters by multiplying flowback and brine generation flow rates by their respective contaminant concentrations to compute mass loads, and then sum the flowback and brine loads. The process is similar for industrial wastewater effluent (after typical wastewater reuse), but we assume that the effluent concentrations comply exactly with regulatory limits for discharge (see Table 6, above).

Table 7 shows the potential average daily loadings of key contaminants from all flowback and brine wastewater (“Avg. WW”) and from treated effluent (“Avg. Effl.”). The treated effluent volume is lower because it reflects the remaining wastewater

volume after much of the original flowback and brine has been recycled. For context, the average daily loadings (computed based on the reference concentrations and average flow conditions) are shown on the final line for the Delaware River at Port Jervis, NY. The river naturally carries some solids and salts at low concentrations, but with high flow rates, the river loading is large.

The same is not true of the metals barium and strontium, which have only trace concentrations in the waters of the Upper DRB. In untreated wastewater (the Avg. WW scenario), the loadings of barium and strontium can dwarf those in the river, indicating significant risk associated with spills. Wastewater reuse reduces volume (the difference between Avg. WW and Avg. Effl. flow), and treatment reduces contaminant concentrations, which combined reduce average loadings in effluent discharged to rivers.

Table 7. Potential average daily loadings of key contaminants from all flowback and brine wastewater and from treated effluent. Natural gas wastewaters are very concentrated, and loadings of key contaminants in the raw wastewater (“Avg. WW”) can be similar to the totals carried by the Delaware River (“Reference” condition). For the effluent loading scenario (“Avg. Effl.”), which includes wastewater reuse, the loadings are greatly reduced, though not eliminated. Units = lbs/d, except flow (MGD).

Scenario ^a	Study Area	Flow	TDS	Cl	SO ₄	Ba	Sr
Reference	DRB ^b	3,260	573,400	71,700	62,300	264	305
Avg. WW	1	0.040	32,000	23,100	19	2,490	700
	2	0.047	37,700	24,500	20	2,640	740
	3	0.042	33,600	21,800	18	2,350	660
	DRB ^b	0.245	142,400	127,400	105	13,800	3,870
Avg. Effl. (w. reuse)	1	0.006	25	13	13	0.50	0.50
	2	0.007	30	15	15	0.59	0.59
	3	0.006	26	13	13	0.53	0.53
	DRB ^b	0.037	154	77	77	3.1	3.1

^a Multiply loadings by 6 for maximum-year, and by 30 (times 365) for total loading.

^b Reference DRB loadings based on average flow at Port Jervis, NY. DRB scenario loadings include all wells in the DRB, including those not in the three study areas.

Note: TDS – Total dissolved solids, Cl – Chloride, SO₄ – Sulfate, Ba – Barium, Sr - Strontium

Finally, we note that the high contaminant concentrations in untreated wastewater make wastewater handling a potentially risky activity in case of spills. Comparing the average wastewater loads to the reference loads, it is evident that spilling even small volumes of untreated wastewater into streams could significantly raise loadings of these contaminants (and many others in the untreated wastewater), posing an

environmental risk. This study does not investigate spill scenarios, but the sensitivity of the basin's waters to spills may warrant further study.

Impacts of Wastewater Discharge

The salts, metals, and other pollutants in the flowback and brine wastewater can create significant loads, despite relatively low flow rates, because the pollutants are concentrated. The TDS concentration in brine makes it nearly six times saltier than seawater (roughly 35,000 mg/L). One way to judge the impacts of the effluent discharges in context is to determine how much the wastewater discharge would raise concentrations of key contaminants in surface waters.

Water quality risk is highest when a high effluent flow is discharged during low-flow conditions, because there is less water for dilution. We investigated two discharge flow scenarios to set a range on the potential water quality changes during a period of lower flow—in this case, the 20th-percentile flow (sometimes called the “Q80”). In both cases, we assumed that the discharge pollutant concentrations exactly met the quality standards in the “Discharge Regulations” column of Table 6 (see page 36).

The first scenario (“Max. Effl. w reuse”) has the effluent disposal flow from the maximum development year (final column from Table 5, page 31) as its flow. This is the flow remaining after reuse. The second scenario (“Max. Effl. no reuse”) has the total wastewater generated in the maximum development year (sixth column from Table 5) as its flow, but it meets the same effluent quality standards.

Given that potential effluent or discharge locations are unknown, we compute the concentration increase caused by diluting the wastewater pollutant loads in the reference streamflow on area-averaged basis. We use the small stream-gage statistics calculated per square mile to estimate the 20th-percentile flow and multiply by the area of the study area to get the flow rate. Table 8 shows the *increase* in concentration the wastewater effluent discharge would cause for the three study areas for the five pollutants. The first row of Table 8 shows the reference pollutant concentrations for natural flow from Table 6. Comparing the concentration increase to these reference concentrations shows the approximate magnitude of the change in water quality.

Table 8. Increase in concentration of pollutants caused by maximum-year effluent discharge during the 20 percent-flow condition. The “Max Effl. no reuse” scenario leads to larger increases than the “Max Effl. with reuse” scenario because of higher flow. Barium and Strontium concentrations change most relative to reference concentrations. Units = MGD for streamflow, effluent flow; mg/L for reference concentration, concentration increase

Scenario	Study Area	Streamflow	Effluent Flow	Concentration Increase				
				TDS	Cl	SO ₄	Ba	Sr
<i>Reference Concentrations for DRB:</i>				46.5	5.8	5.1	0.021	0.025
Max Effl. w reuse	1	22.2	0.036	0.817	0.409	0.409	0.016	0.016
	2	40.2	0.043	0.530	0.265	0.265	0.011	0.011
	3	31.4	0.038	0.605	0.302	0.302	0.012	0.012
Max Effl. no reuse	1	22.2	0.240	5.412	2.706	2.706	0.108	0.108
	2	40.2	0.283	3.513	1.757	1.757	0.070	0.070
	3	31.4	0.251	4.004	2.002	2.002	0.080	0.080

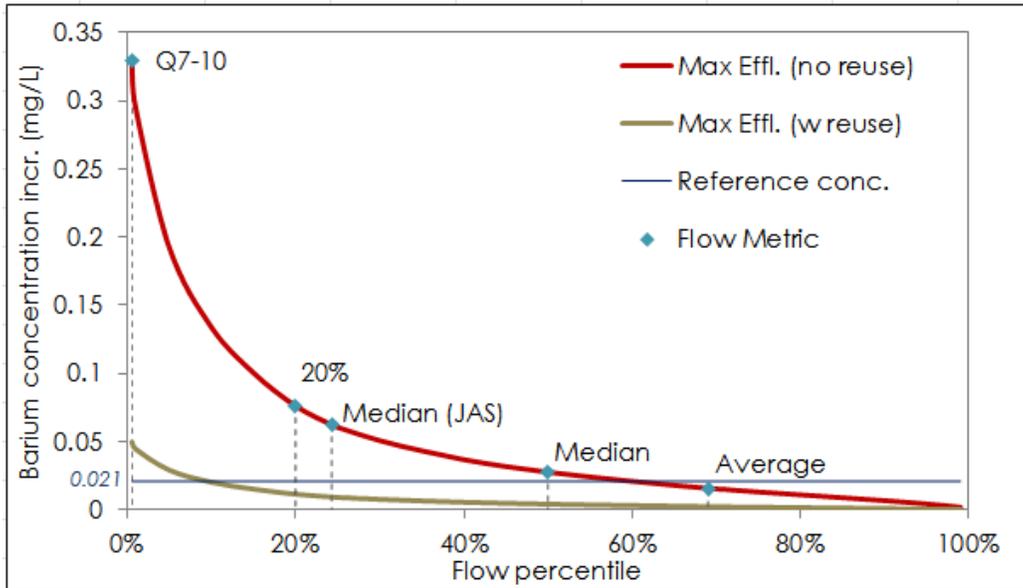
Note: TDS – Total dissolved solids, Cl – Chloride, SO₄ – Sulfate, Ba – Barium, Sr - Strontium

The Max. Effl. with reuse scenario’s increased concentrations reflect a wide variation in percentage changes, with TDS increasing about 1.5 percent over reference concentrations in the study areas, and barium and strontium increasing 50-70 percent. The increased barium loadings are especially of concern, because barium accounts for up to 90 percent of eco-toxicity potential in flowback and brine wastewaters [71]. The lower the wastewater reuse rate, the higher the potential effluent loadings. For barium and strontium, treating all of the wastewater (i.e. no reuse) instead results in a 300-500-percent increase over reference concentrations.

The water quality changes also depend on the flow conditions in the effluent’s receiving water due to the dilution effect. Figure 14 illustrates how the increase in barium concentration changes depending on the flow conditions at the time of discharge. This example considers the same scenarios for Study Area 2. The horizontal blue line shows the reference concentration for barium.

Unsurprisingly, we observe that the concentration increases are much higher during lower flows, and the larger discharge volumes of the no reuse scenario result in larger changes to concentrations. This general pattern will be reflected for all of the pollutants in all of the study areas, though the reference concentrations will be different.

Figure 14. Barium concentration increase versus flow percentile, Study Area 2. The concentration increases are most substantial for the lower flow percentiles. Scenario with no reuse has higher increases. Units = mg/L.



Discussion

If natural gas development were allowed in the DRB, water resources would be affected by both water withdrawals and wastewater discharges. Water withdrawals are small relative to total water availability in the basin, but are large compared to existing demands in the study areas. The withdrawals could remove a significant portion of flow if maximum year withdrawals are taken from smaller streams during critical low-flow periods. In this analysis, we compared the withdrawal rate and available flow generation on the basis of ‘flow per unit area’ over the area of the watershed for the three study areas. While this analysis method is necessary to compare relative flows where actual withdrawal location and timing are unknown, in reality, the impact would depend on the specific location and flow conditions during the withdrawal. On smaller streams, especially, the magnitude of water permanently removed for fracking could reduce the flow considerably during high or peak withdrawal periods. The duration of the impact is uncertain and would depend on how many wells would be served by a particular withdrawal location, and the rate of development.

Wastewater handling, management, and treatment are important for Marcellus wastewaters, notably the flowback and brine, due to the high concentrations and potential toxicity of pollutants in the wastewaters. We considered only the impact that the discharge of wastewater effluent treated to current Pennsylvania standards would have on in-stream concentrations of five pollutants with specific discharge limits. Our analysis showed that under these conditions, in-stream loadings of some pollutants (notably barium and strontium) could increase between 50 and 500 percent, depending on what portion of the wastewater is reused versus treated and discharged. These effects would be most pronounced on smaller streams and during low-flow periods, where the discharge flowrate is a reasonable proportion of the ambient flow.

There are several other potential risk pathways and risks to water quality [50, 72] that this study does not consider. Pollutants other than the five included here—as well as their degradants or derivatives—may pose additional risks to water quality and human and environmental health. The treatment processes needed to meet the 2010 discharge regulations on TDS, chloride, and sulfate may also treat other salts and ionic compounds, and limits on barium and strontium may result in reduced concentrations of other metals. Yet, for many of the pollutants found in natural gas wastewaters (many of which have no regulatory discharge limits), understanding of potential health impacts is still evolving (see the “Health Risks and Affected Population” chapter for more discussion of this issue). For instance, iodide and ammonium (two chemicals not usually measured in water quality analyses of flowback or brine) in Marcellus wastewater effluent have recently been shown to impact formation of disinfection byproducts in drinking water, as well as having ecologic effects [43-44, 73]. Naturally occurring radioactive materials (NORM) in flowback and brine have attracted attention because they are not easily treated and do not quickly degrade in the environment, whether in effluent or solid waste discharge [74-75]. Additional research on effluent concentrations of a wider range of chemicals from wastewater treatment plants meeting the newer Pennsylvania standards would be useful in assessing potential impacts of these other pollutants.

While effluent discharge was the primary water pollution pathway that we included in this analysis, there are other documented pollution pathways by which natural gas wastewaters could be released. For example, Reaven and Rozell performed a probability bounds analysis to determine the likelihood and potential volume of water contamination via transportation of wastewater, well casing failure, migration through subsurface fractures, wastewater spills at the drilling sites, and wastewater disposal [5]. They found that although wastewater disposal (i.e., effluent discharge) was by far the most likely pathway with the highest potential contamination volume, other pathways could lead to low-probability scenarios with high-contamination volumes, especially spills at drilling sites. These “accident” pathways [50] are important considerations in a full consideration of UNGD risk, as some spills will be nearly inevitable [74]. Pennsylvania’s Department of Environmental Protection has

been tracking and reporting permit violations for natural gas operators, and their violations data show that many of these pathways are a reality in Pennsylvania, with 4,006 violations since 2009 (roughly 7,800 wells drilled) [76]. As an example, there have been roughly 290 violations at about 240 well sites involving improper discharge of UNGD wastewaters to Pennsylvania’s streams [76].

The next chapter of this report investigates a different category of water quality risks: those associated with the changes to land cover we described in the “Impacts on Land Cover” chapter.

Impacts on Water Quality due to Changes in Land Cover

Key Findings

- Changes in land cover associated with natural gas infrastructure would lead to short- and long-term changes in hydrology and water quality.
- Changes in land cover could increase erosion rates up to 150 percent immediately after infrastructure construction and 15 percent in the long term.
- Soil-erosion rates during winter months are up to 25 times higher than during summer months.
- Runoff rates could increase by up to 4 percent, offset by an equivalent volumetric decline in groundwater contribution to streamflow.

Unconventional natural gas development results in landscape disturbance based on the need to construct infrastructure to support operations. This report's chapter titled "Impacts on Land Cover" described the potential changes to land cover associated with constructing well pads, roads, and gas gathering pipelines. These changes to the landscape also change the hydrologic character of the DRB, and can affect water quality through changes to sediment and nutrient export. Building roads, pipelines, and well pads requires clearing the land, removing topsoil, regrading, and compacting soil both in the infrastructure footprint and a right-of-way wide enough to install infrastructure. Mitigation measures—such as erosion- and sediment-control practices (silt fences, filter socks, and so forth) and remediation with planting of cover crops—can limit the loss of soil, but some permanent impact due to the initial land clearing and soil compaction is inevitable.

The full scope of water-quality outcomes resulting from land cover changes depends on the location of the infrastructure, the existing watershed conditions, and the

mitigation measures put in place by developers. Infrastructure that is built on land with high slopes and erodible soils; near or adjacent to stream banks; or necessitating the crossing of a stream or disturbance of wetlands will have a larger potential for ecological damage, primarily through erosion. The current condition of the basin in the three study areas is predominantly forested and agricultural, with limited residential and commercial development.

The previous chapter covered some of the potential impacts of the natural gas wastewaters on water quality. This chapter, by contrast, focuses on potential impacts on water quality due to the largely unavoidable land cover changes associated with UNGD. Such land-use changes often correlate to changes in hydrology, water quality, and—by extension—stream health. At the site scale, well pad development has been observed to increase sediment and nutrient concentrations, though vegetated stream buffers and erosion- and sediment-control practices can reduce loadings [77]. At a regional scale, development of well pads has been shown to correlate with increased in-stream Total Suspended Sediment loads [4], due to erosion and sedimentation.

Methodology

We modeled each of the study areas with the MapShed program developed by Penn State University [78]. The water quality calculations were performed with MapShed's integrated GWLF-E model based on the Generalized Watershed Loading Function [79], which simulates runoff, sediment, and nutrient loads based on watershed source areas. We modeled each of the study areas under three conditions:

- **Baseline:** Existing land cover
- **Initial Infrastructure:** Well pad, gathering pipeline, and new roads during or immediately after installation with minimum mitigation
- **Post-Development:** Infrastructure after the hydraulic fracturing operations are complete and gas is being produced, with partial remediation

The Initial Infrastructure condition represents a worst case of erodibility conditions that would likely persist from several days to a few months as the well pads, roads, and pipelines are constructed. This scenario is useful for setting the upper limit on the potential sediment and nutrient loadings, and determining which months of the year have conditions most conducive to erosion in the study areas. This scenario also assumes that the entire land conversion for infrastructure in a study area occurs at once, when, in reality, it would be installed at the pace of development over 30 years.

The Post-Development condition considers the long-term effects of land-use change after all the gas wells have been drilled and are in production. The well pads are

partially deconstructed (leaving only a well head, pump, and brine storage), and the gathering pipeline rights-of-way are revegetated with cover vegetation (low grasses and herbaceous plants); pipelines are operating, and the roads are little changed. We assumed (through parameter selection, not direct modeling) that some erosion and sediment control best management practices (BMPs) are installed, though not optimally, and that the post-development soil would remain somewhat compacted. Ultimately, the Initial Infrastructure and Post-Development scenarios should bracket a range of conditions reflecting a range of potential remediation cases.

We also assumed that all land cover changes are permanent, that there are no other land cover changes in the study area, and that there are no secondary land cover changes (e.g., converting additional forest to farmland to make up for arable area lost to gas infrastructure). We also did not include long-distance transmission pipelines to move natural gas to market and other appurtenant natural gas infrastructure (e.g., centralized storage or wastewater treatment facilities) in this analysis.

The results presented consider only runoff and streamflow produced within the study area (no upstream flow for Study Areas 1 and 3), and only loadings associated with land-use and in-stream processes (no point sources, livestock, or septic systems are included in the model). The results focus on the hydrologic and loading changes on the uplands—that is, the changes in flow or pollutant loadings coming directly from changes in the land surface.

The metrics we used to assess the changes include the following MapShed model outputs:

- **Runoff:** The volume of water that flows off the land surface and into streams during storms
- **Groundwater Recharge:** The volume of water that soaks into the ground during rain events and contributes to streamflow
- **Erosion:** The mass of soil that is dislodged from the land surface by precipitation runoff and is carried into streams
- **Sediment:** The mass of soil that is deposited on land (generally as dust) that gets washed off into streams
- **Nutrients:** The mass of nitrogen (Total Nitrogen, or “TN”) and phosphorus (Total Phosphorus, or “TP”) compounds washed off the land surface in runoff or in groundwater entering the stream⁴

⁴ These can contribute to algal growth, which can lower available oxygen in the stream.

Results

The land-use changes associated with UNGD in the DRB affect hydrology, loadings of sediments, and (to a lesser extent) nutrients in the study areas. The results vary significantly by scenario and condition (Initial Infrastructure versus remediated condition). Table 9 indicates changes in hydrology (runoff and groundwater recharge) and upland loadings (erosion, sediment, nutrients) for each scenario, expressed as a percent change from the baseline total. Only the land surface processes are included in the total.

Table 9. Changes in hydrology and loadings for each scenario. The land cover changes result in large increases in erosion and sediment (“Sed.”) loadings compared to the baseline, especially for Dispersed scenario/Initial Infrastructure (“Initial Infra.”) conditions. The hydrology and nutrient loading changes are smaller in magnitude. Units = % change from baseline.

Study Area	Development Scenario	Condition	Runoff	GW	Erosion	Sed.	TN	TP
1	Dispersed	Initial Infra.	2.8	-0.17	98	54	6.3	11
	Dispersed	Post-Dev.	1.6	-0.09	15	-2.1	-1.6	-5.0
	Concentrated	Initial Infra.	1.7	-0.10	67	33	3.7	6.9
	Concentrated	Post-Dev.	1.0	-0.09	10	-5.5	-1.8	-4.8
2	Dispersed	Initial Infra.	3.4	-0.64	138	125	32.0	49
	Dispersed	Post-Dev.	1.8	-0.32	16	14	2.6	2.7
	Concentrated	Initial Infra.	2.1	-0.43	102	93	23.0	35
	Concentrated	Post-Dev.	1.1	-0.27	13	11	1.8	2.1
3	Dispersed	Initial Infra.	3.4	-0.46	110	96	12.3	20.0
	Dispersed	Post-Dev.	1.9	-0.18	14	12	0.7	-1.6
	Concentrated	Initial Infra.	1.9	-0.18	66	57	7.2	12
	Concentrated	Post-Dev.	1.0	-0.14	8.0	6.8	0.3	-1.1

Notes: GW = Groundwater recharge

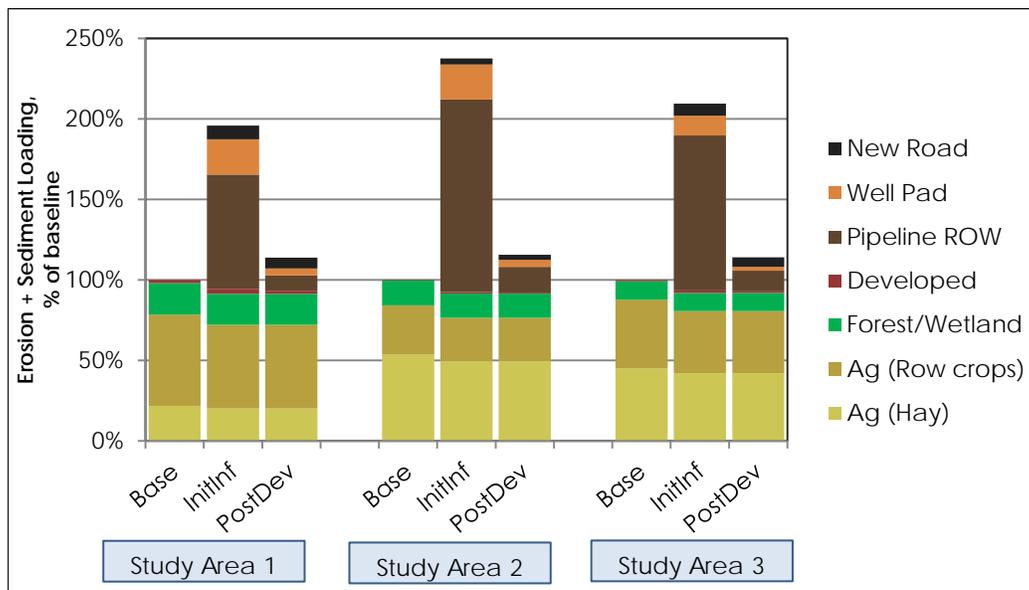
The hydrologic changes show increases in runoff of 1-3 percent, with reductions in groundwater recharge of a few tenths of a percent. On a volume basis, however, these changes are nearly equal, so average yearly streamflow is nearly unchanged, but flow distribution changes. The flows increase (roughly 1.5 percent) at peak flows, and decrease (1 percent or less) across the rest of the flow distribution. In volume terms, the groundwater contribution to flow will decrease by somewhere between 70 (Concentrated scenario, Post-Development conditions) and 145 million gallons per year (Dispersed Scenario, Initial Infrastructure conditions) for Study Area 1. The corresponding ranges are 140-330 million gallons for Study Area 2, and 90-305

million gallons for Study Areas 3. On an area-averaged basis, the approximate range of decreased groundwater flow is 0.35-2 million gallons per year, per square mile.

Table 9 also shows a noticeable change in the erosion and sediment loadings, and less significant changes in nutrient loading. Erosion and sediment changes both increase suspended sediment loadings in streams, but the sediment loadings are much smaller in magnitude. Combining these loadings gives a clearer picture of the potential changes in soil volume leaving the landscape.

Figure 15 illustrates how the combined erosion and sediment loadings change, and how the individual land-use changes affect them. Results are shown as a percentage of the baseline total load (upland only). Thus, the baseline load equals 100, and 240 would represent a 140-percent increase. The stacked bars show the relative contribution of each existing land cover (forest/wetland, agricultural hay and pasture, agricultural row crops, and developed area) and gas infrastructure land cover (well pads, pipelines, roads) to the total loading. The largest contribution to the erosion and sedimentation impacts are from the pipeline right-of-ways, especially for the Initial Infrastructure (“InitInf”) condition. The impacts from roadways are smaller in magnitude but are not reduced as much in the Post-Development (“PostDev”) condition, as compared to well pads and pipeline rights-of-way.

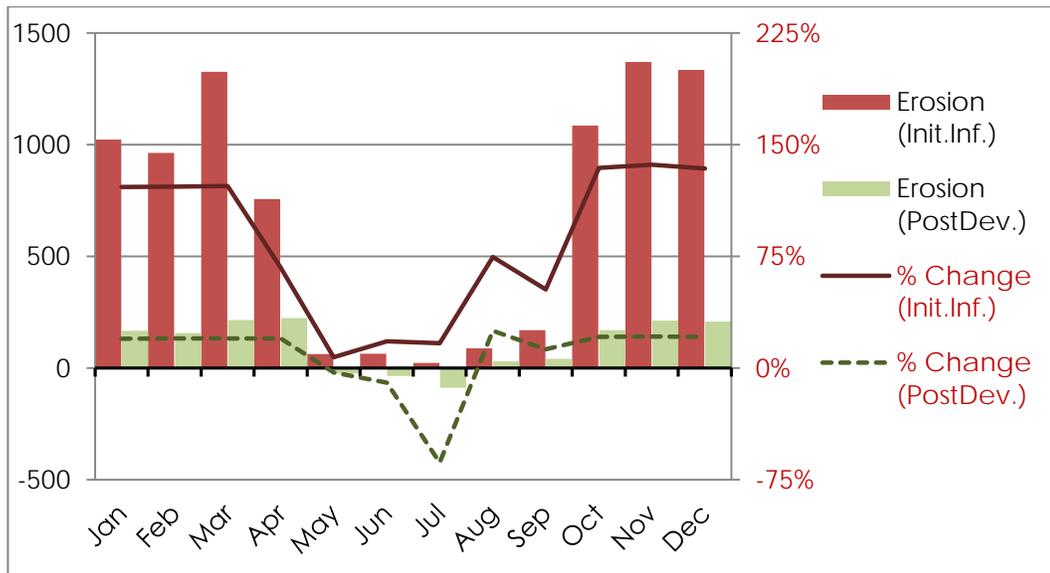
Figure 15. Total upland erosion plus sediment loading, as percent of the baseline loading. Increases in erosion and sedimentation are caused mainly by the pipeline rights-of-way and are more severe in the Initial Infrastructure (“InitInf”) condition than the Post-Development (“PostDev”) condition. Units = percent of baseline. (baseline = 100)



The total change in loading also depends on the types of land cover affected by the conversion. The relative amount of agricultural versus forest area converted has a strong influence on the upland loading results. For example, converting forest area to natural gas infrastructure increases loads, while agricultural (and especially cropland) conversions may lead to net reductions in some loads, especially nutrients. This accounts for much of the variation in the nutrient results in Table 9 (page 46).

We also found the potential changes to erosion rates vary widely during the year. Figure 16 shows the monthly variation in erosion relative to the baseline condition for both the Initial Infrastructure and remediated condition. The changes in winter erosion predominate and account for most of the total change. The difference is such that if the Initial Infrastructure conditions persisted for three months, 25 times more erosion would occur if all infrastructure were built in October through December versus May through July.

Figure 16. Monthly variation in erosion relative to the baseline condition for both the Initial Infrastructure and Post-Development condition. Most of the increase in erosion between baseline and developed conditions occurs in winter months. Units = tons (left axis); percent change (right axis).



Discussion

The land-use changes associated with UNGD in the DRB have the potential to cause noticeable changes in hydrology and erosion, despite affecting a relatively small proportion of the basin. The Initial Infrastructure conditions result in the highest susceptibility of the study area to erosion, noticeably in the winter months. Even in the Post-Development condition, the additional roads, pipelines, and well pads do not perform the same hydrologic functions as the forests they replace, resulting in potentially long-term increases in peak runoff, erosion, and nutrient loading, and possible decreases in stream base flow.

By way of context, in Study Area 2 (178 square miles), the volume of runoff-increase and groundwater recharge-decrease both equal roughly 330 million gallons per year (0.9 million gallons per day) for the “dispersed” scenario for the Initial Infrastructure condition. This yearly volume of water would fill the Empire State Building 1.2 times. Also, if the Initial Infrastructure conditions persisted for three months, on average, approximately 18,000 tons of soil would be eroded. If piled on top of an average suburban house lot (one-quarter acre), the pile of soil would be 45 feet tall.

The results report only the net changes averaged across the entire case study watersheds. The most prominent changes are likely to occur in the upland portions of the watersheds and in small streams and ponds adjacent to the infrastructure development. Further modeling would be needed to assess potential impacts on a smaller scale. Additional land development (for housing, more agriculture, other uses) in the watershed may be more likely to cause downstream impacts, as the hydrologic and water quality functions of upland streams would start as more degraded.

This analysis is a limited one and does not account for the full range of impacts that may result from land-use changes associated with gas development. This analysis used the Mapshed model to estimate pollutant changes over the study area using typical factors for the types of land covers described. It does not cover the large potential variation in parameters such as curve number, soil bulk density (compaction), or other soil factors. Furthermore, the model parameters cannot directly account for the impact of best management practices, or the impacts that may occur were these practices to fail. Pennsylvania data on permit violations indicate that erosion- and sediment-control violations at well sites are relatively common (roughly 630 violations at 530 well sites since 2009) [76]. The severity of these violations is not known, but in some of these cases, the failure (or absence) of best management practices for erosion and sedimentation could result in loadings closer to the Initial Infrastructure condition than the Post-Development condition presented here.

In addition, the flow changes and changes to sediment loadings are likely to affect the ecological conditions of the watershed. The land cover changes will likely result in environmental flow changes (especially increased peak flows and decreased base and low flows), which can affect the health and relative distribution of a wide range of plant and animal species [58-59].

We recommend further study to better assess water-quality outcomes using more-detailed models with greater spatial resolution and more-detailed parameters using sampling data from the modeled watershed. For instance, variability in agricultural practices can have a strong influence on erosion rates and nutrient export. Further study could also compare alternate future land-use changes (e.g., more suburban development) with results for land-use change specifically associated with gas development. Additional study with a more-detailed case study model could also investigate the combined effects of water withdrawal, wastewater effluent disposal, and land cover changes.

Impacts on Air Quality

Key Findings

- Natural gas development could as much as double nitrogen oxides (NO_x) emissions, compared to current emissions in affected DRB counties.
- The primary source of NO_x emissions from natural gas development could stem from compressor stations to move the gas through gathering pipelines, rather than from well development or completion.
- Compressor stations represent a long-term source of NO_x emissions in impacted areas, rather than the short-term, intermittent impact from well development.
- Methane leakage from natural gas development in the DRB could contribute an additional 0.5–2.2 percent per year to the current methane emissions from Marcellus Shale development now occurring in Pennsylvania and West Virginia.

Unconventional natural gas development is an industrial process that involves a host of machinery and operations to extract natural gas from shale deposits. Shale gas operations release a variety of pollutants that can degrade local air quality, including nitrogen oxides (NO_x); sulfur oxides (SO_x); particulate matter (PM); and volatile organic compounds (VOCs), such as formaldehyde, benzene, toluene, ethylbenzene, and xylene (BTEX) [80]. NO_x, SO_x, and PM are subject to national ambient air-quality standards, (NAAQS) due to their potential to cause harm to human health and the environment [81]. Furthermore, NO_x and VOCs are the precursors to ozone, the primary component in smog, which can cause respiratory illness [82].

Impacts on air quality from industrial emissions occur during each of the stages of shale gas development [82]. These emissions stem from the use of diesel-powered equipment to prepare well pads and diesel trucks to transport water and supplies to and from well pads. The drilling, hydraulic fracturing, and production processes also

utilize diesel machinery and contribute to these emissions. In addition, condensate tanks and waste ponds at well pad sites can produce emissions. Significant emissions can also arise from combustion-powered compressor stations that compress natural gas to keep it flowing through the pipeline system.

While these local risks to air quality would most likely impact the DRB in the short term, there is a large field of research that has focused on the potential climate change impacts due to greenhouse gas (GHG) emissions from shale gas development [80, 82-84]. These GHG emissions stem from the leakage of natural gas (i.e., methane, or CH₄) at various points throughout the development cycle, from extraction to processing and transmission. However, the combustion of natural gas to generate electricity releases half as much carbon dioxide (CO₂) as coal, leading many to champion the climate benefits of natural gas and term it a “bridge” fuel to the future. There is considerable debate as to whether the methane leakage from natural gas operations eclipses any of these gains from reduced CO₂ emissions, especially considering that methane has 34 times the greenhouse-warming potential (GWP) of CO₂ (on the 100-year time horizon); on the 20-year time horizon, methane has 86 times the GWP of CO₂ [85]. A recent study suggests that methane leakage should be below 3.2 percent to realize net climate benefits from the transition [86], while field measurements of methane losses have found a range from between 0.3 percent and 17 percent (see Table 11 below for references).

In this chapter, we focus on the potential emissions and impacts to air quality in the DRB from natural gas development. In particular, we calculated the potential contributions to VOC, NO_x, PM, and SO_x emissions from projected natural gas development in four DRB counties: Wayne County (PA), Broome County (NY), Delaware County (NY), and Sullivan County (NY). We performed this analysis at the county-wide scale to compare the results to EPA emission inventories. In addition to criteria pollutants, we calculated the potential contribution to methane emissions from projected natural gas development in these counties. We did not analyze the potential for any more localized impacts on air quality, as this was beyond the scope of the study.

Methodology

To assess the impacts to air quality, we applied relevant values from the professional literature to our build-out scenarios to calculate the emissions associated with natural gas development. For ease of comparison with the common emission values, we report the calculated emissions at the county level, rather than by study area. Furthermore, we used the two development rate scenarios described in Table 1 (“dispersed” and “concentrated”) to illustrate the impacts of the development rate on air quality:

- **Average Development Year:** Assumes that development occurs at a constant rate over a 30-year build-out
- **Maximum Development Year:** Assumes that 20 percent of total well build-out in each county occurs in one year (up to a maximum of 200 wells/year, which is representative of the highest-developing counties in the Marcellus Shale today).

The average and maximum-year scenarios show the potential variation in emissions that could be expected from natural gas development activities in each county.

To assess the local impacts on air quality that might be expected from shale gas development in the DRB, we applied the emissions estimates from a recent study on Marcellus Shale development in Pennsylvania [87] to our projected well development results. This study provided emissions values for VOCs, NO_x, PM, and SO_x on a per-well basis during various well site activities, based on data reported from Marcellus Shale gas producers. In addition to well development, the study reported the contribution from compressor stations that support production. The study estimated emissions from compressor stations based on the reported “potential to emit” values from permits, which indicate the maximum amount of emissions the facility is permitted to emit by the Pennsylvania Department of Environmental Protection. We estimated the number of compressor stations in each county by assuming that a centralized station would serve all well pads within a 50-square-mile radius, based on estimates from Marcellus Shale operators in the New York Department of Environmental Conservation’s Draft Supplemental Generic Environmental Impact Statement [88]. The study reported the high and low values of the range for each pollutant from multiple sites, and we used the average of these values to report results. To estimate the impact of the emissions, we compared the calculated emissions to the counties’ reported emissions from the EPA 2011 National Emissions Inventory (NEI) [89].

To assess the greenhouse gas contributions that might result from shale gas development in the DRB, we calculated methane leakage as a percentage of the natural gas production expected in the DRB. To determine the natural gas production, we assumed that all wells would exhibit an average EUR of 1.6 Bcf per well (the same EUR value that we used to develop our build-out scenarios, see page 9), and applied a well decline curve based on a similar EUR [90] to estimate the monthly production per well in the DRB. We applied this value to the average number of wells that would be developed per month in the two annual scenarios to determine annual production. Using these production values, we then applied leakage rates based on relevant values from professional literature describing field measurements (top-down) of methane leakage (see page 58). We chose to focus on top-down studies for this assessment, based on a recent review of methane leakage from natural gas systems that found that assessments based on inventories (bottom-up) tend to underestimate this leakage [91].

For both the methane and non-methane assessments, our well-development results from the “concentrated” and “dispersed” scenarios result in similar number of wells developed. Thus, only the “dispersed” scenario is considered throughout this chapter.

Results

Criteria Pollutant Emissions

Table 10 shows the estimated annual pollutant emissions from shale gas development in the DRB, based on average and maximum annual well development scenarios. In addition to the number of new wells, we project that 22 new compressor stations could be built in the DRB to support transmission of natural gas through new gathering pipelines. We present the range of potential emissions expected from the two scenarios by evaluating emissions with one compressor station in each county, followed by the emissions with all 22 compressor stations present in the DRB. In each scenario, NO_x emissions would be the largest contributor to air pollution in the DRB from this development.

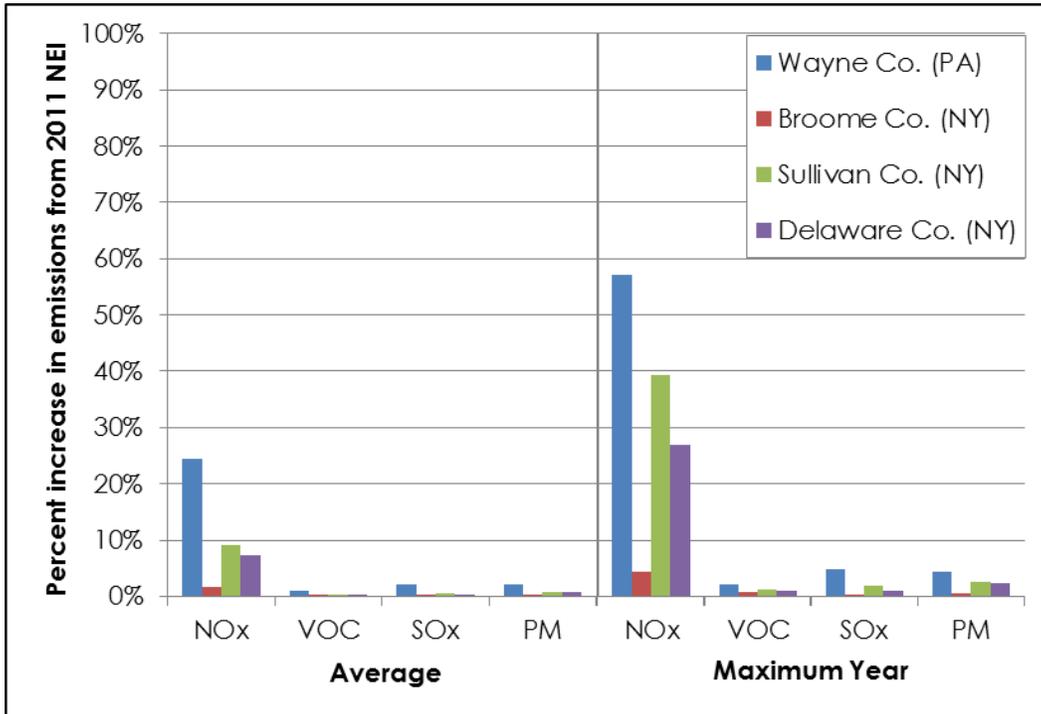
Table 10. Annual emissions estimates for projected natural gas development by county (and for one compressor station) in the DRB. NO_x emissions would be the largest contributor to air pollution by weight. Units = metric tons, unless noted otherwise.

County	Scenario	Wells	CH ₄ (Bcf ^a)	NO _x	VOC	PM	SO _x
Wayne	Avg	78	832	441	91	14	5.6
Broome	Avg	8	93	105	34	4.5	1.3
Sullivan	Avg	27	256	197	50	7.2	2.5
Delaware	Avg	16	184	146	41	5.7	1.8
DRB	Avg	129	1,365	889	216	32	11
Wayne	Max	200	2,081	1,026	190	31	13
Broome	Max	46	483	290	66	10	3.7
Sullivan	Max	163	1,698	850	160	26	11
Delaware	Max	98	1,024	539	108	17	6.8
DRB	Max	507	5,287	2,705	522	84	34

^a Bcf = billion cubic feet.

To determine the extent of these emissions impacts, we compared the projected annual emissions from development in each county (plus one compressor station) to the total emissions of each pollutant in each county from the EPA’s 2011 NEI. Figure 17 shows the results of this comparison for the two scenarios of annual well development.

Figure 17. Pollutant emissions from well development (and one compressor station) for average-year (left) and maximum-year (right) scenarios, relative to total county emissions from the 2011 NEI. Natural gas development could lead to a significant increase in NO_x emissions for three of the four DRB counties.



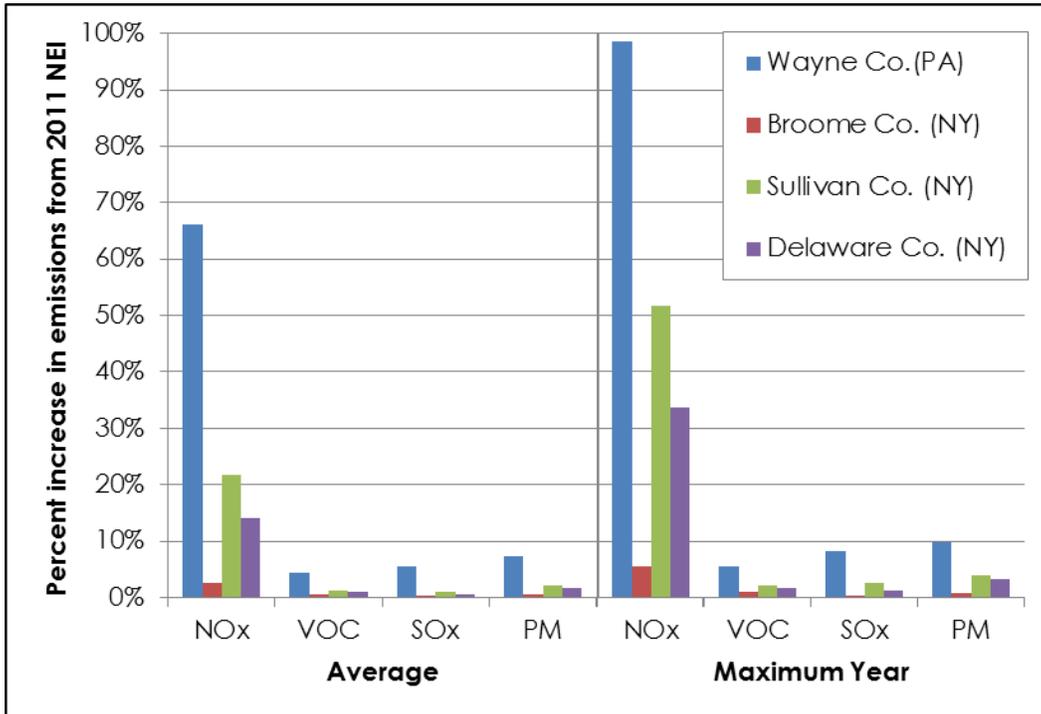
We see noticeable potential increases in NO_x emissions for three of the four counties: Wayne County (PA) and Sullivan and Delaware Counties (NY) could all see greater than a 27-percent increase in NO_x emissions under the maximum annual-development scenario. Under the average annual-development scenario, Wayne County could still see a substantial increase in NO_x emissions (25 percent) from the shale industry, but NO_x contributions from the other counties were all below 9 percent. Broome County (NY) did not see a significant increase in NO_x emissions in either scenario. This is not surprising, since only a small portion of Broome County falls within the DRB.

The contributions to VOC, SO_x, and PM emissions from annual shale gas development did not appear as significant compared to other activities in these counties. None of the counties showed a noteworthy increase in either the average year (less than 2 percent) or maximum year (less than 5 percent) scenarios at the county scale, though the individual pollutants, especially VOCs, could have impacts at a local scale (see “Health Risk Factors and Affected Population” chapter) .

While the emissions attributed to well pad development and well completion represent one-time contributions in the year the well was drilled, compressor stations will continually contribute to a county's emissions inventory after they are built. With this fact in mind, we determined the annual emissions from well development with all 22 compressor stations in place to see the impact on the DRB. Based on our projections, the 22 compressor stations would be spread out in the DRB counties according to the following breakdown: 12 in Wayne Co. (PA), 5 in Sullivan Co. (NY), 3 in Delaware Co. (NY), and 2 in Broome Co. (NY). This breakdown corresponds to the expected number of wells projected in each county. Figure 18 shows the updated annual emissions inventory for the two scenarios with the higher count of compressor stations. Note that these projections for new compressor stations only account for supporting gathering pipelines, and do not account for any additional compressors that may be needed to support larger transmission pipelines to carry the natural gas to market.

With the addition of a full complement of compressor stations, we see significant potential increases in NO_x emissions for three of the four counties. Wayne County (PA) and Sullivan and Delaware Counties (NY) could all now see greater than a 34-percent increase in NO_x emissions under the maximum annual-development scenario. In fact, NO_x emissions could almost double in Wayne County under that scenario, due to the addition of 12 compressor stations. Under the average annual-development scenario, Wayne County would still see a substantial increase in NO_x emissions (66 percent) from the shale industry, but NO_x contributions from the other counties were all below 21 percent. Broome County (NY) still did not see a significant increase in NO_x emissions in either scenario.

Figure 18. Pollutant emissions from well development (and 22 compressor stations) for average-year (left) and maximum-year (right) scenarios, relative to total county emissions from 2011 NEI. The full complement of compressor stations leads to a large increase in NO_x emissions in 3 of the 4 DRB counties.



The contributions to VOC, SO_x, and PM emissions from annual shale gas development did not appear as significant compared to other activities in these counties. Only Wayne County (PA) showed any relative emissions higher than 5 percent across these pollutants at the county scale.

Methane Emissions

Natural gas and petroleum systems represent the largest contributing sector to methane emissions in the United States [16]. Table 10 shows the projected methane emissions from natural gas development in the DRB. Using the well decline curve for a 1.6 Bcf EUR-model well, we estimated the annual production from natural gas development in the DRB to be 22.6 Bcf in an average year, and 87.5 Bcf in a maximum year. We applied methane leakage rates from the academic/professional literature to these production values to estimate the potential methane emissions from development in the DRB. Table 11 presents these results.

Table 11. Potential methane emissions from projected development in the DRB, based on methane leakage rates reported from field measurement (top-down) studies. Units = Bcf – billion cubic feet.

Study	Leakage Rate	Potential Methane Emissions (Bcf)	
		Average Year	Maximum Year
Peischl (2015) [92]	0.3%	0.1	0.3
Peischl (2015) [92]	1.6%	0.4	1.4
Peischl (2015) [92]	1.9%	0.4	1.7
O'Sullivan (2012) [93]	3.6%	0.8	3.2
Miller (2013) [94]	3.7%	0.8	3.2
Petron (2012) [95]	4.0%	0.9	3.5
Karion (2013) [96]	8.9%	2.0	7.8
Schneising (2014) [97]	9.1%	2.1	8.0
Caulton (2014) [98]	10.0%	2.3	8.8
Peischl (2013) [99]	17.3%	3.9	15.1
Average	6.0%	1.4	5.3

Applying the average leakage rate from the literature of 6 percent, we estimated annual methane emissions of 1.4 Bcf in an average year and 5.3 Bcf in a maximum development year. Applying the same methodology to current annual Marcellus Shale production, which is about 4 trillion cubic feet, we estimate total Marcellus emissions to be 240 Bcf. Thus, shale gas development in the DRB could contribute an additional 0.5 percent to 2.2 percent per year to the current methane emissions of the Marcellus Shale.

Discussion

If natural gas development were to proceed in the DRB, there could be varying impacts to air quality. Compared to activities that are already occurring in the DRB counties, our results suggest that NO_x emissions would be the biggest contributor to air pollution from shale gas development. By comparison, the projected NO_x emissions in Wayne County, PA, from the average year of natural gas development (with one compressor) would be equivalent to adding over 53,000 cars to the road in the county that year.⁵

⁵ This is based on EPA's average NO_x emissions (0.693 g/mile driven) per year (12,000 miles driven) for passenger cars [100].

These counties currently enjoy clean, high-quality air, due to the absence of any major emissions sources such as power plants. However, localized development in certain parts of each county could still pose a reduction in air quality due to this development. Some studies have attributed this localized development to a variety of airborne health risk factors (see the “Health Risks and Population” chapter for more details and references). The primary contribution to these NO_x emissions could come from compressor stations, which represent a long-term source of emissions, versus the one-time contribution from well-development activities.

Furthermore, methane releases from natural gas operations are a significant contributor to methane emissions in the United States. Each year, if all 1.4 Bcf of potential methane leakage could be captured and used to fuel a natural gas power plant, roughly 139 gigawatt hours of electricity could be produced⁶, enough to power over 16,000 homes in the area⁷ for a year. While atmospheric methane does not necessarily have significant local effects, it is a powerful greenhouse gas that could have impacts beyond the DRB.

⁶ The EIA estimates that 1,000 cubic feet of natural gas can generate 99 kilowatt-hours of electricity [101].

⁷ Average monthly household electricity use in the Middle Atlantic region is 701 kWh [102].

This page intentionally left blank.

Health Risks and Affected Population

Key Findings

- More research and better tracking of health impacts are needed to reliably project how shale gas development could affect health *outcomes*. Scientific literature has shown that some health risk factors are related to distance (e.g., 1 km, 1 mile) from a well pad.
- Roughly 45,000 people live within one mile of a projected well pad location. This population predominantly resides in Wayne County, PA, where nearly 60 percent of the county's population could be affected by increased well development.
- Development of more wells per pad reduces the number of people in close proximity (<0.5 mile) to well pads, but potential exposures to certain risk factors could be prolonged.

Of the environmental impacts of unconventional natural gas development, those that pose a potential risk to human health often attract the most attention and concern. In large part, the link between unconventional Marcellus Shale gas development and adverse health outcomes has not been rigorously tracked in a manner that has produced conclusive scientific literature [103]. There has been considerable research into the potential pathways and risks of exposure, but the potential health outcomes depend on type, magnitude, duration, and frequency of exposure to contaminants and risk factors [104]. Just as previous chapters noted that there is variation in productivity of individual wells, water use, concentrations of wastewater contaminants, and air emissions rates, the potential risks to human health may vary considerably across the study area, and even from well pad to well pad.

While it is not possible to use the scientific literature to derive rigorous estimates of specific health metrics (e.g., cancer cases above baseline), a number of studies (see Table 12) provide some evidence that risk factors and possibly health outcomes correlate with distance from primary gas development activities (i.e., well pads). This

analysis quantifies the population within certain distances from well pads as an initial estimate of the potential affected population.

While the link between natural gas development and health outcomes has not been rigorously investigated [103], the major potential exposure pathways have been explored. Krupnick et al. [50] documented the risk pathways (routine and accidental) of UNGD agreed upon by a wide range of experts. Of the 15 consensus risk pathways (those with priority for further regulation or voluntary action), 14 involved routine or accidental releases (of frac fluid, wastewater, methane, etc.) to air, surface water, or groundwater, indicating the potential for human health exposures. Where possible, this study considers the risk pathways and accompanying research indicating that risks or health outcomes vary with distance from the activity associated with the risk pathway.

Table 12 summarizes some of the risks and health outcomes identified in the literature based on distance from natural gas activities (most often associated with the well pad). Typically, these studies evaluate risk factors or metrics of health risks/outcomes at several distances from primary gas development activities, such as the injection well site. The most common distance-threshold for measuring the most likely risks is 1,000 meters or a half-mile. To evaluate more general risks, or establish a threshold distance for a control population, the selected distances are commonly 2,000 meters or one mile. For example, a recent study by Rabinowitz et al. [82] investigated health outcomes by surveying residents living within one kilometer, between one and two kilometers, and more than two kilometers from wells in Washington County, PA, regarding health symptoms they were experiencing. Several of the studies simply report sampling results for contaminants, including distance from the potential (gas infrastructure) source. To capture some of these values that might be experienced at the very closest distances, we also consider a distance of roughly 1,000 feet or less. Finally, for distances of less than 300 feet, we consider at-site exposures that residents with well pads very close to their homes might experience, as well as oil and gas workers working on a well pad.

One of the most commonly discussed risk pathways is groundwater contamination via casing and cementing failures [50], allowing methane and/or frac fluid and flowback to enter the groundwater aquifers overlaying the shale. According to a recent analysis of Pennsylvania Department of Environmental Protection violations data, unconventional well casing and cementing failures do occur regularly (in about 2 percent of wells inspected after initial drilling), and appear to occur more often in the northeastern part of the Marcellus (8.5 times higher risk than the rest of the state) [105]. The likelihood of groundwater contamination by methane from these types of failures appears correlated with distance, as Jackson et al. [106] found concentrations of methane in groundwater 6–23 times higher within 1 kilometer of an unconventional gas well than outside that distance. Other pathways include potential for accidents, leaks, or spills of frac fluid or wastewater fluids to infiltrate

into groundwater from the surface. This risk pathway is particularly relevant for Broome (NY), Delaware (NY), Sullivan (NY), and Wayne (PA) Counties, whose population primarily (77–100 percent) uses groundwater for drinking [60].

Krupnick et al. [50] also interviewed experts who identified several risk pathways related to air contaminants emitted from activities in the drilling and production phases of development. Notably, there are air emissions associated with machinery and trucks during drilling and fracking; venting and flaring of methane during completion, production, and transport of gas; and emissions of volatile compounds from frac fluid and waste fluids (especially when stored in open impoundments). Many of these emissions are located near the well pad, but some are much more regionalized (truck traffic) or are associated with particular activities that may occur away from the well pad (e.g., volatile emissions from fluid or wastewater storage). Our analysis primarily considers distance from well pads, but health risks may be equally tied to distance from other activities, such as wastewater storage in impoundments.

Volatile air pollutants are of special concern in much of the health literature, and the first step in quantifying their risk is detecting their presence. Colborn et al. [107] detected dozens of VOCs, polycyclic aromatic hydrocarbons (PAHs), and carbonyls within 1.1 kilometers of a well pad, and noted health impacts, including endocrine disruption associated with exposures to many of the chemicals. A study completed for Forth Worth, Texas [108] detected many of the same chemicals at a slightly greater distance. Presence of these chemicals does not equate to health risk if concentrations are very low.

Studies by Macey et al. [109] and McKenzie et al. [7] computed health risks associated with exposure to the air pollutants (especially benzene, formaldehyde, and hydrogen sulfide) at a few distances from the gas development activities. They found potential for slight increases in cancer risk, and toxicity risk based on computing hazard indices for the measured concentrations of pollutants for chronic and subchronic exposures. More recently, some studies have been seeking evidence these exposures might lead to adverse health outcomes. A study by Rabinowitz et al. [110] indicated that there may be a relationship between dermal and upper respiratory symptoms (reported in health surveys) and distance from well pads. In addition, a study by Jemielita et al. [111] found that hospitalization rates in several Pennsylvania counties correlated with a number of active unconventional gas wells per square kilometer in patients' zip codes, especially for cardiology- and neurology-related hospital admissions.

Table 12. Health risk factors and impacts cited in literature, versus distance from gas development activities. Abbreviation and symbol definitions, as well as color-coding, appear below the table.

Environmental Health Risk	At-site <300 ft	<1000 ft	~0.5mi/1km	~1mi/2km	2 km or more	Studies		
VOCs detected			14 (39/68) ^a		8 (45/59) ^b	[107], [108]		
Benzene	A I C C4	C5	C5	C6		[109], [7]		
Carbonyls detected			4 (8/12) ^a		8 (9/11) ^b	[107], [108]		
Formaldehyde		A I C C5				[109]		
PAHs detected			3 (12/16) ^a			[107]		
Hydrogen Sulfide	A I	I				[109]		
Cumulative excess cancer risk – air			5-6 per million	5-10 per million		[7]		
Total Hazard Index – air, subchronic			0.4 - 5	0.1 – 0.2		[7]		
Total Hazard Index – air, chronic			0.3 - 1	0.2 - 0.4		[7]		
# health symptoms reported			3.27	2.56	1.60	[110]		
Dermal symptoms (OR)			4.13	2.44 NS	Ref.	[110]		
Upper respiratory symptoms (OR)			3.10	1.76 NS	Ref.	[110]		
Silica exposure (% samples > PEL/REL)	47%/ 79%					[112]		
Noise levels (dB)	Max 102	63 (Max:95)	54 (Max:80)	52 (Max:74)		[113]		
Methane conc. in GW (times ref. values)		>6	6	Ref.	Ref.	[106]		
VOC- Volatile Organic Compound; PAH – Polycyclic Aromatic Hydrocarbon; IRIS – Integrated Risk Information System; ATSDR – Agency for Toxic Substances and Disease Registry; MRL – Minimum Risk Level; GW - Groundwater; PEL – Permissible Exposure Limit; REL – Recommended Exposure Limit; OR – Odds Ratio; NS – Not statistically significant								
^a Chemicals detected in >50% of samples (# chemical detected/ # tested) [107]								
^b Chemicals detected in >90% of samples (# chemical detected/ # tested) [108]								
Concentration exceeds ATDR MRL A Acute level I Intermediate Level C Chronic level								
Excess IRIS cancer risk at C4 1/10,000 C5 1/100,000 C6 1/1,000,000 level								
Odds ratio (increased likelihood relative to a reference [*Ref.*] population) # Value times Ref. value #								
Chemicals detected (air)	Health risks (air)	Health outcomes (symptoms)	Exposures To Noise & Dust	Ground-water risks	No or insufficient data	Moderate health risk	Lesser health risk	No significant health risk indicated

Occupational exposures are another category of exposure worth mentioning. Gas industry workers are likely to have higher exposures to volatile chemicals, due to their proximity to emissions sources. Additional health risks for workers and

residents living close to well pads could result from worksite accidents; exposure to airborne silicates (dust) from the mixing of frac sand [112]; and elevated noise levels, which have been found to exceed 100 decibels (dB) at well pad sites during hydraulic fracturing and that persist at lower levels (roughly 60-80 dB) for 60 days or more [88, 113-114]. The noise levels decrease as distance from well increases.

Methodology

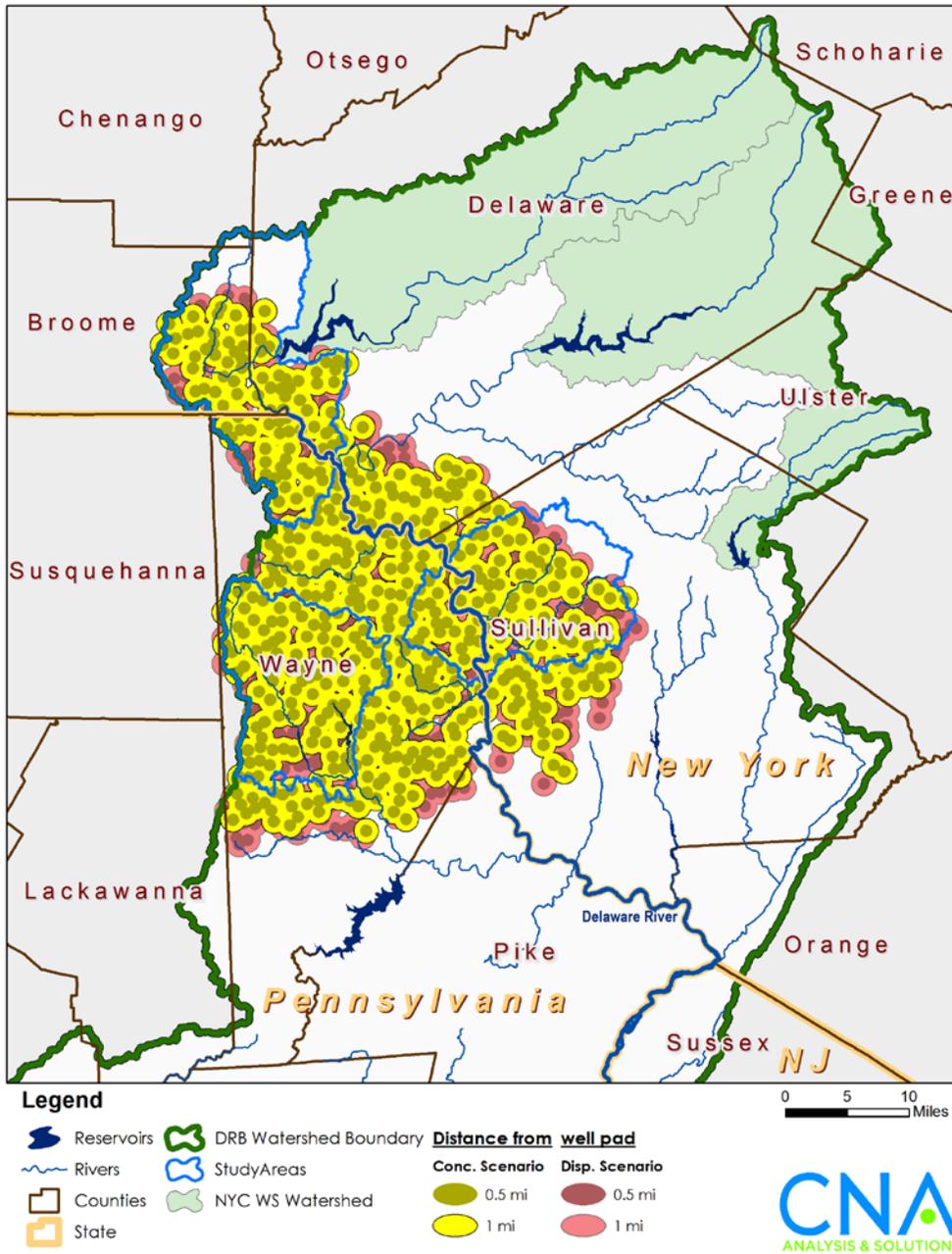
Until more rigorous data on health outcomes, exposure pathways, risk of exposure, and expected dosages become available, it is difficult to perform a detailed assessment of health impact, especially in a prospective analysis. Furthermore, actual risks of exposure depend strongly on both industry practices and regulations. Instead, this study identifies the potential population at risk based on distance to well pad locations identified in this study.

This study uses a buffer-analysis method to determine the approximate number of people and houses within several distances of the well pad commonly cited in the health literature. Using projected DRB well pad locations, we generated circular buffer polygons of 1,000 and 2,000 feet; 0.5 and 1 mile; and 1,000 and 2,000 meters in GIS software.

Figure 19 shows a map of the 0.5-mile and 1-mile buffers around well pads superimposed on county and study area boundaries. The yellow buffers are for the “concentrated” scenario. The red buffers show the additional area affected in the “dispersed” scenario (all of the yellow areas are also included). Similar buffers were created for 1,000 and 2,000 feet, and 1,000 and 2,000 meters.

Using the U.S. Census Bureau’s Census Block data (the finest resolution available) and the associated 2010 Census housing and population counts, we computed the expected population within each buffer distance. We also intersected the census blocks with the buffer areas to determine overlap, and we determined population and house counts based on an assumption of uniform density within blocks (a reasonable assumption, since the blocks are relatively small). Finally, we performed additional intersections with county and study area boundaries to determine the distribution of potential impacts on populations.

Figure 19. Map of the 0.5-mile and 1-mile buffers around well pads superimposed on county and study area boundaries. Most of the population within the portion of the DRB with projected gas development would be within one mile of a well pad. At smaller distances, a smaller population would be affected. Except on a few fringes of the development area, there is not much difference between the concentrated and dispersed scenarios.



Note: NYC WS Watershed – Watershed area of New York City water supply reservoirs.

Results

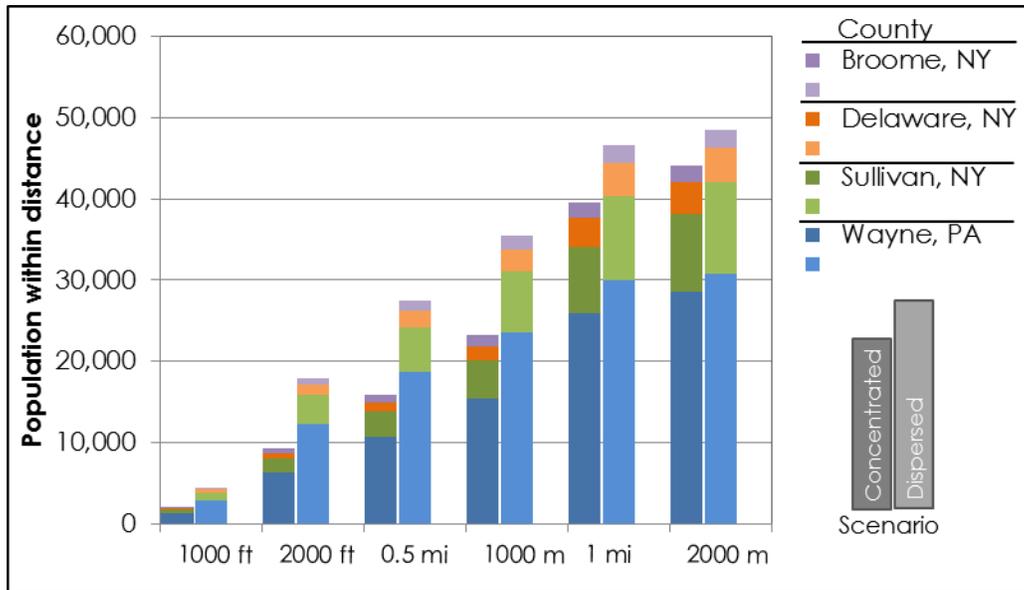
Hydraulic fracturing gas development with multiple wells per pad results in reasonably low overall well pad density, but fairly even distribution across the landscape. This even spacing results in large areas within reasonably short distances of the nearest wells. Figure 19 (previous page) illustrates the extensive portion of the study areas within a mile of the nearest well pad. While the portion of the DRB with well pads has few gaps in between well pads, the areas within a certain radius of well pads are more important to consider in the context of the portions of the study areas and the counties with population in the affected areas. Table 13 shows the area within 0.5 mile and 1 mile of the well pads in square miles, and as a portion of the study areas and most affected counties. The 0.5- and 1-mile distances are representative of the closer and farther distances referenced in the literature (see Table 12). As expected, the “dispersed” scenario results in more total area affected, because there are more well pads developed.

Table 13. Area within 0.5 mile and 1 mile well pad buffer, by county. The “dispersed” scenario affects a larger area, but at 1 mile, the gap between scenarios narrows. Units = square miles, % of county area.

County	Scenario	Within 0.5 mile		Within 1 mile	
		Area	%	Area	%
Wayne County, PA <i>751 sq. mi.</i>	Dispersed	362.1	48%	528.1	70%
	Concentrated	221.6	30%	472.3	63%
Broome County, NY <i>715 sq. mi.</i>	Dispersed	37.8	5%	68.7	10%
	Concentrated	24.2	3%	56.2	8%
Delaware County, NY <i>1,468 sq. mi.</i>	Dispersed	80.4	5%	134.9	9%
	Concentrated	52.3	4%	117.4	8%
Sullivan County, NY <i>997 sq. mi.</i>	Dispersed	130.0	13%	223.9	22%
	Concentrated	72.1	7%	177.7	18%

Figure 20 indicates the population (estimated by 2010 U.S. Census Block data) within several radii common to health-assessment literature. The population is shown by county and stacked to indicate cumulative population in the DRB. The adjacent bars show the difference between the “concentrated” (left) and “dispersed” (right) scenarios. Notably, at distances less than 1,000 meters, there is a significant difference between the scenarios. At distances of 1 mile or more, there is less difference between scenarios. Overall, 40,000–50,000 people live within about 1 mile (or 2 km) of the projected well pad locations.

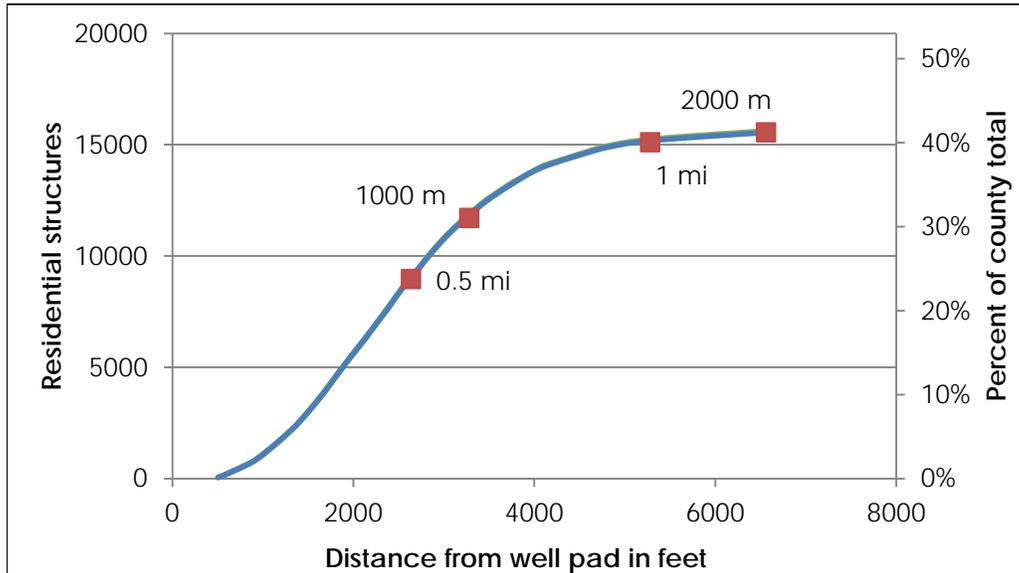
Figure 20. Population within several radii common to health-assessment literature. The population living within several distances (cited in health risk literature) of well pads depends on development scenario. At smaller distances, more people are affected with the “dispersed” scenario. Most of the population that could be affected lives in Wayne County, PA.



The majority of the population potentially affected lives in Wayne County, PA. For this county, we also assessed the portion of residential buildings within these distances using attributed building address points zoned as residential structures. In Figure 21, the horizontal axis shows the distance from well pad (in feet), the left axis shows total residential structures within that distance, and the right axis shows the percentage of the residential structures in Wayne County represented. Note that no structures are within 500 feet of any well pad based on exclusions used in siting the projected well pads. Roughly 40 percent of the residential structures in Wayne County would fall within one mile of a well pad.

These building level results contrast with the affected population results (slightly less than 60 percent of Wayne County’s population of 52,000). The discrepancy may be due to more persons per household in the affected area, or some of the residential buildings being unoccupied or functioning as seasonal/vacation residences.

Figure 21. Wayne County residential structures within x distance (ft) of a well pad (total and percent of all county residential structures). Roughly 40 percent of the residential structures in the county would fall within one mile of a projected well pad location.



Discussion

Within the portion of the DRB projected to have gas development in this study, virtually the entire population falls within roughly one mile (or two kilometers) of the potential well pad sites identified. In total, roughly 45,000 people in the basin are within this distance, which can be compared to the population of nearby cities such as Easton (27,000), Wilkes-Barre (41,000), Bethlehem (75,000), and Scranton (76,000).

At smaller buffer distances (e.g., 2,000 feet, 0.5 mile, or 1,000 meters) representing the areas with most likely health impacts, less of the population is affected. At these buffer distances, there is a significant difference in affected population between scenarios. A smaller population is in close proximity to the wells in the “concentrated” scenario (eight wells per pad). However, the likelihood, dosage, and duration of exposure would likely be higher for those living within the smaller buffer distances for the “concentrated” scenario, due to the greater intensity and duration of gas extraction activities needed to develop eight wells per pad.

Chemical exposure may be higher still near other infrastructure not explicitly considered in this study, including wastewater impoundments or storage facilities,

centralized waste-treatment plants, and gas compressors and pumping equipment. The longer-lived nature of these facilities and potential to handle material from multiple well sites may increase potential exposures for populations living near them. There may be some additional exposure to air pollutants, as well, due to regional air transport from active gas development areas in other parts of the Marcellus Shale, especially in Susquehanna, Bradford, and Wyoming Counties in Pennsylvania.

These estimates of population at risk within the DRB may be an underestimate of current and future population. The population estimates are based on the 2010 Census and include neither population change since that time, nor projected population growth through the completion of natural gas development.

It is important to remember that the well pad locations are not explicit predictions, so the exposure risks of specific properties should not be considered based on the results or maps presented. Across the study areas and this portion of the DRB, the calculated populations within the buffer distances give a reasonable first estimate of populations with potential for different levels of exposures should drilling begin.

Finally, this study does not assess the likelihood of occupational or vehicle accidents, spills, or the ability of the existing emergency response and healthcare systems to handle potential surges in demand. These questions are important to preparedness for local governments, but the projected population affected and maps of affected areas do provide a first step in assessing these needs.

Conclusions

This report presents an estimated projection of potential development of natural gas within the Delaware River Basin, concentrating on three study areas. The actual level of development would depend strongly on the actual production of the wells drilled in the DRB and on the price of gas within the energy markets, which can fluctuate rapidly. For the three study areas, we assessed potential environmental and health impacts using the best current understanding and data on well development. The results are intended to help decision-makers and the public understand the scale of the potential consequences.

We project ultimate development of the DRB portion of the Marcellus Shale could be as high as 4,000 wells, with development of up to about 500-1,000 well pads (based on an average of 8 or 4 wells per pad). This development would be most concentrated in Wayne County, PA. These estimates result from geospatial analysis performed with publicly available information on land and geological characteristics and on actual well-development data.

If natural gas development occurs as projected, natural gas infrastructure will become a widespread and prominent feature of the landscape in the Upper DRB. The repercussions of drilling and infrastructure-building activities would cover a broad range of issue areas, including forest fragmentation, water withdrawal and wastewater discharge, hydrologic and water-quality changes, air emissions, and potential health impacts. There may be others that are not included in this report. At a basic level, drilling rigs and truck traffic will have temporary effects near any one well pad, but over a long build-out, they could become common within the basin. The well pads, roads, and pipelines would most likely be long-term (30+ years)—or, in some cases, permanent—features of the landscape. Similarly, management of water, wastewater, and air emissions can create both short- and long-term impacts to the region.

This report specifically investigated potential consequences associated with land cover change, water and wastewater management, surface water hydrology and quality, air emissions, and affected population in three study areas across the DRB, considering significant projected well development. Key findings include the following:

- **Land cover change:** We found each well pad would cause on average 17-23 acres of land disturbance due to construction of well pads, roads, and

pipeline rights-of-way. Pipeline construction would cause about 75 percent of land disturbance. In the most heavily developed areas that would be fracked, 2-3 percent of total area would be affected. The land cover types in each case study replaced by infrastructure include agriculture (43-63 percent) and forests (24-46 percent). By extrapolating results for our study areas, we estimate the total area required to fully develop the projected well pads, roads, and gathering pipelines in the DRB is between 18 and 26 square miles.

- **Forest fragmentation:** Pipelines and roads associated with gas development could have a noticeable effect on forest habitat in the study areas. Despite only clearing about 1 percent of forested area, the core forest area could decline up to 10 percent, while edge forest could increase by up to 8 percent. These changes have the potential to alter ecosystems and the relative abundance of forest species.
- **Water withdrawal:** If current water use and recycling trends hold, roughly 4.5 million gallons of water withdrawal would be needed for each well. These withdrawals would amount to 1.3 million gallons per day if averaged across the entire DRB over 30 years, but might reach 10 or more times higher during a peak year. Withdrawals during peak years could remove up to 70 percent of available flow from small streams during low-flow periods, but a negligible portion of flow if the withdrawal occurs on mainstem rivers during average-flow conditions.
- **Wastewater discharge:** Wastewater management would be an important issue, due to the high pollutant loadings in untreated flowback and brines. The amount of wastewater reuse, and types of treatment and disposal methods used for natural gas wastewaters would have a strong influence on the pollutant loadings that may enter the basin. If there were no wastewater reuse and all wastewater were treated to exactly meet effluent standards, in-stream concentrations of barium and strontium could increase by up to 500 percent from baseline concentrations at low-flow periods. Total dissolved solids, chloride, and sulfates would see smaller increases. Similar to water withdrawals, the magnitude of these consequences may vary considerably by time and location, but these impacts would occur over a duration of 30 years.
- **Hydrology and surface water quality:** Changes in land cover associated with infrastructure development could lead directly to hydrologic and water-quality changes for the DRB. The initial land clearing could leave the watershed especially vulnerable to increased upland erosion and sedimentation loadings in the short-term (up to 140 percent increase over baseline). Following development, the upland changes in runoff and erosion would persist at lower levels (around 15 percent above baseline). The land

cover changes would also change hydrology by increasing runoff by 1-3 percent during peak flow periods, and reducing groundwater recharge.

- **Air quality:** Industrial processes associated with natural gas development could produce emissions that would degrade the air quality in the DRB. In addition to the contributions from well site-development and well completion, the installation of compressor stations could present significant increases (as much as doubling) in NO_x emissions for three of the four DRB counties. The contributions to VOC, SO_x , and PM emissions from annual shale gas development did not appear as significant compared to other activities in these counties at the county-wide scale (note that this analysis did not look at the potential impacts of these emissions at the local level). Development in the DRB would contribute methane emissions from leakage throughout the process, though small in the context of total emissions from the Marcellus Shale.
- **Affected population:** Due to the relatively even spacing of the projected well pads in the DRB, a large percentage of the population in the affected area would live within one mile of the nearest well, which may present certain health risks, based on current scientific literature. At full development, about 45,000 people in the DRB would live within about one mile of the nearest projected well pad location. Wayne County, PA would be most affected, with 30,000 people (nearly 60 percent of its population) potentially living within one mile of a well pad. At smaller distances of about a half-mile, roughly 15,000 to 25,000 people in the DRB could be affected, depending on the number of wells per pad. Increasing the number of wells per pad from four to eight would reduce the population affected at the closest radii, but may result in longer duration of some exposures due to more wells developed.

Of these findings, change in land cover and associated impacts to forests, hydrology, and water quality appear the most difficult to avoid. The wastewater and air quality risks could pose significant management challenges. The potential health impacts require more study to understand extent and risk levels.

These findings do not cover the full range of potential impacts that may occur if gas development does occur. Instead, the results offer an initial view of the overall level and potential range of impacts. The development projections assume a high degree of development that may never be reached, but the maximum-year development projections for a given year are possible. The scenarios presented focus on identifying conditions when the consequences may be highest and on what the corresponding level of impact would be, averaged across a study area (either county

or watershed).⁸ In assessing risk, it is this type of information that is most useful for planning.

⁸ Of note, this analysis does not account for the maximum potential impacts to sites that may occur within the study areas as a result of locally high development densities, accidents, or variations in practices by gas drilling operators. If development begins, the range of potential impacts could be expected to vary widely through time and across geography.

Appendix A: Chemicals in Natural Gas Wastewaters

The “Impacts on Water and Wastewater Management” chapter investigates a limited set of five contaminants that have effluent-discharge concentration limits under Pennsylvania regulations[69] for wastewater treatment facilities built after 2010 that treat natural gas wastewater. Analyses that have tested water quality of natural gas wastewaters have documented the presence of many more potential contaminants. In Table 14, we have assembled data from 13 studies on the concentrations of contaminants in flowback and brine wastewaters.

The values for flowback and brine reported reflect the average of median values across studies. The range reflects the low and high values reported in either flowback or brine wastewater samples reported in the studies. There have also been some studies of wastewater treatment plant effluent where effluent discharge concentrations have been measured. We include these values in the final column, but note that these facilities represent older industrial wastewater treatment plants that are not required to meet the 2010 Pennsylvania regulations. For cells left blank, no data were available.

Table 14. Pollutants measured in natural gas wastewaters. For cells left blank, no data were available. Units = milligrams per liter, unless otherwise noted.

	Pollutant	Flowback	Brine	Range	Industrial WW effluent
Primary (regulated)	Total Dissolved Solids (TDS)	73,000	205,600	38,500 – 261,000	123,500
	Chloride (Cl)	54,600	99,600	19,600 – 174,700	84,300
	Barium (Ba)	1,017	8,281	4 – 84,300	20
	Strontium (Sr)	1,187	5,225	350 – 4,800	2,005
	Sulfate (SO ₄)	30	55	2.4 - 300	810
Physical and Nutrients	Turbidity	230	207	11 – 3,330	
	pH	6.6	6	4.7 - 7.2	
	Specific Conductance [µmho/cm]	138,000	300,800	6,800 – 710,000	
	Alkalinity	138	70	49 - 327	254
	Acidity			<5 - 470	
	Total Organic Carbon	62.8	984	4 – 19,250	
	Dissolved Organic Carbon	114	43	5 - 700	
	Chemical Oxygen Demand	3100	8,530	195 – 71,000	
	Biochemical Oxygen Demand	100	448	37 - 2070	
	Hardness (as CaCO ₃)	22,100	34,000	630 – 95,000	
	Ammonia (NH ₃ as N)	71	125	29 - 200	68
	Total Kjeldahl Nitrogen	86	116	38 - 200	
	Nitrate (as N)	0.02		0 - 1.2	
	Nitrite (as N)	1.2		0.06 - 29.3	
	Total Phosphorus (as P)	1.3		0 - 8	
Halides (salts)	Bromide (Br)	559	730	108 – 1,200	740
	Fluoride (F)			<0.05 - 50	
	Iodide (I)	6.3		0.2 - 19.3	21
Metals	Sodium (Na)	23,500	37,700	10,700 – 95,500	27,300
	Potassium (K)	49	351	2.4 - 351	
	Calcium (Ca)	7,280	16,900	1,400 – 23,500	13,950
	Magnesium (Mg)	735	1,410	140 – 1,600	941
	Boron (B)	12.2		3.1 - 97.9	
	Chromium (Cr)			0.005 - 151	
	Manganese (Mn)	5	9	1.9 - 18.6	
	Iron (Fe)	45.1	107	13.8 - 242	
	Lead (Pb)	0.01		0 - 0.6	

	Pollutant	Flowback	Brine	Range	Industrial WW Effluent
Hydrocarbons	Oil and Grease	24.2		4.6 - 655	
	Benzene [$\mu\text{g/L}$]	150			8
	Ethylbenzene [$\mu\text{g/L}$]	53			5
	Toluene [$\mu\text{g/L}$]	622			46
	Xylene [$\mu\text{g/L}$]	699			32
	Styrene [$\mu\text{g/L}$]	11			
NORM	Naturally Occurring Radioactive Materials [pCi/L]		2460	0 - 18000	

Sources: [39-43, 62-68, 88]

Notes: $\mu\text{g/L}$ = micrograms per liter; pCi/L = picocuries per liter;
 $\mu\text{mho/cm}$ = micromhos per centimeter

This page intentionally left blank.

Appendix B: Stream Gages

We used the following stream gages operated by the U.S. Geological Survey (USGS) to develop streamflow statistics for the chapter of this report titled “Impacts on Water and Wastewater Management.” Table 15 identifies the stream gages we used, including their record length and drainage area. Table 16 presents several flow statistics (especially low-flow statistics) that we used for computing water and wastewater impacts. The flows are presented in units of million gallons per day, per square mile.

Table 15. USGS stream gages used in this study.

Study Area	ID (this study)	Type ^a	USGS ID	Name	Record Length	DA (sq.mi)
1	1.1	Small Stream	01426000	Oquaga Creek at Deposit, NY	1940–1973	67.6
	1.2	Mainstem	01426500	West Branch Delaware River at Hale Eddy, NY	1912 – 2013	595
2	2.1	Small Stream	01428750	West Branch Lackawaxen River near Aldenville, PA	1986–2013	40.6
	2.2	Mainstem	01430000	Lackawaxen River near Honesdale, PA	1948–2013	164
3	3.1	Small Stream	01427500	Callicoon Creek at Callicoon, NY	1940–1982, 2000–2011	110
	3.2	Mainstem	01427510	Delaware River at Callicoon, NY	1975–2013	1820
DRB	4	Mainstem	01434000	Delaware River at Port Jervis, NY	1960–2013	3070

Source: USGS, compiled by CNA.

^a. Small stream gages have their drainage area (DA) entirely within the study areas; by contrast, mainstem gages include some additional upstream area (except 01430000).

Table 16. Daily flow statistics for the stream gages used in this study. Units = million gallons per day, per square mile.

ID	Q7-10 ^a	5% ^b	20% ^c	Median (JAS) ^d	Median (50%)	Average
1.1	0.017	0.034	0.105	0.147	0.459	1.010
1.2	0.056	0.106	0.228	0.657	0.566	0.950
2.1	0.096	0.132	0.287	0.362	0.732	1.379
2.2	0.053	0.091	0.229	0.279	0.631	1.163
3.1	0.037	0.071	0.176	0.235	0.511	1.039
3.2	0.194	0.259	0.362	0.434	0.558	1.058
4	0.164	0.282	0.366	0.426	0.636	1.061

Source: USGS, calculations by CNA.

^a. Lowest seven-day average flow expected to occur once every 10 years

^b. Fifth percentile flow. Also referred to as the Q95

^c. Twentieth percentile flow, also referred to as the Q80

^d. JAS = July, August, September

This page intentionally left blank.

References

- [1] US Energy Information Administration. 2015. *Drilling Productivity Report For key tight oil and shale regions*. Accessed Jan 28, 2015. <http://www.eia.gov/petroleum/drilling/>.
- [2] Entrekin, S., M. Evans-White, B. Johnson, and E. Hagenbuch. 2011. "Rapid expansion of natural gas development poses a threat to surface waters." *Frontiers in Ecology & Environment* 9 (9): 503.
- [3] Rahm, B. G., and S. J. Riha. 2012. "Toward strategic management of shale gas development: Regional, collective impacts on water resources." *Environmental Science & Policy* 17: 12-23.
- [4] Olmstead, Sheila M., Lucija A. Muehlenbachs, Jhih-Shyang Shih, Ziyang Chu, and Alan J. Krupnick. 2013. "Shale gas development impacts on surface water quality in Pennsylvania." *Proceedings of the National Academy of Sciences USA* 110 (13): 4962-4967. doi: 10.1073/pnas.1213871110.
- [5] Rozell, D.J., and S.J. Reaven. 2012. "Water pollution risk associated with natural gas extraction from the Marcellus Shale." *Risk Analysis* 32: 1382-1393.
- [6] Vidic, R. D., S. L. Brantley, J. M. Vandenbossche, D. Yoxtheimer, and J. D. Abad. 2013. "Impact of Shale Gas Development on Regional Water Quality." *Science* 340 (6134). doi: 10.1126/science.1235009.
- [7] McKenzie, Lisa M., Roxana Z. Witter, Lee S. Newman, and John L. Adgate. 2012. "Human health risk assessment of air emissions from development of unconventional natural gas resources." *Science of The Total Environment* 424 (0): 79-87. doi: <http://dx.doi.org/10.1016/j.scitotenv.2012.02.018>.
- [8] Hays, J., and S.B.C. Shonkoff. 2015. *Toward an understanding of the environmental and public health impacts of shale gas development: an analysis of the peer-reviewed scientific literature, 2009-2014*. edited by Scientists Physicians, & Engineers for Healthy Energy.
- [9] US Government Accountability Office. 2012. *Information on Shale Resources, Development, and Environmental and Public Health Risks*. GAO-12-732.
- [10] US Energy Information Administration. 2014. *Assumptions to the Annual Energy Outlook 2014*.
- [11] Phillips, S.J., R.P. Anderson, and R.E. Shapire. 2006. "Maximum entropy modeling of species geographic distributions." *Ecological Modelling* 190: 231-259.
- [12] Elith, J., C. H. Graham, R. P. Anderson, M. Dudík, S. Ferrier, A. Guisan, R. J. Hijmans, F. Huettmann, J. R. Leathwick, A. Lehmann, J. Li, L.G. Lohmann, B. A. Loiselle, G. Manion, C. Moritz, M. Nakamura, Y. Nakazawa, J. McC. Overton, A. T. Peterson, S. J. Phillips, K. S. Richardson, R. Scachetti-Pereira, R. E. Schapire, J. Soberón, S. Williams, M. S. Wisz, and N. E. Zimmermann. 2006. "Novel methods improve prediction of species' distributions from occurrence data." *Ecography* 29: 129-151.
- [13] Elith, J., S.J. Phillips, T. Hastie, M. Dudík, Y.E. Chee, and C.J. Yates. 2011. "A statistical explanation of MaxEnt for ecologists." *Diversity and Distributions* 17: 43-57.
- [14] Johnson, N. 2010. *Pennsylvania Energy Impacts Assessment Report 1: Marcellus Shale Natural Gas and Wind*.

- [15] Wrightstone, G. 2009. "Marcellus Shale - Geologic Controls on Production." In *AAPG Annual Convention, Denver, CO, Jun 7-10, 2009*. Accessed Oct 29, 2014. <http://www.searchanddiscovery.com/documents/2009/10206wrightstone/>.
- [16] Research, Penn State Marcellus Center for Outreach and. 2014. "Resources: Maps and Graphics." <http://www.marcellus.psu.edu/resources/maps.php>.
- [17] Rystad Energy. 2014. "NASMaps (North American Shale Maps)." <http://www.rystadenergy.com/ResearchProducts/NASAnalysis/nasmaps>.
- [18] Fry, J., G. Xian, S. Jin, J. Dewitz, C. Homer, L. Yang, C. Barnes, N. Herold, and J. Wickham. 2011. "Completion of the 2006 National Land Cover Database for the Conterminous United States." *Photogrammetric Engineering & Remote Sensing* 77 (9): 858-864. Accessed Oct 28, 2014. <http://www.mrlc.gov/nlcd2006.php>.
- [19] *National Elevation Dataset*. Accessed Sep 25, 2014. <http://nationalmap.gov/>.
- [20] IHS. 2014. "Products and Solutions: Energy Equipment." <https://www.ihs.com/industry/energy-equipment.html>.
- [21] *TIGER/Line Shapefiles*. Accessed Sep 30, 2014. <https://www.census.gov/geo/maps-data/data/tiger-line.html>.
- [22] Shapire, R.E. 2013. "Maxent software for species habitat modeling." <http://www.cs.princeton.edu/~schapire/maxent/>.
- [23] O'Dell, P.M. 2010. *Potential for Development of Natural Gas Exploratory Wells to Adversely Affect Water Resources of the Delaware River Basin*. National Park Service Geologic Resource Department.
- [24] Kauffman, Gerald J., and Andrew R. Homsey. 2013. *Economic value of Marcellus Shale gas in the Delaware Basin*. Accessed Jan 29, 2015. <http://www.wra.udel.edu/wp-content/uploads/2013/11/Economic-Value-of-Marcellus-Shale-Gas-in-the-Delaware-Basin-Kauffman-and-Homsey-2013.pdf>.
- [25] Berman, Arthur, and Lyndon Pittinger. 2014. *Resource Assessment of Potentially Productible Natural Gas Volumes From the Marcellus Shale, State of New York*.
- [26] Drohan, P., and M. Brittingham. 2012. "Topographic and Soil Constraints to Shale-Gas Development in the Northcentral Appalachians." *Soil Science Society of America Journal* 76 (5): 1696.
- [27] Kiviat, E. 2013. "Risks to biodiversity from hydraulic fracturing for natural gas in the Marcellus and Utica shales." *Annals of the New York Academy of Sciences* 1286: 1-14.
- [28] Racicot, A., V. Babin-Roussel, J. F. Dauphinais, J. S. Joly, P. Noël, and C. Lavoie. 2014. "A Framework to Predict the Impacts of Shale Gas Infrastructures on the Forest Fragmentation of an Agroforest Region." *Environmental Management* 53 (5): 1023-1033. <http://link.springer.com/article/10.1007%2Fs00267-014-0250-x>.
- [29] Johnson, N., T. Gagnolet, R. Ralls, and J. Stevens. 2011. *Natural Gas Pipelines: Excerpt from Report 2 of the Pennsylvania Energy Impacts Assessment*.
- [30] Slonecker, E.T., L.E. Milheim, C.M. Roig-Silva, A.R. Malizia, D.A. Marr, and G.B. Fisher. 2012. *Landscape consequences of natural gas extraction in Bradford and Washington Counties, Pennsylvania, 2004-2010*. USGS Open-File Report 2012-1154. <http://pubs.usgs.gov/of/2012/1154/>.
- [31] Souther, S., M. W. Tingley, V. D. Popescu, D. T. S. Hayman, M. E. Ryan, T. A. Graves, B. Hartl, and K. Terrell. 2014. "Biotic Impacts of energy development from shale: research priorities and knowledge gaps." *Frontiers in Ecology and the Environment* 12 (6): 330-338.
- [32] Alberti, M., D. Booth, K. Hill, B. Coburn, C. Avolio, S. Coe, and D. Spirandelli. 2007. "The impact of urban patterns on aquatic ecosystems: An empirical analysis in Puget lowland sub-basins." *Landscape and Urban Planning* 80: 345-361.
- [33] Carlisle, D.M., J. Falcone, and M.R. Meador. 2009. "Predicting the biological condition of streams: Use of geospatial indicators of natural and anthropogenic characteristics of watersheds." *Environmental Monitoring and Assessment* 151: 143-160.

- [34] Environmental Systems Research Institute (ESRI) Utility Team. 2011. *Pipeline Route Optimization Interface: Documentation v1.0*. Accessed Sep 4, 2014. <http://www.arcgis.com/home/item.html?id=9bdbafe0b52b44c5add6f82ef08cc13f>
- [35] Menon, E.S. 2011. *Pipeline Planning and Construction Field Manual*. New York: Elsevier.
- [36] Potter, E., and W. Dorshow. 2013. "Optimizing Pipeline Routing in the 21st Century." In *2013 GeoGathering Conference, Colorado Springs, CO, Aug.21-22, 2013*.
- [37] Ferri, N. 2011. "Pipeline Route Optimization for the Eagle Ford Shale Play." In *2011 ESRI Petroleum Users Group Conference, April 18-21, 2011*. http://proceedings.esri.com/library/userconf/pug11/papers/pipeline_route_optimization_for_the_eagle_ford_shale_play.pdf.
- [38] EPA. 2012. *Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources*. U.S. Environmental Protection Agency. EPA/601/R-12/011. <http://www2.epa.gov/sites/production/files/documents/hf-report20121214.pdf#page=209>.
- [39] Hammer, R., Jeanne VanBriesen, and L. Levine. 2012. *In Fracking's Wake: New Rules are Needed to Protect Our Health and Environment from Contaminated Wastewater*. Natural Resources Defense Council. 12-05-A.
- [40] Ferrar, K. J., D. R. Michanowicz, C. L. Christen, N. Mulcahy, S. L. Malone, and R. K. Sharma. 2013. "Assessment of Effluent Contaminants from Three Facilities Discharging Marcellus Shale Wastewater to Surface Waters in Pennsylvania." *Environmental Science & Technology* 47 (7): 3472. <http://pubs.acs.org/doi/abs/10.1021/es301411q>.
- [41] Stroud Water Research Center. 2013. *Ecotoxicity study for mayflies exposed to ambient stream water from the upper Delaware River Basin, reference toxicant, and to produced-water from natural gas drilling*. Stroud Water Research Center. 2013003.Delaware River Basin Commission. <http://www.state.nj.us/drbc/library/documents/naturalgas/StroudStudyFinal082113.pdf>.
- [42] Warner, N. R., C. A. Christie, R. B. Jackson, and A. Vengosh. 2013. "Impacts of Shale Gas Wastewater Disposal on Water Quality in Western Pennsylvania." *Environ. Sci. Technol.* 47 (20): 11849. doi: 10.1021/es402165b. <http://pubs.acs.org/doi/abs/10.1021/es402165b>.
- [43] Harkness, J., G.S. Dwyer, N. Warner, K.M. Parker, W.A. Mitch, and A. Vengosh. 2015. "Iodide, Bromide, and Ammonium in Hydraulic Fracturing and Oil and Gas Wastewaters: Environmental Implications." *Environmental Science & Technology*. doi: 10.1021/es504654n. <http://pubs.acs.org/doi/abs/10.1021/es504654n>.
- [44] Parker, K.M., T. Zeng, J. Harkness, A. Vengosh, and W.A. Mitch. 2014. "Enhanced Formation of Disinfection Byproducts in Shale Gas Wastewater-Impacted Drinking Water Supplies." *Environmental Science & Technology* 48 (19): 11161-11169. doi: 10.1021/es5028184. <http://pubs.acs.org/doi/abs/10.1021/es5028184>.
- [45] EPA. 2013. "Basic Information about Disinfection Byproducts in Drinking Water: Total Trihalomethanes, Haloacetic Acids, Bromate, and Chlorite." EPA Office of Water. Dec 13, 2013. <http://water.epa.gov/drink/contaminants/basicinformation/disinfectionbyproducts.cfm>.
- [46] DRBC. 2008. *Administrative Manual Part III. Water Quality Regulations*. Delaware River Basin Commission. 18 CFR Part 140.
- [47] DRBC. 2008. *Delaware River State of the Basin Report*. Delaware River Basin Commission.
- [48] Baker Hughes, Inc. 2014. "Interactive Rig Counts." Baker Hughes. Accessed Nov 7, 2014. <http://gis.bakerhughesdirect.com/RigCounts/default2.aspx>.

- [49] Krupnick, A. J. 2013. *Managing the Risks of Shale Gas: Key Findings and Further Research*. Resources for the Future.
- [50] Krupnick, A. J., H. Gordon, and S. M. Olmstead. 2013. *Pathways to Dialogue: What the Experts Say about the Environmental Risks of Shale Gas Development*. Resources for the Future. www.rff.org/shaleexpertsurvey.
- [51] SkyTruth, FracFocus via. 2013. *FracFocus Chemical Disclosure Registry - 2013 Reports Data*. Unclassified. Digital Dataset. Accessed 10/01/2014. https://s3.amazonaws.com/skytruth_public/2013_FracFocusReport.txt.zip.
- [52] Mantell, M.E. 2011. "Produced water reuse and recycling challenges and opportunities across major shale plays." Unclassified. EPA hydraulic fracturing study technical workshop #4 - water resources management, March 29, 2011. Accessed November 27, 2014. http://www2.epa.gov/sites/production/files/documents/09_Mantell_-_Reuse_508.pdf.
- [53] Jiang, Mohan, Chris T. Hendrickson, and Jeanne M. VanBriesen. 2014. "Life Cycle Water Consumption and Wastewater Generation Impacts of a Marcellus Shale Gas Well." *Environmental Science & Technology* 48: 1911-1920. doi: 10.1021/es4047654.
- [54] Maloney, K. O., and D. A. Yoxtheimer. 2012. "Production and Disposal of Waste Materials from Gas and Oil Extraction from the Marcellus Shale Play in Pennsylvania." *Environmental Practices*. 14 (04): 278-287.
- [55] Wilson, J.M., and Jeanne VanBriesen. 2012. "Oil and Gas Produced Water Management and Surface Drinking Water Sources in Pennsylvania." *Environmental Practices* 14: 288-300.
- [56] Survey, United States Geological. 2015. Daily Surface Water observations. *USGS Surface-Water Daily Data for Pennsylvania*. Digital download. <http://waterdata.usgs.gov/pa/nwis/dv?>
- [57] Survey, United States Geological. 2015. Daily surface water observations. *USGS Surface-Water Daily Data for New York*. Digital download. <http://waterdata.usgs.gov/ny/nwis/dv?>
- [58] Dephiliip, M., and T. Moberg. 2013. *Ecosystem Flow Recommendations for the Delaware River Basin*. The Nature Conservancy. http://www.state.nj.us/drbc/library/documents/TNC_DRBFlowRpt_dec2013.pdf.
- [59] Poff, N. L., and J.K.H. Zimmerman. 2010. "Ecological responses to altered flow regimes: a literature review to inform the science and management of environmental flows." *Freshwater Biology* 55: 194-205. doi: 10.1111/j.1365-2427.2009.02272.x. http://www.oregon.gov/owrd/docs/SB839/2010_Poff_Ecological_Responses_Altered_Flow_Regimes_Literature_Review.pdf.
- [60] Maupin, M.A., J.F. Kenny, S.S. Hutson, J.K. Lovelace, N.L. Barber, and K.S. Linsey. 2014. *Estimated use of water in the United States in 2010*. U.S. Geological Survey. USGS Circular 1405. Accessed 1 Dec 2014. doi: 10.3133/cir1405.
- [61] DRBC, USACE &. 2008. *Enhancing Multi-jurisdictional Use and Management of Water Resources for the Delaware River Basin, NY, NJ, PA, and DE*. US Army Corps of Engineers and Delaware River Basin Commission. Dec 2008. http://www.nap.usace.army.mil/Portals/39/docs/Civil/DelComp/Enhancing_Multi-Jurisdictional_Use_and_Management_of%20Water_Resources_for_the_Delaware_River_Basin.pdf.
- [62] Haluszczak, Lara O., Arthur W. Rose, and Lee R. Kump. 2013. "Geochemical evaluation of flowback brine from Marcellus gas wells in Pennsylvania, USA." *Applied Geochemistry* 28 (0): 55-61. doi: 10.1016/j.apgeochem.2012.10.002. <http://www.sciencedirect.com/science/article/pii/S0883292712002752>.

- [63] Gregory, Kelvin B., Radisav D. Vidic, and David A. Dzombak. 2011. "Water Management Challenges Associated with the Production of Shale Gas by Hydraulic Fracturing." *Elements* 7 (3): 181-186. doi: 10.2113/gselements.7.3.181.
- [64] Dresel, P., and A. Rose. 2010. *Chemistry and Origin of Oil and Gas Well Brines in Western Pennsylvania*. Pennsylvania Geological Survey, Pennsylvania Department of Conservation and Natural Resources.
- [65] Duraisamy, R.T., A. Heydari Beni, and A. Henni. 2013. "State of the Art Treatment of Produced Water." *Water Treatment*. Edited by W. Elshorbagy, and R.Z. Choudhury. 199-222. Online.: InTech, doi: 10.5772/53478. InTech.
- [66] Hayes, T. 2009. *Sampling and Analysis of Water Streams Associated with the Development of Marcellus Shale Gas*. Marcellus Shale Coalition.
- [67] Hayes, T., and B.F. Severin. 2012. *Barnett and Appalachian Shale Water Management and Reuse Technologies*. Research Partnership to Secure America. 08122-05.
http://www.barnettshalewater.org/documents/RPSEAReport_Final_082112.pdf.
- [68] Olmstead, S. M. 2013. "Wastewater Characteristics from Marcellus Shale Gas Development in Pennsylvania." Resources for the Future: Managing the Risks of Shale Gas Development, Washington, D.C., Jun 27, 2013. Resources for the Future.
- [69] Commonwealth of Pennsylvania. 2010. *95.10 Treatment requirements for new and expanding mass loadings of Total Dissolved Solids (TDS)*. Aug 20, 2010. PA Code 025 § 95.10.
<http://www.pacode.com/secure/data/025/chapter95/chap95toc.html>.
- [70] New York State Department of Environmental Protection. 2015. *FINAL SUPPLEMENTAL GENERIC ENVIRONMENTAL IMPACT STATEMENT ON THE OIL, GAS AND SOLUTION MINING REGULATORY PROGRAM*. New York State Department of Environmental Protection.
- [71] Jiang, Mohan, W. Michael Griffin, Chris Hendrickson, Paulina Jaramillo, Jeanne VanBriesen, and Aranya Venkatesh. 2011. "Life cycle greenhouse gas emissions of Marcellus shale gas." *Environmental Research Letters* 6 (3): 034014. doi: 10.1088/1748-9326/6/3/034014.
- [72] Lampe, D.J., and J.F. Stolz. 2015. "Current perspectives on unconventional shale gas extraction in the Appalachian Basin." *Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances and Environmental Engineering* 50 (5): 434-446. doi: 10.1080/10934529.2015.992653.
- [73] Hladik, M.L., M.J. Focazio, and M. Engle. 2014. "Discharges of produced waters from oil and gas extraction via wastewater treatment plants are sources of disinfection by-products to receiving streams." *Science of the Total Environment* 466-467: 1085-1093. doi: 10.1016/j.scitotenv.2013.08.008.
- [74] Brown, V.J. 2014. "Radionuclides in Fracking Wastewater: Managing a Toxic Blend." *Environmental Health Perspectives* 122 (2): A51-A55. doi: 10.1289/ehp.122-A50
- [75] Kargbo, D. M., R. G. Wilhelm, and D. J. Campbell. 2010. "Natural Gas Plays in the Marcellus Shale: Challenges and Potential Opportunities." *Environmental Science & Technology* 44 (15): 5679.
<http://pubs.acs.org/doi/pdfplus/10.1021/es903811p>.
- [76] Pennsylvania Department of Environmental Protection. March 16, 2015. Database. *Violations, Oil and Gas Compliance*. Unclassified. Online.
<http://stateimpact.npr.org/pennsylvania/drilling/violations/>.
- [77] McBroom, M., T. Thomas, and Y. Zhang. 2012. "Soil Erosion and Surface Water Quality Impacts of Natural Gas Development in East Texas, USA." *Water* 4 (4): 944-958. doi: 10.3390/w4040944.
- [78] MapShed version 1.1 - User's Guide. 2014. University Park, PA: The Pennsylvania State University.
- [79] Haith, D.A., and L.L. Shoemaker. 1987. "Generalized Watershed Loading Functions for Stream Flow Nutrients." *Water Resources Bulletin* 23 (3): 471-478.

