DELAWARE RIVERKEEPER NETWORK

Sent via U.S. Postal Service & Email

June 10, 2016

Joseph Buczynski, Waterways and Wetlands Program Manager
Department of Environmental Protection, Northeast Regional Office
2 Public Avenue
Wilkes-Barre, PA 18711

Email: jbuczynski@pa.gov

RE: Proposed State Water Quality Certification Required by Section 401 of the Federal Clean Water Act for the PennEast Pipeline Company, LLC, PennEast Pipeline Project

Note: This comment is being submitted both for purposes of the section 401 water quality certification as well as Chapter 105 review for the proposed PennEast Pipeline. Please ensure all relevant PADEP personnel and files receive a copy of this comment in order to ensure full and fair review in all contexts and please ensure this comment is made part of the official file and record for both reviews.

Dear Mr. Buczynski,

The Delaware Riverkeeper Network is submitting this comment in response to ongoing and/or anticipated review by the Pennsylvania Department of Environmental Protection of the PennEast Pipeline for purposes of section 401 water quality certification as well as Chapter 105 legal mandates. Please ensure all relevant PADEP personnel and files receive a copy of this comment in order to ensure full and fair review in all applicable legal contexts and please be sure this comment is made part of the official file and record for both reviews.

The Delaware Riverkeeper Network objects to the proposed issuance of Section 401 Water Quality Certification to the PennEast Pipeline project.

Pennsylvania Department of Environmental Protection's (PADEP) May 14, 2016 PA Bulletin notice that it intends to issue a Clean Water Act Section 401 water quality certification for the PennEast Pipeline project without analyzing the information necessary to determine the project's compliance with Pennsylvania's water quality standards is demonstrably illegal and flawed.

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The Delaware Riverkeeper Network requests a hearing on the proposal to issue 401 Certification for the PennEast Pipeline project.

According to the public notice included in the May 14, 2016 Pennsylvania Bulletin, the PennEast Pipeline Project, as proposed, will require approximately:

- ✓ 1,574 acres of earth disturbance,
- ✓ impacts to 15,001 linear feet of Deep Creek (CWF, MF), Mill Creek (CWF, MF), Bear Creek (HQ-CWF, MF), Little Shades Creek (HQ-CWF, MF), Shades Creek (HQ-CWF, MF), Stoney Creek (EV, MF), Wild Creek (EV, MF), Aquashicola Creek (HQ-CWF, MF), Indian Creek (CWF, MF), Hokendaqua Creek (CWF, MF), Monocacy Creek (HQ-CWF, MF), Meadow Run (HQ-CWF, MF), Stoney Run (HQ-CWF, MF), Laurel Run (HQ-CWF, MF), Mud Run (HQ-CWF, MF), Bull Run (CWF, MF), Frya Run (HQ-CWF, MF), Delaware River (WWF) and unnamed tributaries; Trout Brook (CWF, MF), Gardner Creek (CWF, MF), Buckwha Creek (CWF, MF), Yellow Run (EV, MF), Delaware Canal; and UNT's to Abrahams Creek (CWF, MF), Toby Creek (CWF, MF), Little Bear Creek (HQ-CWF, MF), Black Creek (HQ-CWF, MF), Pohopoco Creek (CWF, MF), Hunter Creek (HQ-CWF, MF), East Branch Monocacy Creek (HQ-CWF, MF) and Cooks Creek (EV, MF), Hawk Run (HQ-CWF, MF), and White Oak Run (EV, MF) and the Susquehanna River (CWF, MF); Wild Creek/Beltzville Lake (EV, MF), and Pohopoco Creek/Beltzville Lake (CWF, MF),
- ✓ 35.19 acre(s) of floodway,
- ✓ 43.48 acre(s) of temporary PEM/PSS/PFO wetland impacts, and
- ✓ 7.90 acre(s) of PSS/PFO conversion to PEM impacts.

The breadth of harm to be inflicted by the proposed PennEast pipeline on waterways, wetlands, groundwater, habitats, species, people and communities is significant and severe. Therefore we urge the PADEP to hold a series of public hearings in order to secure facts and information necessary to inform your 401 Certification Determination, as well as your reviews for compliance with Chapter 105, Chapter 102 and other relevant regulatory mandates. There is no other entity that will be holding hearings specific to Pennsylvania's environmental regulations and mandates and therefore hearings are appropriate and necessary.

PADEP is failing to comply with legal requirements that it fully review and consider compliance with relevant and applicable Pennsylvania regulations prior to issuing 401 Certification.

In that PADEP is proposing to issue a section 401 water quality certification for the PennEast pipeline prior to evaluating the information standards and requirements identified in Chapter 105.13 and Chapter 105.14 of the Pennsylvania Code, its issuance of the Section 401 water quality certification is unlawful.

According to PA law:

> For structures or activities where water quality certification is required under section 401 of the Clean Water Act (33 U.S.C.A. § 1341), an applicant requesting water quality certification

> under section 401 shall prepare and submit to the Department for review, *an environmental assessment containing the information required by subsection (a)* for every dam, water obstruction or encroachment located in, along, across or projecting into the regulated water of this Commonwealth. (25 Pa. Code § 105.15(b))

Subsection (a) requires:

> the Department will base its evaluation on information required by § 105.13" and "the factors included in § 105.14(b). (25 Pa. Code § 105.15(a))

Clearly, PADEP must base its decision on an application for a Section 401 water quality certification on an environmental assessment that must include the "information" required by Section 105.13, and on the "factors" identified in Section 105.14(b). Because PADEP has determined that PennEast only needs to show compliance with Chapter 105 after the issuance of the section 401 water quality Certification, it is clear that PADEP will not undertake this review in the appropriate sequence. A promise of future review and consideration does not fulfill the requirements of the law and in fact undermines that future review by committing the agency to approving the project in the future rather than allowing it the unfettered ability to consider whether or not the mandates of the law have been met and whether approval, approval with conditions, or denial is the appropriate outcome.

PADEP has not received the information mandated for 401 review.

Under Section 401 of the Clean Water Act, 33 U.S.C. § 1341, States participate in the review of certain activities requiring a federal license or permit if the proposed activities cause "discharges" into navigable waters. Section 401(a) of the Clean Water Act states that an applicant for a "federal license or permit" to construct or operate facilities which "may result in any discharge" into the navigable waters of the United States must seek certification from the "State in which the discharge originates." 33 U.S.C. § 1341(a)(1). A Certificate of Convenience and Public Necessity pursuant to Section 7(c) of the Natural Gas Act issued by the Federal Energy Regulatory Commission (FERC) is a "federal license or permit" for purposes of Section 401 Certification.

The section 401 water quality certification must certify that the discharge, or potential discharge, "will comply with the applicable provisions of sections 1311, 1312, 1313, 1316 and 1317" of the Clean Water Act. 33 U.S.C. § 1341(a)(1). These sections provide for effluent limitations and state water quality standards. The Clean Water Act relies on the States to establish water quality standards that are approved by the United States Environmental Protection Agency. States must first promulgate comprehensive water quality standards, and then obtain U.S. Environmental Protection Agency approval of them. Therefore, in addition to certifying that the provisions of 1311, 1312, 1313, 1316 and 1317 of the Clean Water Act are satisfied, a section 401 water quality certification also explicitly requires project applications to comply with state water quality standards. *See* 33 U.S.C. § 1341(d).

In Pennsylvania, the regulation addressing the specific procedure for obtaining a water quality certification in the state for the purposes of section 401 of the Clean Water Act is 25 Pa. Code §

105.15(b), which was promulgated under the authority of Pennsylvania's Clean Streams Law. *See* 25 Pa. Code § 105.15(b.). This regulation states that:

> For structures or activities where water quality certification is required under section 401 of the Clean Water Act (33 U.S.C.A. § 1341), an applicant requesting water quality certification under section 401 shall prepare and submit to the Department for review, *an environmental assessment containing the information required by subsection (a)* for every dam, water obstruction or encroachment located in, along, across or projecting into the regulated water of this Commonwealth. (25 Pa. Code § 105.15(b) (emphasis added).)

In 1991, Chapter 105 was amended to require an environmental assessment "where a 401 Water Quality Certification is required under section 401 of the Federal Clean Water Act.".

In addition, § 105.15 (a) requires that:

> "the Department will base its evaluation on information required by § 105.13" and "the factors included in § 105.14(b)." 25 Pa. Code § 105.15(a).

Therefore, it is clear that the PADEP must base its decision on any application for a Section 401 Water Quality Certification on an environmental assessment that must include the *information* required by Section 105.13, and on the *criteria* identified in Section 105.14(b).

In Pennsylvania, in order for a section 401 water quality certification review to be conducted and Certification granted, the information specified in PA regulations must be submitted. PennEast has failed to provide PADEP with the information necessary to fulfill the information mandates that are necessary for PADEP to undertake its section 401 water quality certification review. In a letter sent to PennEast on April 26, 2016, PADEP identified 9 items that were missing from the PennEast materials including, in summary:

1. Information about county, multi county, municipal or multi municipal comprehensive plans;
2. Bog Turtle Habitat screening information;
3. Information regarding threatened and endangered species impacts including letters from appropriate agencies/officials demonstrating that potential impacts have been resolved;
4. Information regarding applicable Act 167 Stormwater Plans and compliance therewith;
5. Maps regarding wetland and waterbody crossings;
6. Information on access roads to wetlands and waterbodies being crossed;
7. Information regarding impacts of proposed above ground structures in FEMA delineated floodways;
8. Stormwater, floodplain and flood risk assessment analyses;
9. Demonstration of an estate or interest in submerged lands to be crossed at the Lehigh River and Pohopoco Creek.

Also in a second letter dated April 26, 2016, PADEP determined that PennEast had failed to submit necessary information regarding:

- its E&S plan
- its Post construction stormwater management plan
- Notice of intent requirements

And more.

Without this information PADEP is unable to conduct the review necessary to grant section 401 water quality certification.

PADEP has denied the public its right and opportunity to comment to PADEP in a meaningful way.
Without having secured and made available to the public the full information necessary to support a section 401 water quality certification determination, the public is unable to comment to the PADEP about the appropriateness of 401 Certification in an informed, meaningful and timely way. Therefore the public is being denied its ability and right to comment, and its ability to inform or impact the determination to be made.

PADEP has not undertaken the review necessary to support section 401 water quality certification.
The May 14, 2016 public notice announces DEP's intent to issue a section 401 water quality certification despite not having all of the requisite information required by Pennsylvania regulation, and despite not, prior to issuance of the certification, having applied and considered compliance with all of the criteria required by regulation to determine if the grant or denial of certification is appropriate. The notice specifically states:

> "PADEP anticipates issuing a state water quality certification to Applicant for the Project that will require compliance with the following State water quality permitting programs, criteria and conditions established pursuant to State law to ensure the Project does not violate applicable State water quality standards…."

PADEP is clearly proposing to issue section 401 water quality certification to the PennEast Pipeline prior to reviewing the information and criteria demanded by 25 Pa. Code 105.15(b). In Pennsylvania, a section 401 water quality certification cannot be issued prior to PADEP insuring that a proposed project meets the requirements and criteria outlined in Chapter 105 of the Pennsylvania Code.

There is no procedure in Pennsylvania's water quality standard regulations that authorizes separate review of a section 401 water quality certification without the information contained within the Chapter 105 permits or without a determination that the water quality standards as outlined in PA law will be complied with.

Nowhere in the regulations exists any support for a precursor anticipatory approval process as is being proposed in the PADEP public notice.

PADEP's failure to follow the express provisions outlined in Chapter 105 of the Pennsylvania Code will render its decision unlawful and subject to the same legal challenges already filed by the Delaware Riverkeeper Network in the case of the Leidy Southeast and the Atlantic Sunrise pipelines.

At a minimum, knowing that there is ongoing litigation challenging PADEP's application of its section 401 water quality certification process, PADEP should allow resolution of the outstanding litigation before proposing using the very same legally challenged process in the case of PennEast. (*See Delaware Riverkeeper Network, et al. v. Pennsylvania Department of Environmental Protection, Docket No. 15-2122 (U.S. Court of Appeals for the Third Circuit).)*

PADEP "Cut and Paste" of text further demonstrates its failure to conduct a project specific section 401 water quality certification review.

PADEP has not secured the materials or undertaken the review necessary to consider the clearly significant impacts this project will inflict on the water resources of Pennsylvania to determine if the project could, as proposed or with PADEP mandated modifications, comply with the section 401 water quality certification mandates of the Commonwealth of Pennsylvania. The failure of PADEP to undertake the work and review necessary for legal and proper issuance of section 401 water quality certification is obvious on its face – not only has PADEP, by its own admission, not received all of the documents necessary to conduct its section 401 water quality certification review, but the notice it placed in the PA Bulletin on May 14, 2016 for the PennEast Project was clearly a cut and paste from another project entirely and was not at all based on a project specific review of PennEast. PADEP's notice states:

- "PADEP may suspend or revoke this Certification if it determines that Tennessee Gas Pipeline Company, LLC has not complied with the terms and conditions of this Certification."
- "The FERC Environmental Assessment for the Project, when available, may be viewed on…."

The company(ies) proposing the PennEast Pipeline is not/are not Tennessee Gas Pipeline Company. PennEast is being proposed by the PennEast Pipeline Company, LLC, a collaborative between AGL Resources; NJR Pipeline Company; PSEG Power; SJI Midstream; Spectra Energy Partners; and UGI Energy Services. Tennessee Gas Pipeline Company is not proposing this project.

In addition, FERC long ago determined and made clear that it was not going to prepare an Environmental Assessment for the PennEast Pipeline proposal but was committed to preparing a full Environmental Impact Statement.

It is very clear that PADEP has undertaken no specific review, analysis or consideration necessary to support its proposed section 401 water quality certification for the PennEast Pipeline, it has merely cut and paste text into a public notice from other projects.

PennEast has not provided PADEP with the quality of data necessary for section 401 water quality certification.

PADEP is prohibited from granting section 401 water quality certification based on remote sensing data. Given that so many property owners have refused access PennEast necessarily has failed to fulfill its obligation to submit field verified data to support its application. In addition, the applicant confirms that it did use remote sensing in portions of its application materials. According to the applicant's Environmental Assessment (page 1-23) "*remote sensing modeling and*

National Wetlands Inventory / National Hydrography Dataset data were used to identify wetlands and waterbodies on non-surveyed/no access parcels".

As already anticipated and confirmed by PADEP personnel reviewing the project, this deficiency prevents section 401 water quality certification review or approval.

In the July 13, 2015 Meeting Minutes submitted by PennEast to the FERC Docket it states:

> "PADEP and USACE cannot issue permits on remote-sensed data. Impacts must be field verified. Remote-sensed data will not be reviewed, and it should not be reported in impact tables. It can be submitted as an addendum."

PADEP personnel present at the meeting included:

- Ann Roda, Program Integration Director
- Neal J. Elko, New Source Review Chief
- Joe Buczynski, Waterways and Wetlands Program Manager
- Kevin White, Waterways and Wetlands Environmental Group Manager
- Bharat Patel, Waterways and Wetlands Permitting and Technical Services Chief
- Robert Jevin, Waterways and Wetlands Application Manager
- Don Knorr, Waterways and Wetlands Water Pollution Biologist Supervisor
- Rhonda Manning, River Basin Commission Water Program Specialist

Pennsylvania does not have the information necessary to support a section 401 water quality certification.

Information available demonstrates that construction, operation, and maintenance of the PennEast Pipeline would inflict significant damage and section 401 water quality certification, even based upon the incomplete information available for public review, should be denied.

In order to secure Chapter 105 approval and/or Section 401 Water Quality Certification, § 105.14. (b) requires, among other things, consideration of:

(1) Potential threats to life or property created by the dam, water obstruction or encroachment.
(3) The effect of the dam, water obstruction or encroachment on the property or riparian rights of owners upstream, downstream or adjacent to the project.
(4) The effect of the dam, water obstruction or encroachment on regimen and ecology of the watercourse or other body of water, water quality, stream flow, fish and wildlife, aquatic habitat, instream and downstream uses and other significant environmental factors.
(5) The impacts of the dam, water obstruction or encroachment on nearby natural areas, wildlife sanctuaries, public water supplies, other geographical or physical features including cultural, archaeological and historical landmarks, National wildlife refuges, National natural landmarks, National, State or local parks or recreation areas or National, State or local historical sites.
(6) Compliance by the dam, water obstruction or encroachment with applicable laws administered by the Department, the Fish and Boat Commission and river basin commissions created by interstate compact.

(7) The extent to which a project is water dependent and thereby requires access or proximity to or siting within water to fulfill the basic purposes of the project. ….
(8) Present conditions and the effects of reasonably foreseeable future development within the affected watershed upstream and downstream of the dam, water obstruction or encroachment ….
(9) Consistency with State and local floodplain and stormwater management programs, the State Water Plan and the Coastal Zone Management Plan.
(10) Consistency with the designations of wild, scenic and recreational streams under the Wild and Scenic Rivers Act of 1968 (16 U.S.C.A. § § 1271—1287) or the Pennsylvania Scenic Rivers Act (32 P. S. § § 820.21—820.29), including identified 1-A candidates.
(11) Consistency with State antidegradation requirements contained in Chapters 93, 95 and 102 (relating to water quality standards; wastewater treatment requirements; and erosion and sediment control) and the Clean Water Act (33 U.S.C.A. § § 1251—1376).
(12) Secondary impacts associated with but not the direct result of the construction or substantial modification of the dam or reservoir, water obstruction or encroachment in the area of the project and in areas adjacent thereto and future impacts associated with dams, water obstructions or encroachments, the construction of which would result in the need for additional dams, water obstructions or encroachments to fulfill the project purpose.
(13) For dams, water obstructions or encroachments in, along, across or projecting into a wetland, as defined in § 105.1 (relating to definitions), the Department will also consider the impact on the wetlands values and functions in making a determination of adverse impact.
(14) The cumulative impact of this project and other potential or existing projects. In evaluating the cumulative impact, the Department will consider whether numerous piecemeal changes may result in a major impairment of the wetland resources. The Department will evaluate a particular wetland site for which an application is made with the recognition that it is part of a complete and interrelated wetland area.

Pipelines using the construction techniques proposed by PennEast, inflict stream, wetland, water quality and groundwater degradation contrary to the above criteria that guide Chapter 105 and 401 Certification decisionmaking. PADEP's 401 Certification analysis does not consider or address these many pathways of degradation nor determine that this degradation will not result in violation of Pennsylvania's water quality standards and applicable review criteria. Given the size and length of the proposed PennEast pipeline and the construction strategies and techniques to be used, and the size of the footprint to be inflicted temporarily and permanently, 401 Certification cannot be justified when reviewed against § 105.14. (b) and the various standards it incorporates.

Expert review of PennEast materials submitted for 401 Certification reveal:
"The application documents outline the aquifers, soils, vegetation, and natural recharge (RR2, RR3, and RR6) but does not consider the impacts that pipeline construction and operation would have on them and the ultimate effect on streams and wetlands, in violation of the relevant requirements (25 Pa. Code § 105.15(e)(1)(x))."[1]

[1] See T. Myers Technical Memorandum, June 2016

Construction of the PennEast Pipeline will bring demonstrable threats and harms to life, property, property rights and riparian rights.

The PennEast pipeline is a significant danger to human life and property. Pipelines are a serious source of human harm and property damage. Between 1986 and 2012, "pipeline accidents have killed more than 500 people, injured over 4,000, and cost nearly seven billion dollars in property damages."[2] Looking at this 28 year period, on average pipelines kill or injure 173 people a year causing over $269 million a year ($269,230,769) in property damage.

According to the Pipeline and Hazardous Materials Safety Administration[3], in the most recent six years found on PHMSA's data portal for gas transmission lines (onshore) there have been over 100 fatalities or injuries requiring hospitalization and over $880 million in damage as the result of 622 pipeline incidents. When explosions happen, the harm to people, property and the environment can be severe and costly. And the risk of accident, incident and harm is increasing. In addition to the actual physical harm that happens when there is an accident or incident, there is the ongoing psychological burden inflicted by the fear of accident, incident or explosion for those who are forced to live next to a gas pipeline, including those who are forced to live with a pipeline because of the power of eminent domain exercised by a pipeline company.

And the hazards of pipelines for human safety and property damage is increasing. According to a report by Pipeline Safety Trust, "The gas transmission lines installed in the 2010s had an annual average incident rate of 6.64 per 10,000 miles over the time frame considered, even exceeding that of the pre-1940s pipes. Those installed prior to 1940 or at unknown dates had an incident rate of 6.08 per 10,000 miles." [4]

In addition, a significant health, safety, property and environmental risk associated with both wet and dry trench methods of gas pipeline crossings of rivers and streams is the potential of releasing hydrocarbons or other contaminants directly into surface water and fragile downstream ecosystems, including hydro-carbon laced liquids such as benzene that are part of the gas being delivered by the pipeline. Pipelines are known to rupture as the result of scour from high flow and flood events, and when they rupture the impacts are severe. The PennEast pipeline is proposing to cross over 1,500 linear feet of waterway in the Commonwealth of Pennsylvania, mostly through open cut methods. This means there will be over 1,500 linear feet of waterways with the PennEast pipeline buried in their bed bringing the real potential of scour and rupture releasing dangerous chemicals into our waterways and on nearby and downstream properties and their owners.

Because open trench pipeline installations may unnaturally alter both stream bank and streambed (i.e., channel) stability, there is an increased likelihood of scouring within backfilled pipeline trenches. This is because open trenches themselves, when backfilled, may not be compacted to stable pre-trench sediment permeability conditions. Flooding rivers can scour river bottoms and expose pipelines to powerful water currents and damaging debris. Additionally, unusually heavy

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[2] ProPublica, *Pipelines Explained: How Safe are America's 2.5 Million Miles of Pipelines?*
[3] https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?Portalpages
[4] https://www.snl.com/InteractiveX/Article.aspx?cdid=A-33791090-11060

rains including those associated with climate change, threaten to increase overall stream degradation and channel migration – thereby exposing shallowly buried pipelines.

Scour hole development proximal to pipelines is well-documented in both stream and seabed settings.[5] Stream-based pipe "*(f)ailures [have been] caused not only by vertical scour of the streambed but also by bank erosion, lateral channel migration, avulsions, bridge scour, and secondary flows outside the main channel. … Several of the pipelines in [a] study failed as a result of a meander migration or avulsion of the stream into previously less active or nonexistent channels*." [6] Based on field observations and hydraulic modeling for the 100-year design flood, researchers documented maximum vertical scour to 26.6 feet (8.1 meters) and lateral scour to 6,274 feet (2,050 meters) at some failed pipeline crossings.

An expert at HydroQuest[7] has determined that, at a minimum, any pipeline installed using the open trench cut method needs to be installed at least 24 feet below the stream bed in order to prevent exposure from scour.[8] While bridge piers are more readily exposed to stream scouring than pipelines, it is telling that bridge failure analyses have determined that channel scour occurs to depths of up to three times that of maximum river floodwater depth (e.g., scour to 30 feet with a 10 foot floodwater depth).

One of the benefits of living next to a stream or other natural body of water is the increased property value those riparian rights bring as well as the recreational and quality of life benefits that can be enjoyed. But the cut of a pipeline diminishes all of these rights and benefits of living near a waterway. Property values are demonstrably harmed by the presence of a pipeline.[9] Aesthetic qualities, ecological health of a stream and instream populations such as fish are diminished due to a pipeline's stream cuts and permanent loss of riparian vegetation essential for healthy riparian and instream habitat. Ecological and aesthetic harm translates into diminished recreational enjoyment and opportunities as well as a diminished ability to enjoy the environment and one's property.

Information on the record demonstrates that construction of the PennEast Pipeline will have significant adverse impacts on the regimen and ecology of the watercourses and waterways it cuts through and/or under; as well as adverse impacts on water quality, stream flow, fish and wildlife, aquatic habitat, instream and downstream uses as well as other significant environmental factors regardless of mitigation techniques used, and that PADEP has not conducted the investigations or reviews of impacts, nor had the full information necessary to

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[5] Fogg, J. and Hadley, H., 2007, Hydraulic Considerations for Pipelines Crossing Stream Channels. Technical Note 423. BLM/ST/ST-07/007+2880. U.S. Department of the Interior, Bureau of Land Management, National Science and Technology Center, Denver, CO. 20 pp. http://www.blm.gov/nstc/library/techno2.htm.

[6] Doeing, B.J., Williams, D.T. and Bradley, J.B., 1997, Gas Pipeline Erosion Failures: January 1993 Floods, Gila River Basin, Arizona. In Storm - Induced Geologic Hazards, Case Histories from the 1992 - 1993 Winter in Southern California and Arizona; Geological Society of America; Reviews in Engineering Geology, Volume XI (ed. Robert A. Larson).

[7] HydroQuest Memorandum re: Hydrologic and Environmental Rationale to Bury Gas Pipelines using Horizontal Directional Drilling Technology at Stream and River Crossings, 6/8/2012 (Hereafter HydroQuest Report)

[8] HydroQuest Report.

[9] *See e.g.* Review of INGAA Foundation Report, "Pipeline Impact to Property Value and Property Insurability", Key Log Economics 3/11/2015

conduct the investigations or reviews, mandated by section 401 water quality certification or Chapter 105 regulatory requirements.

The list of impacts to stream quality and health includes, but is not limited to: erosion and sedimentation, loss of riparian vegetation, habitat loss and fragmentation, air quality impacts, safety concerns, groundwater impacts, soil compaction, increased stormwater runoff, wetland degradation, lost groundwater recharge, and cumulative environmental impacts along the length of the project. These impacts to the environment are not limited to the time period in which the right-of-way is disturbed, but can result in long lasting consequences. To the degree PADEP has or anticipates considering these issues it does so piecemeal, stream by stream or wetland by wetland, but does not give the cumulative and/or ecological system review that the regulations envision. A cut here or there perhaps can be mitigated, but the huge multitude of cuts, mass areas of compacted soils, thousands of acres of earth disturbance and lost trees etc., cannot be remedied and will have unavoidable impacts. In the case of PennEast we are talking about a massive greenfields project with a wide geographic and physical footprint that directly and indirectly impacts a huge number of ecological systems – the cumulative impacts is significant and long lasting and yet is largely ignored by the PennEast application and as such is not properly available for DEP review.

Cumulative Impacts Across the PennEast Project:
There are a tremendous number of streams, wetlands, forests and lands that will be cut by PennEast, including (but not limited to as we will be providing information and evidence that PennEast as under-represented the ecological harms and footprint of the project):

- ✓ 1,574 acres of earth disturbance,
- ✓ impacts to 15,001 linear feet of Deep Creek (CWF, MF), Mill Creek (CWF, MF), Bear Creek (HQ-CWF, MF), Little Shades Creek (HQ-CWF, MF), Shades Creek (HQ-CWF, MF), Stoney Creek (EV, MF), Wild Creek (EV, MF), Aquashicola Creek (HQ-CWF, MF), Indian Creek (CWF, MF), Hokendaqua Creek (CWF, MF), Monocacy Creek (HQ-CWF, MF), Meadow Run (HQ-CWF, MF), Stoney Run (HQ-CWF, MF), Laurel Run (HQ-CWF, MF), Mud Run (HQ-CWF, MF), Bull Run (CWF, MF), Frya Run (HQ-CWF, MF), Delaware River (WWF) and unnamed tributaries; Trout Brook (CWF, MF), Gardner Creek (CWF, MF), Buckwha Creek (CWF, MF), Yellow Run (EV, MF), Delaware Canal; and UNT's to Abrahams Creek (CWF, MF), Toby Creek (CWF, MF), Little Bear Creek (HQ-CWF, MF), Black Creek (HQ-CWF, MF), Pohopoco Creek (CWF, MF), Hunter Creek (HQ-CWF, MF), East Branch Monocacy Creek (HQ-CWF, MF) and Cooks Creek (EV, MF), Hawk Run (HQ-CWF, MF), and White Oak Run (EV, MF) and the Susquehanna River (CWF, MF); Wild Creek/Beltzville Lake (EV, MF), and Pohopoco Creek/Beltzville Lake (CWF, MF),
- ✓ 35.19 acre(s) of floodway,
- ✓ 43.48 acre(s) of temporary PEM/PSS/PFO wetland impacts, and
- ✓ 7.90 acre(s) of PSS/PFO conversion to PEM impacts.

PADEP needs to consider acute, long-term and cumulative impacts of the proposed pipeline in order to support section 401 water quality certification and/or Chapter 105 decisionmaking.

"The acute impacts are largely a function of construction related activities. The acute impacts

will result directly from the clearing of forests, crossing/filling of streams, draining/altering of wetlands and riparian areas, and other pronounced changes to the waterways and landscape of the Delaware River basin." [10]

"The long-term impacts can be even more threatening than the acute impacts as they affect the ecological services and functions of the various ecosystems of the Delaware River watershed that will be compromised during and following the construction of the pipeline and its ROW. Some of these impacts are triggered by the acute short-term impacts of the project and some are associated with the pipelines long-term operation and maintenance. These long-term impacts are linked to the fragmentation of habitat, reduction in water quality, alteration of land cover, changes in the watershed's hydrologic and hydraulic properties, increased water temperatures, introduction of invasive species, creation of "edge habitat", lost or altered spawning and breeding habitat and changes in the amount and quality of stormwater runoff discharged to the Delaware River and its tributaries." [11]

PADEP fails to consider the acute, the long-term or the the cumulative impacts of the PennEast pipeline as is required for section 401 water quality certification. In addition to reviewing cumulative impacts across the PennEast pipeline, there must also be consideration of cumulative impacts across the multitude of pipelines crossed, crossing, or anticipated to cross the same watersheds.

"….once the pipeline is constructed the resulting long-term impacts to the overall ecological properties of the affected lands and water resources are irreversible and cannot be mitigated." [12] As such, review of the impacts must be considered prior to issuing section 401 water quality certification, in order to ensure that the mandates of section 401 water quality certification and/or the Chapter 105 regulations can in fact be achieved. Once section 401 water quality certification is issued, there may be a question as to whether or not it can be withdrawn, as such PADEP needs to ensure all applicable regulatory requirements and standards can be met prior to issuance.

Historically, PADEP review has been primarily focused on each stream cut, each floodplain or forest footprint, each individual wetland cut through or under, but fails to consider the interconnected effects of the various cuts and impacts. PADEP's short shrift nod to a true cumulative impacts analysis fails to fulfill the requirements for cumulative impact review under the applicable regulations.

Impacts which need to be considered cumulatively along the length of the PennEast Pipeline and cumulatively across the many pipelines passed, passing, or anticipated to pass through this same impacted region with future pipeline expansions and which must be considered as part of PADEP's review include, but are not limited to:

- Sediment pollution,

[10] *The Short and Long-Term Consequences of the Construction of the PennEast Pipeline– A White Paper*, Princeton Hydro, LLC (hereafter Princeton Hydro White Paper)

[11] Princeton Hydro White Paper
[12] Princeton Hydro White Paper

- Erosion,
- Loss of macroinvertebrate and fish spawning habitats,
- Impacts to wildlife,
- Adverse effects to wetlands, marshes and vernal pools including alteration of vegetation and increased algae growth due to sediment disturbance,
- Permanent removal of riparian and upland vegetation,
- Loss of forest, forest fragmentation, changes in forest ecology and increased edge effect,
- Soil compaction,
- Increased surface water runoff,
- Reduced groundwater recharge,
- Reduced nutrient cycling capacity and increased algae growth,
- Release of hydrocarbs from heavy equipment leaks and re-fueling,
- Thermal impacts,
- Redirection of groundwater and surface water flows,
- Release of drilling muds,
- Creation of sinkholes,
- Air pollution resulting from methane and other air contaminants,
- Failure of remediation/mitigation efforts including efforts to revegetate construction zones,
- Increased acidification of streams from methane pollution and construction equipment and potential decreased buffering capacity of waterbodies,
- Impacts to recreation, aesthetics, property values and property rights,
- Impacts to health, safety and the environment.

The attached expert report by Princeton Hydro addresses the importance of reviewing long-term impacts, as well as the cumulative impacts – this kind of analysis is important to section 401 water quality certification and Chapter 105 review and has not been performed.

Cumulative Impacts Across Projects

In addition to looking at cumulative impacts across the length of the PennEast project, PADEP is required to examine cumulative impacts across multiple projects, those related and connected to PennEast as well as those impacting the same resources and region as PennEast.

> "The cumulative impacts arise due to the accumulation and synergistic affects of harms across the length of the proposed project, as well as the accumulative and synergistic impact of the proposed pipeline with other past and future pipeline and power transmission projects occurring in the same general region and affecting the same environments as the PennEast Pipeline. Each of the projects has caused, or will cause, similar alterations and impacts to the upland, water, riparian and wetland resources of the Delaware River and its tributaries that have a compounding affect which magnifies the damage inflicted by any one individually."[13]

These cumulative impacts have not been considered by PADEP as necessary to support section

[13] Princeton Hydro White Paper

401 water quality certification.

As noted in the attached comment from the Delaware Riverkeeper Network dated June 3, 2016, it is clear that the footprint of the PennEast pipeline within Pennsylvania is larger than captured by the PennEast submittal. Spectra's Texas Eastern Marcellus to Market project and its Greater Philadelphia Expansion project are clearly part and parcel of the PennEast pipeline footprint and plan that must be fully evaluated under PADEP's cumulative impacts analysis. In addition, there needs to be a delving into any associated export from Philadelphia ports that are already under discussion and associated with these pipelines.

Additionally, PADEP should examine the cumulative impact of the multiple utility and other linear projects that are being proposed or constructed in the Delaware River watershed in the vicinity of the project. For example, there are significant concerns related to the cumulative impacts of the continuous water crossings and wetlands disturbance that pipeline construction activity has on the health and vitality of the Delaware River basin and its tributaries. This is particularly a concern with the PennEast Pipeline, as many of the same subwatersheds subject to development as a result of PennEast were recently, or could be in the future, impacted by construction activity from other pipelines.

Among the pipeline projects that are, will, or have impacted the same subwatersheds as PennEast, are Transco's Leidy line system upgrade projects which include the Northeast Supply Link project, the Southeast Leidy Expansion project and the Atlantic Sunrise project. These projects all upgrade portions of Transco's Leidy line system, which parallels PennEast's proposed project. In addition to the Transco's previous and proposed pipeline projects, there are several other pipeline projects that have been concentrated in the same sub watersheds as the PennEast line, such as: Texas Eastern's TEAM 2014 Project and Columbia's East Side Expansion Project. These projects do not occur in a vacuum. Each project individually depletes the natural and scenic resources of the region, and the combined impact becomes increasingly more severe, unavoidable, unmitigatable, and irreversible. As such, PADEP is required to carefully examine the cumulative impacts of these projects along with the proposed PennEast pipeline.

Furthermore, by creating an entirely new ROW for this Project PennEast is creating a new industrial corridor that will foreseeably be used in the future by the PennEast pipeline company for upgrades. A quick review of other major pipeline corridors in the region support this assertion as natural gas pipeline operators including Columbia, Tennessee Gas Pipeline, Texas Eastern, Millennium and Transcontinental have all within the last three years added looping segments to their pipelines and in some cases additional compression as well. As such, PADEP's section 401 water quality certification and Chapter 105 reviews must account for the potential expansion of the PennEast right of way to accommodate future upgrades, including the addition of expansion loops, compressor stations and above ground apertures.

Water Quality

There are a variety of threats to water quality that will result from the PennEast pipeline, including from construction, operation, and maintenance.

Among the deficiencies of PADEP's review and PennEast's materials to support section 401 water quality certification and Chapter 105 review is the failure to consider the threat of arsenic contamination from mine-impacted soils. As discussed in the attached report by Tom Myers, the section 401 water quality certification and Chapter 105 application, along with DEP's proposed approval of section 401 water quality certification, are submitted/released prematurely as the study to determine the threat of arsenic contamination was not even designed let alone implemented.

Arsenic has also been an identified threat for the Bucks County area where PennEast is proposing to cut and cross. That water quality threat, discussed in the attached powerpoint slides prepared by Dr. Julia Barringer, has also been unaddressed despite its impact on the ability of the project to meet regulatory standards.

In addition, the PADEP review and PennEast materials do not give necessary review to the issue of karst geology and its implications for water quality and ability to meet state standards.

Furthermore: PennEast's application and PADEP's review proposing to grant section 401 water quality certification and later grant Chapter 105 and associated approvals, "d[oes] not consider how pipeline construction and operations could affect recharge and shallow groundwater flow in aquifers near the proposed pipeline. Areas where the pipeline compacts soils over critical recharge areas, especially on ridge tops and valley bottoms, would increase runoff and decrease recharge. …. [R]echarge supports baseflow therefore decreasing recharge will affect baseflow in streams. Most importantly groundwater discharge would be decreased during low flow periods."[14] A decrease in baseflow has implications for water quality as well as stream and habitat health. The attached expert report from Tom Myers provides detailed discussion of this impact.

The section 401 water quality certification review and materials fail to consider the potential transport of contaminants via preferential pathways – the emphasis in this regard by PennEast and the agency has largely been on mitigation and mapping, neither of which would prevent the violation of state standards necessary to support section 401 water quality certification or Chapter 105 permitting.

Sediment Pollution

Studies documenting the effects of stream crossing construction on aquatic ecosystems identify sediment as a primary stressor for construction on river and stream ecosystems.[15] During the construction of pipeline stream crossings, discrete peaks of high suspended sediment concentration occur due to blasting, trench excavation, and backfilling.[16] Excavation of streambeds can generate persistent plumes of sediment concentration and turbidity.[17] This sedimentation has serious consequences for the benthic invertebrates and fish species whose vitality is crucial for healthy aquatic ecosystems. There have been documented reductions in

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[14] See Technical Report by Tom Myers, June 2016

[15] Scott Read, *Effects of Sediment Released During Open-cut Pipeline Water Crossings,* Canadian Water Resources Journal, 1999, 24: (3) 235-251.

[16] *Id.*

[17] *Id.*

benthic invertebrate densities, changes to the structure of aquatic communities, changes in fish foraging behavior, reductions in the availability of food, and increases in fish egg mortality rates.[18] In addition to the stream crossing construction activity itself, the associated new road construction increases the risk of erosion and sedimentation.[19]

There are numerous environmental risks associated with open trench burial of gas pipelines (wet, dry, slurry). Open trench burial involves the excavation of sediments for pipeline installation perpendicular to or across streams and their sometimes wide floodplains, along with removal of vegetation and well-established ecosystems. Disruption of the stream channel and banks can cause destabilization of the stream's natural flows, causing channel migration and erosion that are harmful to the stream. [20] The open trench cut method of crossing streams results in sedimentation, impacts to benthic habitat, and can result in changes to stream morphology that can further affect downstream habitats.[21]

Sedimentation results from the actual crossing activity itself as well as the removal of vegetation and activity that takes place on the stream-adjacent (riparian) lands. While dam and pump methods, can reduce sediment loadings associated with a wet cut method, there are still sediment releases at levels of concern and impact, and the diversion of the water creates impediments to fish and flows that also have impacts on waterways. Additionally, this method of crossing takes longer, and so it results in longer-term direct impacts to the stream and sediment releases over a prolonged period.

Sediment carried in the water column is abrasive and can result in increased erosion downstream.[22] Deposited sediment from construction activities can fill in the interstitial spaces of the streambed, changing its porosity and composition, and thereby increasing embeddedness and reducing riffle area and habitat quality.[23] Furthermore, deposited sediment has the potential to fill in pool areas and reduce stream depth downstream of the construction area.[24]

Sediment pollution is a known and demonstrated impact (further discussion below) that needs serious consideration for a project of the size and magnitude of PennEast, consideration that has not been provided prior to the proposed section 401 water quality certification.

Impacts to Benthic Invertebrates, Fish Communities, Aquatic Ecosystems, Wildlife

Benthic invertebrates can have higher drift rates during stream crossing construction and reduced densities following open trench cut methods of crossing. Reduced densities can be the result of both the higher drift and the increased sedimentation that affects suitability of habitat resulting

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[18] Norman, *supra* note 12, at 9-10.
[19] *En Banc* Hearing of the Pennsylvania Public Utility Commission on Jurisdictional Issues Related to Marcellus Shale Gas Development, Docket No. I-2010-2163461.
[20] Expert Report from HydroQuest, attached.
[21] See Effects of Sediments Released During Open-Cut Pipeline Water Crossings, Canadian Water Resources Journal, Vol. 24, No. 3, 1999.
[22] Pipeline Associated Watercourse Crossings, 3rd Edition, publication prepared for CAPP, CEPA, and CGA by Tera Environmental Consultants
[23] Read, *supra* note 22, at 235-251.
[24] Norman, *supra* note 12, at 9-10.

from the pipeline installation.[25] Changes in downstream diversity and structure of benthic invertebrate communities can also result. While, in time, the benthic community generally restores, that does not diminish or negate the ecosystem affects during the time of damage including the other cascading affects to other ecosystem services otherwise provided by the invertebrates – including as food for other dependent species, the water quality benefits provided by invertebrates helping with nutrient breakdown, and the breakdown of instream detritus creating food for other species.[26]

Using the open trench cut method of crossing can also affect fish, including direct harm but also by reducing the suitability of habitat including for eggs, juveniles and overwintering.[27] Fish exposed to elevated suspended solids levels can experience reduced feeding rates, physical discomfort or damage from the abrasive materials on their gills, decreased instream visibility, reduced food supply, and increased competition as fish attempt to move to cleaner waters.[28] Many of the streams to be cut by the pipeline are designated Class A or wild trout streams which are an important natural and recreational resource for the state – as such many of these streams with native trout have EV wetlands hydrologically connected to their flow.

The filling of riffles not only can have adverse impacts for invertebrates and fish, in terms of taking important habitat, but it can also diminish the ability of the riffles to help create oxygen important for aquatic life.[29] Over time these impacts can depress the immune system of fish, result in lower growth rates, result in increased stress on individuals and populations, cause damage to the gills – all of which can result in a decline in fish and population health and survival rates.[30] This of course all gets compounded by adverse effects to the suitability of habitat for eggs and juveniles necessary to support the overall community and population.[31] Additionally, downstream sedimentation and also disruption of flows during crossing activities can result in areas of the stream that are shallower or dewatered, thereby taking preferred habitat.[32]

"Pipeline construction could affect hydrology in ways that could affect vegetation or aquatic life, in addition to the simple construction impacts. The application does not analyze how the pipeline would affect any specific area with important vegetation types or aquatic species. There are broad statements about temporary impacts during construction, but there no analysis of the change in groundwater flow patterns as described herein."[33]

In addition to the failure of application materials to consider these effects, given that the proposed section 401 water quality certification promises a future review of regulatory standards rather

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[25] Ibid 1.
[26] See e.g. Sweeney, B. W., et al. 2004. Riparian deforestation, stream narrowing, and loss of stream ecosystem services, PNAS, September 2004; 101: 14132-14137.
[27] Ibid 1.
[28] Pipeline Associated Watercourse Crossings, 3rd Edition, publication prepared for CAPP, CEPA, and CGA by Tera Environmental Consultants
[29] Ibid 1.
[30] Ibid 1.
[31] Ibid 1.
[32] Ibid 1.
[33] Technical Report, Tom Myers, June 2016

than a current one, PADEP has also not considered these impacts as is required to support section 401 water quality certification.

Impacts to aquatic life and wildlife are discussed throughout the expert reports attached and are the result of the many impacts discussed in this cover comment as well.

Riparian Forest Impacts

Pipeline construction results in the loss of riparian (streamside) vegetation.[34] For each of the pipeline construction techniques there is a resulting loss of vegetation and foliage associated with clearing the stream banks. Riparian vegetation is an important part of a healthy ecosystem and protects the land adjoining a waterway which in turn directly affects water quality, water quantity, and stream ecosystem health.

Riparian corridors protect and restore the functionality and integrity of streams. A reduction in healthy and mature streamside vegetation reduces stream shading, increases stream temperature and reduces its suitability for incubation, rearing, foraging and escape habitat.[35] While horizontal directional drilling may move the construction footprint further away from the stream, it too results in vegetative losses and soil compaction that can have direct stream impacts. The body of scientific research indicates that stream buffers, particularly those dominated by woody vegetation that are a minimum 100 feet wide, are instrumental in providing numerous ecological and socioeconomic benefits. [36]

The loss of vegetation also makes the stream more susceptible to erosion events, exacerbating the sedimentation impacts of construction. In crossings that result in open forest canopies, increases in channel width, reduced water depth, and reduced meanders have persisted in the years after using an open cut method of installation.[37]

In addition, according to Princeton Hydro speaking directly to the PennEast Pipeline project and the streams targeted for crossing:

> "Clearing of the forest canopy and vegetation growing adjacent to these streams alters their thermal properties and nutrient and sediment loading dynamics thereby threatening their ability to sustain a trout fishery. These changes to the adjacent stream corridors can also affect the food chain dynamics of the system by altering the composition of the benthic and aquatic insect communities and increasing the propensity for algae blooms."[38]

Loss of Vegetation and Soil Compaction

The destruction of forest, including riparian habitat, results in increased stormwater runoff to neighboring streams and wetlands. In addition, the construction of the project will result in soil compaction, which based on testing, experience and review of proposed project documents will

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[34] Norman, *supra* note 12, at 8.
[35] CAPP (2005), *supra* note 16, at 1-4.
[36] See e.g. Newbold et al. 1980, Welsch 1991, Sweeney 1992, Sweeney and Newbold 2014
[37] Ibid 1.
[38] *The Short and Long-Term Consequences of the Construction of the PennEast Pipeline– A White Paper*, Princeton Hydro, LLC

not be properly mitigation, and as a result will result in increased stormwater runoff and prevent vegetation regrowth, both of which will have stream and groundwater impacts.

> "Heavy equipment used in the construction of the pipeline will inherently compact work areas to depths deeper than conventional surface tilling will reach. These lasting impacts include increased runoff to streams and wetlands due to a reduction in infiltration capacity and difficulty in reestablishing vegetation. Infiltration capacity becomes limited when soils lose their porosity and soil structure, resulting in increased runoff volumes to streams. Excessive runoff changes stream geomorphology due to an increase in both volume and velocity. Streambanks and riparian areas are impacted by changes to the stream channel due to the increases in peak flow volume and rate. Streams with more flow also have higher energy. More energy means more in-stream erosion and sediment transport. Compaction also creates conditions where bulk densities of soils are so high that the soils inhibit the germination of plants and plant root growth. The establishment of vegetative cover within the pipeline ROW will be more difficult once surface soils are compacted. If vegetation regrowth is limited within both the temporary and permanent ROW, the likelihood of accelerated erosion will be increased." [39]

Additionally, when a pipeline cuts its path through a forest there are impacts in the direct footprint of the right of way (ROW) of the pipeline as well as impacts 300 feet into the forest on either side of the ROW.[40] Therefore, damage to the forest ecosystem for a 1 mile section of a 50 foot wide pipeline ROW will directly impact 6 acres of forest, and it will damage an additional 72 acres of adjacent forest by transforming it from interior habitat to that of forest edge habitat[41] (i.e. an additional 300 feet of forest on either side of the ROW is impacted). This means that when a forest cut is made, for every 1 mile of pipeline (assuming a 50 foot ROW as PennEast has asserted it will primarily rely upon) at least 78 acres of forest habitat are impacted. In areas with a construction footprint that is wider, the impacts are, of course, greater. Temporary and additional temporary work spaces used by the pipeline company also need to be included in this harm since they are so abundant throughout the area of the pipeline and are often located near sensitive habitats, streams and wetlands.

The additional runoff and permanent loss of vegetation can contribute to erosion, higher damaging peak flows, habitat impacts/loss, loss of shade for protecting stream temperatures, and direct contributions of pollution particularly from pipeline rights of way where herbicides have been used to keep vegetation down. Even in temporary rights of way where, post construction, conditions are supposed to restore both in terms of soil compaction and vegetation, compacted soils and denuded landscapes can and do persist.

After reviewing the impacts of the Tennessee Gas Pipeline Company's construction of the 300 line, engineering expert Michelle Adams determined:

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[39] Memorandum from Meliora Design *re:* Proposed State Water Quality Certification – PennEast Pipeline Project, June 9, 2016 (hereafter Meliora Design Memorandum)

[40] Cara Lee, Brad Stratton, Rebecca Shirer, Ellen Weiss, *An Assessment of the Potential Impacts of High Volume Hydraulic Fracturing (HVHF) on Forest Resources*, The Nature Conservancy, Dec. 19, 2011.

[41] Nels Johnson, et al., Natural Gas Pipelines, The Nature Conservancy, 1 (December 2011).

> "It is my opinion, given with a reasonable degree of scientific and engineering certainty, that the conditions created as a result of the completed 300 Line Upgrade construction have resulted in significant and permanent increases in stormwater runoff volumes, rates, pollutant discharges, and frequencies of discharge, and a corresponding decrease in infiltration volumes. As a result, existing streams and wetlands, including exceptional value streams, have been adversely impacted by stormwater discharges and the discharge of sediment. "[42]

There is every reason to believe that the same impacts which resulted from the TGP 300 pipeline, using the same and similar construction practices as proposed for PennEast, will result here.

In this regard too, PennEast and PADEP have not undertaken the data collection, review or planning necessary to support 401 water quality certification or Chapter 105 decisionmaking:

> "The PennEast Pipeline Project needs to fully evaluate conditions that may increase the likelihood of compaction for the most common landuses found along the pipeline. Areas that contain specific fine textures and high water tables are highly susceptible to compaction. Without identifying these areas for both the ROW and temporary ROW and across all landuse categories, no determination during project review of potential impacts can be made due to a lack of information being provided. Extensive areas being crossed by this pipeline will fall into the category of susceptible to compaction." [43]
>
> "Impacts to resources located outside of the permanent ROW are often ignored or characterized as being temporary and short-term. This conclusion is not supported by experience with soil compaction investigations performed by Meliora Design within pipeline work areas. Once a soil's structure is disturbed with heavy equipment, compaction, and removal of surface vegetation, it is very difficult to regain structure that allows for infiltration of surface water or the regrowth of healthy vegetation following construction." [44]

As noted by Princeton Hydro:

> "PennEast has used post-development TR-55 runoff curve numbers in an attempt to support their contention that there will not be an increase in runoff following the completion of the pipeline. However, it is well established that following land development, especially development on steep slopes and resulting in forest clearing, peak flows and total runoff volumes will increase. In addition, the time of concentration will decrease. Undoubtedly there will be both a greater volume of runoff and velocity as the result of pipeline construction. In addition to increasing the volume and velocity of runoff entering stream systems, these conditions will increase the mobilization and transport of pollutants (including sediments and nutrients), increase the likelihood of scour and erosion and decrease the total volume of precipitation infiltrated back into the soil leading to a decrease in the recharge of the surficial aquifer."[45]

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[42] Affidavit, Michelle Adams, Meliora Design
[43] Meliora Design Memorandum
[44] Meliora Design Memorandum
[45] Princeton Hydro White Paper

Loss of trees in a watershed, even when there exists a buffer between the cuts and the creek, can still have direct impacts on water quality. A seven-year long hydrological study on water quality demonstrates that cutting trees can increase turbidity in nearby water bodies even if the trees and vegetation are left in place.[46] Another study, also involving leaving cut trees/vegetation in place, demonstrates that even five months after deforestation, nitrates had increased and pH was altered in a water body, adversely impacting water quality.[47]

As observed by Meliora Engineering in their attached report:

> "Construction activities of this pipeline such as clearing, grading, trenching, and backfilling, all could adversely affect soil resources by causing accelerated erosion, compaction, and introduction of rock or fill material to the surface. Current regulations rely upon construction plans that focus on temporary erosion and sedimentation controls to protect water quality standards. While temporary erosion and sedimentation measures may help to limit the transport of eroded soils during construction activities, they cannot fully eliminate the acceleration of erosion or soil compaction caused by construction over the long-term operation of a pipeline project. Once sediment reaches a stream or wetland, changes to the habitat of plants, fish, and insects will take place. Sediment from accelerated erosion smothers fish eggs and covers spawning areas with fine sediments, thus inhibiting fish reproduction. Increased turbidity in streams and wetlands prevents light penetration into the water column and increases water temperatures. All of these impacts make meeting water quality standards and the Clean Streams Law nearly impossible. Environmental damage to surface waters does not stop when construction ends if soils are severely damaged and their function in the natural environment is destroyed by compaction."[48]

Stream scour and potential pollution release

PennEast proposes to use the open cut method of crossing for the vast majority of streams it will need to cross, including the Lehigh River and the Susquehanna River. Because open cut pipeline installations may unnaturally alter both stream bank and streambed (i.e., channel) stability, there is an increased likelihood of scouring within backfilled pipeline trenches. Flooding rivers can scour river bottoms and expose pipelines to powerful water currents and damaging debris. Additionally, unusually heavy rains possibly associated with climate change, threaten to increase overall stream degradation and channel migration – thereby exposing buried pipelines.

Scouring that exposes pipelines buried in streambeds is well documented.[49] Exposure of the pipeline raises a greater risk of pipeline damage, breakage and pollution; with pipeline breakage resulting in the catastrophic discharge of its contents into the natural stream system. Talke and

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[46] *See* Marryanna, L. et al, "Water Quality Response To Clear Felling Trees For Forest Plantation Establishment At Bukit Tarek F.R., Selangor," Vol. 18[1] Journal of Physical Science 33-45 (2007) (experimental plot was clear cut, left in place with a 65.6 foot wide buffer next to river, and river's turbidity increased on-average by 279%).

[47] *See* Likens, G.L. et al., "Effects of Forest Cutting and Herbicide Treatment on Nutrient Budgets in the Hubbard Brook Watershed-Ecosystem" 40 Ecol. Monogr. 23-47 (1970) (study also showed large increases for all major ions, except for ammonium, bicarbonate, and sulfate).