- [80] Moore, C.W., B. Zielinska, G. Petron, and R.B. Jackson. 2014. "Air Impacts of Increased Natural Gas Acquisition, Processing, and Use: A Critical Review." *Environmental Science & Technology*. 48 (15): 8349-8359.
- [81] US Environmental Protection Agency. 2014. "National Ambient Air Quality Standards (NAAQS)." <http://www.epa.gov/air/criteria.html>.
- [82] Jackson, Robert B., Avner Vengosh, J. William Carey, Richard J. Davies, Thomas H. Darrah, Francis O'Sullivan, and Gabrielle Pétron. 2013. "The Environmental Costs and Benefits of Fracking." *Annual Review of Environment and Resources* 39 (1): 140822120156004. doi: 10.1146/annurev-environ-031113-144051.
- [83] Howarth, R.W., R. L. Santoro, and A. R. Ingraffea. 2011. "Methane and the greenhouse-gas footprint of natural gas from shale formations." *Climate Change* 106 (4): 679-690.
- [84] Weber, C.L., and C. Clavin. 2012. "Life cycle carbon footprint of shale gas: Review of evidence and implications." *Environmental Science & Technology* 46 (11): 5688-5695.
- [85] Intergovernmental Panel on Climate Change (IPCC). 2013. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*.
- [86] Alvarez, R.A., S.W. Pacala, J.J. Winebrake, W.L. Chameides, and S.P. Hamburg. 2012. "Greater focus needed on methane leakage from natural gas infrastructure." *Proceedings of the National Academy of Sciences USA* 109 (17): 6435-6440.
- [87] Litovitz, A., A. Curtright, S. Abramzon, N. Burger, and C. Samaras. 2013. "Estimation of regional air-quality damages from Marcellus Shale natural gas extraction in Pennsylvania." *Environmental Research Letters*. 8: 014017.
- [88] New York Department of Environmental Conservation. 2011. *Revised Draft Supplemental Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program: Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs*. Accessed Jan. 13, 2015. <http://www.dec.ny.gov/energy/75370.html>.
- [89] *National Emissions Inventory (NEI) Database*. <http://www.epa.gov/ttn/chief/eiinformation.html>.
- [90] US Energy Information Administration. 2014. *Oil and Gas Supply Module of the National Energy Modeling System: Model Documentation 2014*. Accessed Jan 6, 2015. [http://www.eia.gov/forecasts/aeo/nems/documentation/ogsm/pdf/m063\(2014\).pdf](http://www.eia.gov/forecasts/aeo/nems/documentation/ogsm/pdf/m063(2014).pdf).
- [91] Brandt, A.R., G.A. Heath, E.A. Kort, F. O'Sullivan, G. Petron, S.M. Jordaan, P. Tans, J. Wilcox, A.M. Gopstein, D. Arent, S. Wofsy, N.J. Brown, R. Bradley, G.D. Stucky, D. Eardley, and R. Harriss. 2014. "Methane Leaks from North American Natural Gas Systems." *Science* 343: 733-735.
- [92] Peischl, J., T.B. Ryerson, K.C. Aikin, J.A. de Gouw, J.B. Gilman, J.S. Holloway, B.M. Lerner, R. Nadkarni, J.A. Neuman, J.B. Nowak, M. Trainer, C. Warneke, and D.D. Parrish. 2015. "Quantifying atmospheric methane emissions from the Haynesville, Fayetteville, and northeastern Marcellus shale gas production regions." *Journal of Geophysical Research: Atmospheres* Accepted Articles. doi: 10.1002/2014JD022697.
- [93] O'Sullivan, F., and S. Paltsev. 2012. "Shale gas production: potential versus actual greenhouse gas emissions." *Environmental Research Letters* 7: 044030.
- [94] Miller, S.M., S.C. Wofsy, A.M. Michalak, E.A. Kort, A.E. Andrews, S.C. Biraud, E.J. Dlugokencky, J. Eluszkiewicz, M.L. Fischer, G. Janssens-Maenhout, B.R. Miller, J.B. Miller, S.A. Montzka, T. Nehrkorn, and C. Sweeney. 2013. "Anthropogenic emissions of methane in the United States." *Proceeding of the National Academy of Sciences USA* 110 (50): 20018-20022.

- [95] Petron, G. 2012. "Hydrocarbon emissions characterization in teh Colorado Front Range: A pilot study." *Journal of Geophysical Research* 117: 27.
- [96] Karion, A. 2013. "Methane emissions estimate from airborne measurements over a western United States natural gas field." *Geophysical Research Letters* 40: 1-5.
- [97] Schneising, O. 2014. "Remote sensing of fugitive methane emissions from oil and gas production in North American tight geologic formations." *Earth's Future* 2: 548-558.
- [98] Caulton, D.R. 2014. "Toward a better understanding and quantification of methane emissions from shale gas development." *Proceeding of the National Academy of Sciences USA* 111 (17): 6237-6242.
- [99] Peischl, J. 2013. "Quantifying sources of methane using light alkanes in the Los Angeles basin, California." *Journal of Geophysical Research: Atmospheres* 118: 4974-4990.
- [100] EPA. 2008. *Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks*. EPA420-F-08-024. <http://www.epa.gov/otaq/consumer/420f08024.pdf>.
- [101] EIA. "Frequently Asked Questions: How much coal, natural gas, or petroleum is used to generate a kilowatthour of electricity?" <http://www.eia.gov/tools/faqs/faq.cfm?id=667&t=2>.
- [102] EIA. 2012. Data Table. *Table T5.A - Residential average monthly bill by Census Division, and State*. Electronic Download. U.S. Energy Information Administration. http://www.eia.gov/electricity/sales_revenue_price/.
- [103] Werner, A. K., S. Vink, K. Watt, and P. Jagals. 2015. "Environmental health impacts of unconventional natural gas development: A review of the current strength of evidence." *Science of the Total Environment* 505C: 1127-1141. doi: 10.1016/j.scitotenv.2014.10.084. <http://www.ncbi.nlm.nih.gov/pubmed/25461113>.
- [104] EPA. 1992. *Guidelines for Exposure Assessment*. Unclassified. US Environmental Protection Agency. EPA/600/Z-92/001. Accessed 8 Dec 2014. http://www.epa.gov/raf/publications/pdfs/GUIDELINES_EXPOSURE_ASSESSMENT.PDF.
- [105] Ingraffea, A. R., M. T. Wells, R. L. Santoro, and S. B. Shonkoff. 2014. "Assessment and risk analysis of casing and cement impairment in oil and gas wells in Pennsylvania, 2000-2012." *Proceeding of the National Academy of Sciences USA* 4121786 111 (30): 10955-60. doi: 10.1073/pnas.1323422111. <http://www.ncbi.nlm.nih.gov/pubmed/24982144>.
- [106] Jackson, Robert B., Avner Vengosh, Thomas H. Darrah, Nathaniel R. Warner, Adrian Down, Robert J. Poreda, Stephen G. Osborn, Kaiguang Zhao, and Jonathan D. Karr. 2013. "Increased stray gas abundance in a subset of drinking water wells near Marcellus shale gas extraction." *Proceedings of the National Academy of Sciences USA* 110 (28): 11250-11255. doi: 10.1073/pnas.1221635110.
- [107] Colborn, Theo, Kim Schultz, Lucille Herrick, and Carol Kwiatkowski. 2012. "An Exploratory Study of Air Quality Near Natural Gas Operations." *Human and Ecological Risk Assessment: An International Journal* 20 (1): 86-105. Accessed 2014/09/15. doi: 10.1080/10807039.2012.749447.
- [108] Eastern Research Group, and Sage Environmental Consulting. 2011. *City of Fort Worth Natural Gas Air Quality Study*. City of Fort Worth, TX.
- [109] Macey, G.P., R. Breech, M. Chernaik, C. Cox, D. Larson, D. Thomas, and D.O. Carpenter. 2014. "Air concentrations of volatile compounds near oil and gas production: a community-based exploratory study." *Environmental Health* 13 (82): 1-18.
- [110] Rabinowitz, P. M., I. B. Slizovskiy, V. Lamers, S. J. Trufan, T. R. Holford, J. D. Dziura, P. N. Peduzzi, M. J. Kane, J. S. Reif, T. R. Weiss, and M. H. Stowe. 2014. "Proximity to Natural Gas Wells and Reported Health Status: Results of a Household Survey in Washington County, Pennsylvania." *Environmental Health*

Perspectives.

doi:10.1289/ehp.1307732.

<http://www.ncbi.nlm.nih.gov/pubmed/25204871>.

- [111] Jemielita, T., G.L. Gerton, M. Neidell, S. Chillrud, B. Yan, M. Stute, M. Howarth, P. Saberi, N. Fausti, T.M. Penning, J. Roy, K.J. Propert, and R.A. Panettieri Jr. 2015. "Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates." *PLoS One* 10 (7). doi: 10.1371/journal.pone.0131093. <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0131093>.
- [112] NIOSH. 2014. "Hazard Alert- Worker Exposure to Silica during Hydraulic Fracturing." Occupational Safety and Health Administration. Oct 21 2014. https://www.osha.gov/dts/hazardalerts/hydraulic_frac_hazard_alert.html.
- [113] Milton, D., S. Wilson, C. Jiang, L. Dalemarre, A. Sapkota, T. Sangaramoorthy, and M. Boyle. 2014. *Potential Public Health Impact of Natural Gas Development and Productin in the Marcellus Shale in Western Maryland*. Maryland Institute for Applied Health, School of Public Health, University of Maryland - College Park.
- [114] McCawley, M. 2013. *Air, Noise, and Light Monitoring Results For Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations*. West Virginia Department of Environmental Protection Division of Air Quality.



CNA

This report was written by CNA's Energy, Water, and Climate (EWC) division.

EWC division provides integrated analysis of these issues to gain a better understanding of the implications of their interrelationships and to help develop sound policies and programs to improve energy security, foster efficiency, and increase the likelihood of a secure, climate-friendly energy future.





CNA is a not-for-profit research organization that serves the public interest by providing in-depth analysis and result-oriented solutions to help government leaders choose the best course of action in setting policy and managing operations.

*Nobody gets closer—
to the people, to the data, to the problem.*

Exhibit I



U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Washington, D.C. 20590

Hazardous Materials: Liquefied Natural Gas by Rail
Notice of Proposed Rulemaking
Preliminary Regulatory Impact Analysis

Docket No.: PHMSA-2018-0025 (HM-264)
RIN 2137-AF40

Office of Hazardous Materials Safety

October 2019

Table of Contents

EXECUTIVE SUMMARY	3
1. INTRODUCTION	4
1.1 SUMMARY OF THE PROPOSED RULE.....	4
1.2 DETERMINATION OF NEED.....	4
1.3 BACKGROUND	6
1.3.1 LNG.....	6
1.3.2 THE U.S. LNG INDUSTRY	7
1.3.3 LNG BY RAIL IN CANADA, EUROPE AND JAPAN	8
1.3.4 HAZARDOUS MATERIAL RAIL INCIDENT/ACCIDENT HISTORY IN THE U.S.....	9
1.3.5 AN OVERVIEW OF DERAILMENT AND HIGHWAY INCIDENTS INVOLVING LNG OR SIMILAR HAZARDOUS MATERIALS TO LNG	9
2. LNG SAFETY RESEARCH AND STUDIES	12
2.1 PHMSA SAFETY RESEARCH STUDIES	12
2.2 FRA SAFETY RESEARCH STUDIES AND SAFETY TESTING PROJECTS	12
2.3 ACADEMIC AND OTHER STUDIES.....	13
3. CURRENT DOT REGULATIONS OF LNG	14
3.1 PHMSA’S CURRENT REGULATION OF LNG.....	14
3.2 FRA’S CURRENT REGULATIONS OF METHANE, REFRIGERATED LIQUID	14
3.3 PHMSA - SPECIAL PERMITS.....	15
4. BASELINE ANALYSIS	15
5. ANALYSIS OF COSTS, BENEFITS AND REGULATORY IMPACTS	16
5.1 COMPLIANCE COSTS	17
5.2 BENEFITS	17
5.2.1 TRANSPORTATION EFFICIENCY AND EXPANDED TRANSPORT	17
5.2.2 MARKET IMPACTS	18
5.2.2.1 U.S. INTERNATIONAL COMPETITIVENESS	18
5.2.2.2 LNG AS FUEL	19
5.2.2.3 HOME HEATING FUEL SWITCHING.....	20
5.2.3 EMISSIONS	20
5.2.4 SAFETY IMPACTS	21
6. ANALYSIS OF REGULATORY ALTERNATIVES	23

Executive Summary

The Pipeline and Hazardous Materials Safety Administration (PHMSA), in coordination with the Federal Railroad Administration (FRA), is issuing this Notice of Proposed Rulemaking (NPRM) to solicit public comment on potential changes to the Hazardous Materials Regulations (HMR; 49 CFR, parts 171–180), which would permit the bulk transportation of Liquefied Natural Gas (LNG) (also known as Methane, Refrigerated Liquid) in rail tank cars. Specifically, this NPRM proposes to authorize the transport of LNG by rail in a certain tank car specification: United States (U.S.) Department of Transportation (DOT)-113C120W.

Currently, the HMR do not contain the necessary provisions to allow for the bulk transport of LNG in rail tank cars. However, there has recently been increasing interest in the domestic transportation of LNG by rail tank car. On January 17, 2017, PHMSA received a petition for rulemaking (P-1697) from the Association of American Railroads (AAR) requesting a regulatory change to allow Methane, Refrigerated Liquid (commonly referred to as LNG) to be transported in railroad tank cars.^{1 2} With a growing U.S. domestic supply and demand for LNG, rail transportation can serve as an alternative to the transport of LNG by highway and a potential new mode of transportation in the LNG export supply chain. PHMSA has identified LNG as an area market sector with opportunities for innovation and infrastructure development while maintaining a high level of safety.

PHMSA and FRA share the responsibility for regulating the transportation of hazardous materials by rail, using a system-wide perspective and a comprehensive approach that focuses on prevention, mitigation, and response. The joint mission of the agencies is to manage, and reduce, the risk posed to people and the environment by the transport of hazardous material by rail. This NPRM does not impose new compliance costs. Rather, it offers numerous potential benefits, business applications and cost savings to regulated entities, shippers and society at large. Rail transportation in the U.S. is recognized as a safe method for moving large quantities of hazardous materials over long distances. The intent of this regulatory impact analysis is to assess the proposed alternative. In this preliminary regulatory impact analysis, PHMSA presents an overview of the derailment history of DOT-113 tank cars as well as the incident history for the transportation of LNG and similar materials by highway. PHMSA and FRA seek public comment on the preliminary regulatory impact analysis of the proposed changes to address the safe transportation of LNG by rail.

This proposed rulemaking does not impose new compliance costs, since it would merely enable the transportation of LNG by an alternative mode. The potential benefits include transportation efficiency; market impacts; emissions reductions; and safety impacts. This proposed rule is expected to expand production opportunities to the industry by allowing LNG transportation by rail. PHMSA evaluated the benefits categories and expected cost savings qualitatively rather

¹ <https://www.regulations.gov/docket?D=PHMSA-2017-0020>

² The AAR petitioned for rulemaking to authorize the transportation of methane, refrigerated liquid (“LNG”), by rail in DOT-113C120W and DOT-113C140W tank cars.

than quantitatively because this is an enabling rule and there is limited information about the potential market for the transportation of LNG by rail.

1. INTRODUCTION

1.1 Summary of the Proposed Rule

The proposed rule would allow for the bulk transportation of LNG in rail tank cars by authorizing the transportation of LNG by rail in the DOT-113C120W specification tank car. The proposed rule would not impose new or additional operating controls. The NPRM relies on the existing HMR requirements for the transportation of cryogenic flammable materials and the existing industry interchange requirements, including, Circular OT-55, which establishes operational controls for “key trains” that transport certain quantities of hazardous materials, including LNG.³

1.2 Determination of Need

Federal hazardous materials law authorizes the Secretary of Transportation to “prescribe regulations for the safe transportation, including security, of hazardous materials in intrastate, interstate, and foreign commerce,” 49 U.S.C. 5103(b)(1). The Secretary has delegated this authority to PHMSA in 49 CFR 1.97(b). The HMR are designed to achieve three primary goals: (1) help ensure that hazardous materials are packaged and handled safely and securely during transportation; (2) provide effective communication to transportation workers and emergency responders of the hazards of the materials being transported; and (3) minimize the consequences of an accident or incident should one occur. The hazardous material regulatory system is a risk management system that is prevention-oriented and focused on identifying safety or security hazards and reducing the probability and consequences of a hazardous material release.

The Administrative Procedure Act (APA), 5 U.S.C. 551, *et seq.* requires Federal agencies to give interested persons the right to petition an agency to issue, amend, or repeal a rule. 5 U.S.C. 553(e). In accordance with PHMSA’s rulemaking procedure regulations in 49 CFR 106.95, interested persons may ask PHMSA to add, amend, or repeal a regulation by filing a petition for rulemaking along with information and arguments supporting the requested action. PHMSA has reviewed and responded to P-1697⁴ in accordance with § 106.105 and determined that the request merits consideration for a future rulemaking. In addition, this proposed rule would address a comment received to a notification of regulatory review,⁵ issued by the Office of the Secretary of Transportation in October 2017 as part of DOT’s implementation of three executive

³ Circular OT-55 defines a key train as any train with one tank car load of Poison or Toxic Inhalation Hazard1 (PIH or TIH) (Hazard Zone A, B, C, or D), anhydrous ammonia (UN1005), or ammonia solutions (UN3318); 20 car loads or intermodal portable tank loads of any combination of hazardous material, or; one or more car loads of Spent Nuclear Fuel (SNF), High Level Radioactive Waste (HLRW).

⁴ Docket No. PHMSA-2017-0020

⁵ Docket No. DOT-OST-2017-0069-0001; 82 FR 45750 (Oct. 2, 2017)

orders targeted at regulatory reform, that further expressed industry support of deregulatory efforts to address the safe transportation of LNG by rail.⁶

Before recommending federal regulatory action, an agency must demonstrate that the proposed action is necessary. Executive Order 12866 states that federal agencies should promulgate only such regulations as are required by law, are necessary to interpret the law, or are made necessary by compelling need, such as material failures of private markets to protect or improve the health and safety of the public, the environment, or the well-being of the American people.

In the case of this NPRM, regulatory action is needed to eliminate an unnecessary regulatory burden. This proposed rulemaking is expected to be deregulatory, and is the result of an agency review of existing regulations and petitions to identify opportunities to relax or amend current regulations that are (or have become) obsolete or unduly burdensome. Through this NPRM, PHMSA acts on the petition for rulemaking from AAR by proposing to allow the transportation of LNG by rail in DOT-113 rail tank cars and as such serves the purpose of removing undue restrictions in the safe and efficient transportation of energy products in the U.S.

1.2.1 Association of American Railroads Petition for Rulemaking

On January 17, 2017, AAR submitted a petition for rulemaking to PHMSA titled, “Petition for Rulemaking to Allow Methane, Refrigerated Liquid to be Transported in Rail Tank Cars” [PHMSA-2017-0020 (P-1697)]⁷ requesting revisions to 49 CFR 173.319 that would permit the transportation of LNG by rail in DOT-113 tank cars.

In P-1697, AAR requested that PHMSA amend the entry for “UN1972, Methane, refrigerated liquid” in the Hazardous Materials Table (HMT; § 172.101) to add a reference to § 173.319 in Column (8C), thereby authorizing transport of UN1972 in rail tank cars. Additionally, AAR requested that PHMSA amend § 173.319 to include specific requirements for DOT-113 cars used for the transportation of LNG. AAR suggested that the authorized tank car specifications be DOT-113C120W and DOT-113C140W, noting that 120W cars should provide 40 days in transportation before the LNG might vent and 140W cars should provide 45 days. AAR further suggested amending § 173.319(d)(2) to include maximum filling densities comparable to those specified for cargo tanks containing LNG in § 173.318(f)(3).

AAR noted that the current HMR allow for the transportation of LNG by highway, and expressed the opinion that rail transportation of LNG is a safer mode in comparison. AAR stated that LNG is similar in all relevant properties to some other cryogenic liquids currently authorized for rail transportation. AAR also stated that PHMSA had not previously authorized DOT-113 tank cars for LNG because of a lack of demand and that PHMSA currently authorizes the transportation of some hazardous commodities in the DOT-113 tank cars.

⁶ Executive Orders 13771, “Reducing Regulation and Controlling Regulatory Costs” (82 FR 9339; February 3, 2017); 13777, “Enforcing the Regulatory Reform Agenda” (82 FR 12285; March 1, 2017); and 13783, “Promoting Energy Independence and Economic Growth” (82 FR 16093; March 31, 2017).

⁷ PHMSA, <https://www.regulations.gov/docket?D=PHMSA-2017-0020>

AAR's petition P-1697 is consistent with policies of Executive Orders 13771, "Reducing Regulation and Controlling Regulatory Costs"; 13777, "Enforcing the Regulatory Reform Agenda"; 13783, "Promoting Energy Independence and Economic Growth," and 13868, "Promoting Energy Infrastructure and Economic Growth." PHMSA has accepted P-1697 as having merit for consideration for this rulemaking.

1.3 Background

1.3.1 LNG

LNG is natural gas⁸ that has been processed and liquefied through condensation by reducing its temperature to minus 260°F (minus 162°C) at ambient pressure—a process referred to as liquefaction. The liquefaction of natural gas dates back to 1820, when British scientist Michael Faraday first successfully chilled natural gas into a condensed liquefied form. In 1912, the world's first LNG plant was constructed in West Virginia. The first LNG production and regasification facilities in the U.S., referred to as peak shaving plants, started operating in 1941 in Cleveland, OH.⁹ There are now over 100 such facilities in the U.S., located primarily near centers of high demand for natural gas. A facility will liquefy gas during periods of low demand, and store it in an adjacent tank. When demand peaks, LNG is withdrawn from the tank, regasified, and put back into the pipeline, thereby enhancing the pipeline system's ability to meet such periods of high demand. Employing the liquefaction process allows the facilities to reduce the volume of natural gas to about 1/600th of its vapor state.

LNG is odorless, colorless, non-corrosive and non-toxic. To be consumed, LNG must be vaporized by warming and returning it to its gaseous form – this warming and vaporization process is called regasification. The vaporized natural gas is then injected back into a pipeline system, or used to fuel natural gas operated equipment. Alternatively, LNG can be transported by tanker trucks and in ISO containers on roads and highways or by water.

LNG in the U.S. is often considered an international commodity, whereas natural gas is often viewed as a domestic commodity. Natural gas in the U.S. is obtained largely from domestic sources and is transported via pipelines mainly for domestic consumption;¹⁰ whereas LNG is, presently, largely transported by ocean vessels for exporting to numerous international destinations. International trends in the LNG industry directly impact the domestic trends of natural gas and LNG. LNG is often transported via highway or water to supply regions, both domestic and international, that lack a natural gas source, or that lack the infrastructure needed to receive natural gas via pipeline. Hence, LNG production and consumption trends are sensitive to international prices for alternative fuel sources, mainly crude oil, diesel, and coal. The U.S. LNG market grew considerably between 2010 and 2018. During this period, the number of LNG facilities in the U.S. increased by 28.7 percent, and total storage and vaporization capacities increased by 21 and 23 percent, respectively.¹¹ Over the same period, total liquefaction capacity

⁸ Natural gas is mixture of hydrocarbons, predominantly composed of methane.

⁹ Center for Liquefied Natural Gas, <https://lngfacts.org/about-lng/history-of-lng/>

¹⁰ In 2018, most (70%) of the total U.S. natural gas exports were by pipeline, 67% of which went to Mexico.

¹¹ Based on PHMSA annual report data from 2010-2018.

increased by 939 percent due to new LNG export terminals.¹² The U.S. is expected to add 6.05 billion cubic feet per day (Bcf/d) of new liquefaction capacity by 2021, in addition to 3.5 Bcf/d already in operation at Sabine Pass, LA and Cove Point, MD. New “LNG trains”¹³ at Cameron, Freeport, and Corpus Christi—all along the U.S. Gulf Coast—are expected to be commissioned in the next three years.

The U.S. export market continues to thrive. According to the Energy Information Administration (EIA) projections,¹⁴ U.S. LNG export capacity will reach 8.9 Bcf/d by the end of 2019, making it the third largest in the world behind Australia and Qatar. The EIA’s December 2018 Short-Term Energy Outlook forecasts U.S. LNG exports to average 5.2 Bcf/d in 2019, as the new liquefaction facilities are gradually commissioned and ramp up LNG production to operate at full capacity. As of July 2019, U.S. LNG had been delivered to 35 countries on five continents, and the list of destinations continues to grow. The U.S. also imports some LNG, mostly to states in New England,¹⁵ which are constrained by limited pipeline and storage capacity. More than half (53 percent) of U.S. LNG exports in 2017 were shipped to three countries: Mexico, South Korea, and China. Mexico received the largest amount of U.S. LNG exports. Growing natural gas demand in Mexico, particularly from the power generation sector, and delays in the construction of domestic pipelines connecting to U.S. export pipelines led Mexico to rely on LNG imports to supplement imports of natural gas by pipeline.

1.3.2 The U.S. LNG Industry

The current LNG industry in the U.S. was born in the 1970s, when the first regasification plants were built. Today, the industry is comprised of many entities, of various sizes, meeting different consumer needs, user preferences, locations and distribution channels. Large entities include major energy producers, equipment producers, fueling station companies, and LNG marine carriers. In the U.S., the most common use of LNG is for peak shaving facilities. In addition, there are mobile/temporary facilities, which are portable units that supply natural gas to a pipeline during peak demand or during pipeline repair. Together, peak shaving, satellite, and temporary facilities accounted for 85 percent of the in-service facilities reporting to PHMSA in 2016, as well as 41 percent of storage capacity, 38 percent of vaporization capacity, and 18 percent of liquefaction capacity.¹⁶

Currently, LNG is typically transported by truck in the U.S. when used for domestic consumption. PHMSA is unaware of any data source that tracks how much LNG is moved by highway. The Federal Motor Carrier Safety Administration (FMCSA) does not have hazardous material-specific data on volume shipped via highways. The information is not captured by PHMSA’s incident reporting and there is no centralized entity, such as EIA, tracking all hazmat being shipped by highway.

¹² Id.

¹³ An “LNG train” in this context is term of art used to describe a liquefaction and purification facility.

¹⁴ <https://www.eia.gov/todayinenergy/detail.php?id=37732>

¹⁵ New England is composed of six states in the northeastern U.S.: Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, and Connecticut.

¹⁶ Profile of the Liquefied Natural Gas Industry, Final Report, Prepared for PHMSA, by Abt Associates, June 2017.

LNG is not typically transported by pipeline. There are only a few hundred feet of LNG pipeline (compared to more than 300,000 miles of natural gas pipelines) in the U.S. which is primarily used to transfer LNG from liquefaction facilities to storage facilities. Additionally, LNG pipelines may be used in loading and unloading LNG tankers. The limited use of LNG pipelines is due to the required design complexity required to accommodate the physio-chemical and safety characteristics of LNG. LNG pipelines require significant insulation and must be capable of handling significant thermal stress in order to maintain the very low temperature needed to prevent vaporization. As a result, LNG pipelines require costly expenditures to prevent damage to frost sensitive materials and equipment in the vicinity of the pipeline. LNG by pipelines are also possible for intermediate distances in specially designed pipelines used for loading and unloading LNG tankers.

Internationally, marine transportation of LNG has seen exponential growth since 2013.¹⁷ However, domestically there is no marine transportation of LNG. Domestic marine transportation is required to be on U.S.-built ships and no U.S.-built LNG carriers currently exist. PHMSA requires incidents involving the release of a hazardous material in transportation to be reported to PHMSA (49 CFR part 171 subpart B). These reporting requirements extend to any vessel operating to, from, or within the United States, to include those of foreign registry. PHMSA reviewed incident data from 2005-2017 and found no incidents related to transportation of LNG by vessel, and only a small number of incidents by highway with no reported deaths or injuries. Our research into additional sources indicates that such accidents are rare and mainly involve problems with machinery and cargo-handling systems and equipment.¹⁸

1.3.3 LNG By Rail in Canada, Europe and Japan¹⁹

LNG by rail in tank cars is in its early stages of inception in other countries, as in the U.S. In Canada, LNG is authorized to be transported by rail in tank cars that are equivalent to the DOT-113 specification and UN-T75 ISO containers, but service has been limited.²⁰ This is likely due to a lack of demand and the considerable cost of required infrastructure. Also, the fact that the US does not currently authorize the movement in DOT-113 prevents the export of the commodity by that means. LNG is permitted to be transported by rail in Europe in specially designed tank cars, but has not yet been utilized²¹. In Japan, LNG has been authorized to be transported by rail since 2000, in specially designed freight railcars and container railcars. The

¹⁷ According to the EIA, there were 0 MCF of LNG for 2013, but they have grown in each successive reporting year. In 2018, the US exported 1,082,511 MCF of LNG using marine transportation.
https://www.eia.gov/dnav/ng/ng_move_expc_s1_a.htm

¹⁸ Contacts with MARAD, USCG, Society of International Gas Tanker and terminal operators (SIGTTO), and the International Gas Union. See also “LNG Shipping at 50,” at <https://www.sigtto.org/media/2905/lng-shipping-at-50compressed.pdf> and “Carefully to Carry” -- The carriage of liquefied gases in the P&I World, by Thomas Miller stated “The truth is that serious accidents related to gas carrier cargoes have been few”.
<http://www.mea.szczecin.pl/klaster/Carriage%20of%20liquefied%20gases.pdf>

¹⁹ This overview is intended to be concise, covering only a handful of countries. LNG is present in many other major countries, such as China, Australia, Mexico and Russia.

²⁰ Containers for Transport of Dangerous Goods by Rail, a Transport Canada Standard,
<http://www.tc.gc.ca/eng/tdg/containers-transport-dangerous-goods-rail-transport-canada-standard.html>

²¹ In 2015, German VTG unveiled Europe’s first LNG tank car, designed jointly with Czech Republic-based Chart Ferro.

country relies on LNG imports for nearly all of its natural gas supply and ranks as the world's largest LNG importer.

1.3.4 Hazardous Material Rail Incident/Accident History in the U.S.

In the context of rail transportation, "accident/incident" is used to describe the entire list of reportable events.²² These include collisions, derailments, and other events involving the operation of on-track equipment and causing reportable damage above an established threshold; impacts between railroad on-track equipment and highway users at crossings; and all other incidents or exposures that cause a fatality or injury to any person, or an occupational illness to a railroad employee.

Accidents/incidents are divided into three major groups for reporting purposes. These correspond to the following FRA forms: (1) Train accidents -- A safety-related event involving on-track rail equipment (both standing and moving), causing monetary damage to the rail equipment and track above a prescribed amount, reported on Form FRA F 6180.54; (2) Highway-rail grade crossing incidents -- Any impact between a rail and highway user (both motor vehicles and other users of the crossing as a designated crossing site, including walkways, sidewalks, etc., associated with the crossing, reported on Form FRA F 6180.57; and (3) Other incidents -- Any death, injury, or occupational illness of a railroad employee that is not the result of a "train accident" or "highway-rail incident," reported on Form FRA F 6180.55a.

The focus of the accident history overview is on reported derailments incidents. These types train accidents, particularly when occurring outside of switching operations, tend to be the most relevant to the analysis because they have the potential to generate in train forces that can result in an increased probability of death or injury and a larger quantity spilled.

PHMSA requests data from the public on the volume of shipments of cryogenic liquids carried by rail and by truck.

1.3.5 An Overview of Derailment and Highway Incidents Involving LNG or Similar Hazardous Materials to LNG

The purpose of this section is to present an accident history overview of the transportation of LNG. In the U.S., there are no historical records for incidents involving LNG by rail in tank cars, since it has not been shipped in tank cars. LNG by rail in ISO tanks is only permitted by FRA approval. The first example of such permit was granted to the Alaska Railroad Corporation in 2015. Florida East Coast Railroad was also granted a permit in 2017, and is currently transporting LNG by rail. The LNG is permitted to be transported in bulk packaging, ISO-certified tankers atop flatcars. There have been no reported incidents associated with these special permits to date.

Given the absence of data on rail incidents of LNG, this section summarizes the derailment incidents of similar cryogenic liquids transported in DOT-113. The section also presents an overview of highway incidents involving LNG and similar cryogenic liquids. Specifically, the

²² 49 CFR 225.5

tables below show the following: (1) Incidents involving derailments of trains transporting ethylene and argon cryogenic liquids in DOT-113 tank cars, (2) Incidents involving the transportation by highway of ethylene and argon cryogenic liquids, and (3) Incidents involving the transportation by highway of LNG. This overview supports the position that the proposed transportation of LNG by rail is as safe, or, in some cases, safer than the transportation of similar hazardous materials.

Derailment Incidents Involving Hazardous Materials Similar to LNG, Transported in DOT-113 Tank Cars (2005-2017)

The AAR Petition identifies four cryogenic liquids (carbon dioxide refrigerated liquid, argon refrigerated liquid, ethylene refrigerated liquid, and refrigerated hydrogen chloride) with similar properties that are currently authorized to be transported by rail. The petition highlights ethylene, in particular, as having insignificant differences from LNG and that it has been safely transported in tank cars for 50 years.

For the purpose of this overview, PHMSA considers two cryogenic liquids that are currently transported by rail in tank cars: ethylene and argon. LNG, or methane refrigerated liquid, is also classified as a Division 2.1 cryogenic liquid, flammable gas (UN1972). Ethylene, refrigerated liquid (UN1038) is also classified as Division 2.1 flammable gas.²³ Argon, refrigerated liquid (UN1951), though a Division 2.2, non-flammable gas and therefore is likely to have different consequences when an accident occurs, is included in this accident overview because it was involved in a derailment incident while being transported in a DOT-113. The other two commodities mentioned in the AAR Petition are not directly comparable to LNG, because Carbon dioxide, refrigerated liquid (UN2187) is a Division 2.2 non-flammable gas and Hydrogen chloride, refrigerated liquid (UN2186) is a Division 2.3 poisonous gas.

PHMSA conducted a basic comparative analysis of the accident history of similar materials to LNG given the insufficient data on material damages from LNG rail incidents. Based on the 2014, 2015 and 2016 STB waybill data, Argon refrigerated liquid was the only one reported in the 2014, 2015 and 2016 waybill data as shipped in DOT-113 tank cars. Applying a time frame of 2005-2017, PHMSA examined the rail accident history involving cryogenic liquid hazardous material similar to LNG. There were two derailments over 13 years with accidental release of the contents of cryogenic liquids from DOT-113 tank cars. Table 1 (below) shows details on the two derailment incidents involving the transportation of ethylene and argon cryogenic liquids by rail in DOT-113 tank cars. PHMSA records provide details of those derailment incidents: One derailment, in Mer Rouge, LA, (in 2014) involved the accidental release of argon, refrigerated liquid from two tank cars (a DOT-113A90W specification tank car and an AAR204W tank car); one tank car was punctured and released all its content as a result of the derailment. The other derailment in Moran, Kansas, (in 2011) involved the accidental release of ethylene, refrigerated liquid; three DOT-113 specification tank cars containing liquid ethylene derailed. Two of the three tank DOT-113 cars were breached in that incident. A total of 91,539 liquid gallons were released in both incidents, with the total damage valued at \$459,160 in 2017 dollars.

²³ Ethylene is the only refrigerated liquid classified as a Division 2.1 flammable gas transported by rail. Hydrogen is also authorized for transport, but has not been moved by rail in almost 50 years.

Regarding the count of fatalities and injuries, there were no fatalities or injuries by rail in the transportation of the hazardous materials mentioned above.

Table 1 - Incidents Involving Derailments of Ethylene and Argon Cryogenic Liquids in DOT-113 Tank Cars (2005-2017)

Commodity	UN #	Number of Incidents	Death	Injury	Evacuations	Liquid Gallons Released	Total Damages (Original Dollars)	Total Damages (US \$2017)	Avg quantity released per derailment (LGA)	Average damages per derailment (Original \$)	Average damages per derailment (Current \$)	Gas dispersion
ARGON, REFRIGERATED LIQUID	UN1951	1	-		2	47,233	\$218,832	\$227,840	47,233	\$218,832	\$227,840	Yes
ETHYLENE, REFRIGERATED LIQUID	UN1038	1	-		-	44,306	\$210,255	\$231,320	44,306	\$210,255	\$231,320	Yes
Total		2	-		2	91,539	\$429,087	\$459,160	45,769	\$214,544	\$229,580	-

Source: PHMSA data.

Table 2 (below) summarizes incidents involving the transportation of LNG by highway from 2005 to 2017. PHMSA has no data on the volume of shipments by truck and so is unable to calculate an accident rate for truck transport of these materials. There were eight incidents, four of which were crashes and four were non-accident releases. Two of the crashes were single vehicle rollovers. No injuries or fatalities were reported to PHMSA. In addition, the total quantity spilled in those accidents was 11,296 gallons.

Table 2- Highway Incidents Involving the Transportation of LNG (2005-2017)

Number of incidents	8
Amount Released (gallons)	11,296
Average Release Volume (gallons)	1,412
Gas Dispersion Events Reported by Carrier	5
Fire	1

Source: PHMSA Data.

Table 3 shows the number of incidents involving the highway transportation of ethylene and argon cryogenic liquids. As shown, there was one incident for ethylene and 37 involving Argon. None of the incidents resulted in hazardous-material-related fatalities, injuries or evacuations.

Table 3- Highway Incidents Involving the Transportation of Ethylene and Argon Cryogenic Liquids (2005-2017)

Ethylene and Argon Refrigerated Liquids	Ethylene Refrigerated Liquid	Argon Refrigerated Liquid	Total
Number of Incidents	1	37	38

Amount Released (Gallons)	1	148,796	148,797
Total Damage Value	\$1,010	\$161,784	\$162,794

Source: PHMSA Data.

2. LNG SAFETY RESEARCH AND STUDIES

2.1 PHMSA Safety Research Studies

PHMSA funds LNG research through PHMSA's Office of Pipeline Safety Research and Development grants.²⁴ Some of these studies are potentially relevant and beneficial to the safety analysis of LNG by rail as a hazardous liquid commodity. PHMSA sponsored a Review of Vapor Cloud Explosion Incidents report with the primary objective to improve the scientific understanding of vapor cloud development and explosion in order to more reliably assess hazards at large LNG export facilities. Many lessons learned from these events have resulted in safety measures that are required in LNG facilities today. To view all of PHMSA's Pipeline Safety Research and Development projects, visit: <http://primis.phmsa.dot.gov/matrix/>. PHMSA's Office of Hazardous Materials Safety also has several ongoing studies related to LNG transportation and three completed research projects.²⁵ PHMSA evaluated the completed research projects in the context of this proposed rule, but found them to be either not directly applicable to the economic analysis or of limited relevance to the specific issue of transporting LNG by rail. PHMSA will continue to monitor the ongoing studies for potential consideration in the final rule.

2.2 FRA Safety Research Studies and Safety Testing Projects

FRA conducts research on the safe transportation of hazardous material to identify incident trends to find ways to minimize the incident rate of leaks, spills, and damage to the environment due to hazardous materials releases. Also, FRA conducts research in order to lower the potential for loss of lading and reduce the exposure of the environment and populations to hazardous materials releases, and to improve methods of inspection for tank car damage through the investigation of promising non-destructive detection technologies. FRA also conducts research to investigate emerging technologies and take advantage of national and international research programs that would increase the safety and efficiency of rail transportation.

A recent study by FRA was conducted by Sandia National Laboratories, entitled *LNG Safety Assessment Evaluation Methods*.²⁶ The study evaluated published safety assessment methods across a variety of industries including LNG and hydrogen facilities, highway and marine transportation, as well as protocols from the U.S. Department of Defense. The study also

²⁴ Completed Pipeline Safety LNG projects include: [DTRS56-04-T-0005, Modeling and Assessing a Spectrum of Accidental Fires and Risks in a LNG Facility](#), [DTPH5615T00005, Comparison of Exclusion Zone Calculations and Vapor Dispersion Modeling Tools](#), and [DTPH5615T00008, Statistical Review and Gap Analysis of LNG Failure Rate Table](#)

²⁵ Completed Hazardous Materials Safety LNG studies include: "Risk Assessment of Surface Transport of Bulk Quantities of Liquefied Natural Gas", "Transport Risks Associated with Small Scale LNG Facilities", and "Literature Review: Fire Testing and Thermal Modeling of LNG Bulk Packages."

²⁶ www.fra.dot.gov/Elib/Document/16555

reviewed world-wide methodologies for assessing the risks of the transporting of hazardous materials, with emphasis on LNG, by all modes, but with a focus on rail shipments. The primary task of the research was to evaluate the regulatory risk acceptability criteria and to compare the findings with other criteria. All of the methods were evaluated for their potential applicability for use in the LNG railroad application.

FRA is also conducting field experimental research to evaluate the pool fire survivability of a LNG filled portable tank subject to an engulfing pool fire. A new ISO tank is being built for this test, and is expected to be ready before the end of 2019. FRA plans to conduct the full-scale pool fire test of the LNG filled ISO tank before the end in the first quarter of FY2020. FRA is also conducting a full-scale tank car impact testing and analysis of two DOT 113 tanks. The test, which began in March 2019 and is expected to conclude in May 2020, evaluates the performance and crashworthiness of DOT 113 specification tank cars. The test project includes developing puncture models and verifying the models with actual testing data.

Another FRA safety research project underway is an LNG tender crashworthiness assessment that is expected to be concluded in December 2020. This project is a modeling to analyze the performance of an ISO tank (LNG tender) in different accident scenarios: head impact, shell impact, bottom impact and top impact.

FRA is also conducting a full-scale LNG tender rail highway crossing impact test. The project began in 2016 and is expected to conclude in December 2020. The test evaluates the survivability of valves and valve housing on an LNG tender constructed per the AAR proposed standards in a rail crash crossing incident scenario as prescribed on the AAR M-1004 standard.

FRA is commencing another project (fall of 2019) evaluating risk assessment of unit trains versus regular merchandize trains transporting hazardous materials, including LNG. To view FRA safety research studies, visit <https://www.fra.dot.gov/Page/P0505>.

2.3 Academic and Other Studies

Multiple studies have been performed over time regarding the safety and risks of LNG. Many of those focused on the safety of LNG tankers (ocean going ships) since they transport large volumes of LNG and enter ocean ports that may be near populated areas.²⁷ The “Liquefied Natural Gas (LNG) Import Terminals: Siting, Safety, and Regulation” report (Dec. 14, 2009) from the Congressional Research Service focuses attention on the safety of LNG terminals and infrastructure. These and other reports address the physical hazards of LNG, such as pool fires, flammable vapor clouds,²⁸ fire, and cryogenic impacts. Some reports also address ship safety, terminal safety, liquefaction facility safety, and security.

²⁷ Examples of such a studies include the [DOE Report to Congress in 2012 on Liquefied Natural Gas Safety Research](#) and the [Liquefied Natural Gas \(LNG\) Import Terminals: Siting, Safety, and Regulation](#).

²⁸ Some cryogenic liquids produce a gas that can burn in air. The most common examples are hydrogen, methane and liquefied natural gas.

3. CURRENT DOT REGULATIONS OF LNG

The transport of LNG is regulated by multiple DOT agencies, including PHMSA, FRA, FMCSA, and the Maritime Administration.²⁹ The following sections describe PHMSA's and FRA's current regulations.

3.1 PHMSA's Current Regulation of LNG

PHMSA regulates the surface transportation of LNG, in commerce, moved by highway, rail, and waterway, by specifying authorized packaging and labeling. PHMSA regulates LNG as a hazardous material under 49 CFR part 172, which states that LNG is forbidden on passenger aircraft, cargo aircraft, and passenger rail. Part 172 also specifies safe storage of LNG on vessels. LNG facilities may have to obtain additional permits from federal agencies to operate, such as Clean Water Act, Coastal Zone Management Act, and Clean Air Act permits. The Environmental Protection Agency (EPA) also requires greenhouse gas reporting for certain LNG storage facilities (40 CFR part 98).³⁰ PHMSA also regulates many LNG facilities under 49 CFR part 193, which sets federal safety standards for LNG facilities that either receive from or deliver to a 49 CFR part 192 pipeline. Facilities regulated under part 193 include baseload, peak shaving, satellite, and import/export terminals, and operators of LNG facilities must submit annual reports to DOT under 49 CFR part 191.17.

3.2 FRA's Current Regulations of Methane, Refrigerated Liquid

FRA has the enforcement authority and responsibility to ensure the safe transportation of hazardous materials by rail. Movement approvals are required for certain types of hazardous material shipments, such as a one-time shipment of hazardous material carrying tank cars for repair and other non-conforming packaging designed, marked or otherwise represented for the transport of hazardous material. The current HMRs do not contain the necessary provisions to allow for the bulk transport of methane refrigerated liquid (commonly referred to as LNG) in rail tank cars. Bulk methane refrigerated liquid may only be transported via rail in accordance with a PHMSA special permit or an FRA approval.

The proper classification of any hazardous material is required prior to being offered into transportation. In accordance with § 173.115(g), a "cryogenic liquid" means a refrigerated liquefied gas having a boiling point colder than $-90\text{ }^{\circ}\text{C}$ ($-130\text{ }^{\circ}\text{F}$) at 101.3 kPa (14.7 psia). Natural gas has a boiling point of $-260\text{ }^{\circ}\text{F}$. LNG meets the definition of division 2.1, cryogenic liquid and is described by entry "UN1972, Methane, refrigerated liquid (cryogenic liquid), 2.1" on the Hazardous Materials Table (HMT; § 172.101).

The HMR include the design, manufacturing, and maintenance standards for packaging (see parts 178-180). Additionally, the regulations specify which package types may be used for

²⁹ Other departments and agencies include the U.S. Coast Guard, the Federal Energy Regulatory Commission (FERC), the Environmental Protection Agency (EPA), the U.S. Department of Energy, the Bureau of Safety and Environmental Enforcement, and the Department of Homeland Security.

³⁰ For regulation of LNG by other entities, see the following link: <https://www.phmsa.dot.gov/pipeline/liquified-natural-gas/jurisdiction-lng-plants>

specific materials and provide requirements for filling and loading of packages (see part 173). As defined in § 171.8, a “bulk packaging” has a water capacity of greater than 454 kilograms (1,000 pounds) as a receptacle for gases. Per columns (9A) and (9B) of the HMT, bulk packages of LNG are forbidden for transportation by aircraft or passenger rail. Additionally, column (8C) of the HMT provides bulk packaging authorizations for LNG in accordance with § 173.318, Cryogenic liquids in cargo tanks only, and does not include authorization of LNG for tank cars. For cargo rail shipped in ISO containers, a carrier must obtain either a special permit from the Associate Administrator for Hazardous Material Safety, PHMSA (see part 107.105) or a prior approval from the Associate Administrator for Safety, FRA (see part 174.63). FRA has permitted two waivers for shipping LNG by rail in ISO containers to Florida East Coast Railroad and Alaska Railroad.

The DOT-113 rail car has a nominal water capacity of 33,000 gallons, which allows for a payload of approximately 28,500 to 29,000 gallons of cryogenic ethylene. Recently built cars have a gross volume of 34,500 gallons and a net cryogenic ethylene capacity of up to 144,000 pounds (30,380 gallons).³¹ The volume capacity of ISO tank portable containers varies by manufacturer between 5,000 gallons and 11,000 gallons of liquid.

3.3 PHMSA - Special Permits

PHMSA’s Approvals and Permits Division has the primary responsibility for the issuance of DOT special permits (SPs). SPs may authorize a regulated entity relief from the requirements in the HMR provided the applicant demonstrates an equivalent or greater level of safety to what’s intended by the regulation. SPs set forth alternative requirements, or a variance to the HMR in a manner that achieves an equivalent level of safety to that required under the regulations, or if a required safety level does not exist, that is consistent with the public interest. Specifically, SPs are issued by PHMSA under 49 CFR part 107, subpart B. LNG has previously been transported in bulk by rail safely in the U.S. under an emergency special permit (DOT-SP 15968).

4. BASELINE ANALYSIS

The baseline for the regulatory analysis represents PHMSA’s and FRA’s best assessment of the current conditions absent the regulatory action. The agencies considered the baseline conditions represented by existing regulations (as discussed in Section 3, above), industry standards, and voluntary measures, determined from the available data as the baseline to estimate the incremental costs and benefits of the proposed rule. The following entities are affected by the proposed rule: rail carriers, LNG operators, LNG shippers, emergency responders, tank car manufacturers, and tank car owners. The following entities are subject to the proposed rule:

³¹ The rail weight limit is 263,000 pounds with a tare weight range of 117,000 to 120,000 pounds. As stated in the HMRs, “except as provided in § 179.13, tank cars, built after November 30, 1970, or any existing tank cars that are converted, may not exceed 34,500 gallons (130,597 L) capacity or 263,000 pounds (119,295 kg) gross weight on rail.” DOT estimates the cost of a single DOT-113 tank car to be \$700,000 to \$725,000 based on informal feedback from manufacturers.

1. Any person transporting any liquefied natural gas in bulk packaging.³²
2. Any railroad (Class I, II, or III) that transports liquefied natural gas using one or more railroad tank car.

Table 4 represents the numbers of impacted entities. They include estimates for Class I, Class II, and Class III railroads that could transport liquefied natural gas.

Table 4- Number of Railroad Companies

Railroad Class	Total # of Railroads
Class I	7
Class II	21
Class III	510
Total	538

5. ANALYSIS OF COSTS, BENEFITS AND REGULATORY IMPACTS

This NPRM is a deregulatory action. The preliminary regulatory impact analysis summarizes the potential impacts of the rulemaking, including potential benefits, compliance costs, LNG business applications, and safety.

As stated above, there are no incremental compliance costs attributed to this NPRM. The NPRM merely proposes to accept a petition that would authorize LNG to be shipped by rail in tank cars, as it is by highway and water. It does not propose additional regulatory obligations or new compliance actions. Any and all new costs incurred by the industry to facilitate the transportation of LNG by rail are discretionary business costs. Such costs are not due to new regulatory requirements in the NPRM, and hence are not quantified in this analysis. Future shippers of LNG have the option to continue shipping in cargo tanks, trucks, ocean vessels or to begin (upon implementation of this rulemaking) shipping by rail in tank cars. Installing new rail lines can be as controversial as pipelines. The chosen modal option is at the discretion of the shipper and it depends on many economic and logistical factors.

PHMSA does note that, although it does not propose any operational controls in the NPRM, it does seek comment on the appropriateness of requiring operational controls for the transportation of LNG by rail. The operational controls referenced in the preamble to the NPRM include train length and train composition, speed restrictions and braking requirements, routing requirements, combinations of such controls, and any other operational controls that may be reasonable to

³² A bulk packaging is a packaging, other than a vessel or a barge, with (1) a maximum capacity greater than 450 liters (119 gallons) as a receptacle for a liquid; (2) a maximum net mass greater than 400 kilograms (882 pounds) and a maximum capacity greater than 450 liters (119 gallons) as a receptacle for a solid; or (3) a water capacity greater than 454 kilograms (1,000 pounds) as a receptacle for a gas.

apply to movements of LNG by rail. In this RIA, PHMSA also seeks comments on the potential costs and benefits of adding any such operational controls.

5.1 Compliance Costs

None. This NPRM does not impose new compliance costs.

5.2 Benefits

As stated above, there are numerous potential benefits and positive impacts from this proposed rulemaking, including transportation efficiency, expanded fuel usage, including fuel accessibility to remote regions, fuel switching, increased U.S. energy competitiveness, safety impacts, fuel efficiency and fewer emissions.

5.2.1 Transportation Efficiency and Expanded Transport

The proposed rule would be expected to result in transportation efficiencies. Rail and truck transportation of goods compete with, and complement, one another. This could be the case for the transportation of LNG. For heavy loads and long hauls, rail delivery is more efficient than truck. One tank car can replace almost three truck cargo tank trailers. However, rail delivery of LNG has limitations particular to the railway network. Rail delivery operationally takes longer than truck delivery particularly if loads are transported in manifest trains that must be consolidated and sorted onto different trains at rail yards, whereas truck delivery is a direct point-to-point delivery. However, the difference between truck and train delivery times would likely be reduced if unit trains were employed, in which only LNG railcars were transported from origin to destination without railyard sorting. For intermodal deliveries, trucks can complement the rail network by allowing consignees and shippers who are not directly served by rail lines to access rail terminals.

There is also increased efficiency from the fact that trains operate on a fixed schedule and with fixed routes; there is less variability in pick-up and delivery times as compared to trucks. Therefore, the long-distance trips are comparatively quicker. There are also cost savings to be gained from larger capacity and less handling and hence less potential for commodity damage. In addition, since LNG occupies a fraction of the volume of natural gas, and occupies less space, rail transportation (given the potential volume of LNG that could be moved in a single train) is expected to be more economical to transport across long distances and can be stored in larger quantities than trucks.

Rail delivery of LNG could also replace, or supplement, the pipeline delivery of natural gas. If a pipeline were to close due to immediate or planned maintenance work, or due to a pipeline malfunction, railroads could move large supplies of LNG to the demand regions. Railroads are often a substitute for pipelines when the latter is impossible or difficult to construct. Each type of

networks has limitations: pipelines have directional limitations and capacity constraints, while railroads have track safety standards and operational limitations.³³

The proposed rule likely would allow for expanded production opportunities, including complementary and competitive modal opportunities of transporting LNG by rail in new regions, particularly stranded regions, which lack pipeline service; or emerging regions, such as near chemical plants or feedstock sites, where rail may offer a comparative advantage due to terrain manageability. It is difficult to adequately forecast the future volume of shipments of LNG by rail given the limited quantities that are presently transported and the imperfect information regarding the demand for movement of LNG by rail. Furthermore, the analysis cannot predict the prevalence or car distribution of LNG being transported in tank car blocks (2-25 tank cars together) within manifest trains, or being transported in a unit train (typically 25 or more tank cars being moved as a single commodity train) configuration. It is presumed that LNG would likely be transported first in small blocks as part of manifest trains, and not in a unit train configuration. This presumption is based on the lack of available DOT-113 tank cars to transport this commodity. It is also difficult to adequately forecast the future routes of LNG shipments by rail, due to the lack of details of the specific origin and destinations of interstate rail movements and the connectivity of the current rail network to liquefaction and storage facilities.

PHMSA seeks data and comment from the public proposed rule's likely effect on the expected volume of substitution of LNG transport from other modes of transport (including truck, pipeline, and maritime) and the expected expanded volume of LNG transport.

5.2.2 Market Impacts

Reducing the cost of transporting domestic natural gas by enabling the use of rail tank cars for LNG may also have secondary impacts on the market for LNG. While these would not be additive benefits to be considered in a formal benefit-cost analysis, they represent impacts that would serve important policy goals of promoting domestic energy production and consumption. AAR asserts in its petition that LNG is currently missing from the list of commodities authorized for rail transportation "simply due to the historical lack of interest in transporting LNG by rail," but states that the current and expected future demand for transportation of LNG by rail warrants prompt authorization by PHMSA.

5.2.2.1 U.S. International Competitiveness

The absence of consideration of LNG by rail to date may be, as AAR contends, due to the historical lack of interest in transporting it by rail and the absence of economic incentives. However, there are now many opportunities for LNG by rail, including facilitating the rapidly expanding U.S. LNG export industry. U.S. LNG exports are expected to increase in coming

³³ Freight rail operations must comply with the applicable speed restrictions in the track safety standards which are established by FRA at 49 CFR § 213.9. This regulation prescribes minimum safety requirements for railroad track that is part of the general railroad system of transportation, Additionally, the railroads are also required to comply with various train operating requirements established in parts 173 and 174 of the HMR, as well as specific industry standards.

years as new U.S. LNG export capacity comes online.³⁴ As stated above, a recent report by EIA forecasts U.S. liquefied natural gas export capacity to more than double by the end of 2019, making it the third largest in the world following Australia and Qatar. The U.S. also imports some LNG, mostly to New England because states in that region are constrained by limited pipeline and storage capacity. The U.S. also re-exports some natural gas that is originally imported when foreign natural gas prices are favorable.

There are also many new potential economic gains for the U.S. energy industry, including export opportunities to Europe, Japan, Caribbean, Central American and South American countries. European efforts to import more LNG in the coming years could create another potential opportunity for U.S. producers, as the increased adoption of LNG in smaller economies—such as Poland, Greece, Italy and Lithuania—has opened up new opportunities of U.S. exporters. Japan, being the largest LNG importer in the world, is an additional potential trade partner of the U.S. Industry analysts believe there are commercial opportunities for the U.S. through exports by major Japanese electric and gas utilities and Japanese investment in U.S. LNG infrastructure, mainly U.S. power plants and gas liquefaction export facilities.³⁵

5.2.2.2 LNG as Fuel

The AAR Petition cites a “commercial interest” in LNG by rail. The Petition states that “[a]uthorizing transportation of LNG by rail likely would stimulate more interest. In addition, several railroads are actively exploring LNG as a locomotive fuel. If railroads are to use LNG-powered locomotives, they would need to supply LNG along their networks. Transporting LNG in tank cars would be an optimal, if not essential, way to transport LNG to those locations.”

There are many potential uses of LNG as fuel. LNG is an ideal fuel for long-haul trucks, railroad locomotives, ships and tug boats, heavy construction, mining equipment, forestry, and agriculture. The rail industry suggests that allowing LNG to be transported by rail would substantially increase the economic benefits for companies shifting locomotive fuel from diesel to LNG. The use of LNG as locomotive fuel is not a new idea; it dates back to the 1980s. Recent attention has been given to dual-fuel locomotive engines, which can burn natural gas as the primary fuel using diesel fuel only as a pilot fuel for gas ignition. However, becoming an effective large-scale system requires several conditions- fuel source, locomotive, refueling and storage on board. If any component is lagging or is improperly developed, the entire LNG-based system may be unsuitable.

The EIA reported that U.S. natural gas production grew by 10 billion cubic feet per day (Bcf/d) in 2018, an 11 percent increase from the previous year. The increase was the largest annual volumetric growth on record and reached a record high for the second consecutive year.³⁶ From the consumption side, the EIA stated in its Annual Energy Outlook 2018 that it expects a 40 percent increase in natural gas consumption in the U.S. industrial sector by 2050.³⁷ The U.S.

³⁴ See a list of existing and under-construction large-scale U.S. liquefaction facilities

https://www.eia.gov/energyexplained/index.php?page=natural_gas_lng

³⁵ <https://www.export.gov/article?id=Japan-Liquefied-Natural-Gas-LNG>

³⁶ <https://www.eia.gov/todayinenergy/detail.php?id=38692>

³⁷ [Annual Energy Outlook 2018](#)

industrial sector consumes more natural gas than any other sector, surpassing electric power in 2017 and the combined residential and commercial sectors in 2010. In 2017, about two-thirds of total industrial natural gas consumption was consumed for heat or power applications—either for industrial processes, such as in furnaces, or for onsite electricity generation. Several industries including bulk chemicals, food, glass, and metal-based durables used natural gas for 40 percent or more of their heat or power applications in 2017. EIA expects that these industries would continue to use about the same proportion of natural gas for heat or power applications through 2050 because of the cost associated with fuel switching. Industrial fuel switching often involves changing manufacturing processes, which requires substantial capital investment in new equipment. The EIA’s Annual Energy Outlook 2018 projects that U.S. dry natural gas production will increase through 2050 across a wide variety of alternative assumptions about the future.³⁸

5.2.2.3 Home Heating Fuel Switching

There are also potential economic benefits to be gained from switching fuel usage to natural gas (LNG). The potential to switch depends on differences in the relative prices of alternative fuels and the costs of application technologies. Oil furnaces are cheaper than natural-gas options, but gas models are slightly more efficient on average. Natural gas is a common energy source for home central heating systems. However, for rural and mountainous areas with limited access to natural gas, oil-fired boilers and furnaces are often an alternative. While the U.S. natural gas pipeline network extends to most of the lower 48 States, there are areas in the U.S. that are isolated from this network, or that have more demand for natural gas than the pipeline network can supply. A notable example is New England, which is a “stranded” gas market that currently is served by truck delivery of LNG or by waterborne imports. New England could be a candidate for LNG delivery by rail. It is a market with high demand and limited access to the pipeline network. In New England, LNG provides about 8 percent of its total annual gas supply. The nearby states of Pennsylvania, Ohio, and West Virginia currently account for 30 percent of U.S. gas production, which could be more efficiently transported to New England by rail until the pipeline network connects the two regions.

5.2.3 Emissions

According to the 2018 Transportation Statistics Annual Report of the Bureau of Transportation Statistics,³⁹ greenhouse gases and the six other most common air pollutant emissions from transportation, with the exception of particulate matter (PM-10), are below their 2000 levels and continued to decline from 2009 to 2016. Reductions in transportation’s air emissions have contributed to improved air quality in urban areas within the U.S. On average, air quality was good for 247 days in 2015 compared to 192 days in 2000.

As far as rail transportation, a recent FRA commissioned study⁴⁰ found that rail is on average more fuel efficient than trucks. Rail fuel efficiency varies from 156 to 512 ton-miles per gallon,

³⁸ [Annual Energy Outlook 2018](#)

³⁹ <https://www.bts.gov/TSAR>

⁴⁰ Comparative Evaluation of Rail and Truck Fuel Efficiency on Competitive Corridors (2009). The study is dated; trucks have improved but the turn-over in locomotives is much slower.

truck fuel efficiency ranges from 68 to 133 ton-miles per gallon, and rail-truck fuel efficiency ratios range from 1.9 to 5.5⁴¹. The study found that there is a strong correlation between rail-truck fuel efficiency ratio and equipment type. Tank car movement resulted in the highest ratio (Min-Max: 5.3- 5.3).

A study by the AAR states that U.S. freight railroads can, on average, move one ton of freight 479 miles per gallon of fuel, making rail the most environmentally friendly way to move freight over land. Additionally, the study states that moving freight by rail instead of by truck lowers greenhouse gas emissions by 75 percent. EPA data, cited in the study, finds that despite the large volume of freight moved, U.S. freight railroads only account for 0.5 percent of total U.S. greenhouse gas emissions and 2 percent of emissions from transportation-related sources.

5.2.4 Safety Impacts

Safety risk is a consideration of every hazardous material in transportation. PHMSA's Technical Evaluation and Recommendation in response to the AAR Petition states that "[f]rom a material risk point of view, LNG should be authorized for bulk shipments by rail, because the hazards are no greater than materials already authorized." PHMSA's technical evaluation also states that "there is nothing from a chemical perspective that shows any different hazard from other currently authorized cryogenic liquids."⁴² While there may be safety impacts due to a large increase in the number of tank cars transporting cryogenic liquids, this should not change the hazard analysis of authorizing the use of the DOT-113 tank car for LNG. There is currently no quantity limitation to the number of cars within a single consist for any cryogenic materials.⁴³ Therefore, when applying an equivalent level of safety, LNG should be authorized. Any limitation to handle large conveyances of cryogenic tank cars within a single consist should be handled under a separate petition/rulemaking as that same concern is present for many other cryogenic liquids and should be considered outside the scope of this particular request." FRA stated in its Response Letter⁴⁴ to Florida East Coast Railway that "[m]oving hazardous materials by rail is not new, and is one of the safest ways to move dangerous products. In fact, FRA believes it is safer to transport LNG by rail than it would be to transport the product by an alternative method."

In addition, as stated in the accompanying NPRM, the DOT 113C120W specification rail tank cars are constructed to a double pressure vessel design. The commodity tank (inner vessel) is constructed of ASTM A 240/A 240M, Type 304 or 304L stainless steel. The outer jacket (outer

⁴¹ Rail-truck fuel efficiency ratio is calculated as the ratio between rail and truck fuel efficiency, both measured in lading ton-miles per gallon. The study analyzed several types of rail equipment. The tank car movement resulted in the highest ratio, followed by double-stack, covered hopper, and gondola movements. Auto rack movements resulted in the lowest ratios (minimum 1.9 to maximum of 2.2).

⁴² All hydrocarbon materials - from methane to diesel - burn in fires producing about the same temperature within +/- 100 F. A large (30 m diameter and greater) LNG liquid pool fire on land is no worse than any similarly sized gasoline or other hydrocarbon fire. For a good description of potential safety hazards of LNG, see LNG Safety Assessment Evaluation Methods, <https://prod.sandia.gov/techlib-noauth/access-control.cgi/2015/153859r.pdf>

⁴³ To date, volumes of cryogenic materials shipped by rail have been small. To PHMSA's knowledge there have not been any unit trains of any cryogenic materials moved by rail because demand from shippers/receivers is insufficient to require shipments approaching unit train volumes. However, should such demand materialize, there would be no regulatory barrier preventing shipment of this material in a unit train configuration.

⁴⁴ <http://www.saveourfl.com/images/uploads/pages/102317---march-3-2017.pdf>

vessel) is typically constructed of carbon steel. This design provides an increased crashworthiness when compared to a single vessel design rail tank car. The rail tank car is manufactured with a vacuum and insulated area between the two pressure vessels. This vacuum area and the insulation significantly reduce the rate of heat leak from the atmosphere to the liquid inside the tank car thus minimizing the heating of the cryogenic material while being transported. Due to its unique design requirements, the DOT-113 specification tank car is inherently more robust than other tank cars transporting other flammable liquids or liquefied gasses, and is safer from the perspective of material releases resulting from a tank rupture during a derailment. If a DOT-113 is involved in a derailment, the most likely scenario would involve the breach of the outer tank. This breach would cause the loss of the insulating vacuum between the inner and outer tank, and would allow the inner tank and material to warm and build pressure. The resulting pressure build would eventually lead to the activation of the pressure relief systems on the car and the controlled venting of LNG vapor.⁴⁵ While this scenario may result in safety impacts, the controlled venting of LNG vapor is minor in comparison to the uncontrolled release of an entire LNG shipment. Additionally, it is highly unlikely that damage to DOT-113 involved in a derailment would result in explosion due to a boiling liquid expanding vapor explosion. This event is highly unlikely due to specific loading requirements for cryogenic materials, and due to the mandated requirements for redundant pressure relief systems (valves and safety vents) that are built into each car.

From an accident history standpoint, as discussed above, rail transportation of hazardous materials in the U.S. are considered a safe method of transporting large quantities of chemicals over long distances. Rail transportation is also not as adversely influenced by weather conditions as trucks, and can traverse through heavy rain, fog, and snow. Further, rail transportation is well structured and less susceptible to human error. According to the AAR, the rate of rail accidents caused by defective track and by human error were the lowest in 2017. On the other hand, rail accidents in comparison to highway accidents are potentially more catastrophic in size and impact, due to the higher volume of hazardous materials per shipment.

Rail and truck accident rates are not equally comparable due to inherent variations in risk factors associated with each mode of transportation. Variables such as fleet configuration, package type, transportation routing, operational requirements, among others, impact how accidents are compared. Accident studies, therefore, apply different evaluation methods based on the specific mode of transportation of the commodity.

A recent study by Exponent (Hart, et al)⁴⁶ evaluated the risks of the transportation of bulk LNG vs. bulk liquefied petroleum gas (LPG) by truck and rail. The study evaluated the potential risk profiles for the transportation of LNG in bulk packages versus the transportation of LPG which

⁴⁵ DOT-113 tank cars have redundant pressure relief systems. Each car has a total of four pressure relief devices (PRDs) consisting of two pressure relief valves and two pressure relief vents. A combination of each of these devices are mounted on opposite ends of the car to minimize the chances of both sets of devices being damaged in a derailment. In the case of a PRD failure to open, the redundant PRD(s) would vent any over-pressure. Theoretically, if all redundant PRD's failed, and the insulation was compromised, slow over pressurization would lead to an eventual container rupture and release of gas and liquid LNG. A BLEVE would require the compromised tank car with the failed redundant PRD valves to be additionally engulfed in a pool fire.

⁴⁶<https://www.exponent.com/knowledge/alerts/2015/08/bulktransportation/~media/03b73782ec76446798c70f6ac403ef84.ashx>

is currently shipped in bulk via road tanker truck and rail tank car. In general, the study found that the transportation risk profile for the transportation of LNG in a bulk package would be similar to the risk profile of LPG currently in transportation by highway and rail. However, the study suggested that the safety risk for the rail transportation of these materials may be slightly higher than highway transportation due to the larger volume of material transported in a rail car relative to the volume of material transported in a highway tanker.

Currently, as stated above, LNG is not permitted to be transported by rail without a waiver from the FRA, and only in UN ISO tanks. Cryogenic liquefied gases (e.g., ethylene, argon, nitrogen, etc.) are shipped in double-walled vacuum insulated DOT-113 cars with a capacity of 30,000 gallons. Tanker trucks for LPG are single-walled pressure vessels, whereas LNG trucks use double-walled cryogenic tankers.⁴⁷ The Exponent study found that, similar to road tankers, the annual accident rate for all rail pressure tank cars was found to be identical to that for the smaller subset of LPG pressure tank cars; thus, PHMSA reasonably assumes a common accident rate of 6×10^{-7} accidents per mile per year for both LNG and LPG tanker trucks.

6. Analysis of Regulatory Alternatives

Alternative 1: No Action

This alternative effectively denies the AAR's petition and maintains the status quo.

Taking no action would limit the transportation of LNG to highway cargo tanks or ISO portable tanks, which could increase the safety risk as volumes transported would increase. The increase in risk is not only due to the increased number of shipments placed into the public transportation system, but also from the increase in handling cycles (i.e. loading, unloading, etc.) of those shipments.

Alternative 2- Authorize DOT-113C120W and DOT-113C140W

This alternative would adopt the AAR petition in its entirety, including the authorization of the DOT-113C140W specification tank car into the HMR for the transportation of LNG. As discussed in the accompanying NPRM, the intended advantage to the DOT-113C140W tank car is that it would have a similar design and construction to the DOT-113C120W specification, but would potentially allow for 5 days of additional transportation time because the tank car would use a thicker inner tank material that would allow for a higher inner tank test pressure (140 psig) and higher pressure relief device settings. PHMSA and FRA believe that a complete engineering review of this specification is warranted, and that more research and supporting data are needed to demonstrate that this additional transportation timeframe benefits safety or justifies the addition of a new tank car specification to the HMR. While PHMSA is not opposed to considering this request for future action, it does not wish to delay action on the DOT-113C120W tank car. Accordingly, this alternative was eliminated from full consideration in this rulemaking.

⁴⁷ Mileage data were not available for the subset of cryogenic pressure tankers but were available for the larger set of all pressurized tanker trucks.

Alternative 3: Authorize transportation of LNG by Rail in DOT-113C120W Tank Cars and Rely on Existing Operational Controls under DOT Regulations and AAR’s Circular OT-55 (Preferred alternative)

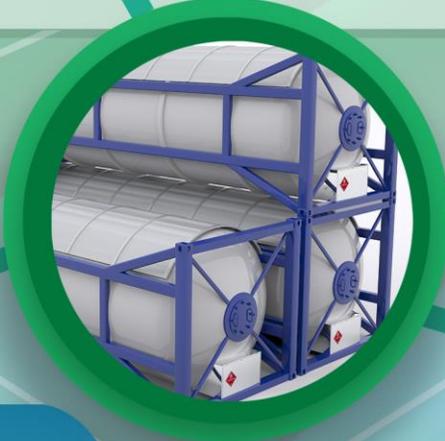
Under this alternative, operational controls specified in AAR’s Circular OT-55 would be required for any key train transporting LNG in DOT-113 tank cars. Specifically, Circular OT-55 defines a “Key Train” and outlines operational controls such as speed restrictions for trains meeting the “Key Train” definition. PHMSA estimates there would be approximately five railroads (1 Class I, 2 Class II, and 2 Class III) to 14 railroads (2 Class I, 2 Class II, 10 Class III) that would be impacted under this alternative. This alternative would not impose any additional costs to the industry because the railroads in practice follow the industry standards and operational controls specified in AAR’s Circular OT-55 to ensure safe transportation of all hazardous materials, including LNG. This alternative reflects PHMSA’s deregulatory effort of authorizing the transportation on LNG by rail and does not impose any costs on the industry. Alternative 3 relies on existing operational controls under DOT regulations and OT-55.

Exhibit J

Final Report

Risk Assessment of Surface Transport of Liquid Natural Gas

March 20, 2019



U.S. Department of Transportation
Pipeline and Hazardous Materials
Safety Administration



final report

Risk Assessment of Surface Transport of Liquid Natural Gas

prepared for

**U.S. DOT Pipeline and Hazardous Materials Safety Administration, Office of
Hazardous Materials Safety**

prepared by

Cambridge Systematics, Inc.
3 Bethesda Metro Center
Bethesda, MD 20814

with

MaineWay Services, LLC, Rutgers University, Transport Analytics, LLC., ScienceSmith
LLC.

date

March 20, 2019

Cover photos courtesy Chart Industries, Inc.

Table of Contents

Executive Summary	1
Overview.....	1
Natural Gas by Pipeline.....	1
Liquefaction	2
LNG by Truck	2
LNG by Rail	3
LNG Demand	3
LNG Mode Choice	5
LNG Mode Choice Case Study	5
Quantitative Risk Assessment	7
LNG and LPG Carrier Analysis	8
Conclusion.....	9
1.0 Introduction	1
1.1 Organization of the Report.....	2
2.0 Natural Gas Background	3
2.1 Natural Gas Pipeline Network.....	4
2.2 Natural Gas Supply.....	6
2.3 Natural Gas Markets	11
2.4 Natural Gas Demand	12
3.0 LNG Outlook and Emerging Markets	15
3.1 LNG Imports.....	16
3.2 LNG Exports	17
3.3 Emerging LNG Applications.....	20
4.0 Supply Chain Analysis	27
4.1 Commodity Flow Framework	27
4.2 LNG Networks.....	27
4.3 LNG Facilities.....	30
4.4 LNG Transportation	38
4.5 LNG Economics	44
4.6 LNG Transportation Scenarios	50
4.7 Future LNG Railroad Transportation	57
5.0 Quantitative Risk Assessment	61
5.1 Introduction	61

5.2	National Fire Protection Administration (NFPA) 59A Protocols	61
5.3	Understanding Risk.....	64
5.4	QRA Uses in Industry and Government	65
5.5	Quantitative Risk Analysis Methodology.....	66
6.0	Rail LNG Risk Assessment	69
6.1	Methodology	69
6.2	Describing Risk in the Rail Event Chain Diagram	70
6.3	Train Accident.....	74
6.4	Train Derailment	74
6.5	Train Derailment Rate.....	79
6.6	Number of Cars Derailed	79
6.7	Derailed Cars Contain Hazardous Materials	81
6.8	Number of Tank Cars Releasing Contents	81
6.9	Loss of Containment.....	82
6.10	Formation of Flammable Atmosphere	86
6.11	Ignition of Flammable Atmosphere	87
6.12	Release Consequence: Exposure to Population	91
6.13	Emergency Response.....	92
7.0	Truck LNG and LPG Risk Assessment	95
7.1	Truck Risk Factors	95
7.2	New England LNG Truck Case Study	96
7.3	Relative Risks of LNG versus LPG in Highway and Rail Transport	97
7.4	LNG and LPG Carrier Analysis.....	97
7.5	Truck LNG and LPG Risk Summary.....	104
8.0	Conclusion.....	105
Appendix A.	Acronyms	A-1
Appendix B.	Bibliography.....	B-1
B.1	Resources on the Properties of Liquefied Natural Gas	B-7
B.2	Additional Links and Resources	B-7
Appendix C.	Regulatory Framework.....	C-1
Appendix D.	Liquefied Natural Gas Defined	D-1
D.1	Methane.....	D-1
D.2	Cryogenic Liquids	D-3
D.3	Natural Gas.....	D-3
D.4	Liquefied Natural Gas (LNG)	D-5

D.5	LNG Storage and Handling.....	D-7
D.6	LNG Storage and Handling.....	D-9
Appendix E.	United States LNG Facilities.....	E-1
E.1	EIA Regions	E-1
E.2	Existing LNG Import/Export Facilities	E-1
E.3	Approved LNG Export Facilities.....	E-3
E.4	Proposed LNG Export Facilities.....	E-4
E.5	Emerging LNG Facilities	E-4
Appendix F.	Cryogenic Tank Cars, Cargo Tanks, and Portable Containers	F-1
F.1	ISO Containers	F-1
F.2	Cargo Transport Trailers.....	F-3
F.3	DOT 113 Railcar	F-5

List of Tables

Table ES-1	Pennsylvania to Massachusetts LNG Cost Scenarios	7
Table 2.1	U.S. Top 11 Gas Producing States 2016	8
Table 3.1	Top LNG Import Countries and Volumes	17
Table 3.2	LNG Exporting Countries and Volumes.....	20
Table 4.1	Elements of Commodity Flow Framework Specific to LNG Supply Chain	27
Table 4.2	Sample of U.S. Natural Gas Merchant Plants	36
Table 4.3	Supply-Side and Demand-Side Factors Affecting Prices	45
Table 4.4	Truck, Railroad and Intermodal LNG Transport Options.....	51
Table 4.5	Scenario 1: Pennsylvania to Massachusetts <i>By Highway</i>	53
Table 4.6	Scenario 2: Pennsylvania to Massachusetts by Intermodal Container	54
Table 4.7	Scenario 3: Pennsylvania to Massachusetts <i>By Rail</i>	56
Table 4.8	Pennsylvania to Massachusetts LNG Cost Scenarios	57
Table 5.1	Summary of IR and SR Quantitative Risk Criteria.....	63
Table 5.2	Quantitative Risk Assessment (QRA) Steps	66
Table 6.1	Rail Event Chain Factors and Parameters	70
Table 6.2	FRA Track Classes and Distribution.....	75
Table 6.3	Derailment Frequency and Severity by Accident Cause (<i>Excerpt</i>)	77
Table 6.4	Distribution of Freight-Train Derailment.....	78
Table 6.5	Parameter Coefficient Estimates of Freight-Train Derailment Rates per Billion Gross Tons 2005–2009.....	79
Table 6.6	Sample Release Size Types for Loss of Containment (LOC) Estimates	85
Table 6.7	Affected Populations during Hazmat Release Events	91
Table 7.1	States with Most Registered LNG Carriers.....	100
Table 7.2	States with the Most Registered LPG Carriers (including Puerto Rico)	103
Table C.1	U.S. Federal Agency LNG Oversight.....	C-2
Table D.1	Methane Gas Properties ^{1, 2, 3}	D-2
Table D.2	Sample Natural Gas Composition	D-4
Table D.3	Chemical Properties of Natural Gas and Natural Gas Liquids	D-6
Table E.1	FERC Approved and Existing LNG Export Facilities May 2017	E-3
Table E.2	FERC Approved LNG Facilities May 2017	E-3
Table F.1	U.S. LNG Motor Carriers	F-5

List of Figures

Figure ES-1	LNG Movements by Truck between States 2016, in millions of cubic feet (MMCF)	4
Figure ES-2	LNG Movement Alternatives between Harrisburg, PA, and Worcester, MA	6
Figure ES-3	Rail LNG Event Chain Diagram	8
Figure 2.1	U.S. Natural Gas Pipeline Network	5
Figure 2.2	U.S. Natural Gas Processing Plants and U.S. Pipeline Network	7
Figure 2.3	U.S. Power Generation and Gas Processing Plants	9
Figure 2.4	Northeast Gas Processing Plants	10
Figure 2.5	Major Natural Gas Hub Locations	11
Figure 2.6	U.S. Natural Gas Consumption 2015–2018—Projected	12
Figure 2.7	U.S. Natural Gas Net Capacity and Additions 2013–2026	14
Figure 3.1	Global LNG Trade Volume 1990–2016	15
Figure 3.2	Top LNG Importing Countries	16
Figure 3.3	LNG Export Demand Growth	18
Figure 3.4	Top LNG Export Countries	19
Figure 3.5	Scale of LNG Applications	25
Figure 4.1	U.S. National Highway System	28
Figure 4.2	North American Freight Rail Network	30
Figure 4.3	U.S. LNG Facilities with Natural Gas Pipeline Network	31
Figure 4.4	U.S. LNG Facilities and U.S. Railroad Network	32
Figure 4.5	Northeast LNG Facilities	34
Figure 4.6	Northeast LNG Facilities and Railroads	35
Figure 4.7	Example of Selected U.S. LNG Suppliers	37
Figure 4.8	Small and Midscale LNG Facility Features	38
Figure 4.9	Net Interstate Natural Gas Movements Million Cubic Feet MMCF	39
Figure 4.10	Gross Interstate Natural Gas Movements by Truck MMCF	40
Figure 4.11	Gross LNG Truck Movements by State	42
Figure 4.12	LNG Truck Movements between EIA Regions MMCF	43
Figure 4.13	U.S. Pipeline Capacity between EIA Regions MMCF/d	44
Figure 4.14	Natural Gas Hub Spot Prices 2014–2017	45
Figure 4.15	Market Hub Price Differential 2014 to 2017	47
Figure 4.16	Example of Natural Gas Delivery Costs By Mode Relative to Distance	48
Figure 4.17	Pennsylvania to Massachusetts Routes By Mode	52
Figure 4.18	(Illustrative Only) Gross Rail LNG Movements by State	58
Figure 5.1	NFPA 59A Timeline	62
Figure 5.2	Acceptability Regions of Societal (Injuries) Risk in the F-N Domain	64

Figure 6.1	Rail LNG Event Chain Diagram.....	72
Figure 6.2	Risk Inputs, Calculations, and Outputs for Rail LNG Transport	73
Figure 6.3	Grade Crossing Collision Rate	74
Figure 6.4	Estimated Train Derailment Rates <i>By Track Class</i>	78
Figure 6.5	Distribution of the Point-of-Derailment 2002–2011	80
Figure 6.6	Selected Tank Car Conditional Probability of Release <i>CPR</i>	82
Figure 6.7	Typical Features of DOT 113 Tank Car.....	83
Figure 6.8	ISO Insulated Tank Container Diagram.....	84
Figure 6.9	LNG Flammability Range	88
Figure 6.10	LNG Release Consequence Diagram	89
Figure 7.1	Distribution of LNG Carriers <i>By State</i>	99
Figure 7.2	Distribution of Crash Rates across LNG Carriers.....	100
Figure 7.3	Distribution of LPG Carriers <i>By State and Province</i>	101
Figure 7.4	Distribution of Crash Rates across LPG Carriers.....	103
Figure C.1	Federal Oversight of LNG Value Chain	C-1
Figure E.1	Natural Gas Regions for Production/Consumption and Storage.....	E-1
Figure F.1	Portable ISO Container	F-2
Figure F.2	Cargo Trailer Specifications—ST-16300	F-4
Figure F.3	MC-338 Cargo Tank Trailer	F-5
Figure F.4	Typical Features of DOT 113 Tank Car.....	F-6
Figure F.5	DOT 113 Rail Tank Car (Front End).....	F-7
Figure F.6	DOT 113 Rail Tank Car (Back End)	F-7
Figure F.7	DOT 113 Ethylene Tank Car Valve Details	F-8
Figure F.8	Major Valves and Fittings of 113C120W Side Loader.....	F-9

Executive Summary

Overview

The Pipeline and Hazardous Materials Safety Administration's (PHMSA) Office of Hazardous Materials Safety (OHMS) contracted with the Cambridge Systematics Team (CS Team) to assess the risk of transporting Liquid Natural Gas (LNG), with an emphasis on rail. In Task 1, the CS Team completed a comprehensive Literature Review. In Task 2, the CS Team developed a Risk Plan. For Task 3, the CS Team identified the factors and parameters for developing the LNG Risk Model in this report. This final report documents the findings and results from all three tasks.

Risk Assessment of Surface Transport of Liquid Natural Gas outlines LNG supply and demand in the context of the overall energy market, including new trends for using LNG for propulsion in the motor carrier, maritime, and rail industries. The CS Team explored how natural gas and LNG are transported throughout the United States, and the relationship between peak-shaving facilities, merchant plants, and export facilities. We also researched accident rates for motor carriers transporting LNG and Liquefied Petroleum Gas (LPG), and outlined LNG handling characteristics.

Natural Gas by Pipeline

A key aspect of this project is to examine the risks of shipping LNG by surface modes, with an emphasis on rail. This requires a review of existing natural gas pipeline network, which is how most gas is transported today.

The majority of natural gas volumes transported in the continental U.S. are moved by pipeline. As natural gas is replacing coal as an energy source, its use is increasing across the country. The appeal of its low price and good pipeline network creates accessibility and competitive pricing. Natural gas—which is principally methane—in its native state is gaseous, but its state of matter depends on the method of transport. With few exceptions, natural gas delivered via pipeline is in a gaseous form. To transport natural gas by a vehicle, it is liquefied via cooling (Liquid Natural Gas), condensing it to 1/600th of the volume in its gaseous form. Keeping the LNG in a liquid state requires maintaining a temperature of -260°F, which is considered a cryogenic temperature.

A facility that is connected to the pipeline supply network may contract their natural gas through interruptible service contracts from the pipeline company. Peak-demand periods, such as during cold winters and hot summers, can exceed pipeline capacity in some regions. To guarantee that service will not be curtailed during peak-demand periods, firm service contracts reserve capacity that must be fulfilled except due to unforeseeable circumstances.¹ Interruptible contracts are lower priority than firm contracts, and flow can be stopped in order to serve the firm contracts, leaving the facility seeking alternative energy sources. Interruptible service is cheaper than firm service, and prices paid for the gas are subject to the rise and fall of the natural gas market.

¹ “Twenty-nine percent of natural gas purchases by U.S. power plants in 2016 were serviced by non-firm contracts. Yet, 57 percent of natural gas purchases by power plants in the Northeast in 2016 were serviced by non-firm contracts. The Northeast has a well-documented shortage of supply during peak periods, which stems from the limitations of the pipeline infrastructure.” Energy Information Administration, “Natural gas power plants...”

However, the U.S. pipeline system cannot be quickly or easily modified. Pipelines are fixed in place, expensive to construct, and require an extensive permitting process; because of this, pipelines are becoming increasingly difficult to build. New pipelines with construction plans face increased scrutiny by the public, and they must undergo permitting processes that span years. This limits pipeline owners from expanding their networks to areas not currently served. It takes years for the pipeline owners to accomplish modifications of their infrastructure in response to supply and demand changes. In this situation, delivering natural gas in liquefied form by truck or by rail may be suitable alternative.

Liquefaction

The process of reducing natural gas into a liquid, called liquefaction, reduces the volume significantly for transport. However, this energy-intensive process increases the upfront cost of LNG. Liquefaction is most efficient at a large scale export facilities that use a series of turbines (trains) to cool the LNG to cryogenic temperatures.² Small-scale liquefaction also is available, though it is less efficient and more costly. Facilities with liquefaction capabilities can store natural gas as LNG and sell it to other facilities, like those that amass supplies for peak periods that are not connected to the pipeline network. In order to generate LNG, both a natural gas supply and liquefaction capabilities are necessary.

LNG by Truck

Truck delivery of LNG is an alternative to pipeline transportation of natural gas. A very small percentage of the volume of natural gas moved across the United States is moved by truck each year. Once natural gas is liquefied, it can be used as fuel for maritime, rail, and truck operations; it can also provide power generation in remote locations (mining, energy, and production companies, etc.). There are three typical reasons for LNG truck movements:

- A facility is not connected to the natural gas pipeline system;
- A facility has an interruptible pipeline supply contract; and
- LNG can be sourced at a more competitive price than other energy sources.

Areas and facilities may not be connected to the pipeline system because they are remote, not densely populated, have some type of geological formation that makes pipeline construction excessively costly (such as mountainous terrain), or have a temporary demand such as construction. Facilities can purchase LNG through brokers who contract and deliver the LNG at prices that compete with other energy sources, such as propane and diesel. When a pipeline is either not expected to be built, or will not be built for a while, LNG is a viable alternative energy source.

Whether or not a facility is connected to a pipeline, the choice to source alternative fuel is driven by price. If the price of natural gas rises too high, a facility with interruptible pipeline service can choose to source their natural gas needs in other ways, whether that be LNG, other energy sources, or through peak shaving, the stockpiling of natural gas while prices are low in anticipation of a future supply shortfall and price spike. Natural gas can be stored in underground caverns or as LNG in tanks at cryogenic temperatures. A facility

² In the context of LNG, the term *train* refers to the series of turbines that are used to cool natural gas to cryogenic temperatures.

without pipeline connections can choose the most competitive fuel source, and as long as LNG is competitive with other energy sources, it could be selected by the consumer.

LNG by Rail

LNG is not shipped by rail in the U.S. because it is not authorized by the Federal Railroad Administration (FRA), except by special permit. The code of Federal regulations, 49 C.F.R. § 172.101 Hazardous Materials Table lists natural gas with high methane content as forbidden to be transported by rail. The FRA has granted special permits to the Florida East Coast Railroad and to the Alaska Railroad. While several Class I railroads have piloted LNG propulsion programs, the comparatively low price of diesel fuel has delayed such programs.

Nevertheless, authorizing LNG rail shipments could change existing demand patterns; demand of LNG transport by rail could appropriate market share from either trucking or pipeline, depending on the network characteristics and other factors. In the case of New England, for example, the railroad network could supplement the existing pipeline network. In addition, availability of LNG transport by rail could affect the market share of other energy sources.

LNG Demand

One of the objectives of this study was to determine future LNG demand. This involves understanding the natural gas industry such that demand can be anticipated based on input factors. Demand for natural gas is determined by origins and destinations for LNG movements, which further determines the possible routing for LNG shipments.

The movements of LNG by truck in Figure ES-1 provides insight into 2016 Interstate truck movements reported to the EIA for the 2016 EIA Annual Report. The CS Team summarized gross Interstate LNG movements and mapped these truck movements with the natural gas pipeline network using the highway Interstate system. The data were not available for the exact origin and destination of each of the movements, so the CS Team employed a “shortest distance method” in GIS using State centroids and ports of entry. Where there are no pipelines, there is truck delivery of LNG—the pipeline system and the highway system are complementary. The truck movements of LNG in 2016 show where demand for LNG has been fulfilled, and where truck movements supplied natural gas to areas that were not sufficiently served by the pipeline network.

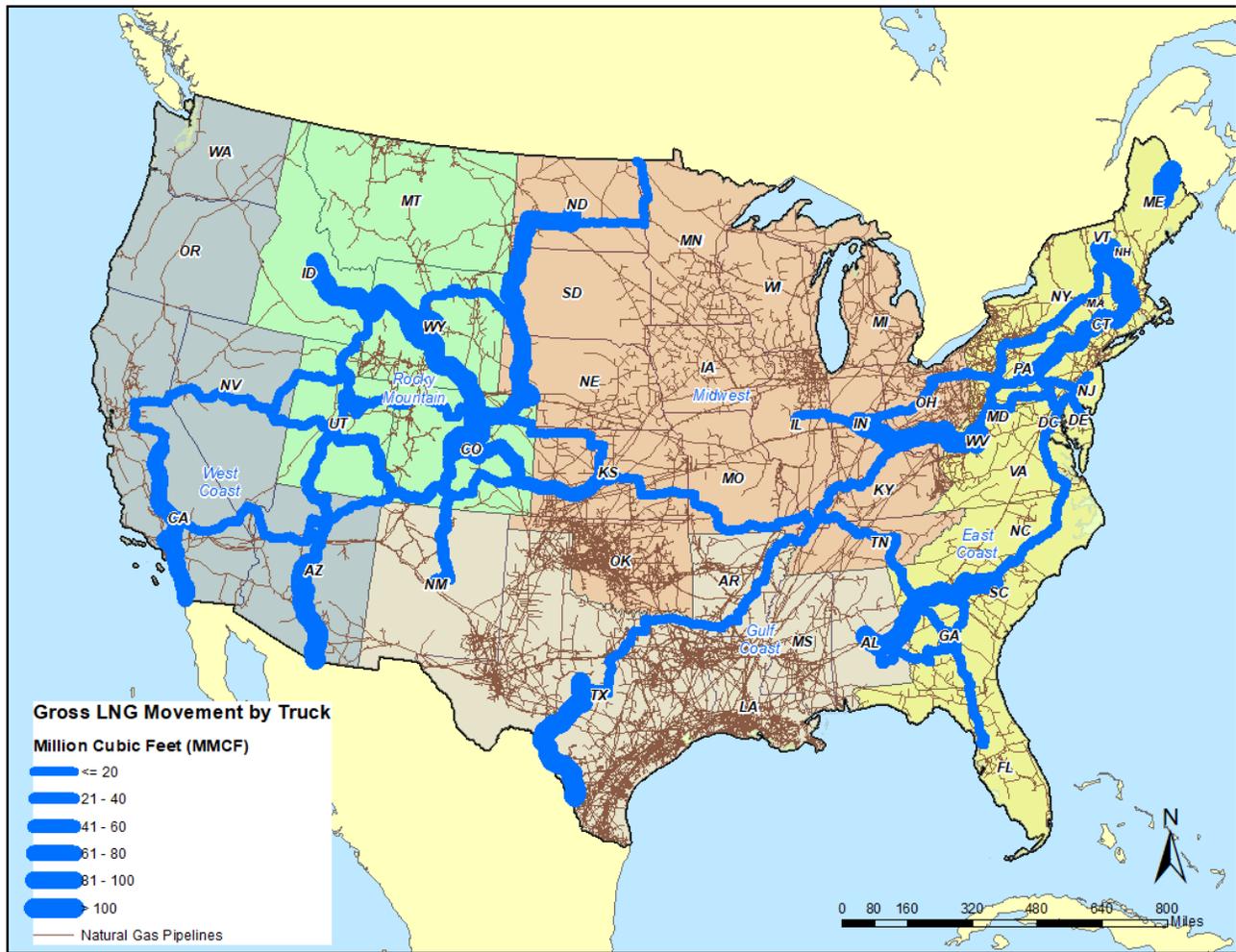


Figure ES-1 LNG Movements by Truck between States
 2016, in millions of cubic feet (MMCF)

Source: Energy Information Administration, "2016 Annual Report."

The potential demand of LNG for regions and individual facilities can be anticipated based on several input factors. These include: 1) connection to the natural gas pipeline system, 2) pipeline supply contract types; 3) volume of demand; 4) proximity to LNG sources of supply; 5) prices of other fuel sources; and 6) the price basis of natural gas between regions. Natural gas price differentials are indicators of the supply and demand situation. Areas with stranded supply will have lower prices than the rest of the market, and areas with underserved demand will have higher prices than the rest of the market. The basis between two regions can justify the increased transportation costs of LNG delivery; where natural gas becomes less accessible and more costly, LNG becomes more attractive as an alternative energy source. As such, demand of LNG transport by railway could take market share of LNG delivery from the trucking industry and market share of natural gas delivery from the pipeline industry, or it could further compete and take market share from other energy sources like diesel and propane.

LNG Mode Choice

Rail and truck delivery of goods complement and compete with each other; this could be the same for LNG. For intermodal deliveries, trucks complement the rail network by providing consignees and shippers not directly served by rail lines access to rail terminals. For heavy loads and long hauls, rail delivery is more efficient than truck. One tank car can replace almost three truck cargo tank trailers. However, rail delivery of LNG has limitations particular to the railway network. In addition, rail delivery operationally takes longer than truck delivery because rail loads in manifest trains must be consolidated and sorted onto trains at rail yards, whereas truck delivery is a direct point-to-point delivery. This would be different if unit trains were employed, in which only LNG railcars were transported from origin to destination without requiring railyard sorting. Rail routing also is circuitous because rail companies prefer to stay on their own tracks to avoid interchange fees. There are certain origin and destination pairs that would make rail delivery of LNG more attractive than truck delivery, but since LNG supply points are spread out across the country, the overall distance that LNG would have to travel from the origin is limited, and this could favor truck delivery.

Rail delivery of LNG could replace or supplement the pipeline delivery of natural gas, such as during a supply disruption, where the rail option could provide duplication and redundancy. If a pipeline had to close due to immediate or planned maintenance work, or due to a pipeline malfunction, railroads could move large supplies of LNG to the demand regions. In addition, railroads could supply natural gas via LNG to destinations that the pipeline would not be able to service. For regions not currently served by pipeline, the demand for large volumes of natural gas on a consistent basis triggers the justification process for building a pipeline, which leaves several years for non-pipeline demand and delivery that could be replaced by pipelines if approved for construction.

Rail delivery could reach areas of the U.S. that currently do not use natural gas because it is too expensive to source and other sources are more accessible. If rail delivery of LNG is cheaper than truck delivery, then the LNG could travel longer distances from the supply source, to compete with other energy sources in areas previously out of reach. These are some of the factors to consider comparing LNG transport by truck and by rail.

The potential origins of LNG are facilities that liquefy natural gas or store LNG. These would include peak shaving facilities, export facilities, merchant plants, natural gas processing facilities, market hubs, and market centers that have liquefaction capabilities. Generally, there would be a large number of facilities that currently supply LNG for truck transport that could potentially supply LNG for rail transport to a single destination. For most destinations, that number can be reduced to a much smaller number by considering the alternative modes of trucking and pipeline, and using the costs of those modes to limit the potential rail origins.

LNG Mode Choice Case Study

To understand the economics of LNG transport by mode, the CS Team developed a case study to compare the LNG shipments by bulk rail, truck, and intermodal delivery. This was an economic case study, not a risk case study; information about the proposed quantitative risk assessment (QRA) can be found in Chapter 5. In this economic case study, the CS Team developed several scenarios to detail Interstate LNG shipment costs by mode between western Pennsylvania and Massachusetts. This was a deliberate choice, since western Pennsylvania is in the productive Marcellus and Utica shale region, and Massachusetts is an area in New England where natural gas is in high demand.

scenarios. Table ES-1 provides a summary of the scenarios and their costs, and the full analysis can be found in Section 4.6.

Table ES-1 Pennsylvania to Massachusetts LNG Cost Scenarios

Scenario	Mode 1	Mode 2	Mode 3	Cost	Transport. Cost per MMBtu	Liquefaction, Gasification, and Storage Costs per MMBtu ¹	Total Cost per MMBtu
1a—Truck	Truck (MC-338)	–	–	\$61,494	\$0.85	\$4.52	\$5.37
1b—Truck	Truck (ISO)	–	–	\$61,183	\$0.85	\$4.52	\$5.37
2—Intermodal	Truck (ISO)	Rail (ISO)	Truck (ISO)	\$54,733	\$0.76	\$4.52	\$5.28
3—Rail	Rail (DOT-113C120W)	Truck (MC-338)		\$46,098	\$0.64	\$4.52	\$5.16

Sources: Cambridge Systematics Inc., Norfolk Southern Railway, Chart Industries.

Quantitative Risk Assessment

One of the key tasks for this study was evaluating the risks of transporting LNG by surface modes. This requires a quantitative risk assessment (QRA). In this context, risk is generally defined as the probability multiplied by the consequences of a hazmat release incident. The CS Team developed parameters and factors that would be required to model the derailment and release probability of LNG rail cars to account for a variety of characteristics. Ultimately, this process will help address the likelihood of a release per shipment, along with the resulting hazards to the public in the event of a derailment or other incident.

Currently, the FRA has not codified quantitative risk criteria for LNG hazardous materials transportation. Additionally, QRA analyses are not common regulatory requirements in the U.S. and there are no broadly accepted risk criteria employed by domestic communities or industries. Nevertheless, this study contributes to the body of knowledge required to better assess LNG risks related to surface transport.

QRA is used to assess risks in other industries, including chemical production, oil and gas processing plants, power generation plants, and manufacturing companies. In addition, U.S. Government agencies have developed QRA techniques to quantify hazardous material (hazmat) transportation and storage risks, determine route and mode choices, and identify appropriate packaging solutions.

Understanding the demand for LNG delivery by rail and/or truck helps identify the safest origins and destinations, and proposed routes can be examined for the probability and consequences of train and/or truck accident. Routes should be evaluated based on their proximity to city centers, sensitive populations, and track conditions. Rail risk factors include FRA class, signalization, and traffic density. Truck risk factors include driver behavior, traffic congestion, and truck speed.

One method commonly used to measure the harmful exposure of people or property to a hazardous material is to identify a series of events in an event chain diagram. In such a diagram, each event is probabilistic, in the sense that its occurrence is not certain, given that the prior event in the chain has taken place: one can only assign a probability to its occurrence. In the case of rail travel, the rail accident is identified as the first event in the chain of subsequent events.

The events in the event chain that must be evaluated to perform a rail QRA, from beginning (accident occurs) to end (a potential fatality) are described in Figure ES-3.

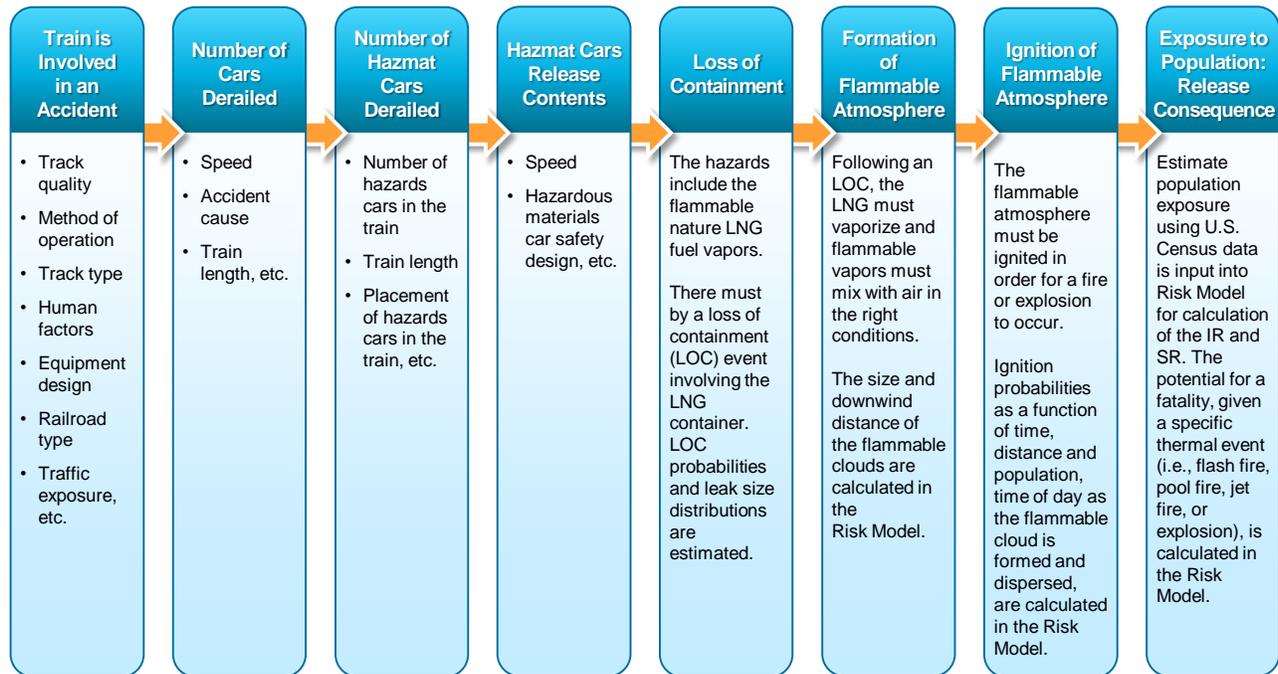


Figure ES-3 Rail LNG Event Chain Diagram

Source: Health and Safety Executive, Exponent, Inc; Liu, X., M. R. Saat, and C. P. L. Barkan, 2017. "Freight Train Derailment Rates for Railroad Safety and Risk Analysis," Cambridge Systematics, Inc.

Risk inputs and calculations further illustrate the relationships between inputs and calculations that determine model outputs. For example, FRA track class, method of operation, and traffic exposure are the inputs used to calculate train derailment frequency. Train speed is an input for both train derailment severity and release probability. Tank car safety design is an input to calculate tank car derailment and release probability. The formation of a flammable atmosphere is an input for calculating size and downwind distance of flammable clouds. These are examples of how risk factors and parameters are connected and interrelated in the QRA process.

LNG and LPG Carrier Analysis

In order to better understand motor carrier transport risk, the CS Team evaluated all U.S. LNG and LPG carriers and crash rates. The results of this research indicate that LPG and LNG motor carriers have very low crash rates relative to other carriers. For example, over the past 45 years, New England LNG carriers completed over 300,000 truck trips up to 150 miles with only two incidents. One incident was a truck rollover and the other was a truck engine fire. In both examples the LNG product in the cargo tank was not released.³

³ ENGIE, Inc., "Facility Overview and Future Trends"

Unlike rail risk factors, such as FRA track class, method of operation, and rail density, truck risk factors include driver behavior, traffic congestion, truck speed, and the volume of trucks on the road relative to other vehicles. Since truck and rail operations have very different risk factors, they need to be evaluated differently.

Conclusion

Natural gas use is increasing in the U.S. due to the prolific production efforts in the Permian and Marcellus shale basins. Natural gas is taking a larger share of the energy market and replacing other energy sources. As a result, consumers are switching from sources such as coal, nuclear, and diesel to natural gas for power, heat, and propulsion. While the U.S. natural gas pipeline network is extensive, some geographic limitations do exist. There are areas of the U.S. that lack pipeline capacity, including the Northeast and Mountain West. Up until five years ago, the U.S. relied on natural gas imports; thanks to the newfound natural gas production capabilities, the U.S. is systematically recommissioning those same natural gas import facilities for export.

With this increased demand for natural gas, LNG transportation complements the distribution of natural gas by pipeline, providing access to areas that are not sufficiently supplied by the pipeline network. While surface transportation of LNG currently is only allowed by truck, and by rail with special permit, modal choice for LNG delivery would increase the opportunity for energy consumers to make competitive choices about their energy supply. There is evidence that a demand exists for shipping LNG by rail, and that rail shipments of LNG can be both competitive and complementary to the truck and pipeline networks. Since railroads have unique advantages and disadvantages compared to trucks, and the public safety implications are not fully developed, risk assessments provide additional insight into the shipment of LNG by rail.

The results of our research indicate that LNG transportation has a good safety record, with minimal maritime, facility, and motor carrier incidents relative to other flammable liquids. In other countries, LNG has been transported safely by rail with no incidents to date. Contributing factors to this safety record include the facts that LNG is not explosive in an uncontained environment, is transported in double-walled containers, and evaporates rapidly when exposed to the atmosphere. Notwithstanding the LNG safety record, it is still important to recognize and plan for LNG risks that do exist.

Developing QRA risk factors and parameters is the first step to modeling LNG transport by motor carrier and by rail. The QRA will help to evaluate the derailment and release probability of LNG rail cars over certain segments of the network, and account for a variety of track and train characteristics. LNG transport by truck does have a successful record; however, understanding truck safety risk factors can help to mitigate or prevent truck crashes and improve LNG motor carrier safety as demand for LNG increases. An LNG risk model can be used to understand the probability and consequences for LNG transportation incidents for both rail and truck delivery. Even though they are treated differently, the underlying event tree analysis approach is the same. When the probability of LNG tank car derailment is understood, better decisions can be made regarding the crashworthiness, placement, and operation of rail cars and the potential consequences from an LNG release due to a derailment. Further study for modeling the probability and consequences of transporting LNG by rail and truck will help decision-makers understand public risks and make informed decisions.

1.0 Introduction

The Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Hazardous Materials Safety (OHMS) contracted with the Cambridge Systematics Team (CS Team) to assess risk of transporting Liquid Natural Gas (LNG), with an emphasis on rail (LNG Risk Study). In Task 1, the CS Team completed a comprehensive Literature Review. In Task 2, The CS Team developed a Risk Plan. Task 3, identifies the factors and parameters for developing the LNG Risk Model. This report documents the findings and results from all three tasks.

At the outset of the study, CS and PHMSA met on June 29, 2017 to discuss the study scope of work and to review the technical research plan. At this meeting, PHMSA asked CS to determine where LNG would be five years out to determine the domestic and global LNG outlook. On July 17, CS, PHMSA and FRA staff met to review the study scope of work in the context of a recent Risk Study conducted by Exponent, Inc. for the Florida East Coast Railway (FECR). The FECR Report was prepared to support the FECR application to transport LNG by ISO containers (and for propulsion) along a specific transportation corridor (Florida's East Coast) which involved specific risks and potential consequences. FRA said that CS could use a redacted version of this report to help inform the LNG Risk Study. As part of the PHMSA LNG Risk Study, CS agreed to provide a peer review of the rail QRA as part of the Literature Review.

This report outlines LNG supply and demand in the context of overall energy market, including new trends for using LNG for propulsion in the motor carrier, maritime, and rail industries. The CS Team explored how natural gas and LNG are transported throughout the United States, and the relationship between peak shaving facilities, merchant plants, and export facilities. The Study Team also researched accident rates for motor carriers transporting LNG and Liquefied Petroleum Gas (LPG) and outlined LNG handling characteristics.

The overall objective of this project was to examine the risks of transporting LNG by rail, which currently is limited by Federal law. The vast majority of natural gas currently is moved by pipeline, and the U.S has a very developed natural gas pipeline network. Natural gas is increasing in use and replacing other energy sources such as coal and diesel. The low price of natural gas and extensive natural gas pipeline network makes natural gas a very competitive and accessible energy source. Since pipelines are fixed in place and expensive to modify and construct, and the natural gas market is a dynamic market that has changed drastically in the past decade, the dynamic nature of the natural gas market and the fixed pipelines are not always compatible. While pipelines owners make decisions to modify the pipeline network, trucks are available to adapt to the changes in natural gas supply and demand. Railways would also be an adaptable transportation option for trucks, but is limited by current regulations. Railway delivery also is complementary to truck delivery, and both could be used for intermodal delivery of LNG. While LNG by rail has not occurred at a statistically significant level, LPG by rail, and LNG by truck both provide proxies for understanding of the related shipments that have occurred. Since railways have unique pros and cons compared to trucks, and the public safety implications are unknown, a risk assessment provides insight into the shipment of LNG by rail. A full risk assessment of LNG delivery of rail would require a risk model, which is the recommended next phase of this study. When the probability of LNG tank car derailment is understood, better decisions can be made regarding the crashworthiness, placement, and operation of rail cars and the potential consequences from an LNG release due to a derailment.

1.1 Organization of the Report

Section 2.0 describes natural gas pipeline network, natural gas facilities, natural gas markets and U.S. natural gas demand. Section 3.0 describes the LNG outlook and emerging markets. This includes the LNG export market, other emerging LNG fuel uses for high horsepower engine applications in the marine, rail and mining sectors. Section 4.0 evaluates the LNG supply chain, including truck and rail applications. Included in this section is a description of LNG facilities, transportation and economics. Section 5.0 explains the quantitative risk assessment background and context. Section 6.0 provides the QRA methodology, event chain analysis and the parameters and factors that would be used in the LNG Risk Model. Finally, Section 7.0 describes risks of motor carrier LNG transport, including risk factors, and an analysis of LNG versus LPG carriers. Section 8.0 is the conclusion.

Appendix A provides a list of acronyms used in the report. Appendix B is the Bibliography. Appendix C describes the regulatory framework of natural gas transport. Appendix D examines the chemical properties of natural gas and handling of LNG. Appendix E covers aspects of LNG facilities not covered in the body of the report and Appendix F describes cryogenic tank cars, cargo tanks, and portable containers.

2.0 Natural Gas Background

Natural gas is a mixture of several hydrocarbon gases. Although natural gas' main constituent is methane, natural gas can also contain ethane, propane, and butane, as well as other gases such as carbon dioxide, oxygen, and hydrogen sulfide. Natural gas is often described as being "dry" or "wet." Dry gas is principally methane, whereas wet gas contains more of the heavier hydrocarbons, such as ethane, propane, and butane. These heavier hydrocarbons are commonly referred to as natural gas liquids (NGLs).⁴ Excess NGLs are usually separated from the gas stream prior to distribution, near the production site at gas-processing facilities. The dry natural gas is then transported under pressure by transmission pipelines directly to large industrial users, power plants, and gas distribution systems. The NGL stream is usually transported by pipeline to fractionator plants that separate the stream for other purposes. NGLs also are used as refrigerants in natural gas liquefaction processes.

Natural gas is essentially a fungible product. In principal, any region connected to the natural gas transmission pipeline network has access to natural gas from across the country.

Liquefied natural gas (LNG) is simply natural gas that has been cooled into a liquid. In many cases, some trace constituents of natural gas are removed before, or as part of, liquefaction. As an extremely cold liquid, at ambient pressure, LNG is a cryogenic liquid. Most sources note a liquefaction temperature of -260°F , which corresponds to methane's ambient pressure boiling point of -258.68°F . Cooling natural gas requires energy and a specialized facility, and the liquefaction process increases the upfront costs of producing LNG.

Natural gas is stored in enormous underground caverns such as depleted oil fields or salt caverns. In its gaseous state, the natural gas requires 600 times more space than in its liquid form. Pipelines are the most effective way to transport natural gas, however, when it is not possible to use pipelines to move the natural gas, or when static storage of natural gas is important, liquefaction increases the density of the natural gas by 600 times. This increased density is more suited to storage and transportation, and is LNG's principal advantage over the gaseous form. LNG is stored and transported in cryogenic tanks. When LNG is re-gasified, the LNG is warmed until the liquid converts back into the gaseous state. The gas is then transferred to a specific facility or to regional distribution pipeline networks. More information on the chemistry of natural gas is provided in Appendix E.

Natural gas is an open market that has recently changed drastically. Natural gas has always been an attractive fuel and has become an important part of the economy in the United States, over the past decade, oil prices initially increased and as the horizontal drilling technology expanded the scope of proven fossil fuel reserves, greater amounts of natural gas became available in North America.⁵ While the U.S. is still a net importer of natural gas, the net amount imported has decreased dramatically in recent years. The U.S. may become a net exporter in the near future.⁶ And, overall, while LNG currently represents a small fraction of the total gas utilization in the U.S., there is increasing interest in the use of LNG for importing low-cost natural gas, for exporting U.S. natural gas to locations where the cost of natural gas is high, and for utilizing stranded gas.⁷

⁴EIA now uses the term hydrocarbon gas liquids, or HGL.

⁵Energy Information Administration, "Natural Gas Explained."

⁶ Energy Information Administration, "Natural Gas Imports and Exports."

⁷ For more information on LNG's properties, consult the "Resources on the Properties of Liquefied Natural Gas" section of Appendix B.

(Footnote continued on next page...)

Natural gas accounts for about one third of U.S. energy consumption.⁸ More than half of U.S. homes use natural gas as their main heating source. Natural gas also is used to produce electricity in about 30 percent of the country's power plants and natural gas is an important heating fuel for numerous manufacturing processes, including steel, glass, and paper production.

2.1 Natural Gas Pipeline Network

The U.S. has a very developed natural gas pipeline network. There is an extensive natural gas pipeline network in North America for the transmission and distribution to users of natural gas. This network comprises more than 210 natural gas pipeline systems, including 305,000 miles of Interstate and Intrastate transmission pipelines.⁹ About two dozen companies operate systems of 1,000 miles or more, and together own 80 percent of the network.

This pipeline network is densest on the Gulf Coast, as the region accounts for nearly 25 percent of the country's transmission pipeline mileage. The network is likewise dense in the Texas panhandle and Oklahoma region, where there are additional oil/gas recovery fields. Because of the central location and large industrial and residential demand of the Midwest, the area also has a dense network of gas transmission pipelines. The Great Lakes States of Illinois, Indiana, Michigan, Ohio, and Pennsylvania account for nearly 25 percent of total line mileage.

As shown in Figure 2.1, the country's natural gas transmission network consists of 300,000 miles of pipeline in the United States, including about 4,000 offshore miles. About two dozen companies own 80 percent of this mileage—with each company operating systems that contain 1,000 miles or more. The natural gas network is densest on the Gulf Coast, as the large gas-producing and gas-consuming States of Louisiana and Texas account for nearly 25 percent of the country's transmission pipeline mileage. Because of its central location and large industrial and residential demand, the Midwest also has a dense network of gas transmission pipelines. The Great Lakes States of Illinois, Indiana, Michigan, Ohio, and Pennsylvania account for nearly 25 percent of total line mileage. In recent years, transmission pipelines have been built to provide natural gas to regions that were once underserved, especially New York and New England.

As shown in Figure 2.1, the country's natural gas transmission network consists of more than 210 natural gas pipeline systems which includes 305,000 miles of Interstate and Intrastate transmission pipelines.¹⁰ It is one of the most extensive pipeline networks in the world. About two dozen companies own 80 percent of this mileage—with each company operating systems that contain 1,000 miles or more. The natural gas network is densest on the Gulf Coast, as the large gas-producing and gas-consuming States of Louisiana and Texas account for nearly 25 percent of the country's transmission pipeline mileage. Because of its central location and large industrial and residential demand, the Midwest also has a dense network of gas transmission pipelines. The Great Lakes States of Illinois, Indiana, Michigan, Ohio, and Pennsylvania account for nearly 25 percent of total line mileage. In recent years, transmission pipelines have been built to provide natural gas to regions that were once underserved, especially New York and New England. Pipeline reversals also are common, as the net-demand regions become net-supply regions, and vice versa.

The majority of natural gas is moved by pipeline, the principal and the most cost-effective means of transporting natural gas domestically. However, there are drawbacks to the pipeline network. In recent years,

⁸ Energy Information Administration, "U.S. Energy Facts Explained."

⁹ Ibid., "U.S. Energy Facts Explained."

¹⁰ Ibid., "U.S. Energy Facts Explained."

transmission pipelines have been built to provide natural gas to regions that were once underserved, especially New York and New England. Pipeline reversals have also increased, as the net-demand regions become net-supply regions, and vice versa.

These drawbacks to pipeline transport are not compatible with the dynamic natural gas market.

Despite the extensive natural gas pipeline network shown in Figure 2.1, underserved regions remain, such as parts of New England, and the western U.S. Pipeline directionality also is important. Built at different times throughout the past century, some of the pipelines were built to function in only one direction. Underserved regions and pipelines that now run counter to supply and demand, are important because they create natural gas supply and demand imbalances that cannot be met with pipeline transmission. These create a need for alternative transportation, such as surface transport of LNG.

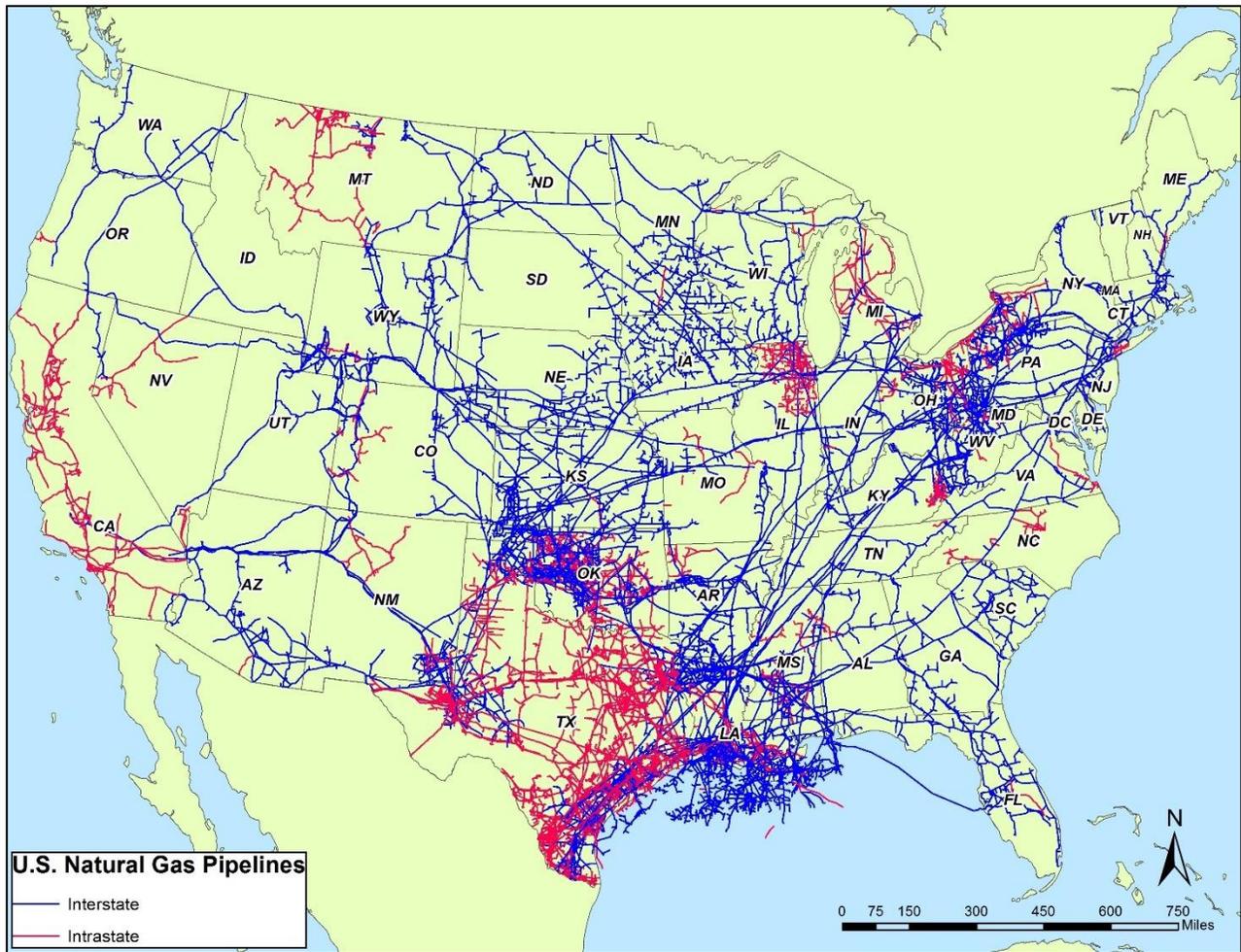


Figure 2.1 U.S. Natural Gas Pipeline Network

Source: Energy Information Administration; Cambridge Systematics, Inc.

The primary networks used in the commodity flow framework will be the North American natural gas pipelines, railroads, waterways and highways. Often referred to as the “midstream” portion of the energy supply chain, pipelines, railroads, waterways and highways move natural gas, natural gas liquids, other fuels

in bulk quantities from “upstream” production and processing facilities to distant “downstream” locations, where the shipments are refined, stored, and/or delivered to end customers by barge, truck, or pipeline.

Despite the extensiveness of the pipelines in the U.S. there are areas that are underserved, such as parts of New England, and the western U.S. Also important to note is the directionality of some of the pipelines. Built at different times throughout the past century, some of the pipelines were built to function in only one direction. The recent changes in the shale revolution have resulted in efforts to reverse certain pipelines to meet new natural gas demands. The limit of a one-way capacity is mostly felt in the Appalachian region, where natural gas produced from the Utica and Marcellus shelves have pipeline capacity that is limited by pipelines that are one way between the southeast and the Midwest regions. The disparity of pipeline capacity between regions of production and demand has spurred the need for additional transportation whether it comes in the form of additional pipelines or liquefying for shipment as LNG by truck.

Natural gas is sold as a fungible product. Therefore, any region connected to the Interstate pipeline network has access to natural gas across the country. Areas not served by pipelines need to transport natural gas from a point of supply with a surface mode such as truck or rail. Natural gas on the market is replaceable by any other natural gas product, and the point of supply can be any number of places regardless to the location of the natural gas seller. The point of supply could be any place connected to the seller such as a natural gas hub or center, a natural gas processing plant, or a LNG peak shaver. Any non-pipeline movements will require liquefaction of the natural gas, and efficient liquefaction of natural gas uses cryogenic turbines that are most economical when liquefying a large amount of product. For these reasons, LNG is usually produced at a limited number of liquefaction facilities. Gasification is much easier and simpler to accomplish than liquefaction.

The volumes of natural gas being produced in some regions, like the Utica/Marcellus, do not align with the outbound pipeline capacity. Pipelines are the first and ideal method to transport natural gas, and it is the inability to utilize the pipeline system that requires other transport modes—whether that underutilization is by lack of access, or capacity.

2.2 Natural Gas Supply

In the past five years, U.S. natural gas supply has increased significantly due to the prolific production efforts in the Permian Basin in Texas, and the Marcellus and Utica Shale Plays located in Western Pennsylvania, Southern Ohio and West Virginia. Once natural gas is extracted from shale gas regions in the U.S., the gas is transported to processing plants that convert the raw gas to natural gas suitable for use either in transmission pipelines, or for liquefaction to prepare LNG.

Once the natural gas is liquefied, the liquefaction facilities, LNG merchant operators, and gas processing plants become the suppliers of LNG. On the demand side, power generation plants, pipeline stations, remote operations requiring fuel (such as manufacturing plants, petroleum exploration, mining) and LNG fuel facilities (truck, rail, maritime) all need LNG. Remote operations are those that are not connected to a natural gas pipeline network.

Natural gas processing details vary, depending upon the raw gas, but in general, natural gas processing will remove sulfur containing contaminants, condensable liquids, e.g., water, NGLs, LPGs; carbon dioxide and inert gases, e.g., nitrogen, argon; and important contaminants, e.g., radon.

U.S. natural gas processing plants are located in the shale oil and gas regions (Figure 2.2), including the Gulf Coast; parts of Utah, Wyoming, Colorado, Oklahoma, Michigan; and North Dakota; and the Marcellus/

Utica Shale Region, including Pennsylvania, Ohio, and West Virginia. The most significant growth in recent years has occurred in the Marcellus/Utica and Eagle Ford Shale plays. While the U.S. natural gas pipeline network extends to most of the lower 48 States, there are still areas in the U.S. that are isolated from this network, or have more demand for natural gas than the pipeline network can supply. The most prominent example is New England, where natural gas is primarily imported as LNG and transported by truck to peak shaving storage facilities.

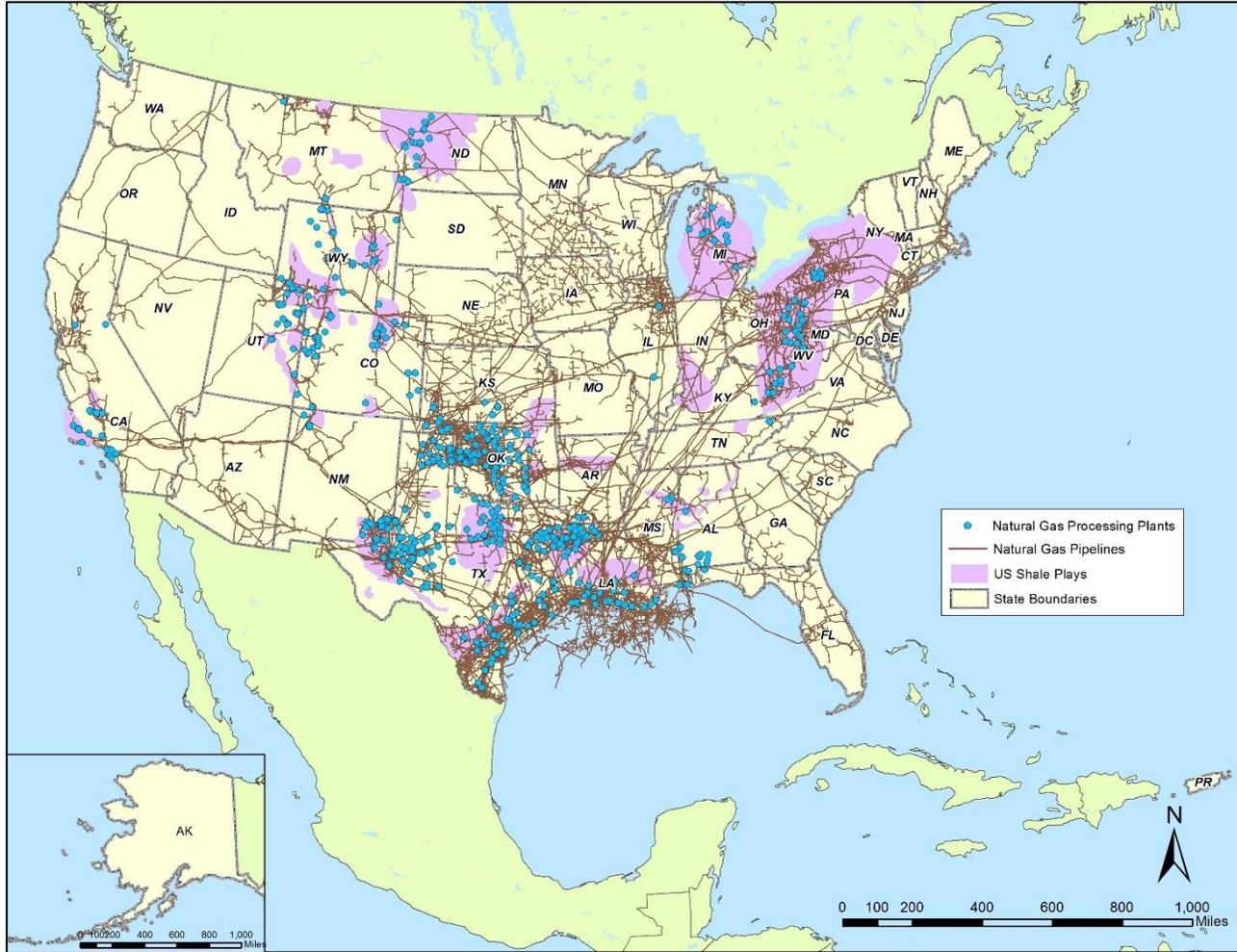


Figure 2.2 U.S. Natural Gas Processing Plants and U.S. Pipeline Network

Source: Energy Information Administration.

Most processing plants are located in States where natural gas wells are located. In 2016, there were 11 States with more than 10,000 gas wells, as listed in Table 2.1. Texas has more than twice as many gas producing wells than any other State. Other high producing gas States include Pennsylvania, Oklahoma, West Virginia, and Colorado.

Table 2.1 U.S. Top 11 Gas Producing States
2016

State	Gas Wells
Texas	133,767
Pennsylvania	66,304
Oklahoma	47,831
West Virginia	46,427
Colorado	45,903
New Mexico	40,535
Ohio	27,403
Wyoming	23,694
Kansas	23,389
Kentucky	18,246
Louisiana	17,760

Source: Energy Information Administration, “Annual Report 2016.”

These processing plants are where the natural gas liquids are removed from the gas—ethane, propane, butane, pentane, and natural gasoline—and the gas is treated for impurities, such as hydrogen sulfide. This prepares the gas for transport as dry natural gas. Dry natural gas is considered to be almost pure methane, which typically has a heat content of 1,035 Btu per cubic feet. Depending on the market differential between any of the NGLs and the price of natural gas, dry natural gas may contain some NGLs, and to assure safe transportation the heat properties of natural gas are often limited to 1,100 Btu per cubic feet. This limits the amount of NGLs in the natural gas to one to two gallons per 1,000 cubic feet of natural gas. After processing, the dry natural gas is fungible.

Other processing plants that conduct “deep processing” also produce LNG as an output of the process. This includes plants that reject nitrogen, recover helium, or recover ethane gases.

Natural gas-fired power generation plants are located throughout the U.S. (Figure 2.3), particularly in more populated areas. This number is increasing as more nuclear power plants retire or convert to natural gas. Figure 2.4 depicts the locations of these plants in relation to the U.S. gas processing plants. Note the proximity of the gas processing plants in the Marcellus Region to the populated area of the Eastern Seaboard. This is resulting in a large number of new gas processing plants and connecting pipelines in this region to supply has to the Northeast.

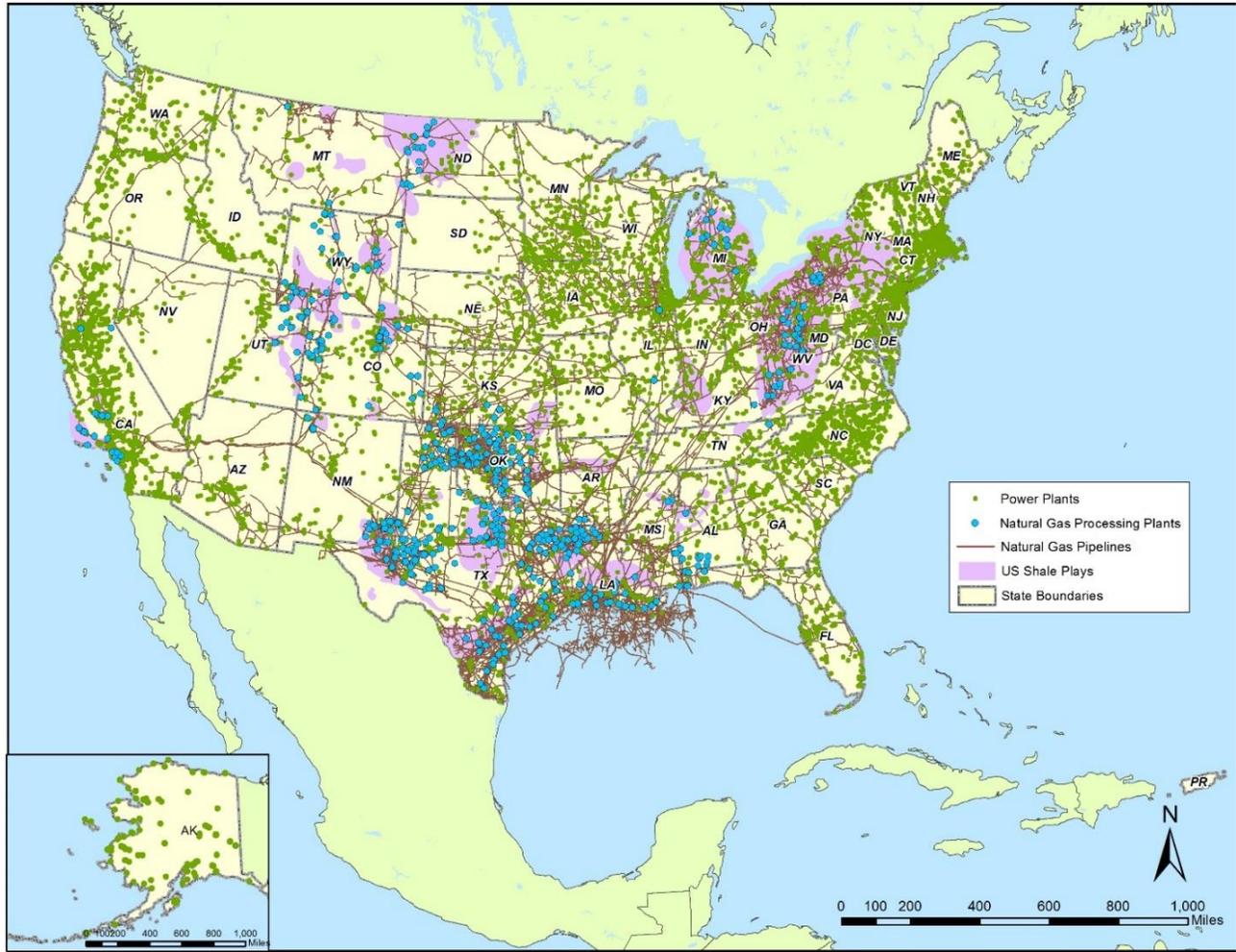


Figure 2.3 U.S. Power Generation and Gas Processing Plants

Source: Energy Information Administration.

There are no gas processing facilities in the Northeast. This is most noticeable in Figure 2.4 where New England is dependent upon other regions for gas processing.

The Northeast region of the U.S. is significant because it has several major population centers that require large amounts of heating fuel during the winter, and high electricity demands in the summer for air conditioning. Figure 2.4 depicts the gas processing facilities in the Northeast. The only gas processing plants in the Northeast are located above the Marcellus and Utica shale plays, while the New England States are devoid of natural gas processing plants.

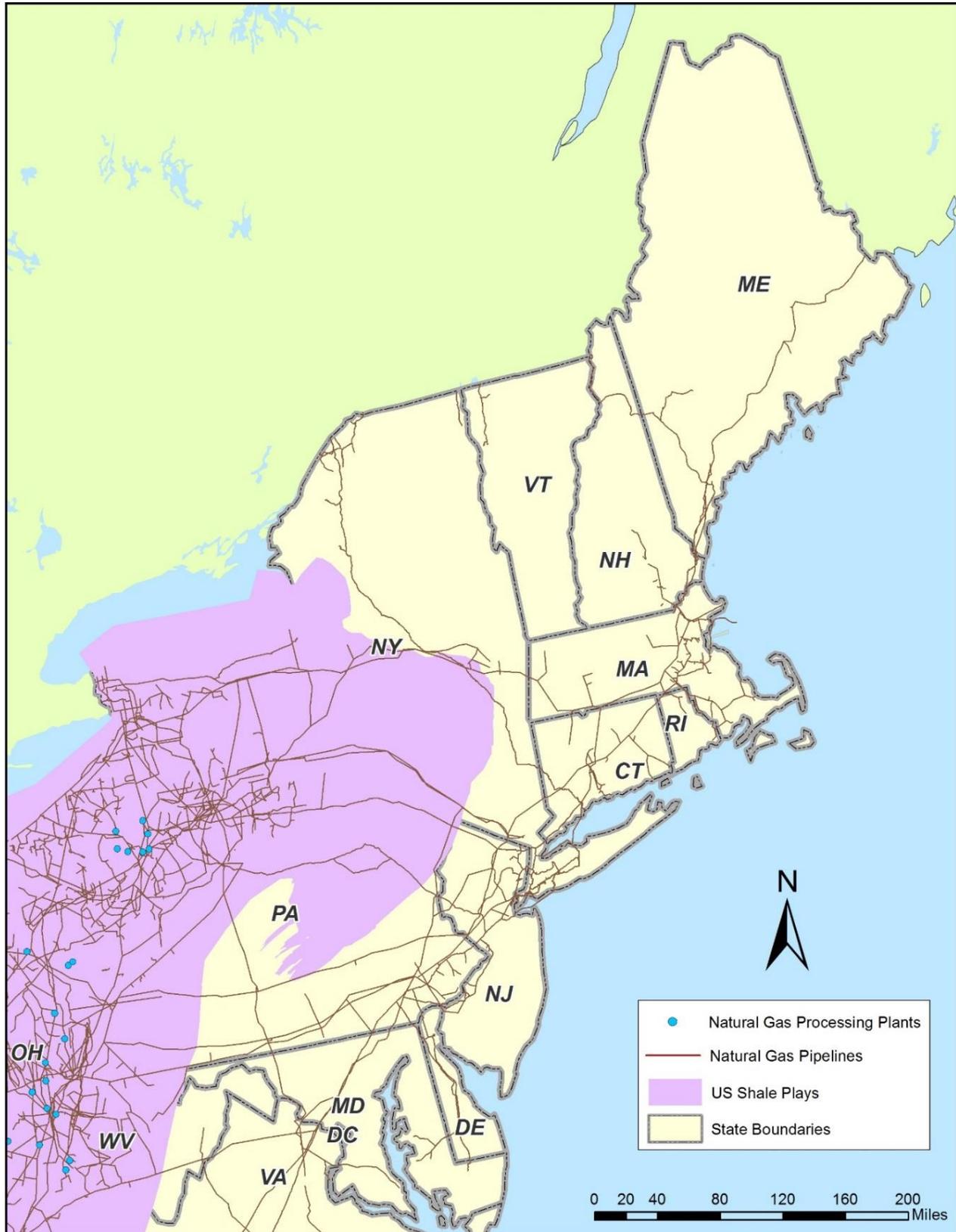


Figure 2.4 Northeast Gas Processing Plants

Source: Energy Information Administration.

2.3 Natural Gas Markets

The pipeline transmission network is a complex mixture of intra and interstate transmission pipelines moving natural gas, and ‘hubs’ that provide physical interconnections for transmission pipelines. Market hubs are centers at which pipelines can trade gas volumes, and transportation can be arranged. Therefore, market hubs play an important role in the pricing and negotiations of natural gas. Hubs also serve as market centers for transactions or to secure transportation and/or storage services. There are over 120 natural gas hubs and market centers in the contiguous United States.¹¹

Natural gas hubs and market centers play a role in the pricing and negotiations of natural gas. Between March 2014 and December 2017, the Intercontinental Exchange (ICE) provided price index data of eight natural gas hubs to the EIA for republication.¹² These hubs included: Algonquin (Massachusetts), Tetco M-3 (Pennsylvania), Chicago Citygate (Illinois), Henry Hub (Louisiana), SoCal-Ehrenberg (Arizona), Socal Citygate (California), and Malin (Oregon). Figure 2.5 shows the locations of these hubs.

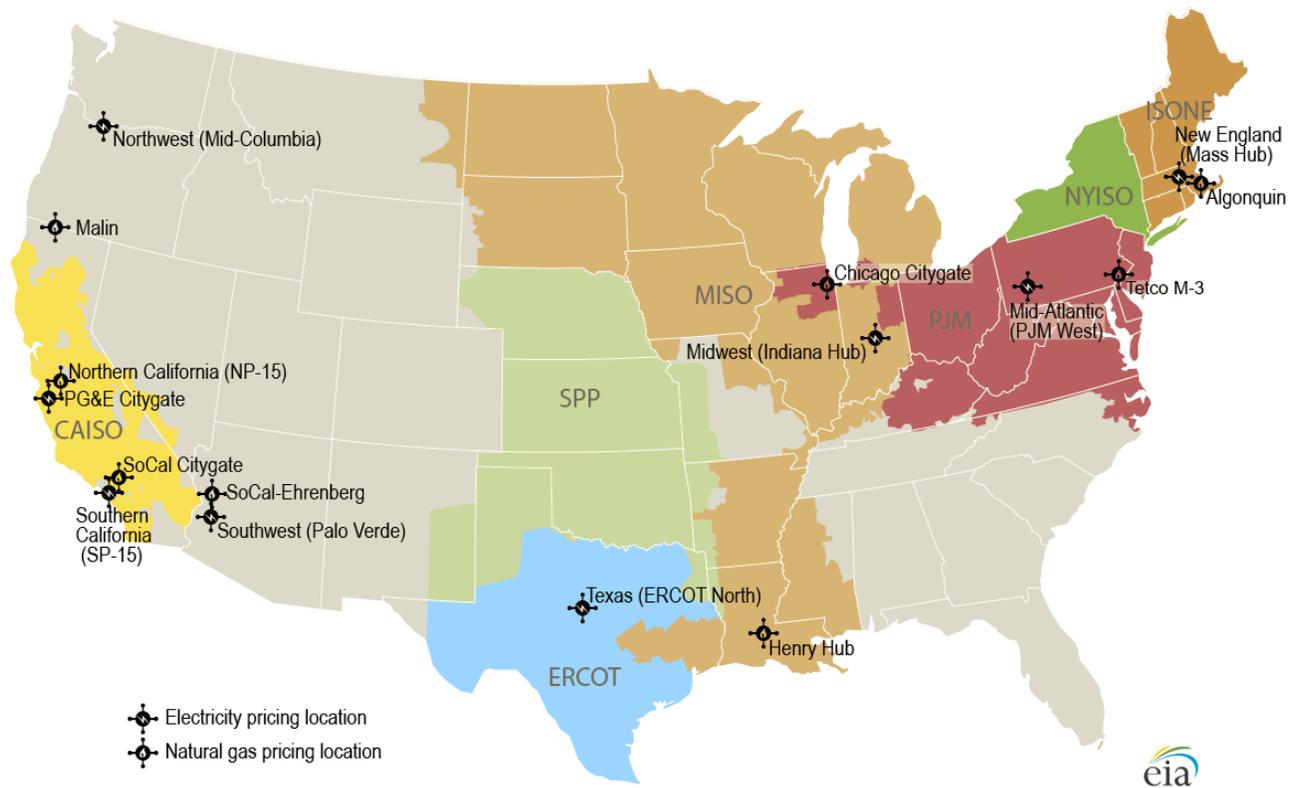


Figure 2.5 Major Natural Gas Hub Locations

Source: Energy Information Administration, “Wholesale Electricity.”

Note: Colored areas denote Regional Transmission Organizations (RTO) and Independent System Operators (ISO).

¹¹ Energy Information Administration, “Wholesale Electricity.”

¹² ICE is a major venue for trading natural gas.

2.4 Natural Gas Demand

The low price of natural gas and its expansive natural gas pipeline network makes natural gas a competitive and accessible energy source. Natural gas is increasing in use and replacing other energy sources. As the natural gas supply has flooded the market, the price has been driven down by oversupply.

The rapid development of domestic energy sources has resulted in significant natural gas production in the United States. In particular, shale oil and gas have been produced in increasing volumes over the past 10 years, due largely to the increased use of new extraction and drilling techniques. This has also resulted in changes in hazmat transportation by motor carrier, rail, pipeline, and barge.

Natural gas consumption is illustrated in Figure 2.6 and serves as an indicator of U.S. demand for natural gas. The leading demand is for power generation, followed by residential, commercial, and industrial uses. Output from hydraulic fracturing sources have grown since 2009 to make up nearly half of the U.S. dry natural gas production by 2014, driven by especially large volumes recovered from the Marcellus basin in Pennsylvania and West Virginia.

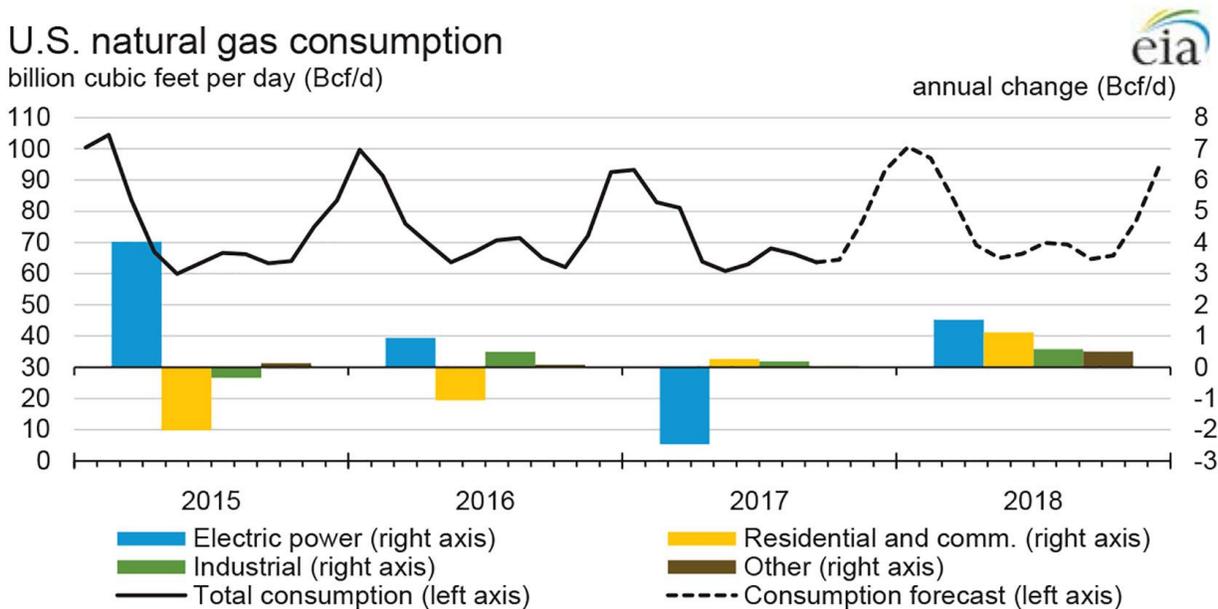


Figure 2.6 U.S. Natural Gas Consumption
2015–2018—Projected

Source: Energy Information Administration.

Other regions of the U.S. will have a role in natural gas demand. For example, gas demand in South Texas will come from consumption from the power, industrial and residential and commercial sectors, and demand from exports to Mexico. Local gas makes up about 2.0 Bcf/d of the total demand in the region. However, overall gas exports to Mexico in 2016 exports increased 0.7 Bcf/d to an average 2.6 Bcf/d. This trend is expected to continue. Significant development is now under way in Mexico’s natural gas-fired combined-cycle power plants, and plans are well underway for an expansive gas pipeline network to serve them.

Crude production is an indicator of gas production, since shale gas is extracted in the same process. Crude production is nearly back up to its peak of 9.6 MMb/d set in April 2015. Dry gas production has been approaching a record 75 Bcf/d, thanks to the Marcellus/Utica shale, as well as associated gas production in crude production regions, such as the Permian and Oklahoma's South Central Oklahoma Oil Province (SCOOP) and Sooner Trend Anadarko Canadian Kingfisher (STACK) shale plays.

As of this writing, market analysts suggest crude oil production is expected to grow even with prices at current levels near \$50/bbl for the next five years. This is likely to impact associated gas production, expected to be at 4.0 Bcf/d for each of the next five years, or 9.0 Bcf/d by 2022.

There also is an ongoing trend in the U.S. to convert diesel power generation plants and coal plants to natural gas. This applies to remote utilities, mining and quarrying operations, industrial and manufacturing facilities, asphalt production, commercial food processing and pulp and paper plants. This is happening despite current oil prices suggesting this trend to switch to natural gas fuel will continue.

Power generation from gas power plants is expected to increase from approximately 26 Bcf/d this year to about 28.6 Bcf/d in 2022. That number will be higher if gas prices are lower, particularly relative to coal. That is almost 3.0 Bcf/d higher than this year, but compared to last year when gas prices were even lower, it is up only about 1.0 Bcf/d. Altogether, between exports and gas-fired generation, industry analysts predict just over 13 Bcf/d of new gas demand by 2022. This increase in natural gas supply is due mostly to the prolific production efforts in the Marcellus and Utica Shale Plays located in Western Pennsylvania, Southern Ohio and West Virginia. The northeast region for natural gas production is expected to increase 43 percent from 2017 to 2027.¹³

The most significant growth for natural gas production is occurring in the New England and Mid-Atlantic States, two projects adding up to 0.65 Bcf/d are planned for the Canadian corridor and four projects totaling 4.3 Bcf/d to the Midwest via Ohio and four projects with a combined 5.2 Bcf/d to the Southeast along the Atlantic Coast are under development.¹⁴

South Texas is the other region in the United States supplying natural gas. Approximately 80 percent of regional gas supply comes from the Eagle Ford Shale while the other 20 percent comes from non-shale drilling activity. Since incremental production will almost entirely come from the shale side, the Eagle Ford shale play will play an important role in natural gas production.

As nuclear power plant retirements increase, natural gas-fired generation capacity will likely grow (Figure 2.7). The retirement of nuclear power plants creates demand for natural gas, as they are usually replaced by natural gas-fired generation capacity; in addition, the low price of natural gas makes it attractive for new capacity in general. In the past seven years, six nuclear power plants announced their intentions to retire early. The most recent announcement came in May 2017 from Exelon's Three Mile Island power plant in Pennsylvania. These six plants have a current operational capacity of about 7.2 gigawatts (GW) with an average capacity factor of 95 percent. In addition to those retirements, construction of South Carolina Electric and Gas Company's 2.2 GW V.C. Summer power plant was halted in July 2017. While nuclear capacity is expected to decrease in the next eight years by 7.2 Exelon announced builds at natural gas-fired power plants will offset some of the lost capacity.¹⁵

¹³ "Bentek Market Call: North American NGLs."

¹⁴ Braziel, "RBN Blog: Too Many Pipelines?"

¹⁵ Energy Information Administration, *Weekly Natural Gas Trends*. September 28, 2017.

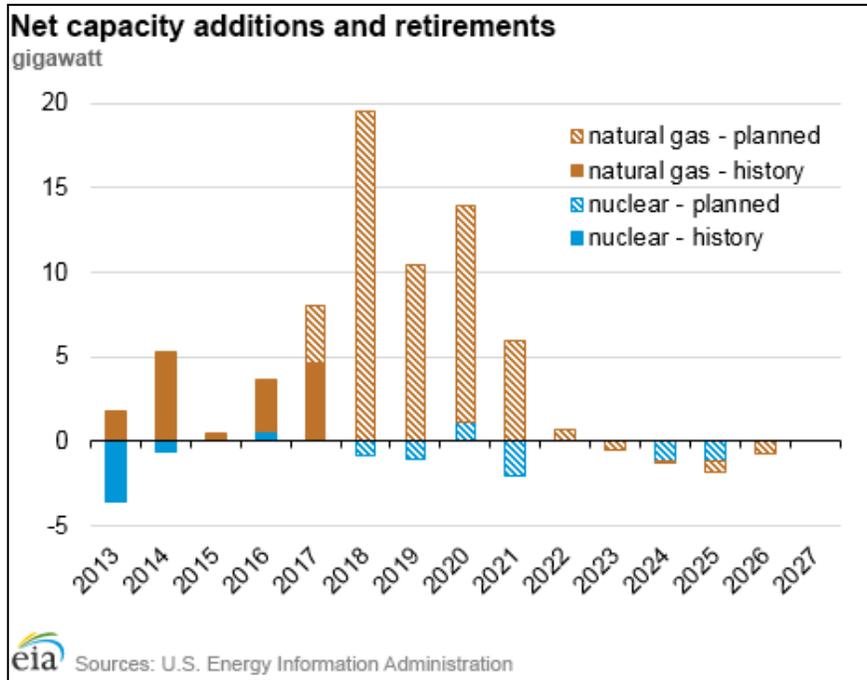


Figure 2.7 U.S. Natural Gas Net Capacity and Additions 2013–2026

Source: Energy Information Administration.

3.0 LNG Outlook and Emerging Markets

The reason for increased U.S. LNG production and the growing number of fuel and bulk transport opportunities is the domestic availability of shale oil and gas in the U.S., particularly in the Marcellus and Utica shale plays in parts of Ohio, Pennsylvania, and West Virginia. This “energy revolution” has changed both the volume and direction of how hazardous materials are transported in the U.S. by pipeline, rail, motor carrier and ship. We also describe in this report the global and U.S. outlook for LNG to understand how these trends will impact future LNG transportation.

LNG is emerging as a versatile fuel for many purposes in the United States and throughout the World, not just for propulsion and transport, but also for power generation. LNG occupies the world stage, as a growing number of countries are importing and exporting LNG, including the U.S.

Emerging LNG markets are placing additional demand on LNG transportation. These markets include using LNG for remote power generation, and for high horsepower engines in the trucking, maritime and railroad industries. Multiple LNG terminals in the Gulf Coast are being converted from import to export facilities, and with the added liquefaction capacity that became operational in 2017, the U.S. became a net exporter of natural gas.¹⁶ Figure 3.1 shows the growth of U.S. liquefaction capacity expected by 2020. More power generation plants are being supplied by natural gas pipelines as more nuclear and coal power plants retire.

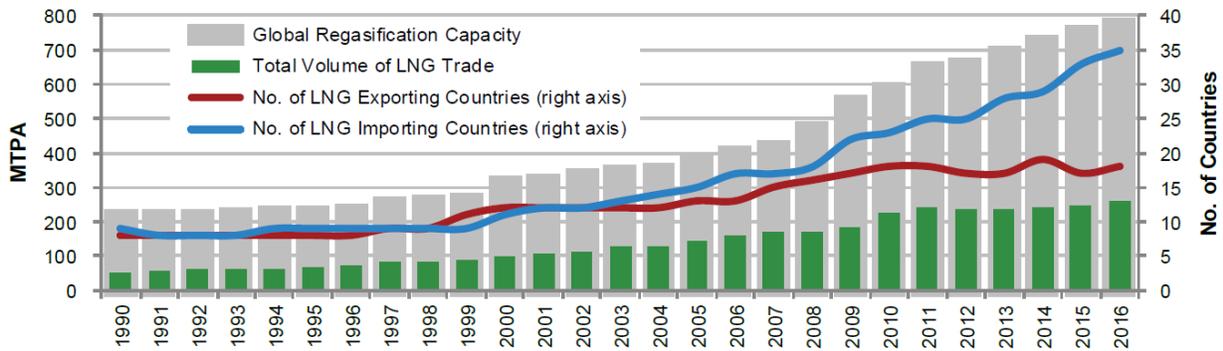


Figure 3.1 Global LNG Trade Volume 1990–2016

Source: IHS Market, IEA, IGU.

The global LNG market continues to expand as countries convert power generation facilities, heavy haul vehicles, vessels and even locomotives to natural gas. The International Gas Union (IGU) reports that 2016 was a record year for global LNG trade with 258 million tonnes (MT) traded. Both regasification capacity and trade volume have been steadily increasing over the last two decades. An increasing number of countries are importing LNG to meet their energy needs. In 2016 LNG trade exceeded 250 million tonnes (MT), as an increasing number of countries imported LNG to meet energy needs. Figure 3.1 shows LNG trade volumes and regasification capacity worldwide in million tonnes per annum (MTPA). The green bars show the total volume of LNG trade, in which the last five years remained constant. The gray bars show global regasification capacity, which has steadily grown for 15 years and is now over 800 MTPA. The number of importing countries (blue trend line) has been steadily increasing since 2000, reaching 35 countries in 2016.

¹⁶ “United States expected to become a net exporter of natural gas this year.” Energy Information Administration, August 9, 2017.

The number of exporting countries (red trend line) increased between 2000 and 2010, then remained constant from 2011 to 2016 at between 16 to 20 countries.

Long-term contracts are an indicator of future demand for LNG. For example, MarkWest has secured 100 percent of long-term contracts for the Marcellus Region over the next 11 years and 97 percent for the Utica Region over the next 15 years.¹⁷

3.1 LNG Imports

Up until recently, LNG has been primarily imported to the U.S. and used for heating and power generation purposes. LNG imports serve areas of the U.S. not well served by the natural gas pipeline network, including New England.

The top five countries importing LNG in 2016 were Japan, South Korea, China, India, and Taiwan. Japan leads by a wide margin, importing nearly one-third of global imports. The Figure 3.2 and Table 3.1 list the volume and market share for the top LNG importing countries.

However, many of these LNG import facilities are being recommissioned as export facilities. In addition, LNG is being used as a fuel for a growing number of sectors, including maritime, rail, motor carrier, mining, oil and gas production, and other “heavy haul” transportation applications.

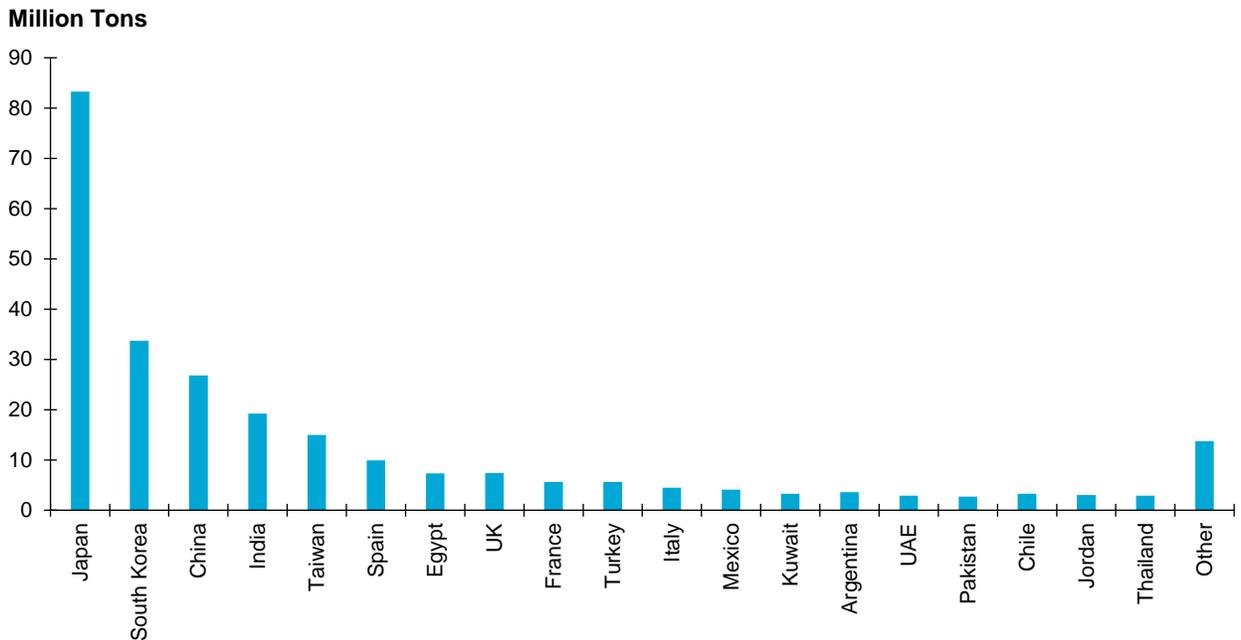


Figure 3.2 Top LNG Importing Countries

Source: International Gas Union World LNG Report, 2017 Edition

¹⁷ Markwest Annual Report 2015.

Table 3.1 Top LNG Import Countries and Volumes

Country	Volume (MT)	Market Share
Japan	83.3	32.3%
South Korea	33.7	13.1%
China	26.8	10.4%
India	19.2	7.4%
Taiwan	15.0	5.8%
Spain	9.9	3.8%
Egypt	7.3	2.8%
UK	7.4	2.9%
France	5.6	2.2%
Turkey	5.6	2.2%
Italy	4.5	1.8%
Mexico	4.1	1.6%
Kuwait	3.3	1.3%
Argentina	3.6	1.4%
UAE	2.9	1.1%
Pakistan	2.7	1.0%
Chile	3.3	1.3%
Jordan	3.0	1.2%
Thailand	2.9	1.1%
Other	13.7	5.3%

Source: International Gas Union World LNG Report, 2017 Edition.

3.2 LNG Exports

LNG exports also contribute to U.S. demand for LNG. Historically, LNG has been imported since the 1970s, but is now being exported in growing volumes. Multiple LNG terminals in the Gulf Coast are being converted from import to export facilities, and with the added liquefaction capacity that became operational in 2017, the U.S. became a net exporter of natural gas.

The EIA stated in their August 9, 2017 article that “The United States’ status as a net exporter is expected to continue past 2018 because of growing U.S. natural gas exports to Mexico, declining pipeline imports from Canada, and increasing LNG exports.” The EIA expects that exports of LNG will continue to increase as liquefaction capacity is added. Figure 3.3 shows the growth of U.S. liquefaction capacity expected by 2020.

Exporting liquefied natural gas is a relatively new phenomenon for the United States. In fact, only one facility in the U.S. currently is operational in Sabine Pass, LA. A common feature of the approved export terminals is that they have all previously been importers of LNG. While the facilities needed to export LNG differ from those needed to import LNG, much of the needed infrastructure already is in place at the existing import

facilities. As a result, companies that already have LNG import operations are at a significant advantage in becoming an exporter of LNG.

Cheniere’s Sabine Pass liquefaction terminal in Louisiana has seen more cargoes depart the facility in the week ending October 13, 2017. Five vessels with a combined LNG-carrying capacity of 18.4 billion cubic feet (Bcf) have departed the plant since October 4, 2017.¹⁸ This compares to three vessels with a capacity of 11.2 Bcf the week before. Natural gas pipeline deliveries to Sabine Pass averaged 2.8 Bcf/d for the week ending October 13, up 0.8 Bcf from the previous week.

In the near future, plans are shaping up for more LNG exports at five new facilities on the Gulf and East Coasts, summarized in Figure 3.3. Cheniere Energy’s Sabine Pass terminal now has four trains producing 2.0 Bcf/d as of 2017. With the start-up of train four in 2017, total deliveries have increased to nearly 3.0 Bcf/d. Cove Point, MD began operations in early 2018, and Cameron LNG, expected to complete the first of three trains by August 2018, a capacity of 2.1 Bcf/d by late 2019 as the second and third trains are constructed. The Elba Island, GA, liquefaction project adds 0.2 Bcf/d by August 2018 and increase to 0.35 Bcf/d by early 2019. Freeport LNG is expected to start one train of 0.67 Bcf/d by November 2018, and increase to 2.0 Bcf/d as trains two and three come online by late 2019. Finally, Cheniere’s Corpus Christi LNG will add two trains totaling 2.1 Bcf/d by mid-2019. South Texas is poised to emerge as a premium destination for growing U.S. gas supply over the next few years, driven by demand from new LNG export capacity along the Texas Gulf Coast, as well as power and industrial demand in Mexico.

Therefore, by the end of 2019, it is possible that the U.S. will have reached nearly 11 Bcf/d of LNG export capacity.

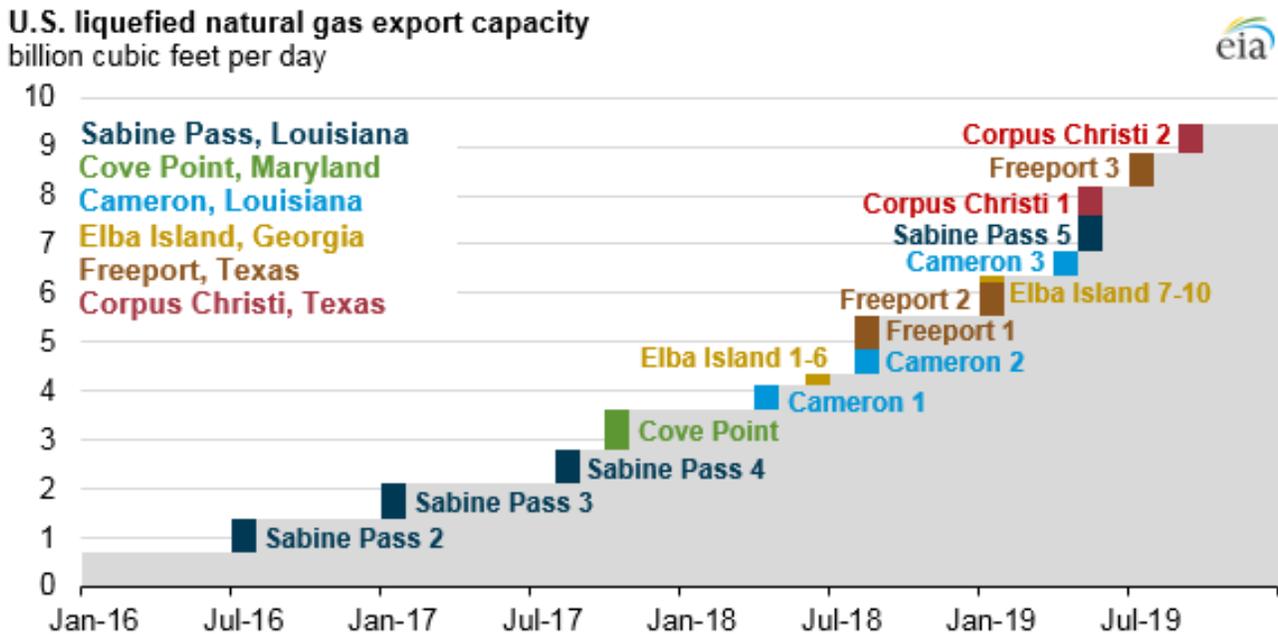


Figure 3.3 LNG Export Demand Growth

Source: U.S. Energy Information Administration, compiled from trade press.

¹⁸ Energy Information Administration, October 2017.

The proposed LNG growth from export terminals is expected to exceed 10 bcf/d by the year 2020. Figure 3.4 and Table 3.2 compare the growth of LNG liquefaction capacity with the growth of LNG exports between 2016 and 2017. Any percent of this liquefaction growth not used for the export market may be available for the domestic LNG merchant market. Therefore, there may be opportunities to transport a small percentage of LNG from these export facilities to power generation plants, mining operations, LNG fuel operations and other LNG demand markets.

The top five LNG exporting countries in 2016 were Qatar, Australia, Malaysia, Nigeria, and Indonesia. Qatar is the source of nearly one-third of LNG exports worldwide. The figure and table below list export volume for all 18 LNG exporting countries.

Like with LNG, exports to Mexico also have experienced a boom in the past couple of years, driven by a growing imbalance of supply and demand in Mexico. Delivery capacity to Mexico is expected to grow to over 6.0 Bcf/d by 2022. Additional pipeline projects add 3.1 Bcf/d of capacity into Mexico and is expected to reach 8.0 Bcf/d in 2022. Mexico can be the home for some incremental U.S. production, but not nearly as much as expansion projects suggest.¹⁹

The Caribbean islands and Hawaii have relied on natural gas, imported as LNG, for years as these islands do not have native fossil fuel resources. Other remote regions include areas of the U.S. not served by the natural gas pipeline network (examples include power plants for the Jamaica Public Service Company, Yukon Energy, and Hawaiian Electric; also boiler fuel for Coca-Cola Puerto Rico Bottlers). The Interior Energy Project will bring increased natural gas to Fairbanks and Interior Alaska. The Alaska Railroad has operated a pilot program to transport LNG by rail for this project. Outside the U.S., examples include remote power for the Pueblo Viejo Mine, and more.

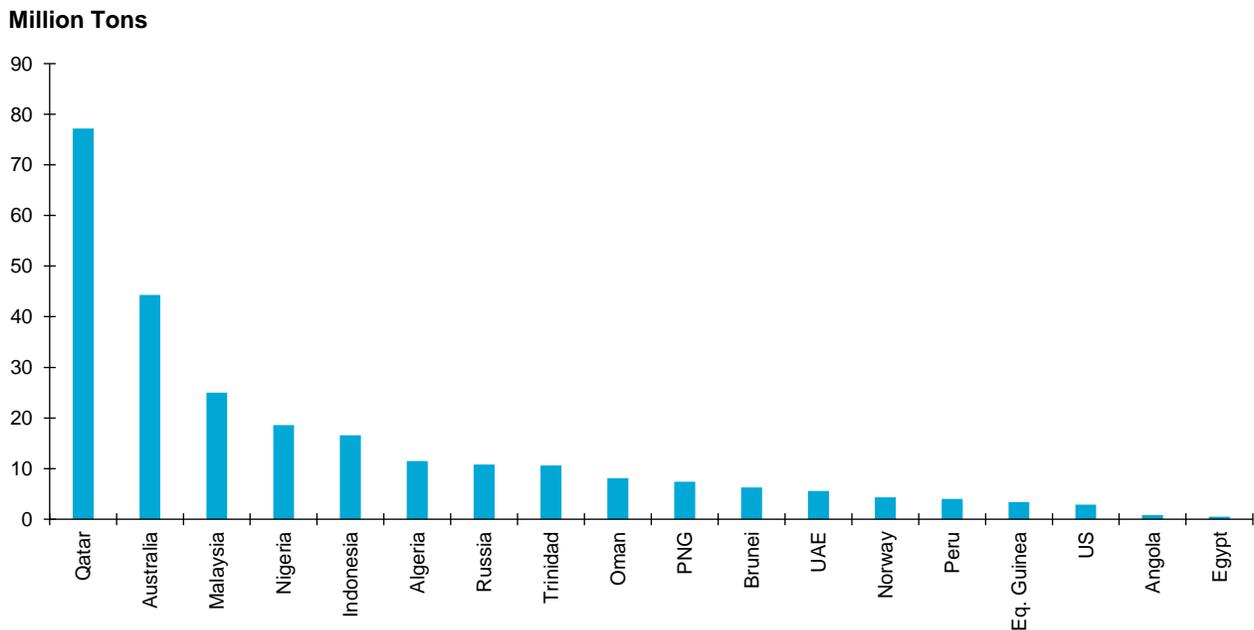


Figure 3.4 Top LNG Export Countries

Source: International Gas Union World LNG Report, 2017 Edition.

¹⁹ Braziel, “RBN Daily Blog October 2017.”

Table 3.2 LNG Exporting Countries and Volumes

Country	Volume (MT)	Market Share
Qatar	77.2	29.9%
Australia	44.3	17.2%
Malaysia	25	9.7%
Nigeria	18.6	7.2%
Indonesia	16.6	6.4%
Algeria	11.5	4.5%
Russia	10.8	4.2%
Trinidad	10.6	4.1%
Oman	8.1	3.2%
PNG	7.4	2.9%
Brunei	6.3	2.4%
UAE	5.6	2.2%
Norway	4.3	1.7%
Peru	4	1.6%
Eq. Guinea	3.4	1.3%
U.S.	2.9	1.1%
Angola	0.8	0.3%
Egypt	0.5	0.2%

Source: International Gas Union World LNG Report, 2017 Edition.

The Caribbean islands and Hawaii have relied on natural gas for years, and that trend is likely to continue, since these islands do not have their own natural resources. Other remote regions include areas of the U.S. not served by the natural gas pipeline network. For example, Jamaica Public Service Company converted its Old Harbour Power Plant to combined-cycle operations, capable of switching between oil and natural gas. Yukon Energy utilizes LNG to replace diesel for peaking and back-up transmission at its Whitehorse power plant in Canada. Coca-Cola Puerto Rico Bottlers has converted the boilers at its manufacturing plants in Cayey and Cidra to operate on LNG that is being delivered by Crowley’s Caribe Energy from Jacksonville, Florida. Hawaiian Electric and the Hawaii Gas Company have committed to importing LNG to replace crude oil and syngas. The Interior Energy Project will bring increasing volumes of natural gas to customers in Fairbanks and Interior Alaska are being served by natural gas through the Interior Energy Project, thereby reducing fuel costs in these remote, off-pipeline communities. The Alaska Railroad has operated a pilot program to transport LNG by rail to reduce costs and improve gas deliverability for this project. In the Dominican Republic, a power plant is being converted to LNG fuel to provide electricity to the Pueblo Viejo Mine. By replacing heavy fuel oil with LNG, this reduces operating costs. The company also plans to convert the fuel supply at its lime kilns to LNG by 2017.

3.3 Emerging LNG Applications

Emerging LNG markets are placing additional demand on LNG transportation. These markets include using LNG for remote power generation, and for high horsepower engines in the trucking, maritime, and railroad

industries. As LNG fuel demand increases, the transportation impact across the U.S. also increases. In our outreach efforts with the North American railroads, we learned there is a demand for LNG in areas with limited or no access to the North American natural gas pipeline network, such as New England, Alaska, parts of the Midwest, Canada, and Mexico. This includes power generation facilities, fueling operations, and remote mining operations. Another emerging area is fueling infrastructure for vessels, including cruise ships, cargo ships, and oil rig support vessels.

3.3.1 Marine LNG Applications

The commercial marine sector has seen growth over the past decade from virtually no LNG-powered commercial marine vessels to 230 units in operation or on order.²⁰

The commercial marine sector has seen significant growth and transformative change. In the last 10 years, the global market has gone from virtually no LNG-powered commercial marine vessels to now 230 units in operation or on order, serving a wide range of applications. This significant growth has been witnessed in Europe, Asia, and throughout North America.²¹

3.3.2 Example LNG Vessels



Harvey Gulf International Marine became the first U.S. vessel operator to contract for construction of vessels capable of operating exclusively on natural gas.

Harvey Gulf International Marine became the first U.S. vessel operator to contract for construction of vessels capable of operating exclusively on natural gas.

In addition to being powered by cleaner burning natural gas, the vessels will achieve “ENVIRO+, Green Passport” Certification by the ABS. The requirements for this certification include, among others, that the vessels be continuously manned with a certified Environmental Officer, be completely constructed with certified environmentally friendly materials, and have advanced alarms for fuel tanks and containment systems. Along with Harvey Gulf’s other vessels under construction, they will be the first Offshore Support Vessels (OSV) to achieve this certification, making them the most environmental friendly OSV’s in Gulf of Mexico.

TOTE Marine has developed LNG operations in use at the Port of Jacksonville, where two vessels are using LNG for fuel. Another example is Crowley Maritime.²²

TOTE Marine has worked with a number of partners to develop state-of-the-art operations that currently are in use at the Port of Jacksonville. In addition to JAX LNG, TOTE has collaborated with the United States Coast Guard, Sector Jacksonville and the Liquefied Gas Carrier National Center of Expertise; Jacksonville Fire Department, Port of Jacksonville, American Bureau of Shipping; and numerous vendors and trade

²⁰ Florida East Coast Railway, High Horsepower Summit 2016.

²¹ Florida East Coast Railway, High Horsepower Summit 2016.

²² Crowley Marine, “Liquefied Natural Gas (LNG).”

associations. This collaboration has been central to the success of the truck-to-ship bunkering operations and will play a critical role in the Port's future.

Crowley Maritime will soon homeport two LNG-powered, combination container-roll-on/roll-off ships at JAXPORT's Talleyrand Marine Terminal. The ships, *El Coquí* and *Taíno*, will each have capacity for 2,400 TEUs with additional space for nearly 400 vehicles. In addition, the company also is building North America's first LNG bunker barge, Clean Jacksonville, and provide LNG for vessels calling at Blount Island. Finally, Crowley-owned Carib Energy has already begun small scale exports of LNG to Puerto Rico and has plans for expansion to a number of countries in the Caribbean and Latin America.²³



Rev LNG received an \$800,000 technology innovation award under the Pennsylvania Department of Environmental Protection's Alternative Fuels Incentive Grant Program. The plan is for Rev LNG to make product using gas from local wells. The firm formed Rev LNG Marine for the emerging market for natural gas fueled watercraft. Pennsylvania has ports in Philadelphia, Pittsburgh, and Erie, that serve ocean, river, and Great Lakes vessels.

3.3.3 Rail LNG Applications

North American railroads are actively exploring the use of natural gas-powered locomotives, with new pilot projects and deployments each year. Pilot projects include:

1. North American Railroads (evaluating both GE and Caterpillar gas engines, checking climate tolerance).
2. Indiana Harbor Belt Railroad (Caterpillar dual-fuel CNG-diesel engines and Hexagon Lincoln Type IV CNG tanks).
3. Florida East Coast Rail (24 mainline locomotive converted to LNG gas, and now operating bulk LNG transport).
4. Alaska Rail hauling LNG cargo (via 40-foot long cryogenic ISO tanks) from Anchorage to Fairbanks, Alaska.



²³ Crowley Marine, "Liquefied Natural Gas (LNG)."

(Footnote continued on next page...)

International railroads also are moving forward with LNG and CNG projects. Russian Railways is working with Gazprom to develop LNG fueling infrastructure to test 40 gas turbine-powered locomotives. Indian Railways is converting existing locomotives to dual-fuel LNG engines and is working with Petronet LNG for fuel supply.²⁴

North American Railroads are evaluating both GE and Caterpillar gas engines, while running pilot LNG locomotives across the country to assess their durability in diverse climates. Railroads are exploring both LNG and CNG (compressed natural gas) locomotive fuel options. For example, Indiana Harbor Belt Railroad is converting 21 locomotives to Caterpillar dual-fuel CNG-diesel engines and Hexagon Lincoln Type IV CNG tanks.

Alaska Rail hauled its first LNG cargo in September 2016 using 40-foot long cryogenic ISO tanks from Anchorage to Fairbanks, Alaska. The Florida East Coast Railroad (FECR) is using LNG to fuel locomotives and testing the feasibility of transporting bulk LNG by rail on its Jacksonville to Miami route.

The development of the natural gas market for locomotives is not limited to operations in North America. International railroads are quickly moving forward with LNG and CNG projects of their own. This is spurred by different, and often simpler, regulatory requirements on the transport of natural gas by rail. In June 2016, Russian Railways struck an agreement with Russian gas supplier Gazprom to develop LNG fueling infrastructure at locations approved by Russian Railways to test 40 gas turbine-powered locomotives.



In December 2016, it was announced that Indian Railways will move forward with converting all of its existing locomotives to dual-fuel LNG engines, which will cut diesel consumption by 20 percent. The company has negotiated a long-term deal with Petronet LNG for fuel supply and is retrofitting locomotives with Cummins 1400 HP engines. It is clear from the number and diversity of rail operators looking at natural gas power around the world that this trend may continue as diesel prices rebound.²⁵

3.3.4 Mining Applications

The mining sector also includes examples of conversion to natural gas, typically in remote locations, relying upon LNG storage. Examples include:

1. The Renard diamond mine in Quebec, Canada (seven 2.06 MW Caterpillar generators, with fuel supplied by Gaz Metro).
2. Casino Mining Corporation in Yukon and Northwest Territories (A new LNG production plant with 600,000 gallons per day output will be constructed in British Columbia to serve these operations).
3. Barrick Gold in the Dominican Republic (LNG powered electricity for the Pueblo Viejo Mine).
4. Wellgreen Platinum in the Yukon Territory of Canada (GE Jenbacher gas engines with LNG supplied by Ferus).

²⁴ Dutta, "Railways speeds..."

²⁵ Indian Infoline News, 2017.

In both the U.S. and Canada, a growing number of LNG projects have been implemented in the mining sector in truck and power generation applications. These investments are a clear sign of the value proposition offered by natural gas in this HHP segment.

Mining LNG examples include Renard Mine, owned by Stornoway, commenced operation on July 15, 2016, with commercial production declared on January 1, 2017. In addition to being the first diamond mine in Quebec, Canada, this project is noteworthy for its massive LNG-fueled power plant. This project was unveiled at the 2015 HHP Summit, and uses seven 2.06 MW Caterpillar generators, with fuel supplied by Gaz Metro.

In September 2016, Ferus Natural Gas Fuels signed an MOU with the Vancouver-based Casino Mining Corporation, to supply LNG to mine projects in the Yukon and Northwest Territories. A new LNG production plant with 600,000 gallons per day of total throughput will be constructed in British Columbia to serve the mining operations. These LNG fueled mining projects will reduce a total of 255,000 tons of CO₂ emissions compared to what would otherwise be diesel-fueled operations.

In the Dominican Republic, Barrick Gold converted the power plant that provides electricity to its Pueblo Viejo Mine to LNG, where it will replace heavy fuel oil to reduce operating costs. The company also plans to convert the fuel supply at its lime kilns to LNG in 2018.

Wellgreen Platinum has deployed GE Jenbacher gas engines for a complete power generation and transmission network operating from a nickel-copper mining project in the Yukon Territory of Canada. Ferus supplies the LNG to power these generators, serving the Yukon communities.

3.3.5 Small Scale LNG Applications

There is a trend toward building small scale LNG facilities throughout the world and the U.S. is no exception. The reason for this trend is primarily economics. Instead of investing billions of dollars in large liquefaction plants, investors prefer instead to start up small operations to test emerging LNG merchant markets, including maritime LNG bunkering, mining operations, energy and production sites, LNG truck fueling operations and remote power generation sites. This trend is accompanied by new liquefaction technologies that include “modular” elements to scale operations according to customer needs.

This small scale LNG market is developing rapidly, especially for transportation fuel and to serve end users in remote areas or not connected to the main pipeline infrastructure.

1. **Production**—“Micro LNG” production plants can produce from 10,000 to 60,000 LNG GPD.
2. **On Road**—Truck and cryogenic trailer, each hauling approximately 9,300 gallons of LNG.
3. **Rail transport on the horizon**—at approximately 30,000 gallons per rail car.
4. **LNG as Marine Fuel**—examples include Harvey Gulf & Tote Maritime using LNG as fuel.
5. Marine transport options also increasing with barges, smaller LNG transport ships and specialized ISO delivery vessels (Figure 3.5).

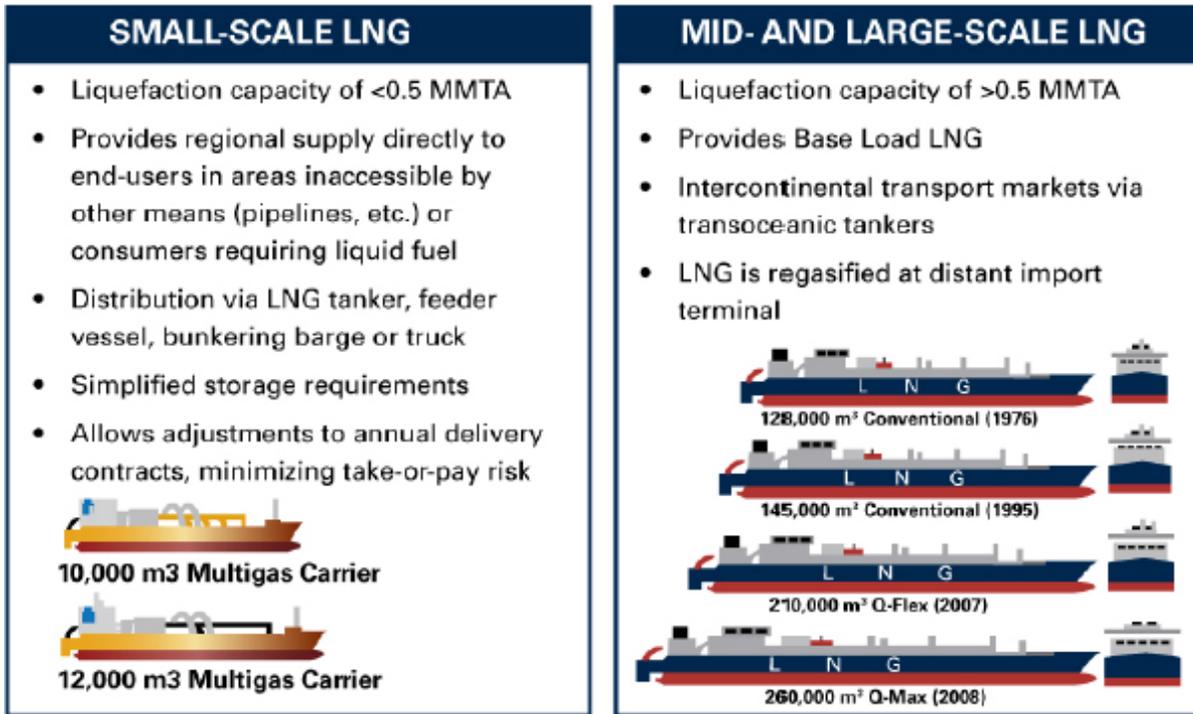


Figure 3.5 Scale of LNG Applications

Source: SSLNG Report, 2015.

4.0 Supply Chain Analysis

During the development of the Risk Plan, the CS Team compiled elements of the movement of natural gas in order to determine potential exposures and risks for different transportation modes. This section describes the supply chain analysis and includes descriptions of the transportation networks, facilities, processing, power generation, movements, and economics of LNG in the context of the changing energy sector in the U.S. We used a commodity-flow framework to describe LNG origins, destinations, and different methods of transport. The networks included in the framework are the highways, pipelines, railroads, and seaports that are used in the transportation of natural gas and LNG; and the facilities included in the framework are those that liquefy, store, and gasify LNG.

4.1 Commodity Flow Framework

The CS Team developed a commodity-flow framework to specify the origins, destinations, and different methods of transport used for LNG. The commodity flow framework includes transportation networks, facilities, transportation flows, and the economics of the evolving U.S. energy sector. Table 4.1 lists the elements of a commodity flow framework that are specific to LNG. LNG requires access to natural gas, liquefaction facilities, and cryogenic containers for transportation and storage.

Table 4.1 Elements of Commodity Flow Framework Specific to LNG Supply Chain

LNG Networks	LNG Facilities	LNG Transportation	LNG Economics
Base load facility supply and demand.	LNG liquefaction facility locations.	Interstate LNG Flows (State to State).	LNG projected import supply.
LNG rail network analysis.	LNG facility storage capacities.	Intrastate LNG Flows (within a State).	LNG projected export demand.
LNG maritime network analysis.	LNG liquefaction capabilities.	Truck trips serving liquefaction facilities.	LNG projected domestic LNG demand.
Projected rail network for LNG transport.		LNG fuel operations and demand.	Peak shaver supply and demand.
Natural gas pipeline network.			
LNG truck network analysis.			

Source: Cambridge Systematics

4.2 LNG Networks

The primary networks used in the commodity flow framework are the North American natural gas pipelines, railroads, waterways and highways. Often referred to as the “midstream” portion of the energy supply chain, pipelines, railroads, waterways and highways move natural gas, natural gas liquids, other fuels in bulk quantities from “upstream” production and processing facilities to distant “downstream” locations, where the shipments are refined, stored, and/or delivered to end customers by barge, truck, or pipeline.

4.2.1 Highway Network

The highway system in the U.S. is most ubiquitous transportation network with roads uniformly distributed across the country. Roads that are a part of the U.S. National Highway System (NHS) are required to be kept in good maintenance, and broadly provide access to locations that are not served by pipelines or rail.

Highways provide flexible access between natural gas processing plants, gas power generation plants, and LNG facilities throughout the U.S. Gas producers rely on the highway network to transport LNG to and from peak shaving facilities, and merchants rely on the highway network to access natural gas and LNG for commercial and industrial operations. (See Figure 4.1).

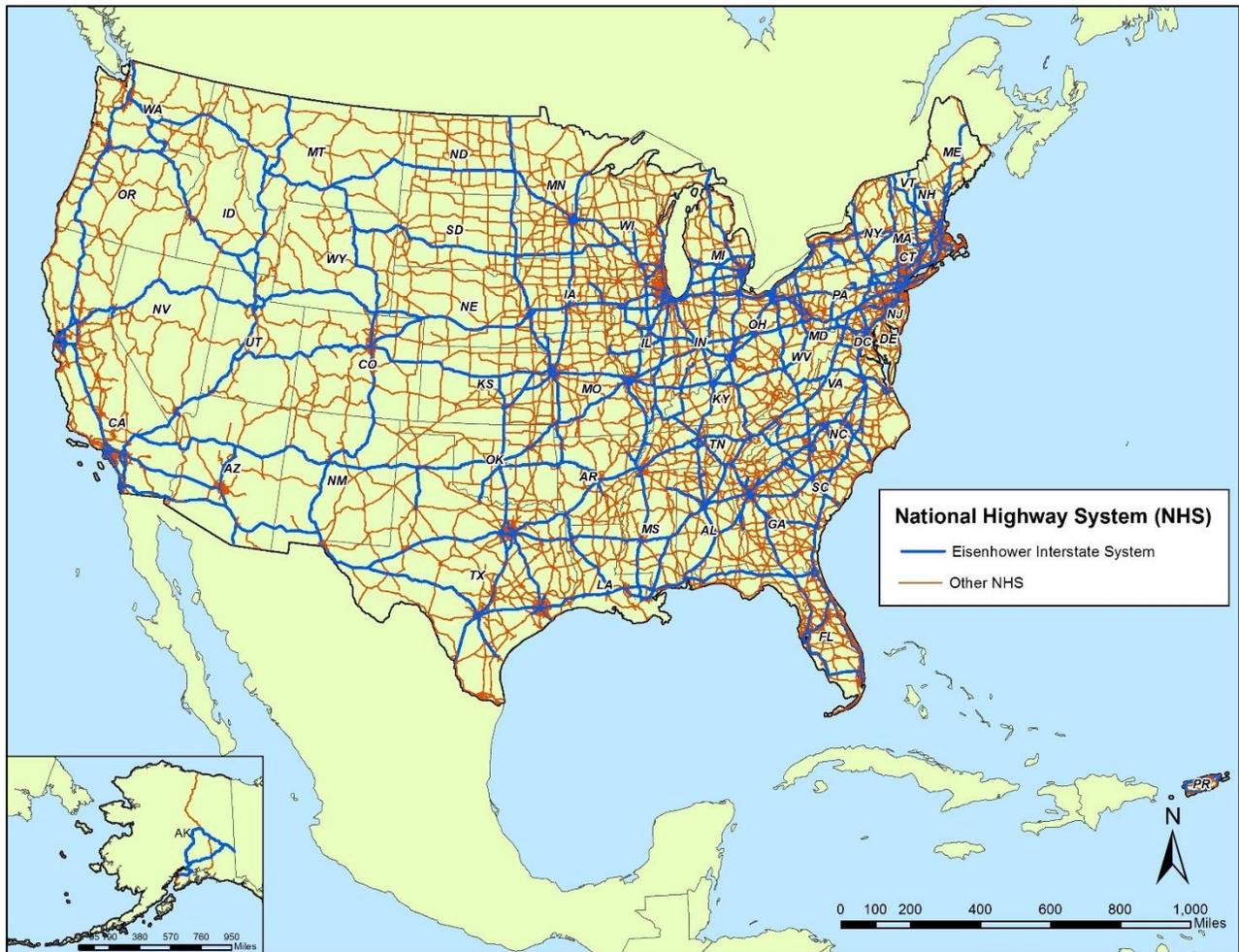


Figure 4.1 U.S. National Highway System

Sources: FHWA Data, November 20, 2017; Cambridge Systematics, Inc.

4.2.2 Freight Rail Network

While LNG currently is not allowed for shipment by rail except by special permit, railroads have historically shipped petroleum and chemicals, including crude oil, ethane, ethylene, and liquid petroleum gases using the extensive North American freight rail network. Because rail transportation is more economical than

highway transportation for large quantities over great distances, railroads could be more cost-effective than trucks in circumstances where pipeline service is not sufficient.

Most of the U.S. freight rail system is owned and operated by these four Class I railroads:

- Union Pacific Railroad and BNSF Railway own most of the mainline track west of the Mississippi River.
- CSX Transportation and Norfolk Southern Railway (NS) own most of the track to the east.

The other three Class I railroads include:

- Canadian National Railway (CN) operates in Canada and owns a large number of subsidiary railway companies in the U.S., which operate on several thousand miles of mainline track in the upper Midwest, and the Great Lakes region, as well as southward to the Gulf Coast.
- The Canadian Pacific Railway (CP) also operates in Canada and owns subsidiary railway companies in the U.S. which operate on track in the Midwest and the mid-Atlantic.
- The Kansas City Southern Railway Company operates in the Mississippi Valley on mostly north–south routes, including extensions into Mexico as Kansas City Southern de Mexico.

Collectively, these seven Class I railroads own, operate, and maintain about 162,000 miles of track in the United States. As shown in Figure 4.2 the freight rail network is highly integrated, exchange traffic with one another to provide connectivity to markets across the country allowing service to locations throughout North America. Class I railroads provide long-distance freight transportation and during the past 30 years, they have fundamentally restructured their networks and operations to concentrate traffic on high-capacity trunk lines by using increasingly longer and heavier trains.

Coal has been a low-value/high-volume commodity that has, for years, been a large portion of railroads' unit train services. Unit trains consist of a single commodity such as bulk commodities like grain, coal, and chemicals; and due to the reduced logistics required by the railroads, the shipper receives speedier service. In recent years, coal demand and shipment volumes have reduced the number of unit trains shipped, while commodities like intermodal traffic and manifest trains have increased over the years.²⁶ Manifest trains are less profitable for the railroads, consist of multiple different commodities and cars, require more sorting and logistics, and have higher operations costs. As Class I railroads have already consolidated their routes to focus on high-density lines and minimize their operation expenses, short-line railroads have begun performing some of the transfer work in terminals. Regional and short line railroads operate more than 40,000 miles of branch-line track to provide feeder service, often for the "last mile" of freight operations in urban areas and U.S. ports.

²⁶ "Safely Transporting Hazardous Liquids and Gases in a Changing U.S. Energy Landscape."



Figure 4.2 North American Freight Rail Network

Source: U.S. DOT Bureau of Transportation Statistics, Association of American Railroads, 2017.

4.3 LNG Facilities

LNG production and surface transport in the U.S. relies upon both specialized facilities dedicated to LNG, and on the underlying infrastructures for natural gas production and distribution, as well as surface transport infrastructure such as highways and railroads.

LNG facilities encompass facilities which liquefy, transport, store, or gasify LNG. Some facilities import or export LNG, others provide natural gas supply to the Interstate pipeline system or local distribution companies, while others are used to store natural gas for extended periods of peak demand. There also are facilities which produce LNG for vehicle fuel or for industrial use. Depending on location and use, an LNG facility may be regulated by several Federal agencies and by State utility regulatory agencies.

There currently are 153 LNG facilities operating in the U.S. performing a variety of services (Figure 4.3). Some facilities import natural gas to the U.S., one now exports natural gas from the U.S., some provide natural gas supply to the Interstate pipeline system or local distribution companies, while others are used to store natural gas for extended periods of peak demand. There also are facilities which produce LNG for vehicle fuel or for industrial use. Depending on location and use, an LNG facility may be regulated by several Federal agencies and by State utility regulatory agencies.

LNG accounts for only a small portion of working gas in storage, but on days when the price of natural gas peaks, LNG often represents a significant part of a company's supply portfolio. The deliverability of LNG is

higher than traditional underground storage facilities such as depleted reservoirs, aquifers, and salt caverns, making LNG especially useful for stockpiling natural gas for periods when demand is high, supply is low, and prices are at a peak. This ratio between the heat content of the supply and the volume of the inventory is known as a high degree of “deliverability.” Under peak conditions, LNG facilities are often constructed with the ability to supply a much larger amount of gas than the amount of space that their inventory occupies, thanks to the six-hundred-to-one gas-to-liquid ratio. Being able to purchase natural gas when the market is at a low, such as during the summer when it is not being used for heating, and store it for the winter when demand may exceed supply, enables LNG facilities to level out the resources throughout the year.

Figure 4.3 shows the 153 LNG facilities operating in the U.S., performing a variety of services, in relation to the U.S. natural gas pipeline network. LNG peak shavers with liquefaction are identified in green, and satellite peak shavers without liquefaction in purple. The import/export facilities are identified by red squares and emerging LNG facilities as blue stars. These “emerging” LNG facilities are mostly merchant plants that have been constructed but do not yet appear in the PHMSA and EIA databases. They include facilities built in Florida, Louisiana, Pennsylvania, Texas, and Vermont.

Additional information on import and export facilities is available in Appendix E. There are 12 import facilities in the United States, nearly all of which are in the process of converting from import-only to import-and-export facilities due to the domestic availability of shale gas.

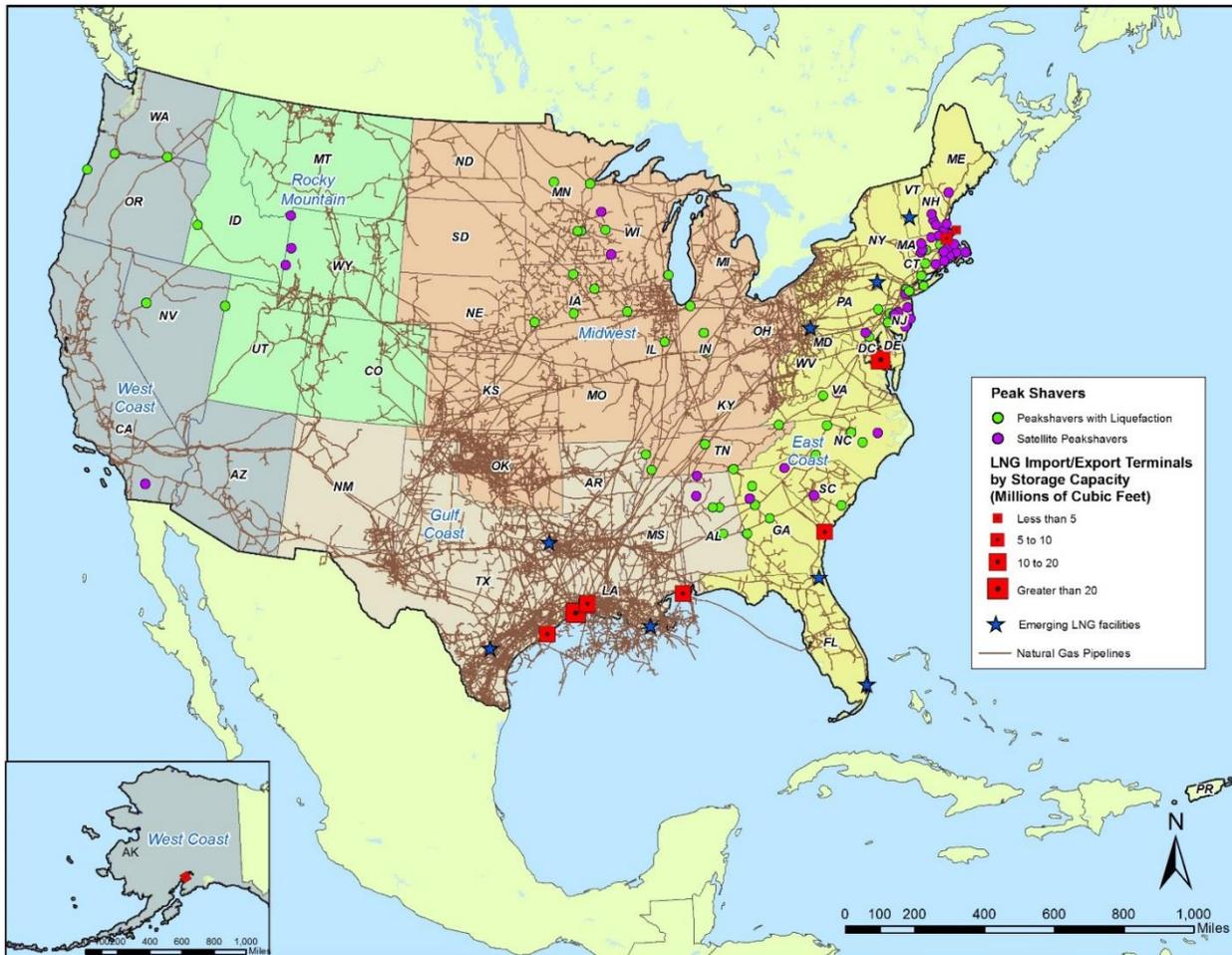


Figure 4.3 U.S. LNG Facilities with Natural Gas Pipeline Network

Sources: Energy Information Administration; Cambridge Systematics, Inc.

As part of understanding the possibility of shipping natural gas as LNG by rail, the placement of LNG facilities relative to the national rail network. Figure 4.4 illustrates the U.S. LNG Facilities and U.S. Railroad Network on a national scale.

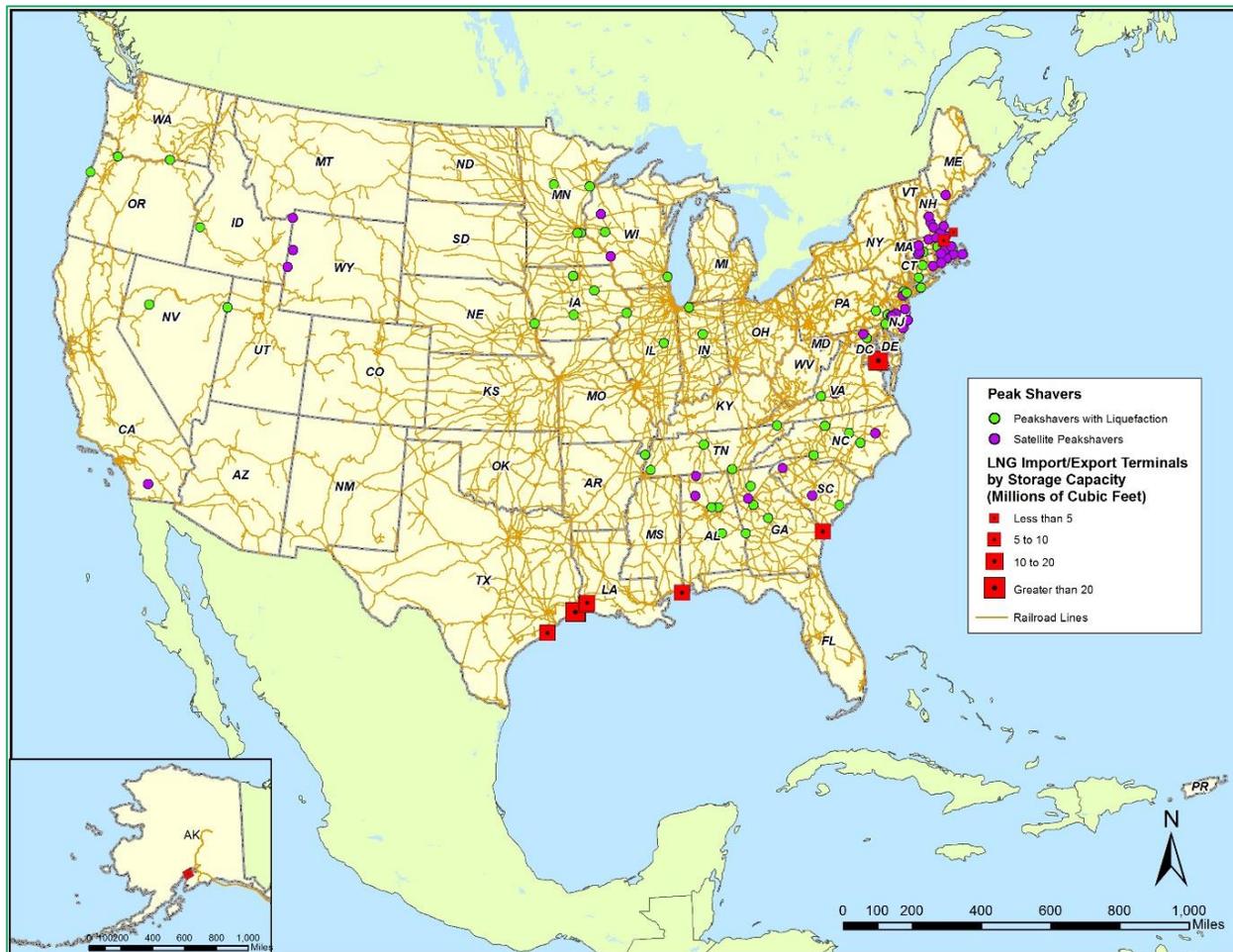


Figure 4.4 U.S. LNG Facilities and U.S. Railroad Network

Sources: Energy Information Administration; Cambridge Systematics, Inc.

The railroad and pipeline networks do show similar patterns when viewed on a national scale, and railroads access some areas that are not reached by pipelines, such as South Dakota. Each of the networks are not homogenous in construction; pipelines have directionality and capacity differences, railroads have track classifications, tonnage differences, and geometric limitations.

Railroad and pipeline networks share some similarities, and also differ in important ways. Both pipelines and railroads have high capital costs, engineering challenges, and permitting requirements that make building new infrastructure costly and time consuming. Neither network is homogenous in construction; pipelines have directionality and capacity differences, railroads have track classifications, tonnage differences, and geometric limitations.

Highways are the most ubiquitous of the network, with the most access. Truck transport of LNG is the only alternative to domestic movements of natural gas that are not handled by pipeline (except for LNG by vessel between California and Hawaii).

This figure does not address the actual feasibility of connecting a LNG facility to a railroad. The intent is simply to provide a network-level view of U.S. rail network and its relationship to LNG facilities. It should also be noted that utilizing an existing rail network is much easier with ISO containers, which can be trucked to a transfer yard and transferred to a flatbed rail car without having to transfer the cryogenic liquid from one container to another.

The Northeast natural gas market has a very high demand and limited pipeline supply. This is particularly the case in New England. This is because New England has limited access to four different pipelines that primarily serve other markets. The lack of public support for additional pipeline infrastructure in New England has been a factor in the history of LNG in this region. Therefore, LNG has been imported by ship to Everett, MA for the past 40 years and transported by truck to 43 peak shaving facilities throughout New England. Natural gas also supplies power generation facilities nearby and in the region. Nearly all of the peak shaving facilities are used for storage only in peak demand, such as the winter, and do not have liquefaction capabilities.

For the majority of the year, New England's natural gas system of pipelines and LNG delivery system operates at less than 50 percent capacity. However, for approximately seven weeks each year, the region's natural gas distribution system does not meet demand. It is during this peak winter period that the LNG import terminal in Everett, MA helps to provide gas to meet this peak demand. The Everett LNG import terminal is managed by Distrigas of Massachusetts LLC, a subsidiary to ENGIE.²⁷ "Everett has also been the primary supplier of LNG to a network of 46 utility-owned, above-ground LNG storage tanks that meet New England's natural gas storage needs. More than 360,000 truckloads of LNG have left the Everett Marine Terminal over its 40-year history, or about 10,000 per year, primarily to refill these storage tanks and prepare for the peak winter heating season. Because of the geological conditions in the region, underground natural gas storage is not feasible. It serves nearly all of the gas utilities in New England and also key power producers, including a direct connection to a neighboring 1,550-megawatt power plant capable of generating enough electricity for about 1.5 million homes in Greater Boston."²⁸

New England has both LNG vaporization capacity from large import terminals as well as from LNG storage facilities owned by the local gas distribution utilities, or "LDCs." One solution that has been used is for LDCs to contract for a baseload level of LNG vaporization during the December 15–March 15 winter period. Engie provides more frequent truck refills of their existing LNG storage facilities, thereby maintaining local gas reliability while freeing up existing pipeline capacity for sale on the secondary market to power plants.

Figure 4.5 shows the LNG facilities in the Northeast overlaid with the natural gas pipeline network. There are 18 peak shavers with liquefaction capabilities that are adjacent to transmission pipeline networks. These facilities liquefy natural gas, accumulating and storing LNG when natural gas is cheapest and available—

²⁷ According to the ENGIE website: "ENGIE manages a range of energy businesses in the United States and Canada, including retail energy sales and energy services to commercial, industrial and residential customers, natural gas and liquefied natural gas (LNG) distribution and sales, and electricity generation and cogeneration. In 2015, ENGIE recorded €69.97 billion in global revenues (\$77.6 billion USD). More than 3,500 employees work in the region, and Houston serves as corporate headquarters."

²⁸ ENGIE, Inc., "Natural Gas & LNG."

during the summer. There are 28 satellite peak shavers, storing LNG supplied exclusively by truck. This is especially obvious in southern New Jersey.