[48] Meliora Design Memorandum

[49] Fogg, J. and Hadley, H., 2007, Hydraulic Considerations for Pipelines Crossing Stream Channels. Technical Note 423. BLM/ST/ST-07/007+2880. U.S. Department of the Interior, Bureau of Land Management, National Science and Technology Center, Denver, CO. 20 pp. http://www.blm.gov/nstc/library/techno2.htm.

Swart (2006) and De La Motte (2004) discuss gas pipelines and how man-made changes and actions have altered channel morphology and changed channel stability. Soil erosion and channel migration reduces the soil cover over a pipeline, resulting in scour hole formation and making the pipeline vulnerable to rupture. Lateral migration of stream channels can also heighten the risk of pipeline exposure.

Given the potential for high flow events to expose or damage the pipe, a detailed hydrologic analysis of the channel is critical for determining placement of the pipe beneath a stream. This data is necessary to actually determine the proper depth to place the pipe. These data are derived from channel degradation and scour analyses. As noted by comments prepared for the Delaware Riverkeeper Network by Princeton Hydro engineering firm, "the Bureau of Land Management (Fogg and Hadley, 2007) recommends modeling of the stream using various "mobile-bed hydraulic" models such as HEC-6 (USACOE, 1993 and USACOE, 1995). To date there has been no mention that such modeling will be conducted at any of the multiple PennEast stream crossings. Even when pipelines are placed to the appropriate depth, exposure of the pipe and release of the materials therein is still a risk that has been sadly realized in communities." [50]

An expert at HydroQuest has determined that, at a minimum, any pipeline installed using the open trench cut method needs to be installed at least 24 feet below the stream bed in order to prevent exposure from scour.[51]

Another significant environmental risk associated with both wet and dry trench methods of gas pipeline crossings of rivers and streams is the potential of releasing hydrocarbons or other contaminants directly into surface water and fragile downstream ecosystems, including hydro-carbon laced liquids such as benzene that are part of the gas being delivered by the pipeline. Gas, as it is extracted from a well, may be mixed with hydraulic fracturing fluids. Hydrocarbon-laced condensate or natural gas liquids (NGLs) associated with natural gas (e.g., benzene) pose an environmental risk if pipe rupture occurs (e.g., to potential bog turtle habitat and travel corridors, fisheries, downstream drinking water supplies as well as underlying aquifers recharged by stream water). For example, a damaging flood event in Texas ruptured eight pipelines and spilled more than 35,000 barrels of oil and oil products into the San Jacinto River.[52] The Bureau of Land Management recognized and addressed this critical issue: *"In 2002, the U.S. Fish and Wildlife Service raised concerns about the potential for flash floods in ephemeral stream channels to rupture natural-gas pipelines and carry toxic condensates to the Green River, which would have deleterious effects on numerous special-status fish species"*. [53]

<u>*Groundwater Impacts*</u>
Pipelines have been seen by experts to be conduits for diverting groundwater from its natural path. According to expert observation, pipeline trenches can divert groundwater and as a result "permanently alter the hydrologic cycle in the vicinity of the pipeline right-of-way. This alteration will decrease the water resources available to support wetland hydrology and stream

[50] Princeton Hydro White Paper
[51] Expert Report from HydroQuest.
[52] Billings Gazette, *supra note* 75.
[53] Fogg and Hadley, *supra note* 70.

base flow in the summer and fall dry season."[54] For example, observations of the Tennessee Gas Pipeline's 300 Line Upgrade project by a hydrologist determined that "pipeline trenches intercepted shallow groundwater in places, creating preferential paths for dewatering shallow groundwater not just in the disturbed construction areas, but also in areas surrounding the right-of-way, further negatively impacting ground water resources and wetlands."[55] As a result, it was observed that the 300 Line Upgrade pipeline project had "already resulted in permanent changes to wetlands…."[56]

As also recognized by Princeton Hydro:

> An "often overlooked impact caused by pipelines (whether wastewater, stormwater or gas/oil) is that their construction can actually alter the movement of groundwater. Essentially when the pipe and pipe trench intercept the shallow aquifer, groundwater flows can be prevented from flowing normally leading to changes in base flow conditions or the hydrologic properties of adjacent wetlands. The pipeline and pipeline trench can function as a subsurface diversion forcing groundwater away from vital stream and wetland resources."

Groundwater is also impacted by soil compaction associated with pipeline construction and maintenance. The compacted soils resulting from pipeline construction increase rainfall runoff and reduce ground water infiltration. This can cause further negative impacts on wetland hydrology and stream baseflow in the area of the pipeline.[57] "Increased runoff as a result of compacted soils, and increased drainage of shallow ground water" around a pipeline, due to previous and proposed construction practices, can increase "surface water flow and groundwater discharge in the wet winter and spring seasons and decrease summer and fall ground water discharge which supports wetland hydrology and stream base flow."[58] The result of reduced groundwater discharge during the dry summer and fall months can be to decrease the size of supported wetlands. So the result is too much or too little depending on the time of year. Another result of the altered flows can be to decrease stream base flow that supports aquatic life and trout habitat in headwater streams in the dry summer and fall period.

> "The application for 401 certification is not complete because it does not include sufficient data or analysis [] regarding groundwater. Pipeline construction will affect groundwater recharge and flow, thereby affecting surface water flow and wetlands water balances. It can affect water quality by providing transport pathways for contaminants to reach wetlands or surface water. PennEast does not analyze any of these impacts as required by 25 Pa. Code § 105.15(e)(1)(x). Specifically, proposed project could affect "water quality" by transport contaminants into streams or nearby groundwater, "stream flow" by diverting groundwater or preventing recharge, "aquatic habitat" by decreasing flow during baseflow conditions which would eliminate aquatic habitat, and "instream and downstream water use" by decreasing flow or contaminating it."[59]

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[54] Affidavit of Peter M. Demicco, DRN v. PA DEP an TGP NEUP, 2012.
[55] Affidavit of Peter M. Demicco, DRN v. PA DEP an TGP NEUP, 2012
[56] Affidavit of Peter M. Demicco, DRN v. PA DEP an TGP NEUP, 2012.
[57] Affidavit of Peter M. Demicco, DRN v. PA DEP an TGP NEUP, 2012.
[58] Affidavit of Peter M. Demicco, DRN v. PA DEP an TGP NEUP, 2012.
[59] See Tom Myers Technical Report for full discussion.

The attached report from Tom Myers discusses in detail the failure of PennEast to provide necessary information regarding geology and groundwater. This information is critical for determining whether the PennEast pipeline is able to meet the criteria necessary for section 401 water quality certification or Chapter 105 and associated regulated mandates. As noted in Myer's report:

> "The PennEast application completely failed to consider how pipeline construction will affect water availability for recharge into bedrock by not considering how compaction will prevent water from accessing fracture zones. "
>
> PennEast's materials "should provide a table of bedrock aquifers that includes relevant properties, including specific capacity statistics or well yields, and conductivity where available. If properties for a given bedrock aquifer have not been published, it is reasonable for PennEast to complete the analyses for existing wells."
>
> "The application did not consider how pipeline construction and operations could affect recharge and shallow groundwater flow in aquifers near the proposed pipeline. Areas where the pipeline compacts soils over critical recharge areas, especially on ridge tops and valley bottoms, would increase runoff and decrease recharge." [60]

Wetlands

Section 105.13(e) outlines much of the information required for a section 401 water quality certification including specific information and analyses required for impacts to wetlands. The information submitted must include a "statement on water dependency." 25 Pa. Code § 105.13(e)(1)(x)(c) and "an analysis of whether the wetland is exceptional value as classified in § 105.17." 25 Pa. Code § 105.13(e)(1)(x)(B).

Where a water obstruction or encroachment, such as a natural gas pipeline, affects an exceptional value ("EV") wetland, PADEP may not grant a section 401 water quality certification unless (1) the applicant affirmatively demonstrates in writing that the seven requirements of 105.18a(a) of Pennsylvania's Chapter 105 regulations are met, and (2) DEP issues a written finding that those seven requirements have been met.

The first requirement pursuant to Section 105.18a(a) requires that applicants demonstrate that the permitted activities will have no adverse impact on the exceptional value wetland, or that the project is necessary to abate a substantial threat to the public health or safety. *25* Pa. Code § 105.18a(a)(1) and (c).

The PennEast Project will have an adverse impact on numerous EV wetlands in Pennsylvania resulting from their permanent conversion from Palustrine Forested Wetlands or Scrub-Shrub Wetlands to Emergent Wetlands, thus resulting in a significant loss to the values and functionality of those EV wetlands.

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[60] See Tom Myers Technical Report for full discussion.

Certified wetlands specialists have found a measurable "decrease" or "loss" in functionality as a result of the permanent conversion of forested wetlands to emergent wetlands.[61] For example, a functional conversion of wetlands from forested wetlands to emergent wetlands generally result in decreases to above ground biomass, structural diversity of the wetland, and local climate amelioration.[62] The conversion will also result in a loss of forest interior habitat, visual and aural screening from human activity, suitability of shade-loving plant species, and the production of mast (such as acorns) for wildlife.[63] Moreover, these conversions also result in increased wetland exposure to wind, ice and sun, as well as the localized effects of global warming on biota.[64]

Wetland functions involving drainage patterns, water quantity, and water quality will also be adversely impacted by a functional conversion of forested wetlands to emergent wetlands. Specifically, emergent wetlands provide decreased soil stabilization, streambank anchoring against erosion, nutrient storage, and temperature maintenance when compared to forested wetlands.[65] As a result, erosion and sedimentation can be expected to increase as a result of the conversion.[66] The function of storm damage shielding can also be expected to decrease as a result of this conversion.[67]

The attached wetlands reports demonstrates the ways in which permanent conversions of wetlands results in adverse impacts to those wetlands.

Land Transformation

The massive land clearing and alteration, including loss of vegetation as well as soil compaction, is among the very egregious elements of the proposed pipeline project. This land transformation causes immediate harms, as well as inflicting "major changes to the overall condition of the affected areas and set the stage for other acute impacts…."[68]

> "The literature suggests at a minimum once cleared of native vegetation it will take five (5) years for recovery of pre-existing vegetation cover and diversity for grassland communities. The recovery time for shrubland forest communities is at least ten (10) years. But it must be stressed that although cover densities may approach pre-site-clearing conditions, some of the native grasses and understory vegetation may never recover due to changes in sunlight exposure, soil porosity, soil compaction and changes in soil moisture content. Also, none of the trees once growing within the ROW will ever be replanted. Thus as noted above, the acute impact of land clearing sets the stage for longer-term impacts that trigger multiple negative effects on the area's biota and ecological functionality."[69]

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[61] *See,* The Effects of Converting Forest or Scrub Wetlands into Herbaceous Wetlands in Pennsylvania: A Report to the Delaware Riverkeeper Network, Schmid and Company, Inc., Consulting Ecologists (2014). (Hereafter Schmid Wetlands Report)
[62] Schmid Wetlands Report
[63] Schmid Wetlands Report
[64] Schmid Wetlands Report
[65] Schmid Wetlands Report
[66] Schmid Wetlands Report
[67] Schmid Wetlands Report
[68] Princeton Hydro White Paper
[69] Princeton Hydro White Paper

Given the significant and long term effects of the land, vegetation and habitat transformation that would result from construction and maintenance of the PennEast pipeline project, PADEP must determine prior to section 401 water quality certification whether such impacts prevent the ability of meeting state 401 water quality certification and/or Chapter 105 regulatory requirements.

Oversized Footprint = Oversized Impacts

PennEast's application and materials proposes, among other things, an unnecessarily oversized set of ROWs both for construction as well as for operation and maintenance. Both during construction as well as in terms of the permanent ROW maintained for the project, ROWs significantly smaller than those proposed by PennEast are viable and available options. In addition to the oversized footprint, PennEast proposes typically invasive construction practices, such as open stream cuts, that also maximize adverse impact and minimize the opportunity for successful mitigation and/or restoration. The proposal to issue section 401 water quality certification based on future consideration of the project undermines PADEP's ability to say 'no' to the project if the footprint and impacts are deemed too great to meet state standards but also undermines PADEP's ability to mandate improved construction, operation and maintenance strategies for avoiding, minimizing and/or mitigating harm.

In Morris County NJ a pipeline company was required to limit its ROW to 34 feet to avoid and minimize harm and to run the ROW along an existing road to decrease fragmentation. Stove piping, HDD, smaller side booms, wood chips to cushion equipment, and sod pillows can all be deployed by the Applicant to greatly minimize harm and maximize potential for restoration.[70]

Alternatives Analysis

PADEP fails to consider the alternative energy options for avoiding the foot print of PennEast all together and otherwise serving the energy needs that PennEast asserts it will serve.

In addition, PADEP fails to fully consider the alternative construction strategies available for minimizing the footprint and impacts of the project. Attached is an expert report by Leslie Sauer that lays out numerous construction practices that would limit the construction footprint and impact of the project, that would limit the permanent and temporary ROW footprints of the project, and that would remediate impacts inflicted during construction. These are available alternatives important for a section 401 water quality certification determination that have not been given due consideration.

Pipeline crossings like those proposed by PennEast inflict significant impact on water quality, health and habitat, and inflict impact and threats to people and property, both at the site of the crossing and downstream. Given the significant and long term effects of the water, land, vegetation and habitat transformation that will result from maintenance and construction of the project, PADEP must determine prior to state 401 water quality certification whether such impacts prevent the ability of meeting state 401 water quality certification and Chapter 105 regulatory requirements.

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[70] Achieving Higher Quality Restoration Along Pipeline Rights of Way, Leslie Sauer

Field Monitoring and Documentation of the Reality of Pipeline Construction, Operation & Maintenance – Both In Compliance with the Law and In Violation of the Law -- Irreparably Harms Rivers, Wetlands and Streams.

As the result of document reviews and field investigations during construction of three sections of pipeline -- the TGP 300 line upgrade, TGP Northeast Upgrade Project (NEUP), and Columbia 1278 pipeline -- in the Upper Delaware River Basin the Delaware Riverkeeper Network documented:

- over 60 instances where best management practices (BMPs) were not present, inadequate or not functioning or in need of repair, maintenance or reinforcement,
- 4 instances of fueling being conducted in wetlands or near waterbodies,
- dozens of instances of poor signage and staking and mapping errors which sometimes led to impacts off of the permitted Right of Way (ROW), loss of trees outside the ROW, and inaccurate mitigation calculations,
- thermal impacts, extreme (and unreversed) soil compaction, nutrient impacts, benthic invertebrate changes from pipeline cuts, including for streams with exceptional value, high quality and or C-1 anti-degradation classifications,
- discrepancies between pipeline company monthly compliance reports and what work and activities to meet compliance and avoid pollution were actually occurring or not occurring on the ground. We also noted excessive lag time in the filing and/or public release of construction reports making for difficult follow up in the field. We documented too few pipeline inspectors and a lack of oversight person-power for these extensive linear projects that spanned many miles and where work was going on simultaneously along the routes with little independent oversight.

Based on first hand observations and monitoring, the Delaware Riverkeeper Network has concluded:

- Interstate natural gas pipeline projects result in a multitude of environmental impacts that inflict high levels of unnecessary ecological damage – this damage is not avoided, nor properly mitigated, despite the resource reports that are drafted or the guidance provided by FERC or other federal or state agencies;
- Violations of environmental laws are common place and an accepted part of pipeline construction – and compliance outweighs penalties and violations to the detriment of the environment and the public;
- Construction problems and potential violations are not properly responded to by the company, by FERC or by other state or federal agencies and mitigation does not undo the harms inflicted -- as a result of both, pipelines inflict enduring and/or repetitive harms on natural resources; and
- Current or proposed guidance from FERC or other regulatory agencies do not prevent, avoid, or otherwise mitigate these ecological and public harms or the multitude of bad practices used by the pipeline companies.

Attached please find: *Field Monitoring Report,* Pipeline Construction & Maintenance Irreparably Harms Rivers, Wetlands and Stream., Addendum to Comment for the PennEast Pipeline, *a* compilation of Delaware Riverkeeper Network generated technical documents, reports and observations compiled as the result of field monitoring which support, inform and expand upon these conclusions. Our observations in the field demonstrate and document that construction, operation and maintenance practices like those being proposed by the PennEast pipeline company, even when followed in full compliance with regulatory standards, results in unavoidable, unmitigated and irreparable harm and violations of state water quality standards and wetlands protections. In addition, our monitoring has documented that over and above these impacts, violations of law are commonplace during pipeline construction, operation and maintenance and as a result the violations of law, including water quality standards and wetland protections, are further exacerbated.

Construction of the PennEast Pipeline will have adverse impacts on natural areas, public water supplies, National, State or local parks or recreation areas or National, State or local historical sites, on critical species and habitats.

As stated in the attached expert report by Princeton Hydro:

> "…along its path in both Pennsylvania and New Jersey, the proposed PennEast Pipeline will cross through environmentally important and critical lands. These include Pennsylvania State Game Lands (#40 and #128), Hickory Run State Park, Boulder Field Natural Area (a National Natural Landmark), Mud Swamp Natural Area, Weiser State Forest, Beltsville State Park, the Kittatinny Ridge, the Appalachian Trail Corridor, the Sourland Mountain Preserve, other State and County parklands, preserved farmland, and areas of cultural significance. Along the route the pipeline traverses steeply sloped areas characterized by erosion prone soils. Many of the affected areas provide critical habitat to a number of threatened and endangered species and species of concern including Bald Eagle, Harrier Hawk, Bobolink and other grassland bird species, Wood Turtle, Bog Turtle, Indiana Bat, Northern Long-Ear Bat, Brook Snaketail Dragonfly and Dwarf Wedge Mussel."

Many of the streams to be cut by the pipeline are designated Class A or wild trout streams which are an important natural and recreational resource for the state. In addition, the game lands, parks and natural areas are important to Pennsylvania's recreation and ecotourism driven economy. The Delaware Riverkeeper Network's River values report, attached, provides facts and figures on the wealth of income that is generated by Pennsylvania, as the result of fishing, hunting and wildlife viewing, including in areas to be impacted by PennEast. The report also discusses costs avoided -- such as water quality remediation, stream restoration, and stormwater management projects – because of healthy forests, streamside lands, wetlands, etc.

The Delaware Riverkeeper Network's dedicated group of volunteer monitors have witnessed and documented multiple state threatened and endangered species and critical wetland habitats such as vernal pools throughout the proposed PennEast pipeline route.

In Pennsylvania, a volunteer documented an osprey nest on a telephone pole near MP 76.7. Ospreys are a state threatened species in PA. Between MP 43.5 and 44, we had reports of several vernal pools, wood frog egg masses, and springs and seeps.

It is a concern that in early April of this year, we received a report that PennEast representatives were seeking to gain access to a property to conduct bog turtle trapping. Bog turtle trapping, or Phase 3 surveys, should only be conducted between April 15th and June 15th according to the U.S. Fish and Wildlife Service. In this case, the PennEast representative was seeking to access the property prior to April 15th. In addition, the Delaware Riverkeeper Network has received reports of unmarked vehicles parking near private landowner property and unidentified men near the property claiming they were doing bog turtle surveys.

It is our understanding that these men must be accompanied by at least one USFWS qualified bog turtle surveyor at all times. We have confirmed that there is a qualified bog turtle surveyor working at this site, but it is unknown if he is present at all times. When approached by landowners, the unidentified men are largely uncooperative in providing identification. PennEast representatives and their consultants should be providing identification as well as their scientific collecting permit when asked. Unmarked vehicles should also have a sign in the windshield identifying them as contractors when parked. This lack of clear communication arouses suspicion to landowners as they are unable to tell if these unidentified people are legitimate employees or trespassers. Premature granting of 401 Certification emboldens this kind of bad behavior and risks abuses by the pipeline company.

The PennEast pipeline proposal is not consistent with the Lower Delaware River Wild & Scenic designation or management plan.

While PennEast has carefully selected a reach of the Delaware River that does not yet have Wild & Scenic designation, it is a reach of river that is surrounded, upstream and downstream, by designated reaches and as a result adverse impacts to the ecological and community health of the corridor and the River inflicted by the PennEast pipeline proposal has direct impacts on the Lower Delaware River Wild & Scenic designation which cannot be simply ignored as PennEast suggests.

The Lower Delaware River Wild & Scenic Management Plan specifically asserts that protection of the non-designation stretches of the Lower Delaware Wild & Scenic Corridor need the same consideration and protection as the designated reaches in order to ensure the important resources of the designated corridor are properly protected:

> "To assure the protection of important resources in the corridor, the Study Task Force concluded that the Management Plan should cover a broader reach of the lower Delaware than that included in the area considered for Wild and Scenic River designation. The Task Force decided that one management plan should be developed covering (1) areas eligible for Wild and Scenic designation, (2) the area south of Washington Crossing, PA, and (3) excluded sections."

In addition, the protected area includes all that area between the "prominent ridge lines on both sides of the lower Delaware River" not just the River waters and channel itself.

Thus it is clear that protection of the Wild & Scenic Lower Delaware River requires that the PennEast pipeline, as it crosses through the Lower Delaware Wild & Scenic River corridor between the prominent ridge lines in Pennsylvania and New Jersey, comply with the guidance, goals and vision of the Lower Delaware River Management Plan. Given that PennEast has not provided any discussion in this regard, and that the PADEP has undertaken no review in this regard, the regulatory mandate that both a Chapter 105 permit and a 401 Water Quality Certification ensure …

> "Consistency with the designations of wild, scenic and recreational streams under the Wild and Scenic Rivers Act of 1968 (16 U.S.C.A. § § 1271—1287) or the Pennsylvania Scenic Rivers Act (32 P. S. § § 820.21—820.29), including identified 1-A candidates."

has not been met.

In addition, while PennEast lightly dismisses the downstream stretches that are listed on the National Rivers Inventory of the National Park Service it fails to give the level of consideration necessary to impacts on those downstream resources or potential future designations.

PennEast's claims of purpose and need for the project, as well as economic value of the project, are self-serving claims that cannot and do not justify the project.

PennEast Pipeline company asserts its proposed pipeline is necessary to serve New Jersey and eastern Pennsylvania communities. In fact, there is no compelling public need for the gas. As noted in the attached expert report from Arthur Berman[71]:

> "Natural gas consumption for New Jersey has been relatively flat for the past four years at average rate of 1.8 billion cubic feet of gas per day (Bcf/d), somewhat below the higher levels of the late 1990s. [] Although consumption increased slightly in 2013 compared to the three previous years, New Jersey cannot be called a growth market…."
>
> "The proposed PennEast Pipeline would deliver an additional 1 Bcf/d of natural gas to New Jersey potentially creating a 53% supply surplus above the current level of consumption."
>
> and "…Pennsylvania has no unfulfilled demand…"
>
> "Because of the lack of demand for Marcellus gas in Pennsylvania and adjacent New Jersey, it is possible that PennEast and its committed suppliers have an unstated intent to send gas to other markets not specified in their proposal…."

[71] *Professional Opinion of Proposed PennEast Pipeline Project*, Arthur E. Berman, Petroleum Geologist, Labyrinth Consulting Services, Inc., February 26, 2015

A second report done by Skipping Stone similarly finds a lack of need for the capacity of PennEast. According to this report, PennEast obtains many of its clients by commitments to switch from one pipeline to the other, which means unfilled excess capacity, not more needed gas delivered. According to Skipping Stone, similar to Labyrinth Consulting[72]:

> "Local gas distribution companies in the Eastern Pennsylvania and New Jersey market have more than enough firm capacity to meet the needs of customers during peak winter periods. Our analysis shows there is currently *49.9% more capacity than needed to meet even the harsh winter experienced in 2013"*

This demonstration of a lack of need is complimented by the predictions and concerns of experts that the industry is proposing an "overbuild" of pipelines from the Marcellus and Utica shales:

> "Speaking to attendees at the 21st Annual LDC Gas Forums Northeast conference in Boston Tuesday, Braziel said an evaluation of price and production scenarios through 2021 suggests the industry is planning too many pipelines to relieve the region's current capacity constraints."
>
> "What we're really seeing is the tail end of a bubble, and what's actually happened is that bubble attracted billions of dollars worth of infrastructure investment that now has to be worked off," he said.

Given the high level of impacts that will be inflicted by the PennEast pipeline on the water resources of Pennsylvania and that the project will necessarily be inflicting unavoidable and unmitigatable harm that will result in a violation of water quality standards, Chapter 105 regulations, and the standards that determine section 401 water quality certification, this lack of need for the PennEast pipeline project is of high relevance and significance to the decisionmaking process.

PennEast's application makes numerous false and misleading economic and job claims for the project.

As discussed in the attached expert analysis from Dr. Jannette Barth with the Pepacton Institute, the analyses upon which PennEast bases its economic and jobs claims is carefully crafted to exaggerate benefits and ignore costs. A second expert report prepared by The Goodman Group finds similar exaggerations of economic and job claims. With regards to gas prices, in fact, for many customers, the construction of PennEast may result in an increase in gas prices, thereby increasing the economic burden of this new pipeline rather than creating any sort of economic gain.[73]

As revealed by the attached expert reports, the assertion that the PennEast pipeline is going to spur economic growth, significant and sustainable jobs, and low energy prices is false and misleading.

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[72] Analysis of Public Benefit Regarding PennEast, Skipping Stone, March 9, 2016

[73] *Analysis of Public Benefit Regarding PennEast*, Skipping Stone, March 9, 2016

Construction of the PennEast Pipeline Will Inflict Significant, Unnecessary and Avoidable Harm on Water Resources, Communities and the Environment.

The Delaware Riverkeeper Network champions the rights of our communities to a Delaware River and tributary streams that are free-flowing, clean and healthy. Delaware Riverkeeper Network is opposed to the proposed PennEast pipeline which, if constructed, will collect and transport methane gas to other markets that will fuel additional and unsustainable gas drilling in the Marcellus shale where communities health and environment are currently being harmed by this unconventional and highly industrialized process of drilling. Delaware Riverkeeper Network does not believe that gas drilling is sustainable for the health of our communities or a thriving economy for our region today or for future generations. PADEP should not grant 401 Certification or Chapter 105 permitting to the PennEast project. At the very least, PADEP has not complied with the laws necessary to support legal granting of section 401 water quality certification or Chapter 105 approval.

Construction, operation and maintenance of the PennEast Pipeline will inflict significant and long term effects on waterways, wetlands, groundwater, floodplains, soils, plants, animals, habitats, and people. These impacts are discussed in these comments as well as the attached reports and documents specifically considering the PennEast pipeline proposal. PADEP must determine prior to section 401 water quality certification whether such impacts prevent the ability of meeting state 401 water quality certification and Chapter 105 regulatory requirements. An after-the-fact review by PADEP cannot be justified by law and is bad public policy that undermines the state's legal authority and disenfranchises Pennsylvania communities counting on the agency to do its job by protecting Pennsylvania's water resources and environment.

The proposed Section 401 Certification is unlawful in process, substance and law. It has been argued that once a state 401 certification has been granted that it cannot be rescinded. Pennsylvania's decision to give its power away in advance of conducting the necessary review and approval is illegal as well as unwise.

Submitted,

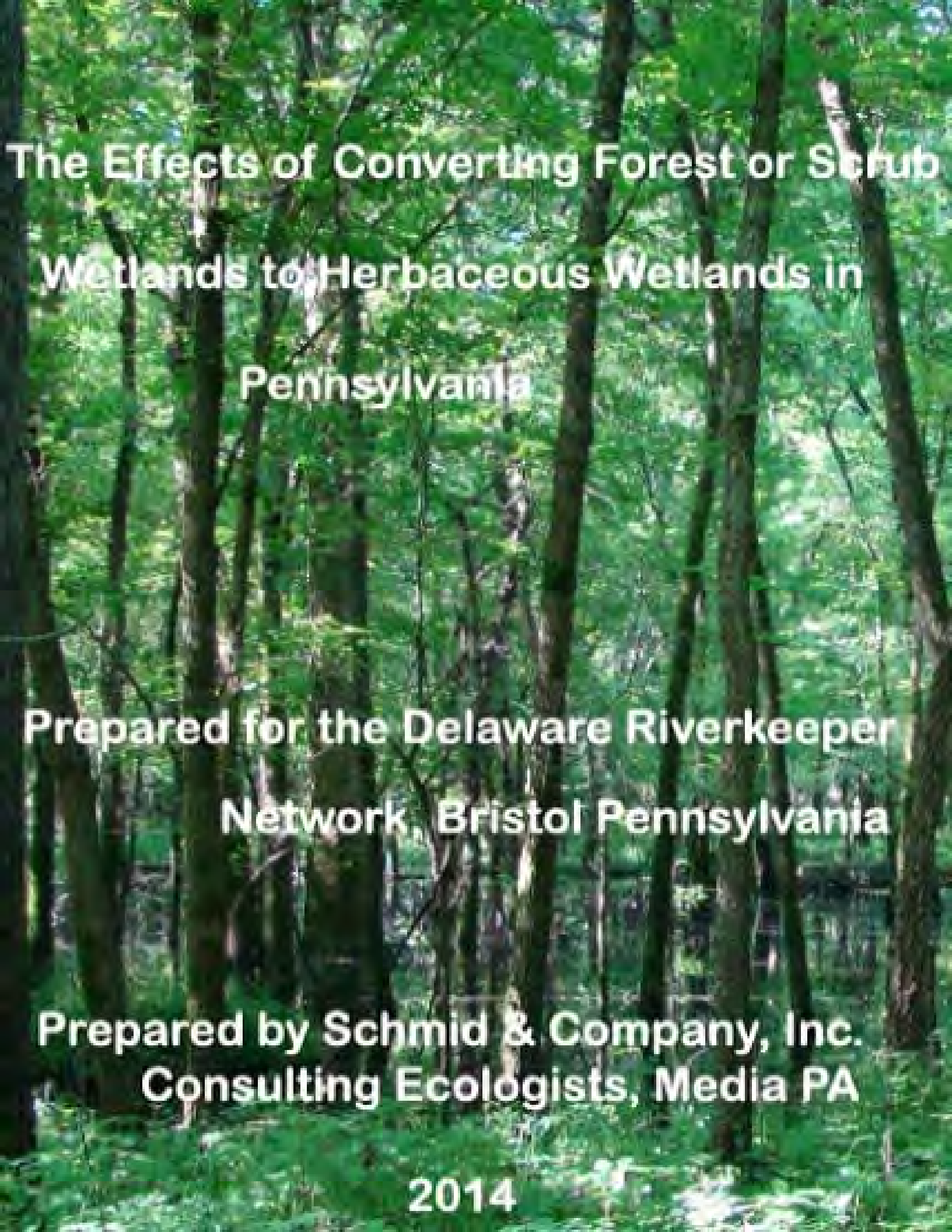
Maya K. van Rossum
the Delaware Riverkeeper

cc:
Delaware River Basin Commission
Federal Energy Regulatory Commission, Docket CP15-558

Attachments

- *The Effects of Converting Forest or Scrub Wetlands to Herbaceous Wetlands In Pennsylvania*, James Schmidt

- *The Short and Long-Term Consequences of the Construction of the PennEast Pipeline– A White Paper*, Princeton Hydro, LLC
- Memorandum from Meliora Design *re:* Proposed State Water Quality Certification – PennEast Pipeline Project, June 9, 2016
- Michelle Adams affidavit re Tennessee Gas Pipeline Company 300 Line
- *Achieving Higher Quality Restoration Along Pipeline Rights of Way*, Leslie Sauer
- *Technical Memorandum, Review Application Materials, Proposed PennEast Pipeline,* Dr. Tom Myers, June 6, 2016
- *Professional Opinion of Proposed PennEast Pipeline Project*, Arthur E. Berman, Petroleum Geologist, Labyrinth Consulting Services, Inc., February 26, 2015
- *Analysis of Public Benefit Regarding PennEast*, Skipping Stone, March 9, 2016
- *Review of PennEast Pipeline Project Economic Impact Analysis*, Jannette Barth, Pepacton Institute
- *Expert Report on the PennEast Pipeline Project Economic Impact Analysis for New Jersey and Pennsylvania*, The Goodman Group Report, Nov 4, 2015
- Review of INGAA Foundation Report, "Pipeline Impact to Property Value and Property Insurability", Key Log Economics 3/11/2015
- HydroQuest Memorandum re: Hydrologic and Environmental Rationale to Bury Gas Pipelines using Horizontal Directional Drilling Technology at Stream and River Crossings, 6/8/2012
- Delaware Riverkeeper Network comments regarding the Spectra M2M project, 6/3/2016
- Delaware Riverkeeper Network, *Field Monitoring Report,* Pipeline Construction & Maintenance Irreparably Harms Rivers, Wetlands and Stream., Addendum to Comment for the PennEast Pipeline
- Marryanna, L. et al, "Water Quality Response To Clear Felling Trees For Forest Plantation Establishment At Bukit Tarek F.R., Selangor," Vol. 18[1] Journal of Physical Science 33-45 (2007)
- Likens, G.L. et al., "Effects of Forest Cutting and Herbicide Treatment on Nutrient Budgets in the Hubbard Brook Watershed-Ecosystem" 40 Ecol. Monogr. 23-47 (1970)
- Powerpoint slides by Dr. Julia Barringer
- News article: Marcellus/Utica On Pace for Pipeline Overbuild Say Braziel, NaturalGasIntel.com, June 9, 2016
- Delaware Riverkeeper Network **River Values** report.
- Peter Demicco affidavit re Tennessee Gas Pipeline Company 300 Line
- DRN White paper, Pipelines, A Significant Source of Harm



The Effects of Converting Forest or Scrub Wetlands to Herbaceous Wetlands in Pennsylvania

Prepared for the Delaware Riverkeeper Network, Bristol Pennsylvania

Prepared by Schmid & Company, Inc.
Consulting Ecologists, Media PA

2014

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The Effects of Converting Forest or Scrub Wetlands to Herbaceous Wetlands in Pennsylvania

Wetlands are tracts of land characterized by the recurrent and prolonged presence of surface water and/or near-surface groundwater. Their vegetation, wildlife, and soil properties are greatly influenced by wetness, that is, by their hydrology. Wetness has a profound effect on the biogeochemical reactions that occur in the top foot of wetland soil, allowing bacteria to render such soils anaerobic (oxygen-free) and thereby affecting the chemistry of the soil particles as observed in soil color and organic matter, determining the kinds of microorganisms present, selecting the kinds of rooted plants able to survive and compete, and in turn affecting the quality of habitat for animals including humans. Like streams, ponds, lakes, rivers, and oceans, wetlands today are deemed to be bodies of surface water, peculiar places transitional between (1) permanent open waters and (2) dry lands wet only during precipitation events. Some wetlands are associated with areas where surface waters and groundwater interconnect.

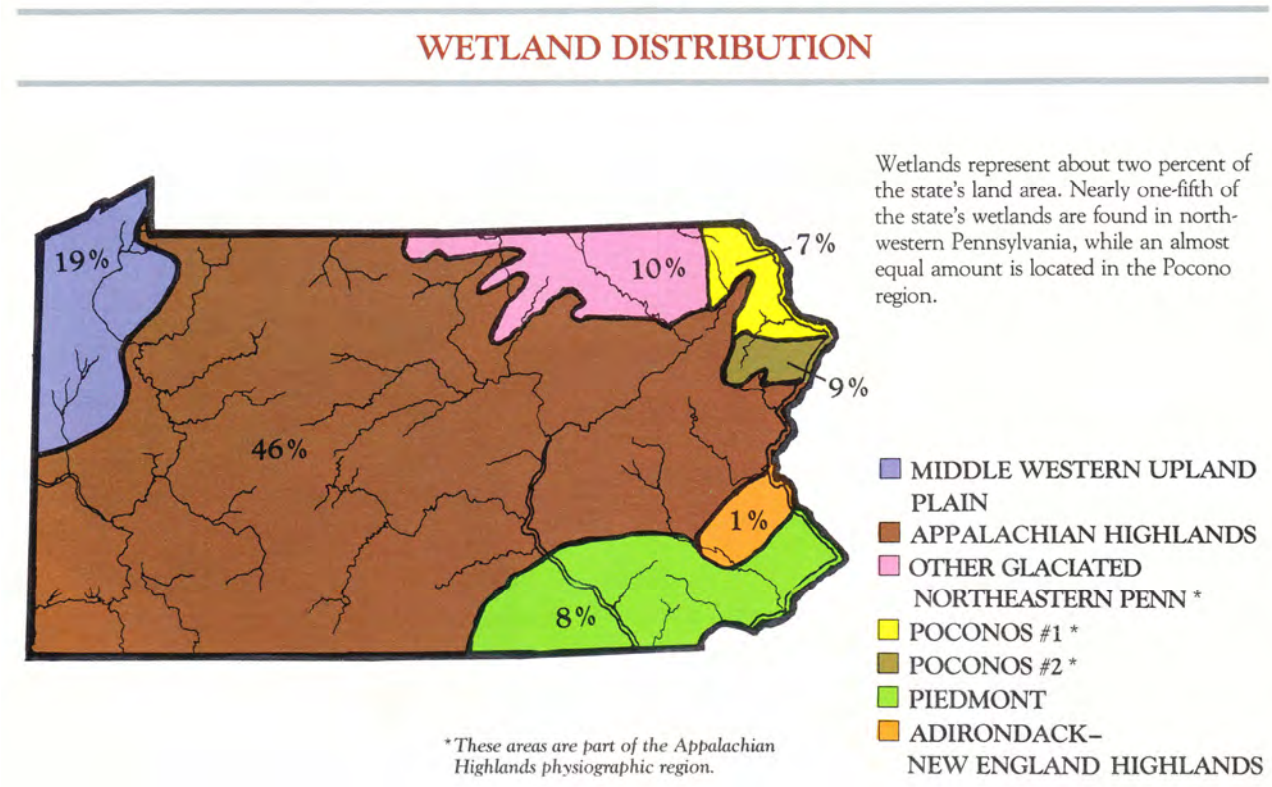
For many years wetlands were regarded as wastelands, and public policy encouraged their physical conversion to accommodate more highly valued land uses of many kinds (farms, cities, roads, residential and commercial development). In response, millions of acres of wetlands were destroyed across the United States, including more than half of Pennsylvania's wetlands (more than 600,000 acres). Not until the latter half of the twentieth century were the environmental and societal values of suddenly scarce wetlands broadly appreciated and subjected to legal protection against unnecessary alteration in the United States (Schmid 2000). Today most construction activities in wetlands are regulated by public agencies concerned with environmental protection. Regulators at the federal, State, and/or municipal level may be involved in permit review and approval. Most construction activities that would affect wetlands are unlawful, unless previously authorized by permit, but the applicable laws vary greatly from place to place in their scope and stringency.

Wetness (above-ground inundation or in-ground saturation within the uppermost foot of topsoil) for periods of two weeks or more, at least seasonally recurrent, is the primary characteristic that locally distinguishes individual wetlands from non-wetland areas that may display similar climate, exposure (aspect), slope, geology (rock type), soils, and biota (plants, animals, bacteria, fungi). The prolonged presence of surface water at relatively shallow depth (< 6 feet) and the presence of emergent vegetation distinguish wetlands from the deep, open waters of lakes and the flowing channels (some with submerged or floating plants) of streams---other bodies of surface water with which wetlands often are closely associated. Wetlands often occupy a landscape zone transitional between open waters and the seldom-wet uplands found at higher elevations. Along with groundwater, surface streams, rivers, lakes, ponds, and wetlands are regulated Waters of the Commonwealth of Pennsylvania. Many, but not all, of the wetlands and other

surface water bodies in Pennsylvania are also Waters of the United States (USEPA and USACE 2014).

In the large and diverse Commonwealth of Pennsylvania there are many kinds of wetlands. Pennsylvania wetlands in the aggregate occupy a small proportion of the land surface, and are most extensive in formerly glaciated areas such as the plateaus of the northeastern and northwestern counties, as shown below in a National Wetland Inventory drawing (from Tiner 1987). Individual wetlands can range in size from a few square feet to many acres. Wetlands today are recognized as contributing to water quality, wildlife habitat, endangered species protection, and the human landscape far out of proportion to their percentage share of the Pennsylvania land surface, and thus warrant stringent protection from human modifications to the extent practicable. These values increase as human population and population density increase. At the same time, the economic value of property where the destruction of wetlands has been authorized can greatly exceed the cash value of that property in its natural condition. Hence the extent to which public agencies can protect wetland resources often conflicts with the desire of private landowners to alter the property which they own.

Pennsylvania Wetlands Are Geographically Concentrated.



Agencies tasked with implementing the federal Clean Water Act (P.L. 92-500, 86 Stat. 816) and the Pennsylvania Dam Safety and Encroachments Act (32 P.S. 693) and Clean Streams Law (35 P.S. 691), long have defined wetlands as

> Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs and similar areas (25 *Pa. Code* 105.1.)

Accurate wetland identification and delineation depend upon a careful analysis of plants, soils, and hydrology using the best available scientific guidance to apply the official definition in each real situation on the surface of the earth. In the central sections of most wetlands the general public can readily ascertain the distinctive conditions that characterize tree-filled swamps and herb-dominated marshes. Precisely locating the boundaries of a wetland, however, in gently sloping transitional areas where the requisite field indicators gradually drop out, typically requires specialized training in the visual appearance of vegetation, soils, and hydrology as they occur outdoors in all seasons, along with thorough knowledge of relevant agency rules for consistent decisionmaking. The details of scientific knowledge of wetland functions and regulatory adjustments in setting regulatory boundaries and analyzing impacts have changed over recent decades as our understanding of wetlands has increased.

To apply the regulatory definition of wetlands in the field, federal and Pennsylvania regulators (25 *Pa. Code* 105.451) employ the Army Corps of Engineers *Wetland Identification and Delineation Manual* (ERL 1987) in conjunction with its recent regional supplements (for example, USACE 2012) and other technical support documents (including Lichvar *et al*. 2014, Vasilas *et al*. 2010, USACE 2014). These official documents provide the guidance necessary for recognizing the current extent of regulated wetlands under various conditions of season, wetness, and human disturbance, using field indicators of vegetation, soil, and hydrology.

In Pennsylvania the Army Corps of Engineers provides, in response to landowner requests, formal written Jurisdictional Determinations (JDs) that confirm the accurately mapped extent of wetlands and bodies of surface water eligible for regulation at the federal, State, and municipal level on specific tracts of land. Absent the issuance of a valid JD, there is no way for a landowner or the public to ascertain accurately the limits of a regulated wetland. Topographic maps, National Wetland Inventory maps, floodplain maps, soil survey maps, and planning maps of many kinds can provide useful technical information, but do not identify in detail the limits of regulated wetlands (or streams) that need to be considered by the sponsors of construction projects. Consultants typically document sites on behalf of landowners and prepare paperwork for agency review. Careful documentation of wetlands whose proffered boundaries are superimposed onto a land ownership survey is required as part of a request for a

JD, and Corps staff typically inspect each property in the field prior to approving a JD. JDs remain valid for five years, in recognition of the fact that wetland boundaries can change over time as a result of natural changes as well as unregulated human activities nearby. Only the Natural Resources Conservation Service (NRCS), an arm of the US Department of Agriculture, issues permanent wetland identifications for purposes of eligibility for federal programs that support crop production. Such NRCS determinations apply only to farming, not to general construction activities.

Delineated wetlands are best avoided when new construction projects are proposed, and permit applicants are expected to minimize unavoidable impacts insofar as practicable. The JD forms the informational basis for permit calculations and for designing compensatory mitigation to offset agency-approved impacts to the extent practicable.

Recent experience confirms that applicant-proffered wetland boundaries continue to warrant detailed scrutiny by the Army Corps of Engineers and other regulators. In one 2010 mining application in Greene County, National Wetland Inventory maps disclosed 4 wetlands on a 642-acre site. The applicant's consultant submitted a proposed delineation to PADEP showing 10 wetlands. After field inspection by the Corps, the JD drawing of the same tract of land showed 27 wetlands (Schmid & Co., Inc. 2013). In Sullivan County a gas company consultant delineated streams and wetlands in a 50-foot wide right-of-way along some 4,000 feet of unpaved township road. After the adjoining landowners secured Corps JDs, the square footage of regulated streams and wetlands increased to 700% of that flagged for the gas company within the same 4-acre strip of land (Schmid & Co., Inc. 2011b). The Corps field representative commented that significant under-identification of wetlands had occurred at several recent gas well installations where he had been involved with enforcement actions. None of those permittees had secured a Corps JD, and PADEP as usual had approved their permits without questioning the accuracy of information in the applications. It is not possible to overemphasize the necessity for JD applications followed by field-checking by Corps staff of proffered delineations as critical to the identification of wetlands in Pennsylvania prior to permit approval. Unidentified wetlands are not protected at all.

Wetland Permits

Regulated activities in Pennsylvania wetlands and other bodies of water cannot legally be initiated prior to permit approval by the Department of Environmental Protection (PADEP), except for waivered activities (25 *Pa. Code* 105.12) and registered activities that conform to the requirements of pre-approved general permits (25 *Pa. Code* 105.441 *et seq.*). Above established minimum thresholds of impact, regulated activities in federally regulated wetlands and waters also require approval from the Army Corps of Engineers. Except for those areas and

activities excluded from regulation by waiver or authorized via general permits, wetland functions by regulation must be identified by an applicant when permit approval is sought for activities that will encroach upon wetlands and other bodies of water in Pennsylvania (25 *Pa. Code* 105.13). Permit applications for relatively small encroachments may be reviewed only by State agencies; larger or more damaging activities must be considered independently also by federal agencies. Few of the more than 2,500 Pennsylvania municipalities have adopted any ordinances protective of wetlands, but some have included wetlands as among resources to be reviewed at the local level, and their wetlands may be protected over and above what State and federal agencies require. Like PADEP, local agencies generally lack the staff resources to identify jurisdictional boundaries for wetlands.

After wetlands have been identified, permit applicants are expected to avoid impacts, and where unavoidable, to make every practicable effort to minimize impacts when planning their construction projects; PADEP is to review such efforts to avoid and minimize impacts [25 *Pa. Code* 105.14(b)(7)]. Where encroachments are proposed into wetlands, it is the responsibility of the permit applicant to identify onsite conditions in every affected wetland as a basis for ascertaining the probable alteration of functions when analyzing unavoidable adverse impacts and providing appropriate compensatory mitigation (25 *Pa. Code* 105.14, .15, and .18a). Impacts are to be analyzed in an Environmental Assessment (§105.15). The extent and nature of unavoidable impacts become the basis for developing the applicant's proposal for site restoration and compensatory mitigation. The quality of wetland assessment depends on the thoroughness and accuracy of underlying wetland inventory as well as the professional competence of the delineator and agency reviewer. Wetland functions form a principal aspect of the environmental assessment.

PADEP and district offices of the Army Corps of Engineers have adopted a joint permit application (Form 3150-PM-BWEW0036A, March 2013) and related forms that solicit the minimum information needed for agency decisionmaking regarding affected wetlands and other bodies of water on properties where construction is planned that may damage these resources. Public notice is required for individual joint permit applications, but not for waivered activities or for registrations of applicant intent to rely upon general permits. PADEP staffers are charged with reviewing each application to insure its completeness, its accuracy, and the applicant's proposed compliance with applicable regulations. Permit files, application data, and related correspondence are public records and can be examined by persons concerned about wetland protection through the procedures of Pennsylvania's Right to Know Law (Act 3 of 2008) and the federal Freedom of Information Act (5 USC 552 *et seq*.). Upon approval of a PADEP permit, the window for filing appeals to the Pennsylvania Environmental Hearing Board by any aggrieved party remains open for thirty days. Applicants are required to conform to the conditions and limitations set forth in general and individual permits. All recipients of individual permits by regulation are required

to file a statement of compliance with permit requirements within 30 days of work completion and to file final as-built plans within 90 days showing any changes from original plans and specifications (25 *Pa. Code* 105.107).

In Pennsylvania some wetlands are deemed more valuable than others. Exceptional Value wetlands deserve *specia*l protection. Such wetlands exhibit one or more of the following characteristics (25 *Pa. Code* 105.17):

1. Serve as habitat for fauna or flora listed as threatened or endangered under federal or Pennsylvania law.
2. Are hydrologically connected to or located within 0.5 mile of the above and maintain the habitat of the endangered species.
3. Are located in or along the floodplain of the reach of a wild trout stream or waters listed as having Exceptional Value and the floodplain of their tributary streams, or within the corridor of a federal or Pennsylvaia designated Wild or Scenic River.
4. Are located along an existing public or private drinking water supply and maintain the quantity or quality of that surface water or groundwater supply.
5. Are located in State-designated natural or wild areas within State parks or forests, in federally designated Wilderness Areas or National Natural Landmarks.

Wetlands that qualify as having Exceptional Value are defined as surface waters of Exceptional Ecological Significance (25 *Pa. Code* 93.1), and thus (like Pennsylvania streams that have been designated or have attained Exceptional Value uses) are to be treated as Tier 3 Outstanding National Resource Waters in the language of the Clean Water Act of 1972 (as amended, 33 *USC* §1251 *et seq*.; *US Environmental Protection Agency Water Quality Handbook* - Chapter 4: Antidegradation [40 *CFR* 131.12]). These highest-quality resources are to be protected from degradation. Wetlands that do not exhibit any of the above-listed characteristics are deemed “Other” wetlands.

Permits for structures and activities in Exceptional Value wetlands are not to be approved unless PADEP finds that: the dam, water obstruction, or encroachment will not have an adverse impact on the wetland, as determined in accordance with §§ 105.14(b) and 105.15; the project is water dependent, requiring access to, proximity to, or siting within the wetland to fulfill its basic purpose; there is no practicable alternative that would not involve a wetland or that would have less adverse effect on the wetland and not have other significant adverse effects on the environment; the project will not cause or contribute to a violation of an applicable State water quality standard; the project will not cause or contribute to pollution of groundwater or surface water resources or diminution of resources sufficient to interfere with their uses; and the applicant replaces the affected wetland in accordance with criteria at § 105.20a [25 *Pa. Code* 105.18a(a)]. Yet Corps Jurisdictional Determinations are not required for Exceptional Value wetlands in Pennsylvania, so these wetlands are equally likely to be overlooked as those lacking exceptional value.

“Other” wetlands also are deemed “a valuable public natural resource” (25 *Pa. Code* 105.17) that is to be protected from significant impacts in similar fashion to

Exceptional Value wetlands. Permits are to be granted to dams, water obstructions, or encroachments affecting Other wetlands only when PADEP finds that: the project will not have a significant adverse impact considering the areal extent of the impacts, values, and functions of the wetlands, the uniqueness of the wetland functions and values in the area or region; comments from environmental agencies have been addressed; adverse impacts on the wetland are to be avoided or reduced to the maximum extent possible; there is no practicable non-wetland impacting alternative; the applicant has convincingly demonstrated that non water-dependent projects have no practicable alternative, overcoming the rebuttable presumption that such alternatives exist; the project will not cause or contribute to violation of an applicable State water quality standard; the project will not cause or contribute to pollution of groundwater or surface water resources or diminution of resources sufficient to interfere with their uses; the cumulative effect of this project and other projects will not result in a major impairment of the Commonwealth's wetland resources; and the applicant replaces the affected wetland in accordance with criteria at § 105.20a [25 *Pa. Code* 18a(b)]. On paper, Pennsylvania offers stringent protection to its wetlands.

Wetland Functions

Nine wetland functions are specifically identified in the definitions section of Pennsylvania's Dam Safety and Encroachments regulations (25 *Pa. Code* 25.1). By regulation, these functions are the minimum that require consideration as PADEP evaluates every encroachment permit affecting 1 acre or less of wetlands. Larger wetlands, as well as Exceptional Value wetlands smaller than 1 acre may require more complex assessment of additional functions and values in addition to these [25 *Pa. Code* 105.13(d)(3)]:

Wetland Functions Requiring Analysis in PADEP Permits

1. Serving natural biological functions, including food chain production; general habitat; and nesting, spawning, rearing and resting sites for aquatic or land species.
2. Providing areas for study of the environment or as sanctuaries or refuges.
3. Maintaining natural drainage characteristics, sedimentation patterns, salinity distribution, flushing characteristics, natural water filtration processes, current patterns or other environmental characteristics.
4. Shielding other areas from wave action, erosion, or storm damage.
5. Serving as a storage area for storm and flood waters.
6. Providing a groundwater discharge area that maintains minimum baseflows.
7. Serving as a prime natural recharge area where surface water and groundwater are directly interconnected.
8. Preventing pollution.
9. Providing recreation.

Different wetlands exhibit different combinations of functions. Some mutually exclusive functions (for example, groundwater recharge and groundwater

discharge) can alternate over time within a single wetland. The functions performed by a wetland may vary over seasons and from year to year. The functions that any given wetland is capable of performing result from both the internal characteristics of the wetland itself and the surrounding context in which that wetland exists, including its connection with other natural areas and with watercourses. Corridors for wildlife movement, for example, are important to allow populations of animals to move between areas of wetland habitat, and many streams function as wildlife corridors. Similarly, only a wetland located on the shore of an open water body can shield other areas from wave action. The success of a wetland in performing functions can be affected greatly by past or ongoing human activity. Most wetland functions are disrupted permanently or temporarily by construction activities that impinge upon the wetland vegetation, soils, or hydrology directly. Human activities that increase performance of one function can accompany decreasing performance of other functions by that wetland.

Wetland functions also can be affected by construction outside the wetland itself out to a distance of 1,500 feet or more (Houlahan *et al*. 2006). For example, wildlife that breed in wetlands, such as reptiles and amphibians including frogs and salamanders, normally range into the adjoining uplands for distances of many hundreds of feet in eastern North America during the course of an annual cycle. If the adjacent lands are deforested or paved, or the wetland isolated by an intervening road or fence, the wetland habitat can be rendered useless to such creatures. By way of further example, altering the light and wind by removing the surrounding forest can cause a major change in the plants and animals that can survive in a wetland. Surface disturbances outside a wetland also can have major impact on the hydrology of the wetland, profoundly altering its ecosystem by draining or flooding it.

There is no State-regulated wetland buffer in Pennsylvania, such as exists in New Jersey or New York. Those States have expressed concern for the variable boundaries of wetlands that result from differing weather conditions year to year. They wisely recognize that the associated transitional areas adjacent to wetlands comprise essential parts of the functioning ecosystem of each wetland. Hence they long have considered the preservation of ecosystems adjacent to a wetland to be an essential part of protecting that wetland's functions and values. The absence of regulated buffers around wetlands in Pennsylvania renders its wetlands at risk of unavoidable degradation, especially in areas of concentrated human populations. A few Pennsylvania municipalities have recognized or sought to remedy this environmental risk through local ordinances that provide for maintenance of some amount of undeveloped protective buffer outside the wetland.

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Wetland Classification

The functions and values of a wetland differ according to the placement of the wetland in the landscape and the manner in which it gains its wetness.

Functional analysis logically addresses different classes of wetlands differently when addressing their potential for damage or rehabilitation. Wetlands and shallow water bodies are usefully categorized at the most basic level by general hydrogeomorphic system. Across most of the Pennsylvania landscape, wetlands and small ponds are assigned to the Palustrine (P) system, which is distinguished from tidal estuarine and marine classes, lakes, and large rivers. Wetlands along the boundaries of water bodies are assigned to the Riverine (R) or Lacustrine (L) systems, although many floodplain wetlands are labeled as Palustrine. Marine (M) and Estuarine (E) classes are of limited extent in Pennsylvania.

The following table identifies the most recent hydrogeomorphic classifications under development by the PADEP (draft Technical Guidance Document 310-2137-002, 7 March 2014, p. 27). The classification is significant as it affects the functional analysis of all water bodies including wetlands.

Mid-Atlantic HGM Wetland Classification:

- Classes
  - Subclasses
    - Modifiers
- Marine
  - subtidal
  - intertidal
- Estuarine
  - subtidal
  - lunar intertidal
  - wind intertidal
  - impounded
- Riverine
  - lower perennial
  - floodplain complex
  - upper perennial
  - headwater complex
  - intermittent
    - beaver impounded
    - human impounded
- Lacustrine (fringe)
  - permanently flooded
  - semipermanently flooded
  - intermittently flooded
  - artificially flooded
- Palustrine
  - Flat
    - Flat mineral soil
    - Flat organic soil
  - Slope
    - Stratigraphic
    - Topographic
      - mineral soil
      - organic soil
  - Depression
    - perennial
    - seasonal
    - temporary
      - human impounded
      - human excavated
      - beaver impounded

PADEP goes on to offer additional detail on the principal kinds of wetlands in Pennsylvania classed by location associated with hydrology that require consideration during functional assessments. The modifiers give an idea of the variability of the basic types (draft Technical Guidance Document 310-2137-002, 7 March 2014, p. 24-25). Once these distinctions have been formally adopted by PADEP for consideration in each permit application, the precision and quality of data provided by applicants' consultants should improve, along with the quality of impact analysis.

Pennsylvania Hydrogeomorphic Wetland Classification Key.

1.	Wetland found along tidal fringe of a marine ecosystem (ocean, beach, rocky shore)	2
1.	Wetland not associated with marine ecosystem	3
2.	Continuously submerged littoral zone	**Marine subtidal** (MF1)
2.	Alternately flooded and exposed to air	**Marine intertidal** (MF2)
3.	Wetland associated with shallow estuarine ecosystem (Mixture of saline and freshwater)	4
3.	Wetland not associated with shallow estuarine ecosystem	7
4.	Wetland not impounded	5
4.	Wetland impounded	**Estuarine impounded** (EFh)
5.	Wetland continuously submerged	**Estuarine subtidal** (EF1)
5.	Wetland alternately flooded and exposed to air	6
6.	Wetland regularly or irregularly flooded by semidiurnal, storm, or spring tides	**Estuarine lunar intertidal** (EF2l)
6.	Wetland flooding induced by wind	**Estuarine wind intertidal** (EF2w)
7.	Wetland associated with freshwater stream or river	8
7.	Wetland not associated with freshwater stream or river	11
8.	Wetland associated with permanent flowing water from surface sources	9
8.	Wetland dominated by ground water or intermittent flows	10
9.	Wetland associated with low gradient tidal creek (see Estuarine types 3)	
9.	Wetland associated with low gradient and low velocities, within a well-developed floodplain (typically >3rd order)	**Riverine lower perennial** (R2)
9.	Wetland part of a mosaic dominated by floodplain features (former channels, depressions) that may include slope wetlands supported by ground water (see Slope 17)	**Riverine floodplain complex** (R2c)
9.	Wetland associated with high gradient and high velocities with relatively straight channel, with or without a floodplain (typically 1st - 3rd order)	**Riverine upper perennial** (R3)
10.	Wetland part of a mosaic of small streams, depressions, and slope wetlands generally supported by ground water	**Riverine headwater complex** (R3c)
10.	Wetland associated with intermittent hydroperiod	**Riverine intermittent** (R4)

Note:	For any riverine type that is impounded, distinguish between:	
	Wetland impounded by beaver activity	**Riverine...beaver impounded** (R...b)
	Wetland impounded by human activity	**Riverine...human impounded** (R...h)
11.	Wetland fringing on a lake or reservoir	**12**
11.	Wetland not fringing on lake or reservoir	**14**
12.	Wetland inundation controlled by relatively natural hydroperiod	**13**
13.	Wetland inundation is permanent with minor fluctuations (year round)	**Lacustrine permanently flooded** (LFH)
13.	Wetland inundation is semipermanent (growing season)	**Lacustrine semipermanently flooded** (LFF)
13.	Wetland inundation is intermittent (substrate exposed often)	**Lacustrine intermittently flooded** (LFJ)
12.	Wetland inundation controlled by dam releases	**Lacustrine artificially flooded** (LFK)
14.	Wetland water source dominated by precipitation and vertical fluctuations of the water table due to low topographic relief	**15**
14.	Wetland differs from above	**16**
15.	Wetland substrate is primarily of mineral origin	**Flat mineral soil** (FLn)
15.	Wetland substrate is primarily of organic origin	**Flat organic soil** (FLg)
16.	Wetland water source is primarily ground water and has unidirectional and horizontal flows	**17**
16.	Wetland forms a depression	**18**
17.	Water source for wetland derived from structural geologic discontinuities resulting in discharge of groundwater from distinct point(s) on slope	**Stratigraphic slope** (SLs)
17.	Water source for wetland accumulates at toe-of-slope before discharging	**Topographic slope** (SLt)
Note:	For any slope type, distinguish between: Wetland substrate is primarily of mineral origin	**...slope mineral soil** (SL...n)
	Wetland substrate is primarily of organic origin	**...slope organic soil** (SL...g)
18.	Wetland with frequent surface connections conveying channelized flow	**Depression perennial** (DFH)
18.	Wetland with infrequent surface water connections conveying channelized flow	**Depression seasonal** (DFC)
18.	Wetland with no surface outlet, often perched above water table	**Depression temporary** (DFA)
Note:	For any depression type that is impounded or excavated distinguish between:	
	Wetland is impounded by human activities	**Depression...human impounded** (DPh)
	Wetland is excavated by human activities	**Depression...human excavated** (DPx)
	Wetland is impounded by beaver activities	**Depression...beaver impounded** (DPb)

Another of the basic classifications of wetlands derived from their appearance and germane to assessing their functions is their vegetation type. The descriptive framework for vegetation structure was devised by the US Fish and Wildlife Service (Cowardin *et al*. 1979) and is used for small-scale mapping by the National Wetlands Inventory. Vegetation and hydrogeomorphic location are combined to identify the principal habitat types identified by PADEP in Pennsylvania (Draft Technical Guidance Document 310-2137-001, March 2014,

p. 7). Notably, PADEP to date has not identified any nontidal Riverine wetland habitat types:

Some Pennsylvania Wetland Habitat Types.

LAB	Lacustrine Aquatic Bed
LEM	Lacustrine Emergent
LFL	Lacustrine Flat
PAB	Palustrine Aquatic Bed
PEM	Palustrine Emergent
PFL	Palustrine Flat
PFO	Palustrine Forested
PSS	Palustrine Scrub/Shrub

Lacustrine Emergent Wetland and Lacustrine Aquatic Bed.

Palustrine wetlands are the most numerous and widespread kinds in Pennsylvania, accounting for 97% of the wetlands mapped in the Commonwealth by the National Wetland Inventory from high-elevation aerial photos taken during the late1970s and early 1980s (Tiner 1990). National Wetland Inventory mapping is a useful tool whose results are valuable for regional wildlife resource management, but it significantly omits many forested wetlands in Pennsylvania and is not a reliable guide to regulated wetland locations or boundaries.

Nevertheless, its incomplete and approximate data are readily available online and often are displayed on maps generated by geographical information systems. Hydric soil map units in county soil maps and wetland patterns on US Geological Survey topographic quadrangles also offer clues to wetland locations. But the actual extent of wetlands and streams can be determined only by field delineation of specific properties when construction activities are proposed.

The principal kinds of vegetation found in Palustrine wetlands are classed as forest (PFO), scrub (PSS), and herbland (PEM) based on visual observation and/or aerial photographs. Available statistics probably underestimate the proportion of forested wetlands in Pennsylvania, inasmuch as they are based on aerial photographs rather than field investigation and omit forested wetlands not distinguishable remotely. Palustrine flats (FL) devoid of vegetation are not common. The focus of vegetation classification is on the size and structure of the general mass of vegetation present in the landscape. An individual plant, depending on species, can pass through the structural stages of herb, shrub, and tree as it grows in wetlands or uplands. The US Fish and Wildlife Service has reported their estimate of cover types of National Wetland Inventory wetlands in Pennsylvania based on 1975-1985 aerial photographs (Tiner 1990):

Palustrine Forests.

Delhaas Woods, Bucks County. Photograph by Roger Earl Latham.

Columbus Bog, State Game Lands 197, Warren County. Photograph by Paul Wiegman.

Acres of National Wetland Inventory Wetlands in Pennsylvania, 1975-1985.

Palustrine Wetlands	
Emergent	*52,338 a*
Deciduous Forested	*146,715 a*
Evergreen Forested	*31,204 a*
Deciduous Scrub-Shrub	*47,539 a*
Evergreen Scrub-Shrub	*1,849 a*
Mixed Deciduous Shrub-Emergent	*25,000 a*
Open Water	*61,841 a*
Other Mixed Types	*26,242 a*
Total Palustrine Wetlands	*392,728 a*
Lacustrine Wetlands	*8,521 a*
Riverine Wetlands	*2,675 a*
PENNSYLVANIA WETLANDS	***403,924 a***

Forest vegetation (FO) is dominated by trees at least 3 inches in minimum trunk diameter measured 4.5 feet above the ground and at least 20 feet tall. Shrubs and herbs can grow beneath the canopy trees, or the forest floor can be essentially bare. Scrub (SS) is dominated by shrubs with multiple stems less than 3 inches in diameter and rarely taller than 20 feet. Herbs can be abundant beneath the shrubs but trees are few; light tends to reach the land surface to a much greater degree than in forests. Herblands (EM) are generally devoid of woody plants but instead support various kinds of non-woody, herbaceous higher plants that emerge from the soil surface. Their plant cover can be sparse or dense. Tracts of land that qualify as forest, scrub, or herbland may intergrade and are mapped as mixed types (for example, FO/SS). The forest, scrub, and herbland categories each can be subdivided into numerous subtypes, depending on the purpose of such classification and appropriate level of detail. For example, Palustrine forest and scrub polygons on maps can be broadleaf deciduous (assigned the modifier “1” by the National Wetland Inventory, as in “PFO1”) or needleaf evergreen (“PFO4”); emergent herbs can be persistent year-round (“1” as in “PEM1”) or nonpersistent (“PEM2”), and any of these modifiers

can be further supplemented by codes for dominant plant genus or species or for other ecosystem attributes where more precise distinctions are needed.

In Pennsylvania Palustrine ecosystems, forested wetlands are more extensive than scrub and herbaceous wetlands. Natural plant succession generally trends toward forest conditions in eastern North America (Braun 1950, Küchler 1964), and thus herbaceous and scrub wetlands tend to reflect earlier stages of natural post-disturbance succession than forested wetlands. The first-approximation airphoto mapping of Pennsylvania wetlands by the US Fish and Wildlife Service reported deciduous forests making up 37% of Palustrine wetlands; evergreen forest, 8%; deciduous scrub, 12%; evergreen scrub, <0.1%; mixed deciduous scrub-herbland, 6%; herbland, 13%; open water (including farm ponds), 16%; and other mixed types, 7% based on 1975-1985 aerial photographs (Tiner 1990). Under natural conditions the forest community is disrupted occasionally by storms, fire, and beaver activity. Human activities today are a much more common source of forest removal. Not all herblands, however, are rapidly changing categories of plant succession on their way to becoming forests; some can persist naturally for long periods of time as viewed by humans. The plants found in particular wetland communities can range from diverse species to almost monotypic where invasives have become established.

State and federal agencies that keep records of wetlands and wetland modifications use these vegetation types for data collection and analysis. Each distinctive vegetation type also is associated with characteristic functions. Herbaceous wetland vegetation is capable of being reestablished relatively quickly following temporary disturbance, within only a few growing seasons, if soil and hydrologic conditions are favorable. Shrubs require additional years to reach full size, and forest trees require decades for canopy closure, even where soil disturbance has not been severe. Diverse populations of desirable native species can require long periods of time to become established in disturbed or newly created wetlands.

Functions of Pennsylvania Wetlands

This section discusses the functions listed above (as set forth in 25 *Pa. Code* 105.1) that are typically associated with Palustrine forested (PFO) wetlands and compares them with similar functions in scrub (PSS) and herbaceous (PEM) wetlands. These functions are subject to disruption by human activities as well as by catastrophic occurrences of weather (hurricanes, tornadoes), ice storms, landslides, floods, and fires. Reductions in some functions may accompany increases in others.

The PADEP list of nine wetland functions in Chapter 105 regulations is reasonably comprehensive and suited to project-scale analysis based on the specific acreage of wetlands affected by an individual permittee. Current regulations do not focus on quantitative annual productivity of timber or wildlife, removal of air pollutants, carbon sequestration, or less tangible functions such as

aesthetic or historic/cultural appreciation. Nor do they require measurement of the values of any identified functions to individuals or groups. They do not specify how to compare the relative values of different functions, how to index current, past, or future functions of specific wetlands to generally accepted "reference" natural wetlands, call attention to the context of land surrounding a wetland, address the scarcity of a vegetation type, or provide for actual consideration of cumulative wetland impacts beyond an individual permit. PADEP long has found it virtually impossible to consider cumulative impacts, even for a single large project, because of its longstanding willingness to consider permits for fragments of a project on a piecemeal basis independently. PADEP does not expect an applicant to address its entire single project in a joint permit submission, much less analyze its proposed impacts cumulatively with those of other permittees over large areas. PADEP also does not focus on the uniqueness or heritage value of specific wetlands (aside from their potential for classing a wetland as having Exceptional Value) or a wetland's actual replaceability or irreplaceability, should damage be authorized.

1. Natural Biological Functions and General Habitat

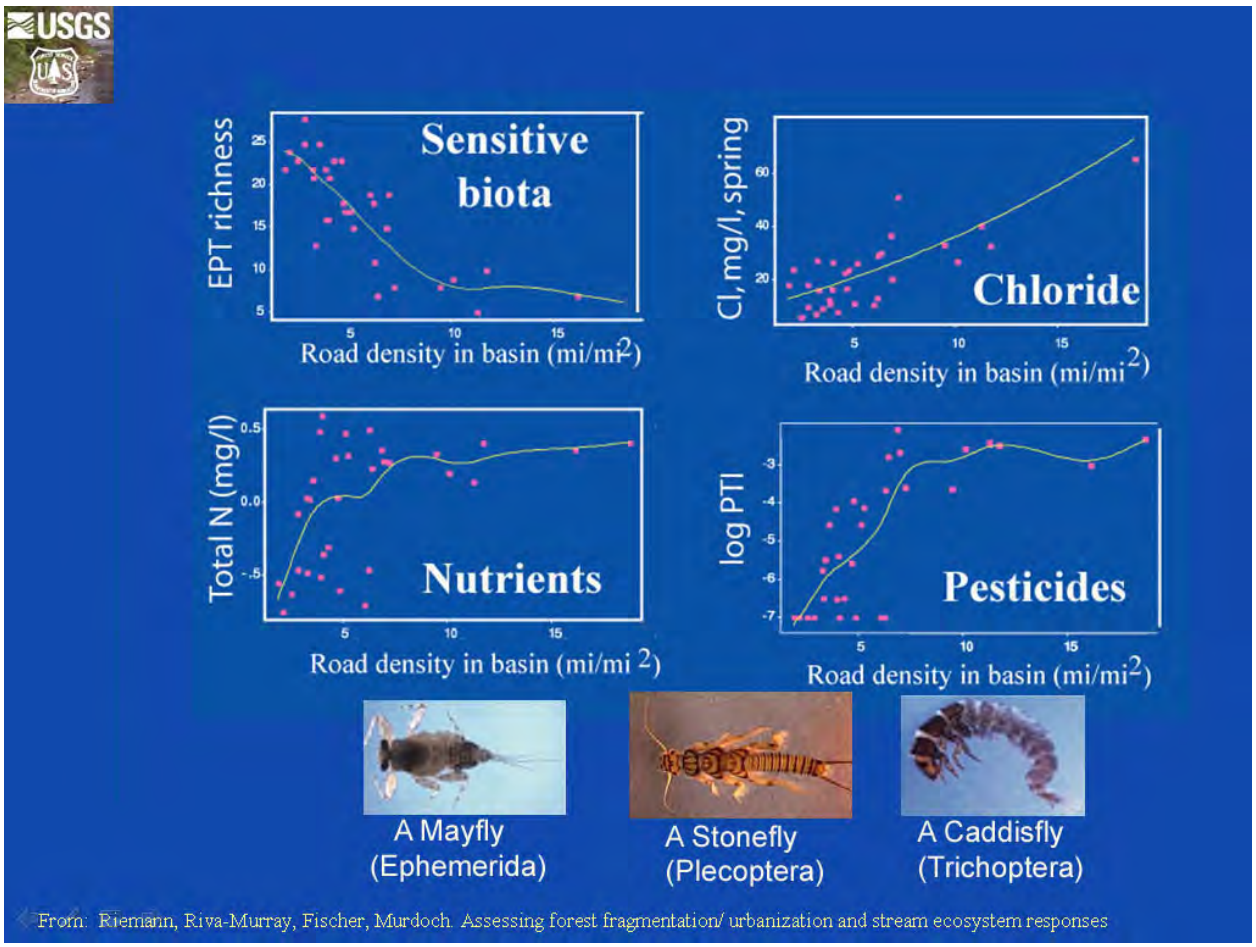
Natural biological functions of all wetlands include food chain production, general habitat, and resting-nesting-spawning-rearing sites for animals and fish. Many rare species of plants and animals are directly dependent on wetland habitats. Trees are the largest kinds of plants and have the greatest ability to modify the environmental effects of solar radiation, precipitation, temperature, humidity, and air quality as a result of their above-ground biomass. These natural, localized environmental modifications are of vital importance to the other plants and to the animals that live within and beneath forest cover. Tree leaves produce more tons of biomass per acre than shrubs for consumption by grazers and accumulate larger standing crops of organic material above ground. Tree trunks and limbs provide food for some animals and homes for many, with more complex structure than scrubs or herblands.

Pennsylvania forests consist of a wide variety of broadleaf deciduous trees, each species of which provides a somewhat different diet to the consumers that depend on it (Zimmerman *et al*. 2012; McShea & Healy 2002). Oaks, maples, ashes, elms, cherries, birches, and beech reflect the ancient geological history of Appalachia, and they returned to glaciated regions when the Pleistocene ice sheets melted. Pennsylvania forests also support many needleaf evergreen trees such as pines, hemlocks, and spruces. Very few stands of unharvested primeval forest remain in Pennsylvania; most of its forests have regrown following two or more episodes of intensive logging, burning, and other human disturbance during the past four centuries---episodes that have greatly affected the streams of the Commonwealth. Closed canopy forest consisting of mature trees requires about a century to recover to a recognizable mature forest structure after fire or clearcutting. About one third of Pennsylvania's forest stands are 80 years old or more; only 7%, 100 years old or more (McCaskill *et al*.

2013). Regenerated forest stands may or may not resemble their predecessors in their species composition when examined in detail, and the largest regrown individual trees are significantly smaller than historic records document as inherited by European colonists. Selective harvesting can remove key forest constituents, thereby reducing habitat value, and the forest canopy is further disrupted by logging roads, well pads, pipeline rights-of-way, borrow areas, and spills of fuel, brine, and other pollutants. Various kinds of shrubs and herbs grow only beneath a mature forest canopy. Wood ducks (*Aix sponsa*), a particularly handsome native species of waterfowl, require tree cavities for nesting as well as nearby water.

Trees growing in adjacent wetlands and streambanks are the major source of food for aquatic organisms in small, headwater streams. The intensity of ongoing human disturbance on the streams of forested areas can be estimated by the linear extent of roads per unit area. As summarized graphically by the United States Forest Service and US Geological Survey, human activity as approximated by road density has a dramatic effect on the quality of streams for sensitive aquatic insects that form the base of the aquatic food chain:

Road Density and Aquatic Parameters.



Both broadleaf and evergreen trees can dominate Pennsylvania wetlands, although broadleaf trees remain much more abundant (McCaskill *et al*. 2013). The value of forested wetlands to wildlife and to landowners is affected by the number of kinds of trees and other plants present (species diversity), their density and biomass (timber volume), the amount of dead timber standing and on the ground, the amount of grazing by domestic livestock and browsing by white-tailed deer, and the proportion of non-natives present. Diverse, high-quality vegetation is at greatest risk of human degradation and is the most difficult to restore (Olson and Doherty 2011). Wetland forests provide nesting, rearing, resting, and feeding sites for birds and mammals. One third of the bird species in the United States depend on wetlands (230 of 636; Welsch *et al*. 1995). Bears spend 60% of their time in forested wetlands during spring and summer (Newton 1988).

Unfragmented wetland forests are of great importance to many declining species of migratory songbirds. Wet forest floors are attractive wintering areas in which endangered bog turtles hibernate, and thick stands of evergreens shelter wintering deer and other animals. As already noted, the nutrients derived from tree leaves and twigs are vital to the macroinvertebrates and fish of Pennsylvania streams. Forest ecosystems are limited in their growth capability and affected in species composition by the availability of nutrients provided by the weathering of rock and transported in by air masses. The carbon from tree litter in turn can make up 99% of the total dissolved organic carbon at the base of the aquatic food web in forested streams (Stoler and Relyea 2011). Isolated vernal pools free of predatory fish are critically important to many uncommon reptiles and amphibians whose populations are dwindling. Discharges of stormwater, waste chemicals, and rubbish can degrade general habitat functions in forest and other wetlands.

Permanent forest disruption across Pennsylvania wetlands and uplands.

Scrub wetlands accumulate less standing biomass than mature forests. Hence any of the functions that derive from quantity of biomass are reduced in scrub as compared with forest wetlands, such as influence on microclimate, the amount of organic matter available for consumers of plant biomass, or the protection offered to soil from erosion. Some herbaceous wetlands can produce biomass in quantities rivaling forests above and below ground, but they lack the structural diversification of above-ground biomass of the woody wetlands. For animals adapted to herbaceous wetlands, such ecosystems provide important general habitat, nesting, resting, and rearing sites. The microtopography of hummocks provides habitat diversity critical to many species. Temporarily or permanently inundated herbaceous wetlands linked to streams and lakes have key importance as spawning and nursery grounds for fish, and inundated scrub wetlands are more common than inundated forests in Pennsylvania. The scrubs and sedge meadows with deep organic deposits associated with very wet herbaceous wetlands are prime spring and summer areas for various reptiles including the endangered bog turtle (*Glyptemys muehlenbergii*). Bog turtles prefer to overwinter in mats of tree roots where emerging groundwater warms near-surface temperatures. Herbaceous wetlands are of special importance to migrating waterfowl.

2. Environmental Study Areas and Refuges

Forested wetlands can serve as environmental study areas, particularly when located near schools, in public parks, and on other sites available to the public. Because natural plant succession in Pennsylvania normally trends toward forest vegetation, forests usually characterize refuges and sanctuaries relatively undisturbed by people, and forested wetlands typically provide high quality habitat to wildlife. The significance of forest cover to wetland wildlife increases as the size of wetlands decreases, particularly in landscapes with intensive human activity.

Scrub and herbaceous wetlands also can serve as study areas and biological refuges. They are less screened visually and aurally from adjacent human activities by their relatively lower quantities of biomass. They provide key habitat for wetland plants and animals that require open sun reaching the soil surface. Herbaceous wetlands are prime locations for birders.

3. Water Quality and Quantity Protection and Drainage Patterns

Forest wetland vegetation has maximal effect on processes affecting water movement and interaction with the land. By their mass, trees are able to slow the energy of falling raindrops and thereby limit soil erosion. Similarly, their mass and shade render the affected ground beneath the trees moister and cooler than nearby areas open to the sun. Decaying leaves provide a surface that readily accepts precipitation and allows it to infiltrate soil rather than quickly running off the surface.

The interflow through soils in turn contributes to natural extended flow of streams, minimizing both flooding and stream dryup. Nutrients can be bound up in tree trunks for centuries, and thereby kept out of waterways. The complex chemical reactions in wetland soils allow bacterial denitrification fostered by the carbon from leaves and vital to preventing excess nitrate-nitrogen from reaching streams. Wetland tree roots also can help anchor banks of streams against erosion. Forest loss to other land uses in Pennsylvania occurs at the rate of about 150 acres per day (McCaskill *et al*. 2013). Presumably most of these converted lands are not wetland forests, inasmuch as PADEP acknowledges the loss of less than 100 acres of all wetlands annually via individual permits, including forested wetlands.

Scrub and nonpersistent herbaceous wetlands stockpile less biomass on the land surface year-round than forested wetlands. They may offer less protection to the soil than forested wetlands, and their smaller roots may provide less resistance to physical erosion of streambanks.

Discharges of wastewater can contain pollutants at sufficient concentrations to overwhelm the ability of natural wetland systems to accommodate the pollutants, resulting in severe damage to the wetland ecosystems by manure, sewage, spilled brine, oil, and other chemicals. Rubbish also can degrade general habitat functions in forest and other wetlands.

4. Shoreline Protection and Stormwater Shielding

Aside from those on the banks of lakes and large rivers, forested wetlands in Pennsylvania generally have limited opportunity to shield other areas from wave and storm damage. Tree roots can stabilize streambanks large and small against stormwater erosion. To a lesser degree scrub wetlands can function similarly. Shrub willows often are planted to stabilize shorelines.

Some herbaceous wetlands occupy the shallow fringes of large water bodies, where they serve to reduce wave action and encourage sedimentation (thereby protecting water quality).

5. Flood Storage

Forested wetlands often serve as temporary storage areas for storm and flood waters. The economic value of such storage increases annually as flood damages rise in response to increased runoff from a growing human population, impervious surfaces from ever-expanding land development, and storm events of increasing severity driven by global warming in response to the burning of fossil fuels. Many forest ecosystems are adjusted to and dependent upon seasonal flooding, unlike most human structures that are easily damaged even by short-term inundation during flood peaks. Scrub and herbaceous wetlands, provided that they are suitably located, can function equally as well as forested wetlands for temporary

stormwater storage, although they may not shade the stored water so effectively and therefore not keep its temperature so low as a dense forest cover.

6. Groundwater Discharge

Spring seep areas are characteristic along the base of slopes in Pennsylvania forested wetlands. The forest shade keeps summer temperatures low as groundwater travels over the land surface toward headwater streams. Trout are a major feature of Pennsylvania streams and much sought-after by anglers. Many Pennsylvania streams have water near the limit of summer warmth that trout can tolerate. Forested wetlands along watercourses are essential to maintaining temperatures low enough for trout to survive and reproduce as global warming continues in response primarily to the burning of fossil fuels. Conversely, because of the warmth of groundwater, spring seeps may become snow-free earlier than dry uplands, and thereby attract feeding turkeys and other wildlife.

Shrub and herbaceous wetlands also can be associated with seeps flowing toward small streams. They are less able to keep surface water temperatures low than forests because of their lesser shade, but they may transpire fewer gallons of water during the course of a hot day. As mentioned previously, groundwater seeps closely associated with masses of tree roots are especially attractive areas for overwintering bog turtles.

Forested Wetland with Seeping Groundwater Discharge.

7. Groundwater Recharge

Countless local topographic depressions in forested wetlands store precipitation, slow its movement toward streams during periods of flood, and enable it to recharge local groundwater during wet seasons. Recharged groundwater, in turn, typically finds outlets to local streams. Recharge can be greater in scrub and herbaceous wetland depressions, because their plant cover transpires less water into the atmosphere than large trees.

8. Pollution Prevention and Sediment Control

Forested wetlands prevent pollution of water bodies by reducing the erosive force of rainstorms. Their trees break the fall of droplets hitting leaves and branches; they anchor the soil with roots and cover it with absorptive leaf litter; their roots bind streambank soils against erosion. Forested wetland soils enable sedimentation, denitrification, and other biogeochemical processing as surface waters pass through. Scrub and herbaceous wetlands can function comparably, but provide less physical protection against soil erosion by precipitation. Forested buffers surrounding wetlands can provide the most effective long-term protection of wetlands from sediment influx originating in disturbed lands.

9. Human Recreation

Wetland forests provide recreational opportunities for Pennsylvania citizens and visitors, calling forth significant contributions to the economy of the Commonwealth on a sustainable basis by those who use the outdoors. Great numbers of people find the seasonally changing display of blooms and colored leaves highly attractive and a sharp contrast to landscapes in urban centers. Recreational hunters seek the game animals---deer, bear, squirrels, waterfowl, and other game birds---that depend on wetland as well as upland forests. Anglers depend on riparian forests to keep the Pennsylvania streams cool enough and to supply food for salmonids. Forested wetlands are especially effective in providing humans with natural landscapes contrasting sharply with urban commercial and industrial environments.

Scrub and herbaceous wetlands also provide recreational opportunities for hiking and for game habitat. Herbaceous wetlands often attract spectacular flocks of migratory waterfowl.

Palustrine Deciduous Scrub Opening in Needleaf-Dominated Bog on Peat.

Rosencrans Bog Natural Area, Clinton County. Photograph by Staff of The Western Pennsylvania Conservancy.

Through its recent draft technical guidance documents PADEP appears to be seeking to expand from a strictly acreage-based evaluation of wetland impacts and working instead toward a weighting of functions, indexing to reference ecosystems, and consideration of conditions adjacent to the affected wetland. State methodology also is just beginning to consider cumulative effects on a watershed basis, which is essential for rationally offsetting the negative side effects (externalities) of construction in wetlands. The proposed technical guidance draws conceptually on federally sponsored work on wetland functions that has been underway for twenty years (Smith *et al*., 1995) as well as the more recent work by Robert Brooks and his coworkers at Riparia, the Cooperative Wetlands Research Center at Pennsylvania State University. PADEP's current list of functions is displayed below.

Table 2
Wetland Functions and Their Value

Functions Related to Hydrologic Processes	Benefits, Products, and Services Resulting from the Wetland Function
Short-Term Storage of Surface Water: the temporary storage of surface water for short periods.	Onsite: Replenish soil moisture, import/export materials, conduit for organisms. Offsite: Reduce downstream peak discharge and volume and help maintain and improve water quality.
Long-Term Storage of Surface Water: the temporary storage of surface water for long periods.	Onsite: Provide habitat and maintain physical and biogeochemical processes. Offsite: Reduce dissolved and particulate loading and help maintain and improve surface water quality.
Storage of Subsurface Water: the storage of subsurface water.	Onsite: Maintain biogeochemical processes. Offsite: Recharge surficial aquifers and maintain baseflow and seasonal flow in streams.
Moderation of Groundwater Flow or Discharge: the moderation of groundwater flow or groundwater discharge.	Onsite: Maintain habitat. Offsite: Maintain groundwater storage, baseflow, seasonal flows, and surface water temperatures.
Dissipation of Energy: the reduction of energy in moving water at the land/water interface.	Onsite: Contribute to nutrient capital of ecosystem Offsite: Reduced downstream particulate loading helps to maintain or improve surface water quality
Functions Related to Biogeochemical Processes	**Benefits, Products, and Services Resulting from the Wetland Function**
Cycling of Nutrients: the conversion of elements from one form to another through abiotic and biotic processes.	Onsite: Contributes to nutrient capital of ecosystem. Offsite: Reduced downstream particulate loading helps to maintain or improve surface water quality.
Removal of Elements and Compounds: the removal of nutrients, contaminants, or other elements and compounds on a short-term or long-term basis through burial, incorporation into biomass, or biochemical reactions.	Onsite: Contributes to nutrients capital of ecosystem. Contaminants are removed, or rendered innocuous. Offsite: Reduced downstream loading helps to maintain or improve surface water quality.
Retention of Particulates: the retention of organic and inorganic particulates on a short-term or long-term basis through physical processes.	Onsite: Contributes to nutrient capital of ecosystem. Offsite: Reduced downstream particulate loading helps to maintain or improve surface water quality.
Export of Organic Carbon: the export of dissolved or particulate organic carbon.	Onsite: Enhances decomposition and mobilization of metals. Offsite: Supports aquatic food webs and downstream biogeochemical processes.
Functions Related to Habitat	**Benefits, Goods and Services Resulting from the Wetland Function**
Maintenance of Plant and Animal Communities: the maintenance of plant and animal community that is characteristic with respect to species composition, abundance, and age structure.	Onsite: Maintain habitat for plants and animals (e.g., endangered species and critical habitats), for rest and agriculture products, and aesthetic, recreational, and educational opportunities. Offsite: Maintain corridors between habitat islands and landscape/regional biodiversity.

Stressors

The functional values of wetlands can be reduced by many stressors, most of which are directly or indirectly the result of human activity and also are more intense and persistent than natural disruptive forces. The evolving PADEP list of stressors lists 37 kinds that are readily observable in the field, grouped into five categories (Draft Technical Guidance Document 310-2137-002, March 2014, p. 33). They prudently have left a blank for other, unlisted stressors in each of the five categories, for less commonly encountered conditions.

PADEP-listed Wetland Stressors.

Vegetation Alteration
Mowing
Moderate livestock grazing (within one year)
Crops (annual row crops, within one year)
Selective tree harvesting/cutting (>50% removal, within 5 years)
Right-of-way clearing (mechanical or chemical)
Clear cutting or Brush cutting (mechanized removal of shrubs and saplings)
Removal of woody debris
Aquatic weed control (mechanical or herbicide)
Excessive herbivory (deer, muskrat, nutria, carp, insects, etc.)
Plantation (conversion from typical natural tree species, including orchards)
Other:
Total Number:
Hydrologic Modification
Ditching, tile draining, or other dewatering methods
Dike/weir/dam
Filling/grading
Dredging/excavation
Stormwater inputs (culvert or similar concentrated urban runoff)
Microtopographic alterations (e.g., plowing, forestry bedding, skidder/ATV tracks)
Dead or dying trees (trunks still standing)
Thermal alteration (power plant or industrial discharges with evidence of high temperatures)
Stream alteration (channelization or incision)
Other:
Total Number:
Sedimentation
Sediment deposits/plumes
Eroding banks/slopes
Active construction (earth disturbance for development)
Active plowing (plowing for crop planting in past year)
Intensive livestock grazing (in one year, ground is >50% bare)
Active selective forestry harvesting (within one year)
Active forest harvesting (within two years, includes roads, borrow areas, pads, etc.)
Turbidity (moderate concentration of suspended solids in the water column, obvious sediment discharges)
Other:
Total Number:

Eutrophication
Direct discharges from agricultural feedlots, manure pits, etc.
Direct discharges from septic or sewage treatment plants, fish hatcheries, etc.
Heavy or moderately heavy formation of algal mats
Other:
Total Number:
Contaminant/Toxicity
Severe vegetation stress (source unknown or suspected)
Obvious spills, discharges, plumes, odors, etc.
Acidic drainages (mined sites, quarries, road cuts)
Point discharges from adjacent industrial facilities, landfills, railroad yards, or comparable sites
Chemical defoliation (majority of herbaceous and woody plants affected, within one year)
Fish or wildlife kills or obvious disease or abnormalities observed
Excessive garbage/dumping
Other:
Total Number:

The more numerous the stressors affecting a wetland, the lower its value. When rating the value of wetland conditions, the proposed PADEP scoring also assigns higher value to wetlands surrounded by forests than to those surrounded by scrub, and assigns higher value to those wetlands surrounded by scrub than to those surrounded by herblands or ponds. Managed wetland buffers are scored lower than wild, unmanaged buffers (Draft Technical Guidance Document 310-2137-002, March 2014, p. 33).

In 2006 PADEP sampled 204 wetlands and used their evolving protocols to rank the condition of those wetlands (PADEP 2014c). How representative the sampled wetlands might be of Pennsylvania wetlands as a whole was not stated, but the rankings from their protocol testing were reported as follows:

Condition Category	Number of Wetlands	Total Acreage	Percent of Resource
Highest	13	127.74	6.10%
High	59	556.19	26.70%
Medium	41	468.89	22.50%
Low	91	930.07	44.70%
Totals	**204**	**2082.88**	**100.00%**

Conversion of Woody Wetlands to Herbaceous Wetlands

Forest and scrub wetlands can be converted to herbaceous wetlands in various ways with effects more or less catastrophic, even if wetland conditions are not intentionally obliterated permanently to enable the construction of roads, buildings, or farm fields. Woody stems can be cut at the ground surface and merely the aboveground trees and shrubs removed, if the goal is to reduce disruption of the soil. More invasively, tree stumps and shrub roots can be grubbed. Biologically active soils can be removed entirely. Hydrology can be diverted or impounded. The amounts and kinds of functions lost and gained will be determined by what conditions previously existed in the wetland as well as the nature and extent of disturbance. If any one of the three major wetland characteristics (hydrophytic vegetation, hydric soils, or hydrology) is not or cannot be restored to natural conditions, then the conversion of wetland to non-wetland will be permanent. The conversion of forested wetlands to scrub or herbaceous wetlands is not readily reversible, inasmuch as forest regrowth at best requires many decades, and may be intentionally prevented by repeated cutting or by spraying herbicides.

When wetland vegetation is changed by people from forest or scrub to herbaceous, many of the wetland's functions can be altered. Detailed study is necessary in order to predict accurately the probable changes and compose plans for appropriate mitigation, because the affected functions will vary at each location supporting a natural wetland.

Where naturally variable wetland hydrology has been restored, some generalist wetland plants usually will follow quickly unless toxic substances also have been introduced, and hydric soils eventually will become recognizable after many years of weathering have elapsed. Pennsylvania wetlands evolved after the retreat of glacial ice, and their biota retains the ability to recover following natural disturbances that are less drastic than those of current technology. Unless artificial plantings are made to accelerate the establishment of desirable species, however, invasives that thrive in human-disturbed wetlands are likely to invade and crowd out preferred species of native plants. Construction activities usually provide ample opportunities for invasive plants and animals to arrive at construction sites. Various online sources provide links to information on invasive species, including those of the Governor's Invasive Species Council of Pennsylvania (www.invasivespeciescouncil.com), the Pennsylvania Department of Conservation and Natural Resources (www.dcnr.state.pa.us/conservationscience/), and the US Forest Service (www.fs.fed.us/invasivespecies).

If the objective is to restore pre-disturbance native wetland vegetation, then near-replacement of pre-disturbance hydrology and soils is most likely to yield the desired plant community. Such replacement only succeeds where careful investigation of plants, soils, and hydrology preceded the wetland disturbance, so that mitigation site modification effectively can mimic the structure of the lost

wetland. Light-tolerant herbaceous and scrub wetland plants can be restored more rapidly than forest vegetation, which takes many years for trees to reach mature size and natural diversity even where maximally successful. Protection of new plantings of native woody species from browsing deer and rabbits often is critical for the survival of the plants during the early years after wetland creation or restoration, and supplemental watering may be necessary during unusually dry years while root systems are being formed. Plantings of herbaceous wetlands can be devastated by migrating waterfowl. Moreover, the early-succession trees which will thrive in an open wetland only slowly are replaced by shade-tolerant species of late forest succession. Late-succession native herbs characteristic of mature Pennsylvania forested wetlands would not be expected to grow until the forest canopy has become reestablished and soil formation has proceeded to approximate natural conditions.

Compensatory mitigation in the form of replacement wetland creation or degraded wetland restoration is intended to result in functioning wetlands that do not require ongoing human intervention. Pennsylvania permit conditions long have required five years of monitoring for wetland restoration and creation projects along with written reports to PADEP, but post-construction monitoring has been sporadic at best and approved wetland restoration plans often have been unsuccessful in execution. Ponds are much easier and quicker to build than forested wetlands, but do not provide mitigation for various wetland functions. Similarly, basins engineered to detain stormwater flows from developed areas seldom result in high-value wetlands.

As one illustrative example of the conversion of woody wetlands to herbaceous cover, pipelines can be considered. The excavation of trenches for miles uphill, downhill, and across streams and wetlands is a catastrophic event followed by some measure of soil cover replacement on top of the pipes. But few pipeline operators

Pipeline construction through Pennsylvania wetlands. The corridor will be maintained free of woody vegetation after the pipe is buried.

Herbaceous Wetland 40 Years after Pipeline Installation.

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are prepared to allow reforestation to obscure right-of-way conditions. Thus pipelines are likely to involve vegetation stressors such as right-of-way clearing, clear-cutting of brush, and removal of woody debris both prior to and for the long term subsequent to pipeline installation. Mechanical clearing using equipment occurs, as does spraying with non-selective chemical herbicides to prevent the reestablishment of trees and shrubs so that rights-of-way can be quickly inspected on the ground and from the air.

In summary, the most probable, usually adverse effects of human conversion of forest or scrub to herbaceous wetlands on PADEP-listed wetland functions, the following would be expected and should be considered carefully:

1. **General Habitat and Natural Biological Functions**
   Aboveground biomass: decrease
   Forest interior habitat: loss
   Structural diversity: decrease within converted wetland
   Visual and aural screening from human activity: loss
   Local climate amelioration: decrease
   Evergreen winter cover for wildlife: loss
   Suitability for shade-loving species of plants: loss
   Production of mast (such as acorns) for wildlife: loss

Exposure to harsh wind, ice, sun: increase
Localized effects of global warming on biota: increase

2. **Study Areas and Refuges**
   Structural diversity of ecosystem: decrease within converted wetland
   Species diversity of plants and animals: decrease within converted wetland
   Visual and aural screening from human activity: loss
   Rare, ancient trees: loss

3. **Drainage Patterns, Water Quantity, and Water Quality**
   Streambank anchoring against erosion: decrease
   Soil stabilization: decrease
   Erosion and sedimentation: increase
   Nutrient storage in ecosystem: decrease
   Maintenance of cold water temperature for trout: decrease

4. **Storm Damage Shielding and Shoreline Protection**
   Streambank stabilization: decrease

5. **Flood Storage**
   Storage volume: no significant change

6. **Groundwater Discharge**
   Volume discharged: increase (reduced transpiration)

7. **Groundwater Recharge**
   Volume recharged: increase (if soil not disrupted)

8. **Pollution Prevention and Sediment Control**
   Erosion and sedimentation control: decrease

9. **Human Recreation**
   Landscape aesthetics: disruption
   Species composition, plants and animals: change
   Forest interior species: loss
   Maintenance of cold water temperature for trout: decrease
   View and hiking corridors: increase

How much functional loss will occur as a result of authorized conversion from forest or scrub to herbland at any wetland location will depend on the functions initially present in the forested wetland, the severity of the disruption to the elements of the environment such as its soil and surface elevation, the location of the converted area in the landscape, and its connection with other wetlands, especially along stream corridors. As some functions decrease, others may increase. The degree to which impacts are negative also depends on the context of reference: “edge” species such as whitetailed deer benefit from forest

fragmentation. Given the complexity of the natural world, under some sets of circumstances an anticipated negative change actually could prove beneficial. The functional loss of forested wetland is never quickly reversible, even if active maintenance were to stop, nor is it capable of offsite mitigation except, at best, until after long time delays.

Not currently identified by PADEP in its list of functions, conversion of forest to herbaceous wetland also entails a reduction in the ability of the wetland to affect human climate and to reduce air pollution. Herbaceous wetlands cannot rival forests in providing shade and screening people from wind. Likewise, they cannot promote the deposition of airborne pollutant particles or take up as much gaseous pollution as forest trees.

In principle, some of the functional losses of vegetation conversion eventually can be replaced by successful wetland mitigation onsite or offsite. But the actual substitution of lost functions by compensatory wetlands is not routine.

Wetland Compensatory Restoration and Creation

Because wetland damage and destruction routinely are authorized by permits, agencies by regulation are to require the restoration of temporary damage and the offsetting replacement of permanent loss of natural wetlands. A plan for the mitigation of unavoidable impacts by regulation is required as part of every individual joint permit application for wetland encroachments in Pennsylvania, other than "small" projects deemed by PADEP to have no significant impact on safety or protection of life, health, or the environment [25 *Pa. Code* 105.13(d)(1)(ix)]. Mitigation is defined (at 25 *Pa. Code* 105.1) as

> An action undertaken to accomplish one or more of the following:
>
> Avoid and minimize impacts by limiting the degree or magnitude of the action and its implementation.
>
> Rectify the impact by repairing, rehabilitating or restoring the impacted environment.
>
> Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action.
>
> If the impact cannot be eliminated by [the foregoing measures], compensate for the impact by replacing the environment impacted by the project or by providing substitute resources or environments.

PADEP records fewer than 100 acres of wetlands authorized for damage annually under individual permits during recent years, along with about 40 miles of streams (PADEP 2014c). These wetland statistics do not include losses through construction authorized by general permits. The statistics also do not include enforcement against unauthorized encroachments into streams and wetlands. (These stream statistics omit altogether about half of the land area of

the Commonwealth that occupies small watersheds where stream, but not wetland, destruction is authorized automatically by waiver.)

Since the 1990s PADEP has sought 1:1 minimum replacement for wetland acreage and functions, with a preference for mitigation adjacent to the loss and on the same property. Mitigation has been designed on an acreage replacement basis, typically with no allowance for less than complete success or the time during which wetland functions are absent. Functional replacement itself has seldom if ever been mandated. For enforcement cases, PADEP policy long has sought to require 2:1 acreage mitigation (PADEP 1992, 1997a). PADEP's stated preference has been for onsite mitigation close to the allowed wetland destruction rather than for remote offsite mitigation. Such mitigation would be undertaken by the permittee, who seldom is expert in wetland mitigation.

Because less intervention is required, the restoration of wetlands previously converted to agricultural uses typically is easier and less uncertain than conversion of uplands to wetlands. Wetland hydrology, for example, sometimes can be restored simply by crushing the drainage tiles installed by farmers in order to dry fields sufficiently for commercial crops. To the extent hydrology is removed temporarily, but then restored, wetland vegetation and some semblance of a wetland ecosystem can be recovered onsite where care is taken to reconstruct natural conditions insofar as practicable. Habitat functions often can be attained more readily in rural mitigation areas than adjacent to urban development sites where the restored or created wetlands are isolated from other areas of comparable habitat. Areas amenable to wetland restoration, however, often are located offsite at considerable distance from impacted areas and affected watersheds. Wetlands in stream valleys and floodplains do not necessarily substitute functionally for wetlands along headwater streams.

Successful wetland creation from dry land, even more than restoration, depends on careful identification of water budgets pre-construction to guide attempted restoration. Abundant field experience has demonstrated that small inaccuracies in analyzing or reconstructing hydrology will result either in dry non-wetlands or in open water ponds rather than vegetated wetlands.

Hydrology normally is removed by blocking the movement of water into a wetland (1) by diking or channelizing and diverting its flow and/or (2) by expediting the removal of water from a wetland by drainage pipes or pumps. Restoration of hydrology may require detailed attention to creating almost flat slopes, and often requires design for seasonal variability in wetness. Most natural wetlands, unlike typical farm ponds and detention basins, have very gently sloping land surfaces rather than abrupt banks. Effective wetness of surface soils within a wetland can be reduced by removal of natural vegetation on and adjacent to the mitigation area, impeding the recovery of wild plants and affecting the survival of replacement plantings. Hydrology derived from channelized stormwater can be toxic to wetland plants, if the stormwater brings in road salts, oil, excessive

nutrients, and other pollutants. Trees typically are less tolerant of salinity change than herbaceous plants (Adamus & Brandt 1990). Where urban runoff is the source of wetland hydrology, functional mitigation may be difficult to achieve.

Timely restoration of near-surface hydric soils that have wetland characteristics depends on the successful removal and segregation of topsoil, and then its replacement above the subsoil. By keeping holding time for stockpiled topsoil to a minimum, some of the natural seed bank can be salvaged to aid in wetland revegetation. Where the structure of the soil layers has been drastically altered, years are required for horizontal layering to become restored by natural weathering. If wetland hydrology was caused by impermeable subsurface layers such as clay lenses, and those are disrupted by excavation, capturing sufficient hydrology for wetland restoration may be impossible. If surface soil density is compacted, additional years are required for natural porosity to return along with the ability for water to penetrate (Stoler and Relyea 2011). The placement of only a few inches of soil on wetland trees and shrubs, as well as herbs, can be fatal to the disturbed plants. Mulch and short-lived cover crops can help stabilize soils without offering severe competition to desirable native wetland plants. A natural balance of groundwater recharge and discharge in constructed or restored wetlands is not easily achieved.

Given these technical considerations and the historical fact that practical humans long focused on draining and converting rather than restoring wetlands and wetland functions, the actual mitigation of wetland impacts has proved generally unsuccessful in Pennsylvania for many decades (*see*, for example, McCoy 1987, 1992; Kline 1991) and has not improved recently (Campbell *et al*. 2002, Cole & Shaffer 2002, Gebo & Brooks 2012, Hoeltje & Cole 2007, Kislinger 2008, PADEP 2014c). Seldom has mitigation created the same kind of wetlands as those damaged. Most attempted mitigation that succeeded in creating wet areas resulted in open water ponds rather than forested or scrub wetlands (Cole and Shaffer 2002). Monitoring and reporting on mitigation success on paper is required of applicants, but often not performed. PADEP staff seldom monitor wetland mitigation sites or require remedial measures of permittees.

PADEP has found that the ability of permittee-constructed mitigation

> to address the needs of a watershed is limited at best. Applicants generally do not have adequate resources to identify watershed needs, plan for and identify high value project sites, and/or secure rights to and produce significant restoration activities. (PADEP 2014c)

69 Permit Wetland Mitigations Scored by PADEP Interns, 1992-1995

Size (acres)	Success	Failure	Not Rated	% Success
0-.10	5	3	1	62.5
.10-.25	8	6	1	57.1
.25-.50	9	7	0	56.3
.50-1.0	11	3	0	78.6
1.0->	13	2	0	86.7
Total	46	21	2	68.7

Most Pennsylvania wetland impacts authorized by individual permit, after avoidance and minimization have been addressed, affect small acreages. Thus PADEP has implemented an acreage-based fee-in-lieu program to enable most permittees affecting small (0.5 acre or less) areas of wetland to substitute a one-time cash payment instead of undertaking their own construction of mitigation wetlands (PADEP 1997b). The half-acre "allowance" for cash contributions was deemed sufficient to allow any landowner enough wetland impact to build a house. Fees were set by PADEP based on its expectation that willing landowners across the Commonwealth would allow conversion of uplands to wetlands or restoration of wetlands with higher quality through voluntary cooperation with PADEP and the National Fish and Wildlife Foundation. This program has greatly assisted permittees, but it has not demonstrably resulted in compensatory wetland mitigation similar in kind or location to wetlands destroyed.

Contributions to the Washington, D.C.-based National Fish and Wildlife Foundation's Pennsylvania Wetland Replacement Project ID 95-096 became routine across the Commonwealth beginning in the 1990s. According to its web page, as of May 2014 this Foundation had sponsored 486 environmental enhancement projects of various kinds in Pennsylvania. Locational and descriptive information for these projects are displayed on an interactive map. But no data apparently exist comparing wetland acreage or functions lost to mitigation accomplished under the Pennsylvania in-lieu-fee program or identifying the geographical proximity of wetland losses versus gains on a watershed basis. Only first-time readers of PADEP regulations might expect any applicant eligible to use the Fund even to consider undertaking onsite mitigation, which is always far more expensive than scheduled contributions to the State's

Fund. The in-lieu fees long have represented a major subsidy to permittees from Pennsylvania residents and their environment (Schmid 1996a, b). Pennsylvania mitigation fees have been the same for Exceptional Value as for Other wetlands, and the acreage-based fees have been presumed to compensate for any and all wetland functions associated with the wetlands lost.

Pennsylvania Wetland Mitigation Replacement Fees (1997-2013).

De minimis impact less than or equal to .05 acre	$ 0.00
Greater than .05 acre to .10 acre	$ 500.00
Greater than .10 acre to .20 acre	$ 1,000.00
Greater than .20 acre to .30 acre	$ 2,500.00
Greater than .30 acre to .40 acre	$ 5,000.00
Greater than .40 acre to .50 acre	$ 7,500.00

Contributions to the Fund relieve permittees of any followup responsibility for mitigation monitoring or success. Between 1997 and 2013 the buying power of cash contributions to the Fund dwindled by about 30% due to inflation, while the market costs of wetland creation can be $100,000 per acre in some locations, according to the Pennsylvania Department of Transportation. Costs are less where free land and prison labor can be obtained (FHWA 2011). Moreover, the success of the wetland mitigation work done under PADEP's Replacement Project apparently has been limited and certainly has been sparsely reported. Pennsylvania's in-lieu-fee program was deemed unacceptable for use to satisfy federal wetland mitigation requirements in 2008, and its "grandfathering" expired in 2013 (33 CFR 332.8). Hence the PADEP currently is seeking federal approval for a new in-lieu-fee program (PADEP 2014c).