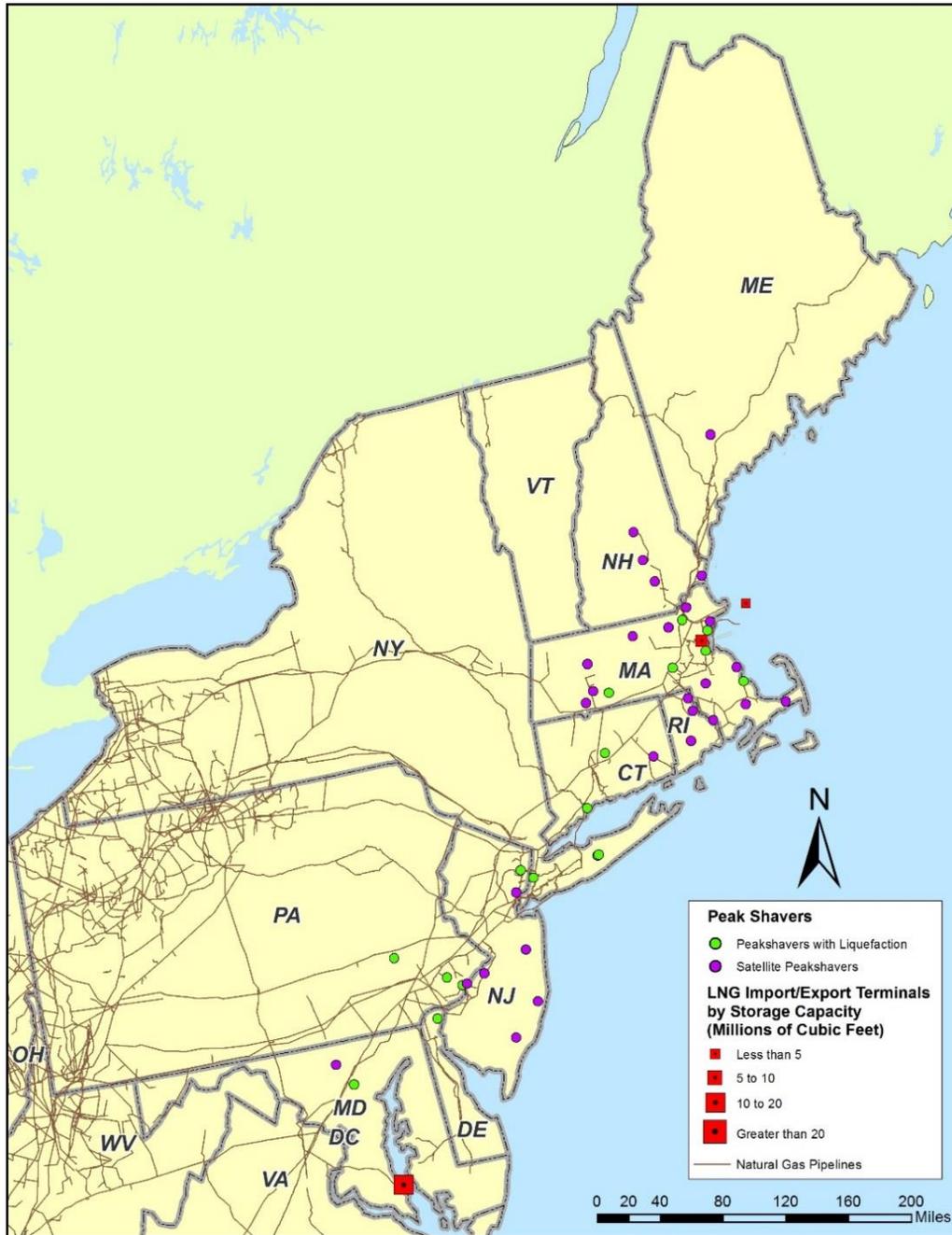


Figure 4.5 Northeast LNG Facilities

Source: Energy Information Administration; Cambridge Systematics, Inc.

New England is an example of a “stranded” gas market that currently is served by truck delivery of LNG. New England could be a candidate for LNG delivery by rail. Figure 4.6 illustrates the proximity of railroads to LNG facilities in the Northeastern United States. It is not the only stranded gas market in the country, but it is a market with high demand and limited access to the pipeline network. Since the majority of LNG is delivered

in New England by truck, the only other alternative without great investment in pipelines (which have been opposed by the local population) would be railroad transportation, and under certain conditions, New England could be a candidate for LNG by rail.

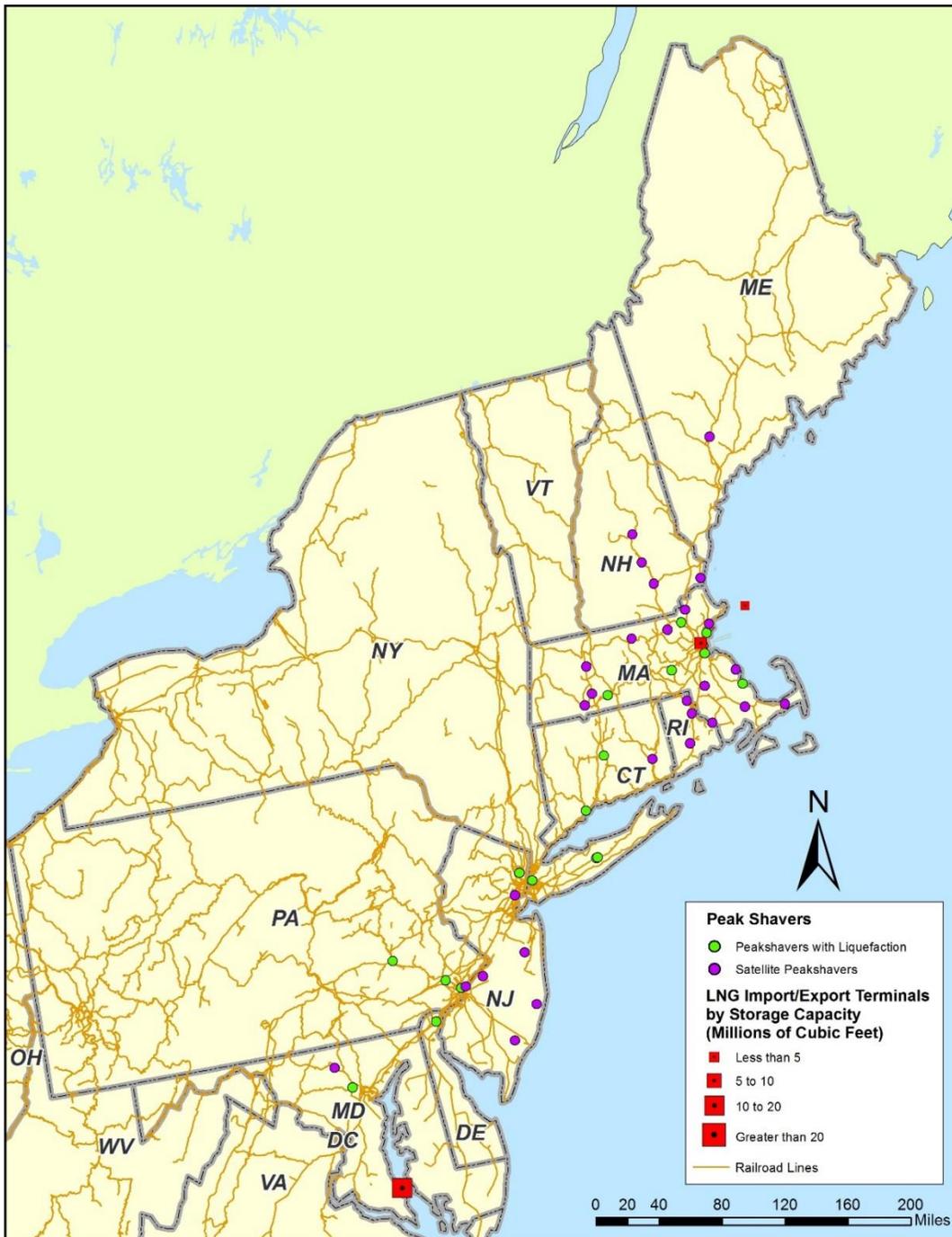


Figure 4.6 Northeast LNG Facilities and Railroads

Source: Energy Information Administration; Cambridge Systematics, Inc.

In both Figure 4.5 and Figure 4.6, there is a cluster of LNG facilities in the Northeast. In this area, the winters are cold, natural gas is one of the fuels used for heating, and the transmission pipeline network is

underdeveloped. New England has limited access to four different pipelines that primarily serve other markets. The lack of public support for additional pipeline infrastructure in New England has been a factor in the history of LNG in this region. Consequently, LNG has been imported by ship to Everett, MA for the past 40 years and transported by truck to distribution points. The seasonally varying—and unpredictable on a short-term basis—nature of the demand for natural gas also creates a need for distributed natural gas storage, against peak demand (peak shaving facilities). For that reason, there are 43 peak shaving facilities in New England. Relatively few New England peak shaving facilities have liquefaction capabilities, because of the limited access to transmission pipeline networks.

4.3.1 North American Merchant Facilities

LNG transportation is a key capability for LNG merchant plants and operators. Merchant operators are commercial energy providers that compete to sell energy on the wholesale energy market. These merchant operations differ than typical utilities in that they are not beholden to the natural gas rate payers in the area. Therefore they can buy and sell LNG on demand and effectively supplement the natural gas and LNG users during times of peak demand. Merchant operators are important players in the natural gas trading market. Table 4.2 lists of some of the merchant power plants in the U.S. that have been identified as trading natural gas. Some of these plants are solely merchant plants and others are merchant plants connected to a utility.

Table 4.2 Sample of U.S. Natural Gas Merchant Plants

Pivotal (owned by Southern Company Gas)	Trussville, AL
UGI (Pennsylvania)	Fortress (Hialeah, FL)
Reading, PA	Memphis, TN
Scranton, PA	Oklahoma, Texas
Citizen's Gas (Indiana)	Jacksonville, FL (two under construction)
Gas Metro (Montreal)	

Sources: Cambridge Systematics, Prometheus, Inc.

The emerging uses for LNG to supplement power generation, remote power generation and LNG fuel has resulted in multiple supply sources across the U.S. Figure 4.7 illustrates the widespread availability of LNG through multiple sources, which are a combination of merchant operators, peak shavers, and gas processing plants.

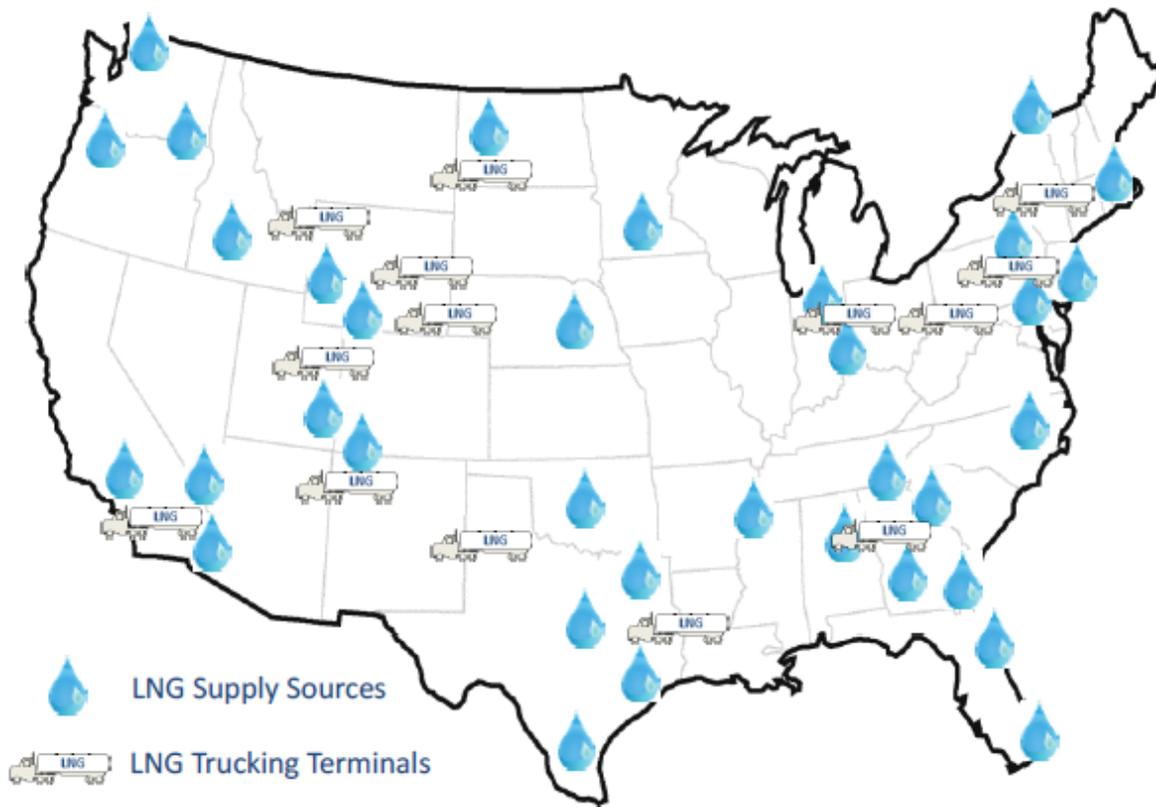


Figure 4.7 Example of Selected U.S. LNG Suppliers

Source: Prometheus, Inc.

4.3.2 Small-Scale LNG Facilities

The NFPA 59A Committee meets to review facilities that liquefy natural gas, facilities that store, vaporize, transfer, and handle LNG, the training of all personnel involved with LNG and the design, location, construction, maintenance, and operation of all LNG facilities. The committee currently is reviewing the issue of “small scale” versus “large scale” LNG facilities.²⁹ At present, the consensus is the threshold is 500,000 GPD. In other meetings with industry representatives, “midscale” LNG facilities also are considered, as illustrated in Figure 4.8.³⁰

²⁹ Meeting with FERC Representative, October 2017.

³⁰ Chart, Praxair Industry Meetings, September and October 2017.

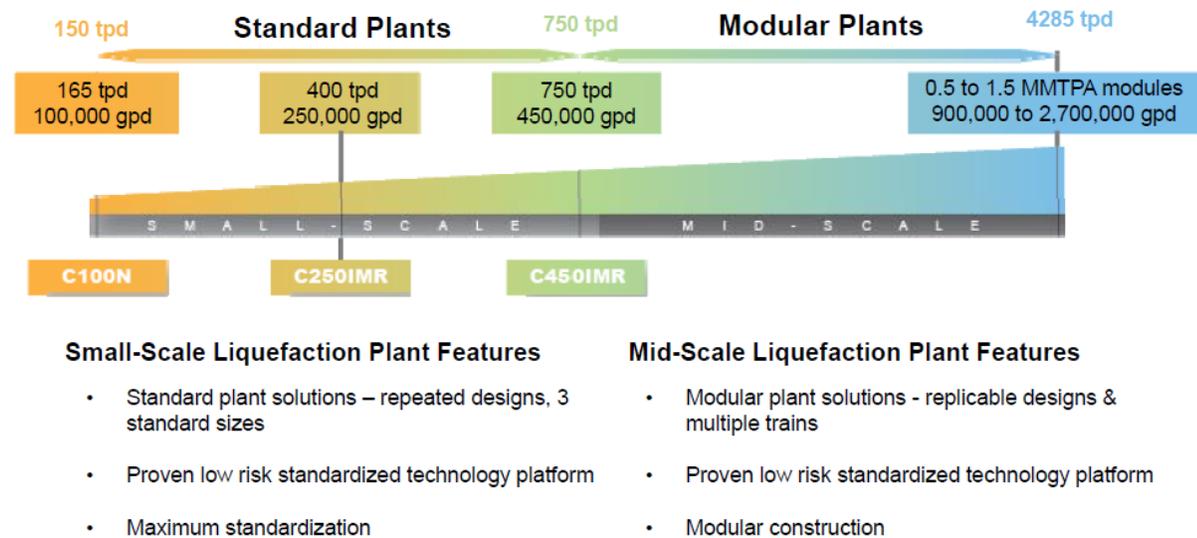


Figure 4.8 Small and Midscale LNG Facility Features

Source: Chart Industries, NFPA.

4.4 LNG Transportation

Natural gas is principally moved by pipeline. When natural gas is moved by truck or vessel it is assumed that it is moved in liquefied form, as LNG. Given the numerous locations across the U.S. for LNG supply, trucks currently are meeting LNG transportation demands in the current market.

Vessel movements cover long distances, and these distances are more efficient by vessel than by pipeline which would require building capital intensive infrastructure. Over short distances, pipeline movements are the most efficient, and in the continental U.S., pipelines move most of the natural gas. However, truck movements of natural gas in its liquefied form do occur, and truck transport is the main alternative to pipeline delivery. Trucks are adaptable to changes in dynamic natural gas market.

Preliminary analysis of the EIA Survey 176 data shows that roughly 65.1 million MMCF of natural gas were moved across the U.S. in 2016—99.574 percent by pipeline, 0.421 percent by vessel, and 0.004 percent by truck. Figure 4.9 shows movements of natural gas that are captured by the EIA Survey 176. This figure shows net Interstate movement, imports, and exports of natural gas, so actual total flows may be larger. Truck movements are very small compared to pipelines.

The majority of natural gas in and out of the U.S. market is moved by pipeline, and when natural gas is moved by truck and barge it is assumed that it is moved in liquefied form. Preliminary analysis of the EIA Survey 176 data shows that roughly 65.1 million MMCF of natural gas were moved across the U.S. in 2016—99.4 percent by pipeline, 0.4 percent by vessel, and 0.004 percent by truck.³¹ The vast majority of natural gas in the world is moved by pipeline, and when natural gas is moved by truck and vessel it is assumed that it is moved in liquefied form. Preliminary analysis of the EIA Survey 176 data shows that roughly 65.1 million MMCF of natural gas were moved across the U.S. in 2016—99.574 percent by pipeline, 0.421 percent by vessel, and 0.004 percent by truck. There is a limited ability to capture current truck

³¹ Energy Information Administration, “Annual Report 2016;” Energy Information Administration, “Survey 176.”

movements. These net Interstate movement, imports, and exports of natural gas are represented by the mode of transportation: pipeline, truck, and vessel; the international movements are shown in red, and the domestic movements are shown in blue. These movements are the net result of movements that may occur in either directions, showing the dominating direction of flow. Since pipeline gas goes into the network, pipeline movements do not extend beyond the next State into which the product flows. Vessel and truck movements, however, represent physical movements of LNG between States and other countries. This information is important in the context of this study to show LNG movements between States by truck.

International movements are shown in red, while the domestic movements are shown in blue. Specific transportation modes also are indicated. Because pipeline movements may extend beyond a State, only net cross-state movements are shown; if gas moves across a State, that volume of gas may be double counted (e.g., show as both entering and leaving the State), so it is not meaningful to total the pipeline flows shown in Figure 4.9. Vessel and truck movements, however, represent physical movements of LNG between specific locations; transshipment or pipeline injection remains possible, however, so again total figures should be treated with care.



Figure 4.9 Net Interstate Natural Gas Movements
Million Cubic Feet MMCF

Source: Energy Information Administration, "Annual Report 2016."

A single truck carries close to 11,000 gallons of LNG, equivalent to almost 1 million cubic feet of natural gas. Therefore, the movements in millions of cubic feet correspond roughly to truck counts. Viewing the current movements of LNG by truck reveals how the market handled the inability to service the consumers by pipeline in 2016. This helps understand the origins that have liquefied LNG supply and the destinations that demand natural gas beyond what the pipeline transmission network can supply.

Reviewing the larger movements reveals some useful information.

- There is significant truck movement from California, Arizona, and Texas to Mexico, reflecting the demand for natural gas in Mexico. That also suggests some liquefaction facilities in each of those States.
- There also is significant truck movement from Canada into the U.S. Northeast, reflecting the strong demand already noted for that region. Though, some movement for ME may simply be transshipment from Canada to Canada.
- Wyoming is a significant source of truck movements of LNG. This is likely due to the Exxon LaBarge facility which removes CO₂ from natural gas in that region, harvests Helium from the natural gas, and liquefies some of the dry gas output.
- Given the relatively large volume of LNG trucked into CO, much of the outbound volume from CO is likely trans-shipment.
- Other States that appear to be more significant sources of LNG truck shipments are Alabama, Indiana, and North Dakota.

It should be noted that this LNG is being transported by truck for distances that per would ordinarily be more cost effective by pipeline. This could be because the local supply prices spiked during a supply shortage, or because the destination is not well connected to the pipeline network, or both.

Figure 4.11 depicts the same truck movements by volume across the U.S. Interstate system. The method for developing this map was to use the data from Figure 4.10 regarding LNG volume, State origin and State destination and assign the corresponding trips to the Interstate highway network. Since the data do not include the exact origins and destinations, the CS team used State centroids to assign the network. This results in some inaccuracies, such as in Florida, where we can assume that LNG is likely transported to Jacksonville to fuel ships, not to Tampa.

Note the LNG truck movements correspond to those areas in the U.S. not well served by the natural gas pipeline network.

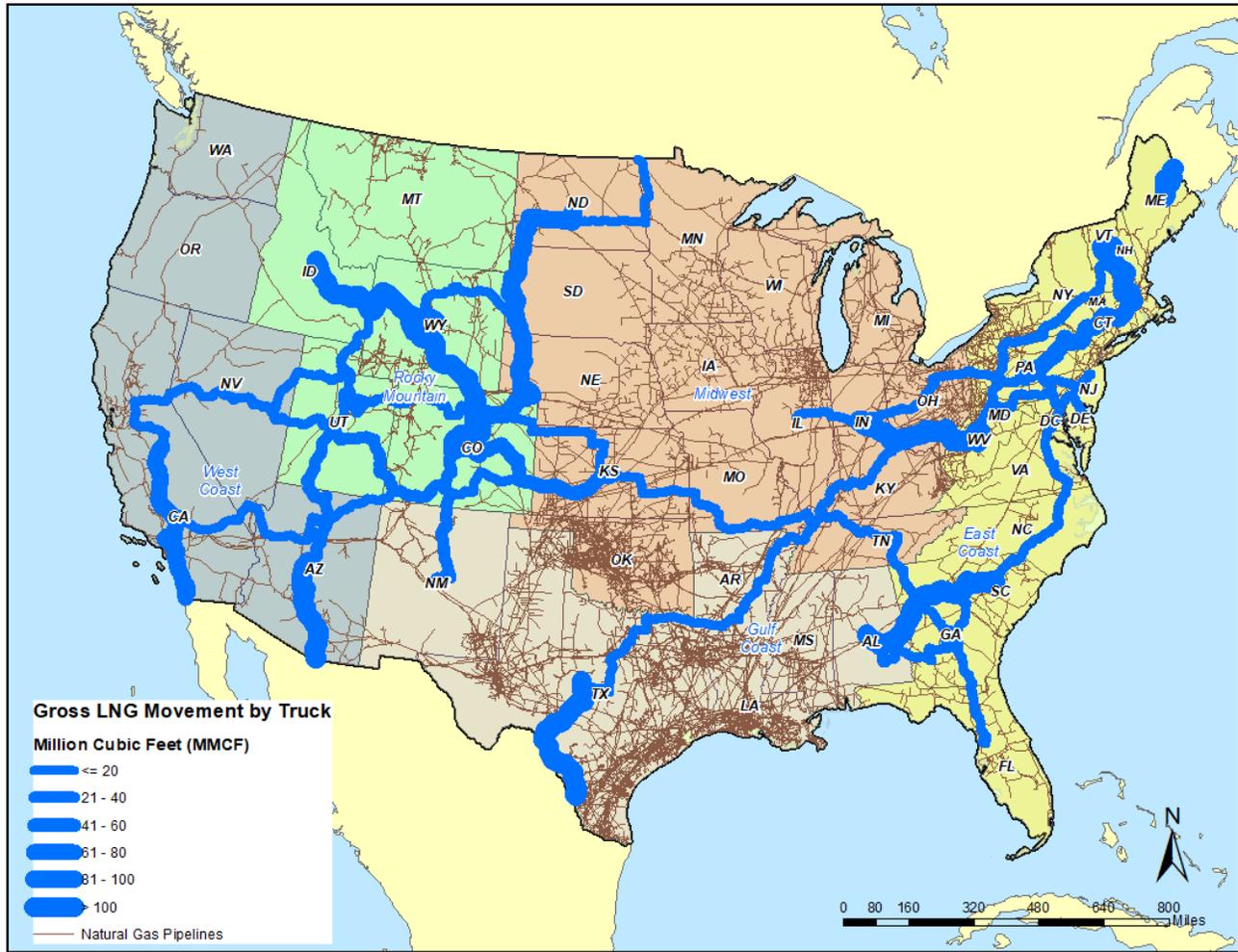


Figure 4.11 Gross LNG Truck Movements by State

Source: Energy Information Administration; Cambridge Systematics, Inc.

Figure 4.12 gives an additional perspective by showing the truck movements solely between production and consumption natural gas regions as defined by the EIA. This figure illustrates that the majority of the movements are within the natural gas regions, but some of the LNG movements do move more than 1,000 miles.

4.5.1 Natural Gas Prices

According to the EIA, three major supply-side factors and three major demand-side factors affect prices (see Table 4.3. And these prices ultimately inform the natural gas users of the most efficient method to obtain natural gas, whether it be from a pipeline or in the form of LNG.

Table 4.3 Supply-Side and Demand-Side Factors Affecting Prices

Supply-Side Factors	Demand-Side Factors
Amount of natural gas production	Variations in winter and summer weather
Level of natural gas in storage	Level of economic growth
Volumes of natural gas imports and exports	Availability and prices of competing fuels

Source: Energy Information Administration, “Factors Affecting Natural Gas Prices.”

As the natural gas supply has flooded the market, the price has been driven down by oversupply. Spot natural gas prices at local hubs give a good idea of the price differential between regions, and these prices drive sourcing and contract decisions. Spot prices are commonly linked, with differences reflecting the transportation cost of moving gas between regions. However, if delivery is not possible between two areas, the prices can move more independently of each other. Figure 4.14 charts the spot prices for the hubs from March 2014 through December 2017.

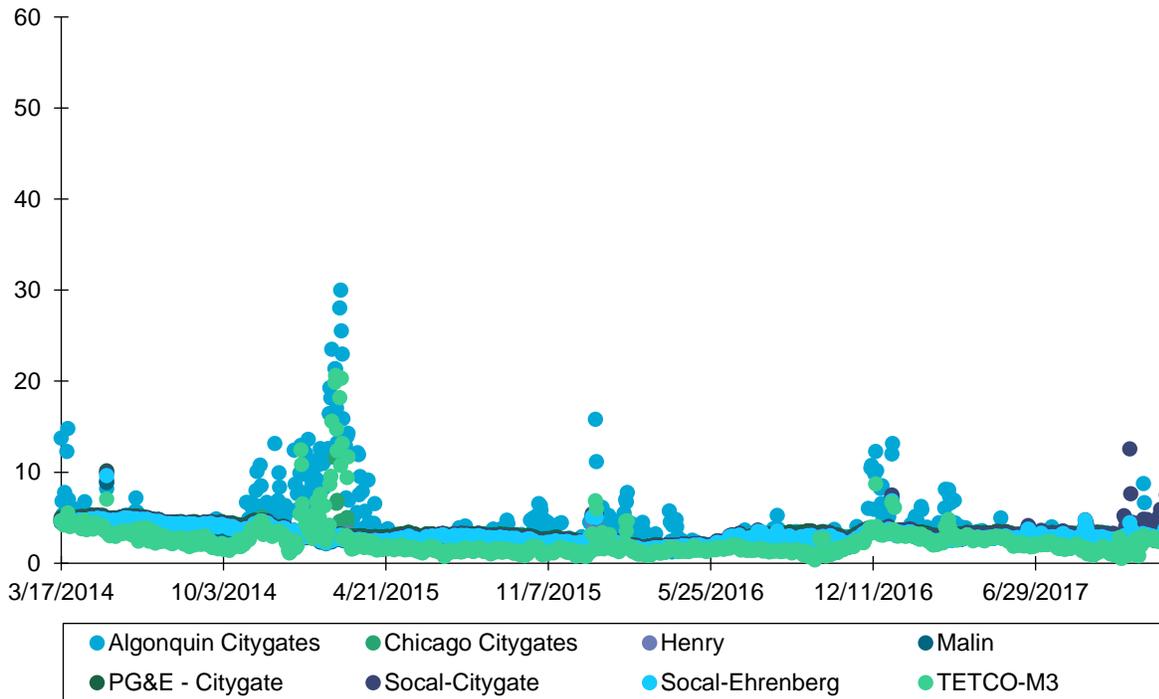


Figure 4.14 Natural Gas Hub Spot Prices
2014–2017

Source: Energy Information Administration.

The Henry hub is the most important natural gas hub in the U.S., and Henry Hub prices are reported internationally as representative of the North American natural gas market. Hub prices can be reported in the form of a basis, which is the price differential between two delivery points, and are often reported as a basis with the Henry Hub.

Local imbalances in supply and demand, where the transmission pipeline network has insufficient capacity to meet demand, can make natural gas more expensive in one region than another.

Two natural gas Hubs, the Algonquin (for Massachusetts), and TETCO (for Pennsylvania) can be compared in this analysis. The Algonquin is a close representation of the natural gas prices in Worcester, MA, and the TETCO-M3 is a close representation of the natural gas prices in Harrisburg, PA. For this analysis, the Henry Hub is included as a reference since it is the primary natural gas hub in North America. When the Algonquin Citygates or the TETCO-M3 hub prices dip below the Henry Hub, this indicates that the region experienced oversupply, which could be from less demand than normal, or more likely for the Utica-Marcellus shale region would be that production exceeded the infrastructure ability to move the natural gas out of the region, creating a local situation of oversupply. When Algonquin Citygates or TETCO-M3 exceed the Henry Hub price, this indicates that the demand exceeded the local area's access to natural gas supply. Market hub prices are reported in \$/MMBtu. Figure 4.15 depicts the hub prices between 2014 and 2017 for the Algonquin, TETCO-M3 and Henry Hubs.

Spot natural gas prices at local hubs give a good idea of the price differential between regions, and drives the sourcing and contract decisions. Spot prices commonly reflect the transportation cost of moving gas between regions, but if delivery is not possible between two areas, the prices act independently of each other.

The typical pattern for the Northeastern region natural gas prices follows the weather. It is normal for prices to fall below the Henry Hub during the summer, when the local demand for natural gas is lower. This is because natural gas is the primary energy source for heating during the winter in the Northeast, and the winters may be especially harsh. During the summer, natural gas may be used for electric power, and this also can be affected by the weather because a hot summer will increase the air conditioning usage and drive up electricity usage. Typically, the winters are harsh, and the summers are mild, leading to undersupply in the winter and oversupply in the summer. The oversupply in the summer is caused by a lack of outbound network infrastructure for the natural gas processed in the Utica-Marcellus shale region, creating stranded supply. The undersupply in the winter is caused by the steep increase in demand during cold periods, and the under capacity of the network to supply the peak demand of the region. To show the price differential between the two regions, look at the spread between the Algonquin hub and the TETCO-M3 hub in Figure 4.15. When the differential is positive the Algonquin Citygate hub prices were greater than the TETCO-M3, and when the differential is negative, the TETCO-M3 hub prices were greater than the Algonquin Citygate hub. The highest price differential shown by the data occurred on December 26, 2017, when the Algonquin hub was \$40.6334 greater than the TETCO-M3 hub. Typically, a price differential is representative of the relative shipping costs between the two regions. When price differentials peak, this acts as a driver to provide more transportation options. Most, but not all, suppliers and users bid on contracts every month during bid week, so they are not generally vulnerable to price spikes. Prices overall will increase for several months during the winter, while the highest price spikes only last a few days.

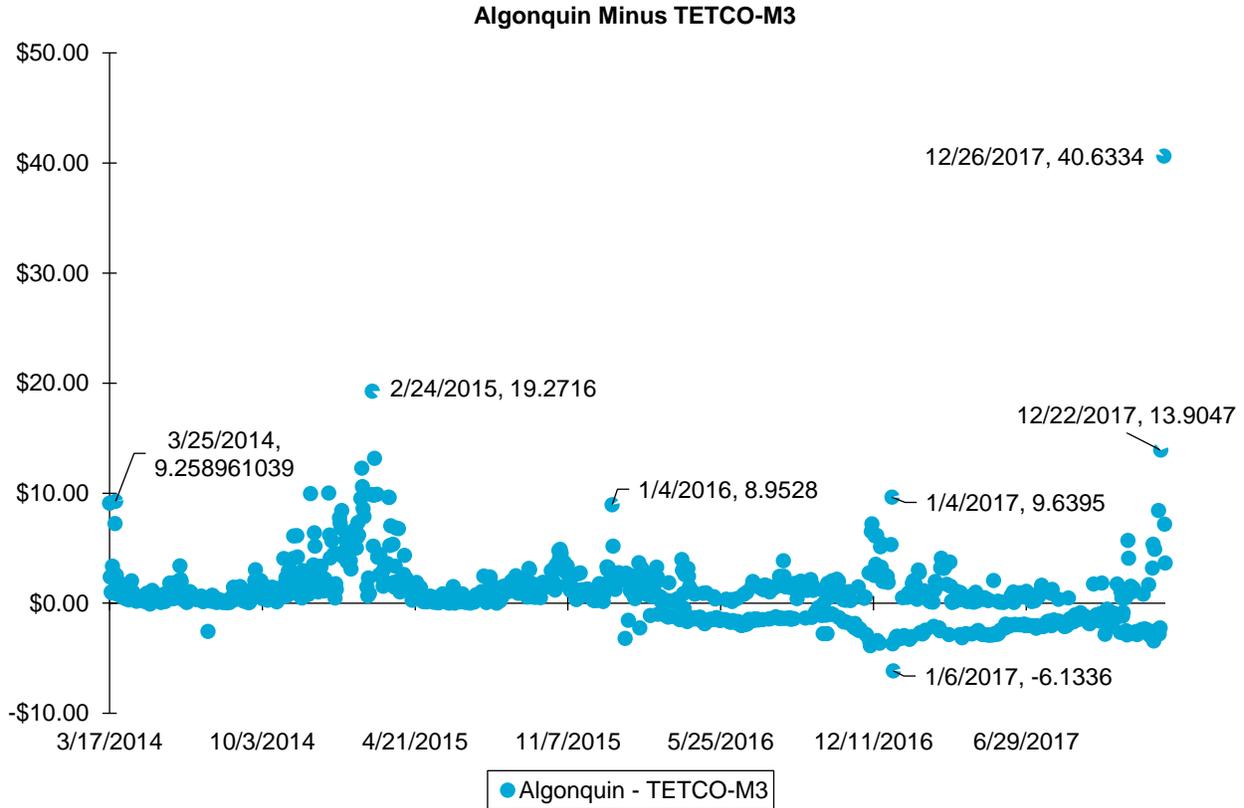


Figure 4.15 Market Hub Price Differential
2014 to 2017

Source: Energy Information Administration.

The cost to produce and deliver LNG is typically about two to three times the price of natural gas. The LNG can be sold at roughly three to four times the cost of natural gas, as long as it is still cheaper per Btu than propane or diesel.³⁴

4.5.2 Transportation Costs of LNG

The natural gas pipeline network in the U.S. is the most extensive in the world, but it does not reach everywhere. Even in densely served areas, there are pockets of geography that are not directly connected to the overall network. Finally, there will be regions (as discussed for the Northeast) where there is a local natural gas distribution infrastructure, but limited access to the transmission pipeline network.

Essentially, pipeline is the most efficient and cost-effective transport of natural gas. However, pipeline delivered gas comes with a cost. When pipeline gas prices go up and other markets can provide the gas for cheaper, there is an alternative supply, making trucking and rail delivery of natural gas feasible. Figure 4.16 illustrates this relationship between natural gas pipeline and LNG transportation costs relative to distance, and is merely an example of how the different transportation modes could compare with each other.

³⁴ Information gathered from an interview with an LNG broker.

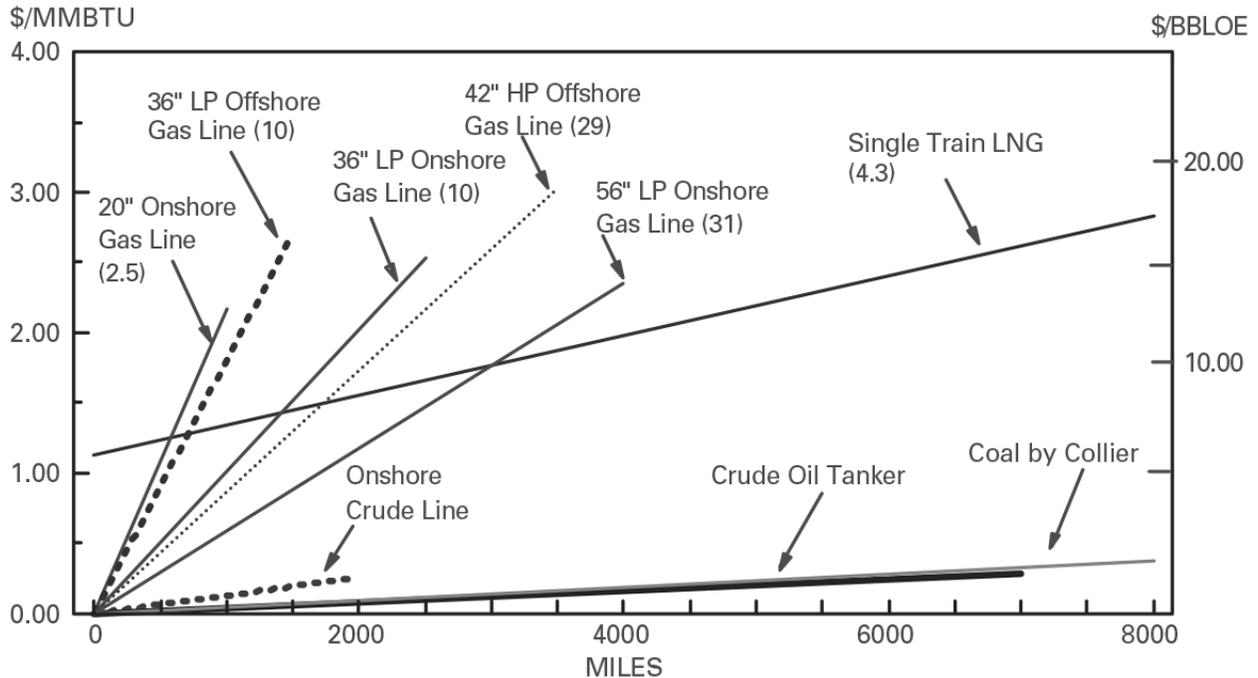


Figure 4.16 Example of Natural Gas Delivery Costs
By Mode Relative to Distance

Source: Jensen, *The Development of a Global LNG Market...*

The above figure was developed in 2004, and represents the costs of transporting natural gas at that time, but the relative shape of the graph does show the relative relationships between the transportation modes. Also, the above figure shows LNG being transported by vessel only. Ultimately, LNG has higher start-up costs, which come from the costs of liquefaction. After the initial cost, LNG typically becomes more economically attractive at longer distances. Intuitively, it would be cheaper to move LNG by vessel across the ocean than to construct an offshore gas line. When comparing the delivery of LNG by truck and rail, the initial costs of liquefaction are there, but the mode of transport is more expensive than by vessel.

Once constructed, pipeline transport is generally the most cost-effective means of transporting natural gas. For the continental U.S., this is generally true for domestic shipments, since the breakeven point between LNG and pipeline delivery is around 3000 miles. As liquefaction costs decrease, LNG delivery breakeven point with pipelines will decrease. LNG will also be more cost effective than pipelines at shorter distances.

Truck movements of LNG are known to occur for mainly economic reasons. For this reason, it is spikes in prices, capacity shortfalls, takeaway constraints, and constrained supplies that drive the movement of LNG by truck, not overall economies of price.

From Figure 4.16, LNG surface transport from a large, single-train LNG facility may be more economical than a pipeline. This depends upon whether or not a given pipeline is available, or can be built. Other factors, such as the possibility of substituting other fuels or the advantages of natural gas versus other fuels are important as well. Additional factors include short-term fluctuations in local pricing, because pipelines take time to construct. However, truck transport is more flexible as trucks can be dispatched quickly. So, when

supply and demand imbalances make local pipeline gas expensive, LNG delivered by truck can become competitive, even if more expensive than what might be possible were a pipeline to be built.

Natural gas movements are a function of price and delivery convenience. Truck and rail delivery are a “flexible and competitive complement to traditional pipeline transportation” for the transport to market from “remote locations not adequately served by pipelines.”³⁵

LNG is sourced because the LNG is the most economical, and competes with other fuel sources such as pipeline gas, propane, and diesel. If another fuel source were more economical to procure, the users could switch products. As long as a supply source is close enough that the cost to transport it and supply it is cheaper than other energy products, the LNG will move.

4.5.3 Competitiveness of LNG

A facility that is connected to the pipeline supply network may contract their natural gas through interruptible service contracts from the pipeline company. Peak demand periods, such as during cold winters and hot summers, can exceed pipeline capacity in some regions. To guarantee that service will not be curtailed during peak demand periods, firm service contracts reserve capacity that must be fulfilled except due to unforeseeable circumstances.³⁶ Interruptible contracts are lower priority than firm contracts, and flow can be stopped in order to serve the firm contracts, leaving the facility seeking alternative energy sources. Interruptible service is cheaper than firm service and prices paid for the gas are subject to the rise and fall of natural gas market.

Examples of regions not well served by pipelines include New England and the Mountain West. A major net-demand region, the Northeast, has become a net-supply region thanks to the Utica and Marcellus shale plays, which produce natural gas economically. The proximity of this supply region is close to a major market of the eastern seaboard. However, the existing pipeline network has limitations in pipeline capacity and directionality. For decades, natural gas has flowed into the Northeast from the Southwest, and now the Northeast is the fastest growing natural gas supply region. Projects already are underway to reverse the flow of pipelines so that the Northeast can provide supply to the Southeast and the Midwest. Additional pipeline capacity and flow reversals take time, and while they await permitting and construction, the Northeast is an example of a region experiencing capacity constraint. New pipelines also face increasing public opposition which further delays and sometimes prevents construction. This will reduce local prices of natural gas, driving investment into new infrastructure. Once the new infrastructure is in place, the price differentials between regions will reduce to the marginal cost of transport. Whenever the pricing differential has enough spread to cover the cost of transport, there is incentive to sell the product in another market. In the case of LNG, the price differential would have to be enough to cover the additional cost of liquefaction, storage, transportation, and regasification. LNG would have to compete with local prices for natural gas or for other fuel sources such as propane.

One of the LNG truck movements apparent from the EIA data was transport from Alabama to New Jersey, a 700 mile trip, one-way. This is a possible example possible price arbitrage, or a supply solution where pipeline construction is not possible or timely. Initial examination of truck rates show that truck delivery can range from \$0.4 to \$1 per MMBtu for this distance. Adding the costs of liquefaction, regasification, and storage, then the overall price of LNG delivery is \$2.00 to \$3.70 per MMBtu. That suggests that any time the

³⁵ Braziel, “The Domino Effect.”

³⁶ Energy Information Administration, “Natural gas power plants...”

spot price of natural gas in Alabama is \$4/MMBtu less than the spot price of natural gas in New Jersey, then transport via truck may be a viable option.

One of the LNG truck movements we identified from the EIA data was from a merchant plant in Alabama to a peak shaving facility in New Jersey. We examined this example because it is a long distance by truck, or over 700 miles one way. This is a good example of how the price differential between market hubs can influence transportation decisions for moving LNG. In this example, if the spot price of natural gas in Alabama is \$4/MMBtu less than the spot price of natural gas in New Jersey, then this large \$4/MMBtu price differential provides incentive for the merchant plant in Alabama to figure out how to move product to New Jersey. Even if the merchant plant sold it to the New Jersey peak shaving facility for a little less than the going rate, the merchant plant in Alabama can make money and the peak shaving facility in New Jersey can save money, so it is mutually beneficial. Also, if the price surge is temporary, there is not enough time to even consider adding a pipeline to fill the demand, the product must be shipped soon, and truck is the only option. All the merchant plant in Alabama has to do is figure out how to get natural gas to New Jersey for less than \$4/MMBtu. Initial examination of truck rates show that truck delivery can range from \$0.4 to \$1 per MMBtu. If you add on the costs of liquefaction, regasification, and storage, then the overall price of LNG delivery is \$2.00 to \$3.70 per MMBtu, which is less than \$4/MMBtu market price differential.

There are limits to how far natural gas can be moved economically via pipeline. Many researchers already have evaluated the economics of LNG shipment versus natural gas shipment. Given an alternative method for transport (such as truck or rail transport of LNG), price arbitrage becomes possible. Using information regarding LNG economics, and our knowledge of the LNG markets, the CS Team developed three scenarios for LNG transport, comparing cargo trailers to rail tank cars or ISO containers on flat cars. Over distances greater than 300 miles, rail transport of bulk materials becomes competitive with road, *provided that the shipments are not time sensitive.*

4.6 LNG Transportation Scenarios

In this section, the CS Team evaluated the movements of LNG by bulk rail, truck, and intermodal delivery to determine which method would be most economical. This was an economic case study, not a risk case study. More information on the quantitative risk assessment (QRA) can be found in Chapter 5. To conduct the case study, the CS Team developed several scenarios to detail Interstate LNG shipment costs by mode. Using information from multiple sources, The CS Team estimated the costs of shipment, and represented how shippers could economically evaluate and view the transportation modes when the pipeline delivery is not feasible or possibly not preferred. Though not presuming to be the method by which such decisions are actually made, the scenarios illustrate the competitive nature between transportation modes.

4.6.1 Methodology

Assuming that pipeline delivery of natural gas is either not an option due to capacity shortfall or a stranded market, this economic model compares the economics of a truck delivery of LNG with two alternative rail deliveries. This economic model, along with industry input, hypothesizes that rail can be economically competitive in some origin-destination scenarios.

First, we identified the parameters in which rail would be a competitive choice based on possible routes for LNG if allowed by rail. This is a start to developing certain parameters to the risk model. Industry input on the logistics of LNG by rail confirms that the ISO container form of delivery would provide conveniences that would enable faster transport, and could be a preferred rail container in scenarios that may involve drayage

movements. Certain rail routes that do not require drayage are favorable for bulk liquid transfer directly to a facility or storage unit. The process of transferring LNG between tanks at a bulk liquid transfer facility requires special equipment that can handle the cryogenic temperatures, and workers trained in the safe handling of cryogenic liquids.

To understand the costs of transporting LNG by truck, portable container, and rail, the CS Team investigated one of the Interstate movements in the EIA data between a natural gas processing facility in western Pennsylvania and a power plant in Worcester, MA. This was a deliberate choice for such scenarios, since western Pennsylvania is in the productive Marcellus and Utica Shale region, and Massachusetts is an area in New England with high natural gas demand.

The shippers' cost for this proposed movement was analyzed in three scenarios. Scenario one is the movement of the natural gas in liquefied form by truck, in a MC-338 cryogenic tank trailer. This is the only scenario that currently is legally available without a special permit. Scenario two is the movement of the LNG by intermodal container. In this scenario, the LNG is loaded into an ISO container, which is placed on a railcar at the facility, moved by rail to an intermodal facility in Ayer, MA and then trucked the remaining 35 miles to the power plant in nearby Worcester, MA. Scenario three is the movement of the LNG by bulk railroad tank car. In this scenario, the LNG is loaded into a DOT 113C120W railcar, and moved by rail to Worcester, MA. Once in Worcester, MA, the material could be delivered to the power plant if a rail spur goes to the power plant. However, since it is less likely that power plants will be able to add rail lines in densely populated areas, it is assumed that the material would go to the bulk liquid transfer facility in Worcester, be transferred to MC-338 truck trailers, and then delivered to the power plant. The summary of these scenarios is shown in Table 4.4 and a map of the scenario routes is in Figure 4.17.

Table 4.4 Truck, Railroad and Intermodal LNG Transport Options

Scenario	Mode 1	Mode 2	Mode 3
1a—Truck	Truck (MC-338)	–	–
1b—Truck	Truck (ISO)	–	–
2—Intermodal	Truck (ISO)	Rail (ISO)	Truck (ISO)
3a—Rail	Rail (DOT-113C120W)		
3b—Rail	Truck (MC-338)	Rail (DOT-113C120W)	Truck (MC-338)

Source: Cambridge Systematics

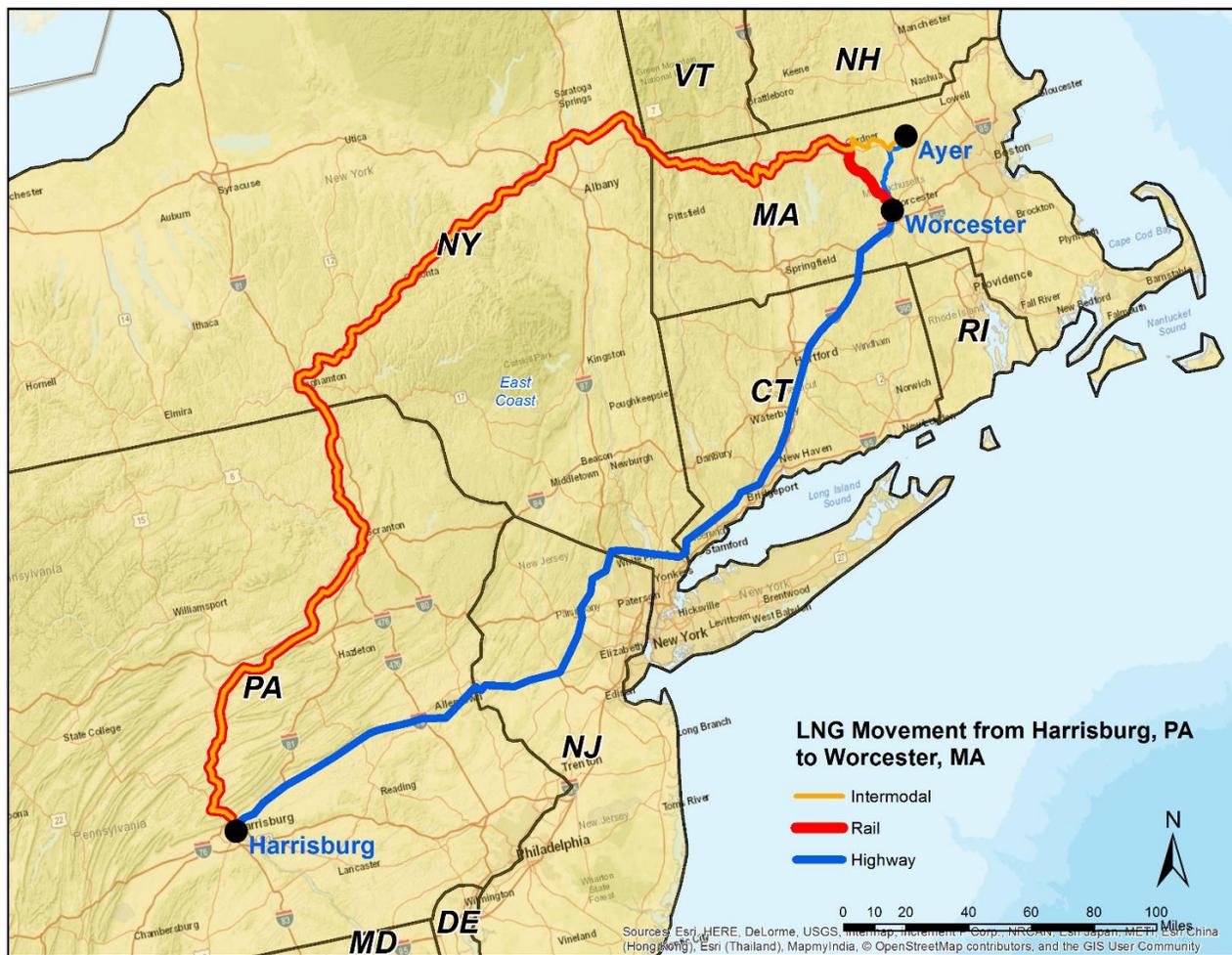


Figure 4.17 Pennsylvania to Massachusetts Routes
By Mode

Source: Cambridge Systematics.

4.6.2 Scenario 1: Pennsylvania to Massachusetts by Highway

Scenario 1 assumes 72,041 MCF of natural gas is transported from Harrisburg, PA to Worcester, MA. The highway route, shown in 4.17 has a trip length of 353 miles. Scenario 1a assumes that the LNG would be shipped in a MC-338 truck trailer, and Scenario 1b assumes that the LNG would be shipped in an intermodal ISO container.

A MC-338 cryogenic tank trailer has a gross capacity of about 12,700 gallons, depending on the manufacturer. Most Interstate highways have a weight limit of 80,000 lbs. GVWR. The truck tractor is typically between 15,000 and 20,000 pounds. Assuming a 16,500-pound tractor weight, and an empty trailer weight of 25,200 pounds, the net allowable payload of LNG would be 38,300 pounds or effectively 10,943 gallons at 3.5 pounds per gallon of LNG.³⁷ Since the volume that can be carried by the truck is limited by the weight limit, the delivery of LNG by truck “weighs out” before it “sizes out.” Truck volumes are limited by weight, not the volume or capacity of the container.

³⁷ Chart Model ST-12700 MC-338 LNG trailer—12,700 gallons gross volume.

An intermodal ISO container has more weight in the trailer due to the need to have a chassis. A chassis could weigh between 5,500 to 8,000 pounds. Assuming a 6,500 chassis weight, a 23,500-pound empty ISO container weight, and the same tractor weight and gross vehicle weight limit as Scenario 1a—16,500 pounds and 80,000 pounds, respectively—the available payload weight would be 33,500 pounds. Although some ISO containers are being built up to 12,200 gallons gross volume, at 3.5 pounds per gallon of LNG, the capacity of an ISO container by highway weighs out at 9,571 gallons of LNG.

At a distance of 353 miles and cost of \$0.114 per ton mile, the total cost to move 72,041 MCF of natural gas by truck is estimated to be \$61,651 by MC-338 and \$61,339 by ISO container. The details of the calculation assumptions are shown in Table 4.5. Even though the MC-338 cargo tank can carry more LNG per vehicle than the ISO container, the overall cost difference is a negligible 0.5 percent. For this scenario, the user would choose the most convenient option, depending on the availability, purchase price, leasing costs, and supply chain fluidity of the containers. For example, ISO containers are easily offloaded and can function as short-term storage, but the opportunity costs of occupying an ISO container would have to be examined. Similarly, a MC-338 trailer could be disconnected from the tractor, with similar opportunity costs for an idle piece of transportation equipment. In a direct truck movement, the benefits between the containers would be dependent on the individual situation and needs of the shipper and receiver. These externalities are not represented in the cost model.

Table 4.5 Scenario 1: Pennsylvania to Massachusetts
By Highway

	Constant Properties	Scenario 1a Highway (MC-338)	Scenario 1b Highway (ISO)
MCF of Natural Gas per gallon of LNG	0.0826		
MMBtu per gallon of LNG	0.082644		
Pounds per gallon of LNG	3.5		
Volume of Natural Gas, MCF	72,041		
Volume of LNG, gallons	872,167		
Container/Tank Gross Capacity, gallons		12,700	12,200
Payload Weight Limit, pounds		38,300	33,500
Payload Weight Limit, tons		19.15	16.75
Payload Volume Limit, gallons		10,943	9,571
Payload Energy Content, MMBtu		904	791
Number of Trucks		80	91
Miles per trip	353		
Truck Miles		28,240	32,123
Ton Miles		540,796	538,060
Cost per Ton Mile	0.114 ¹		
Total Cost		\$61,494	\$61,183
Highway Unit Cost		\$769	\$672
Cost per MMBtu		\$0.85	\$0.85

Note: One Thousand Cubic Feet, MCF. Million British Thermal Units, MMBtu. Tons are in U.S. short-tons, 2,000 pounds per ton.

¹ National Van Rates 13-month average; dat.com.

4.6.3 Scenario 2: Pennsylvania to Massachusetts by Intermodal Container

The second scenario would involve an intermodal container on a rail flat car from Pennsylvania to Massachusetts using Norfolk Southern (NS) routes. Knowing that railroad interchange fees can be approximately \$600 per railcar, the route chosen avoids any such interchanges, and stays on NS, NS shipping partners, and NS joint venture routes. If the ISO containers were only being shipped by rail, they would “size out” before they “weighed out,” and the volume and filling density of the container would determine the amount of LNG per payload. However, since the ISO container would still travel by highway at some point, it is assumed that the containers would weigh out with the same properties as in Scenario 1. Scenario 2 differs in that the route that is traveled is different and that the container will be moved between a truck chassis and a rail flat car, twice. The 91 ISO containers, each containing 9,571 gallons would be transported 507 miles by rail and 35 miles by truck at an average cost of \$0.066 per ton mile for a total of \$54,752 as shown in Table 4.6. This total cost is 11 percent less than the cost by highway alone. With the lower cost, comes higher transport times. Highway delivery is fast and direct, rail delivery is circuitous and lengthy. Unit trains with high volume of a single commodity often can demand better rail service schedules, but a small number of cars would be shipped by manifest train, which makes frequent stops, and takes longer. The scenarios that we are looking represent an entire year’s worth of volume. It is unknown right now if the movement occurred in a single batch, or in smaller batches throughout the year. It is hard to say if the rail delivery of LNG would benefit from unit train service priority.

Table 4.6 Scenario 2: Pennsylvania to Massachusetts by Intermodal Container

	Constant Properties	Scenario 2
MCF of Natural Gas per gallon of LNG	0.0826	
MMBtu per gallon of LNG	0.082644	
Pounds per gallon of LNG	3.5	
Volume of Natural Gas, MCF	72,041	
Volume of LNG, gallons	872,167	
Container/Tank Gross Capacity, gallons		12,200
Payload Weight Limit, pounds		33,500
Payload Weight Limit, tons		16.75
Payload Volume Limit, gallons		9,571
Payload Energy Content, MMBtu		791
Number of ISO Containers		91
Miles per trip, highway	35	
Miles per trip, rail	507	
Highway Ton Miles		53,349
Rail Ton Miles		772,490
Total Ton Miles		825,839
Cost per Ton Mile, highway	0.1137 ¹	
Cost per Ton Mile, rail	0.063 ²	

Table 4.6 Scenario 2: Pennsylvania to Massachusetts by Intermodal Container (continuation)

	Constant Properties	Scenario 2
Total Cost		\$54,733
Rail percent of Costs		89%
Intermodal Unit Cost		\$601
Overall Cost per Ton Mile		\$0.066
Cost per MMBtu		\$0.76

Source: Cambridge Systematics

Note: Million Cubic Feet, MCF. Million British Thermal Units, MMBtu. Tons are in U.S. short-tons, 2,000 pounds per ton.

¹ National Van Rates 13-month average; dat.com.

² CS assumption based on review of STB rail line haul rates and estimated lift and drayage costs in Northeast U.S.

4.6.4 Scenario 3: Pennsylvania to Massachusetts by Rail

The third scenario would involve a bulk liquid rail car from Pennsylvania to Massachusetts using Norfolk Southern (NS) routes. Similar to Scenario 2, the route chosen avoids any interchanges, and assumes NS shipping partners, and NS joint venture routes. It also is assumed that a DOT-113C120W railcar would be used to transport LNG. Chart Industries has optimized the design of rail tank car that fits within the Plate 'C' clearance envelope for tracks in North America. The inner tank has a volume 34,500 gross gallons and can hold 30,680 gallons of LNG based on the 49 CFR 173.319(d) maximum allowed filling density. This volume of LNG would weigh 15.34 tons, and even when, including the weight of the empty car, a loaded car is well below the 263 kip railcar limits.³⁸ Therefore, weight is not an issue with LNG on the rail and the container "sizes out" before it "weighs out."³⁹

The rail route in Scenario 3 differs from Scenario 2 in that rail is employed to the final destination, with a minimal distance by truck, if any. If the power plant did not have rail spur leading to the facility, then the shipment could be shipped to the Bulk Liquid Transload facility in Worcester, which would require a short drayage. In Scenario 3, a total of 28 rail cars, each containing 30,680 gallons of LNG would be transported 467.6 miles by rail, before being transloaded into 80 trucks for 10 miles at an average cost of \$0.064 per ton mile for a total of \$46,028 as shown in Table 4.7. This total cost is 25 percent less than the cost by highway alone, and 16 percent less than the cost of intermodal delivery. However, with the lower cost comes longer transport times. As we explained in Scenario 2, highway delivery is fast and direct while rail delivery can be more circuitous and therefore extend delivery times. Intermodal delivery is known to be generally faster than bulk rail shipments, but this would depend on several factors, including economies of scale, such as unit versus manifest trains. Rail delivery would be the cheapest delivery in terms of direct costs, but the estimate does not capture the costs of labor for transferring the liquid between the tank cars and truck trailers. If the railroad operator is able to drop off the commodity directly to the power plant, then theoretically the double

³⁸ 286,000 lbs. is the modern weight specifications for rail lines, which equates to about a 110 ton car. 263,000 is the minimum weight limit for most of the country's rail lines, which equates to about a 100 ton car.

³⁹ Chart Industries, Call with Scott Nason, November 2017.

handling of the material could be avoided. Otherwise, it can be assumed that there would be some extra time and cost necessary for a bulk liquid transload.

Table 4.7 Scenario 3: Pennsylvania to Massachusetts
By Rail

	Constant Properties	Scenario 3
MCF of Natural Gas per gallon of LNG	0.0826	
MMBtu per gallon of LNG	0.082644	
Pounds per gallon of LNG	3.5	
Volume of Natural Gas, MCF	72,041	
Volume of LNG, gallons	872,167	
Container/Tank Gross Capacity, gallons		34,500
Payload Volume Limit, gallons		30,680
Payload Weight Limit, pounds		107,380
Payload Weight Limit, tons		54
Payload Energy Content, MMBtu		2,536
Number of Tank cars		28
Number of Trucks (10,943 gallons or 19.15 tons each)		80
Miles per trip, rail	467.6	
Miles per trip, highway	10	
Rail Ton Miles		702,952
Truck Ton Miles		15,320
Total Ton Miles		718,272
Cost per Ton Mile, rail	0.063 ¹	
Cost per Ton Mile, highway	0.1137 ²	
Interchange Fee per railcar	\$600	
Number of interchanges	0	
Total Cost		\$46,098
Rail percent of Costs		96%
Rail Tank Car Unit Cost		\$1,584
Overall Cost per Ton Mile		\$0.064
Cost per MMBtu		\$0.64

Source: Cambridge Systematics

Note: Million Cubic Feet, MCF. Million British Thermal Units, MMBtu. Tons are in U.S. short-tons, 2,000 pounds per ton.

¹ CS assumption based on review of STB rail line haul rates and estimated lift and drayage costs in Northeast U.S.

² National Van Rates 13-month average; dat.com.

In addition to the variable costs of transportation, LNG delivery also incurs fixed costs associated with liquefaction, storage, and gasification. The most expensive component in the LNG supply chain is the

liquefaction plant, and the costs for liquefaction depend on the size of the facility. Larger facilities generally are able to reduce the cost of liquefaction due to economies of scale and more advanced equipment that has less waste. All three scenarios are summarized in Table 4.8, along with the assumed fixed costs of liquefaction, gasification, and storage.

Table 4.8 Pennsylvania to Massachusetts LNG Cost Scenarios

Scenario	Mode 1	Mode 2	Mode 3	Cost	Transport. Cost per MMBtu	Liquefaction, Gasification, and Storage Costs per MMBtu ⁴⁰	Total Cost per MMBtu
1a—Truck	Truck (MC-338)	–	–	\$61,494	\$0.85	\$4.52	\$5.37
1b—Truck	Truck (ISO)	–	–	\$61,183	\$0.85	\$4.52	\$5.37
2—Intermodal	Truck (ISO)	Rail (ISO)	Truck (ISO)	\$54,733	\$0.76	\$4.52	\$5.28
3—Rail	Rail (DOT- 113C120W)	Truck (MC-338)		\$46,098	\$0.64	\$4.52	\$5.16

Source: Cambridge Systematics Inc.; NS; Chart Industries.

The three examples illustrate some of the challenges involved with shipping LNG over long distances, and the need to involve multiple modes of transport. Overall, portable ISO containers prove to be the most versatile mode of LNG transport given the variables discussed in these scenarios. Rail delivery would be the cheapest delivery in terms of direct costs, but the estimate does not capture the costs of labor for transferring the liquid between the tank cars and truck trailers. As long as the overall cost of LNG is less than the price differential, then it could be more cost effective to transport the natural gas by LNG rather than by pipeline.

4.7 Future LNG Railroad Transportation

Because, if approved, rail transport would be an alternative to truck for surface transport of LNG, Figure 4.18 shows the routes that may be used if volumes of LNG similar to those currently moved by truck were moved by rail. Lacking the details of the specific origin and destinations of these Interstate movements, the CS Team used State centroids, and developed a hypothetical routing of LNG rail delivery across the country. This is not intended to be accurate, but rather to illustrate how rail shipments may be used to supplement or replace existing truck shipments should rail shipments of LNG be allowed in the HMR.

⁴⁰ ETSAP, “Oil and Natural Gas Logistics.”

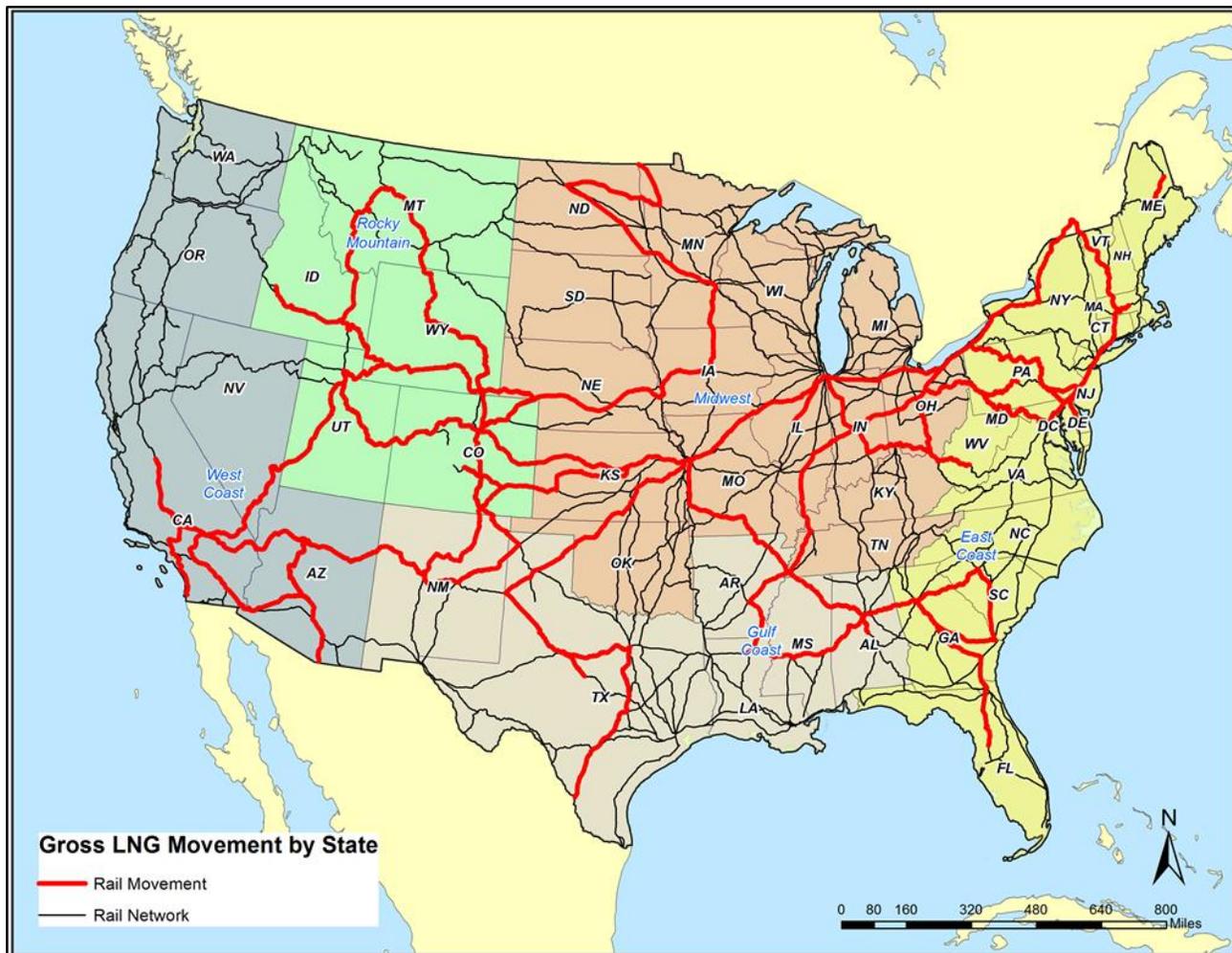


Figure 4.18 (Illustrative Only) Gross Rail LNG Movements by State

Source: Energy Information Administration; Cambridge Systematics, Inc.

These LNG truck movements represent bulk deliveries of natural gas, not in-transit usage as propulsion. The end user could be using the gas for electric power, heat, industrial use, or propulsion. LNG is being transported by truck for distances that per literature would be more effective by pipeline because the destination found it to be the most economical choice. This could be because the local supply prices spiked during a supply shortage, or because the destination is not connected to the pipeline network anyway. If not connected to the network, the destination user could be using LNG to compete with other fuel sources such as propane or diesel. Truck delivery will likely continue until the price differential is less than the marginal costs of transportation. Examples include: 1) pipelines may be in the proposal and permitting process, 2) the region could not have the volumes to justify a pipeline, or 3) a pipeline may not be feasible for geographical, environmental, or political reasons. If the volume is enough to justify a pipeline, then rail might be a more viable option considering its greater capacity over truck. If the volume would not be enough to justify a unit train, than a manifest train would not provide the same level of service, making it difficult to compete with the convenience of truck delivery.

Eventually, the market will find the most economical solution, whether that is an alternative fuel source or an alternative mode of delivery. Until then, price differentials govern the decisions that the consumers make.

Natural gas movements are a function of price and delivery convenience. Truck and rail delivery are a “flexible and competitive complement to traditional pipeline transportation” for the transport to market from “remote locations not adequately served by pipelines.” Natural gas delivered by rail would be slower than truck delivery, unless enough natural gas were delivered at once to build a unit train. Unit trains are treated with higher priority than manifest trains. This comes with additional risk, which will be discussed in Part 2. Natural gas delivered by rail and trucks provide more flexibility in their networks ability to access multiple delivery destinations across the country—pipelines are constrained in their access and delivery points.

Different than the development of non-pipeline crude oil rail deliveries, natural gas comes from many sources. Natural gas comes from many suppliers, and goes to even more users. There is enough natural gas supply and demand spread out across the country, and nearly all of it is transported by pipeline. It is hard to predict if rail delivery can compete with the convenience and speed of truck delivery. “Whenever production exceeds pipeline capacity, the railroads can step in. Whenever new production has to wait for a pipe, it will travel by rail. Whenever markets are disrupted by pipeline congestion, railroads will step in to bypass the tangle. In remote plays where there are no pipelines at all, railroads will be the primary transportation mode.”⁴¹ This is true except if rail delivery is not allowed. In that case, truck or vessel is the only other option.

⁴¹ Braziel, “The Domino Effect.”

5.0 Quantitative Risk Assessment

5.1 Introduction

In the context of this study, Quantitative Risk Assessment (QRA) is used to determine risks associated with LNG transport and handling by surface modes, with an emphasis on rail. QRAs are used to demonstrate the risk caused by the activity and to provide authorities with information needed to make decisions about the level of risk acceptable for site developments or transportation routes.⁴² This section describes the QRA history and process, understanding risk, examples of LNG Modeling and the factors and parameters required to construct the LNG Risk Model.

Over the years, researchers have noted considerable variation in the outcomes of the QRA studies. Numerical differences of two to three orders of magnitude are not uncommon, and also rankings between different scenarios often showed large differences. The inherent variability also found in hazard identification techniques, an essential building block for QRA, adds to the unreliable nature of QRA. While QRA techniques ultimately lead to the development of better decisions and safer systems, it must be understood that QRA is only as good as the data and assumptions contained within the process. The validity of particular instances of QRA should be accompanied by scientific confirmation of these claims which help to overcome doubts and criticisms about QRA efficacy.⁴³

With this in mind, QRA relies on an estimation of the probability and consequences of a release incident. The CS Team focused on parameters and factors to model the derailment and release probability of LNG rail cars to account for a variety of track and train characteristics. The probability will help to address the likelihood of a release per shipment and resulting hazards to the public in the event of a derailment or other incident. When the probability of LNG tank car derailment is understood, better decisions can be made regarding the crashworthiness, placement, and operation of rail cars and the potential consequences from an LNG release due to a derailment.

5.2 National Fire Protection Administration (NFPA) 59A Protocols

The NFPA has been involved in LNG emergency response for many years. This began primarily with fire protection for LNG facilities constructed in the U.S. in the 1970s, during which time maritime LNG specifications were also developed. Work on the NFPA 59 Standard began in 1960 and the first edition was adopted in 1967 (see Figure 5.1). Recommendations for QRA of LNG plants were issued in the National Fire Protection Association (NFPA) standard, NFPA 59A Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG), 2015.

⁴² Uijt de Haag et al., *The 'Purple Book...'*

⁴³ Cornwell and Meyer, "Risk Acceptance Criteria..."

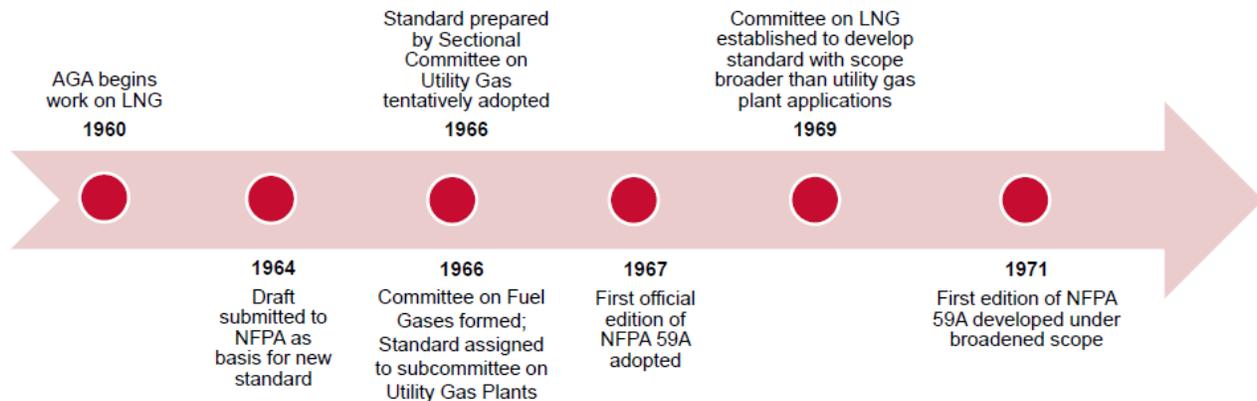


Figure 5.1 NFPA 59A Timeline

Source: National Fire Protection Association, *NFPA 59A: Standard for the Production...*

According to the NFPA 59A (2016 version), the generally accepted QRA techniques and protocols are described in the following publications:

1. Center for Chemical Process Safety’s “Guidelines for Chemical Process Quantitative Risk Analysis”.
2. Health and Safety Executive’s “Five Steps to Risk Assessment”.
3. Health and Safety Executive’s “Risk Criteria for Land-use Planning in the Vicinity of Major Industrial Hazards”.
4. *Risk Management. Risk Assessment Techniques*. European Standard: BS EN 31010:2010.
5. *The ‘Purple Book’: Guideline for Quantitative Risk Assessment in the Netherlands*.

The CS Team reviewed these documents as part of this study to assess applicable QRA elements for the LNG QRA process. While the literature varies between facility and transport risks, the assumptions, parameters and factors used can be applied to this study effort where applicable.

Contained in the NFPA 59A guidance are descriptions of the terms “individual risk” and “societal risk.” These terms have also been defined in Great Britain in the Health and Safety Executive Societal Risk Technical Advisory Group made up of academic, industry and Government specialists. This group has advised HSE and departments over the years on matters relating to societal risk methodology and presents the technical issues which need to be resolved prior to the development and implementation of any system for explicit attention to societal publications. HSE publications have been referenced throughout this report.

5.2.1 Individual Risk

Individual Risk (IR) is defined by HSE (1995) as “the risk of some specified event or agent harming a statistical (or hypothetical) person assumed to have representative characteristics.” The ‘specified event or agent’ may be defined as fatality, injury, or exposure to a defined level of blast overpressure, thermal radiation or dose of toxic material.

NFPA 59A describes IR as “the frequency, expressed in number of realizations per year, at which an individual, with continuous potential exposure, may be expected to sustain a serious or fatal injury.” IR is defined in NFPA-59A as “acceptable IR fatality probabilities” ranging from 10^{-4} yr⁻¹ (or a fatality per 10,000 years) to 10^{-8} yr⁻¹ (or a fatality per 100,000,000 years). This range is known as ALARP “as low as reasonably practicable.”

5.2.2 Societal Risk

Societal Risk is defined in NFPA 59A as “the cumulative risk exposure by all persons sustaining serious or fatal injury from an event in the LNG plant.” Note NFPA 59A explicitly applies to LNG plants and stationary facilities; it does not apply to LNG transportation or portable LNG containers. Thus, the quantitative risk criteria proposed in the standard are not directly applicable to rail shipping of LNG. However, these risk criteria are discussed here as one potential basis for quantitative risk criteria for rail shipping of LNG.⁴⁴

In the Exponent Report for FECR, the PHAST Risk v6.7 tool was used to model the consequences of potential releases and to calculate the resulting Individual Risk (IR) and Societal Risk (SR) for the FECR mainline and yard/intermodal facilities.

Exponent points out in their report that FRA has not codified quantitative risk criteria for LNG hazardous materials transportation scenarios. Additionally, QRA analyses are not common regulatory requirements in the U.S. and no broadly accepted risk criteria are employed by domestic communities or industries. Therefore, Exponent used LPG instead of LNG as a benchmark for calculated risk since accident rates and hole size probabilities in accidents are considered independent of the hazmat commodity shipped.⁴⁵

The risk criteria presented in NFPA 59A are summarized in the following Table 5.1 and in Figure 5.2.

Table 5.1 Summary of IR and SR Quantitative Risk Criteria

IR Criteria (yr ⁻¹)	SR Criteria
Zone 1: IR ≥ 10 ⁻⁵	Unacceptable Risks
Zone 2: 10 ⁻⁶ ≤ IR < 10 ⁻⁵	ALARP: (Region between curves)
Zone 3: 3 x 10 ⁻⁷ ≤ IR < 10 ⁻⁶	Tolerable Risks

Source: National Fire Protection Association, *NFPA 59A: Standard for the Production...*

⁴⁴ National Fire Protection Association, *NFPA 59A: Standard for the Production...*

⁴⁵ Hart and Morrison, *Bulk Transport by Road and Rail*

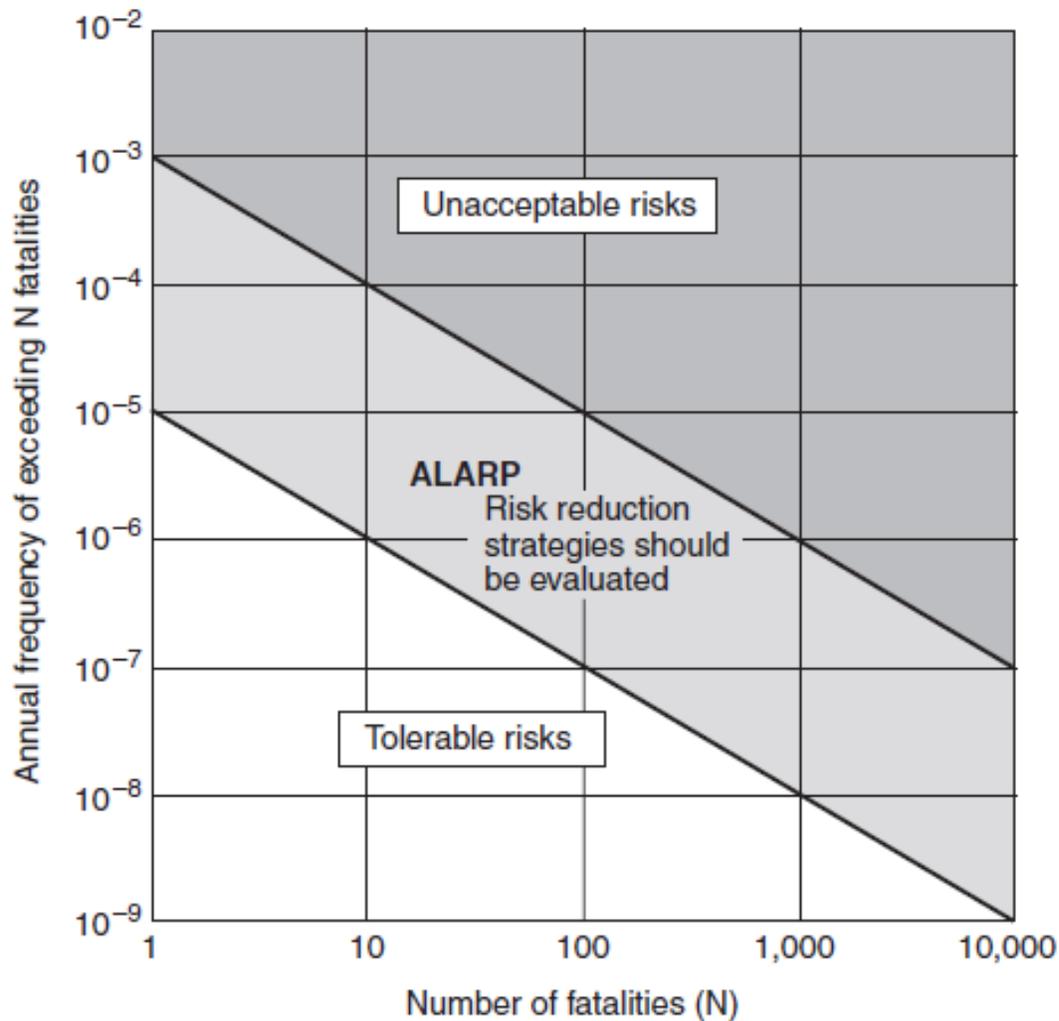


Figure 5.2 Acceptability Regions of Societal (Injuries) Risk in the F-N Domain

Source: National Fire Protection Association, NFPA 59A: Standard for the Production

5.3 Understanding Risk

Risk analysis is a key feature of modern decision-making, for both Government and industry. While not yet mandated by Government regulations, quantitative risk analysis is an increasingly preferred method of hazard evaluation based on numerical estimation of incident frequency and consequences. With regard to assessing hazmat risks, the range of QRA concepts is very broad, given the complexities of hazmat transport and the number of stakeholders involved.

The QRA process requires failure and event data. However, limited reliability or failure rate data has been collected for the equipment in the LNG industry. Usually failure rate data from nuclear, oil and gas industry are borrowed for reliability studies and risk assessment of the LNG facility. Risk modeling techniques include high-level approaches to risk assessment and modeling.⁴⁶

⁴⁶ Texas A&M University, May Kay Center.

The literature discusses a variety of initial or governing approaches to risk. Some models take the form of data-driven risk assessments; other models combine risk analysis with route choice. Additionally, economic risk analysis models in some situations are used to determine the costs of certain decisions based on risk.

An important component of QRA is the risk criteria used to define risk. There are several foreign and several domestic examples of quantitative risk criteria. However, there is a significant disparity in risk criteria for public exposure.

Currently, the U.S. Department of Transportation (DOT) Federal Railroad Administration (FRA) has not codified quantitative risk criteria for LNG hazardous materials transportation. Additionally, QRA analyses are not common regulatory requirements in the U.S. and no broadly accepted risk criteria are employed by domestic communities or industries. Nevertheless, this study contributes to the body of knowledge required to better assess LNG risks with regard to surface transport. The Dutch Government and their respective regulatory agencies have been international leaders in utilizing QRA techniques for determining acceptability of fixed facilities and transportation routes. Therefore, the Dutch “Guidelines for Quantitative Risk Assessment,” (known as the Purple Book) Netherlands, 2005 was used as an important reference for this research.

5.4 QRA Uses in Industry and Government

QRA is used to assess risks throughout industries, including chemical production, oil and gas processing plants, power generation plants, and manufacturing companies. In addition, U.S. Government agencies have developed QRA techniques to quantify hazmat transportation and storage risks, determine route and mode choices and identify the most appropriate packaging solutions. This section identifies how selected U.S. industries and agencies use QRA.

Chemical and manufacturing companies evaluate the risk to human health and the environment from an accident or chemical release during loading and transporting their products. Risk analysis and management is becoming increasingly important to the process industry to meet safety criteria and regulations. QRA is used to determine mode and route choice, packaging selection, application of security measures, manufacturing locations, and emergency response resource planning.

The **Railway Supply Institute (RSI)** and the **AAR** perform research and analyses that support hazmat transportation risk assessment. To meet the Federal regulatory requirements of 49 CFR 172.800—Additional Planning Requirements for Transportation by Rail, AAR developed RCRMS which allows rail operators to consider the 27 required risk factors, including network infrastructure characteristics, railroad operating characteristics, human factors, and environmental and terrorist-related parameters.

The **Environmental Protection Agency** uses an Ecological Risk Assessment Framework to address risk from the transportation and storage of hazardous materials. The EPA’s framework is used as a guide to create six steps that can be used to assess the risk of transporting and storing hazardous materials. The steps are 1) evaluate the area for the risk assessment; 2) identify transportation routes and storage site; 3) identified heavily shipped and stored hazardous materials; 4) identify types of releases and possible outcomes; 5) determine risk; and 6) draw conclusions and make recommendations.

FMCSA has decision-making processes that consider risk assessments which are driven by issues conveyed by external parties or through observations from field investigators. Implementation of the Compliance, Safety, Accountability (CSA) program and the Safety Measurement System (SMS) for measuring the safety of motor carriers and commercial motor vehicle drivers collectively take the place of a risk assessment tool.

FRA uses risk assessment to help identify potential risk reduction strategies, including those that consider route choice, packaging selection, application of security measures, operational changes, research prioritization, and inspection and enforcement prioritization. Its focus is on research prioritization. For rail risk, the likelihood of an accident is not considered to be a hazmat-specific factor. FRA focuses on the factors that affect the probability that the package will be involved in a derailment or a major accident and the probability that it will be damaged or punctured and release the product.

PHMSA (OHMS). For most risk assessments performed by PHMSA, a separate analysis process is used, based on the specifics of the analysis and the available data. Their resource allocation is similar to FMCSA’s Comprehensive Safety Analysis model. Data on prior incidents, inspections, violations, and complaints are used to assess the safety risks for specific companies. Other factors include the types of materials, quantities handled, and the size of the company.

PHMSA (OPS) does not conduct risk assessments but oversees the individual pipeline operators who are required to ensure the safety, integrity, and reliability of their own pipelines. The Pipeline Risk Management Manual is the industry standard methodology for conducting pipeline risk assessments. A key data source is the PHMSA database of pipeline incidents and accidents.⁴⁷

5.5 Quantitative Risk Analysis Methodology

In a QRA both the frequencies of events and their consequences are quantified, using different techniques. QRA methodologies contains some differences, however, there are many examples in technical literature available.⁴⁸ Typically, a QRA will consist of the following steps (Table 5.2):⁴⁹

Table 5.2 Quantitative Risk Assessment (QRA) Steps

Steps	Description
1	Identify the hazards.
2	Summarize hazard identification study findings as set of scenarios to be modeled.
3	Estimate release rates and duration, and quantities of materials involved.
4	Estimate release consequences in terms of an area, inside which a specified level of harm will be met or exceeded.
5	Define mitigation effects (such as shelter-in-place).
6	Define release consequence in a measure of harm (injury or fatality) to individual or population.
7	Estimate event frequency (such as loss of containment).
8	Calculate probabilities and frequencies to determine numerical risk estimates.

Sources: Center for Chemical Process Safety; Exponent Inc.; *The ‘Purple Book’*; European Standards; Cambridge Systematics, Inc.

Steps 1 through 3 help to identify scenarios for modeling, together with the necessary data to compute frequencies and consequences. This process is not normally capable of automation. These scenarios should

⁴⁷ Transportation Research Board, *Hazardous Materials Transportation...*

⁴⁸ Refer to the list on Section 5.2 for examples.

⁴⁹ Health and Safety Executive, “Application of QRA...”

be conducted by an experienced analyst or team of analysts. Step 4, however, usually involves modeling of vapor dispersion, pool fires or explosion effects. In some cases these calculations can be performed by hand or with the aid of spreadsheets, although use of computerized models is common, and recommended for this level of analysis on a case by case basis. In simple cases, where the set of scenarios to be considered is small, Steps 5 to 8 can be performed by hand or using spreadsheets. However, it is more usual to employ risk calculation software. It is possible to produce different types of numerical risk estimate at Step 8, depending on the purpose of the QRA study.

6.0 Rail LNG Risk Assessment

6.1 Methodology

This section describes the proposed methods for developing a rail LNG quantitative risk assessment (QRA). It includes descriptions of event and fault tree analyses, the event tree diagram, and the factors and parameters required to complete the QRA.

Several methods used to estimate the frequency and consequences of hazmat release incidents are known as logical diagram-based techniques. These include Fault Tree Analysis (FTA) and Event Tree Analysis (ETA). Fault trees lay out relationships among events, whereas event trees lay out sequences of events linked by conditional probabilities.

6.1.1 Fault Tree Analysis (FTA)

Fault tree analysis permits the hazardous incident (top event in the diagram) frequency to be estimated from a logic model of the failure mechanisms of a system. FTA is a top-down analysis tool used to identify event causes and to quantify accident scenarios that would result in system failure. FTA is used in the aerospace, nuclear power, chemical and process, pharmaceutical, petrochemical, and other high-hazard industries. The model is based on the combinations of potential failures, including more basic system components, safety systems, and human reliability. A basic assumption of FTA is that all failures in a system are binary in nature; that is, a component or operator either performs successfully or fails completely. In addition, the system is assumed to be capable of performing its task if all subcomponents are working.⁵⁰ The tool starts with an identified hazard (in this case an LNG, release due to a truck or train accident) at the top of the diagram (or top event) and works backward to determine possible causes (such as derailment, loose valves, etc.) using two logical functions: OR and AND. This method relies on a combination of sufficient historical data or expert judgments.

6.1.2 Event Tree Analysis (ETA)

Unlike the “top-down” FTA approach, ETA is a forward, “bottom-up” logical modeling technique. This analysis technique is used to analyze the effects of functioning or failed systems when an event has occurred. ETA is a powerful tool that identifies all consequences of a system that has a probability of occurring after an initiating event. As a starting point, a system-affecting event is identified, such as a derailment, and the analysis tracks additional events as “branches” of the larger “tree.” Each outcome of a branch is usually binary, meaning the outcome either occurs or does not occur. Probability is assigned to each branch to determine the overall outcome. This method calculates the accident probability of all resulting events with the probability of each event, comparing their probability value and obtaining the possibility of accident sequence. Sometimes FTA and ETA are used in conjunction to identify and quantify possible consequences of the top event in the Fault Tree.

Quantitative analysis in the ETA has been used by researchers to determine the occurrence probability of an accident.⁵¹ In this study, the CS Team examined the ETA modeling technique as a sequence of events illustrated by the Event Tree Diagram (ETD).

⁵⁰ Claudio, *Safety Guidelines...*

⁵¹ Tang et al., “A Quantitative Risk Analysis...”

6.2 Describing Risk in the Rail Event Chain Diagram

The harmful exposure of people or property to a hazardous material can be evaluated through a series of events in an **event chain diagram**. Each event is probabilistic, in the sense that its occurrence is not certain, given that the prior event in the chain has taken place: one can only assign a probability to its occurrence. This also is true of the first event in the chain, the occurrence of a train accident.⁵²

The events in the event chain that must be evaluated to perform the QRA, from beginning (accident occurs) to end (a potential fatality), are described in Table 6.1, below. Within each of these events, there are factors and parameters required to fully understand the probabilities.

Table 6.1 Rail Event Chain Factors and Parameters

Event	Factors and Parameters
Accident	In order for the identified consequence to occur, a vessel containing LNG must first be involved in an accident. The likelihood of an accident involving the LNG rail car or ISO is estimated.
Number of Cars Derailed	The number of cars derailed can also be described as derailment severity, which is measured by the number of cars derailed after a train derailment. Influencing factors include speed, accident cause, train length and other factors.
Number of Hazmat Cars Derailed	The probability of the number of hazmat cars derailed is measured by evaluating factors such as the number of hazmat cars per train, train length and the placement of hazmat cars in the train consist. The probability of the number of hazmat cars derailed changes between manifest trains and unit trains.
Hazmat Cars Release Some of All of Contents	The term describing single car release is called the Conditional Probability of Release (CPR). The CPR of a derailed tank car depends on its design characteristics and derailment speed. Researchers have found a strong effect of speed on both derailment severity and release probability of hazardous materials cars derailed. Multiple car releases can also be calculated based on individual car CPR.
Loss of Containment	The hazards evaluated for this study include the flammable nature of the LNG fuel vapors. In order for a fire or explosion to occur, there must be a loss of containment (LOC) event involving the LNG container or vessel. The LOC probabilities and leak size distributions are estimated.
Formation of Flammable Atmosphere	Following an LOC, the LNG must vaporize and the flammable vapors must mix with air in the appropriate concentrations. The size and downwind distance of the flammable clouds are calculated in the Risk Model.
Ignition of Flammable Atmosphere	The flammable atmosphere must be ignited in order for a fire or explosion to occur. The ignition probabilities, as a function of time, distance, and population as the flammable cloud is formed and dispersed, are calculated in Risk Model.
Exposure to Population	The populations that may be affected by an incident involving LNG are estimated using U.S. Census data, and the population data is input into the model for calculation of the Individual Risk (IR) and Societal Risk (SR). The potential for a fatality, given a specific thermal event (i.e., flash fire, pool fire, jet fire, or explosion), is calculated in the Risk Model.

Sources: Health and Safety Executive; Exponent, Inc.; Liu, et al., ., “Probability Analysis of Multiple Tank-Car Release Incidents in Railway Hazardous Materials Transportation.” *Journal of Hazardous Materials*, Vol. 276, ., pages 442–451. Cambridge Systematics, Inc.

The events can be viewed in Figure 6.1 Rail LNG Event Diagram, where each event is described as part of an overall sequence of events. The Risk Model identifies probabilities within each event in the event chain. For example, the Risk Model calculates the probability of the number of cars derailed as well as the size and

⁵² Arthur D. Little, Inc., *Event Probabilities and Impact Zones*, p. 7.

downwind distance of the resulting flammable clouds released during an incident. Disrupting any of the events in the event chain will ultimately mitigate or prevent hazmat releases, thereby reducing overall risk.

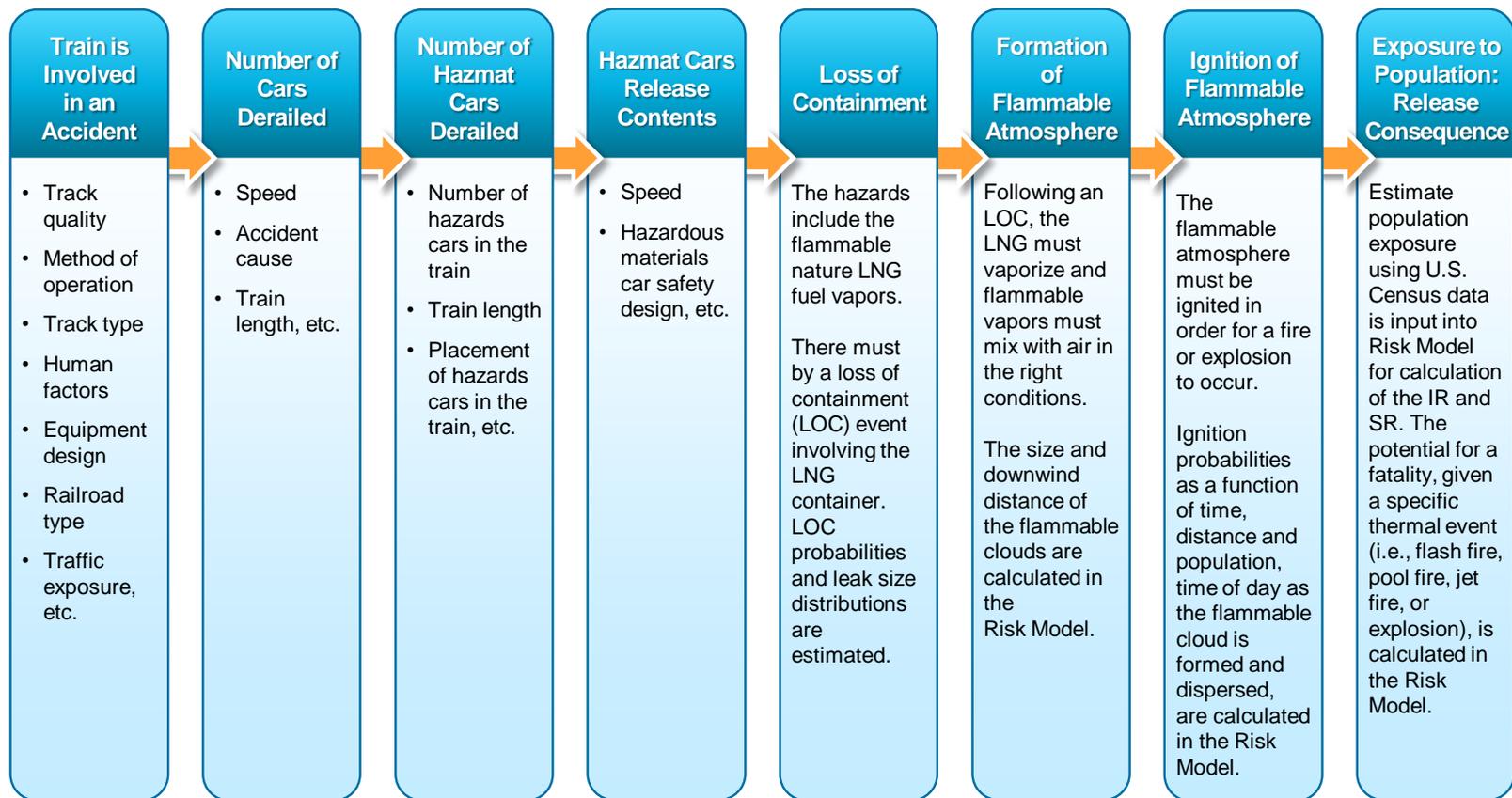


Figure 6.1 Rail LNG Event Chain Diagram

Sources: Arthur D. Little, Inc.; Liu et al.; Exponent, Inc.; Cambridge Systematics, Inc.

Risk inputs and calculations further illustrate the relationships between inputs to the calculations that determine model outputs. For example, FRA track class, method of operation and traffic exposure are the inputs used to calculate train derailment frequency. Train speed is an input to both train derailment severity and release probability. Tank car safety design is an input to calculate tank car derailment and release probability. The formation of a flammable atmosphere is an input to calculating size and downwind distance of flammable clouds. The ignition of the flammable atmosphere created by the LNG release is an input to the calculation of ignition probabilities and the estimated population exposure. Finally, population data and time of day are inputs to estimate population exposure for fatalities (Figure 6.2).

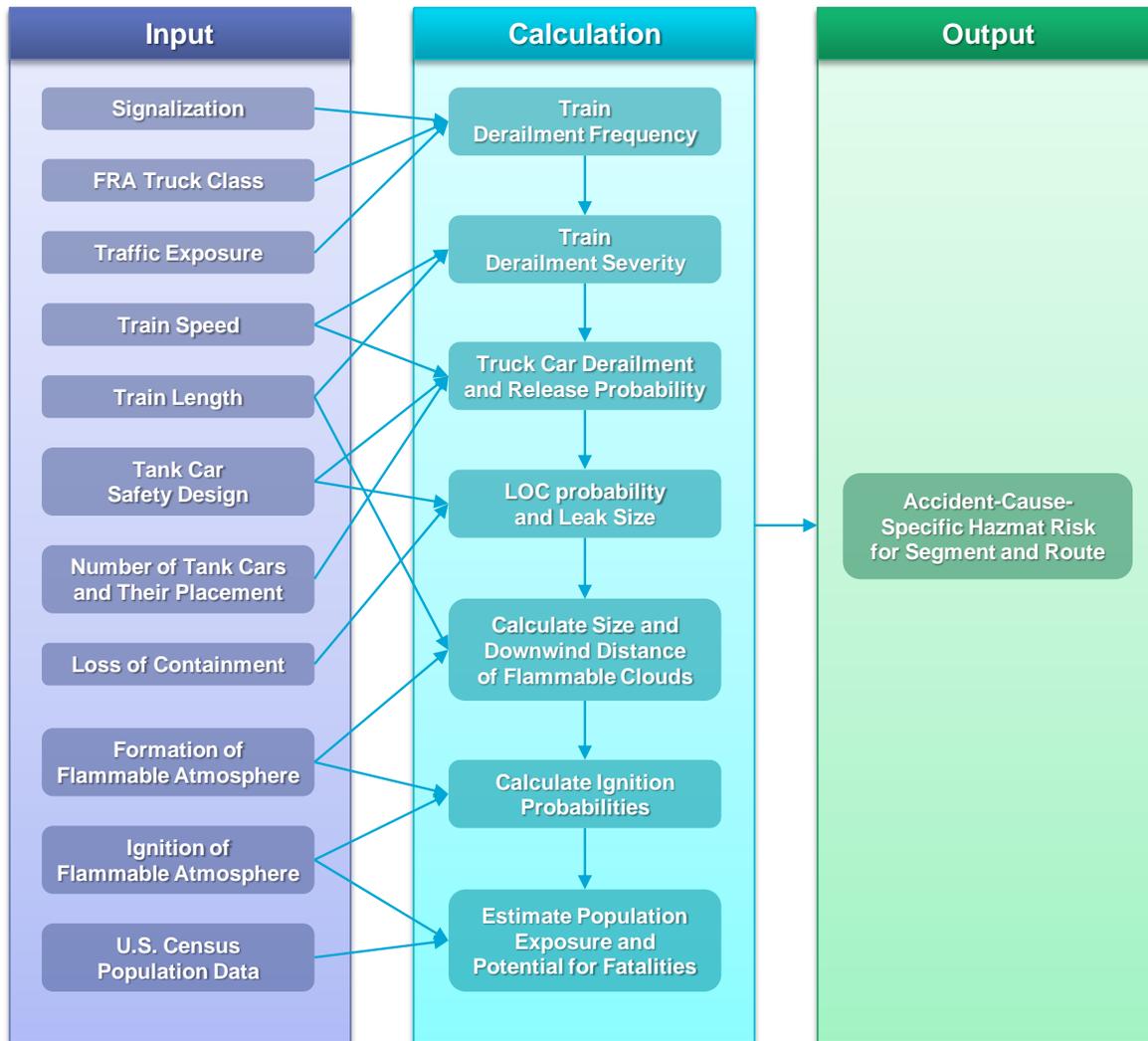


Figure 6.2 Risk Inputs, Calculations, and Outputs for Rail LNG Transport

Source: Liu, et al. “Risk Analysis of Transportation Crude Oil by Rail: Methodology and Decision Support System.” Journal of the Transportation Research Record 2547: 57–65.

Each of these risk inputs, parameters, factors, calculations, and resulting outputs are described in the following section, using the sequence of the event tree diagram from Figure 6.1. The model must take into consideration all of these factors and parameters to effectively estimate LNG Risk by rail.