The generally laudable goals of the new program include (1) high quality mitigation addressing wetland functions as well as acreage, (2) ecologically based mitigation site selection, (3) efficiencies of scale in constructing, monitoring, and administering a few large mitigation projects instead of many small ones, (4) streamlined federal and State permit approvals, and (5) more effective accounting and compliance reporting (PADEP 2014c). PADEP claims that it has the expertise and staff to run an in-lieu-fee program effectively. As has been repeatedly demonstrated by PADEP staff and by independent academics, mitigation to date by permittees affecting more than the half acre of wetlands to which Fund contributions are limited typically has been of poor quality in Pennsylvania and has failed altogether in replacing the functions of wetlands lost.

The new PADEP technical guidance potentially represents an opportunity to have those who hope to benefit from damaging wetlands more effectively internalize the negative externalities of their conduct, a goal consistent with both Pennsylvania and federal law. It is not self-evident that the functions of multiple small, scattered wetlands high in the landscape can be replaced effectively by

larger wetlands in floodplains, and PADEP may be asked to address this issue, as well as many other technical details, prior to gaining federal approval for its proposed in-lieu-fee program. Unquestionably, more information will need to be generated during preparation and review of each application to damage wetlands, if new PADEP technical guidance is adopted along the lines of its current draft. A significant outcome should be the more effective tailoring of compensatory mitigation to the amount and type of wetland impacts. The full costs of mitigation should include both the risk of mitigation failure and the temporal lag between impacts and restoration of functions---which, for forested wetlands can be immense.

Only if this opportunity is fully exploited will future mitigation begin to compensate for permitted impacts in Pennsylvania. The new guidance also can provide a corrective to the mitigation failures and lack of accountability long prevalent in Pennsylvania, while reducing the previous economic subsidies encouraging private destruction of wetland resources. The new information available also should allow better public understanding of the external costs of development and the benefits of successful mitigation, particularly if public access to permit records is made electronically available.

It is high time that human behaviors with harmful side effects in Pennsylvania be mitigated more effectively to enable continued prosperity for its residents and the planet's survival, as well as compliance with Article 1, Section 27, of the Pennsylvania Constitution:

> 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. 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.

When completed, the new PADEP technical guidance may make possible the actual functional mitigation for conversion of forest and scrub wetlands to herbaceous wetlands. If effective, it also should help reduce so-called "natural" hazards from waters---hazards which are in fact failures of human design, construction, planning, and community development in areas subject to natural processes of stormwater movement. If the opportunity is missed, the alternative includes increased environmental plundering of remaining wetland resources, high costs for disaster survivors, especially the most vulnerable, as well as harm to communities and ever growing costs to taxpayers.

Completion of public review, PADEP revision, and implementation of the new technical guidance for wetland assessment and mitigation may take considerable time. Pennsylvania wetlands only slowly have begun to receive some attention from regulators in the context of damage by longwall (that is, high-extraction underground) bituminous coal mining, which was first allowed by Act 54 of 1994. PADEP long refused to recognize even the possibility of damage to wetlands from

longwall mining, but gradually has been implementing more thorough data collection for mine applications (Schmid & Co., Inc. 2000, 2010a, 2011a, 2012, 2013).

The minimal current PADEP information and review requirements for oil and gas permits provide virtually no assurance that wetlands will be identified and protected from this extractive industry, which currently is experiencing a boom across much of the Commonwealth. Similarly, PADEP has failed to protect too many streams, particularly those streams of highest ecological value (Van Rossum *et al*. 2011; Kunz 2011; Schmid & Co., Inc. 2010b). Oil and gas permit applications generate far less environmental information than coal mining applications. Proposed regulations governing surface oil and gas activities currently are under review (25 *Pa. Code* 78, Subchapter C). PADEP and the Environmental Quality Board are preparing responses to the 24,000 comments received on their proposed oil and gas regulations. New Chapter 78 regulations could specify protection for streams and wetlands far more effectively than the regulations they are replacing.

Whether the proposed wetland analysis and mitigation technical guidance will receive similar public attention remains to be seen. Its comment period is still open and likely to be extended.

Authorship

This report was prepared by James A. Schmid, a biogeographer and plant ecologist. Dr. Schmid received his BA from Columbia College and his MA and PhD from the University of Chicago. After serving as Instructor and Assistant Professor in the Department of Biological Sciences at Columbia University and Barnard College, he joined the environmental consulting firm of Jack McCormick & Associates of Devon, Pennsylvania. Since 1980 he has headed Schmid & Company of Media, Pennsylvania.

Dr. Schmid has analyzed and secured permits for some of the largest wetland mitigation projects in the mid Atlantic States, as well as a myriad of smaller projects. He is certified as a Senior Ecologist by the Ecological Society of America, as a Professional Wetland Scientist by the Society of Wetland Scientists, and as a Wetland Delineator by the Baltimore District, Army Corps of Engineers. He has served on the professional certification committees of the Ecological Society and the Society of Wetland Scientists.

When the US Fish & Wildlife Service Pleasantville Office evaluated actual compliance with approval conditions requiring mitigation by about 100 of the Clean Water Act Section 404 fill permits issued by the Corps of Engineers in the State of New Jersey during the period 1985-1992, every Schmid & Company mitigation project was judged in the field to exhibit full compliance with all permit requirements and mitigation goals. Schmid & Company mitigation projects

represented 21% of all the mitigation projects judged fully successful in New Jersey by USFWS in its written report to USEPA. Dr. Schmid analyzed and secured Wetland Mitigation Council approval for the first major freshwater mitigation bank in New Jersey on behalf of DuPont. That bank was donated to The Nature Conservancy.

Dr. Schmid has often analyzed environmental regulatory programs and commented on proposed regulations. His clients continue to include the construction industry, conservation groups, and government agencies, including the Pennsylvania Department of Environmental Protection.

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The Short and Long-Term Consequences of the Construction of the PennEast Pipeline– A White Paper

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A White Paper
The Short and Long-Term Consequences of The Construction of the PennEast Pipeline

1. The PennEast Pipeline Project

The PennEast Pipeline is a joint venture effort of AGL Resources, NJR Pipeline Co, South Jersey Industries, PSEG Power LLC, Spectra Energy Partners and UGI Energy. The pipeline's purpose is to transfer natural gas extracted via "fracking" processes from the shale fields of Luzerne County PA to the Transcontinental Gas Pipe Line Co.'s Trenton-Woodbury Lateral located in Mercer County, N.J. (Figure 1). From its point of origin in Luzerne County it would run through the Lehigh Valley of Pennsylvania in an approximately southeasterly direction cutting through Northampton, Carbon and a portion of northern Bucks Counties. Some of the municipalities in Pennsylvania that the pipeline affects or runs close to include Moore, Bath, Upper and Lower Nazareth, Lower Saucon, Riegelsville, Williams and Durham Townships. The pipeline will cross under the Susquehanna River and Lehigh River and cross under the Delaware River near Durham Township, PA. The line then crosses into New Jersey near Holland Township, in northern Hunterdon County. From there it will continue in an approximately southeasterly direction, running through or close to the following municipalities Milford, Alexandria, Kingwood, West Amwell, East Amwell, Lambertville, Hopewell, Kingston, Pennington and Princeton. In Mercer County the pipeline terminates at the Transco Trenton-Woodbury interconnection.

Overall, the pipeline cuts a path approximately 108 miles long and directly impacts over 1200 + acres of land. Approximately 85% of the affected lands are located within the watershed boundaries of the Delaware River ecosystem. As will be noted repeatedly herein, as well as crossing under the Delaware, Lehigh and Susquehanna Rivers, the pipeline crosses under approximately 80 streams, the vast majority of which are protected under PADEP's Exceptional Value and High Quality regulations, the NJDEP's Category-1, anti-degradation regulations, and the Delaware River Basin Commission's Special Protection Waters anti-degradation regulations. The affected streams are identified in Section 2 of this white paper.

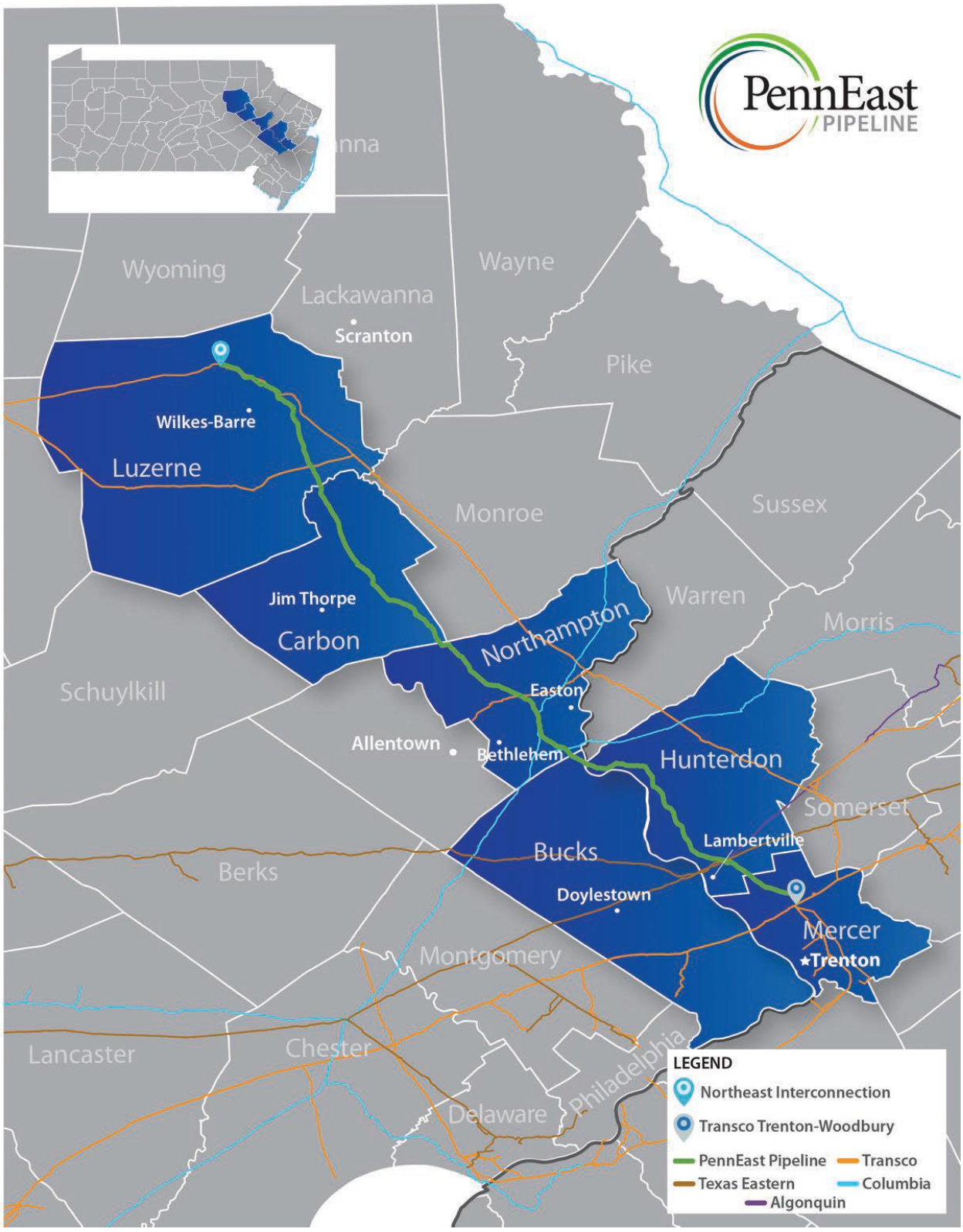
It should be noted that the "pipeline" includes the various appurtenant facilities required for the transport of the gas. These include access/maintenance roads, compressor units, metering stations, regulator stations, delivery stations, holders, valves, and the other infrastructure elements critical to the pipeline's operations. These components of the pipeline are all above ground and are neither benign nor passive operational elements of the system.

While the pipeline itself is 36" in diameter, there will be a 50 foot wide <u>permanent</u> right-of-way (ROW). However, during the pipeline's construction the actual work corridor will vary between 90 feet to 125 feet in width. The temporary and permanent ROWs greatly increase the overall footprint of the pipeline project and the total amount of environmental damage that will be accrued. Once the ROW is cleared it will be kept in a cleared state after the completion of the project in order to facilitate the required periodic inspections and required maintenance of the

pipeline. Along other pipeline routes it has been shown that restoration measures undertaken in constructions zones do not result in near-term ecological restoration and in some cases are themselves a source of enduring impact as the result of high levels of soil compaction. Thus the effects of the project will extend far beyond the actual point in time that the pipeline is installed and construction activities completed.

The balance of this white paper discusses how the PennEast Pipeline will irreversibly disturb and alter the ecological properties of natural waterways including high quality waters, a variety of habitats, preserved farmland and preserved, public open-space.

Figure 1 Proposed Pathway of PennEast Pipeline



2. Environmental Consequences of the PennEast Pipeline

2.1 Environmental Impact Analysis

The National Environmental Policy Act (NEPA) of 1969 defines the procedural requirements used by all federal government agencies to comprehensively evaluate the environmental impacts and risks of a project. The findings of the evaluation are then presented in an Environmental Assessment (EA) and/or an Environmental Impact Statement (EIS). The NEPA process is designed to ensure that all the project's positive and negative environmental factors are equally weighted and appropriately appraised as part of the official decision-making process. The evaluation process must include an assessment of alternatives to the preferred project approach, including a No Action alternative. The evaluation process also involves the solicitation and utilization of public comment and input.

The Natural Gas Act of 1938 (NGA) governs all aspects of interstate transportation and sale of natural gas, and gives the Federal Energy Regulatory Commission (FERC) authority over all such pipeline projects. FERC is an independent federal agency that regulates the interstate transmission of electricity, natural gas, and oil. FERC is charged by Congress "with evaluating whether interstate natural gas pipeline projects proposed by private companies should be approved". The Energy Policy Act of 2005 gave FERC additional responsibilities as outlined in an updated Strategic Plan. As part of that responsibility, FERC approves the siting and abandonment of interstate natural gas pipelines and storage facilities. This must involve the analysis of the project's environmental impacts, with that analysis conducted in a manner consistent with NEPA requirements.

The Clean Water Act and the State issued Water Quality Certificate serve as the links triggering the need for a thorough environmental review and documentation that State environmental requirements are being met. Both the New Jersey and Pennsylvania wetland and surface water regulations are linked to Sections 401 and 404 of the Clean Water Act.

2.2 Overview of Environmental Concerns Associated the PennEast Pipeline Project

The PennEast Pipeline will convey gases extracted from the Marcellus Shale fields located in Luzerne County, PA. Defined as an unconventional gas, the Marcellus Shale gas differs from conventional gas resources in a number of ways including the means by which the gas is collected and transported from its point of origin to its point of distribution.

As noted above there is more to the PennEast pipeline than the pipeline itself. As per the Pipeline Safety Coalition (www.pscoalition.org), the infrastructure associated with any Marcellus Shale pipeline, including the PennEast pipeline, consists of the following:

- Well Head and Well Pad (where the gas is extracted)
- Water Lines (Fresh Water and Flowback; associated with the fracking process)
- Production Lines

- Gathering Lines
- Gas Processing Plants
- Gas Transmission Pipelines
- Compressor Station
- Valves Smart Pig and Smart Pig Launchers (elements associated with various on-going maintenance, inspection and cleaning operations of the pipeline)
- Citygate (the point where the local pipeline connects to an interstate or distribution pipeline)
- Distribution Lines

The siting of the pipeline occurs under the oversight of the Federal Energy Regulatory Commission (FERC). However, FERC does not issue any of the environmental permits needed for the construction of the pipeline, and where required (as is the case with the PennEast pipeline) any State Water Quality Certificates. In this case, the environmental review of the pipeline's construction and the eventual issuance of the majority of the required permits (including all Water Quality Certificates) is the responsibility of the Pennsylvania Department of Environmental Protection (PADEP) and the New Jersey Department of Environmental Protection (NJDEP), with additional permitting required from the US Army Corps of Engineers and a Docket issued by the Delaware River Basin Commission. As will be discussed in further detail in Section 3 of this white paper, it is the collective responsibility of PADEP and NJDEP, and these other regulatory bodies, to rigorously evaluate and assess both the short-term environmental impacts associated with the construction of the pipeline as well as the long-term environmental impacts resulting from its construction, operation and maintenance.

PennEast asserts in its project Fact Sheet:

> *"Our team of engineers and consultants planned this route by balancing the most direct route for the pipeline with numerous environmental, structural, conservation and land use factors. The route is designed to minimize any impacts to the environment and communities along the way."*[1]

However, along its path in both Pennsylvania and New Jersey, the proposed PennEast Pipeline will cross through environmentally important and critical lands. These include Pennsylvania State Game Lands (#40 and #128), Hickory Run State Park, Boulder Field Natural Area (a National Natural Landmark), Mud Swamp Natural Area, Weiser State Forest, Beltsville State Park, the Kittatinny Ridge, the Appalachian Trail Corridor, the Sourland Mountain Preserve, other State and County parklands, preserved farmland, and areas of cultural significance. Along the route the pipeline traverses steeply sloped areas characterized by erosion prone soils. Many of the affected areas provide critical habitat to a number of threatened and endangered species and species of concern including Bald Eagle, Harrier Hawk, Bobolink and other grassland bird species, Wood Turtle, Bog Turtle, Indiana Bat, Northern Long-Ear Bat, Brook Snaketail Dragonfly and Dwarf Wedge Mussel.

[1] http://penneastpipeline.com/wp-content/uploads/2015/01/PennEast_Overview_11-7-14.pdf

The pipeline will also cross under the Susquehanna River, the Lehigh River, and the Wild and the Scenic Delaware River. Although these larger pipeline crossings will be accomplished using directional boring techniques, the crossing of more than 80 smaller streams and tributaries will be accomplished using basic excavation and back-fill techniques. Many of these smaller waterways are ranked within Pennsylvania as Exceptional Value (EV) and High Quality (HQ) and in New Jersey as Category 1 (C-1). Among the affected streams are Mud Run, Wild Creek, Pohopoco Creek, Aquashicola Creek, Spring Mills Brook, Harihokake Creek, Hakihokake Creek, Nishisakawick Creek, Little Nishisakawick Creek, Locatong Creek, Wickecheoke Creek, and Alexauken Creek. These waters are documented trout production and trout maintenance streams. This includes streams pristine enough to support viable populations of native brook trout. Clearing of the forest canopy and vegetation growing adjacent to these streams alters their thermal properties and nutrient and sediment loading dynamics thereby threatening their ability to sustain a trout fishery. These changes to the adjacent stream corridors can also affect the food chain dynamics of the system by altering the composition of the benthic and aquatic insect communities and increasing the propensity for algae blooms.

The pipeline also runs through wetlands, floodplains and riparian areas that are part of the functional ecosystems of the EV, HQ and C-1 waterways. Each of these is a high quality ecosystem and each is an intrinsic element that adds to the ecological functionality and complexity of each waterway. As per the NJDEP Landscape database, the lands through which the pipeline traverses once in New Jersey includes lands mapped as providing habitat for Species of Concern (Rank 2), State Threatened (Rank 3) and State Endangered (Rank 4) species. Filling and/or draining these lands will change not only their hydrologic properties but could negatively affect the hydrology of the adjacent stream ecosystems. Additionally, changes to the plant communities of the traversed wetlands, floodplains and riparian areas can cause trickle down effects on the food chain dynamics of the streams with which they are associated.

One of the immediate "disconnects" related to work conducted in the above noted EV, HQ and C-1 waters is that PennEast uses the FERC definition rather than the State definition of waterways when discussing stream and river crossings. Referencing the PennEast authored fact sheet on stream crossings[2], streams are divided into three categories:

- Minor (streams ≤10' wide at the water's edge at the time of construction),
- Intermediate (perennial stream crossings >10' wide but <100' wide at the water's edge at the time of construction), and
- Major (crossings >100' wide at the water's edge at the time of construction).

The pipe installation technique implemented at each stream crossing will largely be determined by the stream crossing's designation; minor, intermediate or major. Simple, open ditch techniques will be employed for the "minor" crossings while directional boring will be reserved for the "major" crossings. Obviously, the smaller streams, which include headwater, ephemeral

[2] http://penneastpipeline.com/wp-content/uploads/2015/01/PennEast_Crossing_Rivers.pdf

and intermittent waterways, will receive the lowest level of construction sensitivity even though these are the waterways of greatest environmental sensitivity and importance.

Although the focus of this paper is on the environmental impacts attributable to the pipeline, it is important to note that the PennEast Pipeline also traverses through populated areas creating along those sections of the pathway a risk to the health, safety and welfare of the affected populous. For example, over its length the pipeline disturbs wellhead areas that function in the critical recharge of potable water supplies. Each of these transgressions represents a potential impact to a unique public drinking water supply. Pipelines and associated compressor stations are also a source of air pollution contributing to climate change and air quality degradation.

Thus, even when assessed on a superficial scale it is evident that the proposed PennEast Pipeline project brings with it a number of significant and unavoidable environmental impacts. This project will irreversibly and negatively affect the ecological and environmental status of the Delaware River and its tributaries, and decrease the ecological services and functions of the upland, riparian and wetland areas through which the pipeline transects.

2.3 Types of Environmental Impacts

The types of environmental impacts assessed as part of major FERC reviewed projects typically fall into one of four categories:

- Temporary,
- Short Term,
- Long Term, or
- Permanent.

Temporary or acute impacts are typically those manifested during the construction phase of the project and are associated with the major changes to a site including the removal of vegetative cover, site grading and site preparation. FERC labels impacts of short-term consequence as those which may take as much as three (3) years for the affected resources to recover. The focus of many of the mitigative measures proposed for a project usually pertains to lessening a project's short-term impacts. The success of a mitigative measure is normally gauged by the ability of the affected site to return to pre-construction conditions. Conversely long-term impacts are those that will take a considerably longer amount of time for the affected site and the site's resource to recover and/or return to pre-construction conditions. The Bureau of Land Management recognizes that for projects involving the extensive modification of native grasslands and forested lands, <u>it may take 5-10 years for recovery for long-term impacts to even commence.</u> Thus the negative effects of a project's long-term impacts may be realized over an exceptionally long period of time. A permanent impact (which more often may be referred to as an unavoidable impact) are those causing an alteration of the site and/or the site's resources of a nature from which, regardless of the mitigative measures employed, the site never returns or recovers to pre-construction conditions. Even so, FERC may only recognize a permanent impact as being significant if it leads to a "substantial adverse change" in the environmental and ecosystem attributes of the affected site or the site's resources.

FERC reviewed projects must follow the EIS guidelines and requirements established through NEPA. Although the content may vary from project to project, the following are among the various specified elements of a complete and valid NEPA EIS:

- Purpose and Need
- Alternatives Analysis (Proposed Action, No Action, Alternatives and Environmentally Preferred Alternatives)
- Affected Environments
- Impacts (Direct, Indirect, and Cumulative impacts), and
- Proposed Impact Mitigation.

Within this white paper, the environmental impacts that will be created by the PennEast Pipeline are divided into three distinct but inter-related categories: acute, long-term and cumulative.

The acute impacts are largely a function of construction related activities. The acute impacts will result directly from the clearing of forests, crossing/filling of streams, draining/altering of wetlands and riparian areas, and other pronounced changes to the waterways and landscape of the Delaware River basin. These impacts are represented by PennEast as unavoidable, necessary aspects of the basic installation of the pipeline, the creation of the pipeline ROW and the construction of the supporting pipeline infrastructure.

The long-term impacts can be even more threatening than the acute impacts as they affect the ecological services and functions of the various ecosystems of the Delaware River watershed that will be compromised during and following the construction of the pipeline and its ROW. Some of these impacts are triggered by the acute short-term impacts of the project and some are associated with the pipelines long-term operation and maintenance. These long-term impacts are linked to the fragmentation of habitat, reduction in water quality, alteration of land cover, changes in the watershed's hydrologic and hydraulic properties, increased water temperatures, introduction of invasive species, creation of "edge habitat", lost or altered spawning and breeding habitat and changes in the amount and quality of stormwater runoff discharged to the Delaware River and its tributaries. Regardless of any proposed mitigative measures implemented to lessen the acute impacts of the project, owing to the nature of the impacts and the sensitivity of the affected environments, once the pipeline is constructed the resulting long-term impacts to the overall ecological properties of the affected lands and water resources are irreversible and cannot be mitigated.

The cumulative impacts add another layer of ecosystem damage. The cumulative impacts arise due to the accumulation and synergistic affects of harms across the length of the proposed project, as well as the accumulative and synergistic impact of the proposed pipeline with other past and future pipeline and power transmission projects occurring in the same general region and affecting the same environments as the PennEast Pipeline. Each of the projects has caused, or will cause, similar alterations and impacts to the upland, water, riparian and wetland

resources of the Delaware River and its tributaries that have a compounding affect which magnifies the damage inflicted by any one individually. Examples of projects that will contribute to the cumulative effects of the PennEast pipeline are the Leidy Southeast Expansion Project, the proposed Texas Eastern TEAM 2014 Project, the Susquehanna-Roseland project, Columbia's East Side Expansion Project and the proposed Diamond East Pipeline project. The individual impacts associated with each linear development project essentially exacerbate the project specific impacts associated with the proposed PennEast Pipeline project.

2.4 The Importance of Rigorous Impact Analysis

As noted in Section 2.1 an environmental impact analysis is a required element of any project of this scope, as mandated by both FERC and NEPA. It is unfortunate that, in our professional experience, often Environmental Impact Assessments or Environmental Impact Statements associated with pipeline project do not touch on all of the subtleties of a proposed project or its cumulative impacts. Some of the less obvious, yet important, impacts may never be discussed, are dismissed as "de minimis", or are defended as acceptable/justifiable and capable of being compensated through the implementation of some type of mitigative or restoration measure. Such an approach is not acceptable either when a project occurs in previously compromised environments where restoration measures are already needed, in environments of lower environmental sensitivity where the cascading affects may be more easily ignored, or when the project affects high quality, sensitive environments as is the case with the PennEast project even seemingly small affects can have high consequences in the near term and the long term.

The PennEast Pipeline project innately brings with it acute, long-term and cumulative environmental impacts that affect the Delaware River, its tributaries, and the associated upland, riparian and wetland habitats through which the pipeline transects. Due to the environmental sensitivity of the majority of the areas through which the pipeline will pass, even with the best designed mitigative measures in place this project will cause irrevocable and unrepairable damages to the environment.

3. Acute Impacts of Pipeline Construction

Acute impacts are defined as those that are experienced immediately as a result of a given action. Acute impacts may trigger either significant or minor effects, and although sometimes defined as temporary or short-term, acute impacts often set the stage for longer-term, chronic impacts. The project's acute impacts will occur largely during the construction phase of the project and will be connected to highly evident changes to the landscape. The most prominent and obvious acute impacts are linked directly with the actual installation of the pipeline but also include the preparation of the project right-of-way (ROW) and the construction of access roads, equipment and materials staging areas and other appurtenant structures (e.g. compressor stations). These include:

- Land clearing and the removal of vegetation

- Soil disturbance
- Steep slope disturbance
- Bedrock disturbance
- Stream crossings
- Crossing and filling of wetlands, riparian corridors and floodplains, and
- Alteration of the hydrologic regime of streams.

3.1 Land Clearing, Vegetation and Tree Removal

For pipeline projects, the majority of the acute impacts occur during the pre-construction and construction phases. In upland areas, the terrain is cleared of existing vegetation to create access roads, staging areas and the pipeline corridor construction right-of-way. Similar types of vegetation clearing will occur within the wetland and riparian areas transected by the pipeline. In the case of PennEast the clearing of vegetation affects many hundreds of acres of core forest, wetlands and riparian areas (depending on the route they ultimately select) that exist along the 100+ mile pathway. The survey corridor for the pipeline may be as wide as 400'. It is unclear how much clearing will occur within the survey corridor. However, in order to install the pipeline PennEast will physically clear and prepare a 90-120' wide construction corridor. All major vegetation (mature trees, saplings, shrubs, etc.) occurring within the construction corridor will be removed and the land graded. In some cases it will be necessary to construct access roads to reach the pipeline corridor. Also at designated locations along the pipeline it will be necessary to construct the permanent pads needed to support the various pipeline appurtenances (e.g., gas processing plants, compressor stations, various valving stations, test stations, meter stations, etc.).

When the clearing occurs within wetlands and adjacent riparian and floodplain areas, it will be necessary to bring onto the project site construction mats. The mats enable heavy equipment to access and operate in wetland, riparian and shallow impounded areas characterized by saturated soils and/or subgrade conditions lacking enough physical stability and support. Conventional matting is essentially comprised of large (12" x 12") timbers linked together by means of heavy cables. Mats consisting of lighter composite materials may also be used. In either case the mats need to be transported to the site, positioned, removed and relocated thus increasing the likelihood for added disturbance and overall disruption of a site.

Whether the work occurs in wetland, upland or riparian areas, as vegetation is cleared it must be removed. This requires additional machinery such as chippers and grinders, excavators and dump trucks used to collect, process and transport the vegetation to off-site disposal areas. Conversely it may also result in the impact of additional adjacent lands if the cut vegetated material is discarded or disposed on site.

The magnitude of land clearing is one of the more egregious elements of the pipeline project. It will cause immediate, major changes to the overall condition of the affected areas and set the

stage for other acute impacts (e.g., soil erosion) and long-term impacts (e.g., forest fragmentation).

The literature suggests at a minimum once cleared of native vegetation it will take five (5) years for recovery of pre-existing vegetation cover and diversity for grassland communities. The recovery time for shrubland forest communities is at least ten (10) years. But it must be stressed that although cover densities may approach pre-site-clearing conditions, some of the native grasses and understory vegetation may never recover due to changes in sunlight exposure, soil porosity, soil compaction and changes in soil moisture content. Also, none of the trees once growing within the ROW will ever be replanted. Thus as noted above, the acute impact of land clearing sets the stage for longer-term impacts that trigger multiple negative effects on the area's biota and ecological functionality.

3.2 Soil Excavation and Disturbance

The PennEast pipeline is 36" in diameter. The depth to which the pipeline trench must be excavated is established by the DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA). For safety reasons it must be buried deep enough to avoid accidental punctures and to deal with seasonal frost issues. The PHMSA requires pipelines transporting conventional and unconventional gas to typically be covered by 30 to 36 inches of soil overburden. The amount of soil overburden cover may be greater when the pipeline runs under a roadway or when it runs under a stream, river or lake. PHMSA may require additional cover (48 inches to 60 inches) when the pipeline runs under agricultural lands. Less cover however may be allowed (as little as 18 inches) when the pipeline cuts through a consolidated area of bedrock. Nonetheless the amount of excavation required to properly trench the pipe is significant.

Because the placement of the pipe in the trench takes time there is the need to stockpile the excavated soil in areas adjacent to the trench. Each stockpile represents another opportunity for offsite soil migration. This happened during the construction of the TGP pipeline in Northern New Jersey leading to the impact of streams, wetlands and large recreational lakes located adjacent to the pipeline ROW.

In rockier areas, in order to protect the pipe from damage caused by sharp stones it may be necessary to sort the soil. The material sorted from the soil will need to be transported off site. The sorting, stockpiling and off-site transport of the rejected material again increases the opportunity for the offsite migration of soil and impact to adjacent streams, wetlands and other waterbodies.

3.3 Soil Compaction

Right-of-way (ROW) site preparation and construction activities include soil excavation, soil stockpiling, soil removal, operation of heavy equipment, and the blending of topsoil and subsoil materials to produce proper cover. These activities affect the ability of the disturbed soils to sustain their original soil functions. Some of the most pronounced changes to soil health and

function are linked to soil compaction. Soil compaction has been documented repeatedly to negatively affect plant growth, the infiltration and retention of precipitation, soil porosity, and microbial composition. Compaction issues will be magnified in wetland and riparian areas due to the more silty, alluvial and higher moisture content of the prevailing soils. Such soils are especially prone to compaction and will readily lose interstitial pore space. Without adequate pore space the movement of water, air, and soil fauna through the soil is impeded leading to changes in the biophysical dynamics of the soils. This in turn negatively affects vegetative cover and the re-establishment of wetland plant species within the disturbed wetland/riparian corridor.

The newly-developed Cornell Soil Health Test (CSHT) provides a standard for assessing the important physical, chemical and biological processes and functions of disturbed soil. The CSHT was used to evaluate the impacts of a recently constructed pipeline that transected University-owned land. The CSHT analysis definitively showed that soils within the ROW had significantly lower soil quality levels than the soils sampled in the adjacent areas unaffected by the pipeline's construction. The point here is that reliance on standard erosion control and soil handling techniques was proven to inadequately compensate for or address soil compaction issues within the ROW. As noted above, compacted soils inhibit the recharge of precipitation leading to a greater amount of stormwater runoff. The added runoff can lead to an increase in the mobilization and transport of pollutants and an increased opportunity for overall soil erosion.

3.4 Disturbance of Shallow Bedrock and Steep Slopes

Another set of acute impacts will arise where the depth to bedrock is shallow and the overlying soil mantle is thin. In such areas more aggressive excavation practices will be needed, including localized blasting, in order to achieve the required depth and dimension for the pipe trench. Because of the lack of adequate available soil cover, it may also be necessary to import a larger amount of backfill to cover the pipe after its installation. This added truck traffic increases the extent of site disturbance and disruption of the surrounding neighborhoods. As previously noted, to obtain enough suitable cover as well as protect the pipe from "sharp rocks" the PennEast construction plan recognizes the need to conduct on-site soil sorting and blending. Such activities will be especially prevalent in steeper sloped areas. This again increases the opportunity for off-site soil migration. Work on steeper sloped land will also tax the functionality of erosion and sediment control measures. There will be a greater opportunity for the failure of such measures especially if major storm events occur during or shortly after any work conducted on steep sloped areas. Finally issues may be raised with respect to the introduction of invasive species if off-site soils needed to be brought in in order to satisfy a deficit in the amount of available native cover material.

3.5 Stream and Wetland Crossings

Review of the proposed PennEast pipeline pathway shows it will cross over 80 streams including multiple streams that support, or have the habitat properties needed to support, a

cold-water fishery. The affected streams include a number of recognized wild brook trout streams. Where the pipeline crosses each stream, acute impacts will occur as a result of the excavation of the pipe trench, the active de-watering of the trench, the installation of the pipe, and the backfilling of the pipe trench. Each of these crossings thus presents a significant disruption of these well-established fisheries.

The current proposed plan calls for a simple "dig and drop" technique to be used at the majority of the stream crossings. The obvious problems resulting from this technique is attributable to the disturbance of the stream bed and stream banks. The most obvious problem will be an increase in in-stream turbidity. But the disturbance of the stream bottom will also cause a loss of the benthic fauna, benthic fauna habitat and spawning, nursery and foraging habitat critical to the stream's fishery.

Another inherent problem associated with typical "dig and drop" pipeline crossings is the potential for high flow events to expose or damage the pipe. This occurs quite frequently. As such, a detailed hydrologic analysis of the channel is critical for determining placement of the pipe beneath a stream. Without such data it is difficult to actually determine the proper depth to which to place the pipe. These data are derived from channel degradation and scour analyses. For example, the Bureau of Land Management (Fogg and Hadley, 2007) recommends modeling of the stream using various "mobile-bed hydraulic" models such as HEC-6 (USACOE, 1993 and USACOE, 1995). To date there has been no mention that such modeling will be conducted at any of the multiple PennEast stream crossings. Even when pipelines are placed to the appropriate depth, exposure of the pipe and release of the materials therein is still a risk that has been sadly realized in communities.

3.6 Hydrologic Impacts

Acute hydrologic impacts can be divided into two categories. The first is associated with the above noted in-stream construction activities and the other is associated with the hydrostatic testing of the pipe.

As noted above, the existing PennEast pipeline pathway affects over 80 streams. Work conducted in each of these streams means maintaining a water-free work zone. This means either diverting stream flow around the construction zone or actively pumping water out of the construction zone. Even when the work area is segregated from the stream by some type of diversion measure, the shallow depth to groundwater will require the constant dewatering of the pipe trench. Similar types of acute hydrologic impacts will also occur in the wetland and riparian areas traversed by the pipeline again due to shallow depth to seasonal high water (groundwater), standing water or saturated soil conditions. Again, construction in such areas requires the constant dewatering of the work area. As noted above, the compaction of wetland and riparian soils is to be expected and will have grave consequences in the ability for these areas to become fully restored to their pre-disturbance conditions.

The hydrologic impacts resulting from the hydrostatic testing of the pipe is an acute impact that is neither well understood nor adequately discussed. PennEast acknowledges that part of the standard pipeline construction process is the hydrostatic testing of the pipeline. This occurs once the pipe is in place and construction is completed, but prior to backfilling the pipeline trench. Basically the testing involves filling the pipeline with water and then pressurizing the pipeline to a "level higher than the maximum pressure at which the pipe will ever be operated". The hydrostatic pressure test is conducted for a minimum of eight continuous hours. The first acute impact directly resulting from this testing will occur as water is actively pumped from the supplying waterbody; most likely a nearby stream. As highlighted above, many of the streams that are located near or are being transected by the pipeline are EV, HQ and C-1 waterbodies. Such streams are documented trout production or trout maintenance ecosystems. Multiple opportunities arise for the degradation of the "donor" stream during the pumping process. The means by which water is removed, the total volume of water removed and the frequency of the testing all place a hydrologic stress on the donor stream. To date these impacts have not been acknowledged or discussed. Obviously the removal of even small volumes of water from these streams could cause serious acute impacts that negatively affect the habitat quality and resident biota of the stream. In addition to concerns related to the volume of water being removed, impacts to the biota can arise simply as a result of machinery and pumping equipment accessing the stream and the means by which water is pumped and removed from a stream. Water diversion impacts will be of greater significance in headwater and smaller order streams. These impacts will also be greater during periods of low baseflow. In the summer months removal of large volumes of water not only will have a direct effect on stream flow and in-stream water levels, but could also trigger water temperature impacts due to a depletion of passing flow.

Additionally, once the testing is completed the water in the pipe will need to be discharged back into the stream. Again this can affect stream water temperatures. It can also result in the introduction of pollutants, which directly conflicts with the anti-degradation maintenance requirements for C-1, EV and HQ waterways. Finally, at the point of discharge there is the potential for scour and erosion. To date none of the impacts associated with the hydrostatic testing of the pipeline has been acknowledged or addressed.

3.7 Increased Runoff and Stormwater Loading

The simple action of clearing the land, regrading and smoothing the pipeline ROW, compacting and altering the physical structure of the native soils within the ROW, and replacing forest with ground cover will increase the amount of stormwater runoff generated during each storm event. PennEast has used post-development TR-55 runoff curve numbers in an attempt to support their contention that there will not be an increase in runoff following the completion of the pipeline. However, it is well established that following land development, especially development on steep slopes and resulting in forest clearing, peak flows and total runoff

volumes will increase. In addition, the time of concentration[3] will decrease. Undoubtedly there will be both a greater volume of runoff and velocity as the result of pipeline construction. In addition to increasing the volume and velocity of runoff entering stream systems, these conditions will increase the mobilization and transport of pollutants (including sediments and nutrients), increase the likelihood of scour and erosion and decrease the total volume of precipitation infiltrated back into the soil leading to a decrease in the recharge of the surficial aquifer. The long-term impacts of these changes in stormwater runoff will be discussed below in greater detail.

The acute impacts arising from the increased volume and rate of runoff will be most pronounced immediately following the pipeline's construction. Until ground cover is re-established storm flows and runoff volumes will be especially elevated; again with the greatest differences occurring within the disturbed steep sloped areas. PennEast, PADEP and NJDEP acknowledge that acute impacts are likely to occur immediately following construction. This is why erosion and sediment control measures must be implemented and maintained. But even PennEast recognizes that these measures will at times fail…

> "Following construction, PennEast will perform routine maintenance on portions of the ROW …. PennEast also will maintain and repair areas that wash away, subside or are damaged due to natural causes."

Each of these wash out, subsidence and damage events represent an irreversible impact to the adjoining natural area, whether it be forest land, wetland, floodplain, riparian corridor or stream ecosystem. Granted it may be possible to remove some of the soil that washed into the adjoining lands, but the process of removing the soil and/or contaminants involves additional disturbance of impacted wetlands, riparian corridor or waterway and in itself stimulates another host of impacts related to accessing and working within these sensitive environmental areas.

Additionally, PennEast is technically responsible for repairs and maintenance of the ROW. PennEast is not responsible for the repair of areas adjacent to the ROW that were disturbed but are not directly associated with the pipeline. As such, if a stream segment down gradient of the pipeline ROW becomes compromised due to construction activities, it is unlikely that this impacted segment will be repaired.

It also must be emphasized that unlike conventional development projects, the pipeline project does not include the implementation of any post-development stormwater management measures. It is acknowledged that during construction PennEast will implement "temporary erosion control devices…installed in compliance with regulations and best management practices". However, none of the standard types of stormwater BMPs such as bioretention

[3] Time of Concentration (Tc) is the time for runoff to travel from the hydraulically most distant point of the watershed to a specific point of interest within the watershed or the point at which the runoff is discharged from the watershed. It is affected by slope, vegetative cover and surface roughness.

basins, detention basins or even vegetated swales will be constructed or installed as part of the project. Thus unlike conventional development sites, there will be no permanent measures in place capable of controlling the rate of runoff, the volume of runoff or the quality of runoff. Again while the lack of true stormwater BMPs will contribute to the pipeline's long-term hydrologic impacts, the absence of such measures during and immediately following the pipeline's construction limits the ability to mitigate or prevent acute stormwater related impacts.

3.8 Operational Impacts

An often overlooked acute impact is associated with the actual operation of the construction equipment. Machinery will need to be refueled and maintained on a daily basis. Given that much of the pipeline path cuts through undisturbed areas with limited vehicular access, fuel and lubricants will need to be brought to the jobsite. This increases the likelihood of spills and leaks, most of which will be far below any reportable quantities. Nonetheless, whether large or small, these spills represent acute impacts that will further compromise and degrade the environment. Similarly, given the fact that the pipeline will cross over 80 streams, many of which are EV, HQ or C-1, the operation of machinery in these streams (and adjacent wetland and riparian areas) present additional opportunities for the release of fuel and lubricants into the water. Operation of such machinery poses an acute risk even under normal working conditions. The risk and likelihood for acute impact will only be magnified with this machinery working in wetlands and riparian areas with exceptional resource value, and waterways of outstanding quality that support highly sensitive and/or unique biota.

4. Long-Term Impacts of Pipeline Construction

4.1 Synopsis of the Long-Term Impacts That Will Be Triggered by the PennEast Pipeline

Linear development projects such as the PennEast Pipeline result in a multitude of long-term environmental perturbations including:

- Destabilization of the traversed ecosystem,
- Diminishment and alteration of the ecological services and functions provided by these ecosystems,
- Negative changes to the assemblage of the biotic community,
- Increased predation/loss of native forest core species due to the introduction of predators and "edge" species,
- Increased opportunity for the introduction and colonization of invasive species,
- Fragmentation of habitat and the loss of key resources, access to key resources or the quality of key resources required for the success of forest core and wetland core species,
- Reduction in the long-term water quality of the bisected streams,

- Increased thermal impacts to streams resulting from a decrease in stream side tree canopy cover,
- Changes in the watershed's hydrologic and hydraulic properties,
- Increased amounts of stormwater runoff, the rate of runoff and the frequency and longevity of erosive flows,
- Increased opportunity for upland and in-stream erosion,
- Increased pollutant loading to wetlands and streams, and
- Decreased infiltration and recharge of the surficial aquifer (critical to the maintenance of stream baseflow and the hydrodynamic properties of wetlands).

To date there has been no acknowledgement of such long-term impacts by PennEast. More importantly though is that these types of long-term impacts cannot be successfully mitigated or avoided, especially, as is the case with the PennEast pipeline, when the project area includes a high percentage of high quality, currently undisturbed forest, wetland and stream environments and ecosystems.

Within this section of this white paper two of the more egregious and obvious long-term impacts associated with the PennEast pipeline are investigated and discussed in greater detail; Habitat Fragmentation and Hydrologic Impacts.

4.2 Habitat Fragmentation

As per Franklin, et. al., (2002), habitat fragmentation can be defined as:

> "The discontinuity, resulting from a given set of mechanisms in the spatial distribution of resources and conditions present in an area at a given scale that affects <u>occupancy, reproduction, or survival of a particular species</u>."

The impacts and problems of habitat fragmentation have long been analyzed and discussed by ecologists especially with respect to the clearing or alteration of core forest areas. The obvious impact of linear development is that it results in the irreversible alteration of the vegetative cover within the pipeline and pipeline ROW pathway. Initially this is the result of the required clearing of trees, shrubs and understory lands, the grading of land and the back-filling of the pipeline trench. Over the long-term, the maintenance of the ROW requires prevention of any tree growth, which is accomplished by periodic mowing and the use of herbicides. It may also involve the periodic trimming, pruning, cutting back and removal of trees and woody vegetation growing along the perimeter of the ROW in order to prevent the migration of such vegetation into the actual ROW. The inspection and maintenance of the ROW means the repetitive access and traverse of the ROW by inspection vehicles and maintenance equipment. This increases overall site compaction and because there are no stabilized access-ways, it also creates repeated opportunity for soil erosion.

The removal of trees, herbaceous vegetation and groundcover can negatively impact the basic habitat requirements of a given species thereby effecting its survival. Fragmentation not only eliminates vital habitat but can separate species from necessary resources and degrade the forage, refuge and reproductive value of the habitat thereby limiting the long-term success of a species. Habitat fragmentation also greatly increases the opportunity for invasive species colonization (both native and non-native), increased predation, increased nest parasitism and other direct and indirect negative impacts to the species that relied on the complexity of the undisturbed core habitat area, whether a mature forest, wetland or riparian floodplain corridor.

Linear development projects (including roads, transmission lines, pipelines and pipeline ROWs) have been directly linked to a loss of sensitive species (Forman, 2004; Gucinski et al. 2001; Trombulak and Frissell, 2000). Some of these losses reflect the separation of species from needed resources as well as the physical and ecological alteration/degradation of the traversed habitat. The linear fragmentation caused by the pipeline ROW is especially significant as the ROW and pipeline approach and cross streams, especially high-gradient streams. Increased fine sediment loading will occur due to the compromised nature of the wetlands and riparian areas abutting these streams, with those impacts exacerbated by the steeper terrain. These fine sediments are especially impactful to benthic organism, fish eggs, fish larvae and fish fry (Newcombe and MacDonald 1991, Newcombe and Jensen 1996, Gucinski et al. 2001, Angermier et al. 2004, Suttle et. al. 2004).

The above long-term habit fragmentation impacts cannot be mitigated owing to the ecological complexity that they trigger. The resulting ecological losses surpass the compensatory capabilities of the standard mitigation measures proposed as a means of lessening acute project impacts. For example, re-establishing ground cover does not compensate for the changes in the composition of the soil mantle, the complexity of the pre-existing groundcover or the loss of species complexity. Planting trees along the perimeter of the ROW does not compensate for the loss of the ecological services and functions provided by the original core forest. The PennEast pipeline pathway clearly bisects miles of sensitive and unique habitats. The damage to the overall ecological properties of the affected lands and water resources are irreversible. Once the pipeline and its ROW are in place it is impossible to return to or recreate pre-pipeline environmental conditions.

4.3 Hydrologic Impacts

The long-term hydrologic impacts attributable to any pipeline project, including the PennEast pipeline, can be divided into three related categories; increased volume of runoff from the altered ROW, changes in the hydraulic response of runoff from the altered ROW, and increased pollutant loading. These changes in the amount and rate of runoff stem from the alteration of the vegetated cover and the compaction of soil that occurs during the clearing of the ROW, the construction/installation of the pipeline, and the long-term maintenance of the ROW. These impacts will be greater on steeper sloped lands and where the soils have a higher clay/silt content and lower soil saturation coefficient (soils that are easily saturated). Obviously on steeper land there will be a greater tendency for precipitation to runoff as compared to land of

minimal grade. Clayey soils that become saturated very easily will also have a greater tendency to generate more runoff than sandy soils having high water retention characteristics. But the long-term changes in the ROW's hydrologic properties will occur regardless of slope gradient or soil type simply due to the inherent amount of soil disturbance, soil compaction and altered vegetative cover that will occur during the pipeline's construction (USDA, 1986).

An increase in volume runoff will occur when forested lands, and their complex understory, are cleared and replaced with grass. Although the surface of the ROW may be stable following the establishment of the replacement vegetative cover, its runoff characteristics will be different. Referring to the TR-55 table of runoff coefficients (USDA, 1986), even for the best drained soils (hydrologic soil group A) the increase in the runoff coefficient value when converting woods to lawns, ranges from 30%-50%. This translates to a substantial increase in the volume of runoff generated by each storm event. Also because the runoff coefficients have increased, this also translates to a shorter time for runoff to be generated and overall results in greater peak runoff flows (the rate at which runoff leaves the ROW). This combination of an increase in runoff volume and runoff rate has been repeatedly demonstrated to be the root cause of stream erosion. On average, a typical deciduous tree intercepts 700 to 1,000 gallons of precipitation annually, and an evergreen (the majority of the trees that will be removed over the course of the PennEast pipeline) intercepts over 4,000 gallons of precipitation annually (PennState, 2014). Removing acres and acres of trees and replacing them with a grass cover will result in major changes in the ROW's runoff characteristics. Although PennEast will implement post-construction site restoration measures, as they themselves note, restoration will never result in a complete return to prior conditions even where that is the goal -- " Restoration continues until the construction work area is restored <u>as close as possible</u> to its original state". Once again, these changes will be greater on steeper sloped lands and greater where the native soils are thin, clayey and have lower water retention capabilities.

As defined by the NRCS (OCSCD, 2011), soil health and quality relates to:

> "The capacity of a specific kind of soil to function, within natural or managed ecosystems, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation."

The health and quality of a soil is a function of its natural physical, chemical and biological properties. Development activities compromise the functionality of soils, impairing the soil's ability to support vegetation and infiltrate runoff thereby making the soil more prone to instability and erosion and causing a greater amount of runoff to be generated. Some of the most severe damage to the soil's natural properties comes about due to heavy equipment repeatedly traversing the soil, as well as standard grading and post-construction "re-vegetation" techniques. The most noticeable change in soil function occurs due the loss of soil porosity resulting from short- and long-term compaction issues of the ROW. This loss of porosity decreases the native soil's ability to absorb, retain and recharge runoff. The other construction related issues that arise that are less obvious but equally problematic apply to changes in the organic content of the soil and changes in the soil's microbial and biological

communities. These changes come about as the soils are excavated, sorted, mixed and stockpiled and can negatively affect the ability of the soil to sustain a vegetative cover as well as retain and recharge runoff. There are no provisions in the sediment and erosion control regulations of either Pennsylvania or New Jersey that require the pre-construction restoration of the soils to pre-construction organic content, porosity/permeability or fertility (refer to NJSSCC, 2014 and PADEP, 2012). And as noted earlier, PennEast's commitment with regards to the disrobed soils is only to ensure that they are stable. PennEast is under no regulatory obligation to restore the pipeline and ROW soil properties to pre-construction conditions. The fact of the matter is that these changes in the properties of the soils along the pipeline and within the pipeline ROW will contribute to the predicted increases in the volume and rate of runoff. Along the entire length of the 108-mile long pipeline, these changes in the post-construction hydrology of the affected lands (especially the steeper sloped areas) will invariably alter runoff properties. The end result will be impacts to the streams, wetlands and riparian areas traversed by the pipeline and pipeline ROW and increased opportunity for erosion along the steeper segments of the pipeline and pipeline ROW. Because PennEast is not required to implement any of the conventionally utilized best management measures to collect, treat and control ROW runoff, there is no way to mitigate for these changes other than to revegetate. However, once again the cover type will be different pre to post-construction (e.g. trees to grass) and PennEast is only obligated to achieve 80% post-revegetation coverage with the vegetation type it is using.

Another often overlooked impact caused by pipelines (whether wastewater, stormwater or gas/oil) is that their construction can actually alter the movement of groundwater. Essentially when the pipe and pipe trench intercept the shallow aquifer, groundwater flows can be prevented from flowing normally leading to changes in base flow conditions or the hydrologic properties of adjacent wetlands. The pipeline and pipeline trench can function as a subsurface diversion forcing groundwater away from vital stream and wetland resources.

When all of these factors are taken into consideration it is obvious that the pipeline's construction will lead to substantial changes in the hydrology of the affected lands. The impacts will be greatest in steeper sloped areas and these changes will exert the greatest impact on the EV, HQ, C-1 and lower-order streams. These impacts can either be the result of increased volume and rate of runoff or a loss of baseflow due to a decrease in recharge. These predicted hydrologic changes will also similarly impact the wetlands and riparian areas associated with these environmentally sensitive streams. Over the long-term these hydrologic changes can lead to significant ecological changes including the loss of sensitive species, increased eutrophication and habitat degradation.

5. Unavoidable Impacts

FERC recognizes that there are certain aspects of any project that can lead to unavoidable impacts, also referred to as the project's "effects that cannot be avoided due to constraints in alternatives. These effects do not have to be avoided…but they must be disclosed, discussed,

and mitigated, if possible (40 CFR 1500.2(e)". Some examples of such unavoidable impacts that are likely to arise of any pipeline project include:

- The offsite transport of soil due to wind/stormwater erosion of stockpiled soils or resulting from the movement of equipment to and from the ROW and related construction/staging areas.
- Long-term changes in species composition and community structure (height and density) within the construction ROW and ancillary sites caused by the initial clearing and grading of the ROW and then its subsequent long-term maintenance.
- Increased turbidity and sedimentation occurring during the pipeline's crossings of streams and wetlands.
- Increased long-term pollutant loading due to changes in the stormwater runoff characteristics of the affected lands and the lack of implementation of any actual stormwater BMPs.
- Unplanned releases of drilling muds during directional boring operations at stream crossings.
- Trenching activities as part of the pipeline's crossing of streams leading to disturbance related and/or turbidity/sediment related fish, macroinvertebrate, and amphibian mortalities. Trout species eggs and juvenile life stages are especially prone to such mortalities.
- Stream bed erosion and scour impacts caused by the dewatering of work areas or the diversion of flow around work areas.
- Loss of vital mating, spawning, nesting, feeding and/or nursery habit for species dependent on undisturbed core forests, ephemeral wetland or contiguous grassland habitats.
- Degradation of the aesthetic attributes of the affected areas. These impacts will be most obvious where the pipeline ROW cuts through State Game Lands, State and County Parks and public recreational areas and open space areas. These impacts are also significant with respect to New Jersey's Category-1 streams which by regulation (NJAC 7:9B-1.5B) are protected from "measurable changes in water quality based on exceptional ecological significance, exceptional recreational significance, exceptional water supply significance or exceptional fisheries resource(s) to protect their <u>aesthetic value</u> (color, clarity, scenic setting) and ecological integrity (habitat, water quality and biological functions)".

Mitigative measures may be able to lessen the impacts of some of these types of impacts. However, due to the fact that the PennEast pipeline will traverse documented high quality wetland and stream systems that harbor and support threatened and endangered species and species of concern, even the best implemented mitigative measures will not be able to fully prevent ecosystem degradation and losses. These unavoidable impacts need to be fully disclosed, discussed and taken into consideration as part of the aforementioned "hard look" mandated by NEPA as part of this project's environmental review and analysis.

6. Cumulative Impacts

The PennEast Project is but one of a number of pipeline or utility projects occurring within the eastern Pennsylvania, western New Jersey region. Examples of other regional power transmission projects are the Transco pipeline and the proposed Texas Eastern TEAM 2014 Project and the Columbia East Side Expansion Project. As noted earlier, the cumulative impacts arising from the PennEast pipeline are a function of the additive negative environmental effects caused by other past and future pipeline and electric transmission line projects (linear development). In short, the impacts caused by other regional linear development projects worsen the long-term, ecological, project specific impacts attributable to the PennEast pipeline.

The "most favorable route" for the majority of linear development projects tends to be through undeveloped lands. This is reflected in the proposed PennEast pipeline pathway. Such routes avoid populated areas and the human health and safety issues that must be addressed when running conventional and unconventional gas pipelines or power lines through or near established neighborhoods, schools or public facilities. As in the case with the PennEast pipeline, the "most favorable route" involves the disturbance of environmentally sensitive and protected lands, dedicated public open space and preserved farmland. Each of these projects has a permanent access/inspection/maintenance ROW that can vary from 50' to 150' in width. Again, the permanent ROWs associated with these projects further exacerbate the amount of long-term destruction and ecological losses caused along the entire length of the transmission corridor.

Thus, with each of these projects comes some combination of stream impact, core forests destruction, wetland and riparian corridor disturbance, and clearing of steeply sloped lands. As such, each project has caused or will cause its own unique set of impacts and add another layer of acute and long-term assaults to the environment. Additionally, each new project magnifies the project specific impacts of each prior project. When dealing with environmental impact assessment, each project is evaluated independently; the cumulative impacts of multiple linear development projects are not assessed and the additive long-term impacts of past and future linear projects fail to be recognized.

There is no exact tally of the total miles of pipeline or transmission lines that already exist throughout eastern Pennsylvania (http://stateimpact.npr.org). Although the Pennsylvania Public Utility Commission inspects over 46,000 miles of pipeline alone, this does not include any of the smaller "gathering lines" common to Marcellus Shale gas production. These lines are classified as Class 1 pipelines and are exempt from inspection as per Act 127, the Pennsylvania Gas and Hazardous Liquids Pipelines Act. As such, the total miles of pipeline actually cutting through critical forest, wetland, stream and riparian habitats is difficult to compute and the cumulative impacts of these transgressions on the environment difficult to quantify. The same holds true for the power transmission lines and associated ROWs. Some of the major gas transmission lines already located in eastern Pennsylvania include the Blakeslee, Transco, Humbolt, Shickshinny, Wyoming, Appalachian Basin and UGI gas lines. Similarly, in western New Jersey there are already a number of pipelines and transmission lines transecting the

State's sensitive forests, wetland, and streams as well as preserved farmland. These include the proposed Pilgrim Pipeline and the existing Algonquin, TGP, Transcontinental, Elizabethtown, and Texas Eastern gas lines. Add to this all of the large electrical transmission lines such as the Susquehanna-Roseland line, and it becomes clearly evident that the cumulative impacts of these linear development projects cannot be overlooked or underestimated. It is also obvious that the cumulative impacts of these projects will accelerate the long-term negative effects that come about due to the fragmentation of critical forest, wetland and riparian habitats.

Unfortunately such an in-depth analysis of the cumulative impacts is not a required element of most environmental impact analyses and as such normally fails to be discussed within a project's Environmental Assessment or Environmental Impact Statement. In fact even on a single project, the gas companies are inclined to bifurcate and segment projects in an attempt to lessen a project's total impact. This was most recently evidenced in a case brought by the Delaware Riverkeeper Network, New Jersey Chapter of the Sierra Club and the New Jersey Highlands Coalition against FERC and the Tennessee Gas Pipeline Company's Northeast Upgrade Project. In that case the United States Court of Appeals for the District of Columbia found that:

> "In conducting its environmental review of the Northeast Project without considering the other connected, closely related, and interdependent projects on the Eastern Leg, FERC impermissibly segmented the environmental review in violation of NEPA. We also find that FERC's EA is deficient in its failure to include any meaningful analysis of the <u>cumulative impacts</u> of the upgrade projects."

As such, although a usually avoided and rarely conducted part of the environmental impact analysis, the cumulative impacts of past and future related projects merit analysis and discussion. Again, such analyses thus far are lacking in the impact analyses or assessments conducted to date of the PennEast pipeline.

7. The Fallacy of Impact Mitigation

The simple answer given to address the obvious acute construction impacts linked to land clearing and grading is to prepare a construction phase soil erosion and sediment control plan and then implement and maintain the measures identified in the plan over the course of the construction phase. However, soil erosion and sediment control plans represent the minimum that is required to control soil disturbance at a construction site and/or the offsite transport of soil and sediment. Soil erosion and sediment control measures focus on the containment of soil and sediment during the construction phase and then the stabilization of the soils after construction is completed. While preventative by design, these measures do not guarantee the prevention of the off-site transport of soil or sediment or that environments adjacent to the project site will be fully protected from any impacts. The limitations of soil erosion and sediment control plans are clearly recognized in PADEP's Erosion and Sediment Pollution Control Manual (Technical Guidance Number 363-2134-008, 2012), which states that measures and BMPs contained in the manual are "expected to achieve the regulatory standard of

minimizing the potential for accelerated erosion and sedimentation". The Manual also notes that "human activities…typically increase the rate of erosion to many times that which occurs naturally".

In the upland areas through which the pipeline traverses there will be the need to clear cut and remove a large number of densely growing, large trees. Some of this clear cutting will occur in core forest areas. The clear cutting of the trees at the scale needed for this project will create a major acute ecological problem (as addressed elsewhere in this paper). From the perspective of erosion, the logging activity associated with felling the trees and then removing them from the pipeline right-of-way creates an erosion problem that is much different than that caused by conventional development activity. First, unlike a typical development site there is no intrinsic infrastructure being created to facilitate the tree removal. This means additional clearing will be needed to create access roads and staging areas. Second, much of the upland work occurs in locales characterized by steep terrain. This increases the severity of the erosion problems caused by clear cutting. Third, the native soils in these steeper areas are also shallower and more fragile, and once exposed are more likely to erode and unlikely to be easily stabilized. Thus, although erosion and sediment control measures could be implemented, the topography of much of the area through which the pipeline transects will limit the effectiveness of those measures. Therefore, even with the best developed soil erosion and sediment control plan in place there will be sediment and soil erosion impacts given the scale of the project and the sensitivity of the environments traversed by the pipeline.

With this project the types of acute erosion problems that will be created are not limited to upland areas. Some of the more potentially severe acute and long-term impacts are those caused by the pipeline as it crosses through wetlands and streams. These areas are characterized by persistent standing water, actively flowing water or saturated soils. Such conditions present especially difficult conditions for the proper installation of erosion and sediment control measures. Such conditions also decrease the functionality of most erosion and sediment control measures, which by design are meant to work in dry environments. Those control measures intended to be used in wet environments often require the dewatering of the site to allow the measure to be installed or constructed. This in itself creates an impact to the stream or wetland ecosystem and resident organisms by significantly altering the hydrologic regime. Those measures intended to be used in wet conditions will not be able to fully prevent eroded or disturbed soil from being mobilized and transported down gradient, especially during storm events. There is also an increased need to inspect, re-install and maintain erosion control measures installed in wetland and stream environments. The repeated need to access the area to re-install or maintain the erosion control measures is problematic. By repeatedly accessing and working in the wetlands, stream corridor or buffer areas associated with either further increase the likelihood of erosion, sedimentation and acute environmental damage. Thus, although the pipeline plan may involve the implementation of erosion and sediment control measures, those measures will not be sufficient to protect the transected streams or wetlands from sedimentation damages. In fact, due to the need for repetitive maintenance the installed erosion and sediment control measures may actually exacerbate environmental damages and result in more sedimentation and siltation of these

environments. Clearly there is the need to implement proper erosion and sediment control measures, however when working within stream, wetland and riparian corridors the implementation of these measures and their maintenance need to be conducted in a manner consistent with the sensitively of these environments.

A major problem with sedimentation, increased turbidity and siltation in aquatic and wetland environments is the impact this has on the resident biota. Excessive suspended sediments in the water column or prolonged periods of elevated turbidity will directly affect the spawning success of many organisms and impact the feeding of a wide variety of filter feeding species. While these impacts can be damaging at any time of year, the severity is magnified significantly during these ecologically critical times of year. Because different species rely on these streams at different times of year for spawning, nursery or feeding habitat, "working around" certain times of year is not an option.

As noted above, along with the pipeline there will be the need to construct a number of major interconnects and a large compressor station, all of which represent additional large land disturbances. There will also be the need to construct both temporary construction roads and permanent access and maintenance roads, which will further add to the amount of site disturbance and create additional opportunities for soil erosion. Another group of erosion problems will arise as a result of the construction and maintenance of temporary sedimentation basins and dewatering basins. This will again result in more land disturbance and additional opportunities for erosion and sedimentation impacts.

Another erosion problem that has been overlooked is that associated with the excavation and maintenance of the pipe trench. The trench needs to be deep enough to accommodate the pipe, bedding material and cover material. This means in areas where there is shallow depth to groundwater there will be the need to dewater the trench during the construction phase. Until the pipe is placed in the trench and the trench is backfilled, the trench will need to be maintained in a dewatered state between storm events. The repeated flooding and dewatering of the pipe trench resulted in significant turbidity and sedimentation impacts to wetlands and surface waters located with or adjacent to the TGP Pipeline construction zone.

The inadequacies of mitigation also relate to the restoration of each stream that will be crossed as part of the pipeline's construction. Directional boring will be limited to the crossings affecting the Lehigh River, Susquehanna River and Delaware River. A simple "dig and drop" approach will be used by PennEast to traverse the 80+ smaller order, high quality streams. At each of these crossing, some means will need to be implemented to divert flow around the project area and keep the pipe trench dewatered. Again, the trench depth will be at least 5-6 feet below existing stream grade, and could be even deeper to avoid thermal impacts to the stream or to protect the pipe from high-energy event scour and exposure. Overall, this type of construction is very disruptive to the stream and will negatively affect its ecological functionality. The current mitigative measures planned by PennEast, while perhaps addressing short-term erosion and sedimentation impacts, do nothing to restore the streams to their pre-development ecological complexity and functionality. In order to justifiably state that the

pipeline has caused "no impact", at each stream crossing the subject stream must have its stream channel restored to the pre-construction width, depth, slope and substrate. The restored substrate would also have to mirror the pre-construction composition of the streambed and bank materials and condition, including restoration of the kind, quantity and quality of rock, sediment, woody debris and vegetation. Additionally, the stream's restoration must allow for natural channel migrations, flows, sediment transport, and stream channel evolutions typical of natural stream flows. None of the mitigation plans submitted to date by PennEast address these issues or demonstrate the ability to fully restore the streams to pre-construction conditions.

The fact is that the mitigation does not require a return to a pre-construction state, but rather only requires that the minimum, basic requirements stated in the regulations are satisfied. For example with respect to the recently completed Leidy pipeline, TGP offered the following:

"Because the waterbody crossings would be completed in accordance with site-specific measures that may be required by State permitting agencies or the Army Corps of Engineers, we conclude that impacts on waterbodies would be minor and temporary".

The fallacy with this is that the lack of impact is predicted on the assumption the regulatory required mitigation will result in the stream being fully restored to its pre-construction state. That is never the case. Additionally, pipeline projects have had a very bad history of failed mitigation (NYSP, undated). These failures only reinforce that the proposed level of mitigation for stream and wetland crossings not only fail to return the stream or wetland to pre-construction standards but is difficult to achieve.

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Meliora Design

MEMORANDUM

To: Maya Van Rosum
Delaware Riverkeeper Network

Date: June 9, 2016

From: Marc Henderson, PE
CC: Michele Adams, PE

RE: Proposed State Water Quality Certification – PennEast Pipeline Project

Maya,

The Pennsylvania Department of Environmental Protection (PADEP) has been asked to review and evaluate this pipeline project to ensure that the project complies with State water quality standards and associated State laws. Meliora Design has reviewed both project specific documentation and regulatory guidance for pipeline construction on numerous occasions and has found it lacks key information to prevent soil compaction during the construction of natural gas pipelines. Regulatory guidance typically assumes that surface impacts to soils are only temporary in nature and will not play a long term roll in the health of the natural environment where these pipeline construction projects take place. Because the soil disturbance and soil compaction during construction activities is not considered with a high degree of importance, both State and Federal guidance on construction practices are limited in nature and do not prevent soil compaction during and after construction. The project as proposed will not sufficiently mitigate for soil compaction due to construction activities in the pipeline right-of-ways or temporary work zones.

Previous field investigations performed by Meliora Design on behalf of Delaware Riverkeeper Network in temporary right-of-way (ROW) locations along the Tennessee Gas Pipeline's 300 Line Upgrade Project in Milford, Pennsylvania, showed increased soil compaction as reflected in increased soil bulk density measurements when the temporary ROW locations were compared to undisturbed natural areas adjacent to the pipeline ROW. Severe compaction was noted within the former temporary ROW. Based on literature values, measured bulk densities were high enough to inhibit plant growth and infiltration. When plant growth and infiltration is limited, runoff volume and rate will increase. For this particular project, the observed conditions were considered stabilized and restored even though they had less than 70% vegetative cover (potentially inhibited by measured compaction). Absent more stringent requirements, construction activities for the other pipeline projects likely will result in severely

compact soils that are incapable for supporting plant growth or for allowing natural infiltration of rainfall.

More specifically, compaction from temporary work space will be difficult to restore by regrading to pre-existing contours, retilling at the surface, and reseeding the area as standard regulatory guidance indicates. Heavy equipment used in the construction of the pipeline will inherently compact work areas to depths deeper than conventional surface tilling will reach. These lasting impacts include increased runoff to streams and wetlands due to a reduction in infiltration capacity and difficulty in reestablishing vegetation. Infiltration capacity becomes limited when soils lose their porosity and soil structure, resulting in increased runoff volumes to streams. Excessive runoff changes stream geomorphology due to an increase in both volume and velocity. Streambanks and riparian areas are impacted by changes to the stream channel due to the increases in peak flow volume and rate. Streams with more flow also have higher energy. More energy means more in-stream erosion and sediment transport. Compaction also creates conditions where bulk densities of soils are so high that the soils inhibit the germination of plants and plant root growth. The establishment of vegetative cover within the pipeline ROW will be more difficult once surface soils are compacted. If vegetation regrowth is limited within both the temporary and permanent ROW, the likelihood of accelerated erosion will be increased.

More steps can be taken to prevent irreversible levels of compaction on a worksite. Limiting ROW widths to prevent widespread compaction before it takes place is one of the most effective practices that can be implemented. By not allowing compaction and disturbance to take place in the first place eliminates the need for extensive restoration of an area to prevent long term water quality impacts to surface waters. Testing during construction is also a technique that can be used but is not implemented one a widespread basis during pipeline construction. To determine if soil compaction is developing on a work site, soil testing needs to be conducted and reviewed by regulators on a regular basis. By not implementing large-scale testing of bulk densities within both ROW and temporary workspaces, there is no mechanism for identifying soils that have been compacted along the majority of the project length. Procedures that limit compaction deep into the soils such as limiting rutting depths, limiting ROW widths, using timber mats in wet areas with a likelihood of compaction, and restoring soil structure following impacts, should be required in all areas disturbed by pipeline construction of this project. Without acknowledging the role that soil compaction plays as a permanent impact on surface water quality and State water quality compliance, this pipeline project will not be able to comply with Pennsylvania's Clean Streams Law.

In order to protect applicable water quality standards, pipeline projects such as the PennEast Pipeline must protect sensitive natural areas from soil compaction such as wetlands and interior forests. Natural land uses such as interior forests and wetlands rely on vegetative cover to prevent the movement of soils during rain events by intercepting rainfall, stabilizing soils with their roots, and protecting surface soils with leaf litter and detritus. They also require soil with bulk densities low enough to allow for germination and root penetration, infiltration of

rainfall, and the movement of nutrients from the surface down into the root zone. Surface water quality is negatively impacted when these natural systems are disturbed and prevented from functioning in a naturally occurring condition. Federal regulatory guidance on pipeline construction published by FERC acknowledges the potential of compaction during pipeline construction and calls for penetrometer testing of soils within agricultural and residential areas to make sure soils are decompacted following construction. When testing indicates compaction in these areas, a pipeline installer would be asked to implement decompaction procedures according to the Soil Protection and Subsoil Decompaction Plan. This plan is not implemented in other land uses and therefore no compaction will be mitigated following construction in wetlands, interior forests, or other sensitive areas. The regulatory guidance does not provide an explanation as to why agricultural and residential land uses should receive greater protections than natural lands. All land uses will experience more sediment laden runoff from their surfaces, limited regrowth of plants and vegetation, and exposed soil surfaces after compaction. The same considerations to prevent or restore compacted soils should be implemented for both actively used lands as passively used lands. Accelerated erosion is the single largest concern resulting from soil compaction. When runoff does not infiltrate, is not intercepted at the surface by vegetation, and is allowed to travel across exposed soils, sediment is more likely to be transported downgradient to streams and wetlands causing a degradation in water quality and an inability of the surface water to meet designated water quality standards.

The PennEast Pipeline Project needs to fully evaluate conditions that may increase the likelihood of compaction for the most common landuses found along the pipeline. Areas that contain specific fine textures and high water tables are highly susceptible to compaction. Without identifying these areas for both the ROW and temporary ROW and across all landuse categories, no determination during project review of potential impacts can be made due to a lack of information being provided. Extensive areas being crossed by this pipeline will fall into the category of susceptible to compaction.

Impacts to resources located outside of the permanent ROW are often ignored or characterized as being temporary and short-term. This conclusion is not supported by experience with soil compaction investigations performed by Meliora Design within pipeline work areas. Once a soil's structure is disturbed with heavy equipment, compaction, and removal of surface vegetation, it is very difficult to regain structure that allows for infiltration of surface water or the regrowth of healthy vegetation following construction. The only way to avoid permanent compaction of soils is to prevent the compaction from happening in the first place (by limiting ROW widths) and to employ soil disturbance techniques that preserve soil structure.

Construction activities of this pipeline such as clearing, grading, trenching, and backfilling, all could adversely affect soil resources by causing accelerated erosion, compaction, and introduction of rock or fill material to the surface. Current regulations rely upon construction plans that focus on temporary erosion and sedimentation controls to protect water quality standards. While temporary erosion and sedimentation measures may help to limit the

transport of eroded soils during construction activities, they cannot fully eliminate the acceleration of erosion or soil compaction caused by construction over the long-term operation of a pipeline project. Once sediment reaches a stream or wetland, changes to the habitat of plants, fish, and insects will take place. Sediment from accelerated erosion smothers fish eggs and covers spawning areas with fine sediments, thus inhibiting fish reproduction. Increased turbidity in streams and wetlands prevents light penetration into the water column and increases water temperatures. All of these impacts make meeting water quality standards and the Clean Streams Law nearly impossible. Environmental damage to surface waters does not stop when construction ends if soils are severely damaged and their function in the natural environment is destroyed by compaction.

Sincerely,

Marc Henderson, PE
Water Resources Engineer, Meliora Design

COMMONWEALTH OF PENNSYLVANIA
ENVIRONMENTAL HEARING BOARD
2nd Floor, Rachel Carson State Office Building
400 Market Street, P.O. Box 8457
Harrisburg, PA 17105-8457

THE DELAWARE RIVERKEEPER NETWORK,
MAYA VAN ROSSUM, the Delaware
Riverkeeper, *and* RESPONSIBLE
DRILLING ALLIANCE,

Petitioners,

v.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL
PROTECTION, *and* TENNESSEE GAS
PIPELINE COMPANY,

EHB Docket No. _____

Respondents.

AFFIDAVIT OF MICHELE C. ADAMS, P.E.

Pursuant to 18 Pa. C.S. § 4904, I, Michele C. Adams, hereby declare:

1. I have personal knowledge of the statements contained herein and could competently testify thereto if called as a witness.

2. I have a Bachelor of Science degree in Civil Engineering from Pennsylvania State University. I have also taken graduate courses in Water Resource Engineering at Villanova University.

3. I am a licensed professional engineer in the State of Pennsylvania with over twenty-eight years in practice as an engineer in the area of water resources, including surface water hydrology, water quality, stream geomorphology and stream health, erosion and sediment

control, and land use impacts on water quality. I was a principal author of the Pennsylvania Stormwater Best Management Practices Manual, as well as other stormwater guidance manuals.

4. My observations and conclusions reported herein reflect my professional opinion as a civil engineer with expertise in water resources, relying upon generally accepted scientific and engineering methods and principles in water resource engineering. My observations and conclusions stated herein are made with a reasonable degree of scientific and engineering certainty.

Factual Background

5. Tennessee Gas Pipeline Company (TGP) is proposing construction of five 30-inch outside diameter loop natural gas pipeline segments encompassing 40.27 miles in Pennsylvania. Additionally, TGP proposes improvements and modifications to three of its existing compressor stations. This work is proposed to occur in Bradford, Wayne, and Pike Counties.

6. In respect to its Northeast Upgrade Project (NEUP), TGP submitted a Notice of Intent (NOI) for Coverage Under the Erosion and Sediment Control General Permit (ESCGP-1) for Earth Disturbance Associated with Oil and Gas Exploration, Production, Processing, or Treatment Operations or Transmission Facilities.

7. The NOI was most recently updated July 24, 2012, with supporting information, and permit coverage was granted by the Pennsylvania Department of Environmental Protection (DEP) on November 21, 2012. Stream encroachment permits were issued by DEP on November 21, 2012.

Review of Technical Information and Materials

8. I have personally reviewed the supporting technical documentation and correspondence that is related to the proposed TGP Pipeline construction (submitted as part of

the NOI), as well as supporting correspondence and documentation, as listed in Attachment A. This includes review of the numerous Notices-of-Violation (NOVs) issued by the Pike County Conservation District between June 22, 2011 and March 16, 2012 regarding construction of the 300 Line Upgrade Project.

Observations of Site Conditions

9. In addition to a reviewing the technical documentation identified in Attachment A, on November 29, 2012, I visited and personally walked portions of the recently constructed (2011) 300 Line Upgrade in Pike County that are accessible from DCNR lands of Schocopee Road.

10. At this time I also observed and walked portions of the proposed NEUP right-of-way (Loops 323 and 321). Weather conditions were clear and in the high 30's with light snow on the ground.

11. At that time I had the opportunity to observe existing conditions on portions of the 300 Line Upgrade pipeline, including areas of wetland crossings, installed slope breakers, and areas that are represented as having undergone stabilization, contour restoration, and re-vegetation. The 300 Line Upgrade pipeline in Pike County has been in operation for over a year. Both right-of-way (ROW) and temporary work areas (TWS) were observed. I observed a notable sparseness of revegetation in these areas.

12. Additionally at that time, I personally collected a surface soil sample (approximately 6 inches diameter) from an area that had been used as a temporary work space (TWS). At the same time, I collected a similar sample from the undisturbed forest area approximately 30 feet from the edge of the TWS. The samples were sent to a geotechnical testing laboratory and analyzed for bulk density and organic content. The analysis was done by

GeoSystems Consultants of Fort Washington, PA. A systemic program for sampling soil along the 300 Line Upgrade is at present underway to confirm the conclusions drawn based upon the preliminary samples collected on November 29, 2012. Based on my visual observations, similar results regarding soil compaction and lack of organic content are anticipated.

13. As part of the November 29, 2012 site walk, I had the opportunity to visually observe and walk portions of the proposed NEUP Upgrade right-of-way (Loop 323 and 321), including areas that are similar in natural physical conditions to the areas observed on the built 300 Line Upgrade.

Professional Opinions

14. **Opinion 1:** It is my opinion, given with a reasonable degree of scientific and engineering certainty, that the conditions created as a result of the completed 300 Line Upgrade construction have resulted in significant and permanent increases in stormwater runoff volumes, rates, pollutant discharges, and frequencies of discharge, and a corresponding decrease in infiltration volumes. As a result, existing streams and wetlands, including exceptional value streams, have been adversely impacted by stormwater discharges and the discharge of sediment.

15. **Opinion 2**: It is my opinion, given with a reasonable degree of scientific and engineering certainty, that the proposed work for the installation of NEUP under the submitted NOI will also result in significant and permanent increases in stormwater runoff volumes, runoff rates, pollutant discharges, and frequencies of discharge. There will also be a corresponding decrease in infiltration, which is essential to support healthy wetland systems, stream baseflow, and groundwater recharge, including maintaining stream temperatures. Existing streams and wetlands, including exceptional value streams, will be adversely impacted by stormwater

discharges and the discharge of sediment and other pollutants from the pipeline right-of-way, temporary work space areas, and associated roadway and compressor station activities.

16. I base this opinion on the conditions observed at the 300 Line Upgrade site, and the fact that the same practices are proposed for the new construction of the NEUP. The stormwater and erosion and sediment impacts observed at the 300 Line Upgrade project are significant, and similar impacts can be expected from the NEUP. Specifically, the stormwater impacts are caused by the following conditions observed in the existing pipeline work area: lack of organic content in surface soils; extremely high levels of soil compaction, with associated high bulk density characteristics such that the soils are "functionally impervious"; lack of surface vegetation and lack of established of permanent vegetation such that significant soil exposure can be observed; and irregular and inconsistent surface grading, and lack of fine grading to re-establish or replicate natural contours.

17. At areas along the 300 Line Upgrade, high levels of soil compaction, combined with a lack of organic material and vegetation, are such that the disturbed area has a hydrologic performance similar to an unmanaged impervious area, rather than the anticipated hydrologic performance of a restored pervious landscape that is described in the permit application documents and certified by TGP in the NOI for Coverage under ESCGP-1. Based on the conditions observed along the 300 Line Upgrade, the same results can be anticipated for the NEUP, with similar adverse stormwater impacts.

18. **Opinion 3**: It is my opinion, given with a reasonable degree of scientific and engineering certainty, that the restoration plans that TGP has provided in its NEUP NOI fail to demonstrate that there will be no change to stormwater flow.

19. TGP's application asserts that there will be no stormwater impacts following site restoration because (1) the amount of pervious area before and after the earth disturbance will be the same and (2) the natural topographic contours will be restored to their pre-construction condition.

20. TGP's assumptions regarding pervious area and site contour restoration are demonstrably incorrect.

21. TGP's assumption that there will be no change in the amount of pervious area, and therefore no change in stormwater run-off volumes or directions, is incorrect because soil compaction resulting from pipeline installation activities dramatically reduces the permeability of surface soils in "restored" areas of the right-of-way where top soil has not been segregated, making those areas far less pervious than before the restoration.

22. Post-"restoration" conditions at locations along the 300 Line Upgrade Project demonstrate that the permeability of surface soils in the pipeline ROW and associated TWS and additional temporary work space (ATWS) is in fact dramatically reduced in comparison to pre-construction conditions. Testing of preliminary samples collected from representative locations along the 300 Line Upgrade shows that bulk density (soil compaction) has been increased from 0.88 - 1.27 grams per cubic centimeter to 1.99 – 2.47 grams per cubic centimeter as a result of soil compaction. Correspondingly, the ability of the soil to absorb water has been dramatically reduced. Research indicates that woods with low bulk density soil conditions have a permeability rate of many inches per hour. Compacted soils with bulk density values in the range measured in the disturbed pipeline area have a permeability rate of only a few hundredths of an inch or less per hour.

23. TGP's assumption that there will be no change in site topographic contours, and therefore no change in stormwater run-off volumes or directions, is incorrect because the scale of contour restoration is not fine enough to account for changes that have a significant effect on the hydrologic response. Much of the contour restoration provided for in TGP's plans is at a scale of 20-foot contours, corresponding to the contours on the USGS 7.5 minute topographical quadrangle maps for the affected areas. However, changes to natural topography at the scale of 1-ft contour intervals can have significant effects on the hydrologic response of an area. A comparison of the post-restoration grading at the 300 Line Upgrade Project ROW to the uneven nature of the natural forest topography prevailing prior to construction shows that post-restoration topography has been smoothed out, but these changes would only be evident at a scale of 1-ft contour intervals. Thus, the natural topography after the restoration is different from the pre-construction condition in ways that significantly affect hydrologic response, and alter the volume and direction of stormwater run-off.

24. When the effects of soil compaction, reduced organic content, changes in the type of vegetative cover and small-scale changes in topography are taken into account, there is a quantifiable significant increase in run-off volume, run-off flow rates, discharge of pollutants, and frequency of run-off.

25. Based on my analyses of TGP's plans for NEUP restoration, there will be significant and permanent increases in stormwater runoff volumes, runoff rates, pollutant discharges, and frequencies of discharge. There will also be a corresponding decrease in infiltration, which is essential to support healthy wetland systems, stream base flow, and groundwater recharge, including maintaining stream temperatures.

26. **Opinion 4**: It is my opinion, given with a reasonable degree of scientific certainty, that the numerous violations of the Clean Streams Law documented by the Pike County Conservation District during the construction of the 300 Line Upgrade clearly demonstrate that the documentation and performance requirements that PADEP approved in respect to the general permit authorization for the 300 Line Upgrade were grossly inadequate to prevent the discharge of "pollution into waters of the Commonwealth." The use of the same erosion and sediment control measures and the same restoration plans for the NEUP that clearly failed on the 300 Line Upgrade will result in erosion and sediment control violations of the same nature, and additional discharges of pollutants to exceptional value streams and wetlands, during and after NEUP construction.

27. Specifically, for the period between June 22, 2011 and March 16, 2012, Pike County Conservation District documented thirty-two (32) violations associated with the observed discharge of sediment, and five (5) violations associated with the potential discharge of sediment. Of the 17 documented site observation reports that I reviewed, only 3 reports did not include violations. A summary table is included in Attachment B.

28. **Opinion 5**: It is my opinion, given with a reasonable degree of scientific and engineering certainty, that the remaining technical deficiencies documented by the Pike County Conservation District (PCCD) in its October 18, 2012 letter to PADEP have not been adequately addressed.

29. Comments 1 and 2 of the October 18, 2012 PCCD letter regarding anti-degradation analysis and thermal impacts in riparian areas remain unaddressed by the additional information submitted by the applicant in October for the Riparian Zone Tree Planting Plan. This plan (approximately 1 and 1/4 pages in length) lacks detail and fails to provide sufficient

technical requirements and specifications with regards to materials, construction practices, and setbacks from streams and wetlands to assure to assure that High Quality and Exceptional Value waters will be protected.

30. Additional PCCD comments remain unaddressed and are related to inadequate erosion and sediment control measures and lack of topsoil management. These are directly related to Opinions 2 and 3 above.

Technical Basis for Opinions 1, 2, and 3: Observed Conditions and Stormwater Management Deficiencies

31. Section D.1 of the NOI form reads "*Site restoration should be designed to use natural measures to eliminate pollution, infiltrate runoff, not require extensive construction and maintenance efforts, promote pollution reduction, preserve integrity of stream channels, and protect the physical, chemical, and biological qualities of the receiving water*." In its NOI for the NEUP, TGP has indicated (by checking a box under Section D.3), and DEP has accepted, that "The Site Restoration Plan and PCSM BMPs were developed to employ water quality design features and the PCSM BMPs will manage any net increase in stormwater runoff volume resulting from the 2-year / 24-hour frequency storm."

32. Section D.3 of the TGP NOI states that "BMPs will infiltrate all of the Net Change of Runoff."

33. Section D.5 states that there will actually be a net decrease in runoff volume (of 0.008 acre-feet, or 260 gallons).

34. Section D.6 identifies the primary Post Construction Stormwater BMP as "Pre-Construction Drainage Pattern Intact."

35. These assumptions are incorrect, as the disturbed areas of pipeline construction (including temporary and additional temporary work areas in proximity to Exceptional Value

streams and wetlands) that are represented as “restored” and “pervious” will not in reality perform hydrologically as restored pervious areas would. Subsequently, the assumption that the hydrologic response of the disturbed areas will essentially be the same after “restoration” as it was before disturbance cannot be supported. There is, in actuality, an increase in stormwater runoff volumes and rates. The NOI assumptions that the disturbed areas will be restored and additional stormwater management measures will not be required are incorrect. There has been a substantial increase in runoff impacts both during and after construction (as observed on the 300 Line Upgrade). Under the permits at issue, the same is very likely to hold true of the NEUP during and after construction.

36. Specifically, the ability of the land surface to absorb rainfall is directly related to the soil type, soil condition, and the land use cover type. Under the U.S. Department of Agriculture, Natural Resources Conservation Service Cover Complex methodology, this is represented and quantified by the use of a “curve number” value (CN). The lower the CN value, the more a soil can “absorb” rainfall and the less stormwater runoff occurs (i.e., a CN of 55 represents little stormwater runoff, a CN of 98 represents that nearly all rainfall will occur as runoff).

37. Specific numeric CN values are not provided for most of the project area because of this faulty assumption (i.e. that the CN values and runoff responses are the same after restoration as they were before construction). Where CN values are provided for the Main Line Valve 324 area, land uses that are “restored” as meadow are given essentially the same CN value for both before and after disturbance (70 before and 71 after). Again, this indicates that no significant stormwater increase is expected.

38. By assuming that all pervious surfaces perform equally, and by assuming that the disturbed pipeline areas have actually been restored in terms of hydrologic response, both DEP and TGP assert that there will be no stormwater impact after construction.

39. Based on conditions observed on the 300 Line Upgrade, as well as the lack of specific performance requirements and standards for restoration conditions after pipeline construction, these assumptions are incorrect. The CN value assumptions made by TGP and DEP cannot be supported. There is and will continue to be a permanent increase in stormwater runoff after construction due to both soil compaction and lack of organic material. It is clearly erroneous to assume that CN values after restoration will return to pre-construction values.

40. Components that impact CN values and affect stormwater runoff volume and flow include soil compaction and changes in vegetative cover.

Soil Compaction:

41. A number of studies (Pitt, Ocean County Conservation District) have examined the ability of soils to absorb water as a function of how dense or compacted the soil is. Compaction is often represented as Bulk Density and provided in units of grams per cubic centimeter (g/cm3). These studies have found that a soil's ability to absorb water declines sharply as compaction, or bulk density, increases, often as a result of construction practices. Compacted soils affected by construction practices can lose nearly all capacity to absorb rainfall.

42. The sample that I collected on November 29, 2012 was analyzed by a professional laboratory and found to have a bulk density value of between 1.99 and 2.47 grams per cubic centimeter as shown in Table 1 below. A sample collected at the same time from an adjacent undisturbed woodland area had a bulk density value between 0.88 and 1.27 grams per cubic centimeter. For reference, the bulk density of concrete is about 2.4 grams per cubic

centimeter. Table 1, presented in Attachment C, summarizes the measured soil characteristics calculated for the two samples.

Inability to Support Vegetation due to Compaction and Lack of Organic Content

43. As a result of compaction, plant root systems are adversely impacted and vegetative land cover is unable to re-establish. Vegetation can fail to re-establish for years and decades after compaction has occurred. USDA NRCS technical guidance on soil compaction indicates that root growth will be restricted at bulk densities greater than 1.47 grams per cubic centimeter (for clay soils), to 1.80 grams per cubic centimeter (for sand soils). The measured compaction at the 300 Line was between 1.99 and 2.47 grams per cubic centimeter.

44. Organic content indirectly affects the ability of soil to absorb water by affecting the ability of vegetative cover to develop. At the 300 Line Upgrade, organic content from the soil sample from the temporary workspace is significantly lower than the organic content of adjacent undisturbed areas, further limiting the ability of vegetative systems to re-establish. The 300 Line Upgrade permit requirements did not require that topsoil be segregated except in limited areas, and as a result there is no visible topsoil and little measurable organic content.

45. Organic content also directly affects the ability of a soil to absorb water.

46. The vegetation that has re-established at the 300 Line Upgrade, i.e., primarily sparse annual grasses, is significantly different in nature, land cover extent, and hydrologic response than the pre-existing forested land cover, and similar conditions can be expected for areas along the NEUP.

47. As a result of soil compaction and lack of vegetative restoration to “meadow,” the amount of stormwater runoff and the frequency of stormwater runoff are significantly greater on

the 300 Line Upgrade than in the undisturbed areas, and similar conditions will be created by the NEUP disturbance as currently permitted.

48. A conservative estimate of the amount of runoff increase (on a unit basis) is provided in Table 2, Attachment C which compares “woods” in good condition with “C” soils (common throughout the NEUP area) to a land cover of “dirt” with “D” soils as a result of soil compaction.

49. The stormwater runoff projections in Table 2 reflect the results of my calculations, which were undertaken using generally accepted methods and principles in science and engineering, specifically, water resource engineering. Specifically, my calculations are based on the USDA NRCS “Cover Complex Method” which is the same methodology applied by TGP in its permit authorization application. These calculations were arrived at by taking into consideration the effects of soil compaction, reduced organic content, and changes in vegetative cover, in accordance with generally accepted methods and principles in science and engineering, specifically, water resource engineering.

50. Two items can be seen from Table 2. First, the initial abstraction (or amount of rain that must fall before runoff begins) is much higher for woods than for dirt conditions. Specifically, 0.86 inches of rainfall must occur before any runoff begins in a wooded condition. By contrast, runoff will begin from the disturbed area with as little as 0.27 inches of rainfall. As a result, runoff will occur much more frequently.

51. Additionally, as can be seen from Table 2, the amount of runoff will be much greater from the disturbed area than from the wooded condition in every rainfall event. For a 2-year event, there will be an estimated increase in runoff volume of over 27,000 gallons per acre of disturbed area in the single rainfall event. With each runoff event and discharge to surface

waters there is an accompanying increase in pollutant discharge and temperature impacts, and a corresponding decrease in groundwater recharge.

52. The cumulative impacts through the proposed 370.5 acre disturbed area of the NEUP are significant, and in direct contrast to the representation on the NOI that there will not be any increase in runoff volume for the 2-year event. The NOI representation cannot be supported by the observed conditions on the 300 Line Upgrade or by the permit application documents submitted by TGP for the NEUP.

Additional Stormwater Assumptions that Cannot be Supported in the NOI Documentation

53. The NOI documentation includes specific stormwater calculations for Slope Breakers and for Main Line Valve 324 in Pike County. Again, these calculations make technical assumptions that cannot be supported based on the documentation and the observed conditions on the 300 Line Upgrade.

54. Specifically, the slope breaker calculations apply a land use coefficient for "permanent" conditions that is almost the same as the coefficient for "forest" conditions, thereby grossly underestimating stormwater flow rates.

55. Along the same lines, the "time of concentration" value after construction at Main Line Valve 324 is exactly the same as before construction. In other words, by using numerical values that are essentially the same for conditions after development as they were before development, the detailed calculations indicate very little change or impact. But this cannot be supported by the observed conditions on the 300 Line Upgrade sites, and therefore stormwater estimates for flow rates (like volume) have been grossly underestimated.

56. In developing the technical basis for my professional opinions, I relied on the following technical reference materials:

- Pitt, Robert, P.E. Ph.D., BCEE, D.WRE, Department of Civil, Construction, and Environmental Engineering The University of Alabama Tuscaloosa, AL.
- Ocean County Soil Conservation District, Schnabel Engineering Associates, USDA Natural Resources Conservation Service, March 2001 (Rev 06/01/01). *Impact of Soil Disturbance During Construction on Bulk Density and Infiltration in Ocean County, New Jersey*.

- USDA Natural Resources Conservation Service, Soil Quality Institute, Urban Technical Note 2, March 2000. *Urban Soil Compaction*.

- United States Department of Agriculture Natural Resources Conservation Service, June 1986. *Urban Hydrology for Small Watersheds Technical Release 55.*

The foregoing is true and correct to the best of my knowledge, information and belief. I understand that any false statements made are subject to the penalties of 42 Pa. C.S. § 4904 relating to unsworn falsification to authorities.

Executed this 17th day of December, 2012.

Michele C. Adams

ATTACHMENT A

The material I reviewed includes but is not limited to the following material:

2012 October 26 rec'd by PCCD updated Post-construction Stormwater Management for Main Line Valve 324

2012 October 18 Letter from Pike County Conservation District, Susan Beecher, Executive Director and Scott Savini, District Chairman to Joseph Buczynski, P.E. Waterways and Wetlands Program Manager, Pa DEP Northeast Regional Office. Re: Sept 18, 2012 deficiency letter ESCGP-1 Application #020011801 TGP Northeast Upgrade Project, Lackawanna, Milford and Westfall Townships, Pike County.

2012 September 18 Letter from Michael Luciani Project Manager Waterways and Wetlands Program PaDEP to Michael Letson, TGP Pipeline Company. Re Technical Deficiencies ESCGP Application No. 020011801.

2012 September 5 Letter from Pike County Conservation District, Ellen Enslin Sr. Resource Conservationist to Mr. Patel, Pa DEP Northeast Regional Office. Re: 2nd E&S Technical Plan Review ESCGP-1 Application #020011801 TGP Northeast Upgrade Project, Lackawanna, Milford and Westfall Townships, Pike County.

2012 Aug 20 Rec'd by PCCD Letter from Wayne Poppich USACOE to Michael Letson re CENAP-OP-R 20110-32-30

Revised July 2012, Original October 2011 TGPL Antidegradation Analysis and Thermal Impact Analysis, Bradford, Susquehanna, Wayne, and Pike Counties, PA, Prepared by CH2MHill Philadelphia.

Revised July 2012 TGPC NEUP Environmental Construction Plan, Kinder Morgan (2012 August 6 rec'd by PCCD), including Attachments A-E and Appendix A Figures (E&S)

2012 July 24 Revised NOI signed by Michael Letson

2012 Aug 1 Letter from Sara Hayes CH2MHILL to Mike Luciani PaDEP re Response to Technical Deficiencies

2012 Aug 1 (2012 August 6 rec'd by PCCD) CH2MHILL Transmittal from Sara Hayes to Ms. Ellen Enslin.

2012 July 25-26 e-mails Susan Beecher and Gerald Creel

2012 June 29 from Ellen Enslin to Micaheal Luciani

2012 June 27 Letter from Michael Luciani Project Manager Waterways and Wetlands Program PaDEP to Michael Letson, TGP Pipeline Company. Re Time Extension ESCGP Application No. 020011801.

2012 June 19-6 various e-mails PCCD

2012 May 29 various e-mails PCCD

2012 May 22 Letter from Michael Luciani Project Manager Waterways and Wetlands Program PaDEP to Michael Letson, TGP Pipeline Company. Re Technical Deficiencies ESCGP Application No. 020011801 and various e-mails PCCD and DEP June 6 -19 2012

2012 May 16 Letter from John Yardley, Pipeline Group to Chairman Jon Wellinghoff FERC

2012 April 23 – May 3 PCCD e-mails

2012 April 20 Letter from Letter from Pike County Conservation District, Ellen Enslin Sr. Resource Conservationist to Mr. Patel, Pa DEP Northeast Regional Office. Re: 1st E&S Technical Plan Review ESCGP-1 Application #020011801 TGP Northeast Upgrade Project, Lackawanna, Milford and Westfall Townships, Pike County.

2011 December 20 Letter from Pike County Conservation District, Susan Beecher, Executive Director to Kimberly Bose, Secretary, Federal Energy Regulatory Commission. Re OEP/DG2EE/Gas

2011 Notice of Intent and supporting application materials as received by PCCD on November 21, 2011

ATTACHMENT B

SUMMARY OF EARTH DISTURBANCE REPORT VIOLATIONS

June 22, 2011 to March 16, 2012

					Reasons for discharge		
Dates of Violations	Dates of Zero Violations	Potential Discharge	Actual Sediment Discharge observed and Number of Discharge Locations	Overtopped Compost Sock or Silt Fence	Side boards not on properly	Slope Breaker not working	Other
6/22/11		X		1			
	6/30/11						
	7/11/11						
7/26/11			2		1		1
8/15/11			5	2	1	2	
8/24/11		X					
8/31/11			3	2		1	
9/10/11			3	2	1	1	
9/13/11			4				
9/16-17/2011			1				1
9/20-21/2011			4	1			3
9/26/11			2				2
9/28/11			5	1		4	
10/5/11			1				1
	10/6/11						
10/14/11			1				1
10/20/11			1				1
11/4-5/2011		X					
12/12/11		X					
3/16/12		x					
17	3	5	32				

ATTACHMENT C

Table 1 Bulk Density and Organic Content of Soil Samples Collected November 29, 2012 from the 300 Line Temporary Work Area ROW and Undisturbed Forest

Sample	Bulk Density (compaction - English) lbs / ft^3	lbs / ft^3	Bulk Density (compaction - metric g/ cm^3	g/ cm^3	Organic content % by weight	Permeability based on Bkl Denstiy inches/ hour
	Lower	Upper	Lower	Upper		
1 - Pipeline ROW	124	154	1.99	2.47	4	0.001
2 - Forest 30' from ROW	55	79	0.88	1.27	21.6	> 10

For reference, the bulk density of concrete is about 2.4 g/cm^3 and asphalt concrete is about 2.2 g/cm^3.

Table 2 Comparison of Runoff Volume from Forested Conditions to Compacted Sparsely, Vegetated Conditions for 1-year through 100-year Storm Events

Condition	HSG	CN	S	Initial Abstraction	1-year storm 2.30" ra	2-year storm 2.76" ra	10-year storm 3.99" ra	25-year storm 4.90" ra	50-year storm 5.73" ra	100-year storm 6.71" ra
				(in)	(in)	(in)	(in)	(in)	(in)	(in)
Woods Good Condition	C	70	4.29	0.86	0.36	0.59	1.32	1.96	2.59	3.38
Dirt	D	88	1.36	0.27	1.21	1.61	2.72	3.57	4.37	5.31
Net Increase of Runoff (inches)					0.85	1.02	1.40	1.61	1.77	1.93
Increased Volume per Acre (ft^3)					3,080	3,708	5,070	5,850	6,438	7,018
Increased Volume per Acre (gallons)					23,042	27,734	37,921	43,757	48,158	52,492

Achieving Higher Quality Restoration Along Pipeline Rights-of-Way

An Overview of Pipeline Construction Impacts with Recommendations for Reducing Environmental Damage

Principal Author
Leslie Sauer

An Expert Report Prepared for
the Delaware Riverkeeper Network

May 2014
Bristol, Pennsylvania

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The Delaware Riverkeeper Network champions the rights of our communities to a Delaware River and tributary streams that are free-flowing, clean and healthy.

The Delaware Riverkeeper Network gives voice, strength and protection to the communities and waterways of the Delaware River. Through independent advocacy, and the use of accurate facts, science and law, DRN works to ensure the rich and healthy future that can only exist with a clean, healthy and free flowing river system.

The Delaware Riverkeeper Network is unique in that it is founded upon the expectation of personal and community responsibility for river protection, as personified by the Delaware Riverkeeper. DRN is the only grassroots advocacy organization that operates watershed-wide and empowers communities with the engaged interaction and information needed to succeed in protecting our River and region now and into the future.

Achieving Higher Quality Restoration Along Pipeline Rights-of-Way

An Overview of Pipeline Construction Impacts with Recommendations for Reducing Environmental Damage

Principal Author
Leslie Sauer

An Expert Report Prepared for
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May 2014
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Tracy Carluccio

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Front cover photo: Leslie Sauer

Back cover photos (clockwise from top): M. van Rossum, J. Zenes, F. Zerbe, F. Zerbe, J. Zenes

Foreword

Even though shale gas development is currently prohibited within the boundaries of the Delaware River watershed, the explosive growth of shale gas infrastructure is still impacting the communities of the watershed profoundly—a watershed that provides drinking water to 17 million people living in New York (including residents of New York City), Pennsylvania, New Jersey and Delaware. Pipelines, compressor stations and liquefied natural gas facilities intended to take shale gas to new markets in the United States and abroad are being proposed and pursued rapidly within the watershed's boundaries. These projects illustrate the many harms this infrastructure imposes upon human and natural communities as well as the many deficiencies of current law associated with their proposal, review and construction.

Deficiencies include, but are not limited to, a lack of any rational planning; the failure to apply for and comply with reviews mandated by the National Environmental Policy Act; the failure of both federal and state agencies to implement water, air and wildlife protection laws in a way that genuinely achieves real protection; the lack of the political will and resources at the state, regional and federal level to fully implement and enforce community protection laws; and an absence of state laws necessary to protect habitats, waterbodies, and forests of public and private landscapes. These lands serve as the critical natural green infrastructure that protects communities from environmental harm. These habitats underpin the region's economic development and ensure the health, safety and quality of life of our communities. And yet it is these habitats that are so cavalierly ruined by pipeline development.

Four pipelines expansion projects have already cut through the Delaware River watershed since 2011. These projects have left permanent scars across communities, created pollution, increased stormwater runoff, and damaged natural areas important to wildlife, recreation and ecotourism as well as damaging the economic values that each of these brings.

Top to bottom: Right-of-way clearing for expansion of the Tennessee Gas Company's pipeline, J. Zenes; Pipeline under construction in Pike County, PA, T. Carluccio; Greenlick compressor station in Susquehannock State Forest; PAForestCoalition.org.

In addition, eight new and/or expanding interstate pipeline projects are proposed for the Delaware River watershed. New pipelines and pipeline expansions are proposed to cut through:

- Broome, Delaware, Orange and Sullivan Counties in New York
- Berks, Chester, Delaware, Lebanon, Monroe, Montgomery, Pike, Schuylkill and Wayne Counties in Pennsylvania;
- Gloucester, Hunterdon and Sussex Counties in New Jersey; and

- New Castle and Kent Counties in Delaware.

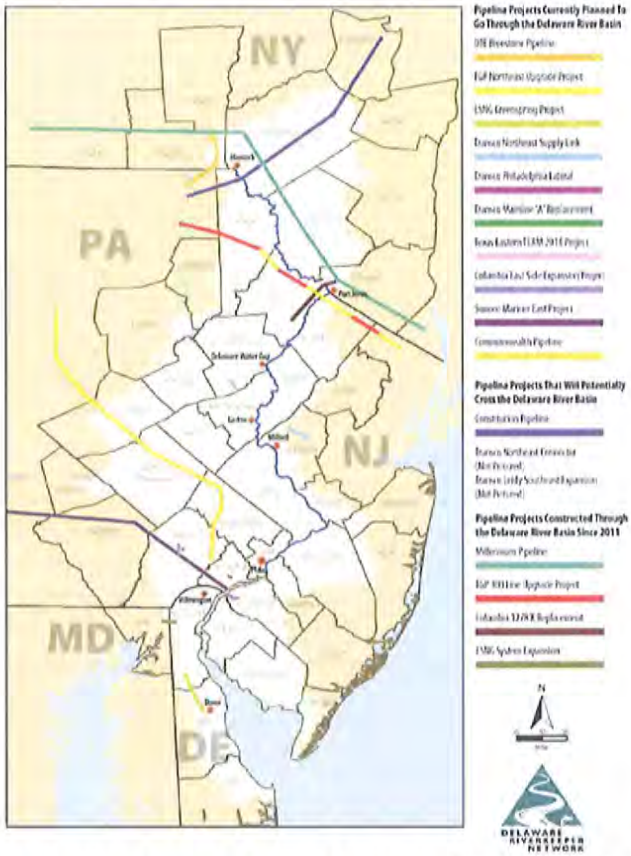
These pipeline projects will be cutting through communities, residential neighborhoods, mature and pristine forests and habitats, and through our highest quality and most valued streams and wetlands. Pipeline cuts are invasive, damaging and permanent.

Due to the irreparable harms shale gas development inflicts on communities and the environment, the Delaware Riverkeeper Network is opposed to all shale gas development and its associated infrastructure. Instead, the Delaware Riverkeeper Network supports sustainable energy as a focus of present and future energy investment and development. But, to the extent that there are pipeline projects now planned for our watershed and beyond, there are ways to dramatically reduce the harms they inflict when they do get through.

The recent frenzy of pipeline construction has highlighted many areas where current practices need significant improvement. To prepare this report, we started from the assumption that—in order to minimize harmful impacts on our environment and communities—we all want the best science and best technology to be used when pipelines pass through our neighborhoods, farmland and natural areas. The Delaware Riverkeeper Network turned to Leslie Sauer, an author and leader in ecological restoration, for insight into how harms from pipeline construction could be minimized or avoided. Ms. Sauer is a founder and former principal of the Philadelphia-based ecological planning and design firm, Andropogon Associates, Ltd.