6.3 Train Accident

Grade crossing incidents are the most common type of train accident. Collisions at grade crossings typically account for well over 90 percent of rail-related fatalities. In 2016, the number of grade crossing collisions was down 42 percent from 2000, injuries from collisions were down 31 percent from 2000, and fatalities from collisions were down 38 percent from 2000. As seen in , the grade crossing collision rate has fallen most years since 1980.⁵³

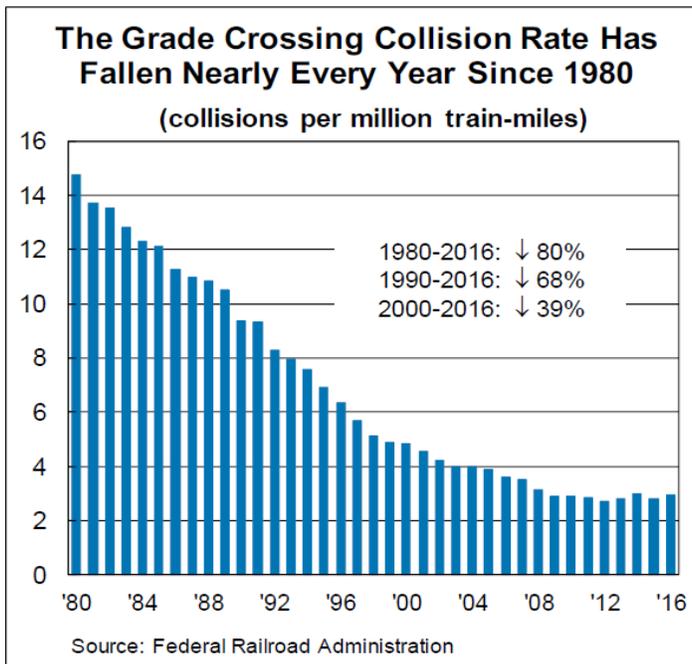


Figure 6.3 Grade Crossing Collision Rate

Source: Federal Railroad Administration

Despite the fact that grade crossing incidents are the most common rail accident, train derailments are the most common type of train accident where monetary damages to track and equipment exceed the FRA reporting threshold. Such derailments damage infrastructure, rolling stock, and can lead to casualties. Factors leading to a train accident include track quality, method of operation, track type, human factors, equipment design, railroad type, traffic exposure, and other factors.

In Canada, Saccomanno et al. analyzed train derailment rates by traffic volume, track type (single track versus multiple tracks), train speed, and region; they also found that train derailment rate varies with infrastructure and traffic characteristics.

A recent paper has developed more up-to-date derailment rates, accounting for the substantial decline in the rate compared to those previously published.⁵⁴ This paper contains the most current estimated rates using Liu’s three-factor derailment rate model. These current derailment rates will be used in the development of the LNG risk model.

6.4 Train Derailment

As mentioned previously, the train derailment rate is affected by a number of factors, such as FRA track class, method of operation, and annual traffic density.⁵⁵ This section describes these factors in detail; taken together, they can be used to assess train derailment probability.

⁵³ Association of American Railroads, September 2017.

⁵⁴ Wang et al., “Trends in U.S. Freight Train...”

⁵⁵ Liu, et al., “Freight-Train Derailment Rates...”

(Footnote continued on next page...)

It is worth noting here that researchers assume there is no statistical difference in derailment rate between hazmat trains and other types of trains. Therefore, the research described in this section used the average derailment rate for all freight trains as a proxy for the hazmat train derailment rate.⁵⁶

6.4.1 FRA Track Class

The connection between derailment rates and infrastructure characteristics has been recognized for many years. Research completed by Nayak et al., Treichel and Barkan, and Anderson and Barkan concluded that the higher FRA track class, the lower the subsequent derailment rates. This can be attributed to the fact that higher track classes are required by FRA for higher operating speeds; therefore, railroads apply higher engineering safety standards and take better care of track sections with higher track classes.

The FRA sets minimum standards for tracks, categorized in six different classes. Track inspection is performed by the FRA as well as the railroad companies themselves. These classes include specifications for track structure, geometry, inspection frequency, and method of inspection, with more stringent requirements for higher track classes. Note that the FRA standards represent *minimum* requirements; in fact, railroads often maintain sections of railroad infrastructure to standards that exceed the minimum required by the FRA.

With about 177,200 miles of track in service as part of the Interstate railroad system, the railroads and the FRA must work together to monitor the system's condition.

Classification of specific railroad sections is determined by maximum permissible speed on that section. Therefore, sections of Class I track may be posted at different speeds depending on certain conditions.

As noted earlier, previous studies have estimated derailment rates based on class-specific ton-mile distribution using traffic data from Class I railroads. FRA track classes and ton-mile distribution rates can be viewed in Table 6.2.

Table 6.2 FRA Track Classes and Distribution

FRA Track Class	Speed mph Freight	Speed mph Passenger	Ton-Mile Distribution ¹	Description
1	10	15	0.8%	Yards, branch lines, short lines and industrial spurs
2	25	30	3.3%	Branch lines, secondary main lines, regional railroads
3	40	60	11.1%	Regional railroads and Class I secondary main lines
4	60	80	54.7%	Main line track for passenger and long-haul freight service
5	80	90	30.0%	Standard for most high-speed track
6	110	110		Amtrak Northeast Corridor

Source: Federal Railroad Administration

¹ Liu, et al., "Freight-Train Derailment Rates..."

⁵⁶ Barkan and Liu, 2018.

6.4.2 Annual Traffic Density

Traffic density is another model variable. Railroad traffic density represents the total weight of all locomotives, rolling stock, and lading traversing a given section of track; it is commonly measured in million gross tons (MGT). Tracks with a higher traffic density are maintained at a higher track quality.⁵⁷ This is because track with a higher traffic density receives more frequent track maintenance leading to higher track quality. For the purposes of derailment probability, track segments with over 20 MGT are considered “higher traffic density.” It is important to note that the AAR also uses the 20 MGT as a threshold.

Signaled track segments have track circuits to detect broken rails, thereby potentially reducing the likelihood of derailments due to this cause. Furthermore, given the same track class and method of operation, derailment rate is inversely related to traffic density level. There are several possible explanations for this. As mentioned above rail lines with higher traffic density receive more frequent track inspection and maintenance (Zarembski and Palese, 2010; Sawadisavi, 2010; Peng, 2011) irrespective of speed (i.e., FRA track class). Busier lines may also have a greater number and variety of wayside defect detectors installed (Schlake, 2010) thereby reducing the incidence of certain infrastructure and equipment-caused train accidents.⁵⁸

The traffic density variable for model purposes is assigned two values, more or less than 20 Million Gross Tons (<20 MGT) annual traffic. The demarcation at 20 MGT is selected because it represents the average annual track traffic density on all U.S. Class I railroad mainlines (AAR, 2005–2009) so the two classifications indicate above or below average traffic density.

6.4.3 Method of Operation

At one time, the FRA recorded 12 different values for methods of operation. For the purposes of this analysis, we are interested in a higher level categorization; specifically, whether or not the track has a system of automatic signaling in place (i.e., “signaled” versus “non-signaled” territory, respectively). We collapse the 12 categories to one of these two conditions. Since then, FRA (2011) has simplified their system so it only records these two categories as well. This categorization also is identified as one of the risk factors specified by PHMSA for railroad hazardous materials route analysis and selection (PHMSA 2008). Approximately 60 percent of U.S. mileage and 80 percent of rail traffic operates on signaled trackage (FRA, 2008). Such trackage uses low-voltage, electric current in the rails (known as “track circuits”) to detect the presence of trains in a given section.⁵⁹

6.4.4 Determining Train Derailment Rates

Other factors contributing to train derailment include track defects, equipment defects, and other causes (see Table 6.3). Together these causes and factors contribute to derailment rates for U.S. railroads. For the Class I mainline, freight train derailment rate from 2002 to 2014, researchers found an average annual decline rate of 10.6 percent for broken rails and 8.7 percent for track geometry defects.⁶⁰ If this trend continues, a statistical model can be used to estimate a more current freight train derailment rate. Possible

⁵⁷ Peng, F. “Scheduling of track inspection...”

⁵⁸ Liu, et al., “Freight-Train Derailment Rates...”

⁵⁹ Ibid.

⁶⁰ Liu, “Risk Analysis of Transportation Crude Oil by Rail...”

strategies to reduce train derailments include train speed reduction to reduce the total number of vehicles derailed and placing tank cars in positions that are less likely to derail.

Table 6.3 Derailment Frequency and Severity by Accident Cause
(Excerpt)

Cause Group	Description	Derailments		Cars Derailed		Average Number of Cars Derailed per Derailment
		Number	Percentage	Number	Percentage	
08T	Broken rails or welds	665	15.3	8,512	22.7	12.8
04T	Track geometry (excluding wide gauge)	317	7.3	2,057	5.5	6.5
10E	Bearing failure (car)	257	5.9	1,739	4.6	6.8
12E	Broken wheels (car)	226	5.2	1,457	3.9	6.4
09H	Train handling (excluding brakes)	201	4.6	1,553	4.1	7.7
03T	Wide gauge	169	3.9	1,729	4.6	10.2
01M	Obstructions	153	3.5	1,822	4.9	11.9
05T	Buckled Truck	149	3.4	1,891	5.0	12.7
04M	Track—train interaction	149	3.4	1,110	3.0	7.4
11E	Other axle or journal defects (car)	144	3.3	1,157	3.1	8.0

Source: Federal Railroad Administration.

Understanding the most important factors affecting derailments is critical to development of effective risk reduction strategies. Train safety and risk analysis rely on an accurate estimation of the derailment rate, which is defined as the number of derailments normalized by some metric of traffic exposure, such as train-miles, car-miles, or gross ton miles. Methods used to determine derailment rates include the Poisson Distribution.⁶¹

Having assembled the data from various sources and ensuring its consistency with regard to the predictor variables of interest, researchers prepared two 5 x 2 x 2 matrices for the rail network and time period studied, one for derailments, and the other for traffic. These matrices were classified according to each combination of FRA track class, method of operation and annual traffic density:

- Track Class: 1, 2, 3, 4, 5.
- Method of Operation: Signaled and non-signaled.
- Annual Traffic Density: <20 MGT and 2:20 MGT.

Table 6.4 presents the distribution of freight-train derailments by the predictor factors used in a previous study.⁶² More than 50 percent of train derailments occur on higher track classes (Class 3 to Class 5), signaled track with annual traffic density above 20 MGT.⁶³

⁶¹ Liu, et al., “Freight-Train Derailment Rates...”

⁶² Ibid.

⁶³ Ibid.

Table 6.4 Distribution of Freight-Train Derailment

Annual Traffic Density (MGT)	Method of Operation (MO)	FRA Track Class (TC)					TC Total
		1	2	3	4	5	
<20	Non-signaled	2.0%	3.5%	4.4%	3.7%	n/a ²	13.7%
	Signaled	1.3%	2.5%	3.3%	4.6%	0.4%	12.2%
	MO Total	3.4%	6.1%	7.7%	8.3%	0.4%	25.8%
≥20	Non-signaled	0.7%	1.8%	2.0%	6.0%	0.5%	11.0%
	Signaled	2.6%	6.7%	11.3%	31.0%	11.6%	63.2%
	MO Total	3.3%	8.5%	13.2%	37.0%	12.1%	74.2%
Total	Non-signaled	2.7%	5.4%	6.3%	9.7%	0.5%	24.6%
	Signaled	3.9%	9.2%	14.6%	35.6%	12.0%	75.4%
	MO Total	6.7%	14.6%	20.9%	45.3%	12.5%	100.0%

Source: Liu, et al., “Freight-Train Derailment Rates”

² There were no instances of non-signaled, Class 5 track with less than 20 MGT of annual traffic.

This information is further illustrated in Figure 6.4, in which derailment rates decrease with increasing FRA Classes.⁶⁴

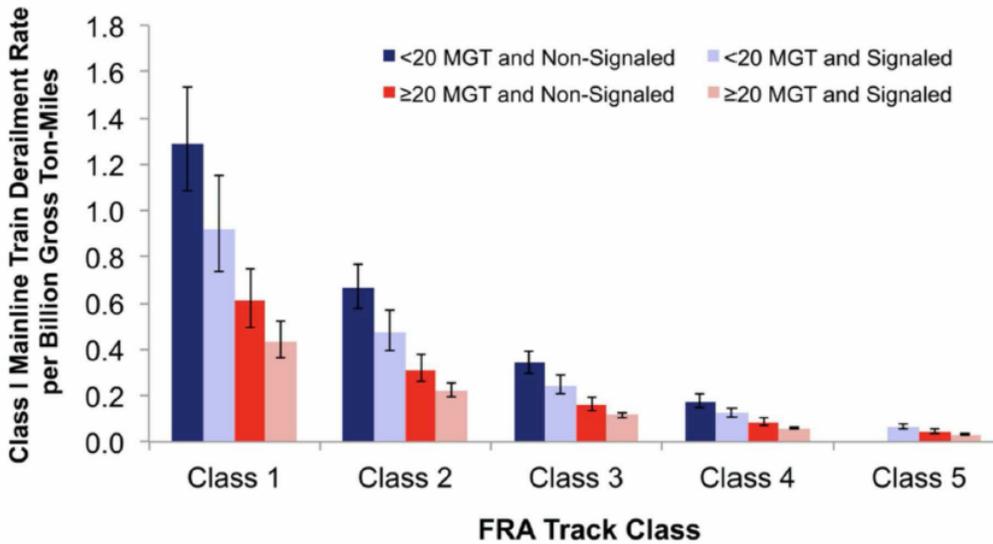


Figure 6.4 Estimated Train Derailment Rates By Track Class

Source: Liu, et al., “Freight-Train Derailment Rates”

Note: Estimated Class I mainline freight-train derailment rates by FRA track class, method of operation and annual traffic density.

⁶⁴ Ibid.

6.5 Train Derailment Rate

Different models have been used to analyze train derailment rates. The example below uses a negative binomial (NB) regression model to analyze freight-train derailment rates on U.S. Class I railroad main tracks. The NB model has been widely used in accident rate analysis in highway transportation (e.g., Miaou, 1994; Hauer, 2001; Wood, 2002; Lord et al., 2005; Lord, 2006; Oh et al., 2006; Mitra and Washington, 2007). Below is the Table 6.5 describing derailment rate per billion gross ton miles (GMT) estimates based on FRA Track Class, Rail Density and Method of Operation:⁶⁵

Table 6.5 Parameter Coefficient Estimates of Train Derailment Rates
In billions of ton miles, 2005–2009

Parameter	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
b ₀ (Intercept)	0.9201	0.1115	0.7016	1.1386	68.11	<0.0001
b _{trk} (Track Class)	-0.6649	0.0341	-0.7318	-0.5981	380.37	<0.0001
b _{moo} (Method of Operation)	-0.3377	0.0974	-0.5286	-0.1469	12.03	0.0005
b _{den} (Annual Traffic Density)	-0.7524	0.0859	-0.9208	-0.5840	76.72	<0.0001
Dispersion	0.0048	0.0062				

Source: Liu, et al., "Freight-Train Derailment Rates..."

Notes:

- Over the 5-year period there were a total of 1,420 derailments and 17.5 trillion GTM of freight train traffic assigned to the 20 different categories in the cross-categorical matrix used in the statistical analysis.
- Traffic exposure is measured by gross ton-miles (GTM) and annual traffic density is measured by gross tonnage on a segment.

6.6 Number of Cars Derailed

The number of cars derailed also can be described as derailment severity. Derailment severity is measured by number of cars derailed after a train derailment. Influencing factors contributing to derailment severity include speed, accident cause, train length, and other factors. Quantifying the relationship between train derailment severity and these associated factors helps the rail industry and Government to develop, evaluate, prioritize, and implement cost-effective safety improvement strategies.

Simulation and statistical analysis are the two basic approaches used in previous studies to model train derailment severity. Simulation models predict the response of railroad vehicles to specific track and environmental conditions. These models are typically based on detailed nonlinear wheel-rail interaction models. For example, Yang et al. (1972, 1973) developed a simulation model to determine the effect of ground friction, mating coupler moment, and brake retarding force on the number of cars derailed. They

⁶⁵ Ibid.

found that the position of the first car involved in the derailment (called point-of-derailment, or POD) and derailment speed could affect the number of cars derailed. Methods for determining the derailment severity and POD include the Truncated Geometric Distribution and the Beta Distribution.⁶⁶

The first vehicle (generally the lead locomotive) in the train is frequently the first to derail. Previous studies found that the nearer the POD is to the front of a train, the more cars derail. Research in 2014 focused on mainline, freight-train derailments on Class I railroads, a group of the largest U.S. railroads accounting for 69 percent of route miles and 88 percent of carloads transported in the U.S.⁶⁷ The analysis showed that approximately 25 percent of train derailments had the POD in the first 10 positions of the train (Figure 6.5).⁶⁸

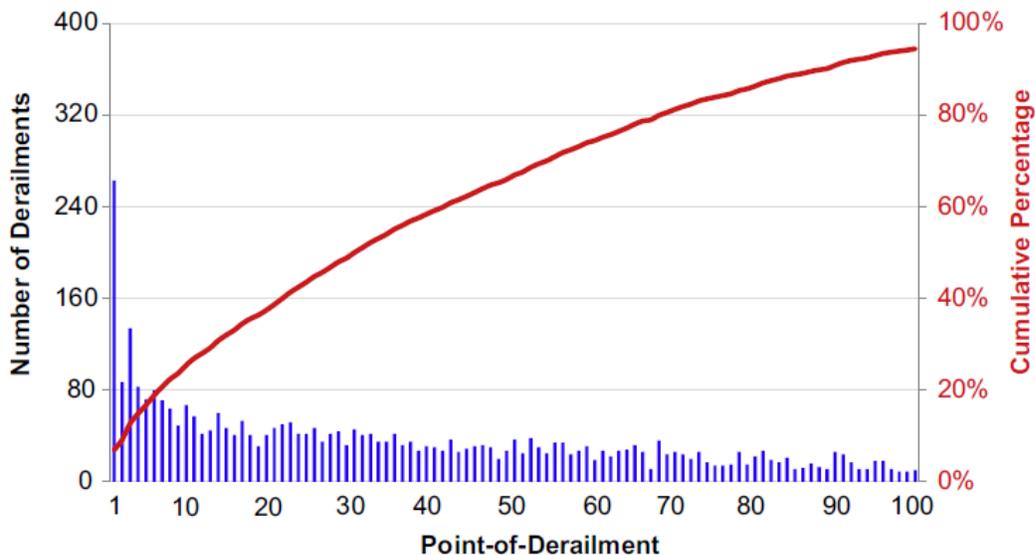


Figure 6.5 Distribution of the Point-of-Derailment
2002–2011

Source: Saccomanno and El-Hage, “Minimizing Derailments of Railcars;” 1989.

Note: This distribution of the point-of-derailment of 3812 Class I mainline freight-train derailments due to all causes, 2002–2011 (partial distribution of POD up to position 100 shown, accounting for 94 percent of all derailments analyzed).

In the late 1980s, Yang et al.’s model was extended by considering coupler failure and independent car motion (Coppens et al., 1988; Birk et al., 1990). The precision of simulation models is subject to the accuracy of modeling train derailment dynamics.

In addition to simulation models, train derailment severity also can be estimated based on historical data. Saccomanno and El-Hage (1989, 1991) developed a truncated geometric model to estimate the mean number of cars derailed as a function of derailment speed, residual train length, and accident cause.

⁶⁶ Saccomanno and El-Hage, “Minimizing Derailments of Railcars;” 1989.

⁶⁷ Association of American Railroads *Class I Railroad Statistics*.

⁶⁸ Bagheri et al., “Reducing the threat...”

The number of tank cars derailed is related to the total number of cars (both tank and non-tank cars) derailed, and the number and placement of the tank cars in a train. Glickman et al. assumed that the number of tank cars derailed follows a hypergeometric distribution when tank cars were randomly placed in the train. Bagheri et al. estimated the total number of tank cars derailed given their positions.

6.7 Derailed Cars Contain Hazardous Materials

The third part of the event tree describes the probability of tank cars containing hazardous materials derailed in a train accident. Influencing factors include the number of tank cars containing hazardous materials in the train, train length, and the placement of those cars in the train consist. Hazardous materials are transported in tank cars in manifest trains and unit trains. The LNG risk model will include an evaluation of the transportation risk in unit trains versus manifest trains by integrating train-specific risk analysis methodology. In a recent paper, researchers determined that a unit train has a higher probability of a release incident per train derailment than a manifest train. Tank cars can be placed in the lowest-probability derailment positions, and tank cars can be distributed to multiple mixed trains. However, shipping hazmat in a unit train also may reduce the number of shipments if the same number of hazmat cars were shipped in multiple manifest trains. This needs to be taken into consideration developing the risk model and is why it is important to consider tank car placement in a train.⁶⁹

6.8 Number of Tank Cars Releasing Contents

Research has demonstrated that not all derailed tank cars release their contents. Studies have found that the use of a more robust tank car design can reduce tank car release probability, reducing hazmat transportation risk (6–8). The Railway Supply Institute (RSI)—Association of American Railroads (AAR) Railroad Tank Car Safety Research and Test Project has developed a tank car accident database (TCAD) containing information on tank cars involved in accidents in the U.S. Using the current subset of this database, Treichel et al. developed logistic regression models to estimate the conditional probability of release (CPR) for nearly all common designs, as well as new designs that incorporate existing design features. The conditional probability of release (CPR) of a derailed tank car depends on its design characteristics and derailment speed.^{70 71} Tank car release probability is a Bernoulli variable. The sum of independent Bernoulli variables with different probabilities follows a Poisson binomial distribution.⁷² If Bernoulli variables are correlated, researchers can use a family of more sophisticated models.⁷³ Barkan et al. and Treichel et al. found that speed affected both derailment severity and release probability of hazardous materials cars derailed. Kawprasert and Barkan extended Treichel et al.'s analysis by accounting for the effect of derailment speed in estimating release probability.

Figure 6.6 illustrates CPR for selected pressure tank cars (DOT 112 and DOT 105).

⁶⁹ Liu, "Risk Comparison of Transporting Hazardous Materials..."

⁷⁰ Barkan et al., "Safety performance of tank cars..."

⁷¹ Barkan, et al., "Benefit cost evaluation..."

⁷² Wang, Y.H. "On the number of successes..."

⁷³ Liu, X. et al., "Analysis of multiple tank car..."

CHLORINE

Car Spec.	Head Thickness (in.)	Shell Thickness (in.)	Jacket	Head Shield	Shell Inside Diameter (in.)	CPR	Percent Improvement Over Pre-HM-246 Baseline
105A500W	0.812	0.775	YES	NO	100.45	0.042	N/A
105J600I	0.954	0.954	YES	FULL	100.45	0.019	54.8 %

ANHYDROUS AMMONIA

Car Spec.	Head Thickness (in.)	Shell Thickness (in.)	Jacket	Head Shield	Shell Inside Diameter (in.)	CPR	Percent Improvement Over Pre-HM-246 Baseline
112J340W	0.625	0.625	YES	FULL	119	0.033	N/A
112J500I	0.900	0.900	YES	FULL	116.75	0.016	51.5 %

ETHYLENE OXIDE

Car Spec.	Head Thickness (in.)	Shell Thickness (in.)	Jacket	Head Shield	Shell Inside Diameter (in.)	CPR	Percent Improvement Over Pre-HM-246 Baseline
105J300W	0.603	0.562	YES	FULL	117.87	0.041	N/A
105J500I	0.900	0.900	YES	FULL	116.75	0.016	61.0 %

*Average mainline derailment conditions - train speed at time of derailment = 26 mph, 11 cars derailed, tank car is the 6th car derailed.
 CPR or "Conditional Probability of Release" is a measure for probability of a spill under certain accident conditions.

The car dimensions shown in Table 1 are meant to be illustrative. They are based on the most commonly built designs as of the publication of this report.

Figure 6.6 Selected Tank Car Conditional Probability of Release
CPR

Source: Railway Supply Institute <http://tankcarresourcecenter.com/standards/>.

Influencing factors contributing to the number of tank cars releasing contents include tank car design, speed, and the tank car's exposure to other contributing factors such as a pool fire created by the derailment. In some hazmat derailments, pool fires have been identified as the cause of a tank car releasing contents following a derailment, sometimes over a period of up to six hours.⁷⁴ In the case of an LNG release, the tank car release may result in a pool fire or vapor dispersion. This will be further evaluated in the Release Consequence section.

6.9 Loss of Containment

The Loss of Containment (LOC) is when LNG is released from a container, which in this case is either the T75 ISO container in a well car (such as FECR) or the DOT 113 tank car, tests for which currently are in progress. The prior sections detailed the development of accident rate and derailment probability estimates for rail cars. Not every accident will lead to an LOC of LNG. The dynamics of an individual accident such as train configuration, train speed, and the type of container will determine whether or not an LOC may occur. This section discusses the development of LOC and the techniques used to estimate release size probability for the QRA model based on industry data and guidelines. For the purposes of this study, the focus is on the DOT 113 tank car and ISO tank well car. Figure 6.7 illustrates the technical specifications of the DOT 113 tank car.

⁷⁴ National Transportation Safety Board, "Report from Mount Carbon Train Derailment."

Inner Tank

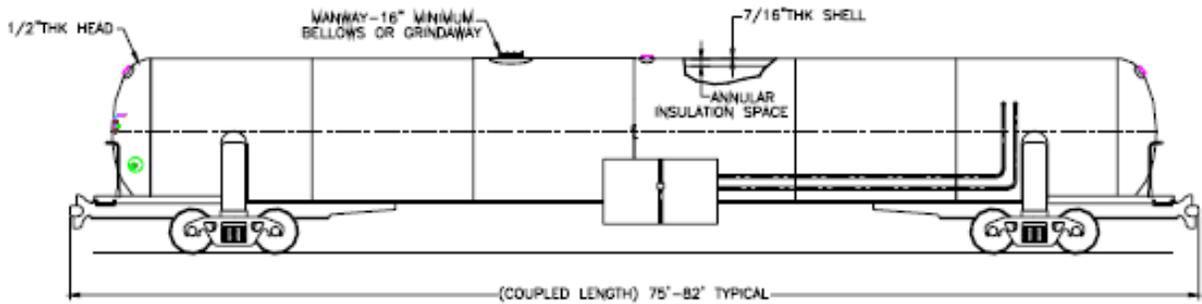
Thickness: 3/16" (minimum); 1/4" (nominal)
 Material: Stainless steel of ASTM A 240/A 240M, Type 304 or 304L

Outer Tank

Thickness: 1/2" heads, 7/16" shells
 Material: Carbon steel

Insulation

Perlite (common in 1960-1990 built cars), or
 Wrapped fiberglass or similar material (common in 1990-and-later built cars)



**Cutaway Drawing of Tank Car
 (Courtesy of Chart Industries)**

Figure 6.7 Typical Features of DOT 113 Tank Car

Source: American Chemistry Council, "Handling and Transportation Guide..."

The DOT-113 railcar is a cryogenic non-pressurized liquid tank car with insulated "thermos bottle" construction. While the DOT definition of cryogenic is refrigerated to -130°F and below, cryogenic is a maximum of -155°F. Class DOT-113C120W tank cars began production in the 1970s and they are the most common tank cars now used for cryogenic ethylene service. The rail weight limit is 263,000 pounds with a tare weight in the 117,000 to 120,000 pounds range. The water capacity on these cars is nominally 33,000 gallons, which allows for a payload of approximately 28,500 to 29,000 gallons of cryogenic ethylene. Recently built cars have a gross volume of 34,500 gallons and a net cryogenic ethylene capacity of up to 144,000 pounds (30,380 gallons).

Class DOT-113C tank cars are equipped with one or dual-pressure relief valves and dual-rupture discs. Except for some class DOT-113D tank cars (described above), the valves and fittings for loading and unloading, and the pressure relief devices are located in cabinets on both sides. In some cases, only one of the two cabinets contains the pressure relief devices, and is identified by the exhaust (vent) stack coming out of the cabinet and reaching the top of the tank car. Loading/unloading valves are normally located in compartments on diagonally opposite corners of car for liquid oxygen, liquid nitrogen, and liquid hydrogen.

LOC probability data for LNG ISO containers and for DOT 113 rail cars currently do not exist. Therefore, general rail industry data has been used with certain engineering assumptions to find comparable LOC data.

For example, pressure tank cars (DOT 112) and cryogenic tank cars (113) have an extensive history of operation with corresponding accident data, and with some engineering judgment, this type of accident data can be applied to the Risk Model. PHMSA maintains an online database that provides historical LOC data for rail tank cars, among other transportation containers and vessels.⁷⁵ The database complements the FRA database in that the PHMSA database records the inventory of hazmat cargo released for each accident; whereas, the FRA database only identifies that an LOC has occurred. The PHMSA database can be accessed for this purpose in order to estimate the LOC probabilities for the DOT 113 tank car and for ISO containers.

The AAR Tank Car Committee is performing research on the crashworthiness assessment of the ISO tank (VOLPE) and fire test of an ISO tank on a rail car. LNG used as a fuel tender also is being considered through the work of the AAR. A LNG ISO Tank pool fire test was completed in May 2017, and presented at the October 2017 AAR Tank Car Committee. There is another test scheduled for June 2018. Figure 6.8 illustrates the specifications of the T75 ISO container:

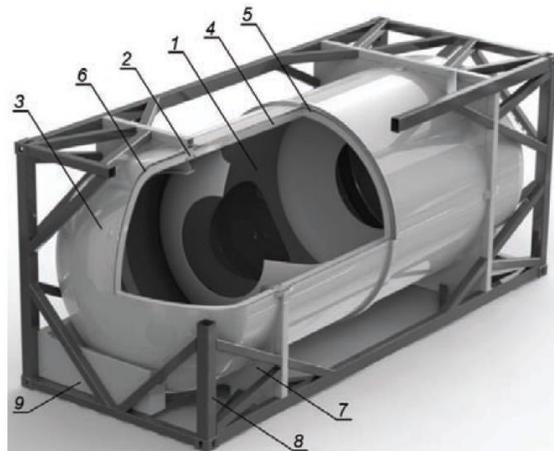


Fig. 1. Model of the LNG tank container for LNG transportation and storage, tank type I and II : 1 – inner tank, 2 – inner supports made of plastic materials, 3 – outer tank, 4 – insulation, 5 – radiation shields, 6 – the vacuum, 7 – outer supports, 8 – container frame, 9 – fittings

Figure 6.8 ISO Insulated Tank Container Diagram

Source: Lisowski and Czyzycki, “Transport and Storage...”

ISO containers are intermodal containers suitable for multiple transportation methods such as truck, rail, or ship. They are manufactured according to specifications from the International Organization for Standardization (ISO). ISO is a worldwide federation of national standards.

The transport of LNG by rail is allowed only by special permits authorized by the FRA—at least two entities in the U.S. have current, active natural gas dual fuel programs and operate under a “Letter of Concurrence” from the FRA. Two types of tenders are being utilized in the prototype programs: ISO container holding maximum of 10,000 gallons of LNG, and tank car holding between 22,000 and 25,000 gallons of LNG. Both major U.S. freight locomotive original equipment manufacturers are actively involved with the AAR Tank Car Advisory Group activities and with the prototype programs.

⁷⁵ Pipeline and Hazardous Materials Safety Administration, “Hazmat Database.”

ISO intermodal containers are used to transport cryogenic bulk liquids—nitrogen, oxygen, argon, methane, nitrous oxide, ethylene, and carbon dioxide. ISO containers with LNG are authorized by rail in the U.S. only by special permit. Containers designed and optimized for LNG also are popular for transportation of ethylene. Containers designed by Chart Industries have hold times of between 44 to 65 days. This means that without intervention, the containers would be insulated and keeping the LNG at cryogenic temperatures for the length of the hold time.

The analysis would assume that LOC could only occur if the DOT 113 rail car or ISO well car was derailed. The PHMSA database does not provide accident data for T-75 ISO portable tank containers, but it does list pressure tank car LOC accidents. Although there are differences between the T75 ISO construction and a DOT-112 pressure tank car, the dynamics and consequences of LOC can be assumed to be reasonably similar. Thus, pressure tank cars were used as a proxy to estimate the probability of an LOC if a car was derailed.⁷⁶

The PHMSA database can be used to collect rail car data from past years for incidents, including spillage, vapor (gas) dispersion, and no release. However, this approach does not account for the substantial differences in rail car design characteristics that are known to affect the probability of release if a car is derailed. The most current published estimates of design-specific tank car release probabilities can be found in a report published by the RSI-AAR Railroad Tank Car Safety Research and Test Project (Treichel et al. 2006). The likely qualitative effect of this is to over-estimate the risk of a release because the LNG 113 tank car is likely to be more robust than average values estimated using hazardous materials cars in the PHMSA database.⁷⁷

The resulting data can then be filtered for pressure tank cars only. Pressure tank car incidents can be sorted by amount released (units are either cubic feet or gallons). The PHMSA data can then be grouped into release volume ranges in order to estimate the probability of a certain leak size. The categories used for the FECR Report are listed in Table 6.6.

Table 6.6 Sample Release Size Types for Loss of Containment (LOC) Estimates

Release Type	Release of Product
No Release	Less than 100 gallons
Small Release	100 to 1,000 gallons
Large Release	1,000 to 30,000 gallons
Catastrophic Release	More than 30,000 gallons

Source: Exponent, Inc.

To understand the history of cryogenic gas incidents by rail, the CS Team examined incidents involving liquid ethylene (UN1038) in DOT-113 Tank cars in the PHMSA Incident Reports Database. The Team identified 73 incidents involving cryogenic ethylene tank cars between 1977 and 2015 reported by PHMSA. Of these 73 incidents, only 5 were listed as “HMS Serious Incident.” Of the 5, 3 included one incident in Moran, KS in which three DOT 113 tank cars containing liquid ethylene derailed and burned. The incident in Brunswick,

⁷⁶ Exponent, Inc. “FECR Risk Assessment, July 2017 Draft.”

⁷⁷ Barkan, C.P.L., Liu, X.; Memo detailing improvements to Exponent Methodology, November, 2017.

MD was due to a broken line in the piping cabinet. Another incident resulted from loss of vacuum in the annular space, due to a failure in the outer tank.

After reviewing the description of each incident, several are related to venting from residue cars. In these cases, a 15 psi (20 percent) increase in the start-to-discharge pressure of the main safety relief valve could have a significant benefit by reducing the number of times cars vent and the amount they vent.

There are no reports of inner vessel punctures. In some cases railcars may be delayed in transit or on a siding or at a plant location. In these situations, there is a chance of venting or the need to flare gas to maintain vapor pressures within acceptable limits.⁷⁸

6.10 Formation of Flammable Atmosphere

Following a loss of containment (LOC), the LNG must vaporize and the flammable vapors mix with air in the appropriate concentrations. The size and downwind distance of the flammable clouds can be calculated in the Risk Model. While the LNG in its liquid state is not flammable, LNG vapors resulting from a release or spill are flammable at concentrations of 5 to 15 percent. When warmed to approximately -112°C (-170° F), LNG vapors become buoyant in air and rise and rapidly disperse into the atmosphere.

Initial vaporization following a release of LNG produces a large quantity of vapor for a short period of time. Flammable mixtures of LNG vapor initially extend downwind for only a short period of time, and as such, the zone of flammability is confined to the immediate vicinity of the release or spill, unless the release is confined in some way. The distance the vapor travels depends on many variables, including the volume of the initial release or spill, its duration, wind velocity and direction, terrain and atmospheric temperature and humidity. If the vapor cloud encounters an ignition source (i.e., with sufficient ignition energy) while still at a flammable concentration, a fire may result. Unless confined, this would result in a flash fire. If the fire propagates back to the source, this would result in a pool fire or jet fire, depending upon the nature of the release. Although LNG is nontoxic, LNG vapors at high concentrations can displace oxygen, resulting in oxygen levels that are too low for safe human exposure.

The release conditions, LNG vaporization, cloud formation, dispersion, and flammable cloud envelope as a function of time can be calculated in various models. In the FECR Risk Study, the Exponent Team used PHAST Risk v6.7. PHAST Risk is a commercial software package developed and distributed by Det Norske Veritas (DNV) which combines a phenomenological release and consequence analysis model with a risk analysis sub model to evaluate spills, sprays, and gas dispersions and the resulting toxic, fire, and explosion consequences on populations.

PHAST is widely used for the calculation of hazard distances from the release of several hazardous substances, including LNG. PHAST is approved by the U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA) for evaluating LNG release exclusion zones.⁷⁹ The PHAST code uses the Unified

⁷⁸ Pipeline and Hazardous Materials Safety Administration, "Incident Reports Database."

⁷⁹ Pipeline and Hazardous Materials Safety Administration, "Pipeline Safety: Issuance..."

Dispersion Model (UDM) as an integral calculation model to estimate the dispersion following a pressurized release or an unpressurized release. It consists of the following linked modules:

- Near-field jet dispersion;
- Non-equilibrium droplet evaporation and rainout, touchdown;
- Pool spread and vaporization;
- Heavy gas dispersion; and
- Far field passive dispersion.

One consideration using PHAST model calculations is that they assume a completely flat terrain and do not account for any obstructions (either natural or nearby equipment) on the dispersion distance of flammable clouds. In many cases, however, this assumption produces a conservative overestimate of the distance to hazardous outcomes.

6.11 Ignition of Flammable Atmosphere

As a liquid LNG does not burn because liquid LNG does not contain sufficient oxygen to support combustion. LNG vapors are flammable in air, but only when between 5 to 15 percent by volume in air. If LNG concentration is lower than five percent it cannot burn because of insufficient oxygen, and if LNG concentration is higher than fifteen percent it cannot burn because there is too much LNG relative to oxygen. Therefore the potential for an LNG explosion is actually low because of the narrow range of UEL (Upper Explosive Limit)/LEL (Lower Explosive Limit) of Methane in LNG (Figure 6.9).

Despite this, LNG is still hazardous. If spilled, LNG will boil rapidly and create a vapor cloud. Initially the primarily Methane vapor will condense water vapor out of the air, making the cloud visible and causing it to hang close to the ground until it warms up. If an ignition source is present the cloud can ignite and it will burn back to the source. Methane vapors in open air exhibit a very slow flame speed of about 4 mph. If the LNG cloud does not ignite, it can travel some distance under the right conditions however, typically it will quickly warm up, rise and dissipate.⁸⁰

If the LNG vapors resulting from a release or spill reach concentrations of 5 to 15 percent, then ignition can occur if there is an ignition source. The timing of the ignition will impact the consequence outcome because the flammable cloud stops growing after ignition since the flammable vapor will be burned. For example, immediate ignition of the release may result in a pool fire or jet fire (or both). Delayed ignition may result in a pool fire, flash fire, or explosion. For each scenario modeled, models can calculate the outcome due to both immediate ignition and delayed ignition for the range of outcomes in the event tree. The immediate and delayed ignition probabilities can also be found in the guidelines published in the Dutch Purple Book.⁸¹

⁸⁰ Professor George Lane, Director Chemical Security Emergency Response Technology, interview Aug 15, 2018 regarding LNG characteristics.

⁸¹ Uijt de Haag et al., *The 'Purple Book...'*

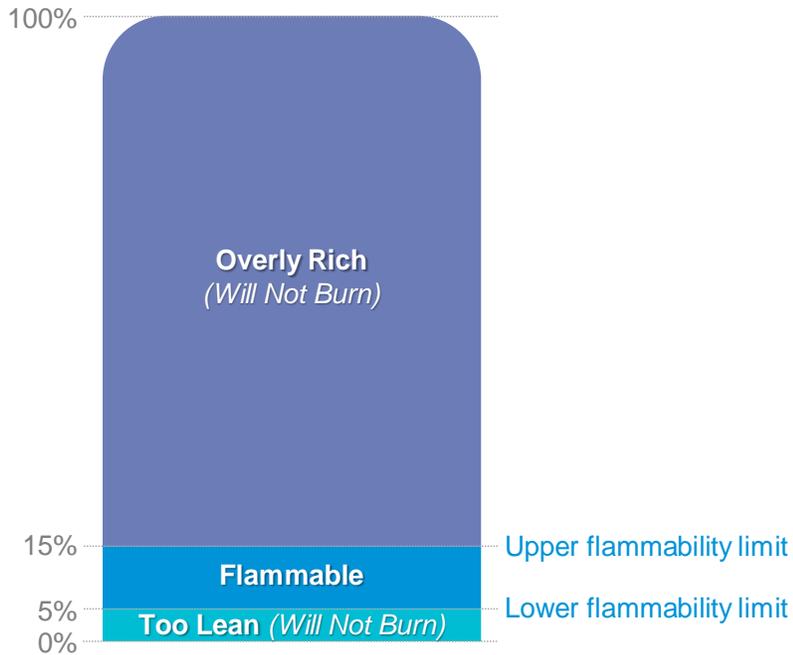


Figure 6.9 LNG Flammability Range

Sources: Foss, Michelle. 2003. LNG Safety and Security. Center for Energy Economics at the Bureau of Economic Geology, The University of Texas at Austin; Cambridge Systematics.

During the LNG production process or during transportation, some simple failures and events can lead to a series of catastrophic events, with the most common being a LNG spill. The flow diagram in Figure 6.10 shows the likely events that can follow after a LNG spill. These include: 1) pool formation, 2) vapor dispersion, and 3) combustion. Researchers have employed experimentation and mathematical modeling to study LNG spills, with the aim of improving knowledge and further understanding the likely case of events following a LNG spill and how it can be prevented and/or managed. Such knowledge and understanding are essential to maintaining and managing the safety of LNG.

There are multiple types of models used to calculate ignition of flammable liquids or atmosphere depending on the size of the LOC, weather conditions, terrain and other factors. This section briefly describes the types of models along with advantages and disadvantages that have been developed to help manage LNG safety. These models include LNG Pool Formation Models (including four examples of Box or Top Hat Models and four examples of Navier-Stokes Models) and three examples of LNG Fire Models.

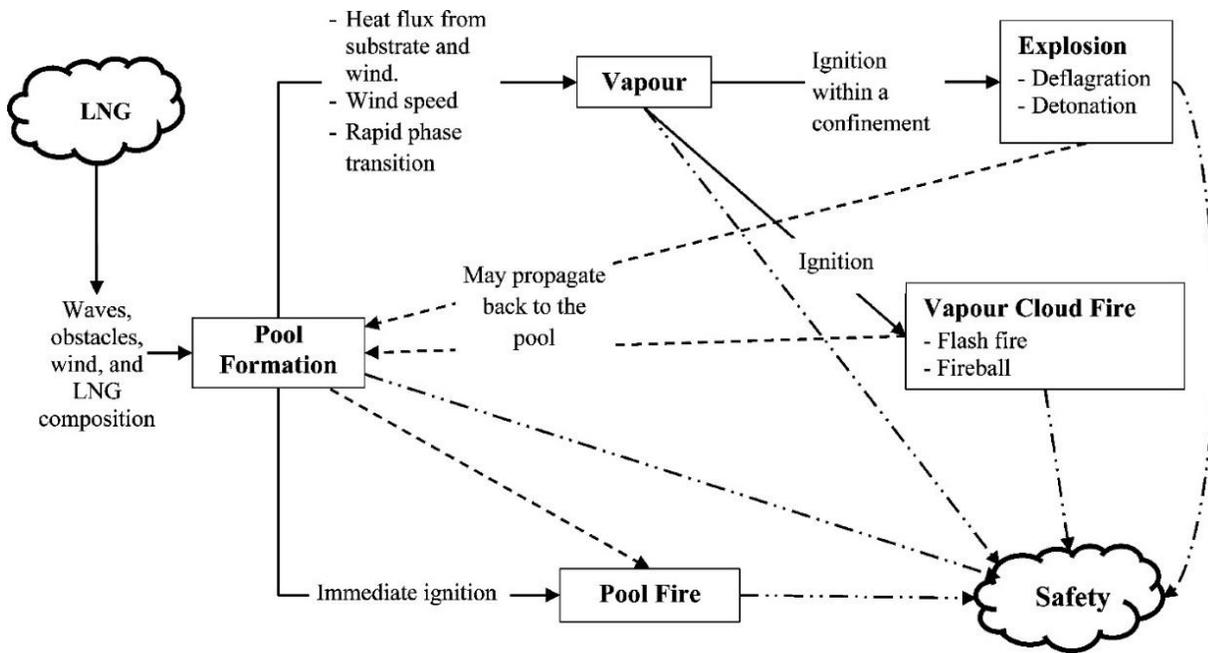


Figure 6.10 LNG Release Consequence Diagram

Source: Ikealumba, W.C. and Wu, H. "Some Recent Advances..."

6.11.1 LNG Pool Formation Modeling

Pools of LNG do not ignite as readily as gasoline or diesel because the auto-ignition temperature of Methane is 1004° F, significantly higher than gasoline at 495°F, and diesel at 600°F. So while open flames and sparks can ignite natural gas, many hot surfaces will not.

Numerical models for LNG pool formation are mainly classified in two categories: the integral model or the Navier–Stokes model. There are numerous models for studying LNG pool formation, including Raj and Kalenkar, Opschoor, SOURCE 5, GASP, SafeSite3G, PHAST, ALOHA, ABS Consulting model, LNGMAP, and FLACS.

The LNGMAP incorporates real-time geographic information, such as wind effects, current effects, atmospheric conditions, etc., into the model. PHAST is an older model than LNGMAP, and it is more widely used because of its ability to model spills on both land and water. PHAST also is more comprehensive than SOURCE5, and GASP models because of its ability to account for noncircular LNG pool formation and inclusion of heat convection/radiation from sources other than the substrate. Navier–Stokes models are more complex and the most complete models. However, modeling pool formation with Navier–Stokes models can be time-consuming because of their complexity. As a result, researchers often model pool formation with integral models and then transfer the data over to Navier–Stokes models for further analysis.⁸²

6.11.2 LNG Vapor Dispersion Modeling

Various numerical models have been developed for studying LNG vapor dispersion. The main differences among the models are in the completeness of simulation for the dispersion process, the capabilities in

⁸² Ikealumba and Wu, "Some Recent Advances..."

different release processes, the ability of the model to describe processes, the completeness in fields and data used, and the complexity of the terrain for which the model is situated. Other differences that are considered when looking at numerical models include the computational requirements, such as power, speed, and memory. Since the 1980s, various numerical models have been developed for the study of atmospheric dispersion of denser than air clouds. Such mathematical models can be classified as either “box top or top-hat” models or “Navier–Stokes models.”

Box-Hat or Top-Hat Models

There are two types of box or top-hat models: modified Gaussian models and similarity-profile models, depending upon the complexity of conservation equations that must be solved. The modified Gaussian models are the simplest because the Gaussian equation is used for the conservation of species while neglecting or simplifying those for momentum and energy. The similarity-profile models use simplified conservation equations with a mathematical complexity of one dimension. Such simplicity is achieved by averaging the LNG cloud properties across the surface of the entire cloud or over the cross wind plane. To regain the structural loss because of averaging, similarity profiles are used, therefore leading to quasi-three-dimensional solutions. Examples of similarity-profile models include SCIPUFF, TWODEE, SLAB, HEGADAS, DEGADIS, ALOHA, and GASTAR. Of these models, the most commonly used are SLAB, HEGADAS, DEGADIS, and ALOHA. ALOHA is the most widely used for safety engineering modeling applications in industry and by first responders because of its fast computational time and reasonable accuracy.

Navier–Stokes Models

The Navier–Stokes models contain the most physically complete description of the LNG dispersion process and are constructed from three-dimensional and time-dependent conservation equations of momentum, mass, energy, and species. Examples of Navier–Stokes models that have been used for denser than air modeling include FEM3, FEMSET, FLACS, HEAVYGAS, and ZEPHYR. FLUENT and CFX numerical models have been the main Navier–Stokes models used for modeling. This is largely due to the key advantages of these models, including robustness, multiple solving methods, high levels of accuracy, and ability to add to the coding for specific simulations.

LNG Fire Modeling

A LNG pool fire can transmit significant radiant heat to an object outside the fire, with the heat flux strongly dependent upon various parameters. These parameters include the properties of fire (e.g., size, shape, and geometry), surrounding atmosphere (e.g., transmissivity), and object (e.g., location and orientation). Technical issues that arise when modeling LNG pool fires are usually due to the scale of the fire. As pool fires become larger, physical phenomena, such as oxygen starvation in the center of the pool fire, smoke generation, and reduction in the emissivity power, become more important (Raj et al). Extrapolation from small fires can lead to misleading results; therefore, developing modeling techniques are in great need for studying large-scale LNG pool fires.

Generally, there are three approaches to modeling LNG fires: 1) the point source method, 2) solid flame method, and 3) field (or Navier–Stokes) method. The point source model can easily produce results; however, the assumptions taken, such as neglecting wind and obstacle effects, assuming that all heat is radiated at the ground level, can lead to questionable accuracy. On the other hand, the solid flame model accounts for wind and atmospheric conditions; however, the cylindrical flame modeling approach can, at

times, lead to inaccurate results. Navier–Stokes models are the most complete and robust models that are able to provide the most accurate results.⁸³

6.12 Release Consequence: Exposure to Population

Release consequences are described in the model as release scenarios. Risk software can be employed for each phase of LNG ISO tank container operations or LNG 113 tank car route scenarios. Most risk software programs require a definition of the release sizes (e.g., no release, small, large, and catastrophic), release conditions, and the LOC frequency for each size of hole for each release scenario. Model conditions for each scenario need to be developed and event trees are commonly used to estimate the release frequencies.

In the FECR Risk Report, the LNG ISO tank container operations were grouped into three separate categories, distinguished by the type of operations and the unique risks present. ISO containers are lifted on and off specially designed rail well cars as part of the LNG operation. Therefore, two categories include lift on and lift off movements and one category defines main line movement.

Identifying affected populations is a critical part of the QRA, and involves the identification of persons impacted by an LNG event. Sensitive populations include those persons who require assistance to evacuate a facility, including schools, hospitals, child care facilities, senior care facilities and correctional facilities and stadiums. HSE decided it needed to improve the quality of the population data it used, so it commissioned the development of the National Population Database (NPD). Table 6.7 describes affected populations that were identified as part of the NPD.

Table 6.7 Affected Populations during Hazmat Release Events

Population Type	Description
<i>Residential</i>	Daytime
	Nighttime
<i>Sensitive</i>	Hospitals
	Schools (primary, secondary, boarding)
	Child care facilities
	Facilities for persons with access and functional needs
	Senior care facilities
<i>Large Gathering Establishments</i>	Correctional facilities
	Places of worship
	Stadiums, Arenas
	Campsites
<i>Transportation</i>	Arterial Highways, collector and local roads
	Railroads, seaports, airports
<i>Employment</i>	Daytime employer population
	Nighttime employer population
<i>Retail</i>	Daytime population
	Nighttime population

Sources: Health and Safety Executive, “Societal Risk...;” Cambridge Systematics, Inc.

⁸³ Ibid.

6.13 Emergency Response

Throughout the world, emergency managers are working to prevent chemical accidents and prepare for them. Preparedness is the best means to avoid incidents or mitigate the impact of incidents.⁸⁴ Emergency management professionals have expressed considerable interest in LNG, as LNG import facilities are being reconfigured for export and LNG transportation shipments by truck, rail, and ship are increasing. LNG export facilities are now operational in Sabine Pass, LA and in Cove Point, MD. After the recent crude oil and ethanol derailments that occurred around the United States and Canada, first responders are participating in training sessions, including response to incidents involving crude oil and ethanol shipments and high hazard flammable trains (HHFT). In response to the Alaska and Florida LNG rail pilot programs, more firefighters are being trained in LNG rail response protocols and best practices in those States.

The LNG export trend has also resulted in more natural gas liquids used in the liquefaction process. This has led to concerns from fire officials on increasing refrigerants gases and blends containing ethane, propane, ethylene, and isobutane. In discussions with fire chiefs, we learned that unlike Liquefied Petroleum Gas (LPG or propane), LNG releases do not allow first responders to cap off a leak or interact with the container. LNG releases involving cryogenic gas would result in an immediate evacuation of the area and securing the adjacent facilities. Given the warming effect of water on cryogenic gases, putting water on a cryogenic release is not recommended. It is very difficult to clean up an LNG incident; the product would need to gas off naturally, and any nearby ignition sources would need to be eliminated to prevent a fire. The most common response involving MC 338 trailer rollovers or crashes is to evacuate the area and maintain a perimeter guard until the LNG has dissipated.

The CS Team also met with representatives from the National Fire Protection Agency (NFPA). The NFPA has been involved in LNG emergency response for many years. This began primarily with fire protection for LNG facilities constructed in the U.S. in the 1970s, during which time maritime LNG specifications were also developed. Recently railroads have been exploring LNG for locomotive propulsion using dual fuel diesel engines. Maritime cargo using LNG propulsion has now expanded to include cruise ships, tugboats, cargo vessels, and offshore supply vessels.

Based in part on simulation analysis and historical data, the U.S. Department of Transportation's Emergency Response Guidebook (ERG) recommends first responders' initial isolation and protective action distances for specific toxic inhalation hazards (TIH). However, since LNG is not considered a toxic inhalation hazard, isolation protective action distances are not documented for LNG. In the ERG guidance section (orange pages), the guidance applies to flammable gases transported in both pressurized and cryogenic containers. In this section of the ERG, as an immediate precautionary measure, the guidance recommends first responders "isolate spill or leak area for at least 100 meters (330 feet) in all directions." For a large spill, the ERG recommends first responders "consider initial downwind evacuation for at least 800 meters (½ mile)." If a tank, rail car, or tank truck is involved in a fire, "isolate for 1,600 meters (1 mile) in all directions; also, consider initial evacuation for 1,600 meters (1 mile) in all directions."

As LNG transportation by motor carrier, rail, and ship continue to increase, first responders in communities where LNG is transported will require additional training. While motor carrier transport of LNG has been conducted safely over the past 40 years, trends suggest that motor carrier transport of LNG will increase. This is due in part to the need for LNG to supplement peak shaving facilities in the U.S. and in part to the growing trend of using LNG for fuel. The USCG continues to examine LNG fueling operations in light of

⁸⁴ Halmemies, "Education Modules for Chemical Accident Prevention..."

interest on the part of cargo ships, cruise ships, and petroleum supply vessels to build LNG-fueled vessels. This will impact bunkering operations in ports around the country, including Jacksonville, FL, Miami, FL, Houston, TX, and Fourchon, LA.

7.0 Truck LNG and LPG Risk Assessment

The objective of this study was to assess the risks of LNG surface transport (rail and truck), with an emphasis on rail transport. This section includes selected information on truck risk factors, including relative risks of LNG versus LPG in highway and rail transport, and LNG versus LPG truck accident rates. LNG has been transported by truck for over 40 years with few incidents, an indication that LNG motor carrier risks are manageable. However, with increasing motor carrier traffic volumes and issues with driver fatigue and hours of service, it is important to recognize how these factors may influence LNG truck transport in the future.

7.1 Truck Risk Factors

Unlike rail risk factors such as FRA track class, method of operation and rail density, truck risk factors include driver behavior, traffic congestion and truck speed, and the increasing volume of trucks on the road relative to other vehicles.

Highway safety researchers have conducted a number of studies quantifying the relationship between accident rates and roadway design. These studies have considered the effects of road curvature, traffic volume, grade, shoulder width, number of lanes and other factors (e.g., Miaou, 1994; Maher and Summersgill, 1996; Hauer, 2001; Lord et al., 2005; Lord, 2006; Mitra and Washington, 2007).

Research has indicated that the risk of a fatal truck crash goes up as the percent of trucks on the road relative to other vehicles also goes up. In fact, the crash risk increase is greater than the increase in the truck volume. In other words, a one percent increase in truck volume corresponds to an increased truck accident risk by more than one percent.⁸⁵ In another report authored by Taylor and Francis, the danger that speed poses is highlighted. In this study, researchers concluded the chance that a fatal truck accident could happen doubles when a truck driver travels at a speed beyond 45 miles per hour.

Additional research on large truck crash risk suggest vehicle safety technologies can be important in lowering crash risk.⁸⁶ This means that as safety technology continues to penetrate the fleet, whether from voluntary usage or Government mandates, reductions in large truck crashes may be achieved. Results imply that increased enforcement and use of crash avoidance technologies can improve the large truck crash problem.⁸⁷

There are many different factors that contribute to commercial vehicle safety, each with its own set of associated technologies and safety practices. Some technologies and practices are intended to improve crashworthiness, or to minimize injuries in the event of a crash (often called “passive safety”). Other technologies and safety measures are designed to reduce the likelihood or severity of a crash (often called “active safety”).⁸⁸

The Federal Motor Carrier Safety Administration (FMCSA) and the National Highway Traffic Safety Administration (NHTSA) conducted the Large Truck Crash Causation Study (LTCCS) to examine the reasons for serious crashes involving large trucks (trucks with a gross vehicle weight rating over 10,000 pounds). From the 120,000 large truck crashes that occurred between April 2001 and December 2003, a nationally representative sample was selected. Each crash in the LTCCS sample involved at least one large truck and resulted in a fatality or injury.

⁸⁵ Dixon & Daley, “A new look at truck accident risk factors.”

⁸⁶ MaineWay Services and Cambridge Systematics, Inc., “Truck Technology Literature Review.”

⁸⁷ Teoh et al., “Crash risk factors...”

⁸⁸ MaineWay Services and Cambridge Systematics, Inc., “Beyond Compliance Literature Review.”

The total LTCCS sample of 963 crashes involved 1,123 large trucks and 959 motor vehicles that were not large trucks. The 963 crashes resulted in 249 fatalities and 1,654 injuries. Of the 1,123 large trucks in the sample, 77 percent were tractors pulling a single semitrailer, and 5 percent were trucks carrying hazardous materials. Of the 963 crashes in the sample, 73 percent involved a large truck colliding with at least one other vehicle.

Hundreds of associated factors were collected for each vehicle in each crash. In descending order, the top 10 factors coded for large trucks and their drivers were:

- Brake problems.
- Traffic flow interruption (congestion, previous crash).
- Prescription drug use.
- Traveling too fast for conditions.
- Unfamiliarity with roadway.
- Roadway problems.
- Required to stop before crash (traffic control device, crosswalk).
- Over-the-counter drug use.
- Inadequate surveillance.
- Fatigue.

Researchers have determined that truck accident rates vary with road type and with population density. U.S. databases have been developed to include highway geometrics, truck volumes, and truck crashes. These help researchers to assess factors impacting truck crashes.

7.2 New England LNG Truck Case Study

Engie, Inc. operates the oldest LNG import facility in the United States, located in Everett, MA. Ships transporting LNG to Boston Harbor offload LNG into storage tanks to fuel a nearby gas-fired power plant and to provide natural gas as heat for commercial, residential and industrial facilities throughout New England. Maritime LNG imports in New England are important since there is not enough available pipeline capacity to supply natural gas to the region. Over the past 45 years, Engie has contracted with motor carriers to transport LNG to 42 storage facilities in New England. During this time, these carriers have completed over 300,000 truck trips up to 150 miles with only two incidents. One was a truck rollover and the other was a truck engine fire. In both examples the LNG product in the cargo tank was not released. Engie officials described the situation in New England in which natural gas is only needed during the winter months. LNG is imported to Everett, MA, where it is off-loaded into storage tanks to power generation systems and later loaded into trucks for distribution to 41 facilities throughout New England. This is an example of how motor carrier LNG transportation has been provided safely and efficiently over the past 40 years with minimal incidents.

7.3 Relative Risks of LNG versus LPG in Highway and Rail Transport

In 2015, researchers studied the relative risks of transporting LNG versus Liquefied Petroleum Gas (LPG) by truck and rail. While LNG and LPG hazards both include fires and explosions due to loss of containment, the properties are very different. LPG is pressurized to keep in liquid form, the release of which would result in a rapid release of highly flammable product. By contrast, LNG is a cryogenic liquid stored in double-walled containers, the release of which would result in cryogenic liquid releasing at a lower rate, and only igniting within a limited vapor range. The analysis revealed that accident rates and hole size probabilities in accidents were independent of the hazmat commodity shipped. Therefore, a single accident rate value could be applied to both LNG and LPG shipments. Most rail accidents were the result of equipment or track failures; whereas truck accidents were the result of brakes, traffic flow or driver behavior. The QRA results indicated the individual and societal risks for highway and rail transport were similar. In general, the safety risk for rail transportation is higher than for highway transport; likely due to the larger volumes of tank cars relative to highway cargo tankers.⁸⁹

7.4 LNG and LPG Carrier Analysis

In order to better understand motor carrier transport risk, the CS Team evaluated all U.S. LNG and LPG carriers and crash rates. The number of motor carriers that transport LNG and LPG in the U.S., and associated safety and demographic information on these carriers, was estimated from the Federal Motor Carrier Safety Administration's (FMCSA) Motor Carrier Management Information System (MCMIS) database.

Using a Hazardous Materials Carrier Report from the MCMIS database, the CS Team examined a list of carriers and carriers/shippers that transport or ship hazardous materials.⁹⁰ Only those carriers listed as "active" in MCMIS, registered as an Intrastate Hazardous Materials carrier or an Interstate carrier that transports hazardous materials, and whose operation type is listed as "carrier" or "carrier/shipper" were included in the analysis.

The Hazardous Materials Carrier Report also indicated what types of hazardous materials a motor carrier are authorized to haul. As LNG is primarily composed of methane, the field "DIV 2.1 Methane" denotes those carriers that may transport LNG. To estimate the number of motor carriers transporting LNG, the data was filtered on the "DIV 2.1 Methane" field to show only those carriers with the following values:

- **B-A:** a carrier is authorized to both haul and ship ("B") hazardous material in both bulk and non-bulk forms ("A").
- **B-B:** a carrier is authorized to both haul and ship ("B") hazardous material in bulk form ("B").
- **B-N:** a carrier is authorized to both haul and ship ("B") hazardous material in non-bulk form ("N").
- **C-A:** a carrier is authorized to haul ("C") hazardous material in both bulk and non-bulk forms ("A").
- **C-B:** a carrier is authorized to haul ("C") hazardous material in bulk form ("B").
- **C-N:** a carrier is authorized to haul ("C") hazardous material in non-bulk form ("N").

⁸⁹ Hart and Morrison, *Bulk Transport by Road and Rail*.

⁹⁰ The MCMIS Hazardous Materials Carrier Report is updated weekly. The version of the report used in this analysis is based on the 10/13/2017 update.

In addition to these categories, some entities that are listed as shippers in the Hazardous Materials Carrier Report were retained in the analysis. This is because those shipper records indicated that those entities also employed drivers and had access to power units. This suggests that they may be involved in the physical transport of LNG. Thus, those shippers with drivers, power units, and the following values under the DIV 2.1 Methane field were included in the analysis:

- **S-A:** a shipper is authorized to ship (“S”) hazardous material in both bulk and non-bulk forms (“A”).
- **S-B:** a shipper is authorized to ship (“S”) hazardous material in bulk form (“B”).
- **S-N:** a shipper is authorized to ship (“S”) hazardous material in non-bulk form (“N”).

A similar analysis was performed to identify LPG carriers. The field “DIV 2.1 LPG” denotes those carriers that may transport LPG. To estimate the number of motor carriers transporting LPG, the data was filtered to show only those carriers with the same authorizations described in the previous paragraph.

7.4.1 LNG Carriers

In total, 521 motor carriers transport LNG (which includes three Canadian carriers that are authorized to operate in the U.S.). Based on these data, motor carriers that transport LNG are broadly distributed across the United States. As shown in Figure 7.1 and Table 7.1, the State of Texas has the most registered LNG carriers with 74 (about 14.2 percent). Texas is followed by Pennsylvania with 30 LNG carriers (about 5.8 percent). The States of California, Illinois, and Florida have the next highest totals at 27 (5.2 percent), 26 (5.0 percent), and 21 (4 percent), respectively. Collectively, these 5 States represent over one-third (approximately 34 percent) of all registered LNG carriers.

The Hazardous Materials Carrier Report also contains data on carrier involvement in crashes. It is important to note, however, that these represent total crashes and are not limited to instances in which LNG was transported. Thus, an analysis of the crash data in the Hazardous Materials Carrier Report is indicative of overall safety performance and not the transport of LNG specifically.

The data field “Number of Crashes” indicates the number of crashes a carrier has had in the past 12 months. In total, LNG carriers were involved in 2,925 crashes. The top 10 LNG carriers for total crashes accounted for nearly three-quarters (72 percent) of total crashes. These carriers also account for approximately 53 percent of total power units which suggests that collectively they are slightly over represented in the data.

The crash rate is calculated by dividing the total number of crashes by the total number of power units for each carrier. Power units are indicative of the magnitude of a carrier’s operations. Thus, the number of power units suggest the extent to which a carrier is exposed to the potential for a crash. Alternatively, vehicle miles traveled could be used as an exposure variable but that information was not available and therefore was not included in the report.

The results indicate that most carriers have no or very few crashes over the previous 12 months relative to their fleet size. Nearly 68 percent of LNG carriers exhibited crash rates below 0.073 crashes per power unit. The largest observed crash rate (among carriers with three or more power units) was 0.25 crash per power unit. It is important to note that these crashes do not exclusively represent incidents involving of LNG-laden vehicles. Instead, they represent crashes in all facets of the carriers’ operations that comprise the data (see Figure 7.2).

Percent of LNG Carriers

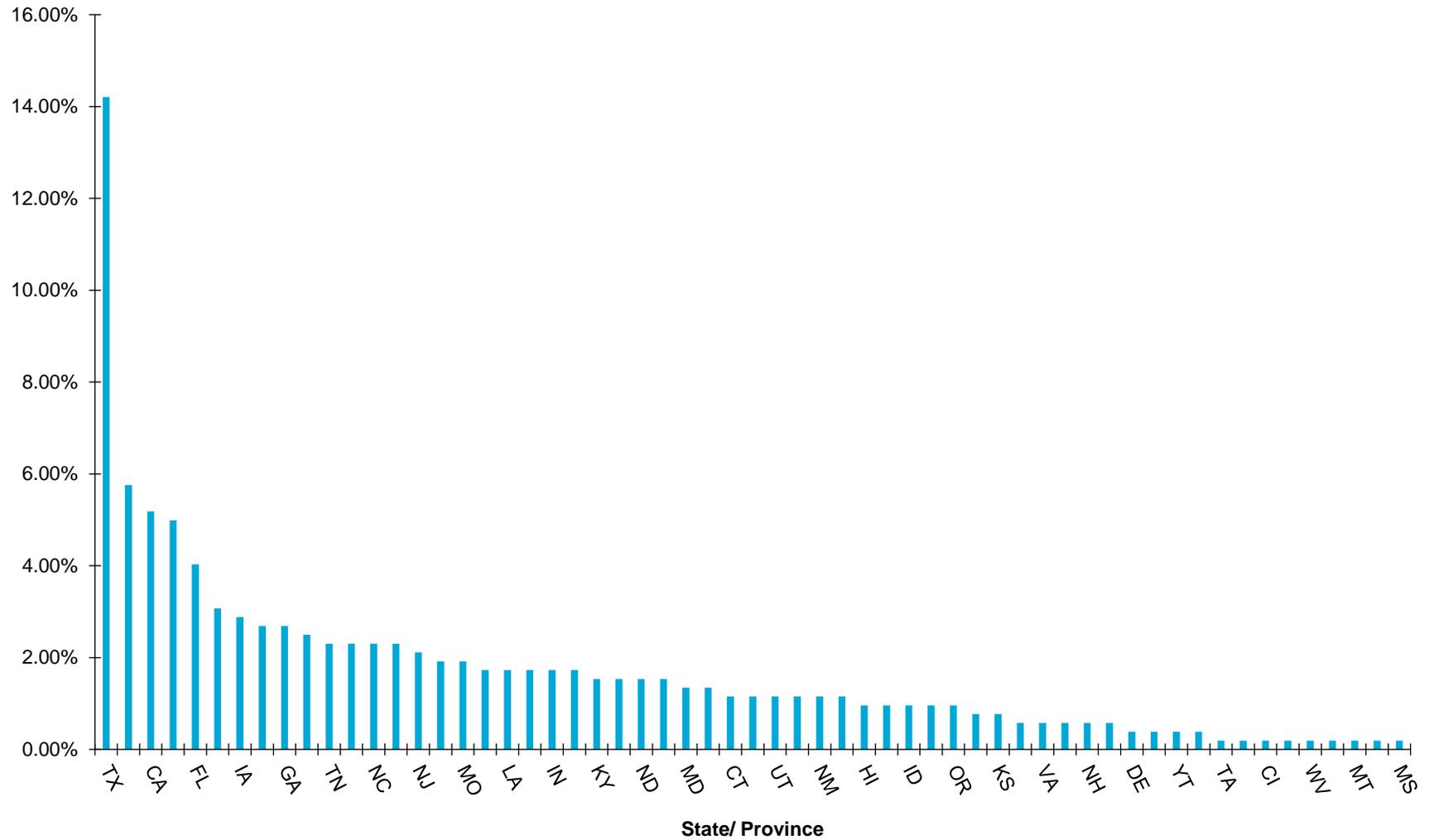


Figure 7.1 Distribution of LNG Carriers
By State

Source: FMCSA, Cambridge Systematics

Table 7.1 States with Most Registered LNG Carriers

State	Number of Carriers	Percent of Total
Texas	74	14.2%
Pennsylvania	30	5.8%
California	27	5.2%
Illinois	26	5.0%
Florida	21	4.0%
Subtotal	178	34.2%
All Other States/Provinces	343	65.8%
Total	521	100.0%

Source: FMCSA, Cambridge Systematics

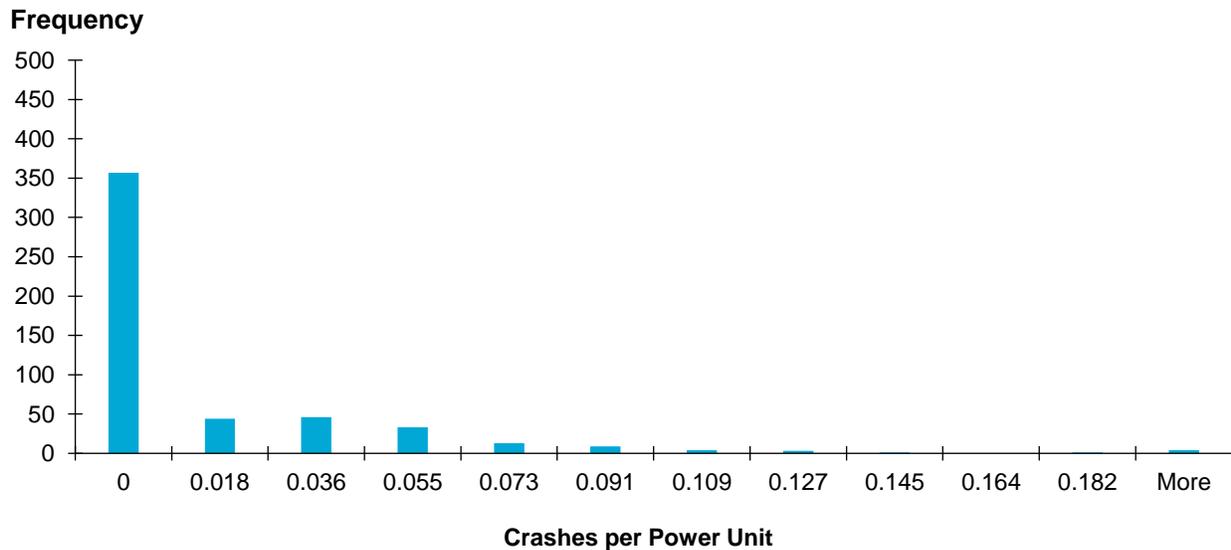


Figure 7.2 Distribution of Crash Rates across LNG Carriers

Source: FMCSA and Cambridge Systematics

7.4.2 LPG Carriers

The CS Team evaluated Liquid Petroleum Gas (LPG) carriers to compare safety performance with LNG. In total, 1,237 motor carriers are estimated to transport LPG (which includes Canadian carriers authorized to operate in the U.S.). Based on these data, motor carriers that haul LPG are broadly distributed across the United States. As shown in Figure 7.3 and Table 7.2 the State of Texas has the most registered LPG carriers with 45 (about 7.9 percent). The State of Minnesota has the next highest total at 107 (approximately 8.7 percent). It is closely followed by Minnesota and Pennsylvania with 61 (4.9 percent) and 58 (4.7 percent), respectively. The States of Illinois and California have 52 (4.2 percent) and 51 (4.1 percent) registered LPG carriers, respectively. Collectively, these five States represent over one-quarter (approximately 27 percent) of all registered LPG carriers.

Percent of Total LPG Carriers

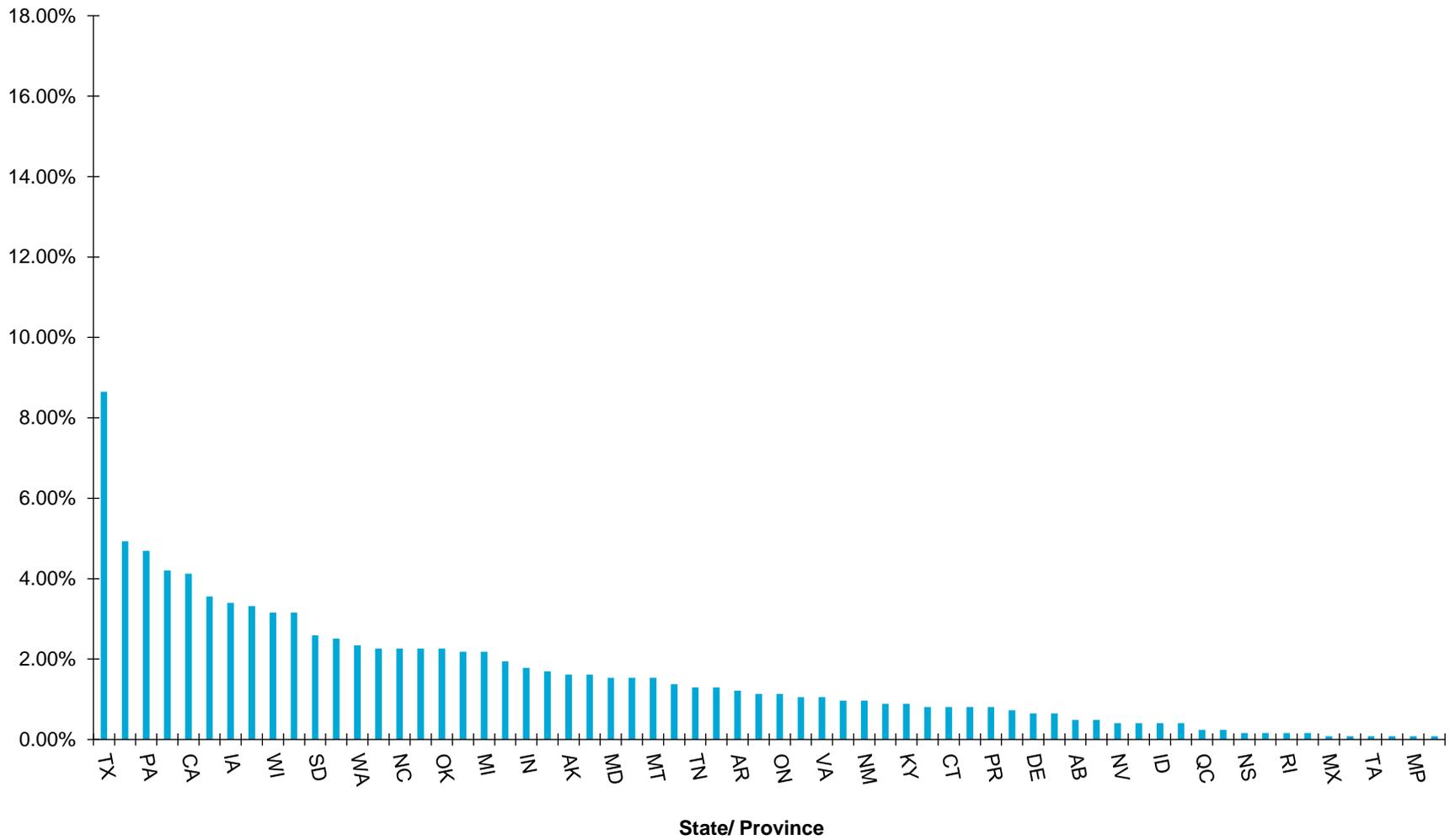


Figure 7.3 Distribution of LPG Carriers
By State and Province

Source: FMCSA and Cambridge Systematics

Table 7.2 States with the Most Registered LPG Carriers (including Puerto Rico)

State	Number of Carriers	Percent of Total
Texas	107	8.7%
Minnesota	61	4.9%
Pennsylvania	58	4.7%
Illinois	52	4.2%
California	51	4.1%
Subtotal	329	26.6%
All Other States	908	73.4%
Total	1,237	100.0%

Similar to the analysis of LNG carriers, the safety performance of LPG carriers is examined using the past 12 months of crash data. As discussed in the LNG analysis, it is important to note that the data represents total crashes and are not limited to instances in which LPG was transported. Thus, an analysis of the crash data in the Hazardous Materials Carrier Report is indicative of overall safety performance and not the transport of LPG specifically.

In total, LPG carriers were involved in 4,925 crashes. The top 10 LNG carriers for total crashes accounted for approximately 60 percent of total crashes. These carriers also account for approximately 41 percent of total power units which suggests that collectively they are slightly over represented in the data.

The crash rate is calculated by dividing the total number of crashes by the total number of power units for each carrier. The results indicate that most carriers have no or very few crashes over the previous 12 months relative to their fleet size. The average crash rate for carriers with three or more power units was 0.015. Nearly 95 percent of LNG carriers exhibited crash rates that fell below 0.073 crashes per power unit (Figure 7.4).

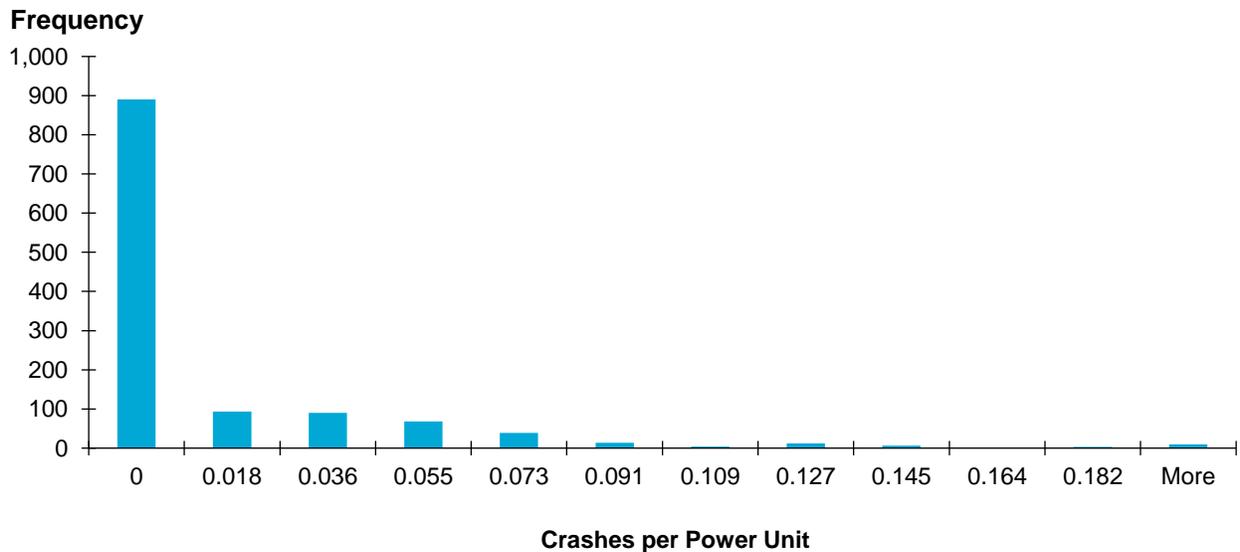


Figure 7.4 Distribution of Crash Rates across LPG Carriers

Source: FMCSA and Cambridge Systematics

7.5 Truck LNG and LPG Risk Summary

The results of this research indicate that motor carriers transporting LNG and LPG have very low crash rates relative to other carriers. For example, over the past 45 years, New England LNG carriers completed over 300,000 truck trips up to 150 miles with only two incidents. One was a truck rollover and the other was a truck engine fire. In both examples the LNG product in the cargo tank was not released.

Unlike rail risk factors such as FRA track class, method of operation and rail density, truck risk factors include driver behavior, traffic congestion, truck speed and the volume of truck on the road relative to other vehicles. Since truck and rail operations have very different risk factors, they need to be evaluated differently.

In comparing LNG and LPG carriers, a total of 521 motor carriers transported LNG over the past year and 1,237 motor carriers transported LPG. Both LNG and LPG carriers exhibited crash rates that fell below 0.073 crashes per power unit. These low crash rates can be attributed to the fact that LNG and LPG carriers represent a small percentage of the overall truck traffic on the highways. In addition, LNG and LPG carriers have high standards for safety and conduct extensive driver training programs to ensure safe transportation and handling of these fuels.

8.0 Conclusion

Natural gas is increasing in use in the U.S. due to the prolific production efforts in the Permian and Marcellus shale basins, taking a larger share of the energy market, and replacing other energy sources. As a result, consumers are switching from sources such as coal, nuclear, and diesel to natural gas for power, heat, and propulsion. While the U.S. natural gas pipeline network is extensive some geographic limitations do exist. There are areas of the U.S. that lack pipeline capacity including the Northeast and Mountain West. Up until five years ago, the U.S. relied on natural gas imports. With the newfound natural gas production capabilities, the U.S. is systematically recommissioning those same natural gas import facilities for export.

With this increase in demand for natural gas, LNG transportation complements the distribution of natural gas by pipeline, providing access to areas that are not sufficiently supplied by the pipeline network. While surface transportation of LNG currently is only allowed by truck, and by rail with special permit, modal choice for LNG delivery would increase the opportunity for energy consumers to make competitive choices about their energy supply. There also is evidence that a demand exists for shipping LNG by rail, and that rail shipments of LNG can be both competitive and complementary to the truck and pipeline networks. Since railroads have unique advantages and disadvantages compared to trucks, and the public safety implications are not fully developed, risk assessments provide additional insight into the shipment of LNG by rail.

The results of our research indicate that LNG transportation has a good safety record, with minimal maritime, facility, and motor carrier incidents relative to other flammable liquids. In other countries, LNG has been transported safely by rail with no incidents to date. This LNG safety record can be attributed to the fact that LNG is not explosive in an uncontained environment, is transported in double-walled containers, and evaporates rapidly when exposed to the atmosphere. Notwithstanding the LNG safety record, it is still important to recognize and plan for LNG risks that do exist.

Developing a QRA with risk factors and parameters is the first step to modeling LNG transport by motor carrier and by rail. This will help to evaluate the derailment and release probability of LNG rail cars over certain segments of the network and to account for a variety of track and train characteristics. LNG transport by truck does have a successful record. However, understanding truck safety risk factors can help to mitigate or prevent truck crashes and improve LNG motor carrier safety as demand for LNG increases. An LNG risk model can be used to understand that probability and consequences for LNG transportation incidents for both rail and truck delivery, even though they are treated differently, the underlying event tree analysis approach is the same. When the probability of LNG tank car derailment is understood, better decisions can be made regarding the crashworthiness, placement, and operation of rail cars and the potential consequences from an LNG release due to a derailment. An added benefit is the ability to also understand the potential consequences from truck LNG movements. Further study for modeling the probability and consequences of transporting LNG by rail and truck will be beneficial to understanding risks to the public.

Appendix A. Acronyms

AAR	Association of American Railroads
Bcf/d	Billion cubic feet per day
BTU	British Thermal Unit
CBRNE	Chemical, Biological, Nuclear or High-Yield Explosives
CMV	Commercial Motor Vehicle
CNG	Compressed Natural Gas
COFC	Container on Flat Car
DOE	Department of Energy
DOT	Department of Transportation
EIA	U.S. Energy Information Administration
ERG	Emergency Response Guidebook
FECR	Florida East Coast Railway
FERC	Federal Energy Regulatory Commission
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
HGL	Hydrocarbon Gas Liquids
ICE	Intercontinental Exchange
IGU	International Gas Union
ISO	International Standards Organization
LDC	Local Distribution Company
LNG	Liquid Natural Gas
LPG	Liquefied Petroleum Gas
MARAD	Maritime Administration
MGT	Million Gross Tons
MMBtu	Million British Thermal Units
MMCF	Millions of Cubic Feet
MCMIS	Motor Carrier Management Information System
MOU	Memorandum of Understanding
MTPA	Million tonnes per annum
NEB	National Energy Board (Canada)
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NGL	Natural Gas Liquid
NHS	National Highway System
PHMSA	Pipeline and Hazardous Materials Safety Administration
QRA	Quantitative Risk Assessment

REA	Rail Equipment Accident [FRA Database]
RTO	Regional Transmission Organization
TCAD	Tank Car Accident Database
TOFC	Trailer on Flat Car
USCG	United States Coast Guard
VCE	Vapor Cloud Explosion

Appendix B. Bibliography

- American Chemistry Council, "Handling and Transportation Guide for Ethylene, Refrigerated Liquid (Cryogenic Ethylene)." Cryogenic Ethylene Transportation Safety Panel, April 2004.
<https://www.americanchemistry.com/ProductsTechnology/Olefins/Handling-and-Transportation-Guide-for-Ethylene-Refrigerated-Liquid-Cryogenic-Ethylene.pdf>.
- The American Gas Association, "Natural Gas Quality and Interchangeability." Accessed March 18, 2018.
<https://www.aga.org/Federal-regulatory-issues-and-advocacy/natural-gas-quality-and-gas-interchangeability>.
- Anderson, R. T., and C. P. L. Barkan, 2004. "Railroad accident rates for use in transportation risk analysis." *Transp. Res. Rec.* 1863, 88–98.
- Arthur D. Little, Inc. *Event Probabilities and Impact Zones for Hazardous Materials Accidents on Railroads*. Alexandria: National Technical Information Service, 1983.
- Association of American Railroads. *Field Guide to Tank Cars, Third Edition, Dec 2017*, in association with the Bureau of Explosives; <https://www.aar.org/wp-content/uploads/2017/12/AAR-2017-Field-Guide-for-Tank-Cars-BOE.pdf>.
- Bagheri, M., F. F. Saccomanno, S. Chenouri, and L. P. Fu, 2011. "Reducing the threat of in-transit derailments involving dangerous goods through effective placement along the train consist." *Accident Analysis and Prevention* 43(3): 613–620.
- Barkan, C. P. L., C. T. Dick, and R. T. Anderson, 2003. "Railroad derailment factors affecting hazardous materials transportation risk." *Journal of the Transportation Research Record* 1825: 68–74.
- Barkan, C. P. L., X. Liu, and M. R. Saat, 2015. "Enhanced tank car design improves the safety of transporting crude oil and alcohol by rail." *TR News* 298: 41–43.
- Barkan, C. P. L., T. T. Treichel, P. Hughes, R. D. Sims, E. A. Phillips, and M. R. Saat, 2006. "Safety performance of tank cars in accidents: probability of lading loss," *Report RA-05-02, RSI-AAR Railroad Tank Car Safety Research and Test Project*.
- Barkan, C. P. L., T. S. Glickman, and A. E. Harvey, 1991. "Benefit cost evaluation of using different specification tank cars to reduce the risk of transporting environmentally sensitive chemicals," *Journal of the Transportation Research Record* 1313: 33–43.
- Barkan, Christopher P. L., Weixi Li, Geordie S. Roscoe, Zhipeng Zhang, and M. Rapik Saat, 2017. "Comparison of Loaded and Empty Unit Train Derailment Characteristics," Submitted for consideration for presentation and publication at the Transportation Research Board 97th Annual Meeting.
- "Bentek Market Call: North American NGLs." Presented at the Marathon Petroleum at Barclays Conference September 5, 2017.
- Braziel, Rusty. "RBN Blog: Too Many Pipelines?" August 2016.
- Braziel, Rusty. "The Domino Effect." 2016.

Center for Chemical Process Safety, "Guidelines for Chemical Process Quantitative Risk Analysis," 2000.

Chart Industries, Meetings with Tim Neeser, Aug 10, 2017, with Chris Varnado and Paul Sjogren on Oct 3, 2017, with Scott Nason in Aug and Oct 2017, and in Feb and Apr 2018, regarding rail cars, cargo tanks, ISO containers, liquefaction technologies and existing and proposed LNG liquefaction sites.

Claudio, Seguran. *Safety Guidelines Chemical Process Risk Analysis*. 2003. ftp://ftp.feq.ufu.br/Luis_Claudio/Seguran%27a/Safety/GUIDELINES_Chemical_Process_Quantitative_Risk_Analysis/0720X_03a.pdf.

Cornwell, J. B., and M. M. Meyer, "Risk Acceptance Criteria, "How Safe is Safe Enough?" Presented at Risk Control Seminar in Puerto La Cruz, Venezuela, October 13, 1997.

Crowley Marine, "Crowley Adds 16 ISO Tanks to LNG Equipment Fleet." Accessed November 29, 2018. <http://www.crowley.com/News-and-Media/Press-Releases/Crowley-Adds-16-ISO-Tanks-to-LNG-Equipment-Fleet>

Crowley Marine, "Liquefied Natural Gas (LNG)." Accessed November 27, 2018. <http://www.crowley.com/What-We-Do/Liquefied-Natural-Gas/Overview>.

"Differing market quality specs challenge LNG producers." *Oil & Gas Journal* 10.11 (2004). <http://www.ogj.com/articles/print/volume-102/issue-38/processing/differing-market-quality-specs-challenge-lng-producers.html>.

Energy Information Administration, "Annual Report 2016."

Energy Information Administration, "Factors Affecting Natural Gas Prices." Accessed November 28, 2018. https://www.eia.gov/energyexplained/index.cfm?page=natural_gas_factors_affecting_prices.

Energy Information Administration, Meetings with EIA Staff, Nov 2017, EIA Weekly Gas Trends, July 2017 to April, 2018, Interstate Gas Movements.

Energy Information Administration, "Natural gas power plants purchase fuel using different types of contracts." *Today in Energy*, February 27, 2018. <https://www.eia.gov/todayinenergy/detail.php?id=35112>.

Energy Information Administration, "U.S. State to State Capacity." Accessed November 28, 2018. <https://www.eia.gov/naturalgas/data.php#pipelines>.

Energy Information Administration, *Weekly Natural Gas Trends*. September 28, 2017. https://www.eia.gov/naturalgas/weekly/archivenew_nqwu/2017/09_28/.

Dixon & Daley, LLC. "A new look at truck accident risk factors." Accessed November 28, 2018. <https://www.dixondaley.com/Articles/A-new-look-at-truck-accident-risk-factors.shtml>.

Dutta, Anisha. "Railways speeds up plans to shift towards gas-fueled locomotives." *Energy World*, May 17, 2017. <https://energy.economictimes.indiatimes.com/news/renewable/railways-speeds-up-plans-to-shift-towards-gas-fuelled-locomotives/58710577>.

Engie, Inc., "Natural Gas & LNG." Accessed March 16, 2018. <http://www.engie-na.com/business/natural-gas-lng/>.

Energy Technology Systems Analysis Program, "Oil and Natural Gas Logistics." *Technology Brief P03* (August 2011).

Exponent Inc., "FECR Risk Assessment, July 2017 Draft." Used with permission from Federal Railroad Administration.

Florida East Coast Railway (FECR). Series of meetings: July 2017; October, 2017; High Horsepower Summit 2016.

Halmemies, S. "Education Modules for Chemical Accident Prevention, Preparedness and Response."

Hart, R., and D. Morrison, 2015. *Bulk Transport by Road and Rail: Relative Risk of LNG versus LPG*.

Health and Safety Executive. "Application of QRA in operational safety issues." Det Norske Veritas Ltd., 2002.

Health and Safety Executive. "Five Steps to Risk Assessment." *INDC 163, Revision 1*, 1998.

Health and Safety Executive. "Risk Criteria for Land-use Planning in the Vicinity of Major Industrial Hazards." *HMSO*, 1989.

Health and Safety Executive, "Societal Risk: Initial briefing to Societal Risk Technical Advisory Group." 2009.

Ikealumba, W. C., and H. Wu, 2014. "Some Recent Advances in Liquefied Natural Gas (LNG) Production, Spill, Dispersion, and Safety," *Energy Fuels* 28(6): 3556-3586.

Indian Infoline News. Accessed November 27, 2018. <https://www.indiainfoline.com/>.

International Gas Union World LNG Report, 2017 Edition.

Jensen, J., 2004. *The Development of a Global LNG Market. Is it Likely? If So, When?* Oxford: Oxford Institute for Energy Studies.

Kawprasert, A., and C. P. L. Barkan, 2010. "Effect of train speed on risk analysis of transporting hazardous materials by rail." *Transp. Res. Rec.* 2159, 59–68.

La Fleur, A. C., K. M. Groth, H. Liao, C. Lopez, and A. B. Munda, 2015. "LNG Safety Assessment Evaluation Methods." Sandia National Labs.

"Liquefied Natural Gas Safety Research." Report to Congress, May 2012. DOE (<https://goo.gl/jhsURa>).

National Association of State Fire Marshals. "Liquefied Natural Gas: An Overview of the LNG Industry for Fire Marshals and Emergency Responders," 2005.

Lisowski, E., and W. Czyzycki, 2011. "Transport and Storage of LNG in Container Tanks," *Journal of KONES Powertrain and Transport* Vol. 18, No. 3.

Liu, X., 2017. "Risk Analysis of Transportation Crude Oil by Rail: Methodology and Decision Support System." *Journal of the Transportation Research Record* 2547: 57–65.

- Liu, X., 2015. "Statistical temporal analysis of freight-train derailment rates in the United States: 2000 to 2012." *Journal of the Transportation Research Record* 2476: 119–125.
- Liu, X., M. R. Saat, and C. P. L. Barkan, 2011. "Analysis of derailments by accident cause: evaluating railroad track upgrades to reduce transportation risk." *Journal of the Transportation Research Record* 2261: 178–185.
- Liu, X., M. R. Saat, and C. P. L. Barkan, 2012. "Analysis of causes of major train derailment and their effect on accident rates." *Journal of the Transportation Research Record* 2289 (2012): 154–163.
- Liu, X., M. R. Saat, X. Qin, and C. P. L. Barkan, 2013. "Analysis of U.S. freight-train derailment severity using zero-truncated negative binomial regression and quantile regression." *Accident Analysis and Prevention* 59: 87–93.
- Liu, X., M. R. Saat, and C. P. L. Barkan, 2013b. "Safety effectiveness of integrated risk reduction strategies for rail transport of hazardous materials." *Journal of the Transportation Research Record* 2374: 102-110.
- Liu, X., M. R. Saat, and C. P. L. Barkan, 2013. "Integrated Risk Reduction Framework to Improve Railway Hazardous Materials Transportation Safety." *Journal of Hazardous Materials* 260: 131–140.
- Liu, X., M. R. Saat, and C. P. L. Barkan, 2013. "Safety Effectiveness of Integrated Risk Reduction Strategies for Rail Transport of Hazardous Materials." *Transportation Research Record: Journal of the Transportation Research Board* 2374: 102–110.
- Liu, X., M. R. Saat, and C. P. L. Barkan, 2014. "Probability Analysis of Multiple Tank-Car Release Incidents in Railway Hazardous Materials Transportation." *Journal of Hazardous Materials* 276: 442–451.
- Liu, X. "Risk Comparison of Transporting Hazardous Materials in Unit Trains versus Mixed Trains," *Transportation Research Record: Journal of the Transportation Research Board*, January 1, 2017. <https://doi.org/10.3141/2608-15>
- Liu, X., C. Liu, and Y. Hong. "Analysis of multiple tank car releases in train accidents." *Accident Analysis and Prevention*, July 2017.
- Liu, X., M. R. Saat, and C. P. L. Barkan, 2017. "Freight Train Derailment Rates for Railroad Safety and Risk Analysis," *Accident Analysis and Prevention* 98: 1–9.
- Liu, X., and B. W. Schlake, 2016. "Probabilistic analysis of the release of liquefied natural gas (LNG) tenders due to freight-train derailments." *Transportation Research Part D: 72, 77-92*.
- MaineWay Services and Cambridge Systematics, Inc., "Beyond Compliance Literature Review," August 2017.
- MaineWay Services and Cambridge Systematics, Inc. "Truck Technology Literature Review," September 2017.
- "Managing LNG Risks—Industry Safeguard Systems." *LNG Information Paper*, 2006. Accessed November 29, 2018. https://giignl.org/sites/default/files/PUBLIC_AREA/About_LNG/4_LNG_Basics/Ing_6_-_safeguard_systems_7.3.09-aacomments-aug09.pdf.

Markwest Annual Report 2015.

Mokhatab, S., J. Y. Mak, J. V. Valappil, and D. A. Wood, 2013. *Handbook of Liquefied Natural Gas*. Philadelphia: Elsevier.

Myhre, G., D. Shindell, F. M. Bréon, W. Collins, J. Fuglestedt, J. Huang, D. Koch, J. F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura, and H. Zhang, 2013. "Anthropogenic and Natural Radiative Forcing." *Climate Change 2013: The Physical Science Basis*. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

Nayak, P. R., D. B. Rosenfield, and J. H. Hagopian, 1983. "Event Probabilities and Impact Zones for Hazardous Materials Accidents on Railroads." *Report DOT/FRA/ORD-83/20*.

National Fire Protection Association. *NFPA 59A: Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2016.

National Transportation Safety Board, "Report from Mount Carbon Train Derailment." Accessed November 28, 2018. <https://www.nts.gov/investigations/AccidentReports/Pages/DCA17MR007-prelim.aspx>.

The North American Energy Standards Board, Inc. "Natural Gas Specs Sheet." Accessed March 18, 2018. https://www.naesb.org/pdf2/wgg_bps100605w2.pdf.

Peng, F., 2011. "Scheduling of track inspection and maintenance activities in railroad networks." Dissertation, University of Illinois at Urbana-Champaign, 2011.

Pipeline and Hazardous Materials Safety Administration, "Hazmat Database." Accessed November 28, 2018. <https://www.phmsa.dot.gov/hazmat-program-management-data-and-statistics/data-operations/incident-statistics>

Pipeline and Hazardous Materials Safety Administration, "Incident Reports Database." Accessed December 15, 2017. <https://www.phmsa.dot.gov/hazmat-program-management-data-and-statistics/data-operations/incident-statistics>.

Pipeline and Hazardous Materials Safety Administration, "Pipeline Safety: Issuance of Draft Decision on Det Norske Veritas (USA), Inc.'s Petition for Approval of the Process Hazard Analysis Software Tool-Unified Dispersion Model." *Docket No. 2011-0075*, October 11, 2011. <https://www.phmsa.dot.gov/regulations-fr/notices/2011-18036>.

Praxair Industry: Conference call with Abdul-Aziz Rashad, September 17, 2017.

Prometheus, Inc. *Prometheus Inc. Mathematics for Science and Innovation*. Accessed January 15, 2018. <http://www.prometheus-us.com/>.

Rahbar, M., and M. Bagheri, 2014. "Risk Assessment Framework for the Rail Transport of Hazardous Materials: Formulation and Solution." *Transportation Research Record* 2411: 90–95.

Raj, P., and T. Lermoff. "Risk analysis based LNG facility siting standard in NFPA 59A." *Journal of Loss Prevention in the Process Industries* 22(6) (November 2009): 820-829.

Risk Management. Risk Assessment Techniques. European Standard: BS EN 31010:2010.

- Saat, M. R., and C. P. L. Barkan, 2011. "Generalized Railway Tank Car Safety Design Optimization for Hazardous Materials Transport: Addressing the Tradeoff between Transportation Efficiency and Safety." *Journal of Hazardous Materials* 189(1–2): 62–68.
- Saccomanno, F. F., and S. El-Hage, 1989. "Minimizing Derailments of Railcars Carrying Dangerous Commodities through Effective Marshaling Strategies." *Transportation Research Record* 1245: 34–51.
- Safely Transporting Hazardous Liquids and Gases in a Changing U.S. Energy Landscape. *TRB Report*, October 2017.
- Simmon, J. A., 1974. "Risk Assessment of Storage and Transport of Liquefied Natural Gas and LP-Gas, Final Report." *EPA/520/3-75-015*, National Technical Information Service.
- Smith, A. D., and P. T. Mabbitt, 1978. "The Conveyance of Liquefied Gas by Rail." *Railway Engineer International* 3(6): 37-40.
- Stocker, T. F., D. Qin, G. K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, and Y. Xia, 2013. *Anthropogenic and Natural Radiative Forcing*, edited by V. Bex and P.M. Midgley. New York: Cambridge University Press.
- Tang, Y., J. Jing, Z. Zhang, and Y. Yang. "A Quantitative Risk Analysis Method for the High Hazard Mechanical System in Petroleum and Petrochemical Industry," *Energies* 11(1) (December 2017):14.
- Teoh, E. R., D. L. Carter, S. Smith, and A. T. McCartt. "Crash risk factors for interstate large trucks in North Carolina." Accessed November 29, 2018. <https://www.ncbi.nlm.nih.gov/pubmed/28882260>.
- Texas A&M University, Mary Kay Center, "LNG Pool Fire Modeling White Paper," Texas A&M University System, September, 2008, http://psc.tamu.edu/files/links/lng-white-paper-on-pool-fire-modeling/LNG_White_Paper.pdf
- Transportation Research Board. *Hazardous Materials Transportation Risk Assessment: State of the Practice*, 2012.
- Treichel, T. T., and C. P. L. Barkan, 1993. "Working Paper on Mainline Freight Train Accident Rates." Research and Test Department. Washington, DC.: Association of American Railroads.
- Tyrell, D., 2015. "Liquefied Natural Gas Tender Crashworthiness Research." Volpe National Transportation Systems Center.
- Tyrell, D., 2016. "Liquefied Natural Gas Tender Crashworthiness in Train-to-Train Collisions." Volpe National Transportation Systems Center.
- Uijt de Haag, P. A. M., B. J. M. Ale, and J. G. Post, 2005. *The 'Purple Book': Guideline for Quantitative Risk Assessment in the Netherlands*. Bilthoven: National Institute of Public Health and the Environment.
- Verma, M., 2011. "Railroad transportation of dangerous goods: A conditional exposure approach to minimize transport risk." *Transportation Research Part C* 19(5): 790-802.
- Verma, M., V. Verter, and M. Gendreau, 2011. "A Tactical Planning Model for Railroad Transportation of Dangerous Goods." *Transportation Science* 45(2): 163-174.

- Verter, V., and B. Y. Kara, 2001. "A GIS-Based Framework for Hazardous Materials Transport Risk Assessment." *Risk Analysis* 21(6): 1109–1120.
- Volkov, D., M. M. Foss, and R. Makaryan. "LNG Safety and Security," *9th Topical Conference on Gas Utilization 2009 - Topical Conference at the 2009 AIChE Spring National Meeting* (January 2009): 318-338.
- Wang, Y. H., 1993. "On the number of successes in independent trials," *Statistica Sinica* 3: 295–312.
- Wang, Z., M. Saat, C. Barkan, and X. Liu. "Trends in U.S. Freight Train Accident Causes and Rates—A Quantitative Approach." Presented at the TRB 96th Annual Meeting, January 8 – 12, 2017.
- Williams, T. A. "AGA Staff Paper: Technical Background and Issues of Gas Interchangeability." April 2006. <https://goo.gl/ypaAVd>.
- Woodward, J. L., and R. M. Pitblado, 2010. *LNG Risk Based Safety: Modeling and Consequence Analysis*. New York: Wiley.
- (Zarembski and Palese, 2010; Sawadisavi, 2010; Peng, 2011)

B.1 Resources on the Properties of Liquefied Natural Gas

- Chevron Corporation, "liquefied natural gas (LNG): safely and efficiently transporting natural gas." Accessed March 16, 2018. <https://www.chevron.com/stories/liquefied-natural-gas>.
- Energy.gov, "Liquefied Natural Gas (LNG)." Accessed March 16, 2018. <https://energy.gov/fe/science-innovation/oil-gas/liquefied-natural-gas>.
- Energy Information Administration, "Natural Gas Explained." Accessed March 16, 2018. https://www.eia.gov/energyexplained/index.cfm?page=natural_gas_home.
- Energy Information Administration, "Natural Gas Imports and Exports." Accessed March 16, 2018. https://www.eia.gov/energyexplained/index.cfm?page=natural_gas_imports.
- Energy Information Administration, "U.S. Energy Facts Explained." Accessed March 16, 2018. https://www.eia.gov/energyexplained/?page=us_energy_home.
- Energy Information Administration, "What are natural gas liquids and how are they used?" *Today in Energy*, April 20, 2012. <https://www.eia.gov/todayinenergy/detail.php?id=5930>.
- Energy Information Administration, "Wholesale Electricity and Natural Gas Market Data." Updated February 1, 2018. <https://www.eia.gov/electricity/wholesale/>.
- Shell Global, "Liquefied Natural Gas (LNG)." Accessed March 16, 2018. <http://www.shell.com/energy-and-innovation/natural-gas/liquefied-natural-gas-lng.html>.