This report complements a video lecture presented by Ms. Sauer. In both the lecture and this report, she discusses the harms that current pipeline construction practices cause, but she also provides recommendations that, if implemented, would avoid, minimize or at least dramatically reduce many of these harms. This expert report has been prepared to advise legislators, government bodies, regulators, decision-makers, and the public to encourage better practices, laws, and regulations should the proposed pipelines be permitted.

Maya K. van Rossum
the Delaware Riverkeeper



Pipeline projects currently planned to pass through the Delaware River watershed. Map prepared by the Delaware Riverkeeper Network.

This is a bad way to build a pipeline.

Below left, an open cut in-stream water crossing

There is a better way.

Above right, a pipeline was rerouted through a park to follow an existing trail wherever possible to limit the creation of new edge.

Above left: Cutting through the Lackawaxen River in Pike County, PA, for a pipeline ROW, A. Stemplewicz
Above right: ROW through a protected forest in Morris County in New Jersey, L. Sauer
Opposite page: the Delaware Riverkeeper, Maya van Rossum, F. Zerbe

Clockwise from top left: Columbia Gas Company's pipeline ROW carving across Pike County, PA, F. Zerbe; Construction of the Tennessee Gas Pipeline Company's North East Upgrade project, F. Zerbe; Removing sediment from Cummins Creek, Pike County, PA, after a rain event, J. Zenes

Achieving Higher Quality Restoration Along Pipeline Rights-of-Way: An Overview of Pipeline Construction Impacts with Recommendations for Reducing Environmental Damage

Leslie Sauer

Summary

For decades, pipeline construction has received limited oversight with minimal demands on construction practices, except at a few sites such as wetlands. Regulation is inadequate and, unfortunately, government agencies, in an effort to foster infrastructure development, have often reduced permitting requirements and costs without considering the environmental and community impacts of these decisions. Pipeline routes often intentionally target natural areas, such as state parks, forests and other wildlands. Over time, pipeline rights-of-way have become wider which magnifies the harms inflicted on both ecological and human communities. With no federal, state, or local regulatory agency tasked with evaluating the full impact of individual pipeline projects or the additive effect of multiple pipeline projects, cumulative impacts of pipeline projects are largely ignored. Also, the opportunity for public participation occurs long after the time when proposed pipeline routes or proposed construction can be affected.

Current pipeline construction practices, as well as longer term right-of-way management, impact both terrestrial and aquatic ecosystems and can result in impacts to surface water and ground water quality. The pipeline construction process often entails unnecessary environmental damage. Loss of vegetation and soil compaction are more obvious, but landscape-scale changes to the watershed are occurring without acknowledgement or mitigation. Moreover, forest fragmentation and edge effect are being ignored. Seven key changes could dramatically reduce the damage to forests and watersheds from pipeline construction: Better enforcement and compliance; More comprehensive baseline assessment; Higher compensation for damages; Narrower rights-of-way; Better methods to reduce compaction; More effective stabilization and restoration; and Better monitoring and management.

Introduction

The network of underground gas pipelines in this country is extensive and growing, especially with the energy industry pushing to move more gas from unconventional drilling wells to market. Pipeline siting, construction and management threaten both the ecological and human communities that they pass through, over and under, yet regulation of pipelines is limited with little opportunity for public input as to the paths they take or how they will be constructed. Currently, no federal, state, or local regulatory agency is tasked with evaluating the cumulative impacts of natural gas pipeline projects and associated infrastructure construction. Furthermore, the common practice by pipeline companies of segmenting large interstate pipeline projects into smaller projects allows them to avoid more thorough review and controls. However, simple changes in pipeline siting and construction practices could dramatically reduce the damage to forests and watersheds from pipeline construction. In the Delaware River watershed, the Delaware River Basin Commission (DRBC) has the power to conduct cumulative reviews for pipeline projects, at least for that portion of the project that is within the boundaries of the Delaware River watershed. This paper provides an overview of the impacts of pipeline construction, examines the changes in pipeline construction and management that could lessen impacts, and identifies the regulations that could be adopted by a government body like the DRBC to better protect both our ecological and human communities.

Unnecessary Harms Caused by Insufficient Regulation, Poor Right-of-Way Planning, and Failure to Consider Cumulative Impacts

The demands of pipeline construction and operation influence selection of pipeline right-of-way planning, but the selection process often fails to consider the full cost of individual pipelines or the additive effect of multiple pipelines. Moreover, opportunities for the public to influence pipeline selection in order to protect ecological or human communities are limited.

Pipeline routes often intentionally target natural areas

Cost is always a significant factor in pipeline route selection. Publicly protected open space is often a first target when pipeline routes are being selected because the cost to acquire access to construct a pipeline through public lands is typically less and often brings with it less opposition (when taken on the whole).

Access to land for pipeline construction is usually acquired through an easement from the landowner providing a right to pass, or right-of-way (ROW), to the pipeline company. Many older ROWs cross landscapes that would receive preferential protection today, just as other pipelines now are often embedded in suburbs that did not exist when they were first built. Yet because it is automatically assumed that expanding an existing line will do less harm than a wholly new ROW, the mistakes of the past are sometimes compounded. At the same time it is also easy to understand why it might be difficult to suggest a new ROW through a built-up landscape in order to avoid expansion in a natural area, regardless of what the actual impacts might be.

A surprisingly difficult consideration when picking a new pipeline route is avoiding other lines already in place. There is an amazing array of pipelines crisscrossing our landscape already. More should be required of the pipeline project planners to cooperate with other pipelines and the existing network already in place to share in efficient transport of gas rather than build new lines. This problem is aggravated by the complete lack of comprehensive planning for this infrastructure. Piecemeal permitting further fractures a process that is already atomized by different ownerships and jurisdictions. Cumulative impacts are ignored altogether.

Pipeline ROW work on Kittatinny Ridge in New Jersey's High Point State Park, M. van Rossum

State forests and other wildlands need a higher degree of protection

The open space taxpayers have bought to protect watersheds and conserve local biodiversity is improperly treated as a convenient reserve for gas production and transmission as well as road construction and other infrastructure. Although protected from residential and commercial development, these lands are being increasingly compromised by pipeline and power line infrastructure projects. State and federal governments have failed to put in place the needed legal protections for our large-scale public landscapes and

A map of the Reading, PA, area created using the National Pipeline Mapping System (NPMS) Public Map Viewer online. Users can view NPMS data one county at a time. The pipelines shown include gas transmission pipelines (blue) and hazardous liquid trunklines (red). Data for gathering or distribution pipelines is not available through the NPMS Public Map Viewer.

their ecological integrity. In addition, there is a body of laws related to power project infrastructure that in fact undermines preservation of lands at the local level—interstate pipelines are exclusively under the jurisdiction of the Federal Energy Regulatory Commission (FERC)—and makes public lands among the most vulnerable areas for infrastructure routes.

Because intact public lands often have important habitats, state and federal reviews are done to identify possible locations of threatened and endangered plants and animals. Agencies identify sites associated with rare, threatened and endangered species and make recommendations along the entire route of every pipeline to avoid harming these species. Examples of recommendations can include relocation of a proposed route or a reduced ROW width. But such adjustments are limited to known sightings of threatened and endangered species. Species that are considered to be rare or of conservation concern, but do not have threatened or endangered status, are not protected.

This effort to respond to known sightings of threatened and endangered species is not an adequate substitute for a broader consideration of the cumulative pipeline route and ROW impacts. In many instances, more could be done to minimize harm, especially for state listed species which appear to get less protection than federally listed species. For example, in one case in Pennsylvania, a pipeline company was required to collect seed from an endangered state plant located in the ROW corridor. Scattering that seed after the ROW was installed was a requirement of the permit, but stronger protections and measures could have been required to either avoid this area entirely or, at a minimum, ensure that the endangered plant was able to re-establish after the ROW was completed, demonstrating performance as well as compliance.

An overly wide pipeline ROW, M. van Rossum

Overly wide ROWs magnify the level of harm

The width of ROWs has incrementally widened over time as larger equipment is used despite the fact that there are many options for significantly narrowing down a ROW to minimize vegetation clearance and reduce damage to soils. Today ROWs are kept minimally vegetated, dependent on herbicides and intensive mowing, but in the past pipelines and other ROWs often supported successional native species. The combination of a wider ROW and management strategies focused on minimizing healthy regrowth compounds the ecological harms. FERC currently recommends a 75 foot ROW, but the 100 foot ROW has become routine, and with no strong pressure to minimize damage, thousands of acres that once were field or forest are now maintained as relatively barren. Safety concerns, the scale of construction and increased security have contributed to the current overwide ROWs. Narrower ROW's could greatly reduce overall impacts and permanent cuts in the landscape.

Local residents protest the Tennessee Gas Pipeline Co.'s North East Upgrade project, F. Zerbe

Public involvement often comes too late

Selection of the pipeline route is the first concern and often is decided upon well before opportunities for the public to participate in the planning process are provided. By the time pipeline permit applications are made public, it is generally considered too late to make any modifications to many aspects of the pipeline. The decision-making process should engage communities early on and in multiple ways and venues as well as throughout the process to ensure community concerns and local resources are identified, addressed and protected. However, in the current system, those interested in influencing pipeline routes must pro-actively seek out information early in the planning process, stay informed about decisions re-

garding new and expanded routes, and educate themselves about opportunities to make comment. And the reality is that often the site design is done before the public has any fair opportunity to become aware or to be heard.

Pipeline cuts are invasive, damaging and permanent. Looking west from Kittatinny Ridge towards Pennsylvania, J. Zenes

Cumulative impacts are ignored

Pipelines, both at the individual project level and when considered cumulatively, have a substantial effect on water resources as well as both the ecological and human communities that they pass through, over and under. Current pipeline construction practices, as well as longer term ROW management, impact both terrestrial and aquatic ecosystems resulting in impacts to surface water and ground water quality. Impacts include, but are not limited to:

- Sediment pollution,
- Exacerbated erosion,
- Loss of macroinvertebrate and fish spawning habitats,
- Adverse affects to wetlands and marshes,
- Permanent removal of riparian vegetation,
- Loss of forest lands, forest fragmentation, changes in forest ecology and increased edge effect,
- Increased surface water runoff,
- Thermal impacts,
- Redirection of groundwater and surface water flows.
- Releases of drilling muds,
- Creation of sinkholes due to drilling, and
- Air pollution resulting from methane and other air contaminants.

As long as this list is, there are still many more impacts which are both individual and cumulative.

Cumulative impacts may span the length of each individual pipeline project, but cumulative impacts can also result from the expanding array and numbers of pipelines across a watershed, region, state and the nation. The sheer number of pipeline ROWs is growing, but the cumulative impacts continue to be ignored.

Currently, no federal, state, or local regulatory agency in the Delaware River watershed is tasked with evaluating the cumulative impacts of natural gas pipeline projects and their associated infrastructure, which can include access roads and compressor stations. In fact, pipeline companies intentionally segment large pipeline projects into smaller projects to avoid more thorough review and controls. While the DRBC has the power to conduct cumulative reviews, at least for that portion of a pipeline project that is within the boundaries of the Delaware River watershed, it has refused to fully exercise that legal authority.

In 2013, the DRBC agreed to partially examine pipelines passing through locations included in the agency's Comprehensive Plan, but for all other pipelines, the DRBC is taking no action other than regulating water withdrawals for hydrostatic testing to check for leaks in pipelines.

Construction of a natural gas gathering line pipeline, T. Carluccio

Impacts of Pipelines Constructed Today

We focus here on the landscape-scale impacts of pipelines, however, all of these consequences are relevant at the local level as well.

The construction process often entails unnecessary watershed impacts

The construction process for a pipeline is fairly simple and entails digging a ditch to accommodate the pipe. Before digging, the vegetation is cleared along the whole ROW and the top soil is reserved, either beside the trench or in a work area. The pipe itself is brought to wooden cradles along side the trench where segments are bent as needed, coated and welded before being placed in the trench by a side boom. The side boom, a piece of equipment that lifts and handles the pipe, is typically the heaviest piece of equipment on site. Once the pipe is laid and the trench refilled, the whole process just moves on up the route. It may take only a few days to complete a given stretch.

A side boom preparing to lower pipe into a trench, J. Zenes

After the pipe is laid and the trench filled, the site is reseeded and stabilization matting is used in areas where erosion is a probability. The landscape is often seeded with non-native plants in an attempt to stabilize soils quickly, then "allowed to revegetate naturally," except that today any plant growth is regularly mowed or herbicided to maintain a relative wasteland across a pipeline ROW that may be 100 feet wide or wider.

The state specifies what techniques should be used at wetlands and stream crossings, including the appropriate ROW widths. All of these terms and conditions are incorporated in permits issued for a pipeline. During construction, a log of site work is posted online to insure compliance with permit requirements that were agreed to with the state, FERC and other regulatory agencies.

Heavy construction equipment backfilling a trench along a pipeline ROW, F. Zerbe

The loss of vegetation may be the most apparent impact, but soil changes are the most pernicious. The single biggest problem is soil compaction, which may be as high as 98%, the same as concrete. Rainwater often runs off the ROW like a stream, creating gullies in the adjacent landscape, which leads to erosion and sedimentation locally.

Failure of erosion controls at pipeline construction site Mountain Road Montague, New Jersey, J. Zenes

Once soil has been disturbed and compacted, it is very difficult to restore its capacity for water infiltration. Re-ripping the soil with a chisel plow is a partial solution to surface compaction, but it leaves

behind an exceedingly erodible surface and does not address the issue of recharge. Ripping deep enough to effect recharge would destabilize large areas of the landscape and be almost impossible to re-stabilize. The damage from soil compaction, loss of vegetation, increased runoff, erosion, and resulting pollution has effects well beyond the boundaries of the ROW where it originates. Sensitive agricultural lands crossed by pipelines are also harmed by soil disturbance and compaction.

Clearing forested wetlands in Montague, New Jersey, in advance of pipeline construction, J. Zenes

Current pipeline construction restoration requirements are very low; they rely primarily on cool grass seeding and erosion blankets and often have poor long term results after the two required maintenance and monitoring seasons for the agencies. Even with such low stabilization standards, the rate of compliance is abysmal. For example, between June 2011 and October 2011, in just two counties in Pennsylvania there were 32 documented sediment discharge violations along the route of the Tennessee Gas Pipeline Company's 300 Line project. Imagine how many such violations go unobserved.

Sediment pollution overwhelms controls and floods wetlands, F. Zerbe

Pipelines can also dewater the headwater areas through which they pass and change the hydrology of wetlands areas along the route. Taken with the loss of vegetation and soil compaction, these impacts cause landscape-scale changes to the watershed yet they are neither acknowledged nor mitigated.

Forest fragmentation and edge effect are ignored

Like the watershed, the forest is also impacted well beyond ROW boundaries. The creation or expansion of a ROW through forest creates a continuous open wound called the 'edge effect.' While the edge effect can be positive when confined to small canopy gaps in a closed forest, edge effects are detrimental when they occur along a continuous seam of fragmentation. Increased wind movement facilitates movement of weedy propagules and invasive species deep into the forest where they find the way suddenly wide open for them with abundant new ground to colonize. Predators and parasitic birds like cowbirds use these corridors to access otherwise difficult to find prey.

A continuous scar fragmenting both forest and waterway, F. Foley

ROWs are like highways bringing the elements of the developed world into otherwise undisturbed areas. Increased windthrow during storms often creates further loss of more mature trees in the forest area adjacent to the ROW. With the repeated and continuous forest fragmentation that results from pipeline construction and maintenance, the species of the forest interior decline, something that has already happened to 90% of forest interior birds. This effect often extends up to 300 feet from the actual edge of the disturbance (i.e.,

the ROW clearing), making a corridor of at least 700 feet wide of disturbance with every 100 foot ROW.

Often a new pipeline uses and expands an existing corridor that may have multiple pre-existing lines. The amount of new edge may be halved using this approach when compared to a new ROW corridor, but this practice has resulted in some ROW corridors becoming, unnecessarily, hundreds of feet wide—this amounts to large habitat losses and a boundary that is increasingly capable of blocking the movement of some species of plants and animals. The existing requirements to protect a few very rare species is insufficient to prevent the general degradation of the forest from this kind of fragmentation. Interior forest is imperiled and cannot be replicated on small-scale sites or over short periods of time. Once lost, forest interior is gone and cannot be restored. Lost with it are those plants and animals that are restricted to the forest interior.

Pipe for the 325 Loop of Tennessee Gas Pipeline Co.'s 300 Line project in cradles in the New Jersey Highlands, J. Wagner

Changes That Could Make a Difference

Current FERC and erosion and sediment control guidelines are inadequate to meeting the challenges of the current pipeline construction boom. State and other federal agencies aren't filling the regulation gap. Unfortunately in an effort to foster infrastructure development, government agencies often seek to reduce permitting requirements and costs without adequately counting the environmental and community impacts of these decisions.

It is increasingly apparent that serious effort with companies and agencies is required to develop new construction strategies and Best Management Practices (BMPs) that better protect our ecological and human communities. A more coordinated approach by regulators is needed to change a process that has for decades received limited oversight and upon which limited demands have been made, except at a few sites such as wetlands. The potential role for FERC, the U.S. Department of Transportation (USDOT) and state environmental agencies in a new pipeline construction paradigm cannot be overstated.

Seven key changes could dramatically reduce damage to forests and watersheds from pipeline construction:

1. Better enforcement and compliance,
2. More comprehensive baseline assessment,
3. Higher compensation for damages,
4. Narrower ROWs,
5. Better methods to reduce compaction,
6. More effective stabilization and restoration, and
7. Better monitoring and management.

Key changes could reduce harms resulting from pipeline construction, M. van Rossum

1. Better enforcement and compliance is vital

The primary regulations pertinent to pipeline construction are the same that apply to new development and road construction. For example, erosion and sediment control regulations for pipelines employ many of the same techniques used with other construction projects. Required techniques may be as simple as reseeding and mulching or as complex as horizontal directional drilling under a river. Regulatory require-

ments vary somewhat from state to state and individual agreements between the pipeline company and the landowner may modify or expand requirements. These regulations are, however, only as good as the extent to which there is full compliance. Unfortunately, the Delaware Riverkeeper Network (DRN) has documented numerous failures in both compliance and performance.

In 2012, DRN staff and trained volunteers monitored pipeline construction activities along the Tennessee Gas Pipeline Company's 300 Line project and documented unstabilized sediment, damaging wetland crossings, scant mulch, and mediocre vegetation growth at many rights-of-way. DRN also logged and responded to pollution report calls from citizens documenting pipeline pollution. As a result of DRN's work, over 17 notices of violation were issued for the 300 Line project in Pike County during Spring 2012 alone. Wayne County also found violations along this pipeline project during the same time period.

According to the Tennessee Gas Pipeline Company's own estimates, the 300 Line project "temporarily" disturbed 108 wetland acres and permanently destroyed 22.9 wetland acres within the Delaware River watershed. The company was required to restore the temporarily disturbed wetlands, but delayed these activities until amphibian populations were already present in these areas for breeding. DRN notified state and local agencies to request that the invasive wetlands work be delayed until the young amphibians present could grow to adulthood and move on, but the agencies allowed the Tennessee Gas Pipeline Company to go forward.

Tennessee Gas Pipeline Company's crossing of Shimers Brook, a trout stream in New Jersey, J. Zenes

Nor does compliance with permit requirements guarantee that the erosion and sediment controls employed will perform as anticipated on site. A real problem is the underlying assumption that the standards are met automatically when regulations are complied with. Often, this is not the case, in part because the techniques recommended are inadequate to the task.

The purpose of environmental regulations may be to protect native species and watersheds, but the actions taken to implement those regulations are not achieving their goal. Looking just at regulations intended to protect rare, threatened and endangered species, no new baseline studies are required before construction, and existing records as to the presence of these species along proposed pipeline routes are incomplete, leaving these species unprotected.

DRN staff document an old growth forest in the path of pipeline construction, J. Zenes

Many natural areas currently being targeted for pipeline construction are on soils, or rock, and difficult to stabilize, resulting in erosion. Severe compaction often disrupts water patterns and further contributes to erosion and sedimentation. DRN has documented many examples of failed stabilization efforts for new pipeline construction with serious and on-going deleterious impacts to the surrounding habitats, demonstrating the need for better enforcement by regulators. Like DRN, regulators could work with trained local volunteers to better ensure that violations do not go unobserved.

We must also look at failures of compliance and performance and prevent them in the future with expanded BMP's mandating better performance on the

ground. Some examples of better construction and management are described below. None are untested. All have been implemented with success on a pipeline in Pennsylvania or New Jersey. All require more effective oversight by agencies as well as expanded jurisdictions and better BMPs.

Attempted stabilization of a pipeline ROW on steep slopes, J. Zenes

2. Better baseline assessment is important

The purpose of baseline monitoring is to inform route selection and the determination of appropriate methods for construction, restoration and management for various segments of the route. Baseline monitoring can help to customize a process that is otherwise a one-size-fits-all approach.

In addition, more complete baseline monitoring would help make up for our currently incomplete records for rare, threatened and endangered species of plants and animals. In preserved lands and healthy ecosystems, full on-the-ground monitoring is vital

Construction documents detailing trees to be removed as well as trees to be saved, L. Sauer

and should not be sacrificed to speedy construction. Cultural and historic resources should be monitored in much the same way.

Problems such as excessive herbivory and the extent of exotic invasives species should also be documented as part of the monitoring. Knowledge of exotic and invasive species should be used to develop and carry out ROW management prescriptions. Specific actions could include treatment prior to tree clearance, treatment for up to five years after construction, and requirements to wash equipment coming from areas with invasive species present before entering less disturbed landscapes along the construction route.

With no cost associated with lost ecological functions and values, natural areas are targeted for pipeline construction, F. Foley

3. Natural area impacts need greater compensation

The cost of crossing natural areas is under-compensated. Typically there is no payment made for lost ecological functions and values when interior forest is damaged by fragmentation or disturbance. Without recognition of the damage being caused, no dollar value is associated with the loss of interior forest and there is no incentive to reduce forest impacts. This failure makes natural areas artificially cheap to cross, shifting real costs and losses to taxpayers, effectively subsidizing the pipeline.

The thorough assessment of site conditions, called for above, will be a vital component of the negotiation of the true cost of crossing publicly owned and preserved landscapes. Compensation should reflect the damages to a site's function as a natural landscape and recreation area as well as the need to effect high quality stabilization and habitat establishment.

Narrowed pipeline ROW with fencing to protect trees, L. Sauer

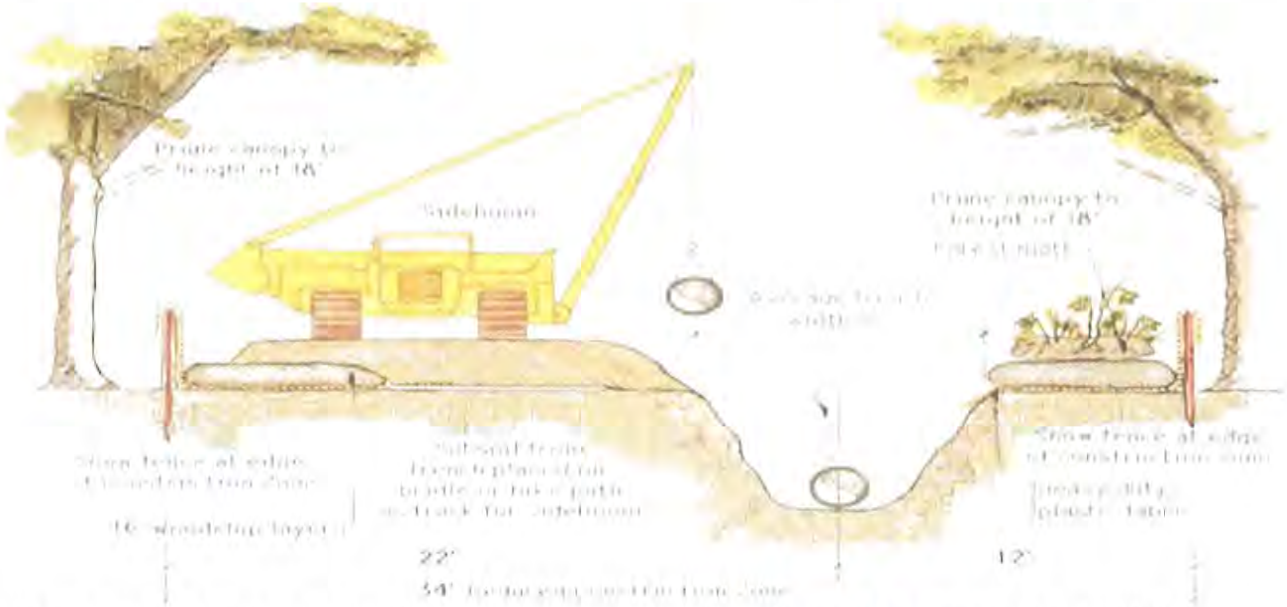
4. Narrower ROWs need to be applied more widely

ROWs must be narrowed to the greatest degree possible. In short, every foot matters. While 100 foot ROWs are now the norm, 30 to 50 foot ROWs were commonplace in the past. Not only were narrower ROWs commonplace, but they can be mandated today when there is a need to protect habitat for a rare plant or animal, or a wetland or other special ecosystem. FERC's *Upland Erosion Control, Revegetation, and Maintenance Plan* and *Wetland and Waterbody Construction and Mitigation Procedures* recommend limiting pipeline construction ROWs to 75 feet. There is no reason that narrower ROWs should be limited to exceptionally sensitive ecosystems; they should be the norm, not the exception.

When there is a need for modification, even in today's pipeline construction projects, flexibility is common and many alternatives to conventional construction techniques may be employed. This includes methods such as 'stove-piping' where the pipe is welded in the trench eliminating the need for a cradle, which in turn reduces the width of the ROW needed. In another method, called 'dragging,' the pipe is welded in a work area and then literally dragged through the trench. Many streams are crossed with horizontal directional drilling (HDD) and have no above ground trench at all, except at either end of the drill.

Typically where alternative methods, such as HDD are employed, additional work area is required at either end of that section of pipe. Additional work areas, when designated, represent another area for serious negotiation concerning need for and the size of the area to be disturbed. Clearing for HDD landing pads and other work areas should be minimized to keep the ROW narrow.

Whenever a ROW is narrowed, safety becomes more of a concern. Additionally, not all methods are applicable everywhere and flexibility may be required. Even the rather proscribed system currently employed recognizes that adaptive methods and construction practices may need to be modified based on field conditions at the time. However, alternatives are currently restricted to a very few sites today. It is essential that pipeline companies and regulators begin viewing for-



Habitat protection measures that can be used during pipeline construction including working a side boom over a cushion of mulch, L. Sauer

Pipeline construction practices can result in tree death even for trees outside the disturbance zone, J. Zenes

ests and other natural landscapes as worthy of the increased protection that can come from reduced ROWs and more flexible construction strategies. Less impactful construction practices should not be the exception; they should become the norm as these methods are technologically feasible and are cost competitive.

In addition to the use of alternative construction methods, the use of smaller and lighter construction equipment could also be used to reduce the ROW width as well as soil impacts. The size of the pipe is obviously a limiting factor here. Nonetheless one pipeline company, Napp Greco, installed a three foot diameter pipe in a 34 foot-wide ROW through a protected forest in Morris County, New Jersey. Imagine how much less damage there would be with 34 foot ROWs. Simply reducing the 100 foot ROW, a size that is routinely used in this area, to 75 feet would result in a 25% reduction in the direct damage to vegetation, habitat and soils.

5. Post-construction compaction needs to be reduced

Even within a narrowed ROW, compaction can be reduced significantly. One opportunity to minimize compaction is by working heavy equipment on top of a cushion made of the wood chips generated on site during the removal and chipping of trees and the subsoil from the excavation of the pipeline trench.

Along the Tennessee Gas Pipeline Company's 300 Line and Northeast Upgrade (NEUP) projects, mulch from the chipping of removed vegetation was blown into the adjacent forest, in some instances, to a depth of over three feet, which causes unnecessary impacts to areas outside of the ROW. In some areas, this deep mulch has caused bark rot, and mature trees buried in the mulch are showing signs of stress (groundcover

Mulch blown into state forest land adjacent to the route of the Tennessee Gas Pipeline Company's Northeast Upgrade project, J. Zenes

Deep piles of mulch caused bark rot and tree death, S. Rando

plants were also buried). Instead, these reserved materials could have been used to reduce harm rather than create more harm.

Compaction rarely reaches more than 12 to 18 inches below the surface. A cushion of wood chips and sub-soil can completely protect the topsoil and plant propagules beneath this layer. Contractors can also use wood chips and sub-soil to add depth over an existing pipeline if the current soil cover is insufficient to allow equipment to work over it.

This practice would allow for narrower ROWs by making it possible for the side boom to work over an existing pipeline along a shared pipeline corridor. Working over a cushion of wood chips and soil also eliminates the need to find land elsewhere for stockpiling or disposal of these materials, further reducing the size of work space requirements and the associat-

A side boom working on a cushion of soil in a narrowed ROW, L. Sauer

ed disturbance. Various commercial mats are another option, but are costly. Using soil from the site eliminates or reduces the need to stockpile this material.

A fabric layer over the natural ground prior to wood-chip stockpiling can be used to delineate the original grade and protect herbaceous species and the rootstocks of woody vegetation that has been cut for construction purposes. These areas can rebound very quickly with original vegetation back in place only days after the trench is refilled as the over-burden is removed. When combined with the use of smaller equipment, this can meet the goal of no loss of infiltration. Soil disturbance can be limited to the ground cover over the trench and any areas actually graded during construction for access which, in turn, could reduce the amount of soil compaction along the ROW by as much as 90% in places.

In areas where reseeding is needed, stabilization with locally native grasses and sedges would also maintain and increase infiltration rates over time. One third of the roots of woodland sedges die each year creating continuous openings deep into the soil to help with infiltration. Cool season grasses currently used for revegetation do not, especially when mowed which produces shallow root systems.

Independent third party certification should be required to evaluate and verify infiltration rates along the route of the completed pipeline to ensure actual compliance with the requirement not to increase runoff. FERC guidelines call for the use of penetrometers or other such equipment to evaluate and compare compaction along the construction route and adjacent undisturbed areas. This work should be completed and the results posted online. Remedial work should be undertaken where necessary.

Soil compaction can further be reduced by using narrower access ways, which by definition results in a smaller area of compacted soil. FERC currently recommends that only a 10 foot wide strip be maintained with annual mowing for access. There are three foot diameter pipes in the region with eight foot-wide access ways with occasional wider areas, or passing sites, along the pipeline route that can accommodate a wide range of equipment.

6. Stabilization and restoration goals need to be met more effectively

When the area of disturbance has been reduced, stabilization becomes easier. Where a wood chip and soil cushion has been used beneath heavy equipment, the land beneath this cushion should need little or no further stabilization once that cushion is removed. The area over the trench may be the only ground requiring planting. One innovative strategy used in Morris County, New Jersey, was to lift the sections of soil and vegetation over the trench, just like sod is lifted, and stockpile them on the side of the trench opposite the side boom. This eliminated the need to segregate and stockpile topsoil and avoided destroying the propagules of existing plants. When these sods of forest soil and roots were replaced over the trench, no further stabilization was required.

Where the original vegetation cannot be replaced over the trench, permanent stabilization BMPs should be

Stockpiling of forest soil and roots for later replacement over the pipeline trench, L. Sauer

developed using species native to each section of the route. The same native grasses and sedges that promote rainwater infiltration also sequester up to a ton of carbon yearly per acre. This is a small but important step toward mitigating the impacts of the clearance of trees from the ROW and providing a better habitat than the typical cold season grasses that are often used currently. Only locally native stone should be used and only organic stabilization products should be used, including mulch and soil blankets.

7. Management and access need to be reevaluated and modified

Recent management practices for pipelines have dramatically reduced the habitat values of ROWs. Once ROWs provided habitat for many early successional species, but today they are more like wastelands, or worse, sources of invasives into the forest interior.

Security concerns that arose after the terrorist attacks of September 11th, 2001 are in part responsible for current management practices. However, security can be addressed while still providing for more ecologically sound management. New management guidelines need to be developed. Some pipelines could have additional surveillance provided by the landowner in the form of management and/or recreational use in the vicinity of the pipeline. Pipeline companies should also anticipate providing long-term protection along a ROW from the ATV use that often begins after a pipeline cuts through an area. These vehicles cause even more soil disturbance, erosion and impacts to waterbodies.

If the ROW is narrowed and the existing soil and vegetation have been protected, and sods have been lifted and replaced over the trench, no further management is required after the trench is refilled as long as invasives are absent. In some forest interior areas, narrow ROWs may permit closed canopy management which would dramatically reduce edge effect and could, in fact, eliminate it over time.

Currently post-construction pipeline revegetation efforts are often sparse or fail completely. Reseeding and additional management may need to be undertaken, but often are not. Poorly stabilized ROWs are rapidly colonized by exotic, invasive vegetation, which can invade previously undisturbed natural areas nearby. Permits typically state that invasive vegetation will be managed, but ROWs all across the Delaware Valley are nonetheless overwhelmed by invasive plants.

DRN staff lead a ROW tour after pipeline construction, S. Rando

Until we have more effective BMP's that truly replace lost ecological values, monitoring and maintenance over a longer term than the two years that is typically required is greatly needed. This is especially important concerning soil stabilization and invasives management. Better stabilization BMPs are needed to address often extreme conditions. Solutions from the developed landscape, such as bringing in topsoil, are not suitable for natural areas.

With more extreme drought and large rainfalls due to climate change, maintenance plans, measures and windows are more important than ever. After all, the regulations presume that the site will be restored to its previous condition. However, ongoing management may be threatened by plummeting natural gas prices and tighter budgets, so additional bonding should be considered to ensure adequate stabilization over time.

Regulations to Protect the Forest and Watershed

As the current pipeline construction process is not without regulation now, many of the key changes recommended here can be incorporated into permitting by simply shifting focus or expanding available options. However, new regulation is needed to require that cumulative impacts are documented, addressed, and avoided or mitigated. Without additional protection, preserved lands are likely to be encroached upon little by little, with devastating cumulative impacts.

Landscape-scale forest and watershed protection are needed

Better protection is needed for lands we consider already protected. Giveaways of public land for pipe-

line ROWs should be avoided if at all possible. To safeguard the most sensitive lands, zones should be established within protected lands where roads, ROWs, etc., are prohibited. Stream and wetland crossings should be avoided as should routes through steep slopes, since these slopes are often problem areas.

Given the region-wide impacts of pipeline construction, we need regional-scale forest protection as well as state-level forest protection. In addition to creating sanctuaries, we need to regulate improved forest protection in all contexts, including greater protection for high quality landscapes, limits on permitted vegetation clearance and grading, restrictions on increasing runoff, recharge requirements, and banning the use of invasive species. Cumulative impacts need to be recognized and monitored with effective metrics on the ground, rather than on paper. Requiring inventories of plant and animal species and establishing costs for loss of mature trees would go a long way to encouraging pipelines to be sited in areas where mature forests do not exist.

As they are maintained today, pipeline ROWs are sources of invasives into the forest interior, F. Foley

Expanded assessment and monitoring are essential

You cannot avoid damaging valued resources if you don't know where they are. You cannot defend your management if you don't monitor its effects. You cannot claim that compaction has not changed if you do not measure it. And so expanded requirements for assessment before construction and monitoring both during and after construction are essential regulatory requirements. Better mapping is also needed, especially of sensitive wetland and waterbodies.

Where community watchdog groups and non-profits organizations are active, as is the case in Pennsylvania, where the development of shale gas infrastructure has become a big concern for communities, pipeline companies should value public input, and encourage safe participation and vigilance by citizen monitors. Unfortunately, this is not often the case. During work on NEUP, the Tennessee Gas Pipeline Company hired private security to deter and harass trained pipeline watch volunteers. Such practices should be forbidden.

DRN staff monitoring a construction crossing of Big Flat Brook, a trout stream, in High Point State Park, New Jersey, F. Zerbe

Alternative construction methods are needed

Agencies should encourage collaboration among contractors, community organizations and non-profits to creatively tackle the need to cushion heavy vehicles, to reduce soil compaction, to remove vegetation, and to restore ROW vegetation. Wherever possible, trees should replace trees. Efforts should be made by the pipeline company to plant larger native tree species stock versus bare root seedlings. As much of Pennsylvania has large deer populations that browse on young shoots, deer exclosures and tree shelters should be installed. In rocky landscapes, excavated boulders and stone can be arrayed to protect new plantings. These measures will increase the rate of recovery.

Current stabilization BMP's are inadequate and need to be expanded

Instead of close cropped landscapes, we need restoration BMPs centered on diverse native species, native grasslands, wildflower meadows, young woodlands and shrublands designed to provide permanent sta-

bilization. In forested landscapes cut by pipelines, efforts should be made to require understory, groundcover, midlayer and canopy layer native species to reflect the vertical diversity important in thriving forested areas and needed for forest interior birds.

Pipeline ROW fenced immediately after construction to protect newly replaced forest sods and to define long-term access routes, L. Sauer

Alternative management strategies need to be developed and implemented

The dialogue on ROW management must include not only concerns for safety and terrorism but also ecological concerns. Current application of the USDOT's Pipeline and Hazardous Safety Administration rules maximizes negative impacts to forests and watersheds. The 30 feet of a ROW over a pipeline is required to be tree-free; a 10 foot access way must be kept even more closely cropped, but close mowing creates shallow ineffective root systems, especially on steep slopes and poor soils.

One alternative is maintaining native grasslands and sedge meadows within the tree-free portion of a ROW. In an emergency, any vehicle needing the 30 feet will not be deterred by tall grasses. Beyond the 30 feet, successional woody forest vegetation could be re-established. Maintaining successional woodlands in part of the ROW could provide habitat for many declining species. Some closed-canopy options would help address the consequences of fragmentation.

An exemplary pipeline installation at Loantoka Park, Morris County, New Jersey, L. Sauer

FERC's wetland guidelines also call for re-establishing riparian vegetation for 25 feet into the ROW on either side of the stream.

Compliance requires improved oversight

The failure rate for compliance with even the current minimal standards illustrates a failure of oversight. In addition to regulatory compliance, we need to include in-the-field evaluation of actual performance of critical factors, in particular infiltration and recharge with independent, third-party verifications and input from the community and watchdog organizations. Additional bonding may be needed to improve compliance. New legislative efforts should not allow for circumventing important existing regulatory protections.

Red spotted newt from wetland in the path of a pipeline ROW, F. Zerbe

STOP
FRACKING
PIPELINES

Opposite page, clockwise from top: Looking east toward the Kittatinny Ridge from Ridge Road in High Point State Park, New Jersey, J. Zenes; DRN staff person documents construction of a pipeline ROW where pipes have been bent to go under Sawmill Road in High Point State Park, J. Zenes; A stream in the upper Delaware River watershed, F. Zerbe; Protest displaying wood from mature trees cut for a pipeline ROW, F. Zerbe; Sediment overwhelms erosion controls, J. Zenes

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June 6, 2016

Technical Memorandum

Review Application Materials, Proposed PennEast Pipeline

Prepared for: Delaware Riverkeeper Network

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1.0 INTRODUCTION

PennEast Pipeline Company, LLC (PennEast) proposes to construct a pipeline to transport natural gas from the Marcellus Shale production region in northern Pennsylvania to portions of southern New Jersey and southeastern Pennsylvania. PennEast submitted applications to the Delaware River Basin Commission (DRBC), State of Pennsylvania (PA), and the Federal Energy Regulation Commission (FERC) for approval. This technical memorandum reviews groundwater impacts caused by the development of that pipeline.

Primary groundwater issues vary depending on the aquifer crossed by the pipeline. The aquifer delineation depends on the underlying bedrock and the surficial deposits at the site. For this reason, in addition to the narratives about the pipeline prepared for the different jurisdiction, the primary chapter for review is Resource Report 2 (RR2)[1]. RR2 discusses the aquifers the pipeline would cross, specifies the recharge areas and rates, and discusses contamination. To supplement the review of RR2, I also reviewed the general project description, Resource Report 1[2], geology report, Resource Report 6[3], soils report, Resource Report 7[4], the vegetation report, Resource Report 3[5], and the wetland delineations reports and maps, Appendix D, USFWS Wetland Delineation Maps.

The diameter of the pipeline would be 36 inches with two of the laterals having either 24 or 12 inch diameter. The pipeline would have a minimum cover of 48 inches, except in a few places (RR1, p 1-66). That suggests the bottom of the pipeline would be at least seven feet below ground surface (bgs). It would also go under other pipelines that it crosses, so ostensibly it could be deeper than seven feet (Id.). Backfill is material removed from the trench (RR1, p 1-68) with the bedding being "rock-free dirt" (Id.) of an unspecified thickness.

2.0 SUMMARY OF GROUNDWATER IMPACTS

Penn East has failed to provide the impacts analysis which require "[a] detailed analysis of the potential impacts, to the extent applicable, of the proposed project on **water quality, stream flow**, fish and wildlife, **aquatic habitat**, Federal and State forests, parks, recreation, **instream and downstream water use**, prime farmlands, areas or structures of historic significance, streams which are identified candidates for or are included within the Federal or State wild and scenic river systems and other relevant significant environmental factors" (25 Pa. Code § 105.15(e)(1)(x), emphasis added). The emphasized factors in the quote (Id.) are hydrogeology related such that changes in groundwater relations, including recharge, preferential flow, pipeline induced drawdown, and contaminant transport, could impact wetlands and streams crossed by or closely approached by the proposed pipeline The following summary discusses how pipeline construction and operation would affect groundwater and how the application fails to consider the impacts on groundwater and the factors noted above.

Pipeline construction could affect groundwater by changing recharge rates and locations, causing drawdown both temporarily, during construction, and permanently causing pathways for contaminants to enter the subsurface, creating preferential flow pathways for shallow groundwater flow, and changing drainage patterns which would affect where recharge occurs. The pipeline would primarily contain natural gas, meaning methane although small amounts of ethane and longer chain gases could be included. A methane leak would be directly into shallow groundwater if the pipeline is below the

[1] PennEast Pipeline, Resource Report 2, Water Use and Quality, September 2015. Hereinafter referred to as RR2.
[2] PennEast Pipeline, Resource Report 1, General Project Description, September 2015. Hereinafter referred to as RR1.
[3] Penn East Pipeline, Resource Report 6, Geological Resources, September 2015. Hereinafter referred to as RR6.
[4] Penn East Pipeline, Resource Report 7, Soils, September 2015. Hereinafter referred to as RR7.
[5] PennEast Pipeline, Resource Report 3, Fisheries, Vegetation, and Wildlife, September 2015. Hereinafter referred to as RR3.

water table (which would be the case in areas with a shallow water table such as wetlands and stream crossings).

- Pipeline construction changes recharge by changing properties of the soils within the right of way (compaction, scraping), properties of the aquifer where it is excavated and backfilled, and by changing surface drainage patterns which could affect the recharge of runoff.
- Pipeline construction lowers the water table temporarily by dewatering the trench. It lowers the water table permanently by changing the aquifer properties within the trench; for example, increased conductivity in the backfill could create a pathway with lower resistance and change the water table level within the trench.
- Pipeline construction creates preferential pathways by changing the properties of the aquifer due to differing properties of the backfill.
    - If the backfill has higher conductivity than the surrounding aquifer, groundwater will flow preferentially within the backfilled trench.
    - If the backfill has lower conductivity, which is possible with substantial compaction of the backfill in a till or alluvial aquifer, it could block flow across the pipeline. The extreme case would be for the pipeline to cause water to surface upgradient from the trench.
- Pipeline construction through bedrock aquifers would absolutely change the properties as described in the previous bullet.
    - If the bedrock is highly fractured, such as in parts of the Catskill formation, backfill with silty till could easily have lower conductivity than the surrounding fractured bedrock.
    - Backfill with alluvium through intact bedrock would cause a high conductivity pathway.
- A leak in a pipeline would enter the groundwater in the trench, and its disposition would depend on properties of the backfill and probably even the rate.
    - A large leak would probably bubble to the surface and volatilize.
    - A small leak would probably dissolve into the groundwater, which can hold methane up to 28 mg/l at atmospheric pressure, and transport along with the groundwater flow as described in previous bullets.
    - Interestingly, because of the gas dissolving into the groundwater and because a small leak could be less detectable, a small leak could cause longer term groundwater problems.
- Pipeline construction can also change surface drainage patterns which could change the location where runoff becomes recharge.

The review in this memorandum regarding groundwater will follow the outline in the previous bullets and of course expand on them.

3.0 GROUNDWATER BACKGROUND

Construction and operations of the proposed pipeline affects groundwater in numerous ways that can then affect surface water and wetlands. If the project decreases groundwater recharge, it will decrease the groundwater discharge as well. That discharge controls baseflow and maintains the water level in wetlands during dry periods. Trench construction and backfill changes the conductivity of the

formations which either causes preferential flow or blocks flow. Higher conductivity leads to preferential flow which can cause an aquifer to drain more quickly and ease the pathway for contaminants to reach wetland and streams. Lower conductivity backfill would restrict groundwater flow that intersects the trench and possibly divert from its natural discharge point or even cause it to surface. All of these factors can decrease surface baseflow, cause wetlands to dry more quickly, and cause more contaminants to reach streams and aquifers. The application documents outline the aquifers, soils, vegetation, and natural recharge (RR2, RR3, and RR6) but does not consider the impacts that pipeline construction and operation would have on them and the ultimate effect on streams and wetlands, in violation of the relevant requirements (25 Pa. Code § 105.15(e)(1)(x)).

3.1 Recharge

The applicant's recharge map (RR2, Figure 2.2.4-1 for Pennsylvania) shows broad areas of equally distributed recharge. Distributed recharge means the recharge estimate is based on recharging being spread over a broad area. The rate is simply a flow, assumed to emanate from recharge over the entire area, divided by area expressed in length/time, usually inches/ year. It does not account for heterogeneities in the geology, such as caused by faults or anticlines (the folding away from the crest of an anticline causes tension cracks in the bedrock which allows more meteoric water to enter the aquifer at the crest than elsewhere) or topography.

Recharge (RR2, Figure 2.2.4-1) was estimated using Wolock (2003), a nationwide digital data set of recharge estimates on a nationwide grid of 1 km grid cells. The abstract for Wolock (2003) is as follows: "This 1-kilometer resolution raster (grid) dataset is an index of mean annual natural ground-water recharge. The dataset was created by multiplying a grid of base-flow index (BFI) values by a grid of mean annual runoff values derived from a 1951-80 mean annual runoff contour map. Mean annual runoff is long-term average streamflow expressed on a per-unit-area basis". Reese and Risser (2010) noted that Wolock emphasized the recharge values "are strictly for the long term, and qualifies the use of the results and method" (Reese and Risser 2010, p 9) and that "site-specific recharge values are not expected to be accurate because of the generalization of data over time and space" (Id.). The values in Figure 6 (RR2) should not be considered to represent the specific recharge at a point, such as the pipeline route.

Reese and Risser (2010) present an alternative recharge estimate for the state of Pennsylvania based on estimates for HUC10 watershed scales, which in Pennsylvania range from about 50 to 400 square miles. Comparison of Reese and Riser (2010) Plate 3 and RR2 Figure 6 does not suggest substantial differences in the methods. Reese and Risser (2010) Plate 5 indicates the estimation errors in the area of the pipeline (in PA) range from 2.0 to 3.83 inches. The regression equation used to develop the statewide estimates (Risser et al. 2008) had the following significant independent variables.

- Mean annual precipitation – more precipitation leads to more recharge, all else being equal. Factors that concentrated precipitation in an area should also increase the recharge.
- Average daily maximum temperature – this would be a surrogate variable for evapotranspiration and recharge likely decreases as this variable increases.

- Percent carbonate rock – carbonate rock is very conductive and this variable is a surrogate for the control that geology exerts on recharge. A larger percentage of carbonate rock means more recharge.
- Percent sand in soil – this probably relates the infiltration capacity of the soil, so that more sand means more recharge.
- Average stream channel slope – this would be a surrogate for more relief which would probably relate to relief and steepness, with more runoff and less recharge occurring where the slope is steeper.

Although these factors were developed at a watershed scale, they could represent factors at a point. Methods used to estimate recharge at a point (for example, Flint and Flint 2008) try to complete a water balance and require estimates of at least the first four factors in the bullet list. Pipelines can have the largest, most widespread impacts to soils and vegetation (Pierre et al. 2015), which would primarily be represented as percent sand in the Risser et al regression equation. Effects on soils would primarily be compaction and lost vegetation.

Sections 3.11 through 3.14 outline factors that affect recharge or are soils related that could have significantly negative effects on the water resources aspects of the environment, specifically streams and wetlands. The applications does not address the impacts at all. These sections present some preliminary analysis but should not be considered a complete analysis. PennEast should complete such analyses prior to its application being considered complete.

3.11 Soils Review

RR7 is the PennEast soils report. It provides maps showing soil types along the proposed pipeline (Figure 7.1-1) and tables listing characteristics of the soils along the pipeline (RR7, Tables 7.1-1, -2). It has a summary table showing percents of the proposed pipeline with critical characteristics including poorly or very poorly drained, excessively drained, poor revegetation potential, high compaction, severe erosion potential, prime farmland crossed, and slope. These tables and figures describe the base soil characteristics, except they fail to include hydrologic soil group (see next paragraph) and fail to consider characteristics together which could lead to more critical conditions. For example, constructing a pipeline through soils that are poorly drained with high compaction, especially on steep slopes, would create zones that would have significantly reduced recharge in the long term and probably increased runoff that could cause erosion down gradient.

Neither RR7 nor RR2 discusses NRCS (1986) hydrologic soil groups, commonly known as A, B, C, or D groups, considered the most important soils classification for hydrology (Pierre et al. 2015). Soils are assigned a curve number which describes their runoff potential and their sensitivity to disturbance which increases the curve number (and therefore runoff and decreases recharge). The runoff classification can even be used to assess recharge, with higher runoff soils (ie, group D) allowing less recharge. Although some of the characteristics provided in RR7 include similar information, descriptions are not as useful for considering the impacts over a large project as would be curve number classifications.

Pipeline disturbance to soils would occur in two ways. There is the removal of vegetation which shelters the soil from raindrop erosion and compaction and furrowing caused by construction traffic on the soils. Some vegetation will regrow but shrub and tree canopy would require decades to reestablish, if allowed to do so due to maintenance requirements.

Table 1 shows the mileage for soils that have high compaction potential and poor drainage along the pipeline developed from RR7 Table 7.1-2. Approximately 9.25 miles or 7.8% of the total length in both states including laterals have high compaction potential and poor drainage. The slopes were moderate, with the steepest being 6%, enough to generate significant runoff from disturbed slopes. Silt and clay make soil easier to compact so pipeline reaches with high silt/clay could be most compacted and recharge most reduced.

Table 1: Soils subject to a high potential of compaction, by mile post. From RR7 Table 7.1-2.