B.2 Additional Links and Resources

https://en.wikipedia.org/wiki/Liquefied_petroleum_gas. Accessed March 18, 2018.

<https://www.afdc.energy.gov/fuels/propane.html>. Accessed March 18, 2018.

http://www.engineeringtoolbox.com/propane-d_1423.html. Accessed March 18, 2018.

http://www.engineeringtoolbox.com/fuels-ignition-temperatures-d_171.html. Accessed March 18, 2018.

[https://www.mathesongas.com/pdfs/products/Lower-\(LEL\)-&-Upper-\(UEL\)-Explosive-Limits-.pdf](https://www.mathesongas.com/pdfs/products/Lower-(LEL)-&-Upper-(UEL)-Explosive-Limits-.pdf). Accessed March 18, 2018.

https://en.wikipedia.org/wiki/Natural_gas_processing. Accessed March 18, 2018.

<https://www.uniongas.com/about-us/about-natural-gas/chemical-composition-of-natural-gas>. Accessed March 18, 2018.

<https://energy.gov/natural-gas>. Accessed March 18, 2018.

http://petrowiki.org/Natural_gas_properties. Accessed March 18, 2018.

https://en.wikipedia.org/wiki/Natural_gas. Accessed March 18, 2018.

<https://www.eia.gov/naturalgas/>. Accessed March 18, 2018.

http://petrowiki.org/Associated_and_nonassociated_gas. Accessed March 18, 2018.

<http://webbook.nist.gov/chemistry/faq/>. Accessed March 18, 2018.

<http://webbook.nist.gov/cgi/cbook.cgi?ID=74-82-8>. Accessed March 18, 2018.

<https://en.wikipedia.org/wiki/Methane>. Accessed March 18, 2018.

<https://en.wikipedia.org/wiki/Methane>. Accessed March 18, 2018.

https://en.wikipedia.org/wiki/Hydrogen_safety. Accessed March 18, 2018.

<https://en.wikipedia.org/wiki/Propane>. Accessed March 18, 2018.

<https://www.ccohs.ca/oshanswers/chemicals/flammable/flam.html>. Accessed March 18, 2018.

<http://www.cryostar.com/web/peak-shaving.php>. Accessed March 18, 2018.

<http://www.ingaa.org/File.aspx?id=21698>. Accessed March 18, 2018.

Appendix C. Regulatory Framework

Federal oversight of LNG throughout the LNG value chain is complex due to the number of Federal agencies involved and the different types and modes of transport, both foreign and domestic.

In the United States, liquefied natural gas (LNG) has the unique distinction of being the only flammable or hazardous material whose storage terminal (siting), handling and terminal operations are regulated by the Federal Government. Regulations are promulgated by the PHMSA. Storage and handling of all other flammable and hazardous materials are regulated by State laws.⁹¹

FERC authorizes interstate pipelines (red), while PHMSA authorizes LNG transfer piping from plants to transportation assets (green). Gathering pipelines from maritime oil wells are authorized by MARAD. Figure C.1 and Table C.1 illustrates these relationships and Federal oversight of the LNG value chain.

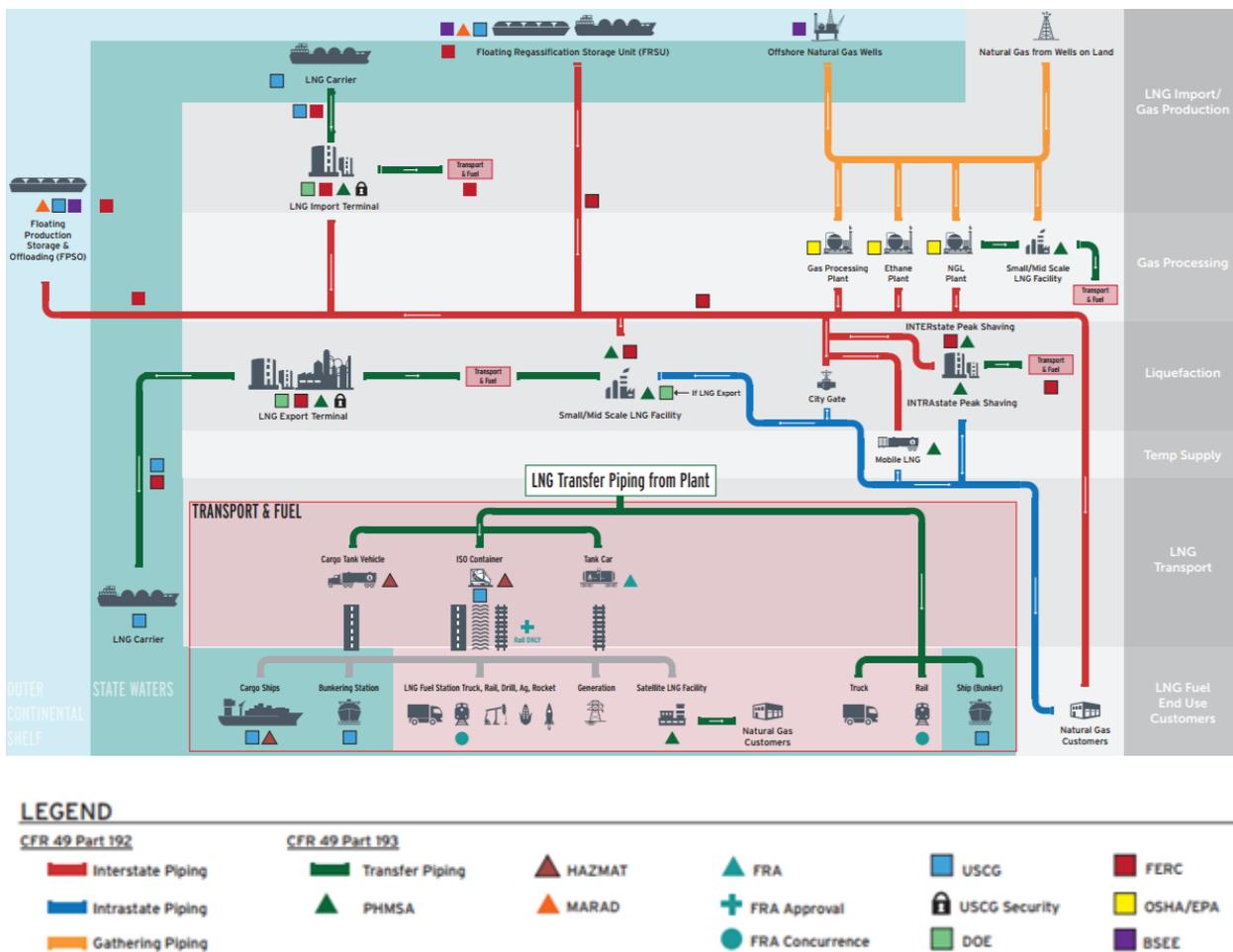


Figure C.1 Federal Oversight of LNG Value Chain

Source: PHMSA, <https://www.phmsa.dot.gov/pipeline/technical-resources/liquefied-natural-gas/regulatory-information/special-permits>.

⁹¹ Raj and Lermoff, "Risk analysis based LNG facility..."

Table C.1 U.S. Federal Agency LNG Oversight

Agency	Description	LNG Oversight
DOE	Department of Energy	Environmental regulation, permitting, import/export
EPA	Environmental Protection Agency	Clean Air Act and the Clean Water Act
FERC	Federal Energy Regulatory Commission	LNG Facility Siting, Permitting, Interstate commerce
FMCSA	Federal Motor Carrier Safety Administration	Cryogenic tanks and cargo tank safety, oversight, regulations, inspections
FRA	Federal Railroad Administration	LNG Locomotive Tenders, bulk transport by special permit
FWS	Fish and Wildlife Service	Endangered species
MARAD	Maritime Administration	Off-Shore LNG facility design, siting, navigation
NOAA	National Oceanographic and Atmospheric Administration	Endangered species
PHMSA	Pipeline and Hazardous Materials Administration	LNG Facility Design, packaging, transportation
USACE	Army Corps of Engineers	Dredging and wetland permits
USCG	United States Coast Guard	Maritime LNG transfer areas, inspections, LNG bunkering

Source: PHMSA, FERC, and Cambridge Systematics, Inc.

DOE is part of an interagency working group on LNG that meets regularly, with the most recent meeting held on October 19, 2017. Participating agencies include PHMSA, DOE, FERC, USCG and EPA.

Section §172.101 contains information on the Hazardous Materials Table (HMT). LNG is characterized as Methane, refrigerated liquid, UN1972, and is classified for transportation as a Flammable Gas, Class 2.1. Section §172.102 contains Special Provisions for LNG portable tank requirements, or the T-75 container. TP5 specifies fill rate and outage for portable tanks. LNG Packaging is shown in column eight of the HMT. There is no “Non-bulk packaging”; Bulk Packaging is described in §173.318 as “Cryogenic Liquids in Cargo Tanks.”

LNG Transportation by Vessel is listed under Stowage “D,” Above Deck on a cargo vessel, or a passenger-carrying vessel, with a restriction on the number of containers.

LNG Transportation by Rail tank car is not authorized at this time. Portable tanks and Cargo tank are authorized on a rail car, but only with approval from Federal Railroad Administration (FRA). Section §174.63 specifies requirements for rail carriers to transport portable tanks of hazardous material in Container-on-flatcar (COFC) and Trailer-on-flatcar (TOFC) service.

LNG Transportation by Highway moves by truck, using double walled, vacuum insulated tanks and cargo tank trailers. There are currently 136 carriers that haul LNG.

LNG Transportation by Pipeline only occurs between LNG storage tanks and ships, locomotives and trucks for loading and unloading purposes. LNG pipelines must be heavily insulated and are generally only used in applications over very short distances.

Appendix D. Liquefied Natural Gas Defined

Liquefied natural gas (LNG) is simply natural gas that has been cooled to convert into a liquid.⁹² In many cases, some trace constituents of natural gas are removed before, or as part of, liquefaction. As an extremely cold liquid (at ambient pressure), LNG is a cryogenic liquid. Most sources note a liquefaction temperature of -162°C (111.15 K, -260°F), which corresponds to the ambient pressure boiling point of methane (-161.49°C ; 111.66 K, -258.68°F).

To understand LNG as a cryogenic liquid, the discussion should begin with methane (the principal constituent of natural gas, and therefore LNG), make a detour to the term “cryogenic liquid,” and then consider natural gas and LNG.

D.1 Methane

Methane needs to be considered first as it is the principal component (usually 90 percent or more) of natural gas. Methane (CH_4 to a chemist) is the simplest “hydrocarbon” (substances predominantly composed of hydrogen and carbon). Most refined liquid fossil fuels (e.g., gasoline, diesel, JP8, etc.) and other common fuels (propane, butane, lighter fluid, etc.) are composed of hydrocarbon compounds. Coal also is principally a hydrocarbon material.

Of the hydrocarbon fuels, methane has the greatest ratio of hydrogen to carbon (4:1), which has important implications. When burned it creates the lowest possible ratio of carbon dioxide (CO_2) to water, so burning methane releases a greater ratio of heat to carbon dioxide than burning any other hydrocarbon. That is, methane as a fuel releases less greenhouse gas (carbon dioxide) than other hydrocarbon fuels, making it “greener.” This, along with the facts that methane combustion easily proceeds to completion (thereby releasing no volatile organic compounds, VOCs), usually burns without forming soot, has been increasingly available in recent years, accounts for the rapid increase in interest in natural gas for fuel use.

Because natural gas is mainly methane, the properties of natural gas and LNG are largely determined by those of the contained methane (Table D.2). Key properties of methane include:

⁹² Natural gas liquefaction is normally accomplished by one of two processes:

- (a) The ‘cascade’ process, in which another cold gas is used to cool the natural gas until it liquefies; or
- (b) The ‘Linde’ process which relies upon the Joule-Thompson effect. That is similar to the technology used in a conventional refrigeration cycle: The gas is compressed, then cooled to remove heat. It is then passed through an orifice and the pressure reduced. The gas expansion naturally cools the gas (through the Joule-Thompson effect). If that cold gas is again compressed and cooled, the next expansion makes it yet colder, until liquefaction occurs.

Table D.1 Methane Gas Properties^{1, 2, 3}

Chemical formula	CH ₄
Molar mass	16.04 g·mol ⁻¹
Appearance	Colorless gas
Odor	Odorless
Density	0.656 g/L (gas, 25°C, 1 atm) 0.716 g/L (gas, 0° C, 1 atm) 0.42262 g/cm ³ (liquid, -162 °C)
Melting point	-182.5 C; -296.4 F; 90.7 K
Boiling point	-161.49 C; -258.68 F; 111.66 K
Solubility in water	22.7 mg/L
Solubility	soluble in ethanol, diethyl ether, benzene, toluene, methanol, acetone

¹ <http://webbook.nist.gov/chemistry/faq/>.

² <http://webbook.nist.gov/cgi/cbook.cgi?ID=74-82-8>.

³ <https://en.wikipedia.org/wiki/Methane>.

It should be noted that (as is typical) the cold liquid is much denser than the gas. Once liquefied, because it is a cryogenic liquid, it must be transported or stored in insulated tanks.

As noted above, methane is a colorless, odorless gas at ambient conditions. It is, however, flammable in mixtures with air at 4.4-17 percent by volume.⁹³ For comparison, the explosive (flammability) limits in air for hydrogen are 4-75 percent by volume in air, for propane are 2.4-9.5 percent by volume in air, and for gasoline are 1.4-7.6 percent by volume in air.^{94, 95, 96}

Methane also is a greenhouse gas. According to the 2013 IPCC report, methane has a global warming potential of 86 for a 20-year time horizon, and 34 for a 100-year time horizon,^{97, 98 99}

⁹³ <https://en.wikipedia.org/wiki/Methane>.

⁹⁴ https://en.wikipedia.org/wiki/Hydrogen_safety.

⁹⁵ <https://en.wikipedia.org/wiki/Propane>.

⁹⁶ <https://www.ccohs.ca/oshanswers/chemicals/flammable/flam.html>.

⁹⁷ https://en.wikipedia.org/wiki/Global_warming_potential.

⁹⁸ Myhre et al., "Anthropogenic and Natural Radiative Forcing."

⁹⁹ Stocker et al., *Anthropogenic and Natural Radiative Forcing*.

(Footnote continued on next page...)

D.2 Cryogenic Liquids

Cryogenic liquids are simply very cold liquids; this term is normally applied to liquids with boiling points below ambient temperatures.¹⁰⁰ The exact temperature range that constitutes “cryogenic” is not well defined.¹⁰¹ One “practical definition” would be any temperature below that of “dry ice,” which is a commonly used low-temperature refrigerant. The most important definition of cryogenic liquid for the present purposes is probably that of the U.S. Department of Transportation (DOT):¹⁰²

“(g) **Cryogenic liquid.** A cryogenic liquid means a refrigerated liquefied gas having a boiling point colder than $-90\text{ }^{\circ}\text{C}$ ($-130\text{ }^{\circ}\text{F}$) at 101.3 kPa (14.7 psia) absolute. A material meeting this definition is subject to requirements of this subchapter without regard to whether it meets the definition of a nonflammable, nonpoisonous compressed gas in paragraph (b) of this section.”¹⁰³

D.3 Natural Gas

The term “natural gas” refers to naturally occurring hydrocarbon gas frequently collected for use as fuel.¹⁰⁴ It is formed in both thermogenic processes, from deeply buried organic material (typically from the carboniferous period), and (principally as methane) in biogenic processes by methanogenic (methane forming) bacteria in various terrestrial locations (bogs, marshes, shallow sediment) or even animals (e.g., fermentation within digestive tracts of mammals) and animal waste (e.g., sewage).

As recovered, natural gas is principally methane, but has a variable composition that includes several additional compounds, such as other hydrocarbons (ethane, propane) and other gasses (carbon dioxide, nitrogen, hydrogen sulfide). There is no formally defined “standard” composition for pipeline/commercial quality natural gas (see more below), though generally there is some processing of natural gas before it is distributed.¹⁰⁵ Water, excessive CO_2 , condensed liquids (NGL) and hydrogen sulfide (H_2S) and other objectionable components (mercaptans, thiols, sometimes traces of mercury, traces of radon) must be removed.

¹⁰⁰ Liquids that boil at temperatures above ambient (such as water) generally need not be handled cold, and therefore are not generally considered to be cryogenic. There are a few examples (e.g., acetone) where liquids have sufficiently low freezing points that they can be made cold and potentially considered ‘cryogenic’ but that is exceptional.

¹⁰¹ See, for instance, the discussion of cryogenics in Wikipedia: <https://en.wikipedia.org/wiki/Cryogenics>. There, one definition is temperatures below $-180\text{ }^{\circ}\text{C}$ (93.15 K; $-292.00\text{ }^{\circ}\text{F}$), while another is below $-150\text{ }^{\circ}\text{C}$ (123.15 K; $-238.00\text{ }^{\circ}\text{F}$); the discussion also considers the term ‘high temperature cryogenic’ referring to temperatures between the boiling point of liquid nitrogen, $-195.79\text{ }^{\circ}\text{C}$ (77.36 K; $-320.42\text{ }^{\circ}\text{F}$) and to $-50\text{ }^{\circ}\text{C}$ (223.15 K; $-58.00\text{ }^{\circ}\text{F}$).

¹⁰² Dry ice (https://en.wikipedia.org/wiki/Dry_ice) is frozen carbon dioxide. It sublimates at 194.65 K ($-78.5\text{ }^{\circ}\text{C}$; $-109.3\text{ }^{\circ}\text{F}$) at normal atmospheric pressure, which keeps it cold, and is therefore a common low-temperature refrigerant substance.

¹⁰³ Source: <https://www.law.cornell.edu/cfr/text/49/173.316>.

¹⁰⁴ Resources:

- (a) <https://energy.gov/natural-gas>.
- (b) Society of Petroleum Engineers’ http://petrowiki.org/Natural_gas_properties.
- (c) https://en.wikipedia.org/wiki/Natural_gas.
- (d) <https://www.eia.gov/naturalgas/>.

¹⁰⁵ https://en.wikipedia.org/wiki/Natural-gas_processing.

(Footnote continued on next page...)

“Natural gas is a naturally occurring gas mixture, consisting mainly of methane. While most of the gas supplied to Union Gas is from western Canada, some gas is supplied from other sources, including the United States and Ontario producers. While the gas from these sources has a similar analysis, it is not entirely the same. The table below outlines the typical components of natural gas on the Union Gas system and the typical ranges for these values (allowing for the different sources).”¹⁰⁶

Note that there is no guarantee of the following composition at your location or as an overall system average (Table D.3).

Table D.2 Sample Natural Gas Composition

Component	Typical Analysis (Mole %)	Range (Mole %)
Methane	95.0	87.0–97.0
Ethane	3.2	1.5–7.0
Propane	0.2	0.1–1.5
iso–Butane	0.03	0.01–0.3
normal–Butane	0.03	0.01–0.3
iso–Pentane	0.01	trace–0.04
normal–Pentane	0.01	trace–0.04
Hexanes plus	0.01	trace–0.06
Nitrogen	1.0	0.2–5.5
Carbon Dioxide	0.5	0.1–1.0
Oxygen	0.02	0.01–0.1
Hydrogen	trace	trace–0.02
Specific Gravity	0.58	0.57–0.62
Gross Heating Value (MJ/m ³), dry basis	38.0	36.0–40.2”

Source: AGA web-page on Natural Gas Quality and Interchangeability, 2017.

It should be emphasized that the preceding information is simply one company’s data on material in their distribution system, and that it, “is *no guarantee of the [preceding] composition at your location*,”¹⁰⁷ which can vary. This obviously complicates any discussion of the properties of “natural gas.”

¹⁰⁶ <https://www.uniongas.com/about-us/about-natural-gas/chemical-composition-of-natural-gas>. The previously cited Wikipedia page (https://en.wikipedia.org/wiki/Natural_gas_processing) also lists some common pipeline spec requirements and cites sources.

¹⁰⁷ For more information, and/or to illustrate the issue, the reader can consult the following sources:

- (a) The American Gas Association, “Natural Gas Quality and Interchangeability.”
- (b) Williams, “AGA Staff Paper.”
- (c) The North American Energy Standards Board, Inc. “Natural Gas Specs Sheet.”
- (d) “Differing market quality specs challenge LNG producers.”

(Footnote continued on next page...)

One reason for the variability in composition of natural gas is the range of sources for natural gas.^{108, 109} It can be associated—found and produced in conjunction—with crude oil production or non-associated and found in natural gas fields where gas is the predominant product.¹¹⁰ The latter tends to originate in deeper, hotter carbonaceous deposits.

Ordinarily, natural gas is distributed by pipeline. However, there are examples of associated natural gas that cannot be collected and distributed economically. These are referred to as “stranded” gas assets. In the past this gas may have been flared (burned) but increasingly this gas is now reinjected to the geological formation against possible future extraction. In those locations where it makes sense (ample gas, easy access to suitable transportation networks to customers wishing to import natural gas), it can be liquefied for transport in insulated tanks, in lieu of constructing dedicated pipelines.

“Dry” gas has relatively low amounts of higher hydrocarbons (i.e., molecules with two or more carbon atoms, versus the one in methane). “Wet” gas has greater fractions of higher hydrocarbons; these often condense to form, “natural gas liquids,” (NGL) as the gas is brought to the surface and the pressure reduced. When gas has more higher hydrocarbons, it may also be referred to as “rich” as it has a higher heat content; as the composition becomes more dominated by methane, or if there are more inert diluents (like nitrogen), the heat content falls and the gas is referred to as “lean.” When necessary, in distribution, natural gas can be adjusted to be leaner (by stripping NGLs), or richer (by injecting higher hydrocarbons like propane or ethane, or NGLs). “Sweet” natural gas is low in sulfur and CO₂; “sour” natural gas contains sulfur and other compounds that need to be removed before use.

D.4 Liquefied Natural Gas (LNG)

As noted above, LNG is a cryogenic liquid formed when natural gas is liquefied, and is a considerably more compact form of natural gas for storage and transport (at the cost of the energy required to liquefy).¹¹¹ Most sources note a liquefaction temperature of -162°C (111.15 K, -260°F), which corresponds to the ambient pressure boiling point of methane (-161.49°C ; 111.66 K, -258.68°F), also as noted above.

In most cases, LNG is liquefied when loaded into a vessel for transport by sea; it is then regasified at the destination, typically an off-shore (for safety) terminal from which it is transferred by pipeline to regional

¹⁰⁸ Resources:

- (a) <https://energy.gov/natural-gas>.
- (b) Society of Petroleum Engineers' http://petrowiki.org/Natural_gas_properties.
- (c) https://en.wikipedia.org/wiki/Natural_gas.
- (d) <https://www.eia.gov/naturalgas/>.

¹⁰⁹ Also see: http://petrowiki.org/Associated_and_nonassociated_gas.

¹¹⁰ According to Wikipedia (https://en.wikipedia.org/wiki/Natural-gas_processing), citing an MIT study (no longer available), as much as 89 percent of U.S. production was non-associated as of 2009; other, more recent, sources (<https://seekingalpha.com/article/3983989-associated-gas-production-falling-natural-gas-daily>) put the non-associated fraction at closer to 80 percent, thanks to production from horizontal/hydraulic fracturing oil wells.

¹¹¹ LNG resources

- (a) Energy.gov, “Liquefied Natural Gas (LNG).”
- (b) As usual, an informative Wikipedia page on LNG: https://en.wikipedia.org/wiki/Liquefied_natural_gas.

(Footnote continued on next page...)

distribution pipeline networks. In more limited cases, such as supply for peak shaving and natural gas distribution in the U.S. Northeast, LNG is transported by truck to distributed locations for regasification.¹¹²

The principal compositional differences between LNG and ordinary natural gas (i.e., gas that has not previously been liquefied) is that trace amounts of higher hydrocarbon compounds that might freeze, along with non-condensable (at least at -162 C) gases have been removed. With some subtle differences because of the presence of those other hydrocarbon compounds (mostly ethane and propane) LNG behaves like liquid methane. These details are normally dealt with at the detailed engineering level. See, for instance, the Society of Petroleum Engineers information on LNG.¹¹³

Closely related materials in commerce include Natural Gas Liquids (NGLs, mainly mixtures of ethane and propane, but this can include other hydrocarbons as well),¹¹⁴ liquefied petroleum gas (LPG; principally propane, with varying amounts of butane),¹¹⁵ ethylene, and propylene. While some NGLs may be refrigerated (cryogenic liquids) LPG is generally stored under pressure at ambient temperatures. Ethylene is transported as a cryogenic liquid (see Table D.3).

Table D.3 Chemical Properties of Natural Gas and Natural Gas Liquids

Property	Methane ^{1a}	Natural Gas	NGL	Propane (LPG) ²	Ethylene ³	Propylene ⁴
Chemical Formula	CH ₄	CH ₄ + others	C ₂ H ₆ , C ₃ H ₈ , ⁵	C ₃ H ₈	C ₂ H ₄	C ₃ H ₆
Melting Point (°C)	-182.5°C	*	N/A	-187.7°C	-169.2°C	-185.2°C
Boiling Point (°C)	-161.49°C	*	N/A	~ -42°C	-103.7°C	-47.6°C

¹¹² The usual purpose is peak shaving, and when not transferred as a gas and re-liquefied at the satellite location, it is currently most often transported by road. See:

- (a) www.beg.utexas.edu/...inc/.../Overview%20of%20U.S.%20LNG%20Industry.ppt.
- (b) <http://www.cryostar.com/web/peak-shaving.php>.
- (c) <http://www.ingaa.org/File.aspx?id=21698>.
- (d) <http://www.corbanenergygroup.com/lng-iso-containers/>.
- (e) <http://www.exponent.com/knowledge/alerts/2015/08/bulk-transportation/~media/03b73782ec76446798c70f6ac403ef84.ashx>.
- (f) <https://www.evollng.com.au/transport>.
- (g) http://files.chartindustries.com/14722928_TransportTrailers.pdf.
- (h) <https://www.elengy.com/en/clients/lng-truck-loading.html>.
- (i) https://ngi.stanford.edu/sites/default/files/7_Groode_IHS.pdf.

¹¹³ Resources:

- (a) <https://energy.gov/natural-gas>.
- (b) http://petrowiki.org/Natural_gas_properties.
- (c) https://en.wikipedia.org/wiki/Natural_gas.
- (d) <https://www.eia.gov/naturalgas/>.

¹¹⁴ Energy Information Administration, "What are natural gas liquids and how are they used?"

¹¹⁵ Resources:

- (a) https://en.wikipedia.org/wiki/Liquefied_petroleum_gas.
- (b) <https://www.afdc.energy.gov/fuels/propane.html>.

Property	Methane ^{1a}	Natural Gas	NGL	Propane (LPG) ²	Ethylene ³	Propylene ⁴
Liquid Density (g/cm ³)	0.42262 (-162°C)	*	N/A	0.580 ⁶ (-42 °C)	0.569 (-103.8°C)	0.6139 (-47.6°C)
Vapor pressure of liquid at 21.1°C (kPa)	(above critical temperature) ⁷	*	N/A	853.16	(above critical temperature)	~ 1200
Critical Temperature (°C)	-82.6 C	*	N/A	96.7°C	9.2°C	92.4°C
Flash point	-188°C	*	N/A	-104°C	-136°C	-108°C
Autoignition Temperature	537°C	*	N/A	470°C	542.8 °C	458°C ⁸
LEL (% v/v in air)	4.4	*	N/A	2.4	2.7 ⁹	2.4
UEL (% v/v in air)	17	*	N/A	9.5	36.0	11
Molar Mass (daltons, g/mol)	16.04	*	N/A	44.10	28.05	42.08
Enthalpy (heat) of combustion	~ -890 kJ/mol (~55.5 MJ/kg)	*	N/A	~-2 MJ/mol (~50 MJ/kg)	~ -1388 kJ/mol (~ 49.5 MJ/kg)	~ -2048 kJ/Mol (~ 48.7 MJ/kg)

* Similar to Methane; exact data varies by source/exact composition.

¹ Most data from <https://en.wikipedia.org/wiki/Methane>.

² Data given here is for pure propane (most from <https://en.wikipedia.org/wiki/Propane>); LPG will be similar.

³ Most data from <https://en.wikipedia.org/wiki/Ethylene>, <https://encyclopedia.airliquide.com/ethylene>, <https://pubchem.ncbi.nlm.nih.gov/compound/Ethene#section=Solubility>, or <http://www.airproducts.com/products/Gases/gas-facts/physical-properties/physical-properties-ethylene.aspx>.

⁴ Data from: <https://en.wikipedia.org/wiki/Polypropylene>, <http://www.thermopedia.com/content/1065/>, <https://www.chemeo.com/cid/23-076-2/Propene>.

⁵ Energy Information Administration, "What are natural gas liquids and how are they used?"

⁶ http://www.engineeringtoolbox.com/propane-d_1423.html.

⁷ Cannot be liquefied at this temperature.

⁸ http://www.engineeringtoolbox.com/fuels-ignition-temperatures-d_171.html.

⁹ [https://www.mathesongas.com/pdfs/products/Lower-\(LEL\)-&-Upper-\(UEL\)-Explosive-Limits-.pdf](https://www.mathesongas.com/pdfs/products/Lower-(LEL)-&-Upper-(UEL)-Explosive-Limits-.pdf).

D.5 LNG Storage and Handling

An important element in managing the risks associated with LNG are practices and technology for LNG storage and handling. Unsurprisingly, the LNG industry has invested considerable effort in developing these practices.¹¹⁶

¹¹⁶ The general properties and hazards of LNG are thoroughly covered in several sources. These include:

- La Fleur et al., "LNG Safety Assessment Evaluation Methods."
- Mokhatab et al. *Handbook of Liquefied Natural Gas*.

(Footnote continued on next page...)

A recurring theme in the practices associated with LNG storage and handling is the use of multiple layers of protection. At the most general level, these layers are:

- Containment, both primary and secondary.
- Safeguard Systems, such as prevention, protection, emergency response.
- Separation.

The underlying ideas are to ensure that in any incident:

- It is difficult for hazards to extend beyond the facility fence line.
- Multiple adverse incidents must occur before any safeguards are overcome, which lowers the likelihood of a hazard occurring.
- There is sufficient separation from vulnerable persons or facilities so that even if an event occurs and overcomes the safeguards, consequences for vulnerable persons or facilities are minimized.

All three layers are deeply enshrined in the management principles and in the applicable standards and regulations that apply to LNG facilities. These include:

- 18 CFR § 380 (National Environmental Policy Act).
- 33 CFR § 127 (Waterfront Facilities Handling Liquefied Natural Gas and Liquefied Hazardous Gas).
- 49 CFR § 193 (Liquefied Natural Gas Facilities; this incorporates NFPA 59A by reference).
- EEMUA 147 (Recommendations for the design and construction of refrigerated liquefied gas storage tanks).
- EN 1160 (Installation and equipment for Liquefied Natural Gas—General Characteristics of Liquefied Natural Gas).
- EN 1473 (*Installation and Equipment for Liquefied Natural Gas—Design of Onshore Installations*).
- NFPA 59A (*Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*), note that this has been incorporated by reference into U.S. DOT regulations).¹¹⁷

The containment layer involves the use of appropriate materials for LNG facilities as well as proper engineering design of facilities and equipment, and of storage tanks in particular. This layer also stipulates

-
- c. National Fire Protection Association, *NFPA 59A: Standard for the Production...*
 - d. "Liquefied Natural Gas Safety Research."
 - e. Volkov et al., "LNG Safety and Security."
 - f. "Managing LNG Risks—Industry Safeguard Systems."
 - g. National Association of State Fire Marshals. "Liquefied Natural Gas..."

¹¹⁷ NFPA 59A Standard for the Production, Storage, and Handling of Liquefied Natural Gas.

secondary containment provisions, such as dikes or secondary containers so that even if primary containers are breached, spills are still confined to the facility.

The safeguard layer includes operations and procedures, alarms and detectors, emergency shutdown procedures and equipment, fail-safe provisions, and the like. This layer is intended to allow early detection and remediation of issues, safe shutdowns and isolations, etc. Extensive and careful documentation and training is stipulated, and there are provisions to continuously capture and implement useful new practices and precautions.

Finally, the regulations universally stipulate setbacks and separation distances, which vary as a function of the hazard or complexity of an operation.

D.6 LNG Storage and Handling

An important element in managing the risks associated with LNG are the practices and technology for LNG storage and handling. Unsurprisingly, the LNG industry has invested considerable effort in developing these practices. A recurring theme in the practices associated with LNG storage and handling is the use of multiple layers of protection. At the most general level, these layers are: 1) containment; 2) safeguard systems, and 3) separation. The underlying ideas are to ensure that in any incident it is difficult for hazards to extend beyond the facility fence line. Multiple adverse incidents must occur before any safeguards are overcome, which lowers the likelihood of a hazard occurring. Finally, it is important that there is sufficient separation from vulnerable persons or facilities so that even if an event occurs and overcomes the safeguards, consequences for vulnerable persons or facilities are minimized. All three layers of protection are deeply enshrined in the management principles and in the applicable standards and regulations that apply to LNG facilities.

An important element in managing the risks associated with LNG are practices and technology for LNG storage and handling. Unsurprisingly, the LNG industry has invested considerable effort in developing these practices.¹¹⁸

A recurring theme in the practices associated with LNG storage and handling is the use of multiple layers of protection. At the most general level, these layers are:

- Containment, both primary and secondary.
- Safeguard Systems, such as prevention, protection, emergency response.
- Separation.

The underlying ideas are to ensure that in any incident:

- It is difficult for hazards to extend beyond the facility fence line.
- Multiple adverse incidents must occur before any safeguards are overcome, which lowers the likelihood of a hazard occurring.

¹¹⁸ Refer to note 118 for additional resources.

- There is sufficient separation from vulnerable persons or facilities so that even if an event occurs and overcomes the safeguards, consequences for vulnerable persons or facilities are minimized.

All three layers are deeply enshrined in the management principles and in the applicable standards and regulations that apply to LNG facilities. These include:

- 18 CFR § 380 (National Environmental Policy Act).
- 33 CFR § 127 (Waterfront Facilities Handling Liquefied Natural Gas and Liquefied Hazardous Gas).
- 49 CFR § 193 (Liquefied Natural Gas Facilities; this incorporates NFPA 59A by reference).
- EEMUA 147 (Recommendations for the design and construction of refrigerated liquefied gas storage tanks).
- EN 1160 (Installation and equipment for Liquefied Natural Gas—General Characteristics of Liquefied Natural Gas).
- EN 1473 (*Installation and Equipment for Liquefied Natural Gas—Design of Onshore Installations*).
- NFPA 59A (*Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*), note that this has been incorporated by reference into U.S. DOT regulations).¹¹⁹

The containment layer involves the use of appropriate materials for LNG facilities as well as proper engineering design of facilities and equipment, and of storage tanks in particular. This layer also stipulates secondary containment provisions, such as dikes or secondary containers so that even if primary containers are breached, spills are still confined to the facility

The safeguard layer includes operations and procedures, alarms and detectors, emergency shutdown procedures and equipment, fail-safe provisions, and the like. This layer is intended to allow early detection and remediation of issues, safe shutdowns and isolations, etc. Extensive and careful documentation and training is stipulated, and there are provisions to continuously capture and implement useful new practices and precautions.

Finally, the regulations universally stipulate setbacks and separation distances, which vary as a function of the hazard or complexity of an operation.

¹¹⁹ National Fire Protection Association, “NFPA 59A: Standard for the Production...”

Appendix E. United States LNG Facilities

E.1 EIA Regions

Discussions of the movement of, and infrastructure for, natural gas in the U.S. need to be informed by the regional base maps for natural gas as defined by the EIA. There are two maps and sets of regions, one based on natural gas production and consumption, and one based on storage (see Figure E.1).

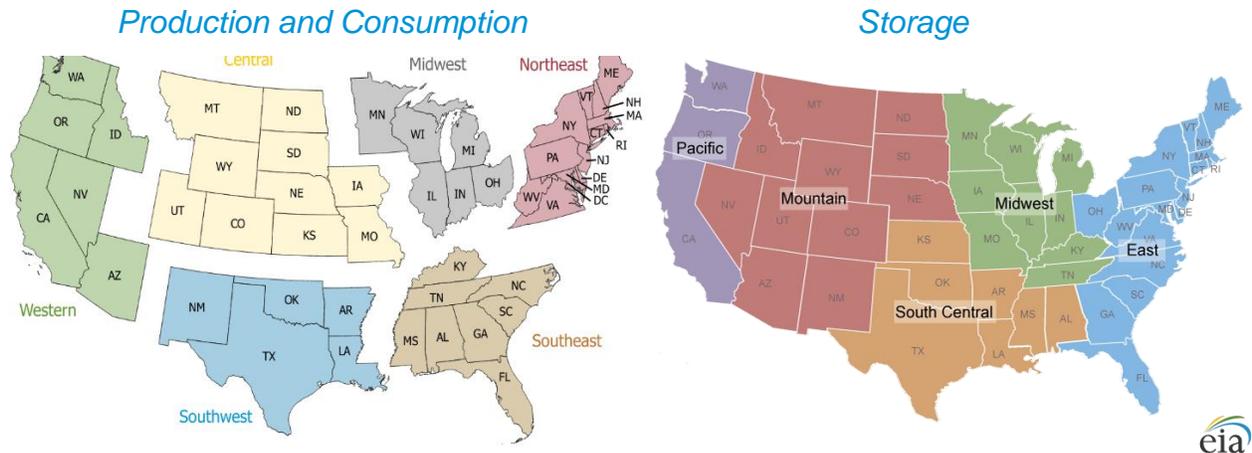


Figure E.1 Natural Gas Regions for Production/Consumption and Storage

Source: EIA. http://ir.eia.gov/ngs/notice_08_31_2015.html.

E.2 Existing LNG Import/Export Facilities

There are 12 import facilities in the United States, nearly all of which are in the process of converting from import-only to import-and-export facilities due to the domestic availability of shale gas. Four of these facilities are described in the following section.

E.2.1 Sabine LNG in Sabine, Louisiana (Existing Import/Export)

- Cheniere Energy has operated an LNG import terminal in Cameron Parish since 2008. In July 2011, the company announced plans to expand its existing facility and transform the Sabine Pass terminal into a bidirectional facility capable of exporting LNG, as well as receiving LNG for regasification. Construction began on the facility in 2012 and is expected to be completed at the end of 2015. When the facility comes online, it will likely be the first domestic export LNG terminal in the contiguous United States and is permitted to export up to 16 million metric tons of LNG. The company has already secured nonbinding deals for 9.8 million metric tons annually.
- Cheniere's Sabine Pass liquefaction terminal in Louisiana, currently the only such a facility to ship U.S. shale gas overseas, exported five cargoes of the fuel in the week ending September 27. According to the Energy Information Administration, five vessels with a combined LNG-carrying capacity of 18.5 billion cubic feet (Bcf) have departed the plant since September 25. This compares to five vessels with a capacity of 17 Bcf the week before. This also means that the liquefaction plant shipped at least 16

cargoes since September 6, when it resumed vessel loadings following Hurricane Harvey, with a total LNG-carrying capacity of 57.4 Bcf. EIA also said in its weekly natural gas report that one vessel with a capacity of 3.8 Bcf was loading at the Sabine Pass terminal on Wednesday. Latin America and Asia-Pacific are continuing to be the preferred regions for shipments of U.S. LNG. The latest data by the Department of Energy shows that Mexico, Korea, China and Chile are the top buyers of the fuel coming from the Sabine Pass plant. In total, more than 175 cargoes of U.S. LNG landed in 25 different countries in the period spanning from February 2016 to August 2017.¹²⁰

E.2.2 Cameron LNG in Hackberry, Louisiana (Proposed Export)

- On October 23, 2014, Sempra Energy broke ground on a new \$6 billion liquefaction processing complex in Hackberry, Louisiana. The LNG facility already has long-term agreements with Mitsubishi Corporation and Mitsui & Co. based in Japan, as well as GDF Suez SA based in France; both will purchase the LNG exports produced at the facility. Initial LNG shipments will begin by the end of 2017 and full operations will be in place by 2019.

E.2.3 Freeport LNG in Freeport, Texas (Proposed Import/Export)

- In July 2014, Freeport LNG received FERC authorization to site, construct and operate a liquefaction project. Final approvals were issued by the DOE and FERC in November 2014. The current facility at Freeport has an LNG receiving, storage, and regasification terminal. The additional project will allow Freeport LNG to export approximately 13.2 million metric tons annually. The Eagle Ford, Barnett, and Haynesville shale gas deposits are expected to be significant sources of supply for the project.
- The Freeport LNG facility will consist of three LNG trains. 20-year agreements have already been signed for the entire capacity of the first two trains; companies include Osaka Gas, Chubu Electric, and BP Energy. Tolling agreements have also been signed by Toshiba Corporation and SK E & S for the remaining facility capacity in train three.

E.2.4 Cove Point LNG in Cove Point, Maryland (Import/Export)

On September 29, 2014, the Cove Point LNG project became the fourth approved LNG export terminal in the contiguous United States. The existing Cove Point facility has been an LNG import terminal for almost 40 years. The new project will create one LNG train that will have the capacity to export 5.75 million metric tons of LNG annually. No new pipelines or storage tanks are needed at the facility and export operations started in January, 2018.

Table E.1 summarizes approved and existing LNG Export terminals.

¹²⁰ According to a press release from the EIA, September 27, 2017.

Table E.1 FERC Approved and Existing LNG Export Facilities May 2017

United States (Import)	Status	Throughput	Contracts
Cove Point, MD	Approved, existing	0.82 bcf/d	Japan, India
Kenai, AK	Approved, existing	0.2 bcf/d	Tokyo Gas, Japan Tokyo Electric, Japan
Sabine, LA	Approved, existing	2.0 bcf/d	BG Gulf Coast LNG, UK Gas Natural Fenosa, Spain Korea Gas Corp, S. Korea GAIL India Limited Total Gas & Power NA Centrica PLC, UK

Source: Federal Energy Regulatory Commission (FERC) Website, Oct 2017.

E.3 Approved LNG Export Facilities

Table E.2 describes LNG facilities approved by FERC as of May, 2017.

Table E.2 FERC Approved LNG Facilities May 2017

United States (Import)	Status	Throughput
Corpus Christie, TX	Approved, under construction	0.4 Bcf/d
Salinas, PR	Approved, not under construction	0.6 Bcf/d
United States (Export)	Status	Throughput
Sabine, LA	Approved, under construction	0.7 Bcf/d
Hackberry, LA	Approved, under construction	2.1 Bcf/d
Freeport, TX	Approved, under construction	2.14 Bcf/d
Corpus Christie, TX	Approved, under construction	2.14 Bcf/d
Sabine Pass, TX	Approved, under construction	1.4 Bcf/d ¹
Elba Island, GA	Approved, under construction	0.35 Bcf/d
Canada (Export)	Status	Throughput
Port Hawkesbury, NS	Approved, not under construction	0.5 Bcf/d
Kitimat, BC	Approved, not under construction	3.23 Bcf/d
Squamish, BC	Approved, not under construction	0.29 Bcf/d
Prince Rupert Island, BC	Approved, not under construction	2.74 Bcf/d

Source: Federal Energy Regulatory Commission

E.4 Proposed LNG Export Facilities

- As of December 3, 2014, there were 16 proposed LNG export terminal applications. At least four of the proposed terminals already have existing LNG import operations in place. As previously discussed, these four locations will be at a significant advantage to begin LNG export operations due to existing infrastructure. At least three of the remaining proposed locations are very close to a current import facility or import facility that is converting to export facility.
- Ten of the 16 proposed terminals are located in the Gulf Coast. Of the remaining proposed terminals, two are located on the west coast in Oregon and Washington; three are located on the east coast in Maine, Georgia, and Florida; and one is located in Alaska.
- At least two of the proposed terminals are far along in the process of becoming an approved export terminal. Corpus Christi LNG had a final Environment Impact Statement issued by the FERC on October 8, 2014. Jordan Cove Energy Project had a final Environmental Impact Statement issued May 1, 2009, but was given several areas to address before continuing the permitting process.
- One MMPA (million metric tons per annum) per module and the Elba Island Plant is proposing 10 liquefaction modules for export. Elba currently has 11 vaporizers for import with 1755 MMcf capacity.
- Smaller peak shavers use bottles of propane, not cargo tank trips by truck. Satellite facilities are usually State controlled. Peak shavers liquefy during low demand, vaporize during high demand. Peak shavers may also inject LNG into an interstate pipeline. When natural gas is not available, sometimes they use a mixture of propane and nitrogen to approximate natural gas BTU levels. (FERC Interview September 2017).

E.5 Emerging LNG Facilities

Emerging LNG facilities are located in Florida, Louisiana, Pennsylvania, Texas and Vermont. They have been constructed but have not yet been documented in PHMSA and EIA databases. This section describes several recent LNG facilities and capacities constructed since 2014.

E.5.1 Scranton and Pittsburg, PA

REV LNG has constructed two liquefied natural gas facilities, primarily for fueling trucks but also for the energy exploration and production sector and eventually for marine customers. One facility is located near Scranton in Bradford County in northeast Pennsylvania and a second plant south of Pittsburgh. Both facilities produce 50,000 GPD with expansion capabilities to 200,000 GPD. Initial onsite storage is 150,000 gallons. Affiliate Rev Hoopes Trucking operates a fleet of 35 LNG tractors. Rev LNG itself has approximately 10 trucks, half of them LNG-fueled, delivering fuel to energy customers. REV LNG trucks serve both facilities and transport LNG to customers across Eastern United States.



E.5.2 Jacksonville, FL

Eagle LNG is building a liquefaction plant in West Jacksonville able to produce 200,000 gallons a day. This plant will serve Crowley Maritime. Eagle also is building a second LNG production and storage facility near the Blount Island Terminal and a holding facility at Talleyrand Marine Terminal. JAX LNG is building a liquefaction and storage facility at Dames Point to fuel TOTE Maritime's ships, with capacity to produce in excess of 120,000 gallons of LNG per day.¹²¹

The Port of Jacksonville, FL, also known as JAXPORT, has developed multiple transportation, storage and export opportunities for LNG. JAXPORT tenants TOTE Maritime Puerto Rico and Crowley Maritime Corp. are leaders in the emergence of LNG as a preferred fuel source for the maritime industry. TOTE Maritime operates two 3,100 TEU LNG-powered containerships out of JAXPORT's Blount Island Marine Terminal. Isla Bella and Perla Del Caribe are the world's first LNG-powered containerships.



E.5.3 Miami, FL

FECR built an LNG liquefaction plant in 2015 with Chart Industries in Hialeah, FL capable of producing 100,000 GPD of LNG. There are three 90,000 gallon tanks located at the Hialeah Rail Yard used to store LNG. The facility is used to produce LNG for export to the Caribbean and for fueling FECR dual-fuel locomotives in service in Florida.

E.5.4 Hawkins, TX

This LNG facility was built as part of an existing gas processing plant, including 50,000 storage tanks for LNG. The project was completed in 2015 and includes a nitrogen rejection unit and is used for the merchant market. Existing gas compression equipment enables vapor recovery as part of the truck filling process. Excess gas is compressed and injected into the natural gas pipeline system.

E.5.5 George West, TX

This LNG facility was built in 2015 with Chart Industries to support the use of fuel for high horsepower engines used in the oilfield in the Eagle Ford Shale Region. This plant has liquefaction capability of up to 100,000 GPD and three 90,000 gal storage capability onsite. Two truck loading racks can load two transport trailers at the same time.

¹²¹ <https://www.jaxport.com/>.

E.5.6 Florence, VT

This plant was built with Chart Industries for a mineral processing facility in Vermont in 2013. The facility includes eight 15,000 gallon storage tanks for a total storage volume of 120,000 gallons. This is a storage-only facility with no liquefaction capability. Over a dozen high horsepower trucks are used 24/7 at this mining facility.

E.5.7 Port Fourchon, LA

The Greater Lafourche Port Commission (GLPC) and tenant Energy World USA (EWUSA) is planning to construct a proposed five million tons per annum midscale liquefied natural gas (LNG) production and export facility at Port Fourchon, LA.



Once constructed, Phase 1 of the Fourchon LNG project will produce two million tons of LNG per year for export, with a program to increase capacity up to five million tons in Phase 2. Fourchon LNG also plans to reserve up to half a million tons of LNG per year for domestic use, with the intent of providing LNG to fuel the next generation of Harvey Gulf offshore supply vessels (OSVs) powered by LNG and operating in the Gulf of Mexico. To support the development of the LNG fueling facility, Harvey Gulf has secured CH-IV International of Houston, Texas as the EPC contractor. The facility will consist of two sites each having 270,000 gallons of LNG storage capacity.

GLPC has been working with Energy World to produce a Preliminary Waterway Suitability Assessment with the U.S. Coast Guard, which will help to ensure that current and future port activities are not adversely affected by the operation of the potential facility. GLPC and Energy World currently are working with the Coast Guard to advance to the next stage of the Waterway Suitability Assessment process for the project. This assessment will also serve to support Energy World's application to the Federal Energy Regulatory Commission (FERC) for project approval.¹²²

¹²² http://portfourchon.com/fourchon_lng_kicks_off_ferc_process/.

Appendix F. Cryogenic Tank Cars, Cargo Tanks, and Portable Containers

Tank and container designs are proprietary to the manufacturers, and must comply with Federal regulations. U.S. regulations for the specifications of cryogenic tank cars, cargo tank trailers, and portable containers were most recently updated in 2016. In the U.S., the UN T75 ISO portable tank and the MC-338 cargo tank are authorized to transport LNG by truck and maritime. Tank manufacturers and subject matter experts in rail engineering give insight into the best practices for handling, safety testing, and issues involving tank car pressure relief valves (PRV), bottom outlets, manifolds and other apertures. Currently there is not a cryogenic tank car approved for LNG, the AAR is reviewing the DOT 113 tank car specifications based on request from shippers to ship LNG by rail, and the AAR petitioned PHMSA to add methane to the list of approved materials transported by the DOT-113.

Reports involving tank safety for LNG gives insight into potential vulnerabilities in tank design, emergency response, loading and unloading processes, and training. Historical incidents for cryogenic containers—as a class, gives insight into the consequences that have occurred as a result of leaks, damage, or other incidents in which cryogenic product was released from the containers. Incidents from other countries in which LNG was released provides insight into what other markets have learned about the safe surface transport of LNG.

Since the DOT-113 has not been used for LNG, there is no record to examine except for the transport of the cryogenic liquid gases that it is authorized to transport. Adding a new flammable gas to the regulation is heavily scrutinized. The creation of a new DOT-117 tank car to replace the DOT-111 used for crude oil and ethanol sets a precedent for tank car redesign and increased safety standards, and reflects concern over tank car safety in derailments. While most derailments are caused by track failure, the track standards and regulations lack technical basis, and tank cars moving hazardous materials should be able to withstand the impact and heat that may arise during an incident.

LNG is permitted to be transported by rail in Europe in specially designed tank cars. Chart and VTG have combined to produce two of these tank cars which have complete approvals and which have completed test runs with LNG. LNG is permitted to be transported by rail in Canada in both DOT-113 tank cars and UN T75 ISO containers. This was approved in 2014, they have to comply with the selection and use requirements of CSA B625-08 clauses 6.1 and 6.4, including the requirement for TC IMPACT APPROVED marking. Even though the DOT-113 is authorized to move LNG in Canada, there has not been enough economical drive, and there are no reports of LNG rail shipments in Canada. The MC-338 and the UN T75 both have documented records in the safe transport of LNG by highway. The UN T75 has a relatively small record on the shipment of LNG by rail in the U.S., but does have a more robust record by other modes such as highway and maritime and in other countries where it is authorized.

F.1 ISO Containers

The transport of LNG by rail is allowed only by special permits authorized by the FRA—at least two entities in the U.S. have current, active natural gas dual fuel programs and operate under a “Letter of Concurrence” from the FRA. Two types of tenders are being utilized in the prototype programs: ISO container holding maximum of 10,000 gallons of LNG, and tank car holding between 22,000 and 25,000 gallons of LNG. Both major U.S. freight locomotive original equipment manufacturers are actively involved with the AAR Tank Car Advisory Group activities and with the prototype programs.

ISO containers are intermodal containers suitable for multiple transportation methods such as truck, rail, or ship. They are manufactured according to specifications from the International Organization for Standardization (ISO). ISO is a worldwide federation of national standards. It is a voluntary organization with one member representing each country in the world, and the aim is to create manufacturing standards such that products may be interchangeable around the world. The work of preparing International Standards is normally carried out through ISO technical committees. The regulations guarantee that a standardized container can withstand the environments endured during transport and the structural integrity needed to be lifted by cranes or other heavy equipment. ISO containers come in various shapes and forms and are used to transport a variety of products.

ISO intermodal containers are used to transport cryogenic bulk liquids—nitrogen, oxygen, argon, methane, nitrous oxide, ethylene and carbon dioxide. ISO containers with LNG are authorized by rail in the U.S. only by special permit. Containers designed and optimized for LNG also are popular for transportation of ethylene. Containers designed by Chart Industries have hold times of between 44 to 65 days. This means that without intervention, the containers would be insulated and keeping the LNG at cryogenic temperatures for the length of the hold time. For the shipment of LNG, the appropriate ISO container is bulk cryogenic liquid container type code T75 (UN T75 / IMO 7). The specifications for these portable tanks are found in 49 CFR 178.274. The chemical ID in UN Standards for LNG is UN 1972. Packing instruction P203 and special provision TP5 apply. Portable T75 tanks do not have any refrigeration equipment, they function by insulating the very cold contents for an extended period of time, much more than the expected travel time.

The ISO tank portable containers have exterior dimensions that are the same standard dimensions as ISO containers, but are a cylindrical tank mounted, protected, and surrounded by a rectangular steel framework. The UN T75 is an insulated stainless steel tank with a surrounding steel frame that conform to typical intermodal container dimensions such as 8 feet wide, 8.5 feet or 9.5 feet tall, and 20 or 40 feet long. The volume of the tanks vary by manufacturer between 5,000 gallons and 11,000 gallons of liquid. ISO container manufactures issue container safety certifications that must be renewed every 30 months by a certified inspector. ISO containers are ideal as their dimensions are standardized by ISO, and containers use space efficiently. Standard ISO container height is 8 ft. 6 in., but they are available in several other specified heights as low as four feet (half-height) and as high as 9 ft. 6 in. (high cube). The standard used to identify intermodal (shipping) containers is ISO 6346:1995. This standardized identification system is used to give each container a unique marking. Figure F.1 shows an ISO portable tank.



Figure F.1 Portable ISO Container

Source: Courtesy Chart Industries.

ISO cryogenic liquid tank containers vary in specifics between manufacturers, but the necessary specifications are the same between the different companies. As shown in **Figure F.1**, UN T75 has a stainless steel tank, which stores the cryogenic fluid, and is mounted by means of the support of insulating material in the outer shielding tank, which is made of carbon steel. In the space between the tanks there is a multilayer insulation material with the radiation shields. The air has been removed from the space between the tanks in order to obtain a medium-level vacuum. The fittings and the tank are placed on external supports in the container frame. The container frame and the outer tank, together with other construction elements must have sufficient strength to meet the requirements of the method of transportation.¹²³

The AAR Tank Car Committee is performing research on the crashworthiness assessment of the ISO tank (VOLPE) and fire test of an ISO tank on a rail car. LNG used as a fuel tender also is being considered through the work of the AAR. A LNG ISO Tank pool fire test was completed in May 2017, and presented at the October 2017 AAR Tank Car Committee. There is another test scheduled for June 2018.

Cryogenic ISO containers are generally used for LNG transport between LNG facilities and power generation plants, for exports on cargo ships and to remote inland locations needing natural gas. ISO containers carrying LNG by highway and ship can be coordinated in order to create a virtual pipeline.¹²⁴ Hawaii Gas is planning the implementation of a virtual pipeline that moves LNG in 40 foot UN T75 ISO containers between the West coast of the U.S. and Hawaii.

Crowley Maritime Corp. has acquired 16 additional ISO tanks for its Carib Energy group that will be used to supply, transport and distribute U.S.-sourced liquefied natural gas (LNG) to customers in Puerto Rico, the Caribbean and Central America. The 40-foot tanks, each of which contain 10,700 gallons of LNG, now feature technological improvements that increase the offload rate, allowing for faster fuel transfers to customers. Adding ISO tanks to [Crowley's] equipment fleet for established business not only allows us continue delivering an uninterrupted supply of LNG to these regions. Furthermore, the improved offloading performance reduces the amount of time required to transfer the fuel from tank to the storage unit, adding to overall efficiency.¹²⁵

F.2 Cargo Transport Trailers

Trucks using cargo tank trailers also transport LNG by highway throughout the U.S. and the Caribbean Islands. These cryogenic transport trailers are designed for liquid nitrogen (LIN), liquid argon (LAR), liquid oxygen (LOX) and LNG. Trailer cylinders such as MC-331, MC-338 (Figure F.2) and CGA-341 are approved the U.S. DOT. MC-331 trailers are used for gases that are liquefied by pressure application, such as LPG, butane, chlorine, and anhydrous ammonia.

¹²³ http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.baztech-article-BUJ5-0040-0026/c/httpwww_bg_utp_edu_plartjok32011jok32011195.pdf.

¹²⁴ <https://vimeo.com/144509960>.

¹²⁵ Crowley Marine, "Crowley Adds 16 ISO Tanks..."

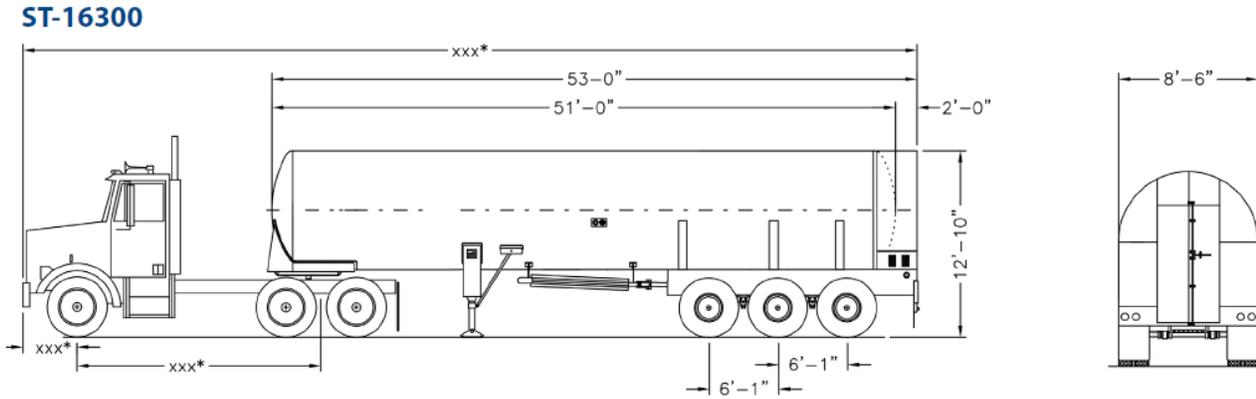


Figure F.2 Cargo Trailer Specifications—ST-16300

Source: Courtesy Chart Industries.

The MC-338 trailer, shown in Figure F.3, is used for cryogenic liquids that must be at least -130 F, such as LNG. MC-338 trailers are a cylindrical shape with loading and unloading pipes on the rear of the tank. The tank is designed as two concentric cylinders, with an annular space that is evacuated of air to vacuum-like conditions. The pressure in these trailers are low pressure, from 23.5 to 500 psi. MC-338 trailers are used for substances which cannot be liquefied by pressure application alone, and must be “super cooled” to become a liquid. This include liquid oxygen, hydrogen, carbon dioxide, natural gas, and ethylene. The CGA-341 specification is for nonflammable cryogenic liquids. MC-338 specifications have a 13,000-gallon capacity. The maximum allowable working pressure is 70 psi. Operationally, carriers may have trailers that they dedicate to specific products, and seek the maximum capacity to give their customer the maximum payload, reducing the unit costs of transport.¹²⁶



¹²⁶ <http://bulktransporter.com/tank-fleets/genox-transportation-growing-demand-cryogenic-gases?eid=forward>.

Figure F.3 MC-338 Cargo Tank Trailer

Source: Courtesy Chart Industries.

Out of a total of over 700 motor carriers, there are 18 motor carriers that transport LNG using cryogenic cargo tank trailers in the United States. Table F.1 shows the U.S. LNG motor carriers reported by MCMIS. The largest carriers by the number of cryogenic cargo tank units are Ryl Corp, Offshore Petroleum, Willcox Fuel LLC, and Broedel Fuel Group LLC. These operate out of Florida, New Jersey, Arizona, New York, and Kansas. There are several carriers in the Caribbean, including Puerto Rico and the U.S. Virgin Islands.

Table F.1 U.S. LNG Motor Carriers

Carrier	Classification	State	Units
Ryl Corp	Interstate	FL	968
Offshore Petroleum Inc.	Intrastate Hazmat	NJ	659
Willcox Fuel LLC	Intrastate Hazmat	AZ	447
Broedel Fuel Group LLC	Intrastate Hazmat	NY	405
Versaair Services LLC	Interstate	KS	140
City Fuel Transport	Interstate	WA	119
Standard Aviation LLC	Intrastate Hazmat	VI	97
Mtm Fuel Services Inc.	Intrastate Hazmat	NY	77
Laurel Fuel Co	Interstate	PA	37
Express Petro Transportation LLC	Interstate	TX	33
Singh Energy Transportation Inc.	Intrastate Hazmat	NY	22
Empire Logistics	Intrastate Hazmat	LA	9
Paradise Gas	Intrastate Hazmat	VI	8
Augusta Service Station	Intrastate Hazmat	MT	8
Sessler Environmental Services LLC	Interstate	NY	4
Maicom Solutions LLC	Interstate	MA	3
Advanced Fuel Delivery LLC	Intrastate Hazmat	CA	3
Sky Transportation Corp	Intrastate Hazmat	PR	2

Source: FMCSA MCMIS Database, accessed October 2017.

F.3 DOT 113 Railcar

The DOT-113 railcar is a cryogenic non-pressurized liquid tank car with insulated “thermos bottle” construction. A cutaway drawing of the typical features for a DOT-113 railcar are shown in Figure F.4.

Inner Tank

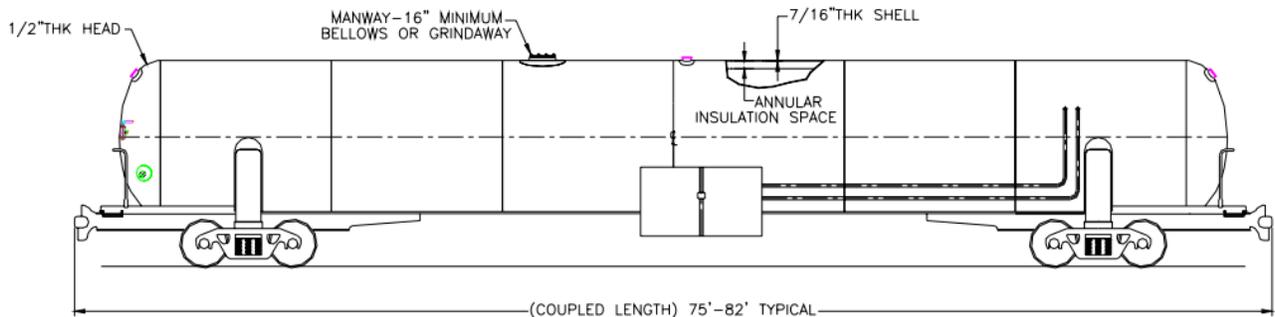
Thickness: 3/16" (minimum); 1/4" (nominal)
Material: Stainless steel of ASTM A 240/A 240M, Type 304 or 304L

Outer Tank

Thickness: 1/2" heads, 7/16" shells
Material: Carbon steel

Insulation

Perlite (common in 1960-1990 built cars), or
Wrapped fiberglass or similar material (common in 1990-and-later built cars)



**Cutaway Drawing of Tank Car
(Courtesy of Chart Industries)**

Figure F.4 Typical Features of DOT 113 Tank Car

Source: American Chemistry Council, "Handling and Transportation Guide..."

While the DOT definition of cryogenic is refrigerated to -130°F and below, as per railroad specification, cryogenic is a maximum of -155°F. Class DOT-113C120W tank cars began to be constructed in the 1970s and are the most common tank cars now used for cryogenic ethylene service. The rail weight limit is 263,000 pounds with a tare weight in the 117,000 to 120,000 pounds range. The water capacity on these cars is nominally 33,000 gallons, which allows for a payload of approximately 28,500 to 29,000 gallons of cryogenic ethylene. Recently built cars have a gross volume of 34,500 gallons and a net cryogenic ethylene capacity of up to 144,000 pounds (30,380 gallons).

Class DOT-113C tank cars are equipped with one or dual pressure relief valves and dual rupture discs. Except for some class DOT-113D tank cars, the valves and fittings for loading and unloading, and the pressure relief devices are located in cabinets on both sides. Figure F.5 and Figure F.6 show both sides of a DOT-113, and the cabinets can be seen in the middle of the car.



Figure F.5 DOT 113 Rail Tank Car (Front End)

Source: Chart Industries



Figure F.6 DOT 113 Rail Tank Car (Back End)

Source: Chart Industries

In some cases, only one of the two cabinets contains the pressure relief devices, and is identified by the exhaust stack coming out of the cabinet and reaching the top of the tank car. Loading and unloading valves are normally located in compartments on diagonally opposite corners of car for liquid oxygen, liquid nitrogen, and liquid hydrogen.

Figure F.7 shows a cabinet that holds the pressure relief devices, and valves and fittings. Figure F.8 shows a close-up and annotated view of the valves and fittings. The cabinets “must be adequate to protect the fittings from direct solar radiation, mud, sand, adverse environmental exposure, and mechanical damage incident to normal operation.” (AAR Field Guide to Tank Cars).



Figure F.7 DOT 113 Ethylene Tank Car Valve Details

Source: Chart Industries

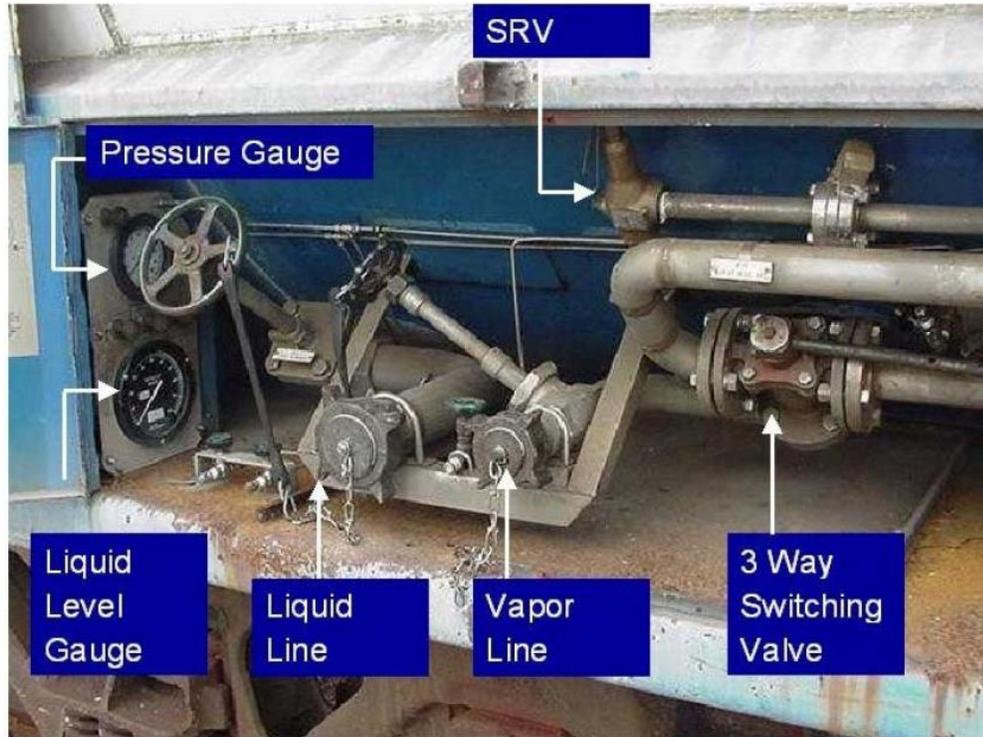


Figure F.8 Major Valves and Fittings of 113C120W Side Loader

Source: American Chemistry Council, "Handling and Transportation Guide..."

The AAR petition to PHMSA on January 17, 2017 (P-1697) requested that PHMSA authorize the transportation of methane, refrigerated liquid ("LNG"), by rail in DOT-113C120W and DOT-113C140W tank cars. While the DOT-113C120W is a tank car used for ethylene, the DOT-113C140W is a modification to the DOT-113C120W that increases the length of time that the tank car maintains the cryogenic conditions. Increasing the hold time could give responders more time to catch a leak and handle an incident. The AAR completed pool fire testing for the ISO container in May 2017, and hopes do similar pool fire testing for the 113 tank car, but the project presently lacks funds.

The first LNG Tank Car in Europe was a project between Chart Industries and VTG AG.¹²⁷ VTG invested in the rail tank cars "to create a so-called rolling pipeline to deliver LNG to industries that have sizeable energy requirements. It plans to work with Brunsbüttel to use LNG tank cars to supply Baltic Sea ports."¹²⁸

DPT, TC, and the AAR have specifications for tank cars. Tank car specifications consist of "Authorizing agency"—"three-digit class designation" "delimiter letter" "tank test pressure in pounds per square inch gauge (psig)" "material of construction (other than steel)" "fusion welding (W)" "fittings, linings, material." Therefore, the difference between DOT-113C120W and DOT-113C140W is the tank test pressure and the minimum burst pressure. DOT-113C120W has a tank test pressure of 120 psig and DOT-113C140W has a tank test pressure of 140 psig. This difference changes how long the contents will safely be stored. It also is

¹²⁷ <http://www.railwayage.com/index.php/mechanical/freight-cars/vtg-unveils-europes-first-lng-tank-car.html>.

¹²⁸ http://www.lngworldshipping.com/news/view_vtg-load-is-a-rail-landmark-for-europe-lng_42734.htm.

known that the DOT is the authorizing agency, the class is 113, the delimiter is C, the tank test pressure is 120 or 140 psig, the material of construction is carbon steel, and the tank is constructed with fusion welding.

DOT-113 is vacuum insulated with a high alloy (stainless steel) or nickel alloy inner container (tank) and carbon steel outer shell (tank, not jacket). Delimiters for cryogenic liquid tank cars:

- A-authorized for -423F loading.
- C-authorized for -260F loading.
- D-authorized for -155F loading.

From the AAR Tank Car Committee, the Docket T55 Service Trials lists four trials related to LNG tank cars: cryogenic gate valve, actuated cryogenic gate valve, cryogenic globe valve, and actuated cryogenic globe valve.

PHMSA HAZMAT Intelligence Portal lists incidents by bulk container back to 2008.¹²⁹ In the most recent decade, DOT113C120W appears with three incidents \$5,000 in damages. Other DOT113 cars appear with incidents: 113A60W, 113A90W, 113AW, 113CW, 113D120W, 113DW. 113A90W and 113AW have the most incidents of this class. AAR Field Guide to Tank Cars explains the different tank cars used for cryogenic liquids. Classes DOT-113 and AAR-204 are designed with an inner container within an outer shell. The space between the inner and outer tanks is vacuum insulated.

- DOT-113A60W tank cars have design service temperature of -423F, a minimum burst pressure of 240 psig, and a tank test pressure of 60 psig.
- DOT-113C120W tank cars have a design service temperature of -260F, a minimum burst pressure of 300 psig, and a tank test pressure of 120 psig.
- (Not used for LNG) AAR Class 204W tank cars must meet the requirements for Class DOT-113, with some exceptions. The minimum required burst strength is 240 psig, with a 60 psig tank test pressure. AAR Class 204W tank cars are not authorized for flammable gas materials, and therefore could not be used for LNG.

According to the Umler Component Registry, there were over 414,000 tank cars in North America in 2016, and more than 700 equipment type codes (ETCs) appear in the Umler Component Registry.¹³⁰ Nearly all of North America's tank cars are owned by shippers or car-leasing companies. About two thirds of the fleet is used to carry materials regulated by the U.S. Department of Transportation (U.S. DOT) and Transport Canada because they are flammable, corrosive, poisonous, or pose other hazards. The total fleet capacity (in gallons) has increased by 45.2 percent recently as most new tanks are larger than before. Through the Federal Railroad Administration (FRA) and PHMSA, U.S. DOT sets the minimum design standards for the cars. Various design features are required to accommodate differences in the physical, chemical, and hazard characteristics of the materials shipped. The Association of American Railroads (AAR) Tank Car Committee assists in the development of detailed tank car design specifications that comply with U.S. DOT standards.

¹²⁹ <https://www.phmsa.dot.gov/hazmat/library/data-stats/incidents>.

¹³⁰ The Umler® system is used to obtain rail equipment data for in North America.

AAR performs this supportive function in accordance with its traditional role in setting industry rules and standards for the interchange of equipment.

Exhibit K



**COUNTY OF LEHIGH, PENNSYLVANIA
RESOLUTION NO. 2020 – 47
SPONSORED BY COMMISSIONERS ELBICH, ZANELLI, BRACE,
GRAMMES, HARRINGTON & SMALLS
REQUESTED DATE: AUGUST 5, 2020**

**ENCOURAGING THE DELAWARE RIVER BASIN COMMISSION
TO DISAPPROVE THE DOCK 2 PROJECT, DOCKET D-2017-009-2
REGARDING THE TRANSPORTATION OF LIQUEFIED NATURAL GAS
THROUGH LEHIGH COUNTY**

WHEREAS, a fundamental purpose of government is to protect the health, safety, and welfare of citizens; and

WHEREAS, Article I, Section 27 of the Pennsylvania Constitution affirms that, “The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment”; and

WHEREAS, Article I, Section 27 further declares, “Pennsylvania’s public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people”; and

WHEREAS, New Fortress Energy is planning the overland transport of Liquefied Natural Gas (“LNG”, also known as liquid methane) by truck on public highways and by rail car on existing railways from a yet-to-be-completed liquefaction plant in Wyalusing, Pennsylvania, to a proposed LNG export terminal in Gibbstown, New Jersey, on the Delaware River (the “Gibbstown Logistics Center”); and

WHEREAS, there is a strong possibility that such transport will pass through parts of Lehigh County; and

WHEREAS, New Fortress Energy subsidiary Energy Transport Solutions received a Special Permit from the Pipeline and Hazardous Materials Safety Administration (“PHMSA”)¹ for the transport of LNG in rail cars designed 50 years ago and never used for LNG transport while subsequent federal rulemaking required a safer rail car design for all other carriers²; and

¹ Special Permit DOT-SP 20534 <https://www.phmsa.dot.gov/safe-transportation-energy-products/dot-20534-pdf>

² <https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/2020-06/2137-AF40%20Final%20Rule%20%206.19.20%20web%20final.pdf>

WHEREAS, the transport of LNG has unique safety hazards, exposing those along this particular rail route to unprecedented and unjustifiable risk. An LNG release boils furiously into a flammable vapor cloud 620 times larger than the storage container. An unignited ground-hugging vapor cloud can move far distances,³ and exposure to the vapor can cause extreme freeze burns. If in an enclosed space, it asphyxiates, causing death.⁴ If ignited, the fire is inextinguishable; the fire is so hot that second-degree burns can occur within 30 seconds for those exposed within a mile. An LNG release can cause a Boiling Liquid Expanding Vapor Explosion.⁵ The explosive force of LNG is similar to a thermobaric explosion – a catastrophically powerful bomb. The 2016 U.S. Emergency Response Guidebook advises fire chiefs initially to immediately evacuate the surrounding 1-mile area.⁶ No federal field research has shown how far the vapor cloud can move, so in the most recent serious Plymouth, Washington, LNG fire, they evacuated a 2-mile radius⁷; and

WHEREAS, Delaware River Partners, LLC, a subsidiary of Fortress Transportation and Infrastructure Investors, LLC, has submitted an application to the Delaware River Basin Commission under Docket D-2017-009-2 to construct a transloading facility (“Dock 2”) at the Gibbstown Logistics Center that would transfer LNG from trucks and railcars to shipping vessels; and

WHEREAS, the Delaware River Basin Commission states, “The vision of the Delaware River Basin Commission is built upon the Compact signed in 1961 by Delaware, New Jersey, New York, Pennsylvania, and the federal government. It is defined in the Delaware River Basin Compact as, “the conservation, utilization, development, management and control of water and related resources of the Delaware River Basin under a comprehensive multipurpose plan will bring the greatest benefits and produce the most efficient service in the public welfare”⁸; and

³ “Immediate ignition with liquid still on the ground could cause the spill to develop into a pool fire and present a radiant heat hazard. If there is no ignition source, the LNG will vaporize rapidly forming a cold gas cloud that is initially heavier than air, mixes with ambient air, spreads and is carried downwind.” P. 10 “Methane in vapor state can be an asphyxiant when it displaces oxygen in a confined space.” P. 11. SP 20534 Special Permit to transport LNG by rail in DOT-113C120W rail tank cars. Final Environmental Assessment. Docket No. PHMSA-2019-0100. December 5, 2019. P. 10.

⁴ SP 20534 Special Permit to transport LNG by rail in DOT-113C120W rail tank cars. Final Environmental Assessment. Docket No. PHMSA-2019-0100. December 5, 2019. P. 11.

⁵ “LNG tank BLEVE is possible in some transportation scenarios.” Sandia National Laboratories, “LNG Use and Safety Concerns (LNG export facility, refueling stations, marine/barge/ferry/rail/truck transport)”, Tom Blanchat, Mike Hightower, Anay Luketa. November 2014. <https://www.osti.gov/servlets/purl/1367739> P. 23.

⁶ US DOT Emergency Response Guidebook. <https://www.phmsa.dot.gov/hazmat/erg/emergency-response-guidebook-erg>

⁷ <https://www.sightline.org/2016/06/03/williams-companies-failed-to-protect-employees-in-plymouth-lng-explosion/>

⁸ <https://www.nj.gov/drbc/library/documents/DRBCvision-mission-values.pdf>

WHEREAS, the Delaware River Basin Commission has recently affirmed in its statement on Diversity, Equity, Inclusion & Justice that its “core values” are “Service: to the public, the regulated community and our DRBC colleagues; Respect: for each other, the public and the Basin’s water resources; Professionalism: defined by high ethical standards, integrity, continuous improvement and accountability⁹; and

WHEREAS, neither the Commonwealth of Pennsylvania nor the Delaware River Basin Commission has assessed the potential public safety, public health or environmental impacts of the proposed overland transport of high volume LNG shipments by truck or by rail car on the communities along the possible transportation routes between Wyalusing, Pennsylvania, and Gibbstown, New Jersey; and

WHEREAS, no federal, state, or local agency has conducted a risk assessment of the specific transportation route(s) along which the LNG would travel; and

WHEREAS, no full scale Quantitative Risk Assessment, which quantifies the frequencies of events such as transportation accidents and their consequences, has been done with regard to the anticipated high volume of trucks or railcars that would contain the LNG that would travel from Wyalusing, Pennsylvania, to Gibbstown, New Jersey¹⁰; and

WHEREAS, neither the Commonwealth of Pennsylvania nor the Delaware River Basin Commission has conducted a comprehensive assessment of the cumulative and long-term impacts of the full scope of New Fortress Energy’s plan to liquefy natural gas from fracking wells in Northern Pennsylvania, transport the LNG by truck or rail to the Gibbstown Logistics Center and export by marine vessels overseas on the Delaware River past Delaware and South Jersey bayshore communities; and

WHEREAS, training or support in Lehigh County has not been provided for emergency or first response service organizations to respond to accidents, fires,

⁹ <https://www.nj.gov/drbc/about/staff/DEIJ.html>

¹⁰ “The QRA will help to evaluate the derailment and release probability of LNG rail cars over certain segments of the network, and account for a variety of track and train characteristics...An LNG risk model can be used to understand the probability and consequences for LNG transportation incidents for both rail and truck delivery. Even though they are treated differently, the underlying event tree analysis approach is the same. When the probability of LNG tank car derailment is understood, better decisions can be made regarding the crashworthiness, placement, and operation of rail cars and the potential consequences from an LNG release due to a derailment. Further study for modeling the probability and consequences of transporting LNG by rail and truck will help decision-makers understand public risks and make informed decisions.” “Risk Assessment of Surface Transport of Liquid Natural Gas”, *prepared for* U.S. DOT Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety *prepared by* Cambridge Systematics, Inc. *with* MaineWay Services, LLC, Rutgers University, Transport Analytics, LLC. ScienceSmith LLC, March 20, 2019. P. ES-9.

explosions, derailments, or other emergencies related to high volume LNG transport within this jurisdiction; and

WHEREAS, the absence of such assessments and support prevents the appropriate management of and avoidance of accidents, derailments, catastrophic events, health harms, and environmental damage and degradation that could occur from the transportation of LNG through these communities, including risks to life, public health, property values, and the clean air and water upon which all citizens and businesses depend; and

WHEREAS, the potential transportation routes travel through communities with proportionately more minority and low-income populations, compounding environmental injustices¹¹;

NOW, THEREFORE, BE IT RESOLVED that:

1. The Lehigh County Board of Commissioners respectfully requests the members of the Delaware River Basin Commission to disapprove the Dock 2 project, Docket D-2017-009-2.
2. The Lehigh County Board of Commissioners respectfully requests the Commonwealth of Pennsylvania fulfill its constitutional duty and act affirmatively to protect the Commonwealth's public safety by taking all actions necessary to effectively control the transportation of Liquefied Natural Gas (LNG) through Lehigh County by truck and/or by rail, provide appropriate emergency response training and resources for Lehigh County agencies, and to conduct a public health and safety analysis, a quantitative risk assessment, and a comprehensive environmental review of the potential impacts to Lehigh County communities.
3. An official copy of this resolution be filed with the Delaware River Basin Commission, 25 Cosey Road, P.O. Box 7360, West Trenton, NJ 08628-0360, and that copies are sent to the voting members at their respective locations: the Governors of Pennsylvania, New Jersey, New York, and Delaware, and the U.S. Army Corps of Engineers.
4. An official copy of this resolution be filed with Governor Tom Wolf of Pennsylvania at Office of the Governor, 508 Main Capitol Building, Harrisburg, PA 17120.

¹¹ Delaware Riverkeeper Network, <https://www.delawareriverkeeper.org/taxonomy/term/1174>

ADOPTED BY THE LEHIGH COUNTY BOARD OF COMMISSIONERS

on the 12th day of August, 2020, by the following vote:

<u>Commissioners</u>	<u>AYE</u>	<u>NAY</u>
Geoff Brace	X	
Nathan Brown (absent)		
Percy H. Dougherty	X	
Bob Elbich	X	
Marc Grammes	X	
Dave Harrington	X	
Dan Hartzell	X	
Zakiya Smalls	X	
Amy Zanelli	X	

ATTEST: 
Deputy Clerk to the Board of Commissioners

COUNTY OF LEHIGH RESOLUTION 2020-NO. 47

CERTIFICATION

I, DIANA SCHOLL, Deputy Clerk to the Board of Commissioners of Lehigh County, do hereby certify that the attached is a true and correct copy of the resolution adopted at a regular meeting of the Commissioners of Lehigh County held on **August 12, 2020**.



DIANA SCHOLL, Deputy Clerk
Board of Commissioners

RESOLUTION NO. 10- 2020

A RESOLUTION OF THE BOROUGH OF KUTZTOWN, BERKS COUNTY PENNSYLVANIA, CALLING UPON THE MEMBERS OF THE DELAWARE RIVER BASIN COMMISSION TO DISAPPROVE THE DOCK 2 PROJECT, DOCKET D-2017-009-2, AND CALLING UPON THE COMMONWEALTH OF PENNSYLVANIA TO FULFILL ITS CONSTITUTIONAL DUTY AND ACT AFFIRMATIVELY TO PROTECT THE COMMONWEALTH'S PUBLIC NATURAL RESOURCES BY TAKING ALL ACTIONS NECESSARY TO PREVENT THE TRANSPORTATION OF LNG THROUGH PENNSYLVANIA BY TRUCK AND/OR BY RAIL, AND TO CONDUCT A PUBLIC HEALTH AND SAFETY ANALYSIS, A QUANTITATIVE RISK ASSESSMENT, AND A COMPREHENSIVE ENVIRONMENTAL REVIEW OF THE POTENTIAL IMPACTS TO COMMUNITIES AND THE NATURAL ENVIRONMENT IN PENNSYLVANIA.

WHEREAS, a fundamental purpose of government is to protect the health, safety, and welfare of citizens; and

WHEREAS, Article I, Section 27 of the Pennsylvania Constitution affirms that, "The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment"; and

WHEREAS, Article I, Section 27 further declares, "Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people"; and

WHEREAS, New Fortress Energy is planning the overland transport of Liquefied Natural Gas ("LNG", also known as liquid methane) by truck on public highways and by rail car on existing railways from a yet-to-be-completed liquefaction plant in Wyalusing, Pennsylvania, to a proposed LNG export terminal in Gibbstown, New Jersey, on the Delaware River (the "Gibbstown Logistics Center"); and

WHEREAS, New Fortress Energy subsidiary Energy Transport Solutions received a Special Permit from the Pipeline and Hazardous Materials Safety Administration ("PHMSA")¹ for the transport of LNG in rail cars designed 50 years ago and never used for LNG transport while subsequent federal rulemaking required a safer rail car design for all other carriers²; and

WHEREAS, the transport of LNG has unique safety hazards, exposing those along this particular rail route to unprecedented and unjustifiable risk. An LNG release boils furiously into a flammable vapor cloud 620 times larger than the storage container. An unignited ground-hugging vapor cloud can move far distances,³ and exposure to the vapor can cause extreme

¹ Special Permit DOT-SP 20534 <https://www.phmsa.dot.gov/safe-transportation-energy-products/dot-20534-pdf>

² <https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/2020-06/2137-AF40%20Final%20Rule%20%206.19.20%20web%20final.pdf>

³ "Immediate ignition with liquid still on the ground could cause the spill to develop into a pool fire and present a radiant heat hazard. If there is no ignition source, the LNG will vaporize rapidly forming a cold gas cloud that is initially heavier than air, mixes with ambient air, spreads and is carried downwind." P. 10 "Methane in vapor state can be an asphyxiant when it displaces oxygen in a confined space." P. 11. SP 20534 Special Permit to transport

freeze burns. If in an enclosed space, it asphyxiates, causing death.⁴ If ignited, the fire is inextinguishable; the fire is so hot that second-degree burns can occur within 30 seconds for those exposed within a mile. An LNG release can cause a Boiling Liquid Expanding Vapor Explosion.⁵ The explosive force of LNG is similar to a thermobaric explosion – a catastrophically powerful bomb. The 2016 U.S. Emergency Response Guidebook advises fire chiefs initially to immediately evacuate the surrounding 1-mile area.⁶ No federal field research has shown how far the vapor cloud can move, so in the most recent serious Plymouth, Washington, LNG fire, they evacuated a 2-mile radius⁷; and

WHEREAS, Delaware River Partners, LLC, a subsidiary of Fortress Transportation and Infrastructure Investors, LLC, has submitted an application to the Delaware River Basin Commission under Docket D-2017-009-2 to construct a transloading facility (“Dock 2”) at the Gibbstown Logistics Center that would transfer LNG from trucks and railcars to shipping vessels; and

WHEREAS, the Delaware River Basin Commission states, “The vision of the Delaware River Basin Commission is built upon the Compact signed in 1961 by Delaware, New Jersey, New York, Pennsylvania, and the federal government. It is defined in the Delaware River Basin Compact as, “the conservation, utilization, development, management and control of water and related resources of the Delaware River Basin under a comprehensive multipurpose plan will bring the greatest benefits and produce the most efficient service in the public welfare”⁸; and

WHEREAS, the Delaware River Basin Commission has recently affirmed in its statement on Diversity, Equity, Inclusion & Justice that its “core values” are “Service: to the public, the regulated community and our DRBC colleagues; Respect: for each other, the public and the Basin’s water resources; Professionalism: defined by high ethical standards, integrity, continuous improvement and accountability⁹; and

WHEREAS, neither the Commonwealth of Pennsylvania nor the Delaware River Basin Commission has assessed the potential public safety, public health or environmental impacts of the proposed overland transport of LNG by truck or by rail car on the communities along the possible transportation routes between Wyalusing, Pennsylvania, and Gibbstown, New Jersey; and

WHEREAS, no federal, state, or local agency has conducted a risk assessment of the specific transportation route(s) along which the LNG would travel; and

LNG by rail in DOT-113C120W rail tank cars. Final Environmental Assessment. Docket No. PHMSA-2019-0100. December 5, 2019. P. 10.

⁴ SP 20534 Special Permit to transport LNG by rail in DOT-113C120W rail tank cars. Final Environmental Assessment. Docket No. PHMSA-2019-0100. December 5, 2019. P. 11.

⁵ “LNG tank BLEVE is possible in some transportation scenarios.” Sandia National Laboratories, “LNG Use and Safety Concerns (LNG export facility, refueling stations, marine/barge/ferry/rail/truck transport)”, Tom Blanchat, Mike Hightower, Anay Luketa. November 2014. <https://www.osti.gov/servlets/purl/1367739> P. 23.

⁶ US DOT Emergency Response Guidebook. <https://www.phmsa.dot.gov/hazmat/erg/emergency-response-guidebook-erg>

⁷ <https://www.sightline.org/2016/06/03/williams-companies-failed-to-protect-employees-in-plymouth-lng-explosion/>

⁸ <https://www.nj.gov/drbc/library/documents/DRBCvision-mission-values.pdf>

⁹ <https://www.nj.gov/drbc/about/staff/DEIJ.html>

WHEREAS, no full scale Quantitative Risk Assessment, which quantifies the frequencies of events such as transportation accidents and their consequences, has been done of the trucks or railcars that would contain the LNG that would travel from Wyalusing, Pennsylvania, to Gibbstown, New Jersey¹⁰; and

WHEREAS, neither the Commonwealth of Pennsylvania nor the Delaware River Basin Commission has conducted a comprehensive assessment of the cumulative and long-term impacts of the full scope of New Fortress Energy's plan to liquefy natural gas from fracking wells in Northern Pennsylvania, transport the LNG by truck or rail to the Gibbstown Logistics Center and export by marine vessels overseas on the Delaware River past Delaware and South Jersey bayshore communities; and

WHEREAS, training or support in [the township/county/district] has not been provided for emergency or first response service organizations to respond to accidents, fires, explosions, derailments, or other emergencies related to LNG transport within this jurisdiction; and

WHEREAS, the absence of such assessments and support prevents the appropriate management of and avoidance of accidents, derailments, catastrophic events, health harms, and environmental damage and degradation that could occur from the transportation of LNG through these communities, including risks to public health, property values, and the clean air and water upon which all citizens and businesses depend; and

WHEREAS, the potential transportation routes travel through communities with proportionately more minority and low-income populations, compounding environmental injustices¹¹;

NOW, THEREFORE, BE IT RESOLVED that:

1. The Borough of Kutztown calls upon the members of the Delaware River Basin Commission to disapprove the Dock 2 project, Docket D-2017-009-2.
2. The Borough of Kutztown calls upon the Commonwealth of Pennsylvania to fulfill its constitutional duty and act affirmatively to protect the Commonwealth's public natural resources by taking all actions necessary to prevent the transportation of LNG through Pennsylvania by truck and/or by rail, and to conduct a public health and safety analysis, a quantitative risk assessment, and a comprehensive environmental

¹⁰ "The QRA will help to evaluate the derailment and release probability of LNG rail cars over certain segments of the network, and account for a variety of track and train characteristics... An LNG risk model can be used to understand the probability and consequences for LNG transportation incidents for both rail and truck delivery. Even though they are treated differently, the underlying event tree analysis approach is the same. When the probability of LNG tank car derailment is understood, better decisions can be made regarding the crashworthiness, placement, and operation of rail cars and the potential consequences from an LNG release due to a derailment. Further study for modeling the probability and consequences of transporting LNG by rail and truck will help decision-makers understand public risks and make informed decisions." "Risk Assessment of Surface Transport of Liquid Natural Gas", prepared for U.S. DOT Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety prepared by Cambridge Systematics, Inc. with MaineWay Services, LLC, Rutgers University, Transport Analytics, LLC. ScienceSmith LLC, March 20, 2019. P. ES-9.

¹¹ Delaware Riverkeeper Network, <https://www.delawariverkeeper.org/taxonomy/term/1174>

review of the potential impacts to communities and the natural environment in Pennsylvania.

3. An official copy of this Resolution be filed with the Delaware River Basin Commission, 25 Cosey Road, P.O. Box 7360, West Trenton, NJ 08628-0360, and that copies are sent to the voting members at their respective locations: the Governors of Pennsylvania, New Jersey, New York, and Delaware, and the U.S. Army Corps of Engineers.
4. An official copy of this resolution be filed with Governor Tom Wolf of Pennsylvania at Office of the Governor, 508 Main Capitol Building, Harrisburg, PA 17120.

ADOPTED by the Council of the Borough of Kutztown, Berks County, Pennsylvania, in a lawful session duly assembled this 18th day of August, 2020.

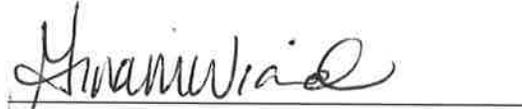
BOROUGH OF KUTZTOWN

BY:



Kevin J. Snyder
President of Borough Council

ATTEST:



Gina M. Wiand
Secretary of the Borough of Kutztown

**BOROUGH OF JESSUP
LACKAWANNA COUNTY, PENNSYLVANIA
RESOLUTION # 12 OF 2020**

**A RESOLUTION OF THE BOROUGH OF JESSUP OPPOSING THE OVERLAND
TRANSPORTATION OF LIQUEFIED NATURAL GAS THROUGH THE BOROUGH
OF JESSUP AND ITS SURROUNDING COMMUNITIES**

WHEREAS, the Borough of Jessup (the “Borough”) is a Borough and Municipality in the Commonwealth of Pennsylvania organized and governed according to the Borough Code; and

WHEREAS, the Borough is a community in Lackawanna County, Pennsylvania with approximately 4,600 residents and commercial district; and

WHEREAS, Section 1203 of the Borough code authorizes the Borough to make and adopt all ordinances, bylaws, rules and regulations as may be necessary for the maintenance of peace, good government, commerce, safety and welfare of the Borough; and

WHEREAS, pursuant to said Borough Code, the Borough has the authority to make regulations as may be necessary for the health, safety, and general welfare of the Borough. See 8 Pa.C.S. Section 1202(5); and

WHEREAS, a fundamental purpose of government is to protect the health, safety, and welfare of citizens; and

WHEREAS, Article I, Section 27 of the Constitution of the Commonwealth of Pennsylvania provides that, “The people have a right to clear air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment”; and

WHEREAS, Article I, Section 27 of the Constitution of the Commonwealth of Pennsylvania further declares, “Pennsylvania’s public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people”; and

WHEREAS, it has been reported to the Borough’s Council that New Fortress Energy and its affiliated entities are planning the overland transport of Liquefied Natural Gas (“LNG” also known as liquid methane) by truck on public highways and by railcar on existing railways from a proposed liquefaction plant to be located in the Wyalusing Township, Bradford County, Pennsylvania (the “New Fortress Energy Facility”) to a proposed LNG export terminal and port location in or near Gibbstown, Greenwich Township, Gloucester County, New Jersey, which is situated along the Delaware River (the “Gibbstown Logistics Center”); and

WHEREAS, LNG would be transported from the New Fortress Energy Facility to the Gibbstown Logistics Center along public highways and railways which run directly through or near the Borough, including its residential and commercial districts; and

WHEREAS, New Fortress Energy's subsidiary, Energy Transport Solutions, received a Special Permit from the Pipeline and Hazardous Materials Safety Administration for the transport of LNG by rail; and

WHEREAS, the transport of LNG by New Fortress Energy and its subsidiaries presents significant safety hazards, including exposing those communities along roadways and railways to unprecedented and unjustifiable risk; and

WHEREAS, Delaware River Partners, LLC, a subsidiary of Fortress Transportation and Infrastructure Investors, LLC, has submitted an application to the Delaware River Basin Commission ("DRBC") under Docket D-2017-009-2 to construct a transloading facility ("Dock 2") at the Gibbstown Logistics Center that would transfer LNG from trucks and railcars to shipping vessels; and

WHEREAS, the DRBC, which is comprised of representatives from the States of Delaware, New Jersey, New York, and Pennsylvania and the federal government, has adopted a compact that declares, "the conservation, utilization, development, management and control of water and related resources of the Delaware River Basin under a comprehensive multipurpose plan will bring the greatest benefits and produce the most efficient service in the public welfare"; and

WHEREAS, neither the Commonwealth of Pennsylvania nor the DRBC has fully assessed the potential public safety, public health, or environmental impacts of the proposed overland transport of the LNG by truck or by railcar on the communities along the possible transportation routes between Wyalusing Township, Bradford County, Pennsylvania, and Gibbstown, Greenwich Township, Gloucester County, New Jersey; and

WHEREAS, no federal, state, or local agency has conducted a risk assessment of the specific transportation route(s) along which the LNG would travel; and

WHEREAS, no comprehensive Quantitative Risk Assessment, which quantifies the frequencies of events, such as transportation accidents and their consequences, has been undertaken of the trucks or railcars that would contain the LNG that would travel from the New Fortress Energy Facility, through or near our Borough and to the Gibbstown Logistics Center; and

WHEREAS, neither the Commonwealth of Pennsylvania nor the DRBC has conducted an assessment of the cumulative and long-term impacts of the full scope of New Fortress

Energy's plan to liquefy natural gas from fracking wells in Northern Pennsylvania, transport the LNG by truck or rail to the Gibbstown Logistics Center and export by marine vessels overseas on the Delaware River; and

WHEREAS, the Borough and its surrounding communities have not been provided with training or support for emergency or first response service organizations to respond to accidents, fires, explosions, derailments, or other emergencies related to LNG overland transport; and

WHEREAS, the absence of such assessments and support prevents the appropriate management of and avoidance of accidents, derailments, catastrophic events, health harms, and environmental damage and degradation that could occur from the overland transportation of LNG through the Borough, including risks to public health, property values, and the clean air and water upon which our residents and businesses depend.

NOW, THEREFORE, BE IT RESOLVED by the Council of the Borough of Jessup on this 14TH day of September, 2020:

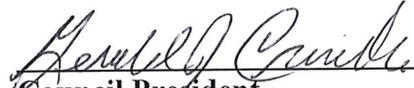
1. The members of the DRBC are hereby called upon to disapprove the pending application for the Dock 2 Project, filed under Docket D-2017-009-2.
2. The Commonwealth of Pennsylvania is hereby called upon to fulfill its constitutional duty and act affirmatively to protect the Commonwealth's public natural resources by taking all actions necessary to prevent the transportation of LNG through Pennsylvania by truck or rail, and to conduct a public health and safety analysis, a quantitative risk assessment, and a comprehensive environmental review of the potential impacts to communities and the natural environment in Pennsylvania.
3. The Borough Manager/Secretary is hereby directed to submit an official copy of this resolution to DRBC, with copies sent to the voting members at their respective locations: the Governors of Pennsylvania, New Jersey, New York, and Delaware, and the U.S. Army Corps of Engineers.
4. The Borough Manager/Secretary is hereby directed to submit an official copy of this resolution to Governor Tom Wolf of Pennsylvania, with copies to Pennsylvania Senator John Blake, Pennsylvania State Representative Kyle Mullins, and Pennsylvania Department of Environmental Protection Secretary Patrick McDonnell.

THIS RESOLUTION IS DULY ENACTED AND APPROVED at a public meeting duly advertised by a majority vote of Jessup Borough Council on this 14TH day of September, 2020.

THE BOROUGH OF JESSUP

ATTEST:


Mia Stine, Borough Manager


Council President

EXAMINED AND APPROVED THIS 14TH DAY OF SEPTEMBER, 2020.

By: 
Mayor of the Borough of Jessup

RESOLUTION NO. 2020-17
BOROUGH OF CLARKS SUMMIT
COUNTY OF LACKAWANNA
COMMONWEALTH OF PENNSYLVANIA

**A RESOLUTION OF THE BOROUGH OF CLARKS SUMMIT
OPPOSING THE OVERLAND TRANSPORTATION OF LIQUEFIED NATURAL GAS
THROUGH THE BOROUGH OF CLARKS SUMMIT
AND ITS SURROUNDING COMMUNITIES**

WHEREAS, the Borough of Clarks Summit (the “Borough”) is a Borough and Municipality in the Commonwealth of Pennsylvania organized and governed according to the 8 Pa. C.S.A. §101, *et seq.* (the “Borough Code”); and

WHEREAS, the Borough is a community in Lackawanna County, Pennsylvania with approximately 5,000 residents and a vibrant commercial district situated along U.S. Routes 6 and 11;

WHEREAS, Section 1203 of the Borough Code authorizes the Borough to make and adopt all ordinances, bylaws, rules and regulations as may be necessary for the maintenance of peace, good government, commerce, safety and welfare of the Borough; and

WHEREAS, pursuant to said Borough Code, the Borough has the authority to make regulations as may be necessary for the health, safety and general welfare of the Borough. *See* 8 Pa. C.S.A. §1202(5);

WHEREAS, a fundamental purpose of government is to protect the health, safety, and welfare of citizens; and

WHEREAS, Article I, Section 27 of the Constitution of the Commonwealth of Pennsylvania provides that, “The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment”; and

WHEREAS, Article I, Section 27 of the Constitution of the Commonwealth of Pennsylvania further declares, “Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people”; and

WHEREAS, it has been reported to the Borough's Council that New Fortress Energy and its affiliated entities are planning the overland transport of Liquefied Natural Gas ("LNG", also known as liquid methane) by truck on public highways and by railcar on existing railways from a proposed liquefaction plant to be located in the Wyalusing Township, Bradford County, Pennsylvania (the "New Fortress Energy Facility"), to a proposed LNG export terminal and port located in or near Gibbstown, Greenwich Township, Gloucester County, New Jersey, which is situated along the Delaware River (the "Gibbstown Logistics Center"); and

WHEREAS, LNG would be transported from the New Fortress Energy Facility to the Gibbstown Logistics Center along public highways and railways which run directly through the Borough, including its residential and commercial districts; and

WHEREAS, New Fortress Energy's subsidiary, Energy Transport Solutions, received a Special Permit from the Pipeline and Hazardous Materials Safety Administration for the transport of LNG by rail; and

WHEREAS, the transport of LNG by New Fortress Energy and its subsidiaries presents significant safety hazards, including exposing those communities along roadways and railways to unprecedented and unjustifiable risk; and

WHEREAS, Delaware River Partners, LLC, a subsidiary of Fortress Transportation and Infrastructure Investors, LLC, has submitted an application to the Delaware River Basin Commission ("DRBC") under Docket D-2017-009-2 to construct a transloading facility ("Dock 2") at the Gibbstown Logistics Center that would transfer LNG from trucks and railcars to shipping vessels; and

WHEREAS, the DRBC, which is comprised of representatives from the States of Delaware, New Jersey, New York and Pennsylvania and the federal government, has adopted a compact that declares, "the conservation, utilization, development, management and control of water and related resources of the Delaware River Basin under a comprehensive multipurpose plan will bring the greatest benefits and produce the most efficient service in the public welfare"; and

WHEREAS, neither the Commonwealth of Pennsylvania nor the DRBC has fully assessed the potential public safety, public health or environmental impacts of the proposed overland transport of LNG by truck or by railcar on the communities along the possible transportation routes between the Wyalusing Township, Bradford County, Pennsylvania, and Gibbstown, Greenwich Township, Gloucester County, New Jersey; and

WHEREAS, no federal, state, or local agency has conducted a risk assessment of the specific transportation route(s) along which the LNG would travel; and

WHEREAS, no comprehensive Quantitative Risk Assessment, which quantifies the frequencies of events, such as transportation accidents and their consequences, has been undertaken of the trucks or railcars that would contain the LNG that would travel from the New Fortress Energy Facility, through our Borough and to the Gibbstown Logistics Center; and

WHEREAS, neither the Commonwealth of Pennsylvania nor the DRBC has conducted an assessment of the cumulative and long-term impacts of the full scope of New Fortress Energy's plan to liquefy natural gas from fracking wells in Northern Pennsylvania, transport the LNG by truck or rail to the Gibbstown Logistics Center and export by marine vessels overseas on the Delaware River; and

WHEREAS, the Borough and its surrounding communities have not been provided with training or support for emergency or first response service organizations to respond to accidents, fires, explosions, derailments, or other emergencies related to LNG overland transport; and

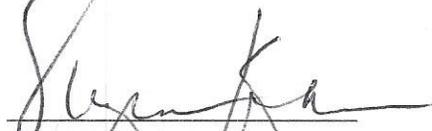
WHEREAS, the absence of such assessments and support prevents the appropriate management of and avoidance of accidents, derailments, catastrophic events, health harms, and environmental damage and degradation that could occur from the overland transportation of LNG through the Borough, including risks to public health, property values, and the clean air and water upon which our residents and businesses depend.

NOW, THEREFORE, BE IT RESOLVED by the **Council of the Borough of Clarks Summit** on this 2nd day of September 2020.

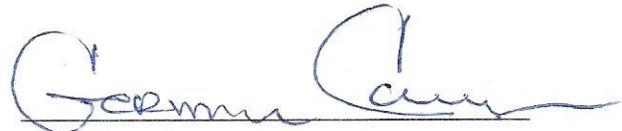
1. The members of the DRBC are hereby called upon to disapprove the pending application for the Dock 2 Project, filed under Docket D-2017-009-2.
2. The Commonwealth of Pennsylvania is hereby called upon to fulfill its constitutional duty and act affirmatively to protect the Commonwealth's public natural resources by taking all actions necessary to prevent the transportation of LNG through Pennsylvania by truck or rail, and to conduct a public health and safety analysis, a quantitative risk assessment, and a comprehensive environmental review of the potential impacts to communities and the natural environment in Pennsylvania.

3. The Borough Secretary is hereby directed to submit an official copy of this resolution with the DRBC, with copies sent to the voting members at their respective locations: the Governors of Pennsylvania, New Jersey, New York, and Delaware, and the U.S. Army Corps of Engineers.
4. The Borough Secretary is hereby directed to submit an official copy of this resolution to Governor Tom Wolf of Pennsylvania, with copies to Pennsylvanian Senator John Blake, Pennsylvania State Representative Bridget Malloy Kosierowski, and Pennsylvania Department of Environmental Protection Secretary Patrick McDonnell.

ATTEST:


Virginia Kehoe
Borough Manager/Secretary

BOROUGH OF CLARKS SUMMIT


Germaine Carey
Council President

Approved this 2nd day of
September 2020


Herman Johnson
Mayor

**RESOLUTION NO. 6 OF 2020
BOROUGH OF CLARKS GREEN
COUNTY OF LACKAWANNA
COMMONWEALTH OF PENNSYLVANIA**

**RESOLUTION OF THE BOROUGH OF CLARKS GREEN
OPPOSING THE OVERLAND TRANSPORTATION OF LIQUEFIED NATURAL GAS
THROUGH THE BOROUGH OF CLARKS SUMMIT
AND ITS SURROUNDING COMMUNITIES**

WHEREAS, the Borough of Clarks Green (the “Borough”) is a Borough and Municipality in the Commonwealth of Pennsylvania organized and governed according to 8 Pa. C.S.A. §101, *et seq.* (the “Borough Code”); and

WHEREAS, the Borough of Clarks Summit (“Clarks Summit”) is also a Borough and Municipality in the Commonwealth of Pennsylvania organized and governed according to the Borough Code; and

WHEREAS, the Borough is a community in Lackawanna County, Pennsylvania with approximately 1,600 residents situated immediately adjacent to Clarks Summit; and

WHEREAS, Section 1203 of the Borough Code authorizes the Borough to make and adopt all ordinances, bylaws, rules and regulations as may be necessary for the commerce, safety and welfare of the Borough and its residents; and

WHEREAS, pursuant to the Borough Code, the Borough has the authority to make regulations as may be necessary for the health, safety and general welfare of the Borough. *See* 8 Pa. C.S.A. §1202(5); and

WHEREAS, a fundamental purpose of government is to protect the health, safety, and welfare of citizens; and

WHEREAS, Article I, Section 27 of the Constitution of the Commonwealth of Pennsylvania provides that, “The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment”; and

WHEREAS, Article I, Section 27 of the Constitution of the Commonwealth of Pennsylvania further declares, “Pennsylvania’s public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people”; and

WHEREAS, the Borough’s Council has become aware that New Fortress Energy and its affiliated entities are planning the overland transport of Liquefied Natural Gas (“LNG”, also known as liquid methane) by truck on public highways and by railcar on existing railways from a

proposed liquefaction plant to be located in the Wyalusing Township, Bradford County, Pennsylvania (the “New Fortress Energy Facility”), to a proposed LNG export terminal and port located near Gibbstown, Greenwich Township, Gloucester County, New Jersey, which is situated along the Delaware River (the “Gibbstown Logistics Center”); and

WHEREAS, LNG would be transported from the New Fortress Energy Facility to the Gibbstown Logistics Center along public highways and railways which run directly through, Clarks Summit, including residential and commercial districts; and

WHEREAS, New Fortress Energy’s subsidiary, Energy Transport Solutions, received a Special Permit from the Pipeline and Hazardous Materials Safety Administration for the transport of LNG by rail; and

WHEREAS, the transport of LNG by New Fortress Energy and its subsidiaries presents significant safety hazards, including exposing those communities along roadways and railways to unprecedented and unjustifiable risk; and

WHEREAS, Delaware River Partners, LLC, a subsidiary of Fortress Transportation and Infrastructure Investors, LLC, has submitted an application to the Delaware River Basin Commission (“DRBC”) under Docket D-2017-009-2 to construct a transloading facility (“Dock 2”) at the Gibbstown Logistics Center that would transfer LNG from trucks and railcars to shipping vessels; and

WHEREAS, the DRBC, which is comprised of representatives from the States of Delaware, New Jersey, New York, Pennsylvania and the federal government, has adopted a compact that declares, “the conservation, utilization, development, management and control of water and related resources of the Delaware River Basin under a comprehensive multipurpose plan will bring the greatest benefits and produce the most efficient service in the public welfare”; and

WHEREAS, neither the Commonwealth of Pennsylvania nor the DRBC has fully assessed the potential public safety, public health or environmental impacts of the proposed overland transport of LNG by truck or by railcar on the communities along the possible transportation routes between the Wyalusing Township, Bradford County, Pennsylvania, and Gibbstown, Greenwich Township, Gloucester County, New Jersey; and

WHEREAS, no federal, state, or local agency has conducted a risk assessment of the specific transportation route(s) along which the LNG would travel; and

WHEREAS, no comprehensive Quantitative Risk Assessment, which quantifies the frequencies of events, such as transportation accidents and their consequences, has been undertaken of the trucks or railcars that would contain the LNG that would travel from the New Fortress Energy Facility, through Clarks Summit and to the Gibbstown Logistics Center; and

WHEREAS, neither the Commonwealth of Pennsylvania nor the DRBC has conducted an assessment of the cumulative and long-term impacts of the full scope of New Fortress Energy's plan to liquefy natural gas from fracking wells in Northern Pennsylvania, transport the LNG by truck or rail to the Gibbstown Logistics Center and export by marine vessels overseas on the Delaware River; and

WHEREAS, the Borough, Clarks Summit, and its surrounding communities have not been provided with training or support for emergency or first response service organizations to respond to accidents, fires, explosions, derailments, or other emergencies related to LNG overland transport; and

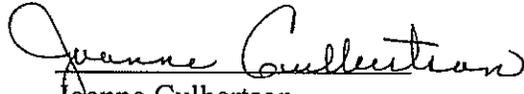
WHEREAS, the absence of such assessments and support prevents the appropriate management of and avoidance of accidents, derailments, catastrophic events, health harms, and environmental damage and the degradation that could occur from the overland transportation of LNG through Clarks Summit, including risks to public health, property values, and the clean air and water upon which our Clarks Green residents and businesses depend.

NOW, THEREFORE, BE IT RESOLVED by the **Council of the Borough of Clarks Green** on this 16th day of September 2020.

1. The members of the DRBC are hereby called upon to disapprove the pending application for the Dock 2 Project, filed under Docket D-2017-009-2.
2. The Commonwealth of Pennsylvania is hereby called upon to fulfill its constitutional duty and act affirmatively to protect the Commonwealth's public natural resources by taking all actions necessary to prevent the transportation of LNG through Pennsylvania by truck or rail, and to conduct a public health and safety analysis, a quantitative risk assessment, and a comprehensive environmental review of the potential impacts to communities and the nature environment in Pennsylvania.
3. The Borough Secretary is hereby directed to submit an official copy of this Resolution with the DRBC, with copies sent to the voting members at their respective locations: The Governors of Pennsylvania, New Jersey, New York, and Delaware, and the U.S. Army Corps of Engineers.
4. The Borough Secretary is also hereby directed to submit an official copy of this Resolution to Governor Tom Wolf of Pennsylvania, with copies to Pennsylvanian Senator John Blake, Pennsylvania State Representative Martin Flynn, and Pennsylvania Department of Environmental Protection Secretary Patrick McDonnell.

ATTEST:

BOROUGH OF CLARKS GREEN


Joanne Culbertson
Borough Secretary


Joseph Barrasse
Council President

Approved this 16th day of
September 2020


Kenneth McGraw
Mayor

RESOLUTION #20-98

A RESOLUTION OF THE BOROUGH OF RUNNEMEDE, CAMDEN COUNTY, NEW JERSEY OPPOSING THE TRANSPORT OF LNG THROUGH NEW JERSEY BY TRUCK

WHEREAS, a fundamental purpose of government is to protect the health, safety, and welfare of citizens; and

WHEREAS, New Fortress Energy is planning the overland transport of Liquefied Natural Gas ("LNG", also known as liquid methane) by truck on public highways and by rail car on existing railways from a yet-to-be-completed liquefaction plant in Wyalusing, Pennsylvania, to a proposed LNG export terminal in Gibbstown, New Jersey, on the Delaware River (the "Gibbstown Logistics Center"); and

WHEREAS, New Fortress Energy subsidiary Energy Transport Solutions received a Special Permit from the Pipeline and Hazardous Materials Safety Administration ("PHMSA") for the transport of LNG in rail cars designed 50 years ago and never used for LNG transport while subsequent federal rulemaking required a safer rail car design for all other carriers; and

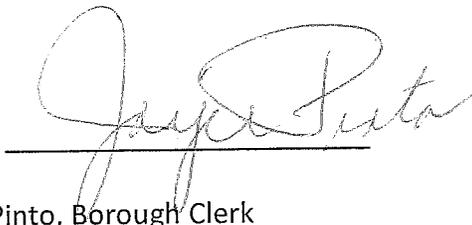
WHEREAS, the transport of LNG has unique safety hazards, exposing those along this particular rail route to unprecedented and unjustifiable risk.

WHEREAS, Delaware River Partners, LLC, a subsidiary of Fortress Transportation and Infrastructure Investors, LLC, has submitted an application to the Delaware River Basin Commission under Docket D-2017-009-2 to construct a transloading facility ("Dock 2") at the Gibbstown Logistics Center that would transfer LNG from trucks and railcars to shipping vessels; and

NOW, THEREFORE, BE IT RESOLVED that:

1. The Borough of Runnemede calls upon the members of the Delaware River Basin Commission to disapprove the Dock 2 project, Docket D-2017-009-2.
2. An official copy of this Resolution be filed with the Delaware River Basin Commission, 25 Cosey Road, P.O. Box 7360, West Trenton, NJ 08628-0360, and that copies are sent to the voting members at their respective locations: the Governors of Pennsylvania, New Jersey, New York, and Delaware, and the U.S. Army Corps of Engineers.
3. An official copy of this resolution be filed with Governor Philip Murphy of New Jersey at Office of the Governor, P.O. Box 001, Trenton, NJ 08625.

ADOPTED by the Council of the Borough of Runnemede, Camden County, New Jersey, in a lawful session duly assembled this 1st day of September, 2020.



Joyce Pinto, Borough Clerk

BOROUGH OF RUNNEMEDE

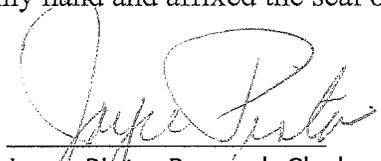


Nick Kappatos, Mayor

I HEREBY CERTIFY, that the foregoing resolution is a true copy of a resolution adopted by Mayor and Council of the Borough of Runnemede, New Jersey at a meeting of said Mayor and Council on the 1st day of September, 2020.

IN WITNESS THEREOF, I have hereunto set my hand and affixed the seal of this Borough.

DATED: 9/1/20


Joyce Pinto, Borough Clerk

Adoption of Resolution

Name	Yes	No	Abstain	Absent
Farrell	<input checked="" type="checkbox"/>			
Kelly	<input checked="" type="checkbox"/>			
Laubenstein	<input checked="" type="checkbox"/>			
Passio	<input checked="" type="checkbox"/>			
Ranieri	<input checked="" type="checkbox"/>			
Cepero	<input checked="" type="checkbox"/>			

2020

OPPOSING THE OVERLAND TRANSPORTATION OF LIQUEFIED NATURAL GAS THROUGH THE CITY OF SCRANTON AND ITS SURROUNDING COMMUNITIES

WHEREAS, the City of Scranton (the "City") is the largest municipality in Lackawanna County and Northeastern Pennsylvania; and

WHEREAS, Section 203 of the City's Home Rule Charter authorizes the Council of the City ("City Council") to make and adopt legislation as may be necessary for the maintenance of the peace, health, safety and welfare of the City and its residents; and

WHEREAS, City Council believes it is a fundamental purpose of government is to protect the peace, health, safety, and welfare of citizens; and

WHEREAS, Article I, Section 27 of the Constitution of the Commonwealth of Pennsylvania provides that, "The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment"; and

WHEREAS, Article I, Section 27 of the Constitution of the Commonwealth of Pennsylvania further declares, "Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people"; and

WHEREAS, it has been reported to City Council that New Fortress Energy and its affiliated entities are planning the overland transport of Liquefied Natural Gas ("LNG", also known as liquid methane) by truck on public highways and by railcar on existing railways from a proposed liquefaction plant to be located in the Wyalusing Township, Bradford County, Pennsylvania (the "New Fortress Energy Facility"), to a proposed LNG export terminal and port located in or near Gibbstown, Greenwich Township, Gloucester County, New Jersey, which is situated along the Delaware River (the "Gibbstown Logistics Center"); and

WHEREAS, LNG would be transported from the New Fortress Energy Facility to the Gibbstown Logistics Center along public highways and railways in Northeastern Pennsylvania, including by way of Interstate 81 which run directly through the City; and

WHEREAS, New Fortress Energy's subsidiary, Energy Transport Solutions, received a Special Permit from the Pipeline and Hazardous Materials Safety Administration for the transport of LNG by rail; and

WHEREAS, the overland transport of LNG by New Fortress Energy and its subsidiaries presents significant safety hazards, including exposing those communities along roadways and railways to unprecedented and unjustifiable risk; and

WHEREAS, Delaware River Partners, LLC, a subsidiary of Fortress Transportation and Infrastructure Investors, LLC, has submitted an application to the Delaware River Basin Commission ("DRBC") under Docket D-2017-009-2 to construct a transloading facility ("Dock 2") at the Gibbstown Logistics Center that would transfer LNG from trucks and railcars to shipping vessels; and

Introduced in Council on above date and referred to Committee on September 22, 2020
PUBLIC SAFETY
L. Reed
City Clerk

Scranton, Pa. September 29, 2020
Committee on Public Safety reports favorably on the within resolution.
Mark McShane
Chairman

CERTIFIED COPY

L. Reed
City Clerk

WHEREAS, the DRBC, which is comprised of representatives from the States of Delaware, New Jersey, New York and Pennsylvania and the federal government, has adopted a compact that declares, "the conservation, utilization, development, management and control of water and related resources of the Delaware River Basin under a comprehensive multipurpose plan will bring the greatest benefits and produce the most efficient service in the public welfare"; and

WHEREAS, neither the Commonwealth of Pennsylvania nor the DRBC has fully assessed the potential public safety, public health or environmental impacts of the proposed overland transport of LNG by truck or by railcar on the communities along the possible transportation routes between the Wyalusing Township, Bradford County, Pennsylvania, and Gibbstown, Greenwich Township, Gloucester County, New Jersey; and

WHEREAS, no federal, state, or local agency has conducted a risk assessment of the specific transportation route(s) along which the LNG would travel; and

WHEREAS, no comprehensive Quantitative Risk Assessment, which quantifies the frequencies of events, such as transportation accidents and their consequences, has been undertaken of the trucks or railcars that would contain the LNG that would travel from the New Fortress Energy Facility, through our City and to the Gibbstown Logistics Center; and

WHEREAS, neither the Commonwealth of Pennsylvania nor the DRBC has conducted an assessment of the cumulative and long-term impacts of the full scope of New Fortress Energy's plan to liquefy natural gas from fracking wells in Northern Pennsylvania, transport the LNG by truck or rail to the Gibbstown Logistics Center and export by marine vessels overseas on the Delaware River; and

WHEREAS, the City and its surrounding communities have not been provided with training or support for emergency or first response service organizations to respond to accidents, fires, explosions, derailments, or other emergencies related to LNG overland transport; and

WHEREAS, the absence of such assessments and support prevents the appropriate management of and avoidance of accidents, derailments, catastrophic events, health harms, and environmental damage and degradation that could occur from the overland transportation of LNG through the City, including risks to public health, property values, and the clean air and water upon which our residents and businesses depend.

NOW, THEREFORE, BE IT JOINTLY RESOLVED, BY THE COUNCIL AND MAYOR OF THE CITY OF SCRANTON, as follows:

SECTION 1. The members of the DRBC are hereby called upon to disapprove the pending application for the Dock 2 Project, filed under Docket D-2017-009-2.

SECTION 2. The Commonwealth of Pennsylvania is hereby called upon to fulfill its constitutional duty and act affirmatively to protect the Commonwealth's public natural resources by taking all actions necessary to prevent the transportation of LNG through Pennsylvania by truck or rail, and to conduct a public health and safety analysis, a quantitative risk assessment, and a comprehensive environmental review of the potential impacts to communities and the natural environment in Pennsylvania.

SECTION 3. The City Clerk is hereby directed to submit an official copy of this resolution with the DRBC, with copies sent to the voting members at their respective locations: the Governors of Pennsylvania, New Jersey, New York, and Delaware, and the U.S. Army Corps of Engineers.

SECTION 4. The City Clerk is hereby directed to submit an official copy of this resolution to Governor Tom Wolf of Pennsylvania, with copies to Pennsylvanian Senator John Blake, Pennsylvania State Representatives Mary Flynn, Pennsylvania State Representative Kyle Mullins, and Pennsylvania Department of Environmental Protection Secretary Patrick McDonnell.

SECTION 5. If any section, clause, provision or portion of this Resolution shall be held invalid or unconstitutional by any Court of competent jurisdiction, such decision shall not affect any other section, clause, provision or portion of this Resolution so long as it remains legally enforceable minus the invalid portion. The City reserves the right to amend this Resolution or any portion thereof from time to time as it shall deem advisable in the best interests of the promotion of the purposes and Intent of this Resolution and the effective administration thereof.

SECTION 6. This Resolution shall become effective immediately upon approval.

SECTION 7. This Resolution is enacted by the Council of the City of Scranton under the authority of the Act of Legislature, April 13, 1972, Act No. 62, known as the "Home Rule Charter and Optional Plans Law", and any other applicable Law arising under the laws of the State of Pennsylvania.

Passed by the Council

September 29, 2020

Receiving the Affirmative votes of Council Persons

Schuster, McAndrew, Rothchild, Donahue, Gaughan

Negative NONE

William Gaughan
President *WR*

Approved 10/5/2020

Perry J. Lepore Mayor

L. Reed City Clerk

Certified Copy

**SOUTH ABINGTON TOWNSHIP
LACKAWANNA COUNTY, PENNSYLVANIA
No. 9 of 2020
RESOLUTION
SOUTH ABINGTON TOWNSHIP BOARD OF SUPERVISORS
LACKAWANNA COUNTY, PENNSYLVANIA**

MODEL LNG TRANSPORTATION RESOLUTION – PA

WHEREAS, a fundamental purpose of government is to protect the health, safety, and welfare of citizens; and

WHEREAS, Article I, Section 27 of the Pennsylvania Constitution affirms that, “The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment”; and

WHEREAS, Article I, Section 27 further declares, “Pennsylvania’s public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people”; and

WHEREAS, New Fortress Energy is planning the overland transport of Liquefied Natural Gas (“LNG”, also known as liquid methane) by truck on public highways and by rail car on existing railways from a yet-to-be-completed liquefaction plant in Wyalusing, Pennsylvania, to a proposed LNG export terminal in Gibbstown, New Jersey, on the Delaware River (the “Gibbstown Logistics Center”); and

WHEREAS, New Fortress Energy subsidiary Energy Transport Solutions received a Special Permit from the Pipeline and Hazardous Materials Safety Administration (“PHMSA”)¹ for the transport of LNG in rail cars designed 50 years ago and never used for LNG transport while subsequent federal rulemaking required a safer rail car design for all other carriers²; and

WHEREAS, the as represented to the Board the transport of LNG has unique safety hazards, exposing those along this particular rail route to unprecedented and unjustifiable risk. An LNG release boils furiously into a flammable vapor cloud 600 times larger than the storage container. An unignited ground-hugging vapor cloud can move far distances,³ and exposure to

¹ Special Permit DOT-SP 20534 <https://www.phmsa.dot.gov/safe-transportation-energy-products/dot-20534-pdf>

² <https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/2020-06/2137-AF40%20Final%20Rule%20%206.19.20%20web%20final.pdf>

³ “Immediate ignition with liquid still on the ground could cause the spill to develop into a pool fire and present a radiant heat hazard. If there is no ignition source, the LNG will vaporize rapidly forming a cold gas cloud that is initially heavier than air, mixes with ambient air, spreads and is carried downwind.” P. 10 “Methane in vapor state can be an asphyxiant when it displaces oxygen in a confined space.” P. 11. SP 20534 Special Permit to transport LNG by rail in DOT-113C120W rail tank cars. Final Environmental Assessment. Docket No. PHMSA-2019-0100. December 5, 2019. P. 10.

the vapor can cause extreme freeze burns. If in an enclosed space, it asphyxiates, causing death.⁴ If ignited, the fire is inextinguishable; the fire is so hot that second-degree burns can occur within 30 seconds for those exposed within a mile. An LNG release can cause a Boiling Liquid Expanding Vapor Explosion.⁵ The explosive force of LNG is similar to a thermobaric explosion – a catastrophically powerful bomb. The 2016 U.S. Emergency Response Guidebook advises fire chiefs initially to immediately evacuate the surrounding 1-mile area.⁶ No federal field research has shown how far the vapor cloud can move, so in the most recent serious Plymouth, Washington, LNG fire, they evacuated a 2-mile radius⁷; and

WHEREAS, Delaware River Partners, LLC, a subsidiary of Fortress Transportation and Infrastructure Investors, LLC, has submitted an application to the Delaware River Basin Commission under Docket D-2017-009-2 to construct a transloading facility (“Dock 2”) at the Gibbstown Logistics Center that would transfer LNG from trucks and railcars to shipping vessels; and

WHEREAS, the Delaware River Basin Commission states, “The vision of the Delaware River Basin Commission is built upon the Compact signed in 1961 by Delaware, New Jersey, New York, Pennsylvania, and the federal government. It is defined in the Delaware River Basin Compact as, “the conservation, utilization, development, management and control of water and related resources of the Delaware River Basin under a comprehensive multipurpose plan will bring the greatest benefits and produce the most efficient service in the public welfare”⁸; and

WHEREAS, the Delaware River Basin Commission has recently affirmed in its statement on Diversity, Equity, Inclusion & Justice that its “core values” are “Service: to the public, the regulated community and our DRBC colleagues; Respect: for each other, the public and the Basin’s water resources; Professionalism: defined by high ethical standards, integrity, continuous improvement and accountability⁹; and

WHEREAS, to the Boards knowledge and as represented to the Board, neither the Commonwealth of Pennsylvania nor the Delaware River Basin Commission has assessed the potential public safety, public health or environmental impacts of the proposed overland transport of LNG by truck or by rail car on the communities along the possible transportation routes between Wyalusing, Pennsylvania, and Gibbstown, New Jersey; and

WHEREAS, to the Boards knowledge without independent investigation and as represented to the Board, no federal, state, or local agency has conducted a risk assessment of the specific transportation route(s) along which the LNG would travel; and

⁴ SP 20534 Special Permit to transport LNG by rail in DOT-113C120W rail tank cars. Final Environmental Assessment. Docket No. PHMSA-2019-0100. December 5, 2019. P, 11.

⁵ “LNG tank BLEVE is possible in some transportation scenarios.” Sandia National Laboratories, “LNG Use and Safety Concerns (LNG export facility, refueling stations, marine/barge/ferry/rail/truck transport)”, Tom Blanchat, Mike Hightower, Anay Luketa. November 2014. <https://www.osti.gov/servlets/purl/1367739> P. 23.

⁶ US DOT Emergency Response Guidebook. <https://www.phmsa.dot.gov/hazmat/erg/emergency-response-guidebook-erg>

⁷ <https://www.sightline.org/2016/06/03/williams-companies-failed-to-protect-employees-in-plymouth-lng-explosion/>

⁸ <https://www.nj.gov/drbc/library/documents/DRBCvision-mission-values.pdf>

⁹ <https://www.nj.gov/drbc/about/staff/DEIJ.html>

WHEREAS, to the Boards knowledge without independent investigation and as represented to the Board, no full scale Quantitative Risk Assessment, which quantifies the frequencies of events such as transportation accidents and their consequences, has been done of the trucks or railcars that would contain the LNG that would travel from Wyalusing, Pennsylvania, to Gibbstown, New Jersey¹⁰; and

WHEREAS, to the Boards knowledge without independent investigation and as represented to the Board, neither the Commonwealth of Pennsylvania nor the Delaware River Basin Commission has conducted a comprehensive assessment of the cumulative and long-term impacts of the full scope of New Fortress Energy’s plan to liquefy natural gas from fracking wells in Northern Pennsylvania, transport the LNG by truck or rail to the Gibbstown Logistics Center and export by marine vessels overseas on the Delaware River past Delaware and South Jersey bayshore communities; and

WHEREAS, training or support in Township has not been provided for emergency or first response service organizations to respond to accidents, fires, explosions, derailments, or other emergencies related to LNG transport within this jurisdiction; and

WHEREAS, the absence of such assessments and support prevents the appropriate management of and avoidance of accidents, derailments, catastrophic events, health harms, and environmental damage and degradation that could occur from the transportation of LNG through these communities, including risks to public health, property values, and the clean air and water upon which all citizens and businesses depend; and

WHEREAS, the potential transportation routes travel through communities with proportionately more minority and low-income populations, compounding environmental injustices¹¹;

NOW, THEREFORE, BE IT RESOLVED that:

1. South Abington Township calls upon the members of the Delaware River Basin Commission to disapprove the Dock 2 project, Docket D-2017-009-2.

¹⁰ “The QRA will help to evaluate the derailment and release probability of LNG rail cars over certain segments of the network, and account for a variety of track and train characteristics...An LNG risk model can be used to understand the probability and consequences for LNG transportation incidents for both rail and truck delivery. Even though they are treated differently, the underlying event tree analysis approach is the same. When the probability of LNG tank car derailment is understood, better decisions can be made regarding the crashworthiness, placement, and operation of rail cars and the potential consequences from an LNG release due to a derailment. Further study for modeling the probability and consequences of transporting LNG by rail and truck will help decision-makers understand public risks and make informed decisions.” “Risk Assessment of Surface Transport of Liquid Natural Gas”, *prepared for* U.S. DOT Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety *prepared by* Cambridge Systematics, Inc. *with* MaineWay Services, LLC, Rutgers University, Transport Analytics, LLC. ScienceSmith LLC, March 20, 2019. P. ES-9.

¹¹ Delaware Riverkeeper Network, <https://www.delawariverkeeper.org/taxonomy/term/1174>

2. South Abington Township, calls upon the Commonwealth of Pennsylvania to fulfill its constitutional duty and act affirmatively to protect the Commonwealth's public natural resources by taking all actions necessary to prevent the transportation of LNG through Pennsylvania by truck and/or by rail, and to conduct a public health and safety analysis, a quantitative risk assessment, and a comprehensive environmental review of the potential impacts to communities and the natural environment in Pennsylvania.
3. An official copy of this resolution be filed with the Delaware River Basin Commission, 25 Cosey Road, P.O. Box 7360, West Trenton, NJ 08628-0360, and that copies are sent to the voting members at their respective locations: the Governors of Pennsylvania, New Jersey, New York, and Delaware, and the U.S. Army Corps of Engineers.
4. An official copy of this resolution be filed with Governor Tom Wolf of Pennsylvania at Office of the Governor, 508 Main Capitol Building, Harrisburg, PA 17120.

Enacted as a Resolution by the Supervisors of South Abington Township on this 12th day of October, 2020.

ATTEST:

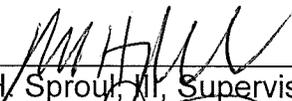
SOUTH ABINGTON TOWNSHIP



David O'Neill, Assit. Secretary

By: 

Giles W. Stanton, Chairman

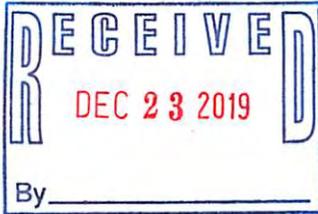
By: 

Joseph H. Sprout, II, Supervisor

By: 

Mark T. Dougherty, Supervisor

Exhibit L



PA2019-10
Port
Dock-2

APPLICATION FOR LAND DEVELOPMENT

Greenwich Township Planning/Zoning Board
Municipal Building
Gibbstown, New Jersey 08027

Number: _____
Date: November 25, 2019

Application is hereby made for approval of Land Development as herein described and shown on the accompanying plans in accordance with the Code of the Township of Greenwich, Chapter 131 entitled "Subdivision of Land and Site Plan Review," Chapter 97 entitled "Land Use Procedures," Chapter 148 entitled "Zoning," and the fees relating to such land development applications included in said Code.

Check type of application submitted:

SUBDIVISION: Concept _____ Major, Preliminary _____ Minor _____ Major, Final _____

SITE PLAN: Concept _____ Major (Conventional) xx - Preliminary and Final Approval Requested

CONDITIONAL USE: _____

Conditional Use Requested: _____

VARIANCE: _____

Variance Requested: _____

GENERAL INFORMATION

1. Applicant Delaware River Partners LLC Phone: 856-224-7000
Address: 200 N. Repauno Avenue, Gibbstown, NJ Zip: 08027
(correspondence will be sent to the above)

2. Owner of Premises: Delaware River Partners LLC Phone: 856-224-7000
Address: 200 N. Repauno Avenue, Gibbstown, NJ Zip: 08027

3. Nature of applicants' interest, if other than owner:

4. If applicant is a partnership, corporation or company, give the name and address of the principals: ** Please see enclosed corporate ownership disclosure, as Exhibit B **

Name: Title:

Address: Zip:

5. Location of Property:
Street Address: 200 N. Repauno Avenue, Gibbstown, NJ 08027
Tax Map Page 5 Block # 8 Lot # 3, 4, and 4.01, with adjacent tidelands

Zoning Classification: Repauno Port & Rail Terminal Redev. Plan, Tract area: +/- 3.99 acre(s) [Proposed Area of Disturbance.]
Waterfront Terminal District

6. List and types of all streets on which the development abuts: Route 44 Bypass, Repauno Ave., Morse St., School St.
State Highway County Highway xx Municipal Highway xx

7. Dimensions of Property: Irregular
Total area in square feet or acres 926.96 ac frontage +/- 2,400 ft If corner lot, specify both frontages:

8. Indicate Present Use:
Proposed area for development is currently vacant; overall facility is being developed as a multimodal port and rail terminal.

9. Proposed Use, if other than Present:
Please see enclosed Project Description as Exhibit A.

10. Proposed Development Name: Repauno Port & Rail Terminal - Dock 2

GENERAL INFORMATION (CONT.)

11. Professionals: Attorney of Record -

Douglas J. Janacek, Esq. Name

Gibbons P.C., One Gateway Center Address

Newark, New Jersey 07102

Associates Telephone 973-596-4641 (direct)

Planner/Engineer - Kevin Webb, P.E., Langan Engineering and Environmental Services

Name and Professional Address 989 Lenox Drive, Suite 124, Lawrenceville, NJ 08648

Associates Telephone 609-282-8014 (direct)

Other professionals submitting plans, data, or reports: (Please attach a separate sheet listing name, address, telephone, profession and itemization of material submitted.)

12. Property is part of minor or major subdivision granted on (date) . [Not Applicable]

13. The Board of Adjustment () or Planning Board () granted a special exception or conditional use () or a Bulk () or Use () variance on ((date) . [Prior Approvals for the Property are annexed hereto as Exhibit F.]

14. Description of the proposed development. Indicate present use; if subdivision, include number of lots; if site plan, indicate proposed use: Please see enclosed Project Description as Exhibit A.

15. Are the following utilities existing? Paved Streets YES NO Storm Sewers YES
NO Curbs YES NO Water YES NO Sidewalks YES NO Gas YES NO
Sanitary Sewer YES NO Electric YES NO Other
(Specify): Please see accompanying site plans for improvements and connections to utility infrastructure.

16. Property taxes and / or assessments for local improvements levied against the property proposed to be developed / subdivided have been paid through November 1, 2019 Proof of payment must accompany this application.

Payment of Taxes is confirmed with Tax Collector's office by Phone on 11/18; written confirmation to be submitted to the Board prior to hearing.

GENERAL INFORMATION (CONT.)

17. List plans and documents submitted. (See appropriate Code for submission requirements, number of copies, etc. All development plans submitted for review and action by the Planning Board **MUST** be prepared by a professional Engineer, Architect and / or Land Surveyor licensed by the State of New Jersey, as indicated by Code.)

PLAN OR DOCUMENT -Title and Date	PREPARED BY
Pease see accompanying cover letter.	

18. If a public hearing and notice is required, copy of notice and affidavit of service is required at the public hearing.

B. SUBDIVISION INFORMATION: (Complete if subdivision requested)

1. Number of Proposed Lots: _____
2. Average Lot Size in square foot or acres: Proposed _____ Required _____
3. Average Street Frontage: Proposed _____ Required _____
4. Will any new streets be created? Yes _____ No _____
5. Purpose of Subdivision: Residential _____
 Industrial _____ Mixed Use _____ Commercial _____
 Office _____ Agriculture _____

C. SITE PLAN INFORMATION: (Complete if site plan requested)

Existing	Proposed	Required
1. Minimum Lot Area: _____	926.96 ac	3 ac (average)
2. Building Coverage Limit _____	_____	none
3. Front Yard _____	_____	none
4. Side Yard _____	_____	none
5. Rear Yard: _____	_____	none
6. Frontage _____	_____	none
7. Impervious Coverage Limit _____	< 50%	50% within Redevelopment Area.

GENERAL INFORMATION (CONT.)

	Existing	Proposed	Required
8. Clearing Limit	_____	_____	none _____
9. Vegetated Area	_____	_____	none _____
10. Number of Curb Cuts	_____	_____	none _____
11. Parking Spaces	_____	_____	none _____
12. Building Height	_____	+/- 15 ft _____	80 ft (or 250 ft) _____
13. Gross Floor Area	_____	_____	none _____

14. How is the Site Plan being presently used?
 Area proposed for development is currently vacant.

15. Does the Site Plan contemplate use of existing building(s)? Yes ___ No^{xx} ___

16. Briefly describe what the site plan proposes: _____ -
 Please see enclosed Project Description.

D. WAIVER (S): (Complete if waiver requested)

1. Site Plan / Subdivision Filing:

Briefly describe each filing requirement waiver you are seeking:
 Please see enclosed Project Description.

2. Site Plan / Subdivision Design Standards:

Briefly describe each filing requirement waiver you are seeking:
 None requested.

E. OTHER AGENCIES: (Other approvals required and date plans submitted)

1. NJ Department Environmental Protection: YES ___ NO ___ MONTH, DAY, YR
2. Gloucester County Soil Conservation District YES ___ NO ___ MONTH, DAY, YR
3. Gloucester County Planning Board YES ___ NO ___ MONTH, DAY, YR

** Please see enclosed list of governmental approvals at Exhibit D. **

GENERAL INFORMATION (CONT.)

4. New Jersey Department of Transportation YES__ NO__ MONTH, DAY ,YR

5. Other: _____ YES__ NO__ MONTH, DAY ,YR

F. SUPPLEMENTAL INFORMATION:

1. Have there been previous application(s) filed with respect to the property within the last five years: YES xx NO____ If yes, state the nature, date and disposition of each prior application:

All prior approvals are annexed hereto.

2. Expert Witness (When Applicable) List the name, address and field of expertise each witness proposed to be used:

<u>Name</u>	<u>Address</u>	<u>Field</u>
-------------	----------------	--------------

To be determined.

3. Describe any deed restriction(s) affecting the property:

To the Applicant's knowledge, no deed restrictions affect this portion of the Property.

4. Describe any deed restriction proposed by the applicant.

None are proposed.

5. Describe any easement(s) or right(s) of way affecting the property.

To the Applicant's knowledge, no easements or rights of way currently affect this portion of the Property.
Please see Exhibit E.

6. Describe any easement(s) or right(s) of way proposed by the applicant.

None are proposed.

GENERAL INFORMATION (CONT.)

7. If other than to the applicant, to whom should Greenwich Township reports and correspondence be sent:

Name /Address

Douglas J. Janacek, Esq., Gibbons PC, One Gateway Center, Newark, NJ 07102 (djanacek@gibbonslaw.com)
Kevin Webb, P.E., Langan Engineering, 989 Lenox Drive, Lawrenceville, NJ 08648 (kwebb@langan.com)

G. CERTIFICATION OF APPLICANT:

The undersigned certify that the applicant(s) named in the foregoing application is/are legally authorized to submit the foregoing application and sign this Certification on behalf of the applicant. The undersigned certify that the information stated in the foregoing application and submissions therewith are true and correct. The undersigned realize that if any of the foregoing statements are willfully false, they are subject to

punishment.

Signature _____

Print Name: _____

Print Title: _____

Date: _____

DELAWARE RIVER PARTNERS LLC

Signature  _____

Print Name: Douglas J. Janacek, Esq.

Print Title: Attorney-in-Fact for the Applicant

Date: _____

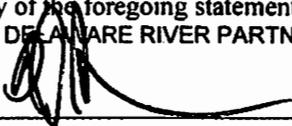
GENERAL INFORMATION (CONT.)

H. CERTIFICATION OF OWNER:

The undersigned hereby certify Delaware River Partners LLC is/are the owner(s) of the property which is the subject of the foregoing application and that the applicant named therein has been authorized to submit said application to the Greenwich Township Planning Board. The undersigned certify that they are said owner(s) or is/are legally authorized to sign this Certification on behalf of the owner. The undersigned realize that if any of the foregoing statements are willfully false, they are subject to punishment.

DELAWARE RIVER PARTNERS LLC

Signature _____

Signature  _____

Print Name: _____

Print Name: Douglas J. Janacek, Esq.

Print Title: _____

Print Title: Attorney-in-Fact for the Applicant

Date: _____

Date: _____

For Township Use Only:	
Received on:	
Certification completed on:	by:
Submitted to GCP/ZB on:	
Fee Amount \$	
Action Taken	
Meeting on:	

EXHIBIT A

Project Description

**Dock 2 – Repauno Port & Rail Terminal
Delaware River Partners LLC
200 N. Repauno Avenue
Block 8, Portions of Lots 3, 4, 4.01, and adjacent tidelands licenses
Gibbstown, NJ 08027**

Application for Preliminary and Final Major Site Plan Approval

Delaware River Partners LLC (“DRP”) seeks preliminary and final major site plan approval from the Township of Greenwich Planning/Zoning board for the development of a dock for the transfer of liquid products to and from vessels. Liquid products include a variety of cargos such as liquefied petroleum gases (propane and butane are examples), liquefied natural gas, and all other hazardous and non-hazardous products consistent with the permitted uses identified in the Repauno Port & Rail Terminal Redevelopment Plan. The proposed development will be on property located at 200 N. Repauno Drive, within the Repauno Port & Rail Terminal, on a portion of the property within Block 8, Lots 3, 4, and 4.01. The development will also take advantage of certain tidelands licenses secured by DRP. This portion of the property is within the Riverfront Terminal District of the Repauno Port & Rail Terminal Redevelopment Plan.

The proposed development of Dock 2 includes the construction of a dock with two (2) berths approximately 1230’ in length, and the grading and construction of a connecting roadway from the existing terminal road onto the dock structure. Each berth will include both mooring and breasting dolphins, and the construction of various lighting fixtures and safety/storage equipment on the proposed loading platforms for each berth, including operational sheds, including gangways and sump structures as necessary. Dock 2 will include connections to allow for transfers of liquid product to and from vessels. Dock 2 is being proposed with a connection to the existing rail rack and will in the future be able to accommodate all uses permitted in the Redevelopment Plan. The proposal also includes the necessary access trestles and support for piping racks, lighting, operational sheds, maintenance, and vehicle access to and from the two (2) berths.

We have confirmed by phone that taxes for the affected properties are paid to date, and written confirmation will be forwarded upon receipt.

DRP seeks the following submission waivers:

- No. 11 (Landscape Plan) No landscaping is proposed for this Application.
- No. 13 (Drainage Plan) No drainage or stormwater management is proposed for This Application, as all dock stormwater is handled by scuppers on the dock itself, and nothing ties into an upland drainage system.
- No. 16 (Drainage Calculations) No drainage or stormwater management is proposed for this Application, as all dock stormwater is handled by scuppers on the dock itself, and nothing ties into an upland drainage system.

EXHIBIT B

CORPORATE DISCLOSURE STATEMENT

DELAWARE RIVER PARTNERS LLC

This Corporate Disclosure Statement is provided in compliance with the requirements of N.J.S.A. 40:55D-48.1 et seq.

Owners holding 10% or more of any class of stock of Delaware River Partners LLC:

Delaware River Partners Holdco LLC, a Delaware Limited Liability Company (>10%)

Owners holding 10% or more of any membership interest in Delaware River Partners Holdco LLC:

Fortress Worldwide Transportation and Infrastructure General Partnership, a Delaware General Partnership (100%)

Owners holding 10% or more of any class of stock of Fortress Worldwide Transportation and Infrastructure General Partnership:

Fortress Transportation and Infrastructure Investors LLC (>99%)

Owners holding 10% or more of any class of stock of Fortress Transportation and Infrastructure Investors LLC:

The equity of Fortress Transportation and Infrastructure Investors LLC is traded on the NYSE under the symbol FTAI. A link to its SEC filing is:

<https://www.sec.gov/cgi-bin/browse-edgar?company=fortress+transportation&owner=exclude&action=getcompany> <<https://www.sec.gov/cgi-bin/browse-edgar?company=fortress+transportation&owner=exclude&action=getcompany>

EXHIBIT C

Application and Escrow Fee Calculation

**Dock 2 – Repauno Port & Rail Terminal
Delaware River Partners LLC
200 N. Repauno Avenue
Block 8, Portions of Lots 3, 4, 4.01, and adjacent tidelands
Gibbstown, NJ 08027**

Application Fee: \$ 400.00

Preliminary and Final Site Plan Review \$ 400.00

Escrow Deposit: \$ 5,000.00

Preliminary and Final Site Plan Review **
Acreage of Disturbance: 3.99 acres

**DRP instead is providing an initial escrow fee of \$5,000.00 to cover the costs of legal, engineering, planning, or other technical review, pursuant to the Municipal Land Use Law.

EXHIBIT D

**LIST OF GOVERNMENT APPROVALS REQUIRED FOR
DOCK 2 SUB-PROJECT**

- Township Planning Board Preliminary and Final Major Site Plan
- Gloucester County Soil Conservation District [pending]
- Gloucester County Planning Board Approval [pending]
- NJDEP Waterfront Development Individual Permit and Water Quality Certificate [originally issued May 20, 2019; reinstated September 5, 2019]
- NJDEP Tidelands Licenses [issued September 9, 2019]
- NJDEP Freshwater Wetlands LOI Line Verifications [approved July 11, 2016]
- NJDEP Freshwater Wetlands General Permits [approved June 30, 2017; modified November 29, 2018]
- Army Corps of Engineers Jurisdictional Determination [issued July 5, 2016]
- Army Corps of Engineers Section 10/404 Permit [pending]
- NJPDES 5G3 Storm Water Permit [*if applicable*]
- Delaware River Basin Commission [issued June 12, 2019]

EXHIBIT E

DEED RESTRICTIONS AND EASEMENTS AFFECTING THE PROPERTY

Deed Restrictions: To the knowledge of the Applicant, no deed restrictions affect the use proposed for the Property.

Easements/Rights of Way: To the knowledge of the Applicant, the following easements may be located near or on the Property, but no conflict exists between their continued operation and the use proposed:

- A roadway access easement appears to benefit Block 8, Lot 4.02, traversing Block 8, Lot 4 between Lot 4.02 and C-Line Road. However, the block and lot referenced on the survey is not consistent with title.

EXHIBIT F

**RESOLUTION #R2017-16
OF THE PLANNING/ZONING BOARD OF GREENWICH TOWNSHIP REGARDING
APPLICATION NO. PB2016-06 OF DELAWARE RIVER PARTNERS LLC
GRANTING PRELIMINARY & FINAL MAJOR SITE PLAN AND VARIANCE AND
WAIVER APPROVALS FOR PROPERTY LOCATED AT THE FORMER DUPONT
REPAUNO PLANT, DESIGNATED AS BLOCK 8, LOTS 3 & 4**

WHEREAS, an application has been submitted by Delaware River Partners LLC for Preliminary & Final Major Site Plan Approval and Variance and Waiver Approvals, for property located at a portion of the former DuPont Repauno Plant, and known as Block 8, Lots 3 & 4, on the Tax Map of the Township of Greenwich, which property is owned by the Applicant; and

WHEREAS, the Applicant has given legal Notice as required by and in accordance with N.J.S.A. 40:55D-12 and applicable Greenwich Township ordinances, by serving proper Notice to property owners within 200 feet of the site, serving Notice on all required governmental agencies and public utilities and by publishing a proper Notice in the newspaper, all at least ten (10) days prior to the hearing; and

WHEREAS, in support of the application the applicant has submitted the following documents:

1. Correspondence from Douglas J. Janacek, Esq. from Gibbons, PC, dated October 20, 2016; and
2. Planning/Zoning Board Application, dated October 17, 2016; and
3. Certification of Owner, dated October 17, 2016; and
4. Submission Checklist; and
5. Corporate Disclosure Statement; and

6. List of Professionals; and
7. Statement of Taxes Paid, dated October 13, 2016; and
8. List of Experts; and
9. Statement of Requested Relief; and
10. List of Outside Agency Approvals; and
11. 200' List of Property Owners, dated October 4, 2016; and
12. Title Report, dated September 12, 1984; and
13. Draft Deed Notices; and
14. Traffic Statement, prepared by Daniel D. Disaro, PE, PTOE, of Langan, 989 Lenox Drive, Suite 124, Lawrenceville, New Jersey 08648, dated October 17, 2016; and
15. Cover Sheet, 1 of 9, (The plans 9 of 9, were prepared by Kevin J. Webb, PE., of Langan, 989 Lenox Drive, Suite 124, Lawrenceville, New Jersey 08648), dated October 17, 2016; and
16. Overall Plan, 2 of 9, dated October 17, 2016; and
17. Demolition Plan, 3 of 9, dated October 17, 2016; and
18. Site Plan, 4 of 9, dated October 17, 2016; and
19. Grading Plan, 5 of 9, dated October 17, 2016; and
20. Soil Erosion and Sediment Control Plan, 6 of 9, dated October 17, 2016; and
21. Soil Erosion and Sediment Control Details, 7 of 9, dated October 17, 2016; and
22. Construction Details, 8 of 9, dated October 17, 2016; and

AIMINO & DENNEN, LLC
ATTORNEYS AT LAW

40 Newton Avenue
Woodbury, New Jersey 08096

23. Construction Details 2, 9 of 9, dated October 17, 2016; and
24. Circulation Exhibit, KT101, prepared by Kevin J. Webb, PE., of Langan, 989 Lenox Drive, Suite 124, Lawrenceville, New Jersey 08648; and
25. At the time of the hearing the following Exhibits were marked:
 - A-1 Overall plan of the site augmented to show the area of development with respect to the Repauno property as a whole; and
 - A-2 Site Plan Exhibit, slightly modified from the submitted site plan and focused on the particular site of development; and
 - A-3 Traffic Circulation Plan.

WHEREAS, the Greenwich Township Planning/Zoning Board has made its determination in this matter based on the following:

1. The documents set forth above;
2. The representations made by the Applicant in its application and by the Applicant, Delaware River Partners LLC, through its representatives, experts and witnesses: Kevin Webb, PE, Langan and Charles Heydt, PP of Langan; and its attorney, Douglas Janacek, Esq., at the time of the hearing before the Board on December 5, 2016;
3. Letter from the Greenwich Township Planning/Zoning Board Engineer, James A. Clancy, PE, PLS, PP, CME, dated December 1, 2016, which is incorporated and made a part of this Resolution by way of reference;
4. Letter from the Greenwich Township Planner, Matthew K. Miller, AIA, PP, dated December 5, 2016, which is incorporated and made a part of this Resolution by way of reference;

5. Letter from the Greenwich Township Master Plan

Consultant/Redevelopment Engineer, J. Timothy Kernan, PE, PP, CME, dated November 23, 2016, which is incorporated and made a part of this Resolution by way of reference;

6. Comments made by the Township Planner, Planning/Zoning Board Engineer and the Master Plan Consultant/Redevelopment Engineer at the time of the hearing on December 5, 2016;

7. The following members of the public spoke at the time of the hearing before the board on December 5, 2016:

A. New Jersey Senate President, Stephen M. Sweeney addressed the Board to show his support for the redevelopment of this property. He noted the bi-partisan work that has taken place between him and the Mayor and Council for at least ten (10) years to bring back this dead site and put people in the area back to work. He further noted his support for the by-pass access road, which Gloucester County had committed 2.5 million dollars towards developing.

B. Charles Breen of 64 Logan Avenue. Mr. Breen expressed concern as to whether the lighting would spill over into the neighboring residences and cause problems. The Applicant's engineer, Mr. Webb testified that in his professional opinion, give the distance from the nearest residential area, which is approximately a mile, and the natural buffering of trees and vegetation, that there would not be any light spillover into the residential areas. Mr. Breen was further concerned over the increased truck traffic for what he saw as only an additional 3 to 5 new jobs.

C. Ron Cundy, 139 Jackson Avenue. Mr. Cundy inquired as to the company that would be doing the work at the site. The Applicant indicated it, Delaware River Partners LLC would be doing the work. He inquired as to whether there were any existing agreements with the refineries in the area. The Applicant testified they had not put them in place yet, but their market studies show there will be a market for this activity. Mr. Cundy inquired about the rail cars. The Applicant testified that the facility will be set up to handle 6 rail cars at a time. Most of the deliveries of the butane to the site will be by rail car. The deliveries back out to the facilities will be by both rail and trucks.

D. Rebecca Tomlin, 110 N. Repauno Avenue. Ms. Tomlin expressed concern that the number of trucks, 48 trucks in and 48 trucks out, would create a lot of traffic for the residential areas.

E. Richard Friendlich, 52 Logan Avenue. Mr. Friendlich inquired as to whether there would be a limit on the amount of traffic until such time as the by-pass road was constructed. The Planning/Zoning Board, Mr. Clancy indicated that as each phase is brought before the Board, they would look at the traffic situation and evaluate any improvements that would need to be made. Kevin Webb, the Applicant's engineer testified that at the present time the traffic calculations showed that the service on the roadways would be excellent. Mr. Friendlich inquired about the storage of rail cars. The Applicant indicated that the rail cars would be stored on site and not near the residential areas. Lastly, he inquired about safety studies for the cavern. The Applicant testified that the studies are on file with the New Jersey Department of Environmental Protection (NJDEP). Mr. Aimino, the board's solicitor

noted that the issues of safety were pre-empted by the NJDEP. The township's redevelopment counsel, John C. Terruso, Esq. testified that the Township has broad powers and will be reviewing all the studies and requirements as a part of the Redevelopment Agreement that the Applicant and the Township will be negotiating and entering into as to each phase of the development. The cavern will not be operational until all the permits and approvals are obtained. Mr. Kernan reviewed some of the required approvals, including but not limited to compliance with the Toxic Catastrophic Prevention Act.

F. Bill Franklin, 624 Betty Rose Avenue. Mr. Franklin testified that he works at Exit 14 and says the right turn is tight. Kevin Webb, the Applicant's engineer testified that the typical trucks are standard tanker trucks which are smaller than tractor trailers that typically serve distribution warehouses. Mr. Webb also reviewed the truck circulation plan which shows that the trucks will not cross paths on the roadway.

G. Joseph DiMenna, 56 Memorial Avenue. Mr. DiMenna noted that the notice to the public contained language that generally asked for additional variances as needed. Mr. Clancy explained that this is typical language that Applicant's insert in their notices in the event additional variances or waivers are noted by the Township's professionals reviewing the project. In this case there was only the one variance and one waiver requested and needed. Mr. DiMenna inquired about the engineering results of the by-pass. The Applicant indicated that they had not yet received the results from the County. The Applicant also indicated they hope to have the cavern up and running in calendar year 2017.

H. Greg Cipolla, 607 Democrat Road. Mr. Cipolla inquired as to whether the Applicant owned the entire site and whether additional development was planned. It was confirmed that the Applicant did own the entire site, that additional development was planned particularly utilizing the future port on the river, but that the planned developments had not been finalized yet. Each phase of the development will go before the Board with notice to the public. Mr. Cipolla expressed his support for the construction of the by-pass road. The Mayor indicated that in his discussions he learned that the project had been held up because of the lack of funding in the state's transportation fund, but now that the fund was funded again, the project would move forward as quickly as possible.

I. Kelly Reggieri, 9 S. Repauno Avenue. Mr. Reggieri inquired about whether Repauno Avenue is or could be a one-way street. The Applicant indicated the Township consultants had considered making the southern portion of Repauno Avenue one way. If that happened, the Applicant would agree to provide adequate signage.

J. Jamie Zaccaria, 13 Hixon Drive, Burlington, New Jersey. Ms. Zaccaria approached the Board indicating she was there representing the New Jersey Sierra Club. The Applicant objected to Ms. Zaccaria testifying on the basis that she did not meet the definition of an "interested party" and that the New Jersey Sierra Club, a corporation, could not appear before the board unless represented by a New Jersey licensed attorney. The Board determined to hear Ms. Zaccaria's testimony, but reserved the right to determine or contend in the future, that she did not meet the definition of an "interested party" and that the New Jersey Sierra Club was not

properly before the Board because of a lack of legal representation. Ms. Zaccaria testified that the Sierra Club has 50 members in the Township. She contends the club represents the entire State of New Jersey with respect to environmental issues and the Delaware River. Ms. Zaccaria expressed concern about spills of toxins from trucks getting into the drinking water. She stated her belief that the project was a threat to the environment.

WHEREAS, the Board, after considering the information and testimony provided at the time of the hearing and examining the submitted and above listed documents, considering the comments and the letters of the Planning/Zoning Board Engineer, James A. Clancy, P.E., C.M.E., the Township Planner, Matthew K. Miller, AIA, PP, NCARB, and the Master Plan Consultant/Redevelopment Engineer, J. Timothy Kernan, PE, PP, CME, makes the following findings of law and statements of fact:

1. The Applicant proposes the operation of a Subterranean Hard Rock Cavern for Liquefied Petroleum Gas (LPG), to store, sell and distribute petroleum products via tanker trucks and rail cars. The operation will have ancillary equipment on site. Additional site improvements include six (6) parking spaces for three (3) full time employees, site lighting, removal of various concrete pads, installation of a pipe rack system with an overhead catwalk above a portion of the of the pipe system, a prefabricated operations building and a bill of lading structure. The existing inactive cavern will be used to receive and store LPG during low demand times (projected to be April through August) and dispense and ship LPG during high demand times

(projected to be November through March). The operation will be idle at times, primarily in September and October.

2. The property in question is Block 8, Lots 3 & 4 which contains approximately 921± acres of the former Dupont Repauno Plant, which totals 1,620 acres in Tract 1. The subject parcel is largely undeveloped but contains a 60' wide right of way to Atlantic City Electric and numerous dirt roads traversing it. As a part of the overall tract the subject parcel is under an administrative consent order that DuPont entered into with the NJDEP. Pursuant to the consent order, The Chemours Company (a successor to DuPont) continues to address the overall concerns of contamination on the property through monitoring, remedial actions and reports. The Applicant indicates that the development of this area would not be affected by or affect the ongoing remediation efforts on the contaminated parts of the property. The subject parcel is affected by wetlands and wetlands transition areas, flood hazard and riparian zone areas, waterfront development areas and is located in the M-D Manufacturing District which is also a Redevelopment Area.

3. The site is bordered to the north by the Delaware River, to the south and southeast by residential areas and to the east by the Ashland Hercules Redevelopment Area.

4. The property is located within the MD Manufacturing District and the E. I. DuPont Redevelopment Area and the proposed use is permitted in this zoning district and Redevelopment Plan. The development of this portion of the property will not be accessible to the general public due to the necessary security and general

safety requirements. Also, the portion of the property is located adjacent to the Delaware River approximately one (1) mile from any public visibility or public domain.

5. The Applicant sought the following variance and waiver in connection with the application, both of which were granted by the Board:

A. Variance from §700-41J, which requires a minimum buffer of 100 feet in width to any residential zone, 50 feet of which shall be landscaped in accordance with the buffer requirements of this chapter and the requirement of a buffer to any residential use which shall be a minimum of 50 feet, 25 feet of which shall be landscaped in accordance with the buffer requirements of the chapter. The Applicant does not propose any buffers as the project is approximately 4,800 feet from the nearest residential use (a daycare center) and nearly 5,000 feet or approximately one (1) mile from the nearest residential zone.

B. Design waiver from the height requirements for lighting to allow them to go 25 feet in some areas up to a maximum height of approximately 30 feet in other areas. The additional height of the lights is required as the lighting is being installed on top of the catwalks and at the truck loading areas for safety purposes.

C. The variance and waiver outlined above were supported by the Greenwich Township Planner, Mr. Miller. The Greenwich Township Planning/Zoning Board weighed the negative and positive criteria with respect to the variance and waiver, as well as, any potential impact on the master plan and/or zoning ordinance and determined that any detrimental effect, if any, was outweighed by the positive aspects of the development, with any conditions imposed, determined that there was no impairment to the master plan or zoning ordinance and the granting of the

variance and waiver was appropriate under the law, represented good sound planning and was in the best interest of Greenwich Township.

6. The Applicant's engineer, Kevin Webb testified giving the Board and the public an overview of the project. Utilizing what was marked as A-1, an overall plan of the tract, he outlined where the proposed development would take place. The entire Repauno site consists of approximately 1800 acres. This site is approximately 920 acres and the project is located approximately 4,800 feet from the nearest residential use, a daycare center. The cavern was completed in 1968 and ceased operations in 1996. The development will include pipelines to move the butane in and out of the cavern facility. In the summer, butane is an excess by-product from the refineries which would be brought to the cavern facility. In the winter, butane is used as a fuel additive, at which point the butane would be sold back to the refineries for use in fuel. Most of the butane will be brought on site by rail cars. The delivery back of the butane will be done by rail car and tanker trucks. The facility will be equipped to handle six (6) rail cars at a time. An extension of the pipe system will allow for the service of tanker trucks which will be equipped to handle a maximum of 48 trucks per day, at a rate of two (2) trucks per hour, at peak times. Additional development will include ancillary equipment pads, a catwalk along the rail service, which will include safety lighting at heights ranging from 25 feet to 30 feet. At the entrance there will be an approximately 360 square foot prefabricated building for an office located on an existing pad. Three (3) employees per shift will work the site 24/7 (three (3) shifts of three (3) people). There will be on-site security on a 24/7 basis regardless of the level of activity.

7. Mr. Webb traced the truck circulation route for the board. Trucks will enter the facility off of US I295 at Exit 14 and go down Repauno Station/Floodgate Road to Route 44 and turn right. They will make a left to head North on Repauno Avenue. Exiting they head down Repauno Avenue, make a left on Democrat Road toward US I295 and the onto the Exit 16A ramp. Inside the plant, the trucks do not cross paths. The trucks go in a circular motion using C-Line Road and Repauno. The trucks do not use A-Line Drive where it intersects with Repauno.

8. The Applicant indicated they were attempting as best as possible to utilize existing structures, for instance existing concrete pads. Mr. Clancy, the Board engineer confirmed that there was not a need for a stormwater management plan as less than one (1) acre of land is being disturbed. All NJDEP approvals are being sought and will be submitted to the Board when obtained.

9. Mr. Kernan inquired as to whether barges would be used on the river to deliver the butane. The Applicant indicated that barges would not be utilized. If the Applicant intended to utilize barges in its operation, the Applicant agreed that it would have to return to the Board for approval.

10. The issue of a new traffic study was raised by the Board. The Applicant stated for the record that they would not be pursuing the Preliminary Approval they had recently received for the warehouse project. As such, the only proposed traffic at this time would be the 48 trucks per day maximum associated with this project. This level of traffic, (which is far below the level contemplated by the warehouse project), fits well within the traffic limits studied in the initial traffic study submitted to the Board and showed that the roadways would be in a position to

handle this level of traffic, given the improvements agreed to by the Applicant. The Applicant agreed that a revised traffic study would be required should the Applicant return to the Board to pursue the warehouse project through either an Amended Preliminary application or new application.

11. The Applicant's professional planner, Charles Heydt testified regarding the requested variance and waiver and the basis for why they should be granted. Mr. Heydt opined that the requested variance and waiver promote the purposes of zoning, specifically citing N.J.S.A. 40:55D-2: (a) encouraging municipal action to guide the appropriate use or development of all lands in a manner to promote public health, safety, morals and general welfare; (h) encouraging the location and design of transportation routes which promote the free flow of traffic; and (j) the conservation and protection of natural resources.

12. With respect to the variance request from the buffer and landscaping requirements, Mr. Heydt indicated that due to the distance from the nearest residential use of nearly a mile, there is no real gain to be had from a buffer and landscaping area near this facility. The lengthy distance and the natural vegetation and terrain are significant buffers from any residential zone. Mr. Heydt noted no negative affect from the lack of the buffer and landscaping for the same reasons. Mr. Miller, the Board Planner, supported this position, likening it to the situation the Board often deals with at the local refinery, where on-site buffers and landscaping have no real benefit or utility.

13. As to the waiver request for the lighting, Mr. Heydt noted that the increased height request was for security purposes. The lighting in question is on

top of the catwalk and provides safety and security lighting for employees using the facility. The need for the additional height is driven by the height of the catwalks which are already above ground. Mr. Heydt testified that the security benefits from the lighting outweigh any possible detriments, of which he believed there were no negative aspects to the lighting. Testimony was provided by the Applicant that given the distance from any residential area, there would be no light spill-over from this site.

14. Mr. Hedyt opined that the the granting of the variance and waiver would be in line with the intent and purpose of the zoning ordinance which is to insure that there are adequate buffers from residential zones, which in this case is accomplished by the lengthy distance of the site from any residential zone and the nature of existing buffers. The same would hold true for the waiver request regarding the lighting as the intent is to provide adequate lighting without detrimental spill-over to residential areas, which is accomplished by the proposed lighting. No impairment to the master plan or zoning ordinance is presented by the granting of this variance or the waiver as the use is permitted and contemplated by the zoning district in question. The Board agreed with this reasoning set forth above, and having weighed the negative and positive aspects of the requests, granted the variance and waiver.

16. Mr. Kernan testified that he had reviewed the Applicant's traffic study and agreed that the study is adequate at this time, given the Applicant's agreement that should the warehouse project be pursued, that a revised traffic study would be submitted.

17. Mr. Clancy confirmed with the Applicant that the daily 48 trucks at a rate of 2 per hour would be the maximum number of trucks at peak time. The Applicant confirmed this statement and indicated that the majority of delivery of butane to the site would be by rail. The delivery off site would be by rail and tanker truck.

18. The Board's planner, Matt Miller, PP, provided testimony regarding his review of the project. He noted that the project meets all the bulk requirements for the zone in question and is a use is in keeping with the permitted uses of the M-D Zone. As indicated herein, Mr. Miller supported the granting of the variance and waiver as requested by the Applicant.

19. The Applicant, through its attorney, Douglas Janacek and its engineer, Kevin Webb indicated that they had reviewed the Planner, Matt Miller's letter of December 5, 2016, the Board Engineer, James Clancy's letter of December 1, 2016, and the Board Master Plan Consultant/Redevelopment Engineer, J. Timothy Kernan's letter of November 23, 2016 and that they agreed to comply with all the recommendations, revisions, conditions, and/or requests set forth in those letters unless specifically modified or indicated otherwise in this resolution.

WHEREAS, the Board, has made its determinations in this matter based on the above exhibits, testimony and oral representations which are incorporated herein by way of reference, and has found and concluded that:

1. The granting of the Preliminary and Final Major Site Plan and Variance and Waiver Approvals, as revised by the terms and conditions of this Resolution, conform to the standards of sound

planning and will have no deleterious effects on the neighborhood from the standpoint of insuring the health, safety, amenities and welfare of the community and are consistent with the purpose and intent of the Zoning and Master Plan; and

2. The benefits of the deviation from the Zoning Code would substantially outweigh any detriment.

WHEREAS, upon motion duly made and seconded to grant the "Application for Land Development" for Preliminary and Final Major Site Plan Approval and Variance and Waiver Approvals, the Board, by a vote of 8 in favor, 0 opposed and 0 abstentions, (Voting for: Rush, Shivery, Byrne, Durham, Wagner, Shoulders, Hewes and Stigale), voted in favor of granting the application subject to certain conditions contained herein.

NOW, THEREFORE, BE IT RESOLVED, by the Planning/Zoning Board of Greenwich Township that the application of Delaware River Partners LLC requesting Preliminary and Final Major Site Plan Approval and Variance and Waiver Approvals for land located at the former DuPont Repauno Plant, Greenwich Township, New Jersey, also known as Block 8, Lots 3 & 4, is **HEREBY APPROVED**, subject, however, to the testimony, representations and stipulations of the Applicant and their professionals and witnesses at the time of the hearing and in their submissions, and further specifically, subject to the following terms and conditions:

1. Subject to the Applicants complying with and obtaining any and all necessary approvals from any other local, county, state and/or federal government or administrative body having jurisdiction over all or part of this land use development

approval. Those approvals include but are not limited to the following: Greenwich Township Building Department Building Permit (not required for sign-off of plan approval); Greenwich Sewer and Water Department; Greenwich Township Fire Official; NJDEP Freshwater Wetlands LOI line verification; NJDEP Freshwater Wetlands General Permits; NJDEP Coastal Permits; New Jersey Toxic Catastrophe Prevention Act (TCPA) Program approval; Delaware River Basin Commission (DRBC); Gloucester County Soil Conservation District; NJDEP Pollutant Discharge Elimination System Permitting; and Gloucester County Planning Board Approval; and

2. In accordance with the Code of the Township of Greenwich, §131-39.1 Fees, the Municipal Land Use Law and any other applicable code provision, no Certificate of Occupancy shall be issued and no occupancy shall be permitted until all other contingencies provided for herein are satisfied and all bills and escrows relating to this property have been paid in full; and

3. The Planning/Zoning Board Engineer and/or Township Planner and/or Master Plan Consultant/Redevelopment Engineer, shall review all plans and amended plans and inspect the site of the development in order to determine compliance with the terms and conditions of the Planning/Zoning Board approval. Any shortcomings noted by any professional shall be addressed to the satisfaction of the professionals before the issuance of a Certificate of Occupancy. The Applicant shall submit appropriate escrow amounts, as determined by the Planning/Zoning Board Engineer and applicable law, for inspections; and

4. The Applicant shall comply with each and every condition, revision, modification and/or other request contained in the Planner's letter of December 5,

2016, the Engineer's letter of December 1, 2016, and the Master Plan Consultant/Redevelopment Engineer's letter of November 23, 2016, unless otherwise specifically modified herein; and

5. The Applicant will post, pursuant to the Municipal Land Use Law and Township Ordinances, an inspection escrow, performance guarantee and a maintenance guarantee, to cover the on-site improvements proposed in this application and an estimate for all site improvements will be prepared by the Planning/Zoning Board Engineer or Master Plan Consultant/Redevelopment Engineer; and

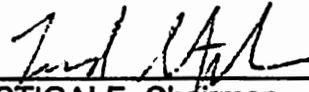
6. In accordance with the Statewide Non-Residential Development Fee Act (N.J.S.A. 40:55D-8.1-8.7), the Applicant is required to make payment of a development fee of 2.5% of the equalized assessed value of the non-residential construction. A condition of receiving a building permit is the payment of approximately ½ of this fee, the balance being calculated and paid at the time of the request for a certificate of occupancy; and

7. Traffic edge markings shall be added to the plans along the on-site roadway to delineate at night.

8. The Applicant shall timely provide the Board and the Board Professionals copies of all permits and approvals obtained by and from the NJDEP regarding the project, specifically including but not limited to those outlined in Paragraph 1 above.

9. The Applicant must enter into a Redevelopment Agreement with the Greenwich Township governing body which shall address and include, but not be

limited to, items such as the project schedule, roadway improvements, signage, one-way traffic on Repauno Avenue, no parking, etc.; sewer and water; security measures, all NJDEP permitting and safety approvals; and compliance with the New Jersey TCPA.



FRED STIGALE, Chairman
Planning/Zoning Board of Greenwich Township

The foregoing Resolution was a memorialization of action taken at a regular meeting of the Planning/Zoning Board of Greenwich Township held on the 5th day of December 2016; and such resolution was adopted by the Planning/Zoning Board of Greenwich Township at its reorganizational and regular meeting held on January 9, 2017, by a vote 8 to approve, 0 to Oppose and 0 to abstain.



KIRK FAIRLEY, Secretary
Planning/Zoning Board of Greenwich Township

THOSE IN FAVOR: *Hewes, Rush, Wagner, Stigale, Shoulders, Byrne, Shivery & Durham*

THOSE OPPOSED: *n/a*

THOSE ABSTAINED: *n/a*

**RESOLUTION #R2017-28
OF THE PLANNING/ZONING BOARD OF GREENWICH TOWNSHIP REGARDING
APPLICATION NO. PB2017-05 OF DELAWARE RIVER PARTNERS LLC
GRANTING PRELIMINARY & FINAL MAJOR SITE PLAN AND VARIANCE AND
WAIVER APPROVALS FOR PROPERTY LOCATED AT THE FORMER DUPONT
REPAUNO PLANT, DESIGNATED AS BLOCK 8, LOTS 4 & 4.02
AND ADJACENT RIPARIAN AREAS**

WHEREAS, an application has been submitted by Delaware River Partners LLC for Preliminary & Final Major Site Plan Approval and Variance and Waiver Approvals, for property located at a portion of the former DuPont Repauno Plant, and known as Block 8, Lots 4 & 4.02 and adjacent riparian areas, on the Tax Map of the Township of Greenwich, which property is owned by the Applicant; and

WHEREAS, the Applicant has given legal Notice as required by and in accordance with N.J.S.A. 40:55D-12 and applicable Greenwich Township ordinances, by serving proper Notice to property owners within 200 feet of the site, serving Notice on all required governmental agencies and public utilities and by publishing a proper Notice in the newspaper, all at least ten (10) days prior to the hearing; and

WHEREAS, in support of the application the applicant has submitted the following documents:

1. Correspondence, Ed Wilkes, PE, Langan Engineering, dated September 8, 2017; and
2. Planning/Zoning Board Application, dated September 7, 2017; and
3. Application for Variance, dated September 7, 2017; and
4. Variance Checklist, dated September 7, 2017; and

5. Subdivision Site Plan Checklist; and
6. Redeveloper Corporate Disclosure; and
7. Resolution #R2017-16, dated December 5, 2016; and
8. Statement of Taxes Paid, dated August 23, 2017; and
9. Statement of Requested Relief, dated September 7, 2017; and
10. List of Experts; and
11. Deed Restrictions and Easements Affecting the Property; and
12. 200' List of Property Owners, dated June 1, 2017; and
13. Tidelands License Application Form, dated November 15, 2016; and
14. Organization Data Form; and
15. Affidavit of Title, dated November 15, 2016; and
16. NJDEP Modification of Waterfront Development Permit, dated August 3, 2017; and
17. Site Plan Application to the Gloucester County Planning Board; and
18. Cover Sheet, 1 of 9, (The plans 9 of 9, were prepared by Kevin J. Webb, PE., of Langan, 989 Lenox Drive, Suite 124, Lawrenceville, New Jersey 08648), dated September 7, 2017; and
19. Overall Plan, 2 of 9, dated September 7, 2017; and
20. Demolition Plan, 3 of 9, dated September 7, 2017; and
21. Site Plan, 4 of 9, dated September 7, 2017; and
22. Grading, Drainage and Utility Plan, 5 of 9, dated September 7, 2017;

and

AIMINO & DENNEN, LLC
ATTORNEYS AT LAW

40 Newton Avenue
Woodbury, New Jersey 08096

23. Soil Erosion and Sediment Control Plan, 6 of 9, dated September 7, 2017; and

24. Soil Erosion and Sediment Control Details, 7 of 9, dated September 7, 2017; and

25. Construction Details 1, 8 of 9, dated September 7, 2017; and

26. Construction Details 2, 9 of 9, dated September 7, 2017; and

27. At the time of the hearing the following Exhibits were marked:

A-1 Overall plan of the entire site augmented to show the area where the wharf will be built, prepared by Langan Engineering and dated October 2, 2017; and

A-2 Site Plan Exhibit CS 101, prepared by Langan Engineering and dated September 7, 2017.

WHEREAS, the Greenwich Township Planning/Zoning Board has made its determination in this matter based on the following:

1. The documents set forth above;

2. The representations made by the Applicant in its application and by the Applicant, Delaware River Partners LLC, through its representatives, experts and witnesses: Kevin Webb, PE, Langan and its attorney, Douglas Janacek, Esq., at the time of the hearing before the Board on October 2, 2017;

3. Two (2) Letters from the Greenwich Township Planning/Zoning Board Engineer, James A. Clancy, PE, PLS, PP, CME, both dated September 28, 2017, both of which are incorporated and made a part of this Resolution by way of reference;

4. Letter from the Greenwich Township Planner, Matthew K. Miller, AIA, PP, dated October 2, 2017, which is incorporated and made a part of this Resolution by way of reference;

5. Letter from the Greenwich Township Master Plan Consultant/Redevelopment Engineer, J. Timothy Kernan, PE, PP, CME, dated September 28, 2017, which is incorporated and made a part of this Resolution by way of reference;

6. Comments made by the Township Planner at the time of the hearing on October 2, 2017;

7. The following members of the public spoke at the time of the hearing before the board on October 2, 2017:

A. Al Zappola of 704 West Broad Street. Mr. Zappola was concerned about the loud pounding noise that he hears from his property very early in the morning. He has approached the construction code office seeking help in stopping the Applicant from starting work so early in the morning. Mr. Janacek informed the Board that Mr. Zappola and Gary Lewis, President of DRP had spoken and that Mr. Lewis would address the situation. Mr. Zappola inquired as to the type of cargo that would be unloaded at the dock. The Applicant does not know at this point what type of cargo will be delivered to the dock.

WHEREAS, the Board, after considering the information and testimony provided at the time of the hearing and examining the submitted and above listed documents, considering the comments and the letters of the Planning/Zoning Board Engineer, James A. Clancy, P.E., C.M.E., the Township Planner, Matthew K. Miller,

AIA, PP, NCARB, and the Master Plan Consultant/Redevelopment Engineer, J. Timothy Kernan, PE, PP, CME, makes the following conclusions of law and findings of fact:

1. The Applicant proposes to replace an abandoned dock facility with the construction of a new cargo wharf, referred to as a marginal wharf, to serve as a part of an intermodal logistics center. Approximately 4.26 acres of land and 1.4 acres of intertidal/subtidal shallows will be disturbed. The project is the initial phase of the Delaware River Partners (DRP) Gibbstown Logistics Center. The improvements include paving, lighting, trench drains, storm sewer and an outfall into the Delaware River. As part of the overall tract, the stormwater management for the subject parcel has been reviewed by the NJDEP and the proposed outfall has been authorized under Permit 0807-16-0001.2.

2. The property in question is Block 8, Lots 4 & 4.02 which contains approximately 926 acres of the former Dupont Repauno Plant, along with adjacent riparian areas. The former plant totals 1,620 acres. The subject parcel is a former dock and is currently inactive. The subject parcel is affected by wetlands and wetlands transition areas, flood hazard and riparian zone areas, waterfront development areas and is located in the MD-Manufacturing District which is also a Redevelopment Area. The proposed use is in keeping with the permitted uses in the M-D Zone and is a permitted use pursuant to the applicable Redevelopment Plan.

3. The surrounding area also contains wetland and wetlands transition areas. The site is bordered to the north by the Delaware River, to the south and

southeast by residential areas and to the east by the Ashland Hercules
Redevelopment Area.

4. The Applicant seeks the following submission waivers which were reviewed and recommended by the Planning/Zoning Board Engineer and/or Planning/Zoning Board Planner. The Board granted the waivers and deemed the application complete at its meeting of October 2, 2017:

2. True and Accurate Plot at scale; uniform sheet size, Block, Lot, Plate, Tract name; and

3. Zoning Classification of Property, Location of Proposed Buildings, Open space, Parking or Recreation areas; and

4. Soil Conservation Service Soil Classification; and

9. Parking Schedule in Accordance with Zoning Ordinance; and

10. Parking and Circulation Plan; and

11. Complete Landscape Plan; and

17. Building Front, Side and Rear Elevations and Floor Plan; and

5. The following Variances were sought and granted by the Board:

A. Variance from §700-41D, which requires two side yards on each lot, neither of which shall be less than twenty (20) feet in width. No side yards are proposed for Lot 4.02; and

B. Variance from §700-57A(3) which sets the maximum heights for lighting fixtures at twenty-five (25) feet. Three (3) light standards at a height of 100 feet are proposed; and

AIMINO & DENNEN, LLC
ATTORNEYS AT LAW

40 Newton Avenue
Woodbury, New Jersey 08096

C. Variance from the requirement that no structures be located closer than seventy-five (75) feet to a tract boundary line. The Applicant is proposing that the structure (wharf) be located closer to the boundary than permitted; and

D. Variance from §700-62B & §700-62E which limits the height of fencing to six (6) feet and prohibits the use of barbed wire on top of fencing. The Applicant proposes fencing at a height of eight (8) feet, topped with barbed wire; and

E. The variances outlined in paragraphs A through D above were supported by the Greenwich Township Planner, Mr. Miller. The Greenwich Township Planning/Zoning Board weighed the negative and positive criteria with respect to the variances and waivers, as well as any potential impact on the master plan and/or zoning ordinance and determined that any detrimental effect, of which they found none, was outweighed by the positive aspects of the development, with any conditions imposed, determined that there was no impairment to the master plan or zoning ordinance and the granting of the variances and waivers was appropriate under the law, represented good sound planning and was in the best interest of Greenwich Township.

6. The Applicant's engineer, Kevin Webb testified giving the Board and the public an overview of the project. Utilizing what was marked as A-1, an overall plan of the tract, he outlined where the proposed development would take place. The current proposed development consists of approximately 4½ acres of land, which was highlighted on the exhibit in tan. The area is over a mile from the intersection at Repauno Avenue and a substantial distance from any residential area.

7. The development is primarily the construction of a new wharf structure (new dock). The wharf will be approximately 730 feet long and will be able to accommodate a ship approximately 870 feet in length. The wharf will be able to handle one (1) ship at a time. There will be a slight increase in the elevation to approximately 10 feet.

8. Mr. Webb noted that there is a small wetlands area proposed for fill that has already been reviewed and approved by the New Jersey Department of Environmental Protection (NJDEP). All permits have been applied for and issued by the NJDEP to allow the work to proceed forward.

9. The current development is solely for the construction of the new wharf. No warehouse, use or support facility is proposed at this time. The construction of the wharf has a long lead time and will likely take 15 to 18 months to complete. By getting this project started the Applicant will be in a better position to begin to market the facility to potential tenants who would look to utilize the wharf. The Applicant will return to the Board for approvals once a tenant has been secured and a proposed use for the property has been determined.

10. The Applicant proposes the installation of three (3) light standards which are 100 feet in height. Mr. Webb testified that while the light fixtures are tall, given their distance from the nearest residential area, there is no possible way there would be any light spillover into any adjacent residential district. Mr. Miller noted that the type of lighting being proposed is often used on interstate highways. This type of lighting eliminates most of the shadowing that is present with conventional lighting standards. Mr. Miller testified that this project presents the perfect situation for the

use of this type of lighting. He saw no possible detrimental effect from the lighting as the nearest residential area is nearly a mile from the development site.

11. The Applicant is seeking to increase the height of the fencing from the permitted six (6) feet to eight (8) feet and to top the fencing with barbed wire for security purposes. Again, this is an industrial site which is a far distance from any residential area. The increased fence height will insure better security for the site. Mr. Miller noted that the Board often permits similar fencing at a height of eight (8) feet in other industrial sites, such as the refineries located in the Township.

12. The Applicant's attorney, Mr. Janacek, confirmed that the Applicant was in agreement with all the recommendations and requirements listed in the letters of the Board's professionals, Mr. Miller, Mr. Clancy and Mr. Kernan.

13. Mr. Miller noted that the setbacks in question bordered either the Delaware River or other property owned by DRP which would be subject to future development. It was his opinion that the requested setback variances made perfect sense given the configuration and location of the development area.

14. Mr. Miller testified that he supported all the variances requested by the Applicant. In his professional opinion the benefits of the deviations outweighed any potential detriment and that there was no impairment of the zoning ordinance or master plan, and no detriment to the public good. In his opinion, the setbacks were made necessary and proper by the configuration and location of the property, make perfect planning sense in this situation and would promote the development of the site. The proposed lighting is a better lighting proposal than could be achieved through conventional lighting, will provide better lighting with less standards and

posed no possible detriment to any adjacent residential area. The fencing proposed was reasonable and necessary to insure security at the premises and conformed to similar fencing approved by the Board at other industrial sites. Mr. Miller noted that no landscaping was proposed by the Applicant. He confirmed that landscaping would make no planning sense in this wharf area.

WHEREAS, the Board, has made its determinations in this matter based on the above exhibits, testimony and oral representations which are incorporated herein by way of reference, and has found and concluded that:

1. The granting of the Preliminary and Final Major Site Plan and Variance and Waiver Approvals, as revised by the terms and conditions of this Resolution, conform to the standards of sound planning and will have no deleterious effects on the neighborhood from the standpoint of insuring the health, safety, amenities and welfare of the community and are consistent with the purpose and intent of the Zoning Code and Master Plan; and
2. The benefits of the deviation from the Zoning Code would substantially outweigh any detriment.

WHEREAS, upon motion duly made and seconded to grant the "Application for Land Development" for Preliminary and Final Major Site Plan Approval and Variance and Waiver Approvals, the Board, by a vote of 9 in favor, 0 opposed and 0 abstentions, (Voting for: Rush, Shivery, Byrne, Durham, Wagner, Sholders, Hewes, Chila and Stigale), voted in favor of granting the application subject to certain conditions contained herein.

NOW, THEREFORE, BE IT RESOLVED, by the Planning/Zoning Board of Greenwich Township that the application of Delaware River Partners LLC requesting Preliminary and Final Major Site Plan Approval and Variance and Waiver Approvals for land located at the former DuPont Repauno Plant, Greenwich Township, New Jersey, also known as Block 8, Lots 4 & 4.02 and adjacent riparian areas, is **HEREBY APPROVED**, subject, however, to the testimony, representations and stipulations of the Applicant and their professionals and witnesses at the time of the hearing and in their submissions, and further specifically, subject to the following terms and conditions:

1. Subject to the Applicants complying with and obtaining any and all necessary approvals from any other local, county, state and/or federal government or administrative body having jurisdiction over all or part of this land use development approval. Those approvals include but are not limited to the following: Greenwich Township Building Department Building Permit; Greenwich Township Fire Official; Gloucester County Soil Conservation District; New Jersey Department of Environmental Protection (NJDEP); Army Corps of Engineers; and Gloucester County Planning Board Approval; and

2. In accordance with the Code of the Township of Greenwich, §131-39.1 Fees, the Municipal Land Use Law and any other applicable code provision, no permits, approval or certificate shall be issued until all contingencies provided for herein are satisfied and all escrows are paid in full and no Certificate of Occupancy shall be issued and no occupancy shall be permitted until all other contingencies

provided for herein are satisfied and all bills and escrows relating to this property have been paid in full; and

3. The Planning/Zoning Board Engineer and/or Township Planner and/or Master Plan Consultant/Redevelopment Engineer, shall review all plans and amended plans and inspect the site of the development in order to determine compliance with the terms and conditions of the Planning/Zoning Board approval. Any shortcomings noted by any professional shall be addressed to the satisfaction of the professionals before the issuance of a Certificate of Occupancy. The Applicant shall submit appropriate escrow amounts, as determined by the Planning/Zoning Board Engineer and applicable law, for inspections; and

4. The Applicant shall comply with each and every condition, revision, modification and/or other request contained in the Planner's letter of October 2, 2017, the Engineer's two (2) letters of September 28, 2017, and the Master Plan Consultant/Redevelopment Engineer's letter of September 28, 2017, unless otherwise specifically modified herein; and

5. The Applicant will post, pursuant to the Municipal Land Use Law and Township Ordinances, an inspection escrow, performance guarantee and a maintenance guarantee, to cover the on-site improvements proposed in this application and an estimate for all site improvements will be prepared by the Planning/Zoning Board Engineer, Township Engineer or Master Plan Consultant/Redevelopment Engineer; and

6. In accordance with the Statewide Non-Residential Development Fee Act (N.J.S.A. 40:55D-8.1-8.7), the Applicant is required to make payment of a

development fee of 2.5% of the equalized assessed value of the non-residential construction, payable in full at the time the project is deemed substantially complete by the Planning Board Engineer or at the time of the request for a certificate of occupancy, whichever comes first; and

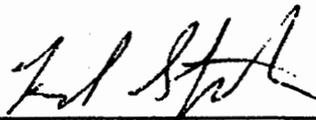
7. The Applicant shall timely provide the Board and the Board Professionals copies of all permits, referenced plans and approvals obtained by and from the NJDEP, The Army Corps of Engineers and any other required permits, referenced plans and approvals, regarding the project, specifically including but not limited to those outlined in Paragraph 1 above; and

8. A detail of the proposed concrete retaining wall shall be provided; and

9. The footing depth/design of the light pole shall be provided; and

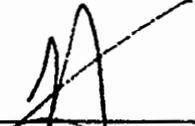
10. Stormwater design is subject to both the NJDEP and Soil Conservation District review and approval; and

11. All stormwater information, as applicable, shall be shown on the plan.



FRED STIGALE, Chairman
Planning/Zoning Board of Greenwich Township

The foregoing Resolution was a memorialization of action taken at a regular meeting of the Planning/Zoning Board of Greenwich Township held on the 2nd day of October 2017; and such resolution was adopted by the Planning/Zoning Board of Greenwich Township at its reorganizational and regular meeting held on November 6, 2017, by a vote 8 to approve, 0 to Oppose and 0 to abstain.



KIRK FAIRLEY, Secretary
Planning/Zoning Board of Greenwich Township

THOSE IN FAVOR: *Hewes, Rush, Durham, Sholders, Chila, Stigale, Shivery
and Wagner*

THOSE OPPOSED: *n/a*

THOSE ABSTAINED: *n/a*

AIMINO & DENNEN, LLC
ATTORNEYS AT LAW

40 Newton Avenue
Woodbury, New Jersey 08096

RESOLUTION #R2019-21
OF THE PLANNING/ZONING BOARD OF THE TOWNSHIP OF GREENWICH
REGARDING APPLICATION NO. PB2019-05 SUBMITTED BY DELAWARE RIVER
PARTNERS LLC GRANTING AMENDMENTS TO SITE PLAN WITH WAIVERS
FOR PROPERTY DESIGNATED AS BLOCK 8, LOTS 4 & 4.02 AND ADJACENT
RIPARIAN AREAS

WHEREAS, an Application has been submitted by Delaware River Partners LLC for Amendments to Site Plan and Waiver Approvals, for property located at a portion of the former DuPont Repauno Plant, and known as Block 8, Lots 4 & 4.02 and adjacent riparian areas (the "Property"), on the Tax Map of the Township of Greenwich, which property is owned by the Applicant; and

WHEREAS, the Applicant has given legal Notice as required by and in accordance with N.J.S.A. 40:55D-12 and applicable Greenwich Township ordinances, by serving proper Notice to property owners within 200 feet of the site, serving Notice on all required governmental agencies and public utilities and by publishing a proper Notice in the newspaper, all at least ten (10) days prior to the Hearing; and

WHEREAS, in support of the Application the Applicant has submitted the following documents:

1. Application dated September 7, 2017, revised through March 15, 2019.
2. Correspondence from Douglas J. Janacek, Esquire dated March 15, 2019.
3. Application Exhibit A, Redeveloper Corporate Disclosure.
4. Application Exhibit B, Site Plan Submission Checklists.
5. Application Exhibit C, prior Resolution of Approval (#R2017-28).
6. Application Exhibit D, Statement of Taxes Paid.

7. Application Exhibit E, List of Experts.
8. Application Exhibit F, Deed restrictions regarding the property.
9. Amended Site Plans bearing a revision date of March 15, 2019:
 - A. Cover Sheet.
 - B. Overall Plan.
 - C. Demolition Plan.
 - D. Final Plat Site Plan.
 - E. Grading, Drainage and Utility Plan.
 - F. Soil Erosion and Sediment Control Plan.
 - G. Soil Erosion and Sediment Control Notes and Details.
 - H. Construction Details #1.
 - I. Construction Details #2.

WHEREAS, prior to the Board hearing, the Greenwich Township Governing Body approved the project proposed in the Application pursuant to the requirements set forth in the Master Redevelopment Agreement entered into between Delaware River Partners LLC and the Township of Greenwich, dated July 8, 2016 (“Master Redevelopment Agreement”) and the Redevelopment Plan, Repauno Port & Rail Terminal, Township of Greenwich, dated January 2019 and adopted by Ordinance No. 1-2019 (“Redevelopment Plan”); and

WHEREAS, the Board has made its determination in this matter based on the following:

1. The documents set forth above;

2. The representations made by or on behalf of the Applicant in the Application as well as the testimony offered from the Applicant's professional, Kevin J. Webb, PE, LEED AP from Langan Engineering & Environmental Services;

3. Report dated May 6, 2019, from the Board's Master Plan Consultant/Redevelopment Engineer J. Timothy Kernan, P.E., P.P., C.M.E., which is incorporated and made a part of this Resolution by way of reference;

4. Report dated May 31, 2019, from the Board's Engineer James A. Clancy, PE, LS, PP, which is incorporated and made a part of this Resolution by way of reference;

5. Representations made by the Applicant's attorney, Douglas J. Janacek, Esquire;

6. Testimony from the Board's professional J. Timothy Kernan, P.E., P.P., C.M.E;

7. Testimony from the Board's professional Matthew K. Miller, AIA, PP, NCARB;

and

8. The Hearing was opened to the public, and no members of the public came forward to speak.

WHEREAS, the Board, after considering the information and testimony provided at the time of the hearing and examining the submitted and above listed documents, considering the comments of the Township Planner, Matthew K. Miller, AIA, PP, NCARB, and the Master Plan Consultant/Redevelopment Engineer, J. Timothy Kernan, PE, PP, CME, makes the following findings of law and statements of fact:

1. The Applicant proposes an amendment to its Preliminary and Final Site Plan Approval for work associated with the construction of a wharf located on the Property ("Wharf Project"). According to the Applicant, the amendments are necessary as a result of changes in the storm

water management system, specifically the addition of a water quality management device, which necessitated alterations to locations of drainage routes and changes to the design of retaining walls. The Applicant further requested approval of revisions to on-site lighting, electric service, access roadway locations and other related improvements.

2. Development at the site is currently subject to the terms and conditions of Greenwich Township Planning/Zoning Board Resolution #R2017-28, which shall continue in full force and effect except as specifically amended herein.

3. The Property contains approximately 926 acres of the former Dupont Repauno Plant totaling approximately 1,620 acres. The Property is a former dock and is currently inactive. The Property is affected by wetlands and wetlands transition areas, flood hazard and riparian zone areas, and waterfront development areas. This Property is located in the Riverfront Terminal District, which has been designated as an area in need of redevelopment and is subject to the Redevelopment Plan.

4. The Applicant seeks submission waivers for No. 11 (Landscape Plan) and No. 19 (Lighting Plan). The waiver requests were reviewed, and the Board granted the waivers and deemed the Application complete at its meeting on June 3, 2019.

5. The Applicant sought no variances.

6. The Applicant's Engineer, Kevin J. Webb, PE, LEED AP, testified utilizing Exhibit A-1, which was an enlarged version of the Final Plat Site Plan, Sheet 4 of 9 of the Langan plans. Mr. Webb testified concerning the specific details of the amendments, most of which were necessitated by conditions in the field. Mr. Webb testified that the changes are relatively minor in nature and will result in a better development project than was authorized in the initial

approvals. The Applicant conducted a lighting pattern analysis and is proposing upgraded lighting in the Application.

7. The Applicant's attorney represented that the Applicant has secured approvals from the Gloucester County Planning Board as well as the Gloucester County Soil Conservation District. Counsel agreed to provide the Planning Board with copies of those approvals.

8. Timothy Kernan testified consistently with the provisions of his report dated May 6, 2019. In Section 4.0 of his report, Mr. Kernan raised the issue of whether the section of Repauno Avenue between Broad Street and Democrat Road should be converted to one-way in the southbound direction. This is an issue that has been raised in the past to address truck traffic related to the development until such time as the proposed bypass road is constructed. The Applicant's attorney indicated that the Applicant had previously agreed that if Repauno Avenue was made one-way, the Applicant would implement appropriate signage for the same only if an issue was communicated to them through the Township Police Department, and no such communication has occurred. While the Applicant agreed to provide a trip generation report, the Applicant made an affirmative representation that no new trips will be generated by virtue of the Application before the Board. Mr. Kernan testified that he is agreeable to addressing revised traffic patterns in conjunction with subsequent applications, with due consideration for additional traffic burdens placed upon the Township. In the interim, Mr. Kernan testified that perceived problems may be addressed with the Applicant by the Township Police and the Township Mayor and Council. Matthew Miller testified that he agrees that changes in traffic patterns may be handled in the context of future applications.

9. Matthew Miller presented the May 31, 2019 report of James Clancy. Mr. Miller emphasized that "as built" drawings must be submitted and approved as a condition of approval. The Applicant agreed to this condition.

10. Both Mr. Kernan and Mr. Miller testified that they supported granting the amendment to site plan subject to the Applicant complying with the terms and conditions of the professional review letters. The Applicant's counsel agreed to comply with said review letters, with the exception of Section 4.0 of Mr. Kernan's report addressing the "Truck Route" and the proposed conversion of Repauno Avenue to a one-way street, which may be revisited in the event an issue is communicated to the Applicant by the Police Department.

11. Applicant shall pay a development fee of 2.5% of the equalized assessed value of the non-residential construction into the State of New Jersey's Affordable Housing Trust Fund. The amount of the fee shall be subject to the approval of the Township Solicitor.

WHEREAS, the Board, has made its determinations in this matter based on the above exhibits, testimony and oral representations which are incorporated herein by way of reference, and has found and concluded that:

1. The granting of the Amendment to Preliminary and Final Major Site Plan and Waiver Approvals is reasonable and necessary and is consistent with sound land use planning and engineering principles; and

WHEREAS, upon motion duly made and seconded to grant the Amendment to Preliminary and Final Major Site Plan and Waiver Approvals, the Board, by a vote of 9 in favor, 0 opposed and 0 abstentions, voted in favor of granting the application subject to certain

conditions contained herein. (Voting for: Fairley, Sholders, Stigale, Wagner, Shivery, Chila, Hewes, Zampaglione, Walko).

NOW, THEREFORE, BE IT RESOLVED, by the Planning/Zoning Board of Greenwich Township that the Application of Delaware River Partners LLC requesting Amendment to Preliminary and Final Major Site Plan Approval and Waiver Approvals for land located at the former DuPont Repauno Plant, Greenwich Township, New Jersey, also known as Block 8, Lots 4 & 4.02 and adjacent riparian areas, is **HEREBY APPROVED**, subject, however, to the testimony, representations and stipulations of the Applicant and its professional at the time of the hearing and in its submissions, and further specifically, subject to the following terms and conditions:

1. Subject to the Applicant complying with and obtaining any and all necessary approvals from any other local, county, state and/or federal government or administrative body having jurisdiction over all or part of this land use development approval.

2. In accordance with the Code of the Township of Greenwich, §131-39.1 Fees, the Municipal Land Use Law and any other applicable code provision, no permits, approval or certificate shall be issued until all contingencies provided for herein are satisfied and all escrows are paid in full and no Certificate of Occupancy shall be issued and no occupancy shall be permitted until all other contingencies provided herein are satisfied and all bills and escrows relating to this property have been paid in full; and

3. The Planning/Zoning Board Engineer and/or Township Planner and/or Master Plan Consultant/Redevelopment Engineer, shall review all plans and amended plans and inspect the site of the development in order to determine compliance with the terms and conditions of the

Planning/Zoning Board approval. Any shortcomings noted by any professional shall be addressed to the satisfaction of the professionals before the issuance of a Certificate of Occupancy; and

4. The Applicant shall comply with each and every condition, revision, modification and/or other request contained in the Engineer's letter of May 31, 2019, and the Master Plan Consultant/Redevelopment Engineer's letter of May 6, 2019 (with the exception of Section 4.0, which only needs to be addressed as referenced above if the Police Department communicates to the Applicant a need for the same), unless otherwise specifically modified herein; and

5. The Applicant will post, pursuant to the Municipal Land Use Law and Township Ordinances, an inspection escrow, to cover the on-site improvements proposed in this application. An estimate will be prepared by the Planning/Zoning Board Engineer, Township Engineer or Master Plan Consultant/Redevelopment Engineer; and

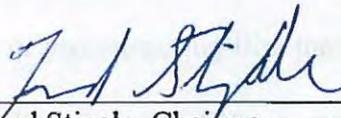
6. In accordance with the Statewide Non-Residential Development Fee Act (N.J.S.A. 40:55D-8. 1-8.7), the Applicant is required to make payment of a development fee of 2.5% of the equalized assessed value of the non-residential construction, payable in full at the time the project is deemed substantially complete by the Planning Board Engineer or at the time of the request for a certificate of occupancy, whichever comes first; and

7. The Applicant shall timely provide the Board and the Board Professionals copies of all permits, referenced plans and approvals obtained by and from the Gloucester County Planning Board, Gloucester County Soil Conservation District, NJDEP, USACOE and Greenwich Police, Fire and Building Departments.

8. An "As Built" drawing of the work approved in conjunction with this Application shall be provided.

9. As required by the Master Redevelopment Agreement and the Redevelopment Plan, the Applicant shall execute a subproject redevelopment agreement with the Township for the Wharf Project prior to the issuance of any temporary and/or final certificate of occupancy for the Wharf Project.

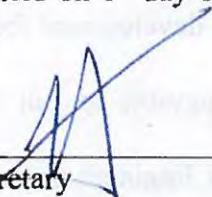
PLANNING/ZOING BOARD
TOWNSHIP OF GREENWICH



Fred Stigale, Chairman

ATTEST:

The foregoing Resolution was a memorialization of action taken at a regular meeting of the Planning/Zoning Board of the Township of Greenwich held on the 3rd day of June, 2019; and such resolution was adopted by the Planning/Zoning Board of the Township of Greenwich at a regular meeting held on 1st day of July, 2019, by a vote 7 to approve, 0 to oppose and 0 to abstain.



Kirk Fairley, Secretary

In favor of the resolution: Fairley, Sholders, Stigale, Chila, Zampaglione, Hewes & Shiverg

Opposed to the resolution: n/c

Abstained: n/c

**RESOLUTION #R2019-23
OF THE PLANNING/ZONING BOARD OF GREENWICH TOWNSHIP REGARDING
APPLICATION NO. PB2019-08 OF DELAWARE RIVER PARTNERS LLC
GRANTING PRELIMINARY AND FINAL SITE PLAN APPROVAL FOR PROPERTY
LOCATED AT THE FORMER DUPONT REPAUNO PLANT, DESIGNATED AS A
PORTION OF BLOCK 8, LOTS 3 & 4**

WHEREAS, an application has been submitted by Delaware River Partners LLC for Preliminary and Final Site Plan Approval, for property located at a portion of the former DuPont Repauno Plant, and known as a portion of Block 8, Lots 3 & 4, on the Tax Map of the Township of Greenwich, which property is owned by the Applicant; and

WHEREAS, the Applicant has given legal Notice as required by and in accordance with N.J.S.A. 40:55D-12 and applicable Greenwich Township ordinances, by serving proper Notice to property owners within 200 feet of the site, serving Notice on all required governmental agencies and public utilities and by publishing a proper Notice in the newspaper, all at least ten (10) days prior to the hearing; and

WHEREAS, in support of the application the Applicant has submitted the following documents:

1. Letter from the Applicant's attorney, Cameron W. MacLeod, Esq., dated July 12, 2019; and
2. Preliminary and Final Site Plan Application with Exhibits, dated July 12, 2019; and
3. Submission Checklist, dated July 12, 2019; and

4. Trip Generation Memorandum, prepared by Kevin J. Webb, PE., of Langan, 989 Lenox Drive, Suite 124, Lawrenceville, New Jersey 08648, dated July 12, 2019; and
5. Resolution R2017-16 (Block 8, Lots 3 & 4), adopted January 9, 2017; and
6. Resolution R2017-28 (Block 8, Lots 4 & 4.02), adopted November 6, 2017; and
7. Resolution R2019-21 (Block 8, Lots 4 & 4.02), adopted July 1, 2019; and
8. Governing Body Resolution No. 117-2019, adopted July 15, 2019; and
9. Stormwater Management Report, prepared by Edward F. Wilkes Jr., P.E. and Kevin J. Webb, P.E., of Langan, 989 Lenox Drive, Suite 124, Lawrenceville, New Jersey 08648, dated July 12, 2019; and
10. Cover Sheet, Sheet 1 of 35, (All plans prepared and signed by Kevin J. Webb, PE., of Langan, 989 Lenox Drive, Suite 124, Lawrenceville, New Jersey 08648), dated July 12, 2019; and
11. Overall Existing Conditions Plan, Sheet 2 of 35, dated July 12, 2019; and
12. Existing Conditions & Demolition Plan 1, Sheet 3 of 35, dated July 12, 2019; and
13. Existing Conditions & Demolition Plan 2, Sheet 4 of 25, dated July 12, 2019; and

MIMINO & DENNEN, LLC
ATTORNEYS AT LAW

40 Newton Avenue
Woodbury, New Jersey 08096

14. Existing Conditions & Demolition Plan 3, Sheet 5 of 25, dated July 12, 2019; and
15. Overall Site Plan, Sheet 6 of 35, dated July 12, 2019; and
16. Site Plan 1, Sheet 7 of 35, dated July 12, 2019; and
17. Site Plan 2, Sheet 8 of 35, dated July 12, 2019; and
18. Site Plan 3, Sheet 9 of 35, dated July 12, 2019; and
19. Overall Vehicle Movement Plan, Sheet 10 of 35, dated July 12, 2019; and
20. Vehicle Movement Plan Insets, Sheet 11 of 35, dated July 12, 2019; and
21. Overall Grading & Drainage Plan, Sheet 12 of 35, dated July 12, 2019; and
22. Grading & Drainage Plan 1, Sheet 13 of 35, dated July 12, 2019; and
23. Grading & Drainage Plan 2, Sheet 14 of 35, dated July 12, 2019; and
24. Grading & Drainage Plan 3, Sheet 15 of 35, dated July 12, 2019; and
25. Utility Plan 1, Sheet 16 of 35, dated July 12, 2019; and
26. Utility Plan 2, Sheet 17 of 35, dated July 12, 2019; and
27. Utility Plan 3, Sheet 18 of 35, dated July 12, 2019; and
28. Lighting Plan 1, Sheet 19 of 35, dated July 12, 2019; and
29. Lighting Plan 2, Sheet 20 of 35, dated July 12, 2019; and
30. Lighting Plan 3, Sheet 21 of 35, dated July 12, 2019; and
31. Lighting Details 1, Sheet 22 of 35, dated July 12, 2019; and
32. Lighting Details 2, Sheet 23 of 35, dated July 12, 2019; and

33. Lighting Details 3, Sheet 24 of 35, dated July 12, 2019; and
34. Overall Soil Erosion & Sediment Control Plan, Sheet 25 of 35, dated July 12, 2019; and
35. Soil Erosion & Sediment Control Plan 1, Sheet 26 of 35, dated July 12, 2019; and
36. Soil Erosion & Sediment Control Plan 2, Sheet 27 of 35, dated July 12, 2019; and
37. Soil Erosion & Sediment Control Plan 3, Sheet 28 of 35, dated July 12, 2019; and
38. Soil Erosion & Sediment Control Notes and Details, Sheet 29 of 35, dated July 12, 2019; and
39. Outfall Profiles & Basin Cross Sections, Sheet 30 of 35, dated July 12, 2019; and
40. Construction Details 1, Sheet 31 of 35, dated July 12, 2019; and
41. Construction Details 2, Sheet 32 of 35, dated July 12, 2019; and
42. Construction Details 3, Sheet 33 of 35, dated July 12, 2019; and
43. Construction Details 4, Sheet 34 of 35, dated July 12, 2019; and
44. Construction Details 5, Sheet 35 of 35, dated July 12, 2019; and
45. At the time of the hearing the following Exhibits were marked:
 - A-1 Overview of the Site (Sheet 2); and
 - A-2 Close Up of the Proposed Facilities (Sheet 6).