Begin MP	End MP	Length (miles)	Drainage	Slope (%)	Soil series
0	0	0.05	Poorly	6	Chippewa silt loam
3.1	3.1	0.05	Very poorly	2	Wayland silt load
5.5	5.5	0.05	Poorly	6	Rexford loam
6.2	6.3	0.1	Poorly	2	Holly Silt Loam
6.5	6.5	0.05	Poorly	2	Holly Silt Loam
13.1	13.3	0.2	Poorly	6	Rexford loam
16.8	16.9	0.1	Very poorly	4	Chippewa very stony silt loam
17.7	17.7	0.05	Very poorly	4	Chippewa very stony silt loam
17.7	17.8	0.1	Very poorly	1	muck
24.5	24.5	0.05	Very poorly	3	Lickdale and Tughill very stony loams
26.5	26.6	0.1	Very poorly	4	Norwich very stony loam
27	27.3	0.3	Very poorly	1	muck and peat
29.5	29.6	0.1	Very poorly	1	muck and peat
30.1	30.9	0.8	Poorly	4	Shelmadine very stony silt loam
30.9	31.1	0.2	Very poorly	3	Lickdale and Tughill very stony loams
31.1	31.2	0.1	Poorly	2	Shelmadine silt loam
32.4	32.6	0.2	Very poorly	3	Lickdale and Tughill very stony loams
33.1	33.1	0.05	Poorly	2	Holly Silt Loam
34.5	34.8	0.3	Very poorly	1	Papakating silty clay loam
35.1	35.4	0.3	Poorly	4	Shelmadine very stony silt loam
35.4	35.4	0.05	Poorly	4	Shelmadine very stony silt loam
36	36	0.05	Poorly	4	Shelmadine very stony silt loam
36	36.1	0.1	Very poorly	3	Lickdale and Tughill very stony loams
36.1	36.2	0.1	Poorly	4	Shelmadine very stony silt loam
36.1	36.1	0.05	Poorly	2	Holly Silt Loam

36.5	36.6	0.1	Poorly	4	Shelmadine very stony silt loam
36.6	36.8	0.2	Very poorly	3	Lickdale and Tughill very stony loams
36.8	36.9	0.1	Poorly	4	Alvira and Shalmadine very stony silt loams
36.9	37.2	0.3	Poorly	2	Alvira and Shalmadine very stony silt loams
41.1	41.2	0.1	Poorly	2	Alvira and Shalmadine very stony silt loams
41.2	41.5	0.3	Poorly	4	Alvira and Shalmadine very stony silt loams
41.6	41.6	0.05	Poorly	2	Holly Silt Loam
45	45.1	0.1	Poorly	2	Holly Silt Loam
49	49.4	0.4	Very poorly	1	Papakating silty clay loam
53.5	53.5	0.05	Poorly	4	Andover-Buchanan gravelly loams
53.5	53.5	0.05	Poorly	4	Andover-Buchanan gravelly loams
53.7	53.7	0.05	Poorly	2	Andover-Buchanan gravelly loams
54.2	54.3	0.1	Poorly	2	Andover-Buchanan gravelly loams
54.3	54.4	0.1	Poorly	2	Andover-Buchanan gravelly loams
54.3	54.3	0.05	Poorly	4	Andover-Buchanan gravelly loams
55.9	56	0.1	Poorly	2	Brinkerton-Comly silt loams
56.7	56.7	0.05	Poorly	6	Brinkerton-Comly silt loams
58.5	58.5	0.05	Poorly	2	Brinkerton-Comly silt loams
59.2	59.2	0.05	Poorly	6	Brinkerton-Comly silt loams
60.3	60.3	0.05	Poorly	2	Holly Silt Loam
61.4	61.5	0.1	Poorly	2	Brinkerton-Comly silt loams
63.5	63.6	0.1	Poorly	2	Holly Silt Loam
70.9	71	0.1	Poorly	1	Fluvaquents
72.5	72.8	0.3	Poorly	4	Cokesbury-Califon channery silt loams
72.9	73	0.1	Poorly	5	Cokesbury silt loam
73.1	73.4	0.3	Poorly	4	Cokesbury-Califon channery silt loams
73.4	73.6	0.2	Poorly	5	Cokesbury silt loam
1.3	1.4	0.1	Poorly	5	Cokesbury silt loam
92.5	92.7	0.2	Poorly	1	Croton silt load
92.7	92.8	0.1	Poorly	1	Bowmansville silt loam
92.8	93	0.2	Poorly	1	Croton silt load
93	93.5	0.5	Poorly	1	Croton silt load
93.3	93.3	0.05	Poorly	4	Croton silt load
94	94.1	0.1	Poorly	4	Croton silt load
94.3	94.3	0.05	Poorly	3	Croton silt load
94.5	94.6	0.1	Poorly	3	Croton silt load

94.5	94.6	0.1	Poorly	1	Croton silt load
95	95.1	0.1	Poorly	4	Croton silt load
97.4	97.5	0.1	Poorly	4	Reaville wet variant silt loam
104.8	104.8	0.05	Poorly	1	Bowmansville silt loam
105.9	106	0.1	Poorly	1	Bowmansville silt loam
108.3	108.3	0.05	Poorly	1	Doylestown and Reaville variant silt loams
112.7	112.9	0.2	Poorly	1	Doylestown and Reaville variant silt loams

Individual reaches shown in Table 1 are mostly less than 0.3 miles in length, with a 0.8 mile reach at MP 30.1 being an exception. Details of these areas would help determine the significance of the impact. Depth to bedrock is essential to the assessment because it defines the thickness through which groundwater flow would occur, but the presentation of such information in RR6 is very poor, with depth to bedrock provided only as related to soil types without mile posts (RR6, Table 6.3-4). The detailed geology map (Figure 6.1-2, RR6) is barely usable because it shows only a surface geology strip along the pipeline and is difficult to get an overall assessment of the system. The bedrock geology map (RR2, Figure 2.2-1) is very difficult to read because the color coding is of aquifer yield.

Starting at MP 29.5 is a series of high compactable soils through MP31.2 (Table 1 and Figure 1). This reach is generally up and down the slopes of a ridge in Hickory Mountain State Park so runoff would be straight downhill. Pipeline construction would cause a strip of decreased recharge and increased overland flow. Recharge along the pipeline from about MP 29.6 to 30.0 would directly support the wetland centered at MP 29.6 (Figure 2). Recharge varies from 20 to 22.2 in/y in this area (Figure 2.2.4-1, RR2), so pipeline construction would reduce recharge (and inflow to the wetland) by as much as 4.4 af/y (0.006 cfs or 2.8 gpm). Based on the size of the wetland, the area affected by the pipeline appears to be a couple percent of its tributary area, but the effect of losing it would depend on the connectivity of parts of the wetland.

Figure 1: Snapshot of a portion of RR7 Figure 7.1-1 showing soils along the proposed pipeline, MP 29.5 to MP 31.8.

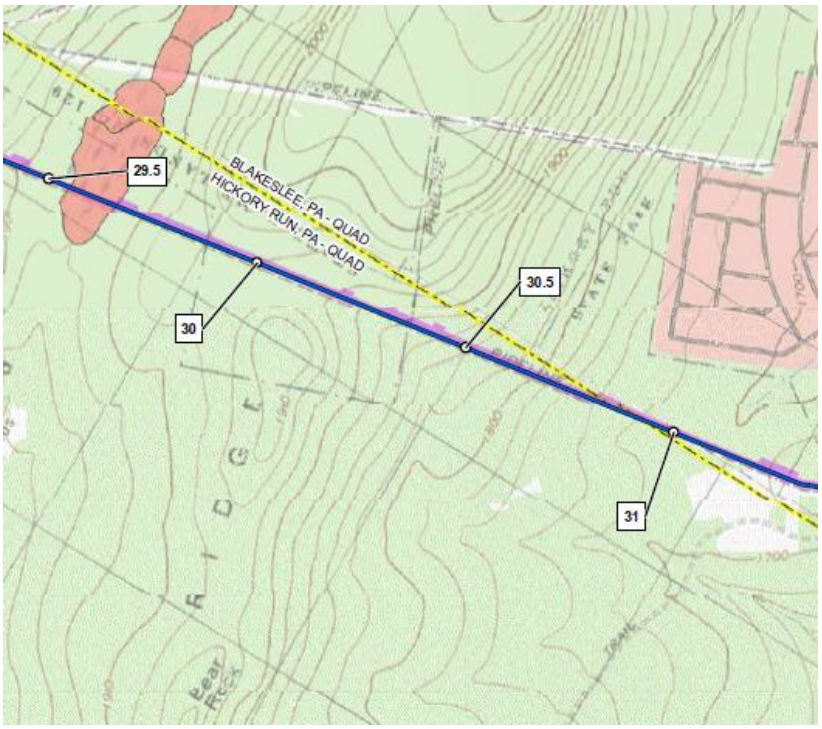

Figure 2: Snapshot of wetlands map (Appendix D, p 9 of 32).

At least 0.2 miles of compactible soil between MP 94.5 and MP 95.1 would reduce flow to the wetlands MP 95.1 (Figure 3). The soil is Croton silt loam (Figure 4). Other wetlands cross or bound the pipeline

near MP 94.5 (Figure 3). The pipeline could intercept recharge either percolating at these points or flowing to the wetlands through shallow groundwater.

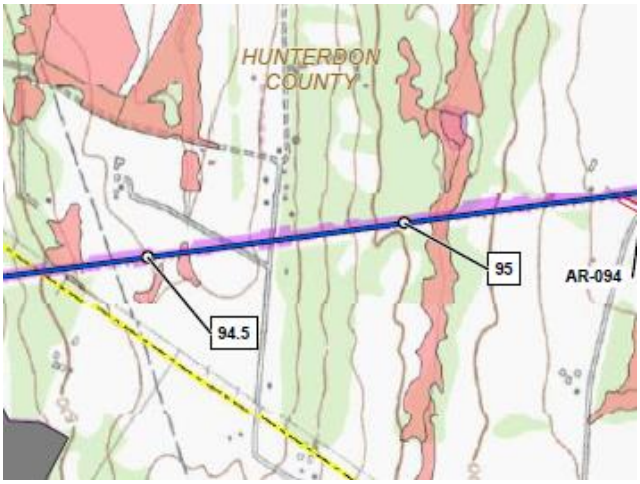

Figure 3: Snapshot of wetlands map (Appendix D, p 26 of 32).

Figure 4: Snapshot of soils maps from MP 93.8 to 95.8 (RR7, Figure 7.1-1). CoxBb is compactible Croton silt loam.

Compactible soils from MP 27 to 27.3 coincided directly with wetlands between the same mile posts. This could be one of the more challenging areas for pipeline construction and likely one of the areas that will be highly impacted. Compaction will not only prevent recharge through a significant section of the wetland but compaction could also create zones across which water will not flow thereby creating segmented aquifers within the wetland. This would render either section more susceptible to drought and more susceptible to a contaminant spill because the dilution potential would be reduced.

Compactible soils from MP 34.5 through 34.8 control drainage to both sides of a wetland at MP 35.6 (Figures 5 and 6). If compaction eliminates up to 3.3 af/y of recharge that supports a wetlands not much larger than 3.3 acres (Figure 6), the water balance of the wetlands would be considerably changed and the wetland would become impacted by drought.

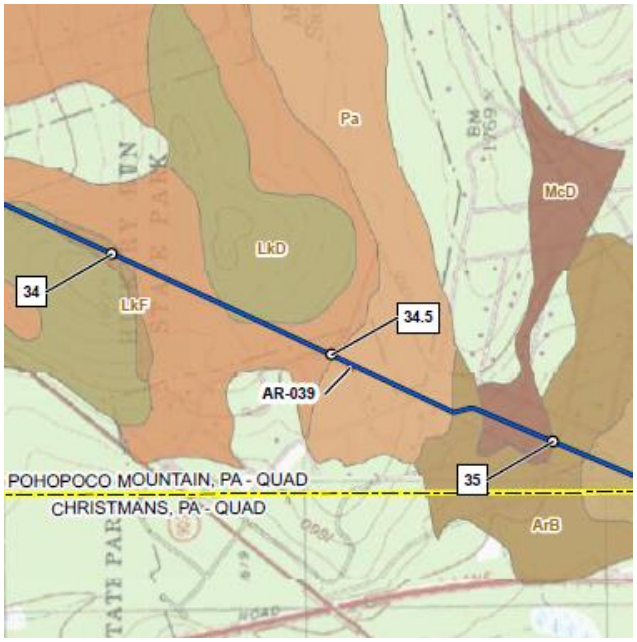

Figure 5: Snapshot of soils map from MP 33.8 to 35.2 (RR7, Figure 7.1-1).

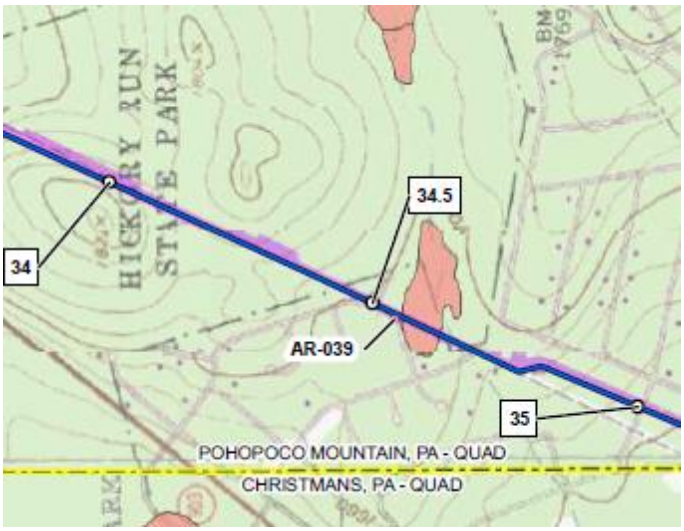

Figure 6: Snapshot of wetlands map (Appendix D, p 10 of 32).

Compactible soils from MP 49 to 49.4 coincide with wetlands between the same mile posts along the Aquashicola Creek. (Figure 7). This section will be in the floodplain of Aquashicola Creek in Papakating silty loam (Table 1), which is considered poorly draining. Compaction in this soil at this area may not affect recharge as much as it will prevent recharge from the south from reaching the creek. The trench could create a barrier that segments the floodplain. Considering the width of the floodplain area with a compacted trench bisecting it, the pipeline could cause geomorphic impacts during flood events. The stream could be captured by the trench or shifted from side to side. Groundwater forced to the surface by the trench could form small channels near the pipeline.

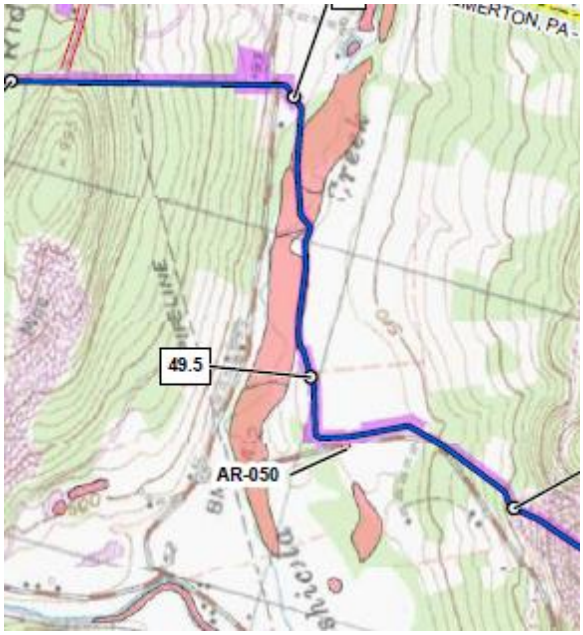

Figure 7: Snapshot of wetlands map (Appendix D, p 14 of 32).

3.12 Bedrock Underlying the Pipeline

RR2 delineates aquifers crossed by the proposed pipeline as bedrock (PADCNR 2000), principal (Trapp and Horn 1997), and surficial aquifers (Id.). Bedrock aquifers are simply the geologic formation that underlies the pipeline. RR2 (p 2-2) claims there are up to 40 bedrock aquifer types based on the difference in bedrock formations to be crossed by the proposed pipeline. Therefore, there are up to 40 different sets of transmissivity and groundwater storage properties which means up to 40 different responses to stresses on the aquifer. The map (RR2, Figure 2.2-1) does not show the locations very well but the table (RR2, Table 2.2-1) specifies mile posts along the pipeline for each formation. Structural aspects of the bedrock formations, such as faulting and folding (synclines, anticlines) exert control over the bedrock aquifer properties, but the application does not specify where these factors control the properties (RR2, p 2-2). Maps showing broad generalizations of aquifer specific capacity (RR2, Figure 2.2-1) or aquifer yield (RR2, Figure 2.2-2) are not a substitute for transmissivity or aquifer storage properties.

Bedrock beneath the shallow aquifers controls whether recharge circulates deeply or flows a short distance and discharges to a surface channel; at a small scale such as on ridge tops or slopes the channels are probably small. Fractures control where recharge enters the bedrock as well as how contaminants circulate through the aquifers. Fractures allow a higher proportion of the recharge to enter the bedrock whereas areas with no fractures will force most of the recharge to flow elsewhere and possibly recharge at points away from where the precipitation falls. Two factors, the formation type and topographic position, control bedrock fractures, and therefore conductivity, specific yield, and the ability for recharge to enter the bedrock and how deeply it circulates.

The basis for specifying bedrock aquifers in RR2 is very general; Trapp and Horn (1997) provide broad aquifer descriptions based on a regional analysis. RR2 Figure 2.2-1 shows broad aquifer zones with large ranges of specific capacity. Specific capacity is an easy to estimate property that reflect the conductivity of the bedrock at a point (see http://www.wrd.org/engineering/specific-capacity-well-1.php). Other reports that are not even referenced in RR2 or other volumes provide much more detail about the bedrock aquifer properties. Taylor (1984) describes the properties of bedrock aquifers that underlie the pipeline from MP 0.0 to about 62.8. Low et al (2002) describes the properties of underlying bedrock formations from MP 62.8 to about 77.6, through Northhampton and Bucks County. Herman (2001) describes in detail the properties of bedrock aquifers through the Newark Basin of New Jersey. Poth (1972) discusses the Martinsburg Formation. Rather than relying on broad generalizations, PennEast should discuss details of the bedrock underlying the pipeline by milepost, as it does for soils and wetlands.

The topography partially controls the location of fractures. Taylor further describes the variability:

> Wells in higher topographic positions (hilltops and hillsides) have smaller yields than those in lower topographic positions (valley, gullies, and draws). Valleys and draws often form where the rocks are most susceptible to physical or chemical weathering. Hilltops are generally underlain by more resistant rocks. Lithologic variations and weaknesses in rocks caused by bedding partings, joints, cleavage, and faults promote rapid weathering and can produce low

areas in the topography. These types of geologic features often occur in high-permeability zones which yield significant amounts of water to wells. (Taylor 1984, p 29).

Specific capacity provides guidance regarding the yield throughout the depth of the wells, whereas it is shallow fractures that would allow recharge to enter the bedrock and deep fractures that control how deep the recharge circulates (Taylor 1984). Most bedrock formations have the maximum fractures between 100 and 150 feet bgs with the Catskill Formation having the most fractures from 150 to 250 feet bgs (Taylor 1984, Table 7). Hamilton group bedrock has relatively more fractures near the ground surface, between 0 and 50 feet bgs than other formations (Id.). The topographic position therefore better describes the tendency for surface fractures and describes locations where bedrock is most receptive to recharge.

The surface geology map in RR6 Figure 6.6-2 shows just the thin mantle of till or alluvium and the bedrock geology map in RR6 Figure 6.6-1 is one page showing the entire pipeline. Although RR2 acknowledges that fractures may have a larger specific capacity, nothing in RR2 provides details of how specific capacity varies along the pipeline layout. The broadscale mapping in RR2 Figure 2.2-1 does not provide sufficient detail on mile posts to verify the table.

RR2 Table 2.2-1 is also not very useful because it shows just the mile posts for start and end of bedrock aquifers. Without an indication of the geomorphology of the reach, it is not possible to know whether the reach would be an area with or without fractures, meaning it does not disclose much about the recharge along the reach. Table 2.2-1 should include a column indicate whether it is a ridge top, valley bottom, or slope greater than a given percent. Its proximity to anticlines and synclines should also be noted as these structures affect the location of the fractures. The geomorphic feature could differ among provinces.

Lower specific capacity on ridges means that recharge will remain in the shallow till or alluvial aquifers mantling the bedrock. As noted, the depth to bedrock in many areas is only a few feet so recharge flows as shallow groundwater. The shallow groundwater flow from ridgetops reaches drainages, usually high elevation first order drainages, where the bedrock has higher yields and some of the shallow groundwater enters it. Recharge maps such as Figure 2.2.4-1 (RR2) are highly misleading because they present recharge as a rate, inches per year, distributed over an area. Reality is that the rate is highly variable with the underlying geology, soil type and thickness, and topography controlling the actual recharge location.

For example, between MP 29.5 and 31.2, a reach discussed above regarding soils, the bedrock is Catskill Formation with aquifer specific capacity of 0 to 43 gpm/ft according to RR2 Figure 2.2-1. The range of 0 to 43 gpm/ft is very high. Taylor (1984) documented a very wide range of well yields (he did not calculate specific capacity) for the Catskill Formation up to 300 gpm. The wide range in yields is due to the variability found in fractured bedrock aquifers. Considering that compaction could reduce recharge up to 4.4 af/y through this reach, the bedrock properties control whether the lost recharge is shallow or deep. RR2 does not provide the detail necessary to adequately assess how the lost recharge will affect hydrogeology of the area.

As noted there is a large variation in properties for bedrock aquifers. For example, specific capacity at wells in the Brunswick Formation varies from 0.13 to 140 with a median equal to 2.0 (Low et al 2002), which indicates that most wells have very low specific capacity but occasional wells are in high yield fracture zones. The 90th percentile value is 11 gpm/ft, so the 140 gpm/ft value is clearly a highly fractured outlier. Highly conductive zones allow far more water to enter the aquifer than simply falls at the location of the fractures. Surface water could collect and percolate deeply into the bedrock where the channels lie over the fractures, which tend to occur more in valley bottoms. Shallow groundwater flow or interflow over a bedrock would enter fracture zones preferentially as well. Compaction of surface soils and shallow aquifers could either prevent the recharge at a point from entering the fracture zone or prevent the shallow flow from reaching the fractures. RR2 completely fails to acknowledge these potential changes or indicate where they could be more prevalent or more important.

- RR2 should provide a table of bedrock aquifers that includes relevant properties, including specific capacity statistics or well yields, and conductivity where available. If properties for a given bedrock aquifer have not been published, it is reasonable for PennEast to complete the analyses for existing wells.

Table 2 shows relevant properties for bedrock types over which the pipeline. Considered with the soils Table 2 and the topographic position of the reach, it is possible to match locations where recharge will be most affected (Table 1) with the areas in which bedrock accepts most recharge (Table 2) to determine where pipeline construction and compaction could affect deep recharge the most. Compacting areas overlying shallow, conductive bedrock will most affect deep groundwater recharge.

- The PennEast application completely failed to consider how pipeline construction will affect water availability for recharge into bedrock by not considering how compaction will prevent water from accessing fracture zones.

Table 2: Hydrogeologic properties of bedrock formations near the PennEast pipeline. SC is specific capacity. All data from Taylorl (1984) and Low et al. (2002), unless otherwise specified.

Formation	**Min Yield**	**Max Yield**	**Domestic Median yield**	**Nondomestic median yield**	**Comments**
Catskill	0	300	12	35	1146 well analyzed
Pocono	3	350	12	18	
Mauch Chunk	0	710	25	50	
Llewellyn	2	50	10		limited data, just seven domestic wells
Pottsville	5	300	25	48	
Spechty Kopf	-				a thin formation between the Catskill and Pocono
Trimmers Rock	1	60	6	15	

Mahantango	-					Hamilton Group
Marcellus	1	900	10		65	Hamilton Group
Buttermilk Falls Limestone	-					
Ridgeley	2	650	10		122	part of Onondaga and Old Port Formatin
Decker	-					
Bloomsburg	2	500	6		66	
Shawangunk	-					
Jacksonburg	1	1200	17		75	dolomite (Drake 1965), properties from Lehigh County (Sloto et al. 1991)
Allentown	5	1500	30		150	dolomite (Drake 1965), properties from Lehigh County (Sloto et al. 1991)
Leithsville	2	1000	25		250	dolomite (Drake 1965), properties from Lehigh County (Sloto et al. 1991)
	Min SC	**Max SC**	**Median SC**	**Yield (gpm)**	**Median K (ft/d)**	**Comments**
Hardyston	0.04	18	0.57	31	0.24	
Felsic to mafic gneiss	-					
Hornblende gneiss	-					
Trenton gravel	0.01	80	6.6	105	430	very shallow
Igneous and metamorphic rocks	-					
Brunswick conglomerate	-					Conglomerate for other formations, but not Brunswick
Brunswick	0.07	140	1.5	60	1.3	
Lockatong	0.05	40	0.4	10	0.78	
Stockton	0.07	75	1.3	60	1.2	
Diabase	0.01	5	0.12	7.5		very few, very shallow fractures
Martinsburg	0.06	10	0.61	1	1.3	Northhampton County only, K from model calibration (Sloto et al. 1991)
Jacksonburg	0.01	34	1.2		3.1	properties from Lehigh County, K from model calibration (Sloto et al. 1991)

Allentown	0.03	125	4.3		47	properties from Lehigh County, K from model calibration (Sloto et al. 1991)
Leithsville	0.18	375	2.4		125	properties from Lehigh County, K from model calibration (Sloto et al. 1991)

3.13 Mine-Impacted Soils

Beginning at about MP 5.1 and continuing to MP 11.2, the soils table (RR7, Table 7.1-1) lists various soils reaches as "mine dump" or strip mine, burned". The geology section notes strip mines in this area (RR6, p 6-22). Partially shown on Figure 8, these soils cover substantial areas on the east side of the Susquehanna River crossing. Excavating or otherwise disturbing mine spoil can release contaminants, including acid mine drainage if sulfides are present. Much of the parent bedrock is acid or could produce acid if disturbed (RR6, p 6-38). The primary mineral of concern, apparently, is arsenic (Id.). The mine spoil is considered to have high conductivity (RR7, p 7-15), so the potential for contaminants released by construction disturbance is relatively high. It has the potential for high erosion when disturbed (RR7, p 7-16).

This environmental impact report was released before investigations regarding contaminants could even be completed. For example, PennEast is "**currently working out** the parameters of a study of the leachability of the arsenic-bearing rocks under conditions that might exist during pipeline construction and operation" (RR6, p 6-39, emphasis added). This would be to assess whether arsenic could be mobilized to reach nearby wells or those that tap bedrock fractures (Id.). Another failure to consider is karst, which the studies acknowledge (RR6, p 6-33, -34) occurs but provides no mapping for its location. Karst can be a significant preferential flow pathway for contaminants and therefore could exacerbate contamination issues or incidents caused by pipeline construction or operation. The report states that "PennEast **is developing** a Karst Mitigation Plan" (RR6, p 6-46, emphasis added) which means the impacts of the pipeline due to encountering karst is not known. It is not appropriate to publish an environmental study for review without having the more important aspects of the geology to be affected by the project not understood.

- The PennEast application does not assess the potential for pipeline construction to generate acid generation or leach arsenic in areas where it crosses mine spoil. The application was submitted before they complete relevant studies. The application should revised to address the potential impact of acid drainage and arsenic leaching and specify appropriate monitoring and mitigation.

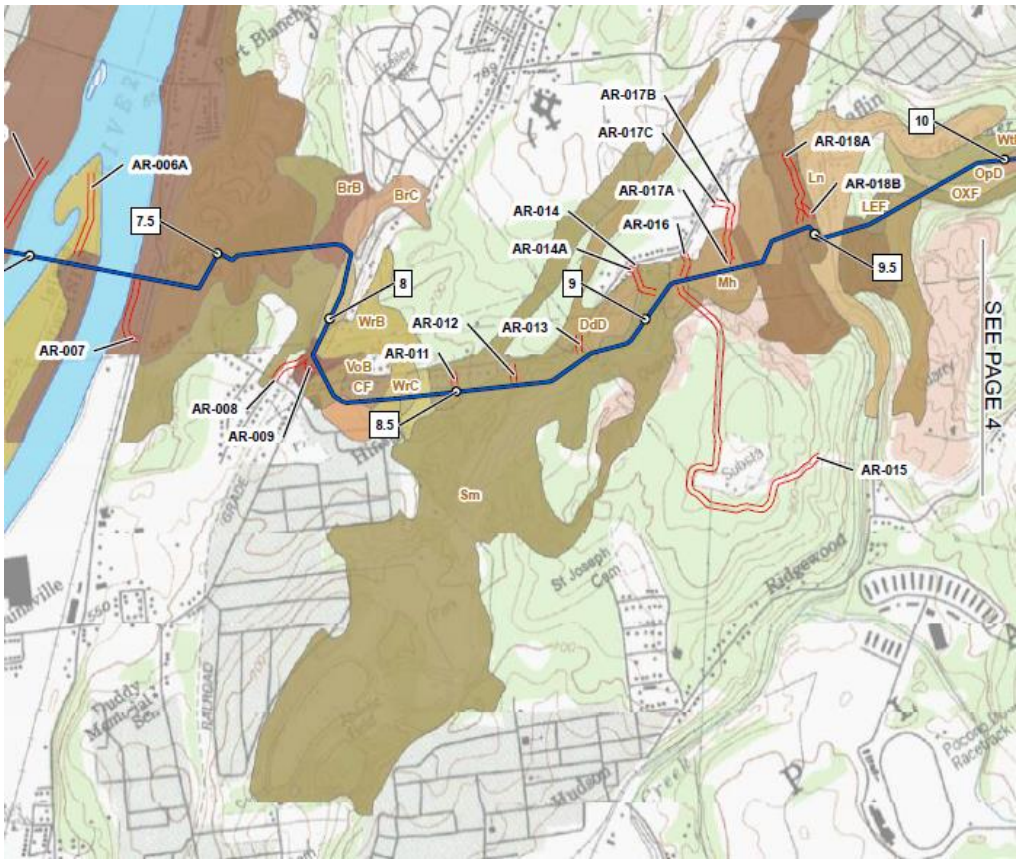

Figure 8: Snapshot of soils map (RR7, Figure 2.1-1) showing MP 7.0 to 10.0. Soil SM is strip mine.

3.13 Analysis of Impacts

The application did not consider how pipeline construction and operations could affect recharge and shallow groundwater flow in aquifers near the proposed pipeline. Areas where the pipeline compacts soils over critical recharge areas, especially on ridge tops and valley bottoms, would increase runoff and decrease recharge. As discussed previously in this section, recharge supports baseflow therefore decreasing recharge will affect baseflow in streams. Most importantly groundwater discharge would be decreased during low flow periods.

Table 3 shows mile posts between which pipeline construction would compact soils in valley bottoms, not including Susquehanna and Delaware River. There are 8.1 miles of pipeline in valley bottoms with 1.9 miles overlain by compactible soils. Recharge varies significantly as discussed above, but if all of the recharge is lost over the area affected by the pipeline, for 10 or 22 in/y, the total lost recharge is 40.9 and 90 af/y, respectively, 0.056 or 0.124 cfs. Considered as flow rate per mile, the loss is 0.007 or 0.15 cfs/mile, which can be significant for small streams during baseflow or small wetlands.

Table 3: Proposed pipeline reaches by milepost which lie in drainage bottoms. Compactible soils is a marker showing the soil overlying the bedrock is compactible as defined in Table 1.

Beginning MP	Ending MP	Miles	Bedrock	Compactible soils

0.5	0.8	0.3	Catskill	
4.2	4.4	0.2	Catskill	
11.5	12	0.5	Pottsville, Mauch Chunk	
16.6	16.7	0.1	Catskill	
18.2	18.4	0.2	Catskill	
19.5	19.7	0.2	Catskill	
22.6	23.2	0.6	Spechty Kopf	
33	33.2	0.2	Catskill	X
38.7	38.9	0.2	Catskill	
39.4	40.5	1.1	Catskill	
43.4	43.6	0.2	Marcellus	
45	45.1	0.1	Catskill	X
45.2	45.3	0.1	Catskill	
45.5	45.6	0.1	Catskill	
48.1	48.3	0.2	Mahantango	
49	49.7	0.7	Decker through Pocono Island	X
55.8	55.9	0.1	Graywack and shale of Martinsburg	
56.6	56.8	0.2	Graywack and shale of Martinsburg	
60.2	60.4	0.2	Martinsburg	
61.4	61.5	0.1	Jacksonburg	X
70.3	70.4	0.1	Allentown	
70.8	71.1	0.3	Leithsville	X
81.2	81.3	0.1	Brunswicke conglomerate	
81.7	81.8	0.1	Brunswicke conglomerate	
82.2	82.3	0.1	Brunswick	
82.7	82.8	0.1	Brunswick	
82.9	83.1	0.2	Brunswick	
83.8	83.9	0.1	Brunswick	
84.8	84.9	0.1	Brunswick	
86.7	86.8	0.1	Brunswick	
87.6	87.8	0.2	Brunswick	
88.3	88.4	0.1	Brunswick	
89.5	89.6	0.1	Brunswick	
89.7	89.8	0.1	Brunswick	

99.9	100	0.1	Diabase	
100.2	100.3	0.1	Diabase	
104.4	104.9	0.5	Brunswick	x

Pipeline construction in valley bottoms affects groundwater flow in other ways. If the conductivity of the backfill is higher than that of the surrounding aquifer material, the trench could intercept flow to the stream and cause it to flow elsewhere, possibly never to reach the stream. If the conductivity is lower than that of the surrounding aquifer material, it could deflect the groundwater flow away from the stream, although it could also cause the groundwater flow to discharge to the surface away from the stream. These effects are discussed below in the Preferential Flow section, Section 3.2, and quantified using numerical simulations below.

Table 4 shows mile posts between which pipeline construction would compact soils on ridge tops. Recharge on ridges has a longer path to follow to reach streams, although some is very shallow and may support isolated streams and springs. On ridge tops with receptive bedrock, a significant amount of recharge will circulate deeply into the bedrock. There are 17.1 miles of pipeline on ridge tops so, considering recharge at just 10 in/y, total lost recharge is as much as 86 af/y. Considered as flow rate per mile, the loss is 0.007 or 0.15 cfs/mile, which can be significant for small streams during baseflow.

Table 4: Proposed pipeline reaches by milepost which lie in drainage bottoms.

Beginning MP	Ending MP	Miles	Bedrock
0.8	1.1	0.3	Catskill
1.7	2	0.3	Catskill
2.3	2.5	0.2	Catskill
3.6	4.1	0.5	Catskill
12.7	12.9	0.2	Mauch Chunk
14.3	14.5	0.2	Spechty Kopf
15.3	15.6	0.3	Catskill
17.2	17.7	0.5	Spechty Kopf
20.4	21.2	0.8	Pocono
23.4	24	0.6	Catskill
29.5	30.5	1	Catskill
33.8	34.4	0.6	Spechty Kopf/Catskill
39	39.5	0.5	Catskill
45.2	47.7	2.5	Catskill
48.4	48.8	0.4	Buttermilk Falls Limestone
51	51.3	0.3	Shawangunk
59.6	61.3	1.7	Martinsburg

73.6	74.2	0.6	Hornblende gneiss
78.2	79	0.8	Jacksonburg limestone
80.6	81.2	0.6	Brunswick conglomerate
81.3	81.6	0.3	Brunswick
81.8	82.2	0.4	Brunswick
82.4	82.7	0.3	Brunswick
84.1	84.9	0.8	Brunswick
85.7	86.7	1	Brunswick
87.9	88.3	0.4	Brunswick
88.5	89.5	1	Brunswick

3.14 Summary and Recommendations

Pipeline construction would affect recharge distribution in the areas crossed by the pipeline. It does this by compaction and vegetation removal. This increases runoff as well which may allow recharge to occur elsewhere downhill. Trench compaction may also prevent groundwater from flowing across floodplains and reaching streams or wetlands near their normal discharge point.

- PennEast should compete site-specific impact analyses that considers the potential for pipeline construction effects, including compaction and vegetation removal, to change recharge patterns.
- PennEast should complete site-specific impact analyses showing how the changed location and rates of recharge would change baseflow in streams and it wetlands.
- PennEast should propose methods to monitor these effects. Piezometers should be installed in wetlands downgradient from the pipeline to monitor changes in water levels and compare those changes to predicted changes. Piezometers should also be installed in strategic locations of the trend backfill and just outside the trench to determine whether the trench is causing drawdown or whether preferential flow is occurring (see Sections 3.2 and 3.3).
- PennEast should proposed methods to mitigate these effects. If the analysis shows changes in recharge or flow patterns, the backfill could have drains installed to allow cross-trench flow. If necessary the surface of the pipeline could be scarified to increase infiltration through the soils.

3.2 Preferential Flow

Groundwater follows the path of least resistance, which usually means the path with the highest conductivity. All but the most homogeneous formations have pathways that are much more conductive than the overall formation. The proportion of the overall flow through an aquifer that occurs through these natural pathways can be quite large.

Pipeline construction would create preferential flow pathways in two ways. One would be by creating a trench with higher conductivity than the surrounding formation. Groundwater would tend to flow into

and then through the high-conductivity trench. This could occur in shallow groundwater either in low conductivity glacial till deposits or bedrock deposits. This could be most critical where the pipeline follows a steep gradient along a mountainside.

The second way is by blocking the natural flow paths with a lower conductivity backfill that diverts groundwater along the interface between the trench and the natural formation. This could occur by compacting a trench developed in high conductivity alluvium or highly fractured bedrock so that the backfill has a lower conductivity and diverts the flow along the contact. This would be most critical in areas where the pipeline follows a steep gradient along a mountainside.

PennEast has not even acknowledged this potential issue, much less analyzed it. Preferential flow is most probable along slopes where groundwater flows from ridges to valley bottoms, although the effects could also occur in valley bottoms and ridgetops. It could be analyzed with analytic or numerical calculations for groundwater flow along a pipeline reach from recharge to discharge.

- PennEast should divide the pipeline into reaches from ridge top to wetland or stream to consider the effect of changing conductivity on groundwater flow. Impact analysis would include analytic or numerical[6] calculations with and without the pipeline, and include recharge estimates along the reach and different baseline (natural in-situ) parameters for the bedrock and shallow aquifers. The with-project scenario would include the trench parameterized with values representative of lower and higher conductivity backfill. PennEast should estimate the changes in discharge to downgradient wetlands or streams. Because the model is interpretative, the results are indicative of potential changes. PennEast should identify the areas where the impacts are most likely and propose monitoring and mitigation (see section 3.14) for the potential impacts.

3.3 Drawdown

A pipeline causes drawdown by providing preferential flow paths, as described in the previous section, which will change flow gradients and groundwater levels. This would affect areas depending on shallow groundwater tables, which would include wetlands where small difference in water level that persists for a substantial time period could change the character of the wetland. It would also include areas that have vegetation that depends on shallow groundwater. Lowering the water table, even a small amount, for a substantial period could have long term effects on the vegetation types, whether formally delineated as a wetland or not.

Wetlands crossed by the project depend on groundwater. Wetlands in four Pennsylvania Counties, Luzerne, Carbon, Northhampton, and Bucks had as their most common primary indicators of hydrology

[6] Numerical calculations would include the use of numerical groundwater models to make interpretative simulations. Interpretative means that the model would be parameterized according to commonly accepted field estimates of the properties. Using logical parameter changes to reflect the backfill, the model would be run with the trench. The with- and without trench results would be compared to assess potential impacts. An interpretative model is not predictive but only indicative of likely changes because it has not calibrated.

high water table (A2), saturation (A3), and oxidized rhizospheres on living roots (C3), with second indicators including drainage patterns (B10)[7].

RR3 discusses the importance of shallow groundwater for several vegetation types or features. The following list is just several observations from RR3 in which the importance of shallow groundwater was emphasized. Shallow groundwater is likely important for other vegetation types in other areas.

- Perhaps the most important is the leatherleaf – cranberry bog found along the pipeline route in Luzerne County (RR3, Table 3.3-4).
- There are also vernal pools which may be seasonally supported by a high groundwater table (RR3, p 3-27). Pipeline construction could affect vernal pools by preventing the groundwater table from supporting the pool as it did prior to construction. A pipeline could also divert the drainage patterns that seasonally fill the pools.
- Scrub-shrub wetlands depend on the "presence of high groundwater for extended periods" (RR3, p 3-39).
- RR3 notes the importance of springs for creating habitat to support the endangered (in Pennsylvania and New Jersey) bog turtle. "Bog turtles inhabit distinct types of wetland habitats that include spring-fed hydrology and mucky soils. Clear groundwater with rivulets and shallow pockets of surface water typify the hydrology of bog turtle wetlands, and subterranean tunnels with flowing water are used by bog turtles both in winter for hibernation and during the hot summer months. Deep, organic, mucky soils in which bog turtles can burrow are an important component of their habitat" (RR3, p 3-65). Pipelines near enough to springs to lower the water table could decrease the flow of necessary clear groundwater. It would not just be those within 150 feet of the pipeline, but could include springs supported by groundwater flow that has been diverted by preferential flow paths in the trench or blocked by the trench.
- A species of special concern in New Jersey, the American oystercatcher, could be affected by restrictions on the groundwater flow in its habitat (RR3, Appendix 3B-2).

Pipeline construction could affect hydrology in ways that could affect vegetation or aquatic life, in addition to the simple construction impacts. The application does not analyze how the pipeline would affect any specific area with important vegetation types or aquatic species. There are broad statements about temporary impacts during construction, but there no analysis of the change in groundwater flow patterns as described herein.

- PennEast should use the numerical and analytic analyses recommended in Section 3.2 to estimate the drawdown in the groundwater along pipeline reaches.
- PennEast should list areas with special vegetation that are near shallow aquifers that could be impacted by drawdown from the pipeline determine in the previous bullet.

[7] PennEast Pipeline Project, Wetland Delineation Report – Pennsylvania, February 3, 2016, p 1-6 through 1-9.

3.4 Contaminant Transport

The preferential flow analyzed in section 3.2 can also enhance the movement of contaminants into wetlands or streams. Consideration of contaminants in the application mostly relies on mitigation of spills and the location of the pipeline away from hazardous waste sites. RR2 Table 2.2-7 lists 13 sites that potentially have hazardous waste, but fails to note the type of waste. RR2 does not analyze the potential for the pipeline construction causing contaminants to be leached and transported to a nearby receptor. RR2 only states that hazardous waste encountered during construction will be handled in accordance with applicable federal law. However, it does not present a methodology for locating hazardous wastes, such as in sampling in advance of construction.

As noted above, there is also a reach with potentially acid producing soils, but RR2 does not analyze the potential transport of acid or acid-related contaminants due to pipeline construction. There is also no proposal for sampling acid soils before construction.

Methane leaks from the pipeline are a potential contaminant source due to the pipeline. RR2 suggests that leak detection would help to prevent such problem. The implication is that leak detection will prevent any problem, but there is no indication about the accuracy of such claims.

Mapping wells (RR2, p 2-9) or springs and streams (RR2, p 2-11) within 150 feet of the pipeline does not protect those water features because contaminants can easily flow far beyond that distance from the pipeline. This is particularly true where the trench intersects fracture zone or higher conductivity zones.

- The application should consider the transport of contaminants, either methane or spills, along the preferential flow pathways and assess where they would discharge. This could be into a stream or spring, or into a broader aquifer where it could affect wells. This could be done using the numerical or analytic calculation methods established in section 3.2. Because they are mapped, the analysis should include the areas with mapped hazardous waste sites.
- PennEast should disclose details about the pipeline leak detection. What rate of leak can be detected?
- PennEast should analyze the extent that methane could spread from the pipeline through the groundwater due to a leak. This is probably a preferential flow issue in that the methane would disperse along the higher conductivity in the trench until it reaches a receptive fracture intersecting the pipeline or wetland or stream.

4.0 CONCLUSION

The application for 401 certification is not complete because it does not include sufficient data or analysis of available regarding groundwater. Pipeline construction will affect groundwater recharge and flow, thereby affecting surface water flow and wetlands water balances. It can affect water quality by providing transport pathways for contaminants to reach wetlands or surface water. PennEast does not analyze any of these impacts as required by 25 Pa. Code § 105.15(e)(1)(x). Specifically, proposed project could affect “water quality” by transport contaminants into streams or nearby groundwater, “stream flow” by diverting groundwater or preventing recharge, “aquatic habitat” by decreasing flow during

baseflow conditions which would eliminate aquatic habitat, and "instream and downstream water use" by decreasing flow or contaminating it.

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February 26, 2014

Ms. Kimberly Bose
Federal Energy Regulatory Commission
Office of the Secretary
888 1st Street, NE
Washington, DC 20428

Re: Docket No. PF15-1-000: Comments Regarding PennEast Pipeline Project, Scoping Period

Dear Ms. Bose,

Attached please find an expert analysis of "need" for the PennEast Pipeline Project.

Arthur E. Berman, author of the attached analysis, is a Geological Consultant and Director of Labyrinth Consulting Services. Mr. Berman is a petroleum geologist with 36 years of oil and gas industry experience. Mr. Berman is an expert on U.S. shale plays, and has published more than 100 articles on oil and gas plays and trends.

Please accept this expert analysis for the record from the Delaware Riverkeeper Network.

Sincerely,

Maya K. van Rossum
the Delaware Riverkeeper

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February 26, 2015

Professional Opinion on the Proposed PennEast Pipeline Project

The PennEast Pipeline project proposal fails to adequately address need and volume requirements and, therefore, should not be approved unless these issues are adequately addressed. Based on current natural gas supply and demand, there is no apparent need for the gas that would be transported by the pipeline. If future demand is anticipated, this must be stated and explained clearly in the proposal. Assuming that need is shown, the proposal is vague about what portion of the approximately 1 billion cubic feet per day (Bcf/d) would be delivered to consumers in southeastern Pennsylvania versus New Jersey. It is also unclear whether there may be an intention not stated in the proposal to supply gas to markets beyond Pennsylvania and New Jersey.

Existing interstate pipelines provide all of New Jersey's natural gas demand and Pennsylvania is a net exporter of natural gas to other states so has no unfilled demand. Based on these facts about present supply and demand, it is not clear that a need exists for the PennEast Pipeline project.

Natural gas consumption for New Jersey has been relatively flat for the past four years at average rate of 1.8 billion cubic feet of gas per day (Bcf/d), somewhat below the higher levels of the late 1990s (Figure 1). Although consumption increased slightly in 2013 compared to the three previous years, New Jersey cannot be called a growth market as the proposal states. New Jersey gas supply is shown in Table 1. The small difference between supply and consumption is accounted for by processing and transportation loss, and compression needs.

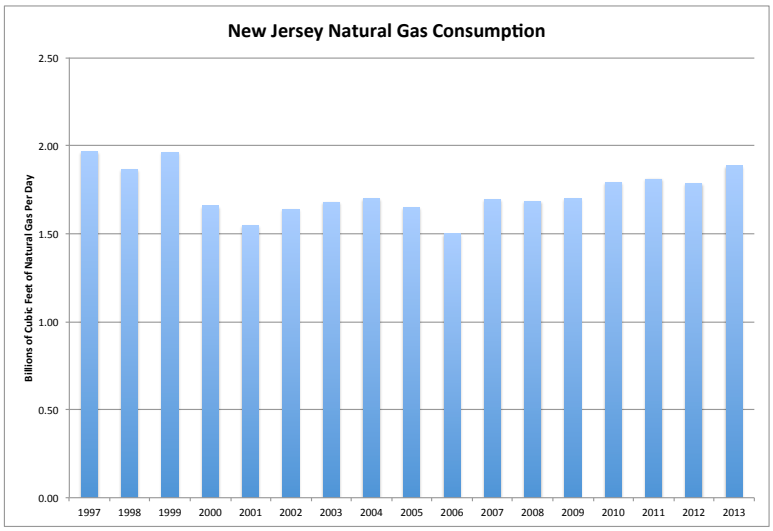


Figure 1. New Jersey annual natural gas consumption. Source: EIA.

Net Natural Gas Pipeline Deliveries

Bcf/d	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997
New Jersey	1.8	1.8	1.7	1.7	1.3	1.3	1.2	1.4	1.2	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.1	1.1
Pennsylvania	-2.8	-2.5	-1.6	-1.2	-0.2	0.0	0.0	-0.7	-0.3	0.0	0.0	0.0	0.0	-0.4	0.3	0.3	0.4	0.6

Table 1. New Jersey and Pennsylvania net natural gas deliveries by interstate pipeline. Source: EIA.

Pennsylvania natural gas demand has grown since the recent boom in Marcellus Shale production (Figure 2). At the same time, Pennsylvania has been a net exporter of natural gas since 2003 (Table 1). Pennsylvania exported 2.5 Bcf/d in 2013 and 2.8 Bcf/d in 2014. It must, therefore, be assumed that most if not all of the gas for the proposed PennEast Pipeline would go to New Jersey.

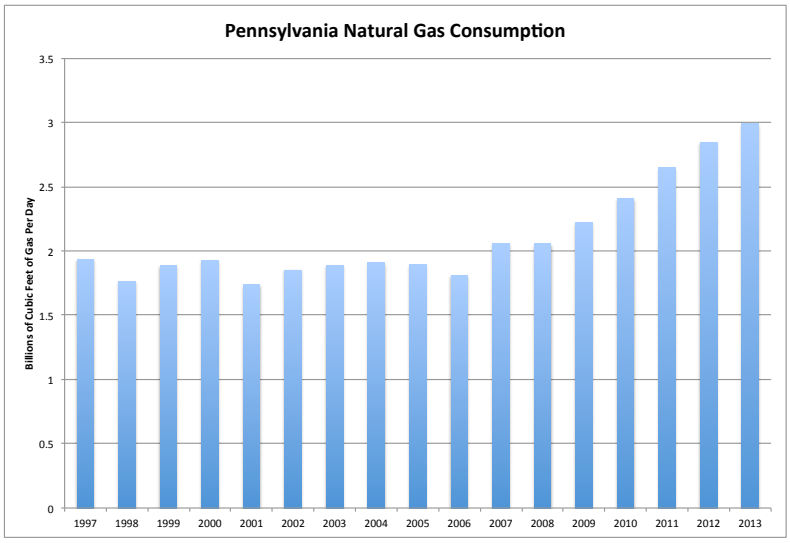


Figure 2. Pennsylvania annual natural gas consumption. Source: EIA.

Although PennEast discusses price competition and diversity of supply as positive potential outcomes for their proposed pipeline, they fail to address need. Additional future need for natural gas may exist as New Jersey moves away from heating oil and coal-fueled sources of electric power but these are not mentioned in the proposal.

The proposed PennEast Pipeline would deliver an additional 1 Bcf/d of natural gas to New Jersey potentially creating a 53% supply surplus above the current level of consumption. Assuming that PennEast can demonstrate some need, it is unclear why 1 Bcf/d of additional supply is warranted or appropriate particularly in light of the considerable property and environmental issues that construction will entail. If PennEast intends to supply additional markets outside of New Jersey, there is no mention of this in the proposal.

Marcellus Shale production today can only be described as an epidemic of over-production. When the play began in earnest in 2005, the northeastern United States relied on pipeline gas deliveries from the Gulf Coast. At that time there was a positive differential relative to Henry Hub pricing. As production has increased, the northeastern gas market is near saturation and spot prices are presently at a negative differential of about -$1/ million cubic feet compared with the Henry Hub.

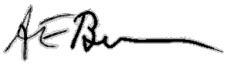
The over-supply from the Marcellus Shale is expected to increase as more wells are drilled. The only relief for producers is to export gas outside of Pennsylvania via new pipelines and by reversing flow in existing pipelines. The plan to export gas to New Jersey benefits producers who have consciously destroyed value in Pennsylvania by providing them with additional markets for their gas. It is unclear if there is any benefit to the public. Although it is certainly the right of mineral owners to over-produce natural gas at a loss if

they choose to and can justify it to shareholders, it is unclear why FERC should grant them the means to remedy the unfavorable price environment that they have deliberately brought upon themselves.

Because of the lack of demand for Marcellus gas in Pennsylvania and adjacent New Jersey, it is possible that PennEast and its committed suppliers have an unstated intent to send gas to other markets not specified in their proposal including the Cove Point LNG export facility in Maryland. Although much has been made of the supposed profitability of LNG export based on the price arbitrage between North America and Europe and East Asia, these claims fail to address the cost of liquefaction and trans-ocean transport.

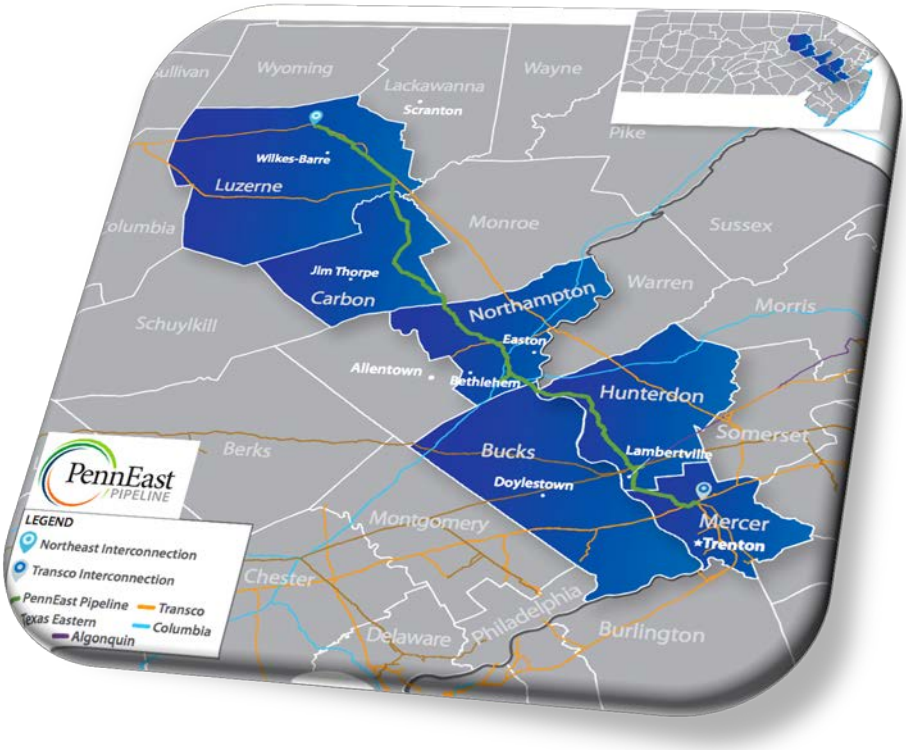
The best case for LNG export from a brown field export terminal like Cove Point yielded marginally economic outcomes before the recent drop in oil prices. Since most LNG contracts in Europe and Asia are based on crude oil-price linkage, lower oil prices now make LNG export sub-commercial.

In summary, the proposed PennEast Pipeline project should not be approved because need has not been demonstrated. If need can be shown, the proposed 1 Bcf/d volume must be justified.



Arthur E. Berman
Petroleum Geologist

Analysis of Public Benefit Regarding PennEast Pipeline



Author: Greg Lander

For

The New Jersey Conservation Foundation

SkippingStone

www.skippingstone.com

March 9, 2016

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Skipping Stone is an energy markets consulting firm that helps clients navigate market changes, capitalize on opportunities and manage business risks. Our services include market assessment, strategy development, strategy implementation, managed business services and talent management. Market sector focus areas are natural gas and power markets, renewable energy, demand response, energy technology and energy management. Skipping Stone's model of deploying only energy industry veterans has delivered measurable bottom-line results for over 270 clients globally.

Skipping Stone operates Capacity Center which is a proprietary technology platform and data center that is the only all-in-one Capacity Release and Operational Notice information source synced with the Interstate pipeline system. Our database not only collects the data as it occurs, it is a storehouse of historical Capacity Release transactions since 1994. We also track shipper entity status and the pipeline receipt and/or delivery points, flows and capacity. Our analysts and consultants have years of experience working in natural gas markets. Capacity Center has worked with over a hundred clients on a wide variety of natural gas market and pipeline related reports and projects.

Headquartered in Boston, the firm has offices in Atlanta, Houston, Los Angeles, Tokyo and London. For more information, visit www.SkippingStone.com.

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Executive Summary

In evaluating the PennEast application, FERC Commissioners will seek to determine whether the application to build new pipeline capacity provides evidence of public benefit. This study evaluates a central claim in the application – that PennEast will lower costs to consumers. This analysis also examines unserved demand for firm capacity and evaluates two alternatives for meeting peak demand needs of electric generation customers, thereby ensuring reliability of electric generation.