WHEREAS, the Greenwich Township Planning/Zoning Board has made its determination in this matter based on the following:

1. The documents set forth above;
2. The representations made by the Applicant in its application and by the Applicant, Delaware River Partners LLC (DRP), through its representatives, experts and witnesses: Kevin Webb, PE, from Langan and its attorney, Douglas Janacek, Esq., of Gibbons P.C., at the time of the hearing before the Board on September 9, 2019;
3. Letter from the Greenwich Township Planning/Zoning Board Engineer, James A. Clancy, PE, PLS, PP, CME, dated August 26, 2019, which is incorporated and made a part of this Resolution by way of reference;
4. Letter from the Greenwich Township Planner, Matthew K. Miller, AIA, PP, dated September 5, 2019, which is incorporated and made a part of this Resolution by way of reference;
5. Letter from the Greenwich Township Master Plan Consultant/Redevelopment Engineer, J. Timothy Kernan, PE, PP, CME, dated August 19, 2019, which is incorporated and made a part of this Resolution by way of reference;
6. Comments made by the Township Planner at the time of the hearing on September 9, 2019;
7. Comments made by the Planning/Zoning Board Engineer, at the time of the hearing on September 9, 2019; and
8. The following members of the public spoke at the time of the hearing before the board on September 9, 2019:

A. Steve Laszczyk, 9 Brandt Avenue. Mr. Laszczyk inquired as to the number of rail cars that can be stored on site at any time. The Applicant indicated that the facility can store up to 80 rail cars at any one time.

B. Ron Cundy, 139 Jackson Avenue. Mr. Cundy asked if there would be any storage of propane. Mr. Webb indicated that the cavern would continue to store butane. The propane would go from rail car to the wharf to a ship. Mr. Cundy further questioned emergency egress should the need arise. He was informed the by-pass road would be the emergency exit.

C. Donna O'Leary, 124 Swedesboro Road. Ms. O'Leary questioned what route would be used for the trucks in this project. Mr. Webb confirmed that the transportation of the LPG would be by train, not truck. Takes approximately 36 to 48 hours to unload an 80 car train.

D. Leslie Feaster, 156 N. Repauno Avenue. Mr. Feaster was concerned about the level of noise. Mr. Webb indicated that the majority of the noise would be in the construction phase.

E. Will Durham, 133 Dupont Avenue. Stated he was a resident for 56 years on Dupont Avenue. He thanked DRP for placing their business in Greenwich Township. He has not had any problems with the construction vehicles and noted that DRP has been very open with the local fire officials.

F. Russell Leone, 657 Paulsboro Road. Mr. Leone wanted to know if they were going to widen Route 44. He was informed they were not widening Route 44.

G. Mark Pandolfo, 251 Marshall Avenue. Inquired about LNG being brought to the site. Mr. Webb informed him that this project was for LPG to be delivered by rail, not LNG.

WHEREAS, the Board, after considering the information and testimony provided at the time of the hearing and examining the submitted and above listed documents, considering the comments and the letters of the Planning/Zoning Board Engineer, James A. Clancy, P.E., C.M.E., the Township Planner, Matthew K. Miller, AIA, PP, NCARB, and the Master Plan Consultant/Redevelopment Engineer, J. Timothy Kernan, PE, PP, CME, makes the following conclusions of law and findings of fact:

1. The Applicant is seeking approval for a subproject referred to as "LPG Transloading Facility" which includes development of a facility on a portion of the subject property to enable transloading of liquefied petroleum gases (LPG) consisting of propane or butane between railcars and ships with the proposed improvements to include rail spurs and storage tracks; a double-sided rail rack for transloading of LPG; aboveground piping and their associated support racks to the existing wharf; a 2,000 square foot operations/control building; associated filling and grading; surface parking; circulation roadways; fire protection system; and ancillary support equipment and utility infrastructure, including stormwater management facilities as set forth the proposal for development dated June 13, 2019.

2. The property in question is Block 8, Lots 3 & 4 which contains approximately 921± acres of the former Dupont Repauno Plant which totals 1,620± acres. The subject parcel is located at the north side of the site adjacent to the

Delaware River and within proximity to the recently developed wharf. The overall property is affected by wetlands and wetlands transition areas, flood hazard and riparian zone areas, waterfront development areas and is located in the M-D Manufacturing District which has also been designated a Redevelopment Area. The proposed use is in keeping with the permitted uses in the M-D Zone and is a permitted use pursuant to the applicable Redevelopment Plan.

3. The surrounding area also contains wetland and wetlands transition areas. The site is bordered to the north by the Delaware River, to the south and southeast by residential areas and to the east by the Ashland Hercules Redevelopment Area.

4. The Applicant requested waivers for landscaping and an opinion/acknowledgment/waiver regarding lighting standards for this application.

5. The Applicant obtained approval for this subproject from the Greenwich Township governing body pursuant to Resolution No. 117-2019. The Applicant acknowledged on the record that it must, as a condition of approval, have a signed Re-Development Agreement with Greenwich Township for this subproject prior to the issuance of a temporary and/or final Certificate of Occupancy or Certificate of Approval; and

6. The Applicant's attorney, Mr. Janacek gave the Board an overview of the project. The Applicant is seeking Preliminary and Final Site Plan Approval for an LPG rail terminal facility to be installed for use in connection with the recently constructed wharf. An operations building, support structures and some grading of

the site will take place. There are no variances needed or requested. Waivers for landscaping and a lighting plan are requested.

6. The Applicant's engineer, Mr. Webb indicated that the site in question is within Block 8, Lots 3 & 4. The development will take place at the riverfront portion, about 4,000 feet from any residential property. It is adjacent to the wharf and near the butane cavern. The work will be immediately east of the cavern.

7. The existing rail line is parallel to A-Line Road. The new rail spur goes to the east of the existing line. Four (4) storage tracks and two (2) tracks for the rack itself. The railrack connects to a pipe rack which leads to the wharf and ultimately to a vessel. Forty (40) rail cars can be on the rack lines. The facility can handle 80 railcars at any one time. There is an Operations and Control building which is 2,000 square feet with 10 parking spaces provided. Typically, it would house 3 to 4 employees.

8. Mr. Webb testified that there is automatic fire suppression in the loop. The new terminal road is parallel to the river which provides access to the operations building and the wharf. A gravel road that connects to A-Line Road is provided for maintenance. Pole mounted lighting at 20 feet is provided for parking and at 30 feet for the roadways. The Applicant agreed to install reflectors in the pavement.

9. No landscaping is proposed for the project as the property is so far away any residential properties, the landscaping would never be seen. The Board's planner supported the waiver for landscaping opining that the landscaping would serve no real purpose.

10. Mr. Webb indicated that the hours of operation would be for the most part 24/7 with multiple shifts. There would be 3 to 4 employees in the Operations Building and a total of 50 to 70 employees working at the site at peak times. This information will be added to the plans.

11. The Applicant has been working with the local fire department regarding emergency response. The Applicant agreed as a condition of approval to add one (1) fire hydrant close to the intersection of the terminal road and the gravel maintenance road.

12. Mr. Janacek confirmed that the Applicant will comply with all the conditions and requirements set forth in all the Board's professionals letters and in the Redevelopment Plan.

13. Mr. Webb confirmed that there is no on site storage of the LPG on site. The LPG goes from the rail car to the wharf to the ship.

14. Mr. Clancy raised the issue of the Applicant repairing pot holes, at a minimum in the area from the security booth to the limit of the new paving. The Applicant agreed to repair the pot holes as requested by Mr. Clancy.

15. Mr. Clancy discussed the issue of additional lighting on the rear of the Operations Building. The Applicant agreed to install two (2) additional shoe box light fixtures at the rear of the Operations Building.

16. Mr. Miller indicated his support for the landscaping waiver due to the distance from any residential area. He further did not see an issue with lighting, again because of the project being so far from any residential area. Mr. Miller noted in Mr. Kernan's letter the potential issue of NJDOT Hazmat Security Plan &

Compliance and NJDOT Hazmat Shippers Registration. The Applicant indicated that they have USDOT certification for the butane operations. If and to the extent required, the Applicant will pursue these requirements and provide proof of compliance to the Board.

17. The Board determined that the waivers for landscaping and for a lighting plan were appropriate given the extreme distance from any residential property being such that the development area will not be seen, the landscaping will serve no real purpose at this industrial site and there will be no possible impact as far as light spillage onto residential properties, and thus granted the waivers for landscaping and a lighting plan.

WHEREAS, the Board, has made its determinations in this matter based on the above exhibits, testimony and oral representations which are incorporated herein by way of reference, and has found and concluded that:

1. The application meets the standards for the granting of Preliminary and Final Site Plan Approval under the Township of Greenwich Zoning Code; and
2. The granting of the Preliminary and Final Site Plan Approval, as well as the requested waiver regarding lighting and landscaping, as revised by the terms and conditions of this Resolution, conform to the standards of sound planning and will have no deleterious effects on the neighborhood from the standpoint of insuring the health, safety, amenities and welfare of the community and are consistent with the purpose and intent of the Zoning Code and Master Plan.

1 2 3 4

WHEREAS, upon motion duly made and seconded to grant the "Application for Land Development" for Preliminary and Final Site Plan Approval, the Board, by a vote of 9 in favor, 0 opposed and 0 abstentions, (Voting for: Sholders, Rush, Shivery, Wagner, Hewes, Byrne, Zampaglione, Chila, and Fairley), voted in favor of granting the application subject to certain conditions contained herein.

NOW, THEREFORE, BE IT RESOLVED, by the Planning/Zoning Board of Greenwich Township that the application of Delaware River Partners LLC requesting Preliminary and Final Site Plan Approval for land located at the former DuPont Repauno Plant, Greenwich Township, New Jersey, also known as a portion of Block 8, Lots 3 & 4, is **HEREBY APPROVED**, subject, however, to the testimony, representations and stipulations of the Applicant and their professionals and witnesses at the time of the hearing and in their submissions, and further specifically, subject to the following terms and conditions:

1. Subject to the Applicant complying with and obtaining any and all necessary approvals from any other local, county, state and/or federal government or administrative body having jurisdiction over all or part of this Site Plan Waiver approval. Those approvals include but are not limited to the following: United States Army Corps of Engineers (modified 1/10/2018); NJDEP Freshwater Wetlands Letter of Interpretation (approved 7/11/2016); NJDEP Waterfront Development/Flood Hazard Area/Coastal Wetlands Multi-Permit (modified 11/29/2018); NJDEP Freshwater Wetlands General Permit (modified 11/29/2018); NJPDES Permits; NJ Toxic Catastrophe Prevention Act (TCPA) Program Approval; NJ Air Pollution Control Act Permit; Greenwich Township Building Department; Greenwich Township

Fire Official; Greenwich Township Sewer Department; Gloucester County Planning Board Approval; and Gloucester County Soil Conservation District; and

2. In accordance with the Code of the Township of Greenwich, §131-39.1 Fees, the Municipal Land Use Law and any other applicable code provision, no permits, approval or certificate shall be issued until all contingencies provided for herein are satisfied and all escrows are paid in full and no Certificate of Occupancy shall be issued and no occupancy shall be permitted until all other contingencies provided for herein are satisfied and all bills and escrows relating to this application for development have been paid in full; and

3. The Planning/Zoning Board Engineer, Township Planner, or Master Plan Consultant/Redevelopment Engineer, as set forth above, shall review all plans and amended plans and inspect the site of the development in order to determine compliance with the terms and conditions of the Planning/Zoning Board approval. Any shortcomings noted by any professional shall be addressed to the satisfaction of the professionals before the issuance of a Certificate of Occupancy. The Applicant shall submit appropriate escrow amounts, as determined by the Planning/Zoning Board Engineer and applicable law, for inspections; and

4. The Applicant shall comply with each and every condition, revision, modification and/or other request contained in the Planner's letter of September 5, 2019, the Engineer's letter of August 26, 2019, and the Master Plan Consultant/Redevelopment Engineer's letter of August 19, 2019, unless otherwise specifically modified herein; and

MIMINO & DENNEN, LLC
ATTORNEYS AT LAW

40 Newton Avenue
Woodbury, New Jersey 08096

5. In accordance with the Statewide Non-Residential Development Fee Act (N.J.S.A. 40:55D-8.1-8.7), the Applicant is required to make payment of a development fee of 2.5% of the equalized assessed value of the non-residential construction, payable in full at the time the project is deemed substantially complete by the Planning Board Engineer or at the time of the request for a certificate of occupancy, whichever comes first; and

6. All previous approvals for this project, including but not limited to the terms and conditions of Resolution R2017-16; Resolution R2017-28 and R2019-21, remain in full force and effect, unless specifically modified pursuant to the terms and conditions of this resolution; and

7. The Applicant, as a condition of approval, must have a signed Re-Development Agreement with Greenwich Township for this subproject prior to the issuance of a temporary and/or final Certificate of Occupancy or Certificate of Approval; and

8. The Applicant shall install one (1) fire hydrant close to the intersection of the terminal road and the gravel maintenance road; and

9. The Applicant shall repair the pot holes, at a minimum, in the area from the security booth to the limit of the new paving; and

10. The Applicant shall install two (2) additional shoe box light fixtures at the rear of the Operations Building, or other equivalent lighting to the satisfaction of the Planning/Zoning Board Engineer; and

11. With respect to the issue of NJDOT Hazmat Security Plan & Compliance and NJDOT Hazmat Shippers Registration, if and to the extent required,

The Applicant will pursue these requirements and provide proof of compliance to the Board.



FRED STIGALE, Chairman
Planning/Zoning Board of Greenwich Township

The foregoing Resolution was a memorialization of action taken at a regular meeting of the Planning/Zoning Board of Greenwich Township held on the 9th day of September 2019; and such resolution was adopted by the Planning/Zoning Board of Greenwich Township at its regular meeting held on October 7, 2019, by a vote 8 to approve, 0 to Oppose and 0 to abstain.



KIRK FAIRLEY, Secretary
Planning/Zoning Board of Greenwich Township

THOSE IN FAVOR: Fairly, Wagner, Sholders, Rush, Zampaglione, Hertz, Chole & Shively

THOSE OPPOSED:

THOSE ABSTAINED:

989 Lenox Drive, Suite 124 Lawrenceville, NJ 08648 T: 609.282.8000 F: 609.282.8001

To: Greenwich Township Planning Board
Greenwich Township Police Department

From: Kevin J. Webb, PE

Date: November 15, 2019

Re: Trip Generation
Delaware River Partners, LLC
Repauno Port & Rail Terminal, Dock 2 Site Plan Application
Block 8, Lots 3, 4, and 4.01, Township of Greenwich, Gloucester County, NJ
Langan Project No.: 130088803



In accordance with Item 4.4 of the Redevelopment Plan, we have prepared this assessment of anticipated site-wide traffic at the Repauno facility during the construction and operation of the proposed Dock 2.

Item 4.4.1 of the Redevelopment Plan states that the site-wide trip generation shall be limited to a maximum of 550 vehicle trips per day prior to the construction of Phase 1 of the proposed Route 44 Bypass. Furthermore, the trip generation is clarified to include both vehicles and trucks used by site employees and visitors, but excludes traffic related to the ongoing site remediation by Chemours and construction traffic related to the proposed bypass road.

The proposed Dock 2 facilities will not generate any operational traffic without an associated use within the Terminal. Operational traffic generated by any uses anticipated to utilize Dock 2 will be identified and analyzed as part of their respective future development applications, and will be subject to the limitations of Section 4.4.1 as described above. Construction of Dock 2 will start after the completion of the approved LPG Transloading Facility, which also identified as the rail rack. The number of trips generated by the existing operational activities at the site will vary due to the seasonality of the existing butane cavern operations.

The component parts of the overall site-wide traffic are described and tallied below.

ADMINISTRATIVE SERVICES TRAFFIC

This category includes traffic associated with DRP's employees and visitors. The total number of DRP administrative and support staff employees is estimated at 14, including employees, 2 maintenance contractors, and 3 security contractors. Visitors, consultants, and delivery trucks historically account for 3 additional vehicles per day.

Each of these 17 vehicles would be expected to account for 2 trips: 1 entering and 1 exiting. Approximately 8 employees would be expected to leave the site and return during the workday for outside meetings or meals, thereby generating additional trips.

Technical Memorandum

In summary, the administrative services traffic is estimated at 50 trips per day:

$$17 \text{ vehicles} \times 2 \text{ trips/day} + 8 \text{ vehicles} \times 2 \text{ additional trips/day} = 50 \text{ trips/day}$$

OPERATIONAL TRAFFIC – EXISTING BUTANE CAVERN

The butane cavern operation is seasonal. During April through October, the cavern typically receives butane via railcar delivery or is idle, thereby generating no vehicle trips. During November through March, the cavern generally ships butane off-site by truck. The truck rack at the butane cavern can accommodate up to 2 trucks at one time or a theoretical maximum of 48 trucks in a 24-hour period. To date, no more than 16 trucks per day have served the cavern at peak operation during the shipping season, with a typical average of 8 trucks per day.

All trucks generate 2 trips: 1 entering and 1 exiting. Two operators support the butane cavern, thereby generating 4 trips/day. In summary, based on historical operations the existing butane cavern operation is estimated to generate 36 trips per day:

$$2 \text{ vehicles} \times 2 \text{ trips/day} + 16 \text{ trucks} \times 2 \text{ trips/day} = 36 \text{ trips/day}$$

OPERATIONAL TRAFFIC – LPG TRANSLOADING FACILITY AND DOCK 1

When the LPG Transloading Facility is completed and operational, the only vehicle trips that it will generate are those associated with its operators and other support personnel at Dock 1. DRP estimates a total of 11 operational staff (8 rail rack operators, 2 operators at Dock 1, and 1 supervisor) will support the rail rack operation for each of two shifts, thereby generating 44 trips/day. An additional 5 vehicles are anticipated for inspectors and support personnel at Dock 1, including those used by various inspectors and surveyors, and those for potential vessel supply deliveries.

$$11 \text{ vehicles} \times 2 \text{ shifts} \times 2 \text{ trips/day} + 5 \text{ vehicles} \times 2 \text{ trips/day} = 54 \text{ trips/day}$$

CONSTRUCTION TRAFFIC – DOCK 2

Construction traffic will be comprised of construction vehicles used by construction employees to arrive at the site and those supporting the on-site construction. We estimate a total of 50 construction vehicles will support this work, including 25 vehicles used at the construction site and 25 additional personal vehicles for employees who are transported to the work area using vans that do not otherwise leave the site. In total, we estimate 100 trips/day will be generated during the construction phase.

$$50 \text{ vehicles} \times 2 \text{ trips/day} = 100 \text{ trips/day}$$

Technical Memorandum

Trip Generation
Repauno Port & Rail Terminal, Dock 2 Site Plan Application
Block 8, Lots 3, 4, and 4.01, Township of Greenwich, Gloucester County, NJ
Langan Project No.: 130088803
November 15, 2019- Page 3 of 4

OPERATIONAL TRAFFIC – DOCK 2

Upon completion of Dock 2, the only vehicle trips that it will generate are those associated with its operators. DRP estimates 4 operators will support the rail rack operation, thereby generating 8 trips/day.

$$4 \text{ vehicles} \times 2 \text{ trips/day} = 8 \text{ trips/day}$$

ANALYSIS

Using the figures calculated above, the current baseline administrative and operational activities generate 112 trips/day for the majority of the year and a total of 148 trips/day during the limited period when butane is being shipped off-site via truck.

During construction of Dock 2, the site-wide trip generation will increase above those baseline levels to 240 trips/day.

See Table A on page 4 for a summary of all calculations.

CONCLUSION

The proposed Dock 2 will not generate any operational traffic without an associated use within the Terminal. The site-wide trip generation will be less than the maximum 550 trips/day specified in the Redevelopment Plan, even during the construction of Dock 2.

As specified during prior applications, operational and construction-related truck traffic shall use the entrance and exit routes shown on the attached Truck Traffic Routes plan, dated November 16, 2018, prepared by Langan.

Technical Memorandum

TABLE A - TRIP GENERATION CALCULATIONS

ADMINISTRATIVE SERVICES TRAFFIC

DRP employees	9 vehicles	
DRP maintenance contractors	2 vehicles	
DRP security contractors	3 vehicles	
Visitors	3 vehicles	
Additional workday trips	8 vehicles	
Subtotal	25 vehicles	x 2 trips/day = 50 trips/day

OPERATIONAL TRAFFIC - EXISTING BUTANE CAVERN

DRP cavern operators	2 vehicles	
Butane trucks	16 vehicles	
Subtotal	18 vehicles	x 2 trips/day = 36 trips/day

OPERATIONAL TRAFFIC - LPG TRANSLOADING FACILITY/RAIL RACK AND DOCK 1

DRP operators and supervisors (Shift 1)	11 vehicles	
DRP operators and supervisors (Shift 2)	11 vehicles	
Dock 1 Inspectors and Vessel Service	5 vehicles	
Subtotal	27 vehicles	x 2 trips/day = 54 trips/day

CONSTRUCTION TRAFFIC - DOCK 2

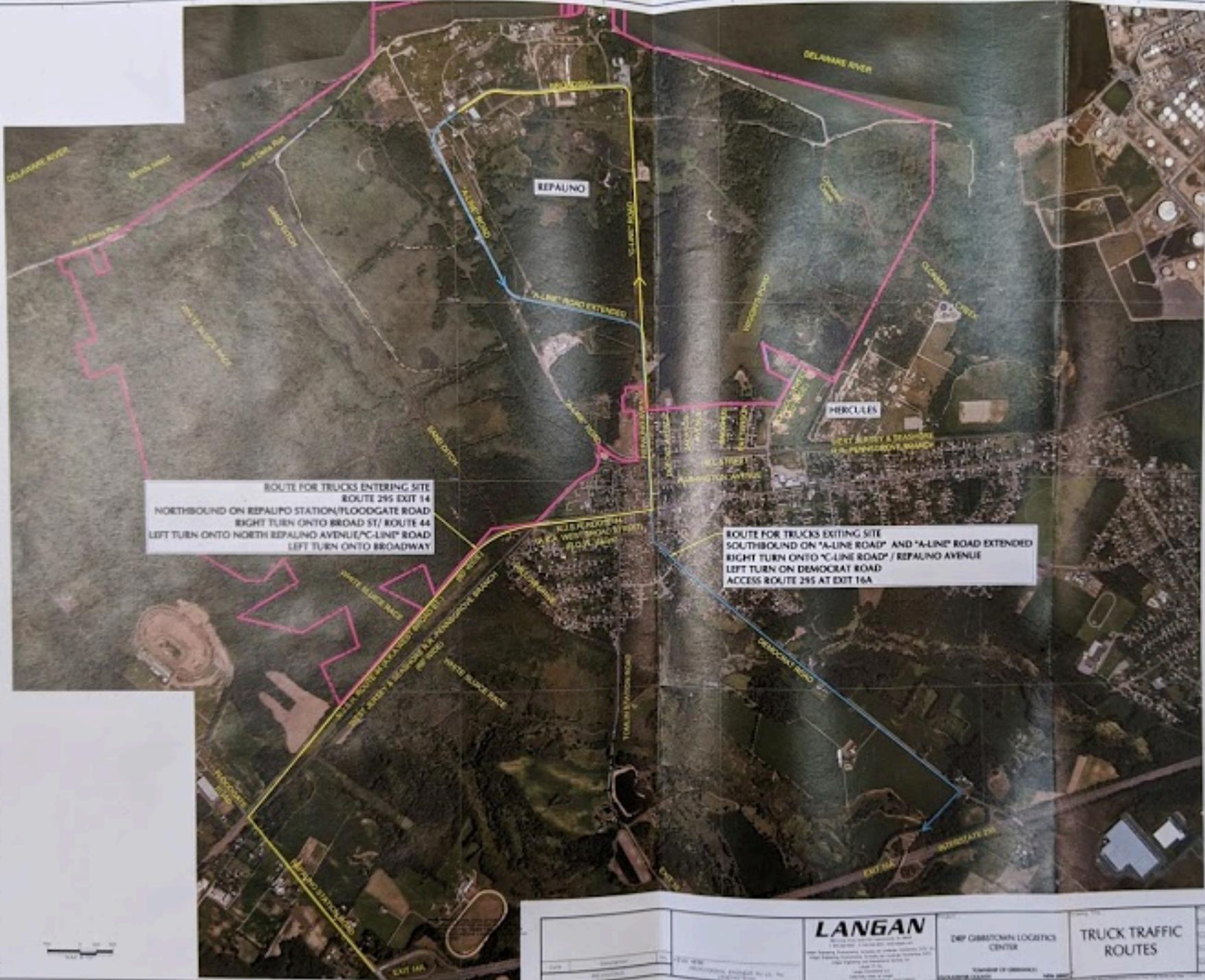
Construction support vehicles	25 vehicles	
Construction employees	25 vehicles	
Subtotal	50 vehicles	x 2 trips/day = 100 trips/day

OPERATIONAL TRAFFIC - DOCK 2

DRP operators	4 vehicles	
Subtotal	4 vehicles	x 2 trips/day = 8 trips/day

TOTAL DURING DOCK 2 CONSTRUCTION PHASE **240 trips/day**

TOTAL AFTER CONSTRUCTION **148 trips/day**



ROUTE FOR TRUCKS ENTERING SITE
 ROUTE 295 EXIT 14
 NORTHBOUND ON REPALINO STATION/FLOODGATE ROAD
 RIGHT TURN ONTO BROAD ST/ ROUTE 44
 LEFT TURN ONTO NORTH REPALINO AVENUE/'C-LINE' ROAD
 LEFT TURN ONTO BROADWAY

ROUTE FOR TRUCKS EXITING SITE
 SOUTHBOUND ON 'A-LINE ROAD' AND 'A-LINE' ROAD EXTENDED
 RIGHT TURN ONTO 'C-LINE ROAD' / REPALINO AVENUE
 LEFT TURN ON DEMOCRAT ROAD
 ACCESS ROUTE 295 AT EXIT 16A



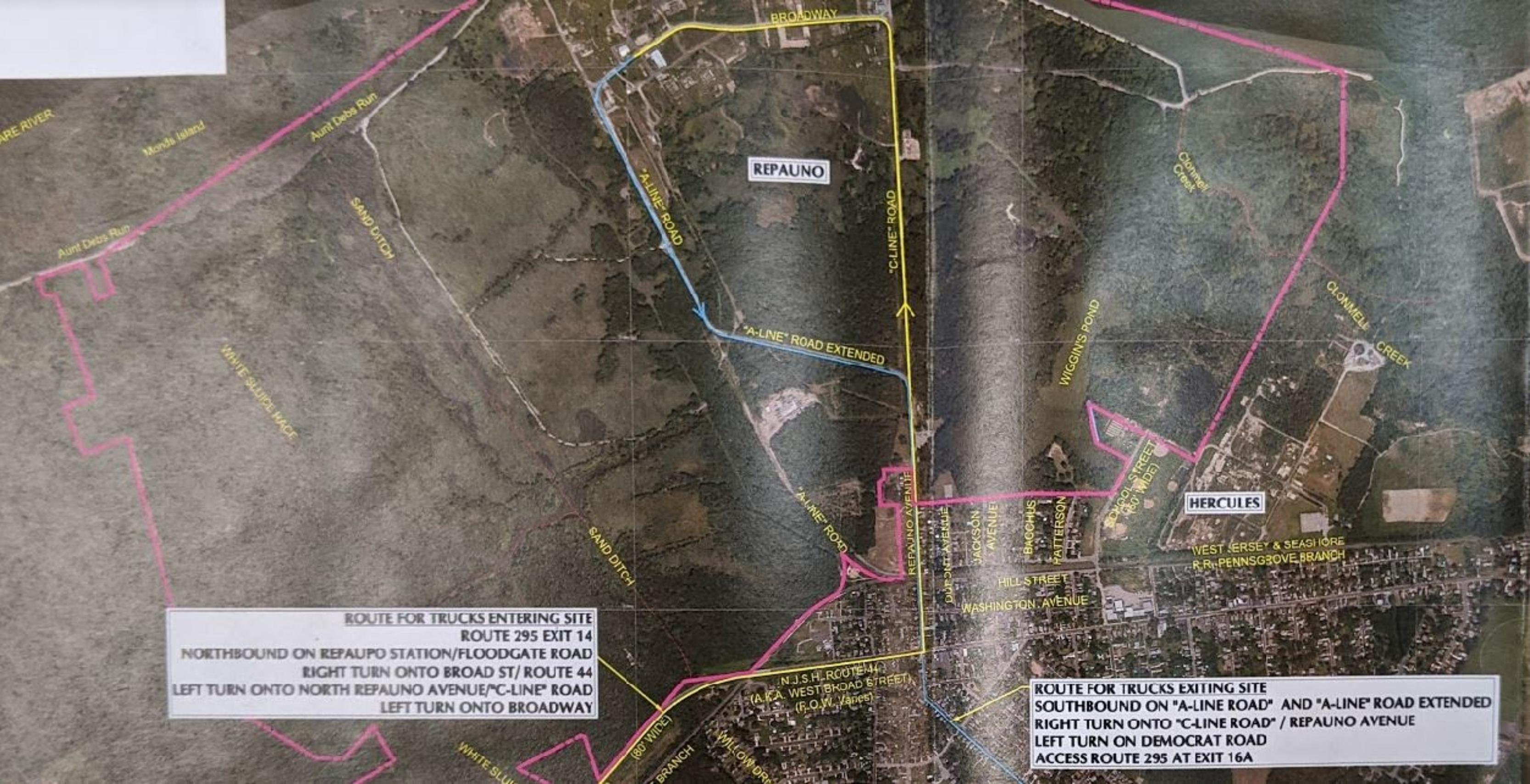
LANGAN

DWP GIBBSTOWN LOGISTICS CENTER

TRUCK TRAFFIC ROUTES

KT103

DATE	DESCRIPTION	BY	DATE	DESCRIPTION	BY



REPAUNO

HERCULES

ROUTE FOR TRUCKS ENTERING SITE
ROUTE 295 EXIT 14
NORTHBOUND ON REPAUNO STATION/FLOODGATE ROAD
RIGHT TURN ONTO BROAD ST/ ROUTE 44
LEFT TURN ONTO NORTH REPAUNO AVENUE/"C-LINE" ROAD
LEFT TURN ONTO BROADWAY

ROUTE FOR TRUCKS EXITING SITE
SOUTHBOUND ON "A-LINE ROAD" AND "A-LINE" ROAD EXTENDED
RIGHT TURN ONTO "C-LINE ROAD" / REPAUNO AVENUE
LEFT TURN ON DEMOCRAT ROAD
ACCESS ROUTE 295 AT EXIT 16A

BROADWAY

"A-LINE" ROAD

"C-LINE" ROAD

"A-LINE" ROAD EXTENDED

"A-LINE" ROAD

REPAUNO AVENUE

DEMOCRAT AVENUE

JACKSON AVENUE

BACCHUS

PATTERSON

HILL STREET

WASHINGTON AVENUE

SCHOOL STREET
(60' WIDE)

WEST JERSEY & SEASHORE
R.R. PENNSGROVE BRANCH

N.J.S.H. ROUTE 44
(A.K.A. WEST BROAD STREET)
(R.O.W. Varies)

(80' WIDE)

WILLOW DRIVE

WHITE SLUICE

ARE RIVER

Monda Island

Aunt Debs Run

SAND DITCH

WHITE SLUICE RACE

SAND DITCH

WIGGIN'S POND

CLONMELL CREEK

Clonmell
Creek



SUBDIVISION, SITE PLAN CHECKLIST

(REQUIRED SUBMISSION by APPLICANT)

Date _____ Submit 5 copies of the preliminary Application and Supporting Documents (application dependent) for determination of completeness

PART 1 -Important Information to be Supplied

1. xx Application Form, Site Plan (1 8 Copies each of FINAL) and Required Fee
2. xx True and Accurate Plot at Scale. Uniform sheet size, Block, Lot, Plate, Track Name Owner(s) of Record
3. xx Zoning Classification of Property, Location of Proposed Buildings, Open Space, Parking or Recreation Areas.
4. xx Soil Conservation Service Soil Classification
5. xx Acreage of Tract to nearest 1/10thAcre
6. xx Contours at 2 Foot Intervals maximum, extended 200 Feet beyond Lot Lines where possible.
7. xx Location of Water Sources; their Extent Surface Elevation, Depths and their Flood Plains; Wetlands Delineation
8. xx All Lot Lines, Setback Lines, Railroads and their Right of Ways, Location and Purpose of any Easement. Underground or Overhead Utility Lines of any Street which abut the Property
9. xx Parking Schedule in Accordance with Zoning Ordinance
10. xx Parking and Circulation Plan showing Location, and Arrangement Vehicular Accessways and the Location, Size, and Capacity of All Parking and Loading Areas.
11. W Complete Landscape Plan, including Size and Type of All Plantings.
12. xx Paving Construction Detail: Sidewalk, Curbs and All Other Areas Devoted to Pedestrian Use.
13. W Drainage Plan Containing Size, Location, and Slope of any existing or Proposed Pipes.

SUBDIVISION, SITE PLAN CHECKLIST(Cont.)

(Required Submission by Applicant)

14. xx Size, Type, Invert Elevation and Location of any Existing or Proposed Drainage Inlets
15. xx Proposed Contours with Intervals of 1 Foot for more than 3% but less than 15% and 5 feet when 15% or more. Show Location Ditches, Swales, Berms, and Streams.
16. W Drainage Calculations to Substantiate the Capacity of Drainage System.
17. xx Buildings Front, Side and Rear Elevations and Floor Plan
18. xx Key Map Showing Location of Site within Township
19. xx Site Lighting Plan
20. xx Copy of Protective Covenants. Submit Deed Restrictions Applying to Tract.
21. xx Any Other Information which is Deemed to be Necessary for the Review of the Site Plan by the Board

Part II -Requirements for Submittal

1. xx Application Form (18 Copies)
2. xx Monthly Meeting Date
3. xx Application Deadline
4. xx Application Fees
5. xx Escrow Fees
6. xx Site Plans (Plot Plan -18 Copies)
7. xx Proof of Taxes Paid to Date
8. xx Request for List of Property Owners
10 (to be submitted) Certification of Service Notice upon
Adjoining Land Owners.
9. xx List of Property Owners within 200'

SUBDIVISION, SITE PLAN CHECKLIST (Cont)
(Required Submission by Applicant)

- 11. (to be submitted) Notices of Certified Mail (Green Cards/Receipts)
- 12. (to be submitted) Proof of Publication
- 13. xx Copy of County Planning Board Application
- 14. N/A Variance Questions Answered

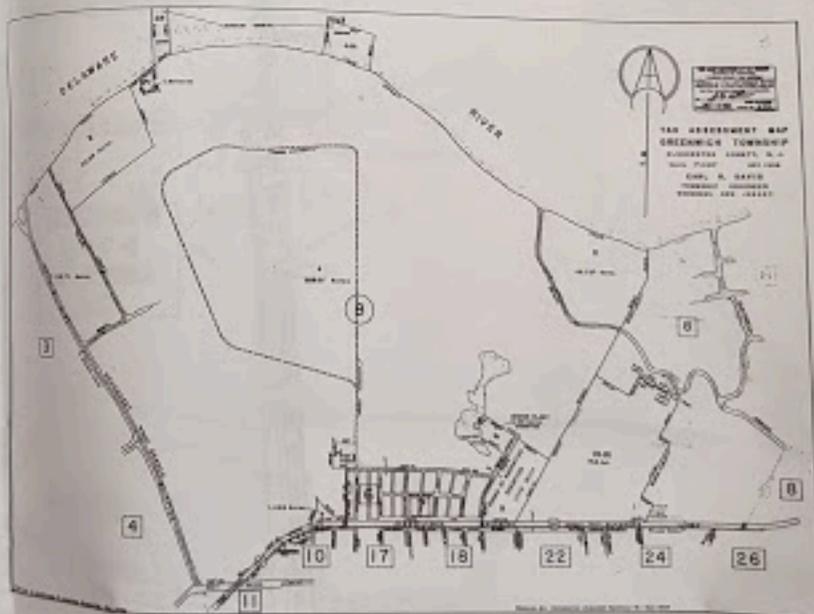
PRELIMINARY AND FINAL SITE PLAN APPLICATION REPAUNO PORT & RAIL TERMINAL DOCK 2

PART OF BLOCK 8, LOTS 3, 4 & 4.01 AS SHOWN ON TAX MAP SHEET 5
TOWNSHIP OF GREENWICH, GLOUCESTER COUNTY, NEW JERSEY



SITE LOCATION PLAN

SCALE 1 INCH = 1,000 FT
MAP REFERENCE: USGS BRIDGEPORT QUADRANGLE



TAX MAP

NOT TO SCALE
MAP REFERENCE: TOWNSHIP OF GREENWICH TAX MAPS, SHEET 5

ZONING REQUIREMENTS
STANDARDS AS REFERENCED IN THE REDEVELOPMENT PLAN
FOR REPAUNO PORT & RAIL TERMINAL
PREPARED BY MASER CONSULTANTS, JANUARY 20

STANDARD

SHEET INDEX

SHEET NO.	DRAWING NO.	DESCRIPTION
1	CS001	COVER SHEET
2	VL100	OVERALL EXISTING CONDITION
3	CS100	OVERALL SITE PLAN
4	CS101	SITE PLAN 1
5	CS102	SITE PLAN 2
6	CG101	GRADING, DRAINAGE & UTILITIES
7	CG102	GRADING, DRAINAGE & UTILITIES
8	LL101	LIGHTING PLAN 1
9	LL102	LIGHTING PLAN 2
10	LL501	LIGHTING DETAILS
11	CE101	SOIL EROSION & SEDIMENTATION
12	CE102	SOIL EROSION & SEDIMENTATION
13	CE501	SOIL EROSION & SEDIMENTATION
14	CS501	CONSTRUCTION DETAIL
15	CS502	CONSTRUCTION DETAIL

DOWN ON TAX MAP SHEET 5 R COUNTY, NEW JERSEY



TAX MAP
TO SCALE
OF GREENWICH TAX MAPS, SHEET 5

SHEET INDEX

SHEET NO.	DRAWING NO.	DESCRIPTION	LAST REVISION
1	CS001	COVER SHEET	
2	VL100	OVERALL EXISTING CONDITIONS PLAN	
3	CS100	OVERALL SITE PLAN	
4	CS101	SITE PLAN 1	
5	CS102	SITE PLAN 2	
6	CG101	GRADING, DRAINAGE & UTILITY PLAN 1	
7	CG102	GRADING, DRAINAGE & UTILITY PLAN 2	
8	LL101	LIGHTING PLAN 1	
9	LL102	LIGHTING PLAN 2	
10	LL501	LIGHTING DETAILS	
11	CE101	SOIL EROSION & SEDIMENT CONTROL PLAN 1	
12	CE102	SOIL EROSION & SEDIMENT CONTROL PLAN 2	
13	CE501	SOIL EROSION & SEDIMENT CONTROL NOTES & DETAILS	
14	CS501	CONSTRUCTION DETAILS 1	
15	CS502	CONSTRUCTION DETAILS 2	

SITE LOCATION PLAN

SCALE 1 INCH = 1,000 FT

MAP REFERENCE: USGS BRIDGEPORT QUADRANGLE

TAX MAP

NOT TO SCALE

MAP REFERENCE: TOWNSHIP OF GREENWICH TAX MAPS, SHEET 5

ZONING REQUIREMENTS

STANDARDS AS REFERENCED IN THE REDEVELOPMENT PLAN
FOR REPAUNO PORT & RAIL TERMINAL
PREPARED BY MASER CONSULTANTS, JANUARY 2019

STANDARD
AVERAGE & LOT AREA

REQUIRED
3 AC

PROPOSED

4.64 AC **LOT 3**
916.59 AC **LOT 4**
5.73 AC **LOT 4.01**
15 FT*

MAXIMUM BUILDING/ STRUCTURE HEIGHT

* PER REDEVELOPMENT PLAN 7.2(1)j, SMOKESTACKS, TOWERS, FLARES, SPIRES, SILOS, UTILITY LINES, PIPING, AND THE LIKE SHALL BE EXEMPT FROM THE HEIGHT LIMITATIONS. SAID STRUCTURES ARE LIMITED TO 250 FEET MAX.

LIST OF OUTSIDE AGENCIES RETAINING JURISDICTION

AGENCY	APPROVAL REQUIRED	STATUS	DATE
GLOUCESTER COUNTY PLANNING BOARD	SITE PLAN APPLICATION	UNDER REVIEW	
GLOUCESTER COUNTY SOIL CONSERVATION DISTRICT	SOIL EROSION AND SEDIMENT CONTROL CERTIFICATION	UNDER REVIEW	
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION	FRESHWATER WETLANDS LETTER OF INTERPRETATION	APPROVED	7/11/2016
	WATERFRONT DEVELOPMENT INDIVIDUAL PERMIT (IN-WATER)	APPROVED	5/20/2019
	WATERFRONT DEVELOPMENT INDIVIDUAL PERMIT (UPLAND)	MODIFIED	11/29/2018
	FLOOD HAZARD AREA INDIVIDUAL PERMIT		
	FLOOD HAZARD AREA VERIFICATION		
	COASTAL WETLANDS PERMIT		
	FRESHWATER WETLANDS INDIVIDUAL PERMIT	APPROVED	6/30/2017
	FRESHWATER WETLANDS TRANSITION AREA WAIVER FOR REDEVELOPMENT	MODIFIED	11/29/2018
	TIDELANDS LICENSE (DOCK)	APPROVED	9/9/2019
	TIDELANDS LICENSE (DREDGING)	APPROVED	9/9/2019
UNITED STATES ARMY CORPS OF ENGINEERS	NJPDES CONSTRUCTION STORMWATER DISCHARGE PERMIT (IF APPLICABLE)	FUTURE SUBMITTAL (IF REQ'D)	
	JURISDICTIONAL DETERMINATION	APPROVED	7/5/2016
DELAWARE RIVER BASIN COMMISSION	INDIVIDUAL PERMIT UNDER SECTIONS 10 AND 404	UNDER REVIEW	
	DOCKET	APPROVED	6/12/2019

AREA OF PROPOSED IMPROVEMENTS

**BLOCK 8
LOT 3
5.73 ± AC.**

**BLOCK 8
LOT 2
4.64 ± AC.**

**BLOCK 8
LOT 4
912.592
AC.**

NOTES AND REFERENCES

1. THIS PLAN AND EACH INSTRUMENT HEREIN IS A PART OF THE PROJECT AND IS SUBJECT TO THE TERMS AND CONDITIONS OF THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA, AND TO THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA, AND TO THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA.
2. EXISTING CONDITIONS SHOWN ON THIS PLAN ARE BASED ON A REVISION OF THE SURVEY OF THE TRACT DESCRIBED IN THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA, AND TO THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA.
3. EXISTING CONDITIONS ARE ALSO BASED ON THE SURVEY OF THE TRACT DESCRIBED IN THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA, AND TO THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA.
4. THE VERTICAL CURVES ARE BASED UPON NORTH AMERICAN VERTICAL CURVE DATA.
5. THE PROPOSED IMPROVEMENTS ARE BASED UPON THE SURVEY OF THE TRACT DESCRIBED IN THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA, AND TO THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA.
6. THE FOLLOWING ARE THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA, AND TO THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA:

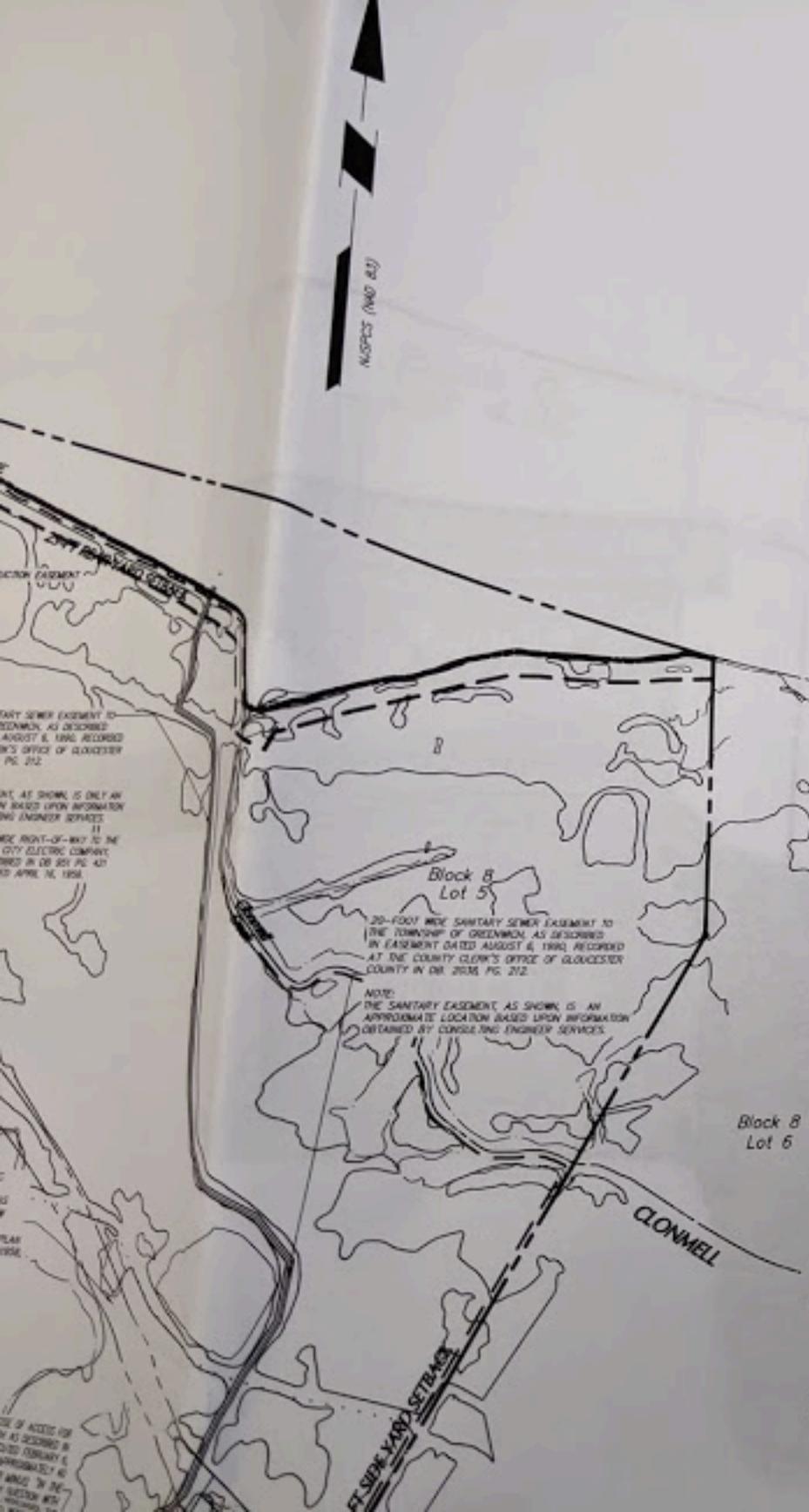
7. THE LOCATION OF THE IMPROVEMENTS AND THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA, AND TO THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA.
8. THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA, AND TO THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA.
9. THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA, AND TO THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA.
10. THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA, AND TO THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA.
11. THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA, AND TO THE INSTRUMENTS HERETOFORE FILED IN THE PUBLIC RECORDS OF THE COUNTY OF SAN DIEGO, CALIFORNIA.

SITE PLAN INSET

NOTES AND REFERENCES

- BOUNDARY INFO TAKEN FROM PLANS ENTITLED "SURVEY OF PROPERTY FOR: DELAWARE RIVER PARTNERS, LLC FORMERLY DUPONT-REPAUND SITE, GREENWICH TOWNSHIP, GLOUCESTER COUNTY, NEW JERSEY" PREPARED BY ADAMS, REHMANN & HEGGAN, DATED APRIL 13, 2018, LAST REVISED APRIL 18, 2019. THE MERIDIAN OF THIS SURVEY IS REFERENCED TO NEW JERSEY STATE PLANE COORDINATE SYSTEM (NJSPCS) NORTH AMERICAN DATUM 1983 (NAD 83).
- EXISTING CONDITIONS SURVEY SHOWN IS BASED ON A REPORT OF TITLE PREPARED BY FIDELITY NATIONAL TITLE INSURANCE COMPANY, TITLE NO. 2013-80667, REVISED TO FEBRUARY 13, 2015 AND IS SUBJECT TO THE CONDITIONS AND RESTRICTIONS LISTED THEREON THE TITLE REPORT AND SEVERAL NOTED UNRECORDED DOCUMENTS WERE SUPPLIED BY E.I. DU PONT DE NEMOURS AND COMPANY.
- EXISTING CONDITIONS ARE ALSO BASED IN PART ON A FORMER SURVEY OF THE ENTIRE TRACT PERFORMED FOR E.I. DU PONT DE NEMOURS AND COMPANY DATED 12/15/2000 PREPARED BY CONSULTING ENGINEERING SERVICES, FOUND MONUMENTATION, PHYSICAL EVIDENCE, DEEDS OF RECORD, AND TAX MAP INFORMATION.
- THE VERTICAL DATUM IS BASED UPON NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
- THE TOPOGRAPHIC SURVEY ILLUSTRATED IN THIS PLAN SET WAS PERFORMED DURING A TIME PERIOD WHERE THE GROUND WAS OBSCURED IN LARGE PART BY VEGETATIVE COVER. THE FINAL TOPOGRAPHY WAS DEVELOPED FROM A COMBINATION OF DATA SOURCES INCLUDING NEW LIDAR DATA ACQUIRED IN JULY, 2014; AERIAL PHOTOGRAPHY DATED JULY, 2014; NEW ORTHOPHOTOGRAPHY DATED JULY, 2014; NJ STATE LIDAR DATA OBTAINED IN THE SPRING OF 2007; NJ STATE ORTHOPHOTOGRAPHY (2012); PLANIMETRIC DETAIL ON A SURVEY BY CONSULTING ENGINEER SERVICES, DATED DECEMBER 15, 2000. THIS TOPOGRAPHIC SURVEY SHOULD NOT BE USED FOR FINAL DESIGN OR EARTHWORK CALCULATIONS WITHOUT FIELD VERIFICATION OF THE ELEVATIONS BY THE CONTRACTOR.
- THE FOLLOWING MONUMENTS AND COORDINATES ARE THE BASIS OF SURVEY CONTROL FOR THIS PROJECT. SURVEY CONTROL WAS ESTABLISHED BY MONARCH SURVEYING AND ENGINEERING. MONARCH SURVEYING AND ENGINEERING DRAWING, "SURVEY CONTROL PLAN" DATED DECEMBER 29, 2016 REFLECTS THE COMPLETE SITE SURVEY CONTROL.

PT 4768	N 369130.89	E 267989.82	EL +7.90	FND RB W/CAP
PT 5071	N 368981.55	E 269297.00	EL +8.21	FND RB W/CAP
PT 5072	N 369427.52	E 268980.66	EL +5.93	FOND NAIL (151)
PT 5073	N 369412.24	E 268603.11	EL +6.50	FOND NAIL (125)
- FRESHWATER WETLANDS, STATE OPEN WATERS, AND WETLAND TRANSITION AREAS SHOWN AS VERIFIED BY NJDEP, FILE NO. 0807-16-0001.1. COASTAL WETLAND AREA WIDTHS SHOWN ARE ASSUMED BASED ON ADJACENT FRESHWATER WETLAND TRANSITION AREAS.
- THE LOCATION OF STRUCTURES AND UNDERGROUND UTILITIES AS INDICATED HAVE BEEN OBTAINED FROM EXISTING RECORDS AND FIELD SURVEYS. UNDERGROUND STRUCTURES AND UTILITIES MAY BE PRESENT WHICH ARE NOT DOCUMENTED OR LOCATED.
- CONTRACTOR TO VERIFY ALL EXISTING CONDITIONS AND BE THOROUGHLY FAMILIAR WITH THE SITE BEFORE WORK COMMENCES. ANY DISCREPANCIES IN THE DRAWINGS SHALL BE IMMEDIATELY REPORTED TO THE ENGINEER AND OWNER BEFORE FURTHER WORK COMMENCES.
- THE CONTRACTOR SHALL CALL UTILITY "ONE-CALL" NUMBER 72 HOURS PRIOR TO ANY EXCAVATION ON THIS SITE. CONTRACTOR SHALL NOTIFY LOCAL WATER AND SEWER DEPARTMENTS TO MARK OUT THEIR UTILITIES.
- THE NJDEP FLOOD HAZARD AREA ELEVATION VARIES FROM 9.0 TO 12.0 AND WAS CALCULATED BY LANGAN ENGINEERING AND ENVIRONMENTAL SERVICES USING METHOD 2 (FEMA TIDAL METHOD) AS SPECIFIED IN N.J.A.C. 7:13-3.4.



NAD 83

Block 8
Lot 5

Block 8
Lot 6

CLONMELL

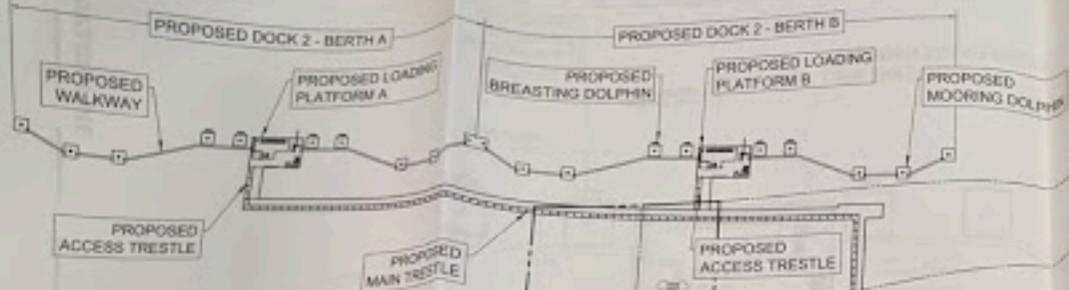
30-FOOT WIDE SANITARY SEWER EASEMENT

30-FOOT WIDE SANITARY SEWER EASEMENT

20-FOOT WIDE SANITARY SEWER EASEMENT

NOTE: THE SHANTARY EASEMENT, AS SHOWN, IS AN APPROXIMATE LOCATION BASED UPON INFORMATION OBTAINED BY CONSULTING ENGINEER SERVICES.

NOTE: THE SHANTARY EASEMENT, AS SHOWN, IS AN APPROXIMATE LOCATION BASED UPON INFORMATION OBTAINED BY CONSULTING ENGINEER SERVICES.



DELAWARE RIVER

TRESTLE VEHICLE
ACCESS ROAD
CONNECTION TO
PROPOSED
TERMINAL ROAD

PROPOSED
PIPE RACK
CONNECTION
TO PHASE 1A
RAI PIPE RACK

Lot 4.01 Lot 3

EXISTING
BUZZARD RACK

EPIC TRANSCOILING
FACILITY IMPROVEMENTS
(UNDER CONSTRUCTION)

Block 8
Lot 4

Block 8
Lot 4.02

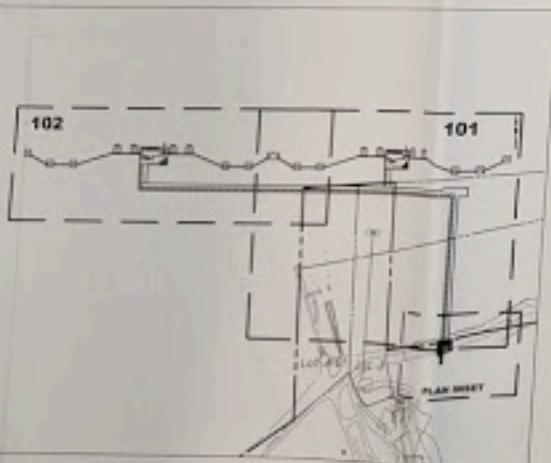
EXISTING
RAFF AREA

RAFF AREA
IMPROVEMENTS

EPIC TRANSCOILING
FACILITY IMPROVEMENTS
(UNDER CONSTRUCTION)

BROADWAY

CLUMP ROAD



SITE PLAN INSET KEY

SCALE 1 INCH = 300 FEET

DELAWARE RIVER

MATCH LINE

FLOW ARROW (TYP.)

FIRE HYDRANT (TYP.)

TYPICAL DOLPHIN ELEVATION LAYOUT ENTIRE PERIMETER ELEVATION: 1.50

ELECTRIC AND COMMUNICATION LINES ROUTED ON 3 FT CABLE TRAY ADJACENT TO WALKWAY

ELECTRIC AND COMMUNICATION LINES ON CABLE TRAY ROUTED ABOVE VEHICLE ACCESS AREA

DRAINAGE SCUPPER (TYP.)

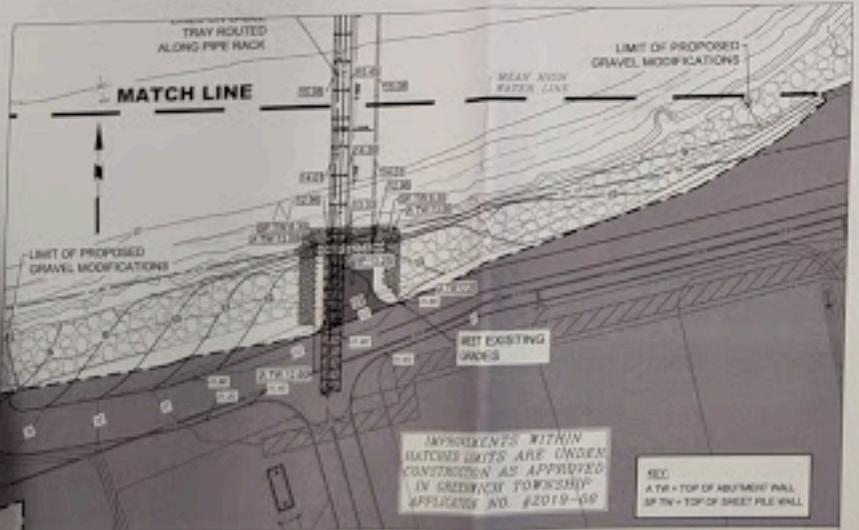
ELECTRIC AND COMMUNICATION LINES ROUTED ON 3 FT CABLE TRAY ADJACENT TO WALKWAY

DRAINAGE SCUPPER (TYP.)

MATCH LINE

DRAINAGE SCUPPER (TYP.)

FIRE WATER LINE



GRADING, DRAINAGE & UTILITY PLAN INSET
SCALE 1 INCH = 4 FEET

MATCH LINE
SEE INSET

ELECTRIC AND COMMUNICATION LINES ON CABLE TRAY ROUTED ALONG PIPE RACK

LIMIT OF PROPOSED GRAVEL MODIFICATIONS

MAY ADD WATER LINE

LIMIT OF PROPOSED GRAVEL MODIFICATIONS

GRADING, DRAINAGE & UTILITY NOTES
ALL SPOT SHOTS ARE TOP OF DECK/PAVEMENT ELEVATIONS UNLESS OTHERWISE NOTED.
FOR ABUTMENT AND SHEET PILE WALL SEE SHEET CS402 FOR MORE DETAILS.
ALL IMPROVEMENTS IN THE DELAWARE RIVER ARE WITHIN THE DESIGN LIMITS APPROVED BY UNITED STATES ARMY CORPS OF ENGINEERS.



Date	Description	By
	REVISIONS	

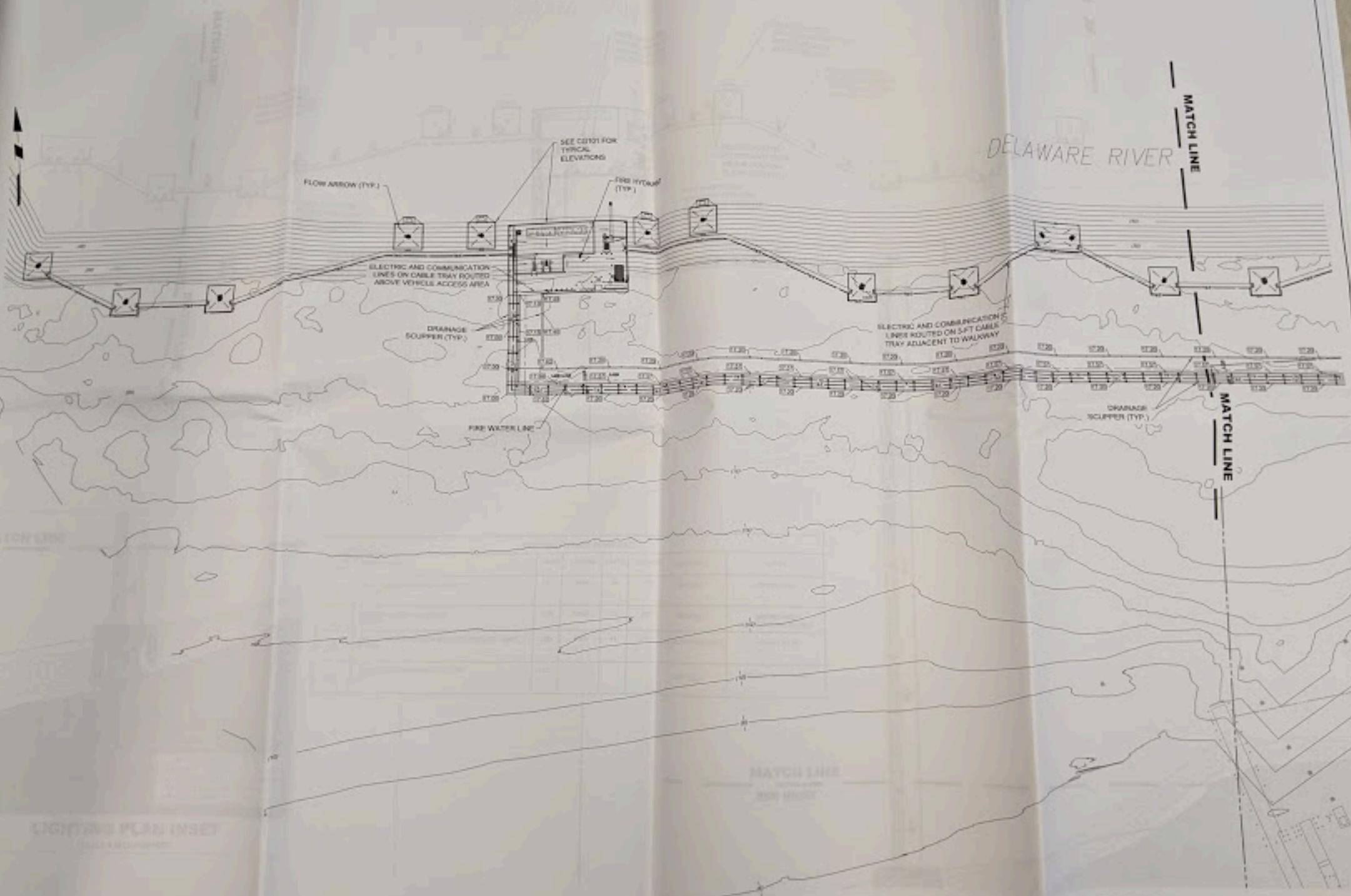
LANGAN
Professional Engineer
NJ Lic. No. 24024615300

LANGAN
Langan Engineering and Environmental Services, Inc.
90 Leno Drive, Suite 104
Lawrenceville, GA 30046
7-800-250-8800 • 770-962-8857 • www.langan.com

REPAIRING PORT & RAIL TERMINAL DOCK 3
GREENWICH TOWNSHIP

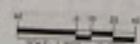
GRADING, DRAINAGE & UTILITY PLAN 1

Project No.	000000	Drawing No.	CG10
Date	01/20/2019	Sheet	100
Drawn By	JPL/KWS		
Checked By	AGS/SP		



LIGHTING PLAN INSET
SCALE 1/8" = 1'-0"

GRADING, DRAINAGE & UTILITY NOTES
 ALL SPOT SHOTS ARE TOP OF DECK/PAVEMENT ELEVATIONS UNLESS OTHERWISE NOTED.
 FOR ADJUSTMENT AND SHEET FILE WALL SEE SHEET CS022 FOR MORE DETAILS.
 ALL IMPROVEMENTS IN THE DELAWARE RIVER ARE WITHIN THE DREDGING LIMITS APPROVED BY
 UNITED STATES ARMY CORPS OF ENGINEERS



 LANGAN Langan Engineering and Environmental Services, Inc. 980 Lakes Drive, Suite 124 Cary, North Carolina 27513	Project No. 13000004	Drawing No. CG102 1002
	Date 11/18/2014	Drawing Title GRADING, DRAINAGE & UTILITY PLAN 2
Project Title REPAIRING PORT & RAIL TERMINAL DOCK 2	Drawn By JMS/MSB	



LUMINAIRE REQUIREMENTS

1. CONSTRUCTION - DIE CAST ALUMINUM HOUSING, IMPACT RESISTANT GLASS LENS, SEALED AGAINST MOISTURE AND ENVIRONMENTAL CONTAMINANTS. EXTERIOR PARTS ARE FINISHED POWDER COATING TO PROVIDE SUPERIOR RESISTANCE TO WEATHERING AND CORROSION. FINISHING STEEL HARDWARE.
2. INSTALLATION - POLE MOUNTED.
3. LISTING - FM APPROVED.
4. WARRANTY - 3 YEAR LIMITED WARRANTY.
5. BASE OF DESIGN FIXTURE HUBBELL MODEL WFL-2000-03-40-10-00

POLE MOUNTED ROADWAY LED DETAIL



LUMINAIRE REQUIREMENTS

1. CONSTRUCTION - DIE CAST ALUMINUM HOUSING, IMPACT RESISTANT GLASS LENS, SEALED AGAINST MOISTURE AND ENVIRONMENTAL CONTAMINANTS. EXTERIOR PARTS ARE FINISHED POWDER COATING TO PROVIDE SUPERIOR RESISTANCE TO WEATHERING AND CORROSION. FINISHING STEEL HARDWARE.
2. INSTALLATION - POLE MOUNTED.
3. LISTING - FM APPROVED, UL LISTED FOR WET LOCATIONS, SEE CLASSIFICATION 2.
4. WARRANTY - 4 YEAR LIMITED WARRANTY.
5. BASE OF DESIGN FIXTURE SAFAVIT CRUISE-HINDS MODEL WFL-2000-03-40-10-00

POLE MOUNTED FLOODLIGHT LED DETAIL



LUMINAIRE REQUIREMENTS

1. CONSTRUCTION - DIE CAST ALUMINUM HOUSING, IMPACT RESISTANT GLASS LENS, SEALED AGAINST MOISTURE AND ENVIRONMENTAL CONTAMINANTS. EXTERIOR PARTS ARE FINISHED POWDER COATING TO PROVIDE SUPERIOR RESISTANCE TO WEATHERING AND CORROSION. FINISHING STEEL HARDWARE.
2. OPTICAL - 30° BEAM, 40 IN. DIA.
3. INSTALLATION - POLE MOUNTED, STANCHION - 2"
4. LISTING - FM APPROVED, UL LISTED FOR WET LOCATIONS, SEE CLASSIFICATION 2.
5. WARRANTY - 4 YEAR LIMITED WARRANTY.
6. BASE OF DESIGN FIXTURE SAFAVIT CRUISE-HINDS MODEL WFL-2000-03-40-10-00

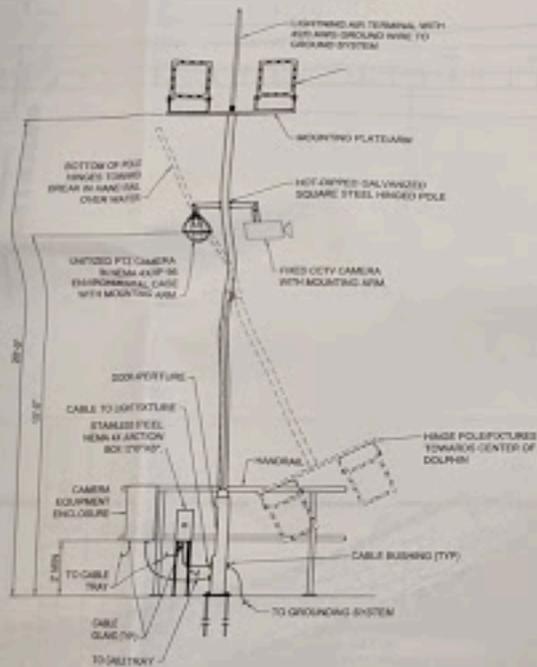
PENDANT LED DETAIL



LUMINAIRE REQUIREMENTS

1. CONSTRUCTION - TOUGH POLYCARBONATE LENS INTERNALLY HOUSED IN TETRA, UNIT IS SEAL TO WITH A THERMO WELD, COMPLETELY VACUUM BURNED, CAPABLE OF PROTECTING AND KEEPING UNIFORMITY.
2. OPTICAL - 360° HORIZONTAL OUTPUT, 100% NAUTICAL MILE RANGE.
3. INSTALLATION - POLE MOUNTED.
4. LISTING - FM APPROVED, UL LISTED FOR WET LOCATIONS, SEE CLASSIFICATION 2.
5. WARRANTY - 4 YEAR LIMITED WARRANTY.
6. BASE OF DESIGN CHARMAN UNIFORMITY LIGHT

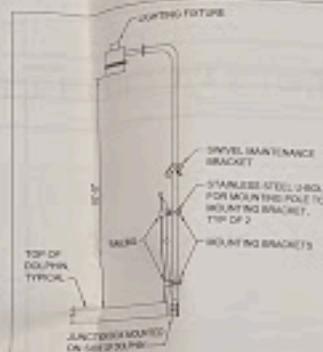
POLE MOUNTED NAVIGATION LIGHT DETAIL



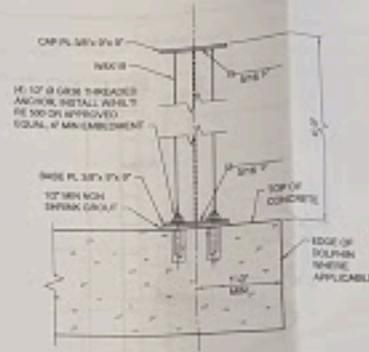
NOTES

1. SUBMIT DETAILS WITH CALCULATIONS, FOR REVIEW. DESIGN POLE WITHSTAND TO WITHSTAND 100 MPH WIND.
2. FLOODLIGHT POLES TO BE CONTROLLED BY LIGHTING CONTACTOR.
3. FLOODLIGHT POLES.
4. PROJECT CCTV CAMERAS WHERE INDICATED ON PLANS.

FLOODLIGHT POLE



SWIVEL POLE MOUNTING DETAIL



POLE MOUNTED NAVIGATION LIGHT SUPPORT

NAVIGATION LIGHT SUPPORT FINISHING AND PAINTING NOTES

1. GALVANIZED BOLLARDS AND NAVIGATION LIGHT SUPPORT ASSEMBLY SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM A 103 OR ASTM A 103-88. ALL APPLICABLE SURFACES OF THE BOLLARDS SHALL BE GALVANIZED. HOT-DIP GALVANIZED ITEMS SPECIFIED TO BE ZINC-COATED AFTER FABRICATION.
2. REPAIR OF ZINC-COATED SURFACES: REPAIR DAMAGED SURFACES WITH GALVANIZING REPAIR METHOD AND PAINT CONFORMING TO ASTM A 780 OR BY APPLICATION OF STICK OR THICK PASTE MATERIAL SPECIFICALLY DESIGNED FOR REPAIR OF GALVANIZING, AS APPROVED BY THE OWNER'S REPRESENTATIVE. CLEARANCE TO BE REPAIRED AND REMOVE SLAG FROM WELDS. HEAT SURFACES TO WHICH STICK OR PASTE MATERIAL IS APPLIED, WITH A TORCH TO A TEMPERATURE SUFFICIENT TO MELT THE METAL IN THE STICK OR PASTE. SPREAD MOLten MATERIAL UNIFORMLY OVER SURFACES TO BE COATED AND Wipe OFF EXCESS MATERIAL.
3. SURFACE PREPARATION: PREPARE GALVANIZED SURFACES TO BE PAINTED AND/OR COATED IN ACCORDANCE WITH COATING MANUFACTURER'S RECOMMENDATIONS. WASH CLEANED SURFACES, WHICH HAVE BECOME CONTAMINATED WITH RUST, DIRT, OIL, GREASE, OR OTHER CONTAMINANTS WITH SOLVENTS UNTIL THOROUGHLY CLEAN. SURFACES TO BE EMBEDDED IN CONCRETE SHALL BE FREE OF DIRT AND GREASE. GALVANIZED SURFACES TO BE PAINTED SHALL BE BRUSHED OFF SLIGHTLY CLEANED IN ACCORDANCE WITH SSPC-SP10 AND CLEARED OF ANY GREASE OR OTHER FOREIGN MATTER WITH A SUITABLE DEGREASER BEFORE APPLYING COATINGS.
4. PRIMER AND INTERMEDIATE COAT: SHOP APPLY ONE COAT OF PRIMER AND ONE COAT OF INTERMEDIATE COAT IN ACCORDANCE WITH MANUFACTURER'S PRINTED INSTRUCTIONS. PRIMER AND INTERMEDIATE COAT SHALL BE A CYCLOHEXANONE EPOXY CARBOXYL CARBOXYLATE RESIN OR APPROVED EQUAL APPLIED TO A DFT OF 4 MILS, IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.
5. TOP COAT: SHOP APPLY ONE COAT OR MORE TOP COATS AS NEEDED TO PROVIDE COMPLETE COVERAGE, IN ACCORDANCE WITH MANUFACTURER'S PRINTED INSTRUCTIONS. TOP COAT SHALL BE AN ACRYLIC ALIPHATIC POLYURETHANE CARBOXYL CARBOXYLATE RESIN OR APPROVED EQUAL APPLIED TO A DFT OF 3 MILS, IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.
6. TOP COAT COLOR SHALL BE SAFETY YELLOW, OR AS OTHERWISE SELECTED BY THE OWNER.

DELAWARE RIVER

MATCH LINE

FLOATING TURBOGY BARRIER (TYP.) TO BE INSTALLED AND REMOVED WITH PILE WORK

FLOATING TURBOGY BARRIER (TYP.) BARRIER MATERIAL TO BE MADE OUT OF POLYETHYLENE PLASTIC SHEET 32 MIL OR SUITABLE ALTERNATE

FLOATING TURBOGY BARRIER (TYP.) BARRIER MATERIAL TO BE MADE OUT OF POLYETHYLENE PLASTIC SHEET 32 MIL OR SUITABLE ALTERNATE

MATCH LINE

MATCH LINE

REINFORCED SILT FENCE (TYP.)

LIMIT OF DISTURBANCE 0.80 AC

SOFT WIDE CONSTRUCTION ENTRANCE ONLY REQUIRED IF CONSTRUCTION BEGINS BEFORE COMPLETION OF TERMINAL ROAD

IMPROVEMENTS WITHIN DASHED LIMITS ARE UNDER CONSTRUCTION AS APPROVED BY GREENWICH TOWNSHIP APPLICATION NO. 42019-08

SOIL EROSION & SEDIMENT CONTROL PLAN INSET

SCALE: 1"=40'± FEET

FLOATING TURBOGY BARRIER (TYP.) TO BE INSTALLED AND REMOVED WITH PILE WORK

SOIL EROSION & SEDIMENT CONTROL/SOIL COMPACTION NOTES:
1. THE DISTURBANCE AREA SHALL BE EXEMPTED FROM SOIL COMPACTION, ACCORDING TO THE "STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY", STANDARDS FOR LAND GRADING, DATED JANUARY 2014, REVISED 07/2017. THE EXEMPTION CRITERIA THAT APPLY ARE EXEMPTIONS 2 AND 3.

MATCH LINE

SEE INSET

REINFORCED SILT FENCE (TYP.)

LIMIT OF PROPOSED GRAVEL MODIFICATIONS



Date: Description:

Handwritten signature and initials.

LANGAN

Langan Engineering and Environmental Services, Inc.
485 Lane Drive, Suite 120
Lansdale, PA 19382

REPAIR PORT & RAIL TERMINAL DOCK

Project No. 1000002

Date: 10/2020

Drawn By: HSK/06

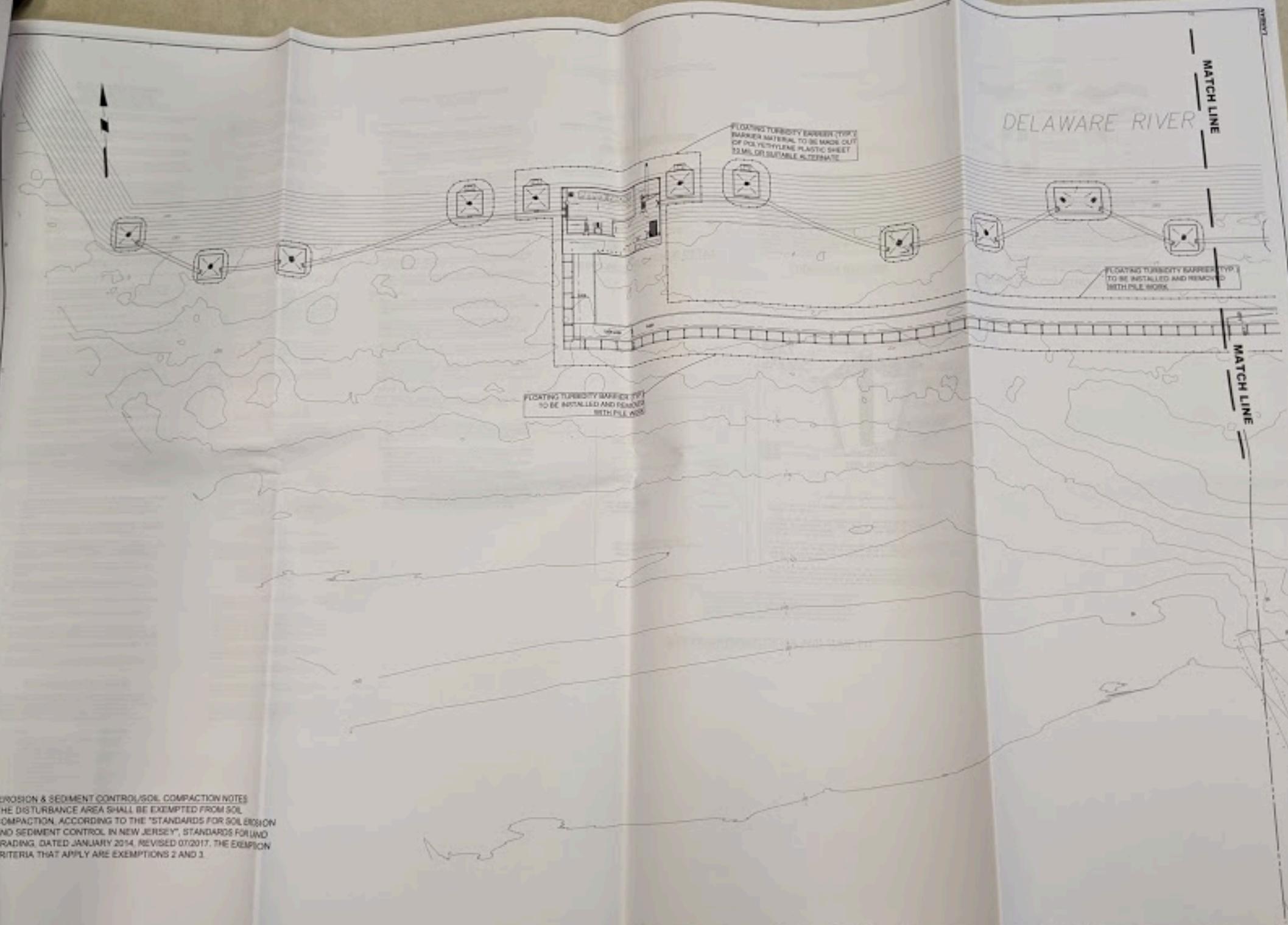
SOIL EROSION & SEDIMENT CONTROL PLAN 1

Sheet No.

1000002

CE101

1001



SOIL EROSION & SEDIMENT CONTROL/SOIL COMPACTION NOTES
 1. THE DISTURBANCE AREA SHALL BE EXEMPTED FROM SOIL COMPACTION, ACCORDING TO THE "STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY", STANDARDS FOR LAND GRADING, DATED JANUARY 2014, REVISED 07/2017. THE EXEMPTION CRITERIA THAT APPLY ARE EXEMPTIONS 2 AND 3.



REV	DESCRIPTION

[Signature]
 PROFESSIONAL ENGINEER
 No. 16, 260,000,000

LANGAN
 Langan Engineering and
 Environmental Services, Inc.
 980 Lanza Drive, Suite 100
 Lawrenceville, GA 30046
 770-962-8800 F 770-962-8801 www.langan.com

REPAIR AND RAIL TERMINAL DOCK

SOIL EROSION & SEDIMENT CONTROL PLAN 2

Project No. 2008860
 Date 11/16/2017
 Drawn By KJL/DBR
 Checked By
 Drawing No. **CE102 1002**

ES SHALL BE IN PLACE OF PROPOSED
 IN PLAN SHALL BE LEFT IN AREA IS STABILIZED
 ALL MATERIALS AND TECH. SUR. EXHIBITION EXHAUSTIVE PLAN
 A MORE THAN FIFTY SHALL IMMEDIATELY ACCORDANCE WITH THE INCLUSION IN THE BEING, THE DISTURBED AND RECONSTRUCTED PERIOD TIME, MAINT TO PROVIDE THE SAFETY OF COMMUNICATION

NE A TEMPORARY OF 1 YEAR FOR ACRES FOLLOWING ROUGH AND STABILIZATION AND EROSION CONTROL AND MAINTENANCE ONLY
 WHENEVER A WILL BE REFINISHED FOR A PERIOD
 TO BE IN SUBMIT
 TO THE CERTIFICATION REQUIRED BEFORE THE

TO A TEMPORARY OF 1 YEAR FOR ACRES FOLLOWING ROUGH AND STABILIZATION AND EROSION CONTROL AND MAINTENANCE ONLY
 WHENEVER A WILL BE REFINISHED FOR A PERIOD
 TO BE IN SUBMIT
 TO THE CERTIFICATION REQUIRED BEFORE THE

TO A TEMPORARY OF 1 YEAR FOR ACRES FOLLOWING ROUGH AND STABILIZATION AND EROSION CONTROL AND MAINTENANCE ONLY
 WHENEVER A WILL BE REFINISHED FOR A PERIOD
 TO BE IN SUBMIT
 TO THE CERTIFICATION REQUIRED BEFORE THE

TO A TEMPORARY OF 1 YEAR FOR ACRES FOLLOWING ROUGH AND STABILIZATION AND EROSION CONTROL AND MAINTENANCE ONLY
 WHENEVER A WILL BE REFINISHED FOR A PERIOD
 TO BE IN SUBMIT
 TO THE CERTIFICATION REQUIRED BEFORE THE

ACID SOILS NOTES

- IN ORDER TO PROVIDE SUITABLE CONDITIONS FOR GROWTH AND VEGETATION AND TO PREVENT THE EXCESSIVE OF TRANSPARENT WATER IN THOSE AREAS UNDERGOING ACID FORMATION WITH A pH BELOW THE FOLLOWING REQUIREMENT SHALL BE MET
1. LIMIT THE EXCAVATION AREA AND EXPOSURE TIME WHEN FROM ACID PRODUCING SOILS ARE EXPOSED.
2. TYPICAL STRIPPED FROM THE SITE SHALL BE STORED SEPARATELY FROM FROM ACID PRODUCING SOILS.
3. ECONOMY OF HIGH ACID PRODUCING SOILS SHOULD BE LOCATED ON LEVELS, LIMIT TO MINIMUM TO BE MAINTAINED ESPECIALLY WHEN THIS MATERIAL HAS A HIGH pH CONTENT.
4. TEMPORARILY EXPOSED ACID PRODUCING SOILS SHOULD BE COVERED TO PREVENT WEATHER FROM ACID STRIPPS OF THIS MATERIALS UNDER EXPOSURE. IF SUCH POSSIBLE, STRIPPINGS SHALL BE COVERED WITH A MINIMUM OF 5 TO 6 INCHES OF ORGANIC COVER TO PROTECT SOILS FROM ACIDIFICATION. STRIPPINGS SHALL BE INSTALLED AT THE END OF EACH DAY TO CONTROL MOVEMENT OF THE STRIPPINGS ON SLOPE. STRIPPS SHALL NOT BE APPLIED TO THE EXPOSURE TO PREVENT STRIPPS TO COMBINATION WITH HIGH ACID PRODUCING SOILS.
5. HIGH ACID PRODUCING SOILS WITH A pH OF 4.0 OR LESS, OR EXHAUSTIVE PLAN STRIPPINGS FROM AN EXCAVATION DEEPER THAN 2 FT SHALL BE TRUCKED TO AN OFF-SITE LOCATION TO BE APPLIED AT A RATE OF 10 TONS PER ACRE OR 100 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA. COVERED WITH A MINIMUM OF 12 INCHES OF STRIPPINGS OR 100 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA TO BE PLANTED SHALL BE COVERED WITH A MINIMUM OF 12 INCHES OF STRIPPINGS OR 100 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA.
6. EXCAVATION AREAS SHALL NOT BE LOCATED OR EXPOSED TO AREAS OF ANY SURFACE OF A SLOPE OR TYPICAL SLOPE OR STREAM BANKS UNLESS APPROVED OTHERWISE.
7. TO PREVENT POTENTIAL WATER EXHAUSTIVE EQUIPMENT LEAKAGE OR MOVEMENT OF THE EXHAUSTIVE EQUIPMENT TO BE CLEANED AT THE END OF EACH DAY TO PREVENT SPILLINGS AND LEAKS. HEAVY DUTY SAFETY OF POLYETHYLENE LINERS POSSIBLE TO EXHAUSTIVE EQUIPMENT IS TO 2 INCHES THICK AND TO PROTECT MOVEMENT FROM EXHAUSTIVE EQUIPMENT AND TO PROTECT BROKEN CONTROL PRACTICES FROM EXHAUSTIVE EQUIPMENT. STRIPPINGS SHALL BE TRUCKED TO AN OFF-SITE LOCATION TO BE APPLIED AT A RATE OF 10 TONS PER ACRE OR 100 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA. COVERED WITH A MINIMUM OF 12 INCHES OF STRIPPINGS OR 100 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA.

DUST CONTROL NOTE

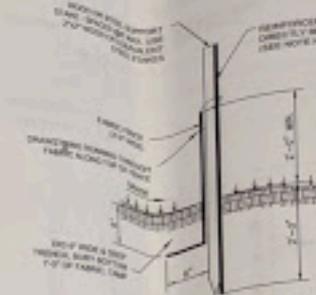
TO CONTROL DUST FROM EXPOSED SOIL SURFACES, REDUCE AIR AND/OR SITE DAMAGE AND HEALTH HAZARD, AND IMPROVE TRAFFIC SAFETY, THE SITE SHALL BE SPRINKLED UNTIL THE SURFACE IS WET.

SEEDING SCHEDULE

1. TEMPORARY SEEDING SHALL CONSIST OF SPRINKLING APPLIED AT A RATE OF 10 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA. COVERED WITH A MINIMUM OF 12 INCHES OF STRIPPINGS OR 100 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA.
2. PERMANENT SEEDING SHALL CONSIST OF SPRINKLING APPLIED AT A RATE OF 10 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA. COVERED WITH A MINIMUM OF 12 INCHES OF STRIPPINGS OR 100 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA.
3. SEEDING SHALL BE DONE BY SPRINKLING AT A RATE OF 10 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA. COVERED WITH A MINIMUM OF 12 INCHES OF STRIPPINGS OR 100 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA.
4. PERMANENT SEEDING TO BE DONE BY HYDROSEEDING AT A RATE OF 100 LB PER ACRE. STRIPPINGS TO BE COVERED WITH A MINIMUM OF 12 INCHES OF STRIPPINGS OR 100 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA.
5. FERTILIZER FOR THE ESTABLISHMENT OF TEMPORARY AND PERMANENT VEGETATION SHALL BE 10-10-10 APPLIED AT A RATE OF 10 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA. COVERED WITH A MINIMUM OF 12 INCHES OF STRIPPINGS OR 100 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA.
6. IF SEEDING PREVENTS THE ESTABLISHMENT OF A TEMPORARY OR PERMANENT VEGETATION, STRIPPINGS TO BE STABILIZED WITH MULCH AS INDICATED IN NOTES.
7. MULCH TO CONSIST OF SMALL GRASS STRAW OR SALT PILE ANCHORED WITH A MINIMUM OF 12 INCHES OF STRIPPINGS OR 100 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA.
8. IF RECONSTRUCTION PREVENTS THE ESTABLISHMENT OF TEMPORARY OR PERMANENT VEGETATION, STRIPPINGS TO BE STABILIZED WITH MULCH AS INDICATED IN NOTES.
9. ALL SEEDING AREAS SHALL BE COVERED WITH A MINIMUM OF 12 INCHES OF STRIPPINGS OR 100 TONS PER ACRE OR 1000 POUNDS PER 1000 SQUARE FEET OF SURFACE AREA.

STABILIZATION WITH MULCH ONLY STANDARDS

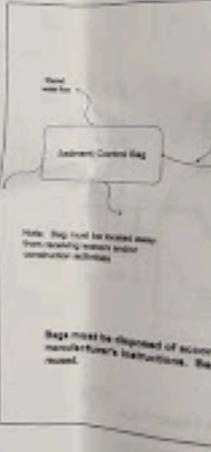
- STABILIZATION WITH MULCH ONLY STANDARDS
1. MULCH SHALL BE APPLIED TO PERMIT THE USE OF CONVENTIONAL EQUIPMENT FOR EXISTING PREPARATION. SEEDING, MULCH APPLICATION, AND STABILIZATION SHALL BE DONE IN ACCORDANCE WITH THE STANDARDS FOR MULCH AND SEEDING, PG. 10-11.
 2. MULCH SHALL BE APPLIED TO PERMIT THE USE OF CONVENTIONAL EQUIPMENT FOR EXISTING PREPARATION. SEEDING, MULCH APPLICATION, AND STABILIZATION SHALL BE DONE IN ACCORDANCE WITH THE STANDARDS FOR MULCH AND SEEDING, PG. 10-11.
 3. MULCH SHALL BE APPLIED TO PERMIT THE USE OF CONVENTIONAL EQUIPMENT FOR EXISTING PREPARATION. SEEDING, MULCH APPLICATION, AND STABILIZATION SHALL BE DONE IN ACCORDANCE WITH THE STANDARDS FOR MULCH AND SEEDING, PG. 10-11.

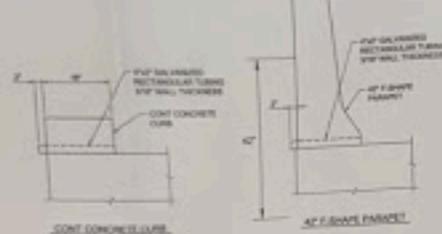
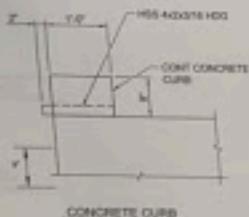


1. TO PERMIT THE USE OF CONVENTIONAL EQUIPMENT FOR EXISTING PREPARATION, SEEDING, MULCH APPLICATION, AND STABILIZATION SHALL BE DONE IN ACCORDANCE WITH THE STANDARDS FOR MULCH AND SEEDING, PG. 10-11.
2. MULCH SHALL BE APPLIED TO PERMIT THE USE OF CONVENTIONAL EQUIPMENT FOR EXISTING PREPARATION. SEEDING, MULCH APPLICATION, AND STABILIZATION SHALL BE DONE IN ACCORDANCE WITH THE STANDARDS FOR MULCH AND SEEDING, PG. 10-11.
3. MULCH SHALL BE APPLIED TO PERMIT THE USE OF CONVENTIONAL EQUIPMENT FOR EXISTING PREPARATION. SEEDING, MULCH APPLICATION, AND STABILIZATION SHALL BE DONE IN ACCORDANCE WITH THE STANDARDS FOR MULCH AND SEEDING, PG. 10-11.

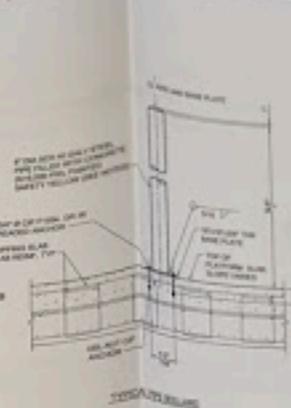
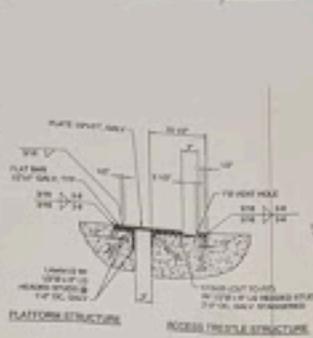
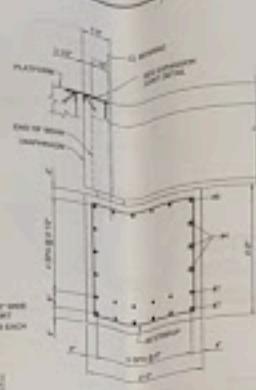
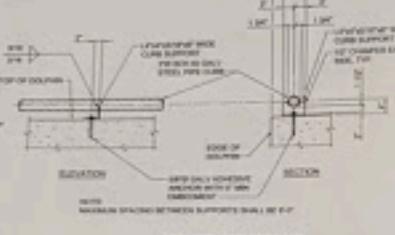
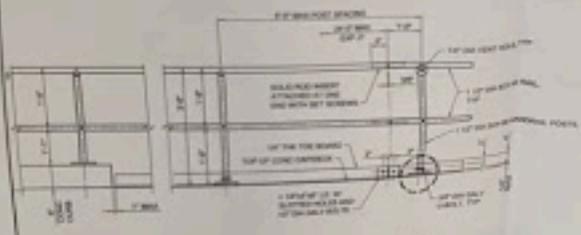
REINFORCED SILT FENCE

- REINFORCED SILT FENCE
1. TO PERMIT THE USE OF CONVENTIONAL EQUIPMENT FOR EXISTING PREPARATION, SEEDING, MULCH APPLICATION, AND STABILIZATION SHALL BE DONE IN ACCORDANCE WITH THE STANDARDS FOR MULCH AND SEEDING, PG. 10-11.
 2. MULCH SHALL BE APPLIED TO PERMIT THE USE OF CONVENTIONAL EQUIPMENT FOR EXISTING PREPARATION. SEEDING, MULCH APPLICATION, AND STABILIZATION SHALL BE DONE IN ACCORDANCE WITH THE STANDARDS FOR MULCH AND SEEDING, PG. 10-11.
 3. MULCH SHALL BE APPLIED TO PERMIT THE USE OF CONVENTIONAL EQUIPMENT FOR EXISTING PREPARATION. SEEDING, MULCH APPLICATION, AND STABILIZATION SHALL BE DONE IN ACCORDANCE WITH THE STANDARDS FOR MULCH AND SEEDING, PG. 10-11.

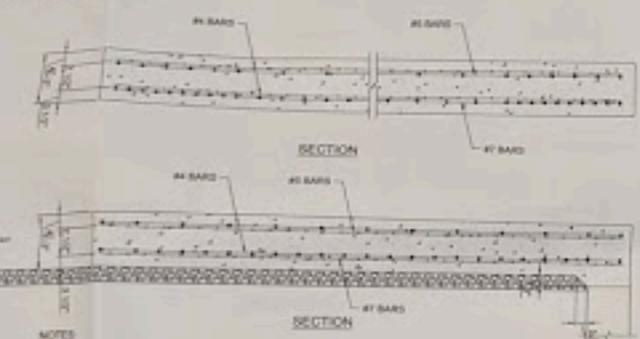




LOADING PLATFORM DRAINAGE SCUPPER

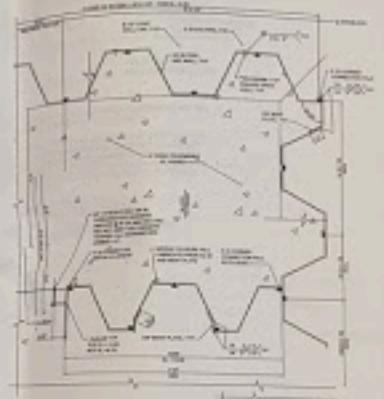


- CRACKING AND SHRINKING NOTES:**
1. REINFORCEMENT WITH LAPS AND ANCHORAGE SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE FOLLOWING: ALL SURFACES OF THE REINFORCED SHALL BE PROTECTED WITH AN OILY COATING FROM CORROSION TO BE DISCONTINUED AT THE FABRICATION.
 2. REINFORCEMENT SHALL BE CONSTRUCTED WITH PROPER SPACING AND WITH PROPER LAPS AND ANCHORAGE. ALL REINFORCEMENT SHALL BE CONSTRUCTED WITH PROPER LAPS AND ANCHORAGE. ALL REINFORCEMENT SHALL BE CONSTRUCTED WITH PROPER LAPS AND ANCHORAGE.
 3. SURFACE REINFORCEMENT SHALL BE CONSTRUCTED WITH PROPER LAPS AND ANCHORAGE. ALL SURFACES OF THE REINFORCED SHALL BE PROTECTED WITH AN OILY COATING FROM CORROSION TO BE DISCONTINUED AT THE FABRICATION.
 4. REINFORCEMENT SHALL BE CONSTRUCTED WITH PROPER LAPS AND ANCHORAGE. ALL SURFACES OF THE REINFORCED SHALL BE PROTECTED WITH AN OILY COATING FROM CORROSION TO BE DISCONTINUED AT THE FABRICATION.
 5. REINFORCEMENT SHALL BE CONSTRUCTED WITH PROPER LAPS AND ANCHORAGE. ALL SURFACES OF THE REINFORCED SHALL BE PROTECTED WITH AN OILY COATING FROM CORROSION TO BE DISCONTINUED AT THE FABRICATION.
 6. REINFORCEMENT SHALL BE CONSTRUCTED WITH PROPER LAPS AND ANCHORAGE. ALL SURFACES OF THE REINFORCED SHALL BE PROTECTED WITH AN OILY COATING FROM CORROSION TO BE DISCONTINUED AT THE FABRICATION.

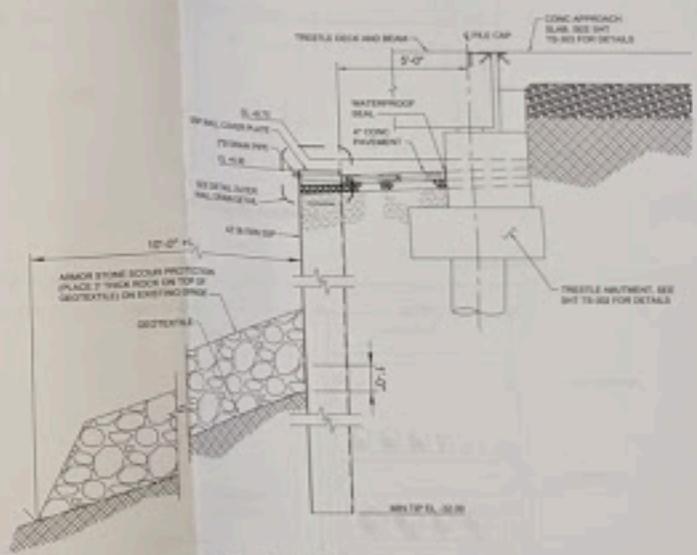


- NOTES:**
1. ENSURE THAT ALL REINFORCEMENT STEEL IS CORROSION PROTECTED.
 2. FINE AGGREGATE BASE MATERIAL WITH 3.5 GAL PER SQ YD LIQUID ASPHALT MATERIAL TYPE 90-10, 90-20, OR 90-25 IF AGGREGATE BASE IS EXPOSED FOR MORE THAN TWO WEEKS.

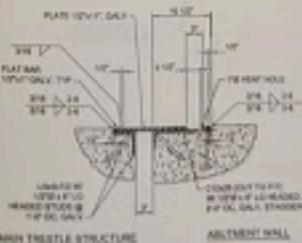
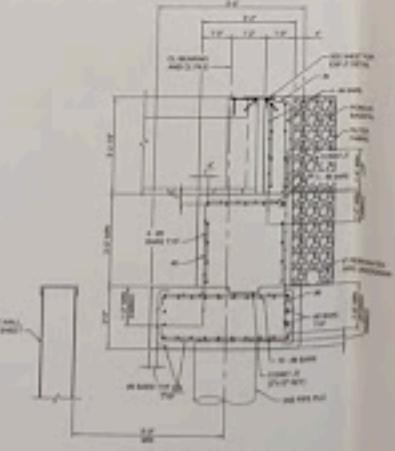
ACCESS TRISLE AND LOADING PLATFORM CONNECTION



- NOTES:**
1. NORTHWEST ABUTMENT CORNER CONNECTIONS ARE SIMILAR, BUT OPPOSITE HAND.



- NOTES:**
1. PAVEMENT SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE FOLLOWING: ALL SURFACES OF THE REINFORCED SHALL BE PROTECTED WITH AN OILY COATING FROM CORROSION TO BE DISCONTINUED AT THE FABRICATION.
 2. PAVEMENT SHALL BE CONSTRUCTED WITH PROPER LAPS AND ANCHORAGE. ALL SURFACES OF THE REINFORCED SHALL BE PROTECTED WITH AN OILY COATING FROM CORROSION TO BE DISCONTINUED AT THE FABRICATION.



- NOTES:**
1. ALL REINFORCEMENT SHALL BE CONSTRUCTED WITH PROPER LAPS AND ANCHORAGE. ALL SURFACES OF THE REINFORCED SHALL BE PROTECTED WITH AN OILY COATING FROM CORROSION TO BE DISCONTINUED AT THE FABRICATION.

REVISIONS

No.	Description	Date
1		

PROFESSIONAL ENGINEER
No. 0000000000

LANGAN
Langan Engineering and
Environmental Services, Inc.
980 Green Drive, Suite 100
Lawrenceville, GA 30046

PROJECT
REPAIR AND RAIL TERMINAL DOCK 1

CONSTRUCTION
DETAILS 1

Project No. 00000000
Sheet No. **CS501-1001**
Drawing No. 00000000
Checked By: [Signature]
Date: [Date]