Our major conclusions are as follows:

1. **Local gas distribution companies in the Eastern Pennsylvania and New Jersey market have more than enough firm capacity to meet the needs of customers during peak winter periods.** Our analysis shows there is currently *49.9% more capacity than needed to meet even the harsh winter experienced in 2013 (the Polar Vortex Winter)*[1].

2. **Providers of gas-fired electric generation can meet their need for electric reliability more cost-effectively by using either dual fuel or natural gas from LNG facilities.**

   Natural gas pipelines are typically fully utilized between 10 and 30 days a year. Building a pipeline that is only fully utilized for a short period of time is not a cost-effective way to provide reliable electricity. Electric generation customers prefer to purchase supplies using interruptible contracts[2], knowing that they may not be able to obtain gas supplies during peak demand periods. Under pressure to improve electric reliability, such customers now have to choose between contracting for firm supply from new pipeline capacity, such as PennEast, or choose an alternative to natural gas. A common alternative is to switch to oil-fired generation when natural gas is not available; a second is to purchase natural gas from LNG facilities.

   Based on our analysis of alternative costs, an electric generator would bear a higher fixed cost burden by choosing to meet peak demand through firm pipeline capacity and would be economically better off choosing oil or LNG for the few days each year of high electric demand.

3. **PennEast will add significant excess capacity to the market in Eastern Pennsylvania and New Jersey.** Shippers representing almost 40% of capacity stated in the application that they intend to shift their gas supplies from existing competitor pipelines to PennEast, leaving excess and unutilized capacity on other pipelines.

4. **The impact of PennEast may well be to increase, rather than decrease, costs to gas customers. Analysis shows that rate-paying consumers of local gas distribution companies (LDCs) bear the greatest risk of increased costs regardless of whether they are on PennEast or competing pipelines.** Customers of the LDC shippers subscribing to PennEast will pay the full cost of annual service for only

[1] Concentric Energy Advisors' (Concentric) report for PennEast used peak sendout figures for this period.
[2] Interruptible transportation contracts are contracts under which no fixed charges are incurred, rather charges are only incurred when and to the extent the contract is actually used to deliver gas.

a few days of effective usage per year. Customers served by LDCs on competing pipelines are likely to suffer financial losses in two ways. First, as PennEast adds 1 billion cubic feet per day of capacity to the market, the value of existing capacity in the secondary market will collapse, shrinking by as much as 50 to 90%. Our analysis of transactions on two competitor pipelines shows that the loss of benefit to ratepayers, just on those two pipelines, could be between $130 to $230 million each year. Second, as customers shift contracts from existing pipelines to PennEast, FERC rules permit those pipelines to file for rate increases on remaining customers to recover lost revenues. Resulting rate increases could expose ratepayers to additional costs of over $50 million per year – just on these two pipelines.

5. **PennEast claims of potential savings for gas consumers or electric generation customers are based on faulty assumptions and analysis.** The price spike experienced during the Polar Vortex is unlikely to be repeated and does not alone justify the addition of new pipeline capacity. PennEast claimed benefits that are not based upon future projections of gas prices and do not take into account 8.1 billion cubic feet per day of infrastructure scheduled to ramp up in 2017. PennEast does not address evidence that similar price spikes did not occur in Winter 2014/2015 or the introduction by PJM and NEISO of important Supply Assurance Programs that reduce dependence on constrained natural gas pipelines during peak demand periods.

6. **FERC should not rely on non-arms-length transactions as a foundation for finding market need.** Owners of PennEast contracted for 74.2% of total capacity. FERC Commissioners have a special responsibility to protect rate-paying customers. For PennEast, 38.9% of the capacity is held by local gas distribution companies whose parent firms will benefit from their ownership of PennEast, and whose customers – rate-payers – are at risk of paying for unneeded capacity for 15 years.

7. **In the case of PennEast, the precedent contracts signed by local distribution companies are not arm's length and should not be relied upon for a finding of public convenience and necessity.**

8. **The Commission should institute a full evidentiary proceeding with discovery and cross-examination to determine what demand is being met by the proposed pipeline and whether less disruptive and more cost effective alternatives exist to meet such demand.**

Section I – Study Overview

Skipping Stone was asked to review the proposed PennEast Pipeline and provide its opinion of the potential utilization of the incremental capacity into the geographic region, and what that might mean for electric generation customers. Understanding that the choice faced by electric generation firms would require an analysis of the cost and benefits of purchasing firm capacity on a new pipeline compared to other options, we also provide indicative cost-benefit analyses of two alternatives. Skipping Stone was also asked to examine possible financial motivations of the Sponsor/Shippers of PennEast as an alternative explanation for the purpose of the project.

This review is based on our examination of documents from the PennEast Pipeline LLC FERC Certificate Application CP15-558 and publicly available natural gas industry data and documents.

The application makes a number of assertions about the project purpose as follows:

> "to bring lower cost natural gas produced in the Marcellus Shale region in eastern Pennsylvania to homes and businesses in New Jersey, Pennsylvania, New York and surrounding states."
>
> "…with the additional pipeline capacity, energy consumers throughout eastern Pennsylvania and New Jersey would have realized over $890 million in reduced energy costs in the winter of 2013-2014…. Further, without additional natural gas infrastructure providing the region increased access to the abundant dry natural gas reserves located in the eastern Pennsylvania production area, similar price spikes and correspondingly, the potential savings offered by the PennEast Project, could be anticipated in the future. Thus, the PennEast Project is expected to bring annual energy cost savings and significant economic benefits to the Pennsylvania and New Jersey economies."

The assertion that PennEast will produce <u>annual energy cost savings</u> requires looking at a number of salient factors, including:

1) What is the demand that PennEast is purporting to serve, is there unmet demand for year-round, firm capacity in the subject region, and related to that, what would be the utilization rate of such incremental capacity into the subject market.[3] And at such utilization rate, what would be the effective per-unit cost of such incremental capacity at indicative utilizations?
2) Is firm, year-round capacity a cost-effective solution to meet electric generation customers' needs during peak winter periods?
3) What might be offsetting costs to any potential savings?

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[3] In this regard, Skipping Stone assumes that the utilization rates of other lines serving the subject market are or remain the same and that utilization of the PennEast line comes from displacement of peak-shaving resources and electric generation. Even if PennEast were to be higher utilized than the estimated utilizations used in this memorandum, such higher utilization of PennEast would come at the expense of utilization of other pipelines serving the market. Thus, for economic analysis of the effective per unit cost of the added capacity, Skipping Stone assumes for these purposes that in the aggregate, PennEast would serve load unmet by existing natural gas pipelines (i.e., load met by LNG, or oil-fired electric generation).

4) Are the potential savings predicated on repeats of unusual circumstances?
5) Have there been developments in electric and gas markets subsequent to the filing of the PennEast application which undermine the assumptions that must be made in order for there to be future savings associated with the incremental capacity proposed to be provided by PennEast?
6) In light of potentially questionable demand, what financial motives might underpin the Sponsor/Shippers' decision to seek permission to construct a new natural gas pipeline.

Section II – Unserved Demand for Pipeline Capacity and Analysis of Cost-Effective Alternatives

Can LDCs Meet Needs for Firm Pipeline Capacity?

To evaluate whether current pipeline capacity is sufficient to meet current and future demand from LDCs and other customers requiring firm capacity in the Eastern PA, NJ region, it is important to identify the Peak Day demand from LDCs in the region and compare it to Total Peak Day Resources available in the region. The Concentric Energy Advisors report, sponsored by PennEast, fails to examine actual pipeline contracts and available resources to meet peak demand in determining whether PennEast is, in fact, needed to meet peak demand.

We utilized information provided by Concentric about LDC demand in the region from Table 2: "Eastern Pennsylvania and New Jersey LDC Summary Operating Statistics."[4] Information for each LDC is reproduced below in Table 1 as columns (a), (b), (c), and (d) representing Local Distribution Companies (LDCs), Number of Natural Gas Customers, 2013 Retail Sales Volumes (Mcf) and Peak Day Sendout (Mcf), respectively.

To properly calculate current Peak Day Resources it is important to include not only LDC held pipeline capacity and LNG sendout capability, but to also include winter pipeline subscribed capacity levels of retailers[5] serving load in eastern PA and NJ, end-users and electric generators with contracts to locations in the same geographic area[6] and capacity held by producer marketers into this same geographic area[7]. Rows 13 and 14 provide the contracted winter pipeline capacity for these two categories of pipeline capacity holders. For both

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[4] Sources: EIA Form 176, Annual 1307(f) Filing materials, State LDC Filings, and information provided by LDCs.

[5] Here, retailers are those marketers that explicitly serve residential and commercial load in the geographic area and have pipeline FT contracts with firm primary delivery points in the subject geographic area. Note these entities can be distinguished from wholesale Producer-Marketers because these retailer entities in these markets and others have capacity releases from LDCs that carry the indicator that they are serving retail load under one or another "retail choice programs" of LDCs.

[6] With respect to electric generators' capacity, Skipping Stone excluded subscribed winter pipeline capacity level contracts that were for lateral capacity only as these lateral capacity(ies) only entitle the electric generators to move gas under these agreements from one end of the lateral to another.

[7] This type of capacity contract is often referred to as "producer-push" capacity where the capacity comes into the geographic area often (but not always) to pooling points from which it can be purchased for delivery to actual delivery locations within the geographic area.

categories, note that capacity held by shippers to New York points or to pipelines leaving New Jersey, such as Algonquin, was excluded.

We include additional information in columns (e)[8], (f) and (g).

- Column (e) shows these same entities' 2015 Contracted Winter Pipeline Capacity levels in their eastern PA and NJ service locations[9]
- Column (f) provides publicly available LNG vaporization capacity in the same geographic area (including proposed) and
- Column (g) shows Total Peak Day Resources (which is the total of columns (e) and (f))[10]

Table 1. Analysis of LDC Demand in Eastern Pennsylvania and New Jersey

	(a)	(b)	(c)	(d)	(e)	(f)	(g)
		No. of Natural Gas Customers	2013 Retail Sales Volumes (Mcf)	Peak Day Sendout (Mcf)	2015 Contracted Winter Pipeline Capacity	2015 LNG Vaporization (Mcf)	2015 Total Peak Day Resources
	Eastern Pennsylvania						
1	UGI Utilities	357,408	116,675,523	654,050	494,607	202,500	697,107
2	UGI Penn	163,796	56,733,872	416,488	218,490	0	218,490
3	PGW	498,694	73,229,988	616,000	304,892	225,000	529,892
4	PECO	498,843	85,834,449	759,594	551,834	161,700	713,534
5	Subtotal	1,518,741	332,473,832	2,446,132	1,569,823	589,200	2,159,023
	New Jersey						
6	PSEG	1,790,240	453,524,804	2,973,000	1,894,994	64,000	1,958,994
7	NJNG	501,595	67,616,570	690,415	525,604	170,000	695,604
8	SJG	359,732	58,997,922	495,056	404,871	75,000	479,871
9	SJR Proposed					250,000	250,000
10	Elizabethtown	278,871	52,732,119	440,148	302,435	24,000	326,435
11	Subtotal	2,930,438	632,871,415	4,598,619	3,127,904	583,000	3,710,904
12	Concentric Regional Total	4,449,179	965,345,247	7,044,751			
13	Retailers, End-Users & Power Gen w- Eastern PA & NJ Capacity				940,095	0	940,095
14	Producer/Marketers w-Eastern PA & NJ Capacity				3,748,500	0	3,748,500
15	Regional Totals			7,044,751	9,386,322	1,172,200	10,558,522

[8] Skipping Stone used 2015 Winter Contracted Capacity because this is the level of capacity to which the PennEast capacity is additive. In addition, it represents the level of capacity that exists (and would exist) absent PennEast and that would be utilized to meet repetitive peak send-outs of the magnitude of those experienced in 2013.

[9] Note that Skipping Stone excluded from such subscribed winter pipeline capacity level contracts that were for lateral capacity only as these lateral capacity(ies) do not entitle the entity(ies) to receive more gas but rather are means of moving gas under these agreements from one end of the lateral to another.

[10] Note that Skipping Stone did not include propane-air resources of any of the entities in the Total of Peak Day Resources.

The above analysis shows that currently subscribed pipeline capacity alone exceeds the Concentric identified entities' peak day sendout by over 33% (Line 15 column (e) divided by Line 15 column (d)). Including these entities' LNG resources increases deliverability resources to 10,558,522 (Mcf per day). The purpose of LNG resources is to provide a local distribution company with additional supplies during peak demand periods that are more cost-effective than the purchase of additional firm pipeline capacity. In total, there are 49.9% more resources available to meet peak day demand from local gas distribution companies in the region than is needed, according to Concentric's own demand data (Line 15 column (g) divided by Line 15 column (d)).

If PennEast is not needed to supply the needs of LDCs in the region, then is the additional supply of 1 billion cubic feet per day of pipeline capacity actually necessary, and for what purpose?

Is Firm Pipeline Capacity Cost-Effective for Electric Generation Customers?

The Concentric study analyzes demand for electric generation, which is typically provided either by contracts for interruptible capacity or by means of bundled (transportation capacity and gas) sales at the generators' delivery points out of the gas network[11], rather than by generator-held contracts with pipelines for firm capacity. That said, the report nevertheless argues that additional capacity is needed for electric generation and to prevent "price spikes."

The period of greatest demand for natural gas is that period of "coincident demand," when gas demand for home heating (provided by LDCs) and for electric generation are both high. In the eastern PA, NJ region coincident demand occurs during winter cold spells. If the demand that PennEast might serve is the coincident demand of natural gas for heating and electric generation in the winter-period, then one has to ask two related questions:

- What is the duration of this coincident demand?
- What is the most economical means of meeting such coincident demand?

Recent studies by EISPC, ICF, ENERGYZT and Skipping Stone[12] have all identified that the period of this coincident demand is from 10 to 30 days, and may increase to 45 days by 2020 and 60 days by 2030. The following analysis calculates the cost of capacity for 10, 20 and 30 days, and includes calculations for 45 and 60 days for completeness.

Is Dual Fuel a Cost-Effective Alternative?

To assess the most economical means of meeting this very short period of peak-period coincident demand, we compare the costs of relying on firm pipeline capacity with a well-known alternative, the use of dual fuel for electric generation. First, we calculate the cost of providing

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[11] These delivery points out of the gas network are either at direct-to-plant pipeline points or are points on LDC systems where the generator can receive gas from the LDC.

[12] EISPC "Study on Long-Term Electric and Natural Gas Infrastructure Requirements in the Eastern Interconnection" September 2014
ICF "Options for Serving New England Natural Gas Demand October 22, 2013
ENERGYZT "Analysis of Winter Reliability Solutions for New England Energy Markets August 2015
Skipping Stone "Solving New England's Gas Deliverability Problem using LNG Storage and Market Incentives" September, 2015

pipeline capacity that is fully utilized only between 10 and 60 days per year. We then compare this cost with the equivalent cost of using fuel oil rather than natural gas. This analysis also assumes that because the pipelines in the subject geographic area are fully subscribed from their production locations to their market locations, then electric generation customers, to get such capacity for natural gas during coincident peak demand days, would require incremental firm pipeline capacity that cannot be interrupted during such periods of peak demand.

The all-in cost is the effective cost to a power generator reserving capacity year-round[13] that is only needed from 10 to 60 days per year[14]. To illustrate, Skipping Stone provides the analysis shown in Table 2. This analysis is based on two assumptions that can be adjusted: The 100% Load Factor Pipeline Cost (assumed to be $.50/Dth/Day); and the Winter Gas Cost (using the estimated 2019/2020 winter gas cost published by NYMEX in Feb-2016).

Table 2. Analysis of All-in Cost of Capacity

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
100% Load Factor Pipeline Cost	Days Per Yr	Annual Cost/Dth /Day of Capacity	Equivalent Days of 100% load Factor Use /Yr	Cost of Pipeline Capacity per Dth used	Winter Gas Cost	All-in Delivered Cost per Dth used	Dth/Gal	Equivalent $/Gal
$0.43	365	$156.95	10	$15.70	$2.90	$18.60	0.139	$2.58
$0.43	365	$156.95	20	$7.85	$2.90	$10.75	0.139	$1.49
$0.43	365	$156.95	30	$5.23	$2.90	$8.13	0.139	$1.13
$0.43	365	$156.95	45	$3.49	$2.90	$6.39	0.139	$0.89
$0.43	365	$156.95	60	$2.62	$2.90	$5.52	0.139	$0.77

Calculation of All-in Comparative Costs for Fuel Oil

How does the total cost of using natural gas to meet peak load, available only through year-round firm capacity, compare with the cost of using No.2 fuel oil?

First, we evaluate the cost of contracting for firm pipeline capacity for a given number of peak days. Column (c) shows the annualized cost per Dth per day of capacity[15]. Column (d) varies

[13] This same all-in cost calculation would also apply to an LDC displacing some amount of LNG vaporization capacity with year-round pipeline capacity. This occurs when the LNG vaporization and LNG storage capacity is utilized to an extent such that it makes economic sense to add an increment of pipeline capacity and then "grow into" that pipeline capacity again relying on LNG for needle peaks until overall load growth and winter period demand once again makes anther incremental pipeline capacity addition economical..

[14] The reason that such capacity may only be needed by a power generator from 10 to 60 days per year is that there is sufficient otherwise un-used existing capacity all but those days when the coincident demand from electric generation and heating load exceeds existing pipeline capacity. See also Concentric report Page 18 where it discusses price spikes when demand is greater than 8 Bcf/d into the subject market which according to Figure 11 on page 17 occurred some 15 times during the Polar Vortex winter of 2013/2014.

[15] The annual cost per Dth per day presents what the cost for one Dth on one day would be if one Dth per day of capacity was reserved for a year and only used on one day to receive the one Dth.

the number of equivalent days of 100% load factor, or days of peak usage. Ten days of full use is equivalent to 5 days of full use and 10 days of 50% use. The all-in cost of capacity per Dth (assuming a cost of $0.43 per Dth per day of reservation and 10 days of use during times of peak load) has an effective capacity cost of $15.70 per Dth used. At 30 days of peak load, the all-in capacity cost drops to $5.23. To calculate the all-in cost of use, we add the cost of gas during the winter period, $2.90 per Dth, for a total delivered fuel cost of $18.60 per Dth used.

Column (i) shows the price per gallon for fuel that results in an equivalent cost per Dth for the natural gas alternative. For peak demand of 10 days, the natural gas alternative would be the lower cost alternative if the cost of No.2 fuel oil is $2.58 per gallon or higher, equivalent to $108.56 per barrel of oil. For peak demand of 30 days, the natural gas alternative would be the lower cost alternative if the cost of No.2 fuel oil is $1.13, equivalent to $47.47 per barrel of oil.

It should be noted that this 10 to 60 days of peak demand analysis is for illustrative purposes to show that even a pipeline that has a daily transportation rate of as little as 43 cents can result in very high effective costs in use unless it is utilized much more than 60 days – i.e., the existing gas system is constrained on that many or more days.

Based on this basic analysis of alternative costs, one can readily see that it is highly unlikely that a generator will choose to bear the fixed cost burden of the pipeline capacity and would be economically better off choosing oil as fuel during the few days of coincident demand each year.

Calculation of All-in Comparative Costs for LNG

In addition to the oil alternative, securing additional LNG deliveries at locations downstream (i.e., north and east) of the NJ/PA demand centers, as well as from existing LNG facilities within the NJ/PA geographic area cited by the Concentric report, are likely to be even less expensive as a supply alternative. Of note here, any additional LNG that is vaporized at Northeast LNG facilities, such as Eastern MA or New Brunswick, Canada, can make supplies traveling to the Northeast on various pipelines available instead for delivery into the NJ/PA region. This is because the LNG resources would physically serve the New England market thereby enabling supplies otherwise bound for New England to remain in the NJ/PA market and serve demand there. As a result, additional capacity would become available on one or more of the major pipelines connecting the NJ/PA demand centers to New England, such as Texas Eastern, Transco, Tennessee or Columbia to Algonquin (or Maritimes and Northeast).

Because of the current substantial excess of worldwide LNG, future LNG supplies are currently priced at $6.00 to $8.00 per Dth vaporized into New England markets. At these prices, LNG supplies are likely to clear the market lower than the above modeled oil prices in Table 2. Customers can arrange LNG supplies in advance of the winter period and ensure that the inventory is either in the LNG tanks or on the floating storage and regasification ships during the winter period. LNG inventory is arranged in advance in much the same way as pipeline capacity is reserved in advance, except subscription terms are typically year to year and for use of existing facilities do not require multi-year commitments.

Section III – Potential for Increased Costs to Captive Customers on Competing Pipelines

The FERC Commissioners are concerned with protecting consumers from excessive rates. We analyzed the potential impact of additional capacity on captive customers of competing pipelines with particular regard for the likely impact on rate-payers. Shippers who own capacity on competing pipelines are likely to suffer two negative impacts, or offsetting costs, as a direct result of the addition of the substantial 1 Billion cubic feet per day incremental capacity proposed by PennEast.

Shippers will encounter two sources of increased costs:

1) As the total supply of capacity increases, the value of secondary market capacity is likely to decline, particularly if demand is largely unchanged over the vast majority of the year (i.e., all but the highest 10 – 60 demand days per year).[16] Thus, shippers who own existing pipeline capacity and seek to resell unused capacity into the secondary capacity market **will suffer a loss of value**.

2) Non-renewal or turnback of subscriptions on existing lines could lead to cost-shifting to captive customers of such lines at the next rate case. The risk of non-renewal is significant, as several PennEast Shippers stated in the PennEast application that they plan not to renew portions(s) of their existing legacy capacity portfolios. In addition, other shippers may find that they are able to rely on excess capacity as a consequence of the addition to the market of the PennEast capacity and also choose to not renew. The revenue lost from such turnbacks will ultimately be re-distributed to the pipelines' remaining shippers.

What is the Impact of PennEast on Secondary Market Capacity Values?

Since there is no evidence of significant increased demand for the 40% of capacity purchased for in-state New Jersey use, the increased supply from PennEast will add to the total supply of pipeline capacity in the region and lead to significant underutilized capacity.

The secondary market enables shippers to find buyers for their unneeded capacity by means of either capacity release transactions and/or Asset Management Agreements[17] (AMAs). As a result of excess capacity, secondary market values related to capacity release and AMAs could drop dramatically.

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[16] The reductions in secondary market values impact any firm capacity holder with a less than 100% load factor use of their capacity which sells their unused capacity to others during period of low use. These secondary market purchasers pay the capacity holder for their firm rights. To the extent a particular geographic area is flooded with new capacity, the secondary market values drop to near zero because the supply greatly exceeds the demand. Specifically, it is generally LDCs that sell unused capacity and use large percentages (usually 80% or more) of these secondary market revenues to reduce rates paid by their firm sales customers (ex. residential and commercial customers).

[17] Asset Management Agreements are agreements where a purchaser agrees to provide capacity management services (and often gas supply) and pay the holder of firm capacity often large sums of money to gain control of their capacity in return for agreeing to use a limited amount of that capacity to meet the needs of the selling party while using the balance to make other sales to other parties. These AMAs are effectuated through capacity release transactions in the secondary market.

In particular, for the purposes of this memorandum, Skipping Stone studied capacity release transactions[18] on two pipelines in the subject geographic area: Texas Eastern Transmission (TETCO) and Transcontinental Gas Pipe Line (Transco). The period studied was 2015. The transactions analyzed were those where the capacity terminated in the same eastern PA and NJ geographic area as that discussed in the Concentric study for PennEast.

Skipping Stone found for these two pipelines that the value of traded capacity was in excess of $250 Million in 2015. The aggregated dollars, quantities and average rates for the two lines' 2015 transactions are set forth in the two tables that follow.

Table 3. Texas Eastern (TETCO) Traded Capacity[19]

TETCO 2015 Capacity Release Quantities, Rates and Value			
Eastern PA and NJ locations	**Annualized Daily Equivalent Traded (Dth)**	**Avg Rate per Dth/Day**	**Dollars Realized 2015**
From M2 and into M3	1,398,127	$0.3415	$174,292,476

[18] The transaction types studied were releases from capacity holders to acquiring shippers that were done outside of those done to enable retail choice. Under retail choice many LDCs release capacity at pipeline maximum rates (regardless of capacity values) to marketers that have contracted to serve firm customers on the LDCs' systems. These transactions do not reflect competitive pipeline capacity market conditions and therefore were eliminated so as not to overstate the value of released capacity in the subject markets. In addition, in those cases where no price was provided under an AMA transaction, the average price for the similar capacity was used.

[19] TETCO presents the values of their trades on a segment and point basis so Skipping Stone provided just the segment values (i.e., the values of capacity to get gas into M3 which is the eastern PA and NJ zone from the adjacent M2 area which is the western PA and OH zone) as those would be the values most impacted by an incremental 1 Billion Cubic feet (1,000,000 Dth/d) of capacity into their M3 zone serving eastern PA and NJ. Transco on the other hand reports the values for their trades on a point-to-point basis so the value of getting to a market area point from supply areas is that which would be impacted.

Table 4. Transcontinental Gas Pipe Line (Transco) Traded Capacity

Transco 2015 Capacity Release Quantities, Rates and Value				
ST	County of Delivery	Annualized Daily Equivalent Traded (Dth)	Avg Rate per Dth/Day	Dollars Realized 2015
NJ	Camden	2,000	$0.3050	$222,650
NJ	Essex	215,924	$0.1761	$13,879,181
NJ	Gloucester	104,589	$0.1430	$5,459,521
NJ	Mercer	208,184	$0.3453	$26,238,007
NJ	Middlesex	264,000	$0.2130	$20,524,680
NJ	Union	1,274	$0.0200	$9,300
PA	Monroe	152,459	$0.2553	$14,204,015
PA	Montgomery	167,962	$0.1135	$6,958,227
PA	Philadelphia	42,691	$0.1683	$2,622,767
Totals and Average		1,159,083	$0.2130	$90,118,348

Within the subject market area, the Annualized Daily Equivalent Traded[20] quantity on the two pipelines was approximately 2.55 Billion cubic feet per day. The impact of adding another 1 Billion cubic feet to the same market, an amount roughly equivalent to a 40% increase in regional capacity, would likely crush these values; potentially by as much as 50-90% depending on time of year and other factors. Thus, the PennEast pipeline is likely to put at risk the value of existing capacity, which recently traded for $260 Million per year in secondary market transactions. The greatest volume of existing capacity is held by local gas distribution companies, and ratepayers receive 80% of the value of such resale transactions. These ratepayers are captive customers of the LDCs served by existing pipelines and would suffer a significant financial loss if excess capacity were to be approved by FERC Commissioners.

Notably, this loss of benefit to ratepayers in the subject market would be experienced every year and we estimate could be between $130 Million and $230 Million, or averaging $180 Million each year until such time as the regional demand increase sufficiently to make use of the incremental capacity.

What is the Impact of Non-Renewals of Subscribed Capacity on other Pipelines?

With the addition of the incremental capacity associated with PennEast into the subject market, shippers with contracts expiring in the near to medium term (3 to 10 years from now) would be able to either forgo renewal and rely on the existence of the capacity or be able to negotiate substantial discounts.

[20] Annualized equivalent means if there were two trades, one of 1,000 Dth/d for a year and another for 365,000 Dth/d for a day, the Annualized Daily Equivalent of each would be 1,000 Dth/d and the total of the two would be 2,000 Dth/d.

We evaluate the potential impact of non-renewals on customers of Texas Eastern (TETCO) and Transco pipelines. The rates on TETCO and Transco for capacity to Eastern PA and NJ run on average between $0.52 and $0.67 per Dth/day. To illustrate, we calculated the impact if half of PennEast capacity, or 500,000 Dth/d, were to go unsubscribed on existing pipelines. At the average of the two rates above (~$0.595), the result would be a loss of over $108 Million per year between the two pipelines.

FERC rules permit affected pipelines to file for rate increases on remaining customers to seek to recover lost revenues. This could mean that the same ratepayers facing a potential loss of secondary market benefits could see a substantial portion of the costs of a rate increase as well. Moreover, like the cost of lost secondary market benefit, the cost of increased rates would be a cost they would bear every year.

Even if Pennsylvania and New Jersey ratepayers were forced to absorb **only half** of the potential lost revenues of $108 Million, this conservative estimate shows that ratepayers could be asked to pay an additional $50 Million a year.

Section IV – Factors that Diminish Possible Future Savings Suggested by Concentric

Are Potential Savings Due to a Repeat of Polar Vortex Circumstances Likely?

Concentric cites the 2013/2014 market disruptions coincident with the Polar Vortex as a measure of savings that could have been realized had PennEast been in service at that time.

Concentric appears to be justifying the build of a pipeline purely on the basis of a past price experience, one that notably did not occur in either the 2014/2015[21] nor in prior winters. So, the likelihood of reoccurrence is lower than assumed by Concentric. Concentric should, in any case, reduce their estimate of "potential savings" based on the likelihood of a reoccurrence of the conditions that would create such savings.

Furthermore, any calculation of potential savings should also include potential additional costs that would be borne by ratepayers holding capacity on competing pipelines. The costs, as calculated above, could range from $180 to $280 Million a year (averaging possibly $230 Million a year).

In addition, potential savings are reduced or even wholly eliminated as additional pipeline capacity comes online. Several other projects are slated to come on line before or around the same time as PennEast might come on line. If this occurs, the price depression facing producers with trapped gas supplies will largely be or have been abated. As recently reported by Barclays Bank[22], "Almost 8.1 Bcf/d of infrastructure in the Northeast region has been fully subscribed and is scheduled to ramp up in 2017." Barclays goes on to state "[m]ost of the 2017 pipeline projects are in the southwestern portion of the Marcellus and Utica shales[23], which potentially could strengthen price points," meaning that once the trapped production has outlet to market, the currently favorable pricing will dissipate, if not fully evaporate.

Pipelines should be planned to address longer-term conditions and trends, rather than as a response to a single event, since planning and construction of pipeline capacity takes several years. In order to have been in service by the winter of 2013 PennEast would have had to have started its development process somewhere around the 2008/2009 period. The gas price situation at that time was wholly different from the price situation today, and five years from now the price situation will be wholly different from today's, with or without PennEast.

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[21] Notably the winter of 2014/2015 was colder and had colder days than the Polar Vortex winter of 2013/2014.

[22] See Natural Gas Intelligence March 03, 2016 "Barclays Reduces 2016 NatGas Price Outlook and Sees Breakout in 2017"

[23] These projects largely involve east to west capacity additions and pipeline flow reversals to the south and west. This means that these now trapped supplies will soon have choices of markets and will flow to the most favorably priced market, whereas absent these additions, producers have few choices and compete with one another to gain access to the limited NE market, namely the subject geographic area identified by Concentric.

Are Potential Savings Impacted by Recent Electric Market Reforms?

In the past two years, both PJM and NEISO have instituted market rules which heavily incentivize generators to have fuel during peak critical periods[24]. Skipping Stone will refer to these market rule changes as "Supply Assurance Programs."

Notably also, in the short-run NEISO has instituted its Winter Reliability Program where it pays generators to have fuel oil and/or LNG in tanks ready to be used to assure such critical winter period fuel supplies are available for generation. In New England this has had the effect in both of the past two winters (2014/15 and 2015/16) of greatly dampening price spikes. In turn, price spikes in the subject geographic area have also been dampened, as the pipelines running through eastern PA and NJ also either continue north and east or supply pipelines running into New England.

Under the Supply Assurance Programs, both PJM and NEISO have auctions that create price signals and payments to generators. While significant dollars are to be paid to generators under these Supply Assurance Programs, they are amounts that are far short of amounts required to cover year-round firm transportation on interstate pipelines. As a result, anecdotally and to Skipping Stone's knowledge, gas-fired generators have either opted to install dual fuel capability, arrange for peaking LNG supplies, or make firm supply call arrangements with large wholesale players to backstop their commitments.

The likely ongoing impact of these developments is that the scrambling for supply that led to the enormous price spikes experienced during the period covered by the Concentric report are much less likely to occur in the future. Thus, it is increasingly likely that price spike avoidance, a claimed attribute of a proposed PennEast Pipeline, has in large part already, and enduringly, been addressed. To the extent, then, that the potential for future price spikes have been largely avoided by such market rule changes, the supposed benefits from such avoidance have already been realized – without the proposed presence of PennEast to do so.

[24] In PJM this market rule change is known as "Capacity Performance" and in NEISO the market rule change is referred to as "Pay for Performance".

Section V – Weak Public Benefit but Strong Financial Incentives

Given the lack of evidence from the LDC Sponsor/Shippers of their systems' load growth, as well as certain LDC Sponsor/Shippers' statements made regarding replacing some of their currently contracted interstate capacity with proposed new-build PennEast capacity, questions arise as to what could be the driver behind such a project.

Generally pipelines are proposed and built to meet known demand, such as when LDCs sign-up for expansion to serve new territories or replace over-reliance on winter-peaking resources. Pipelines can also be proposed to meet the needs of Producers who seek to move gas from capacity constrained supply areas to liquid market locations. From our review of the documents, the PennEast Pipeline is proposed to serve neither demand from LDCs nor supply from Producers.

What then is a possible motivating genesis for PennEast?

Is Return on Capital a Motivating Factor?

A potential motivator might be a rather simple one: namely, a vehicle for the LDC Sponsor/Shippers to replace dollars collected from ratepayers and sent to third-party unaffiliated interstate pipelines, with dollars collected from ratepayers and paid to themselves – or rather paid to the affiliated, non-regulated, companies owned by the same corporate shareholders as the regulated LDC signing the contracts.

Under an LLC structure such as that of PennEast, the owners (called unit-holders) are generally entitled to distributions of cash net of direct expenses and retained working capital. Direct expenses of new pipelines are both Fixed and Variable. Fixed Expenses can be simplified into the categories of a) interest payments, b) overhead, c) maintenance expenses and d) Non-income taxes (ex. property taxes and franchise taxes). Variable expenses, such as the costs of running compressors and those related to transporting gas, are collected from customers as they transport gas and do not meaningfully figure into the profits of pipeline owners. Thus, for the purposes of this analysis they will be disregarded.

In addition, Pipeline LLCs typically have a 50% Equity and 50% Debt capital structure. Below is a simplified but typical structure for the annual revenue of a pipeline and how it is generally put together.

Assuming an initial capital cost of $1.2 Billion, at the LLC level, investors would put in $600 Million and banks would finance the other $600 Million. For these purposes, Skipping Stone will assume an annual interest rate of 5%. Generally, pipelines then seek to get rates that will generate revenue based upon an annual percentage of total capital that is between 8% and 10% more than their interest rate (i.e., 13% to 15%) and apply that percentage (i.e., revenue level) to total initial capital cost (i.e., the $1.2 Billion). Assuming the lower level, 13% applied to the $1.2 Billion would mean that the pipeline would seek rates that recovered $156 MM per year. Once pipelines have determined their desired revenue level they then design their rates. In our simplified example, applying that revenue level to a pipeline with 1 Bcf per day (1,000,000 Dth/d) of capacity yields daily rates per the below.

Table 5. Simple Economic Structure of Pipeline Revenue Derivation

	Dollars ($M)	Typical Pctg.	Annual Revenue ($M)	Capacity (Dth/d)	100% LF Rate ($/Dth/d)
Assumed Interest Rate		5.0%			
Typical delta to Int Rt%		8.0%			
Upfront Costs					
Total Capital Cost	$1,200	13.0%	$156	1,000,000	$0.4274

Then, there are costs that are deducted from the pipeline's revenues which in the case of LLC structured pipelines result in distributable cash – otherwise considered return to the investors. A typical illustrative revenue, cost and distributable cash[25] structure of a new-build LLC Pipeline is set forth below.

Table 6. Typical LLC Pipeline Revenue, Cost, and Distributable Cash Structure

	Applicable Dollars for Pctg ($M)	Typical Pctg.	Annual ($M)	Capacity (Dth/d)	Cost Component in Rate
Annual Revenue			$156	1,000,000	$0.4274
Annual Costs					
Total Capital Cost Financed		50.0%			
Interest Cost	$600	5.0%	$30	1,000,000	$0.0822
Typical Annual Costs as Pctg of Total Capital Cost					
Operations & Maintenance	$1,200	1.0%	$12	1,000,000	$0.0329
Non-income taxes	$1,200	2.5%	$30	1,000,000	$0.0822
Overhead	$1,200	2.0%	$24	1,000,000	$0.0658
Total Annual Cost	$1,200	8.0%	$96	1,000,000	$0.2630
			Annual Cash ($M)		**Portion of Rate to Investor Cash**
Distributable Cash	$1,200	5.0%	$60	1,000,000	$0.1644

In addition, it is often the case that entities that form LLC Pipelines also double leverage their invested capital. This generally means that while the LLC gets 50% of its total capital cost as equity (in the case above $600 Million), the LLC Members then finance often as much as 50% of that equity contribution at their respective corporate levels. If this were to be the case with all of the LLC members of the LLC Pipeline, then their total equity cash investment would be just

[25] Note that Distributable Cash is on-going once the pipeline has established what it considers sufficient Working Capital Reserves, usually on the order of 2-4% of Total Capital Cost.

$300 Million and assuming they financed their other $300 Million at the same 5% (for an annual cost of $15 Million) then the return on equity to those partners would be $45 Million ($60 Million of cash minus $15 Million of interest) on a $300 Million cash investment. This would mean that those entities would possibly be seeing a 15% return on their cash investments.

The potential 15% return on capital is a very healthy one indeed in this overall economic environment. It is quite possible that this level of financial gain is a very strong motivator behind the proposed PennEast Pipeline.

Do Non-Arm's-Length Commitments Demonstrate Market Need?

Since the restructuring of the US Natural Gas Pipeline Industry in the mid 1990's, the Federal Energy Regulatory Commission (FERC) has had a policy of relying on contracts to pay for new pipelines and expansions of existing pipelines as evidence of market need sufficient to find such construction was in the "public convenience and necessity." A finding that a project is in the public convenience and necessity is what is required for the FERC to both grant eminent domain and to justify any construction of interstate facilities. That said, for most of the past 20 years since it established its policy of reliance on contracts as evidence of market need, those contracts were almost always between un-related parties – they were arm's-length contracts.

That previously prevailing fact is not the case with respect to 74.2% of the capacity and ownership of PennEast. In fact most of the Shippers, that is, the contracting parties on whom FERC typically relies as evidence of market need, are owners with a distinct financial interest in the existence of the pipeline and the returns it will provide. Moreover, assuming the LDC shippers are able to have their PennEast Contracts paid for by those LDCs' ratepayers, one has to question whether the FERC can continue its policy of relying on contracts as evidence of market need, the foundational aspect to a finding of public convenience and necessity.

This cannot be overstated or overemphasized.

If non-arm's-length contracts, possibly motivated by financial gain to affiliates of the shippers, are properly scrutinized then there may be *no market need* for a large proportion of the PennEast capacity upon which a finding of public convenience and necessity can rely. Instead, it may be that rather than a market need, there is purely a shareholder return "need" which should not be sufficient to grant a certificate of public convenience and necessity.

Section VI – Conclusion

As discussed in this memorandum, given all of the following:

1) The potentially evident low percentage utilization;
2) The likely existence of lower cost potentially less disruptive alternatives[26];
3) The likely negative impacts on ratepayers who presently benefit from secondary market transactions to reduce their energy costs;
4) The possible negative impact on LDC ratepayers due to turnback of capacity and/or non-renewal of capacity due to a potential glut of capacity;
5) The likely elimination of favorable pricing for gas in the supply area of the proposed line owing to other known developments;
6) The inappropriateness of relying on past events rather than modeling and forecasting future events based upon known changes as a justification for an action as large as adding a Billion cubic feet of incremental pipeline capacity to a limited geographical area;
7) Recent changes in Electric market rules which may have already eliminated the conditions that gave rise to the price spikes of the past;
8) The likely inappropriateness of reliance on non-arm's-length transactions as a foundation for finding market need; and finally,
9) The fact that most of the sponsors of the proposed line are the regulated utility-shippers' unregulated affiliates that are likely committing ratepayer dollars to provide equity returns that will be realized by the unregulated affiliates;

the Commission should institute a full evidentiary proceeding with discovery and cross-examination to determine what demand is to be met by the proposed pipeline and whether less disruptive and more cost-effective alternatives exist to meet the demand determined from such evidentiary proceeding.

[26] Especially alternatives relying on greater utilization of existing LNG facilities to meet short duration peak demands

Review of PennEast Pipeline Project Economic Impact Analysis

Review Conducted by:

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Submitted to:

Delaware Riverkeeper Network

April 4, 2016

Review of PennEast Pipeline Project Economic Impact Analysis

Jannette M. Barth, Ph.D.
Pepacton Institute LLC

Delaware Riverkeeper Network retained Pepacton Institute LLC (PI) to review the analysis presented in the report titled, "PennEast Pipeline Project Economic Impact Analysis," prepared by Econsult Solutions and Drexel University (ES&D), dated February 9, 2015. The ES&D report states on the title page, "Report Submitted To: PennEast Pipeline Company LLC," so presumably, ES&D were retained by PennEast to conduct the analysis and prepare the report.

Based on a review of the ES&D analytical methodology, assumptions, economic impact estimates, and comparison to additional relevant data and research, we conclude that that the ES&D analysis and conclusions are incomplete, inaccurate, and unreliable.

The ES&D report states, "The purpose of the report is to quantify the economic benefits resulting from the Project." The report is organized into four sections: Description of the PennEast project, one-time economic and fiscal impact from construction, annual impact of the project, and summary of overall economic impact for the six-county region and the two impacted states.

While the title of the ES&D report implies that it is analyzing economic impacts, it clearly states that its purpose is to quantify only economic benefits. A comprehensive economic impact analysis would attempt to quantify both benefits and costs.

As is typical of most economic impact assessments conducted or funded by the oil and gas industry, the ES&D report exaggerates the economic benefits and ignores the costs.

This review shows how the benefits are exaggerated and then discusses the many significant costs that have been ignored by ES&D.

ES&D reached the following two conclusions, each of which will be reviewed below in discussions of methodology, assumptions and results.

- In Pennsylvania and New Jersey combined, the design and construction is estimated to generate an approximate $1.62 billion in one-time total economic impact, supporting about 12,160 jobs with $740 million in wages.
- In Pennsylvania and New Jersey combined, the ongoing operations of the project is estimated to generate annually an approximate $23

> million in total economic impact, supporting 98 jobs with $8.3 million in wages.

ES&D further claims, "The primary ongoing impact of PennEast Pipeline will be to expand and stabilize the supply of natural gas in both states, thus leading to a reduced price of natural gas to final customers." This claim will be discussed as well.

Employment and Income Impacts: Methodology

ES&D uses IMPLAN, an input-output model that is commonly used to show positive economic impacts caused by a proposed new development entering a region. Any new economic activity in a region will bring in additional expenditure, which, through multiplier impacts, usually results in some economic benefit in the form of jobs and income.

PI has reviewed many economic impact studies conducted or funded by the oil & gas industry [1]. Input-output modeling is used frequently by the oil & gas industry to show that oil & gas production, transmission and delivery will benefit the economy. The studies funded by the oil & gas industry tend to greatly exaggerate economic benefits and minimize or more commonly, entirely ignore significant economic costs. The results of these studies are used to try to convince the public and elected officials that shale gas development and its infrastructure will bring great economic benefits to communities.

ES&D included a short paragraph in an appendix that states a few of the shortcomings of input-output models, but instead of attempting to adjust their results to correct potential inaccuracies due to shortcomings, they simply state, "regardless, I-O models still serve as the standard in the estimation of local and regional impacts."

Economists and other researchers who are attempting to reach accurate, unbiased conclusions would make adjustments in order to at least partially correct for known shortcomings in models being used. No such adjustments were discussed in the ES&D report.

In addition to the shortcomings pointed out by ES&D, limitations of input-output models have been pointed out elsewhere. The following is a discussion of input-output models as applied to the shale gas industry generally, and is thus of relevance to the PennEast Pipeline Project [2].

> An additional weakness is the fact that environmental impacts are ignored. Wassily Leontief, who received the Nobel Prize in Economic Science for his model of input-output economics, had himself stressed

as early as the 1970s that environmental repercussions and externalities should be incorporated into input-output analysis [3-5]. Leontief recommended that a pollution abatement industry be entered into the input-output matrix, and that the abatement industry be in the business of eliminating pollutants generated by the productive sectors, consumers, and the abatement industry itself. And Wiedmann, Lenzen, Turner, and Barrett stated, "in the last few years models have emerged that use a more sophisticated multi-region, multi-sector input-output framework . . . in order to calculate environmental impacts. . . . Results demonstrate that it is important to explicitly consider the production recipe, land and energy use as well as emissions in a multi-region, multi-sector and multi-directional trade model with detailed sector disaggregation" [6]. The industry-sponsored studies have not addressed environmental repercussions, such as water and air contamination, or externalities such as damage to roads and costs to communities. Unless appropriate adjustments are made, input-output analysis tends to use unrealistic assumptions. Bess and Ambargis [7] and Lazarus, Platas, and Morse [8] discuss some of the limitations of input-output analysis. For example, Bess and Ambargis state, "Regional input-output models can be useful tools for estimating the total effects that an initial change in economic activity will have on a local economy. However, these models are not appropriate for all applications and care should be given to their use. . . . Key assumptions of these models typically include fixed production patterns and no supply constraints. Assumptions about the amount of inputs that are supplied from the local region are also important in these models. Ignoring these assumptions can lead to inaccurate estimates" [7]. There are several additional problems of particular relevance to the application of input-output analysis to the study of shale gas development. For example, while spending patterns in communities with an established drilling industry [or extensive pipeline development] would probably be different than spending patterns in communities without an established drilling industry [or extensive pipeline development], this difference is not reflected. Input-output analysis implicitly assumes that all populations have identical spending patterns. This assumption exaggerates the estimated economic impact if new workers are transient. The gas industry frequently brings in transient workers and houses them in man-camps or rental housing on a short-term basis. Such workers often send their wages to their families living elsewhere, improving the economies in those distant locations … and thereby exaggerating the estimated economic impact. In addition, input-output analysis assumes "constant returns to scale." This means that the gas industry

would get no volume discounts on supplies. This is an unrealistic assumption, and it inflates estimates of industry spending and thus estimates of economic impacts from the industry's activity in the community. Input-output models used in the industry-sponsored studies tend to be static in time, implying that there are no changes in coefficients over time and no allowance for price changes in factors of production such as supplies and labor. The production function is also assumed to be constant. This does not allow for input substitution or changes in the proportions of inputs as technology and/or prices change over time. Input-output models tend to be aspatial, implying that transportation costs are not fully reflected.

Employment and Income Impacts: Assumptions

As ES&D correctly points out, "The workforce for the Project is likely to be comprised of personnel from across the country due to the specialized nature of pipeline construction." (Page 10)

It is likely that the workforce will come from parts of the country that have more miles of pipelines already installed. According to data from PHMSA Pipeline Safety Program, the three states with the greatest number of natural gas transmission pipelines as of 2010 are Texas with 54,933 miles, Louisiana with 30,093 miles, and Oklahoma with 13,124 miles. These are likely to be the states from which many of the temporary workers will come to build the PennEast and other pipelines in the Northeast and other parts of the country. And these are the same states from which many of the temporary workers came to work in the early shale gas boom in Pennsylvania. This is the industry pattern.

When a temporary workforce comes from out of state for a short term project (such as six months of installing a pipeline), most of the wages earned are likely to be sent to the workers' families in their home states, helping the economies there rather than the economies of New Jersey or Pennsylvania.

The assumption made by ES&D is that "25 percent of the disposable income of the construction workforce will be spent outside of Pennsylvania and New Jersey." No justification is provided for this assumption. Reports from Pennsylvania indicated that at the beginning of the short-lived shale gas boom, possibly up to 97% of the workers came from out of state, so the 25% assumption made by ES&D is probably far too low.

It is curious that ES&D state that they used "detailed budget projections provided by PennEast," but they do not provide detailed expenditure inputs in the report. For the construction phase, they show only the six broad categories of Land Acquisition, Materials, Construction Labor, Project Management, All over head construction

services, and Other (in Table 3.1 on Page 10). The modeling effort is presented as a black box, jumping from Table 3.1 with the broad expenditure categories, to Table 3.2, with the impact estimates. A detailed input-output analysis should separate Construction Labor and Materials, the two largest categories, into more detail. For the Ongoing Operations Economic Impact section, the expenditure categories are even fewer, having been separated into only the three very broad categories of Labor, Maintenance and Operations (in Table 4.1 on Page 14). If a high proportion of labor or particular materials must be imported to the local region, as opposed to sourced locally, then the economic impact on the immediate region will be relatively weak. Research presented in the Oil & Gas Journal shows the unsurprising result that pipeline construction costs are different for different regions. Material cost includes the cost of line pipe, pipeline coating and cathodic protection. Labor costs include construction labor as well as surveying, engineering, supervision and administrative labor, each with specific cost levels. And there are miscellaneous costs such as telecommunications equipment, freight, cost of ROW and allowance for damages. The region in which each of the costs and benefits occur should be considered and reflected in an economic impact study [9].

Employment and Income Impacts: Results

It appears that ES&D did not make an effort to check the reasonableness of their results. Normally, a researcher will compare their conclusions to those of other studies to check for veracity and accuracy.

The employment estimate of 12,160 jobs for the design and construction phase of the Project is very optimistic in light of job creation from other similar projects.

The Goodman Group, Ltd. (TGG) provided a detailed critique of the job estimates that were presented in the PennEast study [10]. As pointed out on page 21 of the TGG critique, based on the estimates provided, the overall multiplier for the potential economic impact from design and construction of the project is 10.7 jobs per $1 million project cost. TGG compared job creation from other pipeline projects and found that "the multipliers for other similar gas pipelines are only 8 – 36% of the PennEast Analysis multiplier" (Page 30 of the TGG report). TGG compared job estimates for the following four Northeast US Gas Pipeline Projects: Atlantic Sunrise, Northeast Supply Link, Northeast Energy Direct (NED), and Constitution. Their findings are summarized in Figure 2 of the TGG report and are repeated in the following table.

Multipliers
(Jobs per $1 million project cost)

Pipeline Project	All Workers	In-State Workers
PennEast PennEast(FERC project cost)	10.2 10.7	NA NA
Atlantic Sunrise	NA	3.8
Northeast Supply Link	3.9	NA
Northeast Energy Direct	2.0	1.4
Constitution	1.5	0.9

(Source: The Goodman Group report)

PI reviewed additional information in order to make independent comparisons. Our findings, described below, provide further support for the conclusions reached by TGG, that the job estimates reported by ES&D are highly exaggerated.

As stated above, PI has reviewed many economic impact studies of shale gas development. The industry regularly exaggerates job creation, often on the order of ten-fold.

An early industry-funded study that was often quoted toward the beginning of shale gas development in Pennsylvania claimed that 88,000 jobs would be created in Pennsylvania in 2010 due solely to shale gas development. The reality is that only 65,000 jobs were created statewide in ALL industries in Pennsylvania in 2010, and half of those were in education and health and in leisure and hospitality. Later, industry claimed that 48,000 jobs were created in Pennsylvania from the fourth quarter of 2009 to the first quarter of 2011, about a year. The Keystone Research Center debunked this claim by pointing out that the 48,000 jobs referred to "new hires," and does not reflect separations in the form of layoffs or quits. Using appropriate data, the Keystone Research Center found that Marcellus core and ancillary industries created less than 6,000 net new jobs between the fourth quarter of 2007 and the fourth quarter of 2010 [11]. Governor Corbett of Pennsylvania, based on shale gas industry claims, stated that 200,000 jobs had been created in his state due to shale gas development. Not only did the Keystone Research Center (not industry-funded) find that less than 6,000 net new jobs were created in three years in Pennsylvania in Marcellus core and ancillary industries, but other Pennsylvania-based economists have pointed out that the Governor's claim is highly exaggerated and implies a multiplier of about seven, which would be extraordinarily and unrealistically high for any industry. (https://stateimpact.npr.org/pennsylvania/2013/11/06/economists-question-corbetts-marcellus-shale-jobs-claims/)

As Ohio began to be exploited for shale gas, an industry-funded study again claimed that 200,000 jobs would be created there. An independent study (not industry-

funded) estimated that there would be only 20,000 jobs created, only one-tenth of industry's estimate.

The Multi-State Shale Research Collaborative has confirmed our early predictions and now established findings that job creation from shale gas development is greatly exaggerated. For example, among other conclusions, the Collaborative found that Marcellus Shale drilling has had "little overall impact on the state economy in any state studied"; "employment estimates have been overstated, and the industry and its boosters have used inappropriate employment numbers, including equating new hires with new jobs and using ancillary job figures that largely have nothing to do with drilling"; and "industry-funded studies have substantially overstated the total jobs impact of the shale industry" [12]. Specifically, they found an estimated 3.7 jobs created for every well drilled in the Marcellus region, as compared to industry's claim that 31 jobs are created per well drilled. So, as above, independent research finds approximately one-tenth of the amount of job creation claimed by the shale gas industry.

Such exaggeration appears to apply to studies of the economic impacts of infrastructure as well, such as power plants and pipelines. Take, for example, the CPV Woodbridge Energy Center (WEC) that broke ground in October of 2013. It is a 700 megawatt (MW) natural gas fueled power plant located in Woodbridge Township, NJ, which is in Middlesex County. According to the website, "WEC will employ as many as 500 to 600 skilled workers during construction and 25 permanent employees." (http://www.cpvwoodbridge.com/about.php), accessed January 18, 2016). Construction was expected to take two years. As county level data for 2015 is not yet available, we took a look at the Quarterly Census of Employment and Wages, on the Bureau of Labor Statistics website, and found that during the first year of construction, from the end of 2013 to the end of 2014, only 27 jobs were added to the NAICS code 2371 Utility System Construction in Middlesex County. Note that Utility System Construction includes more than power plants. Even if all 27 jobs were generated by construction of WEC in the first year of construction, it is difficult to believe that another 473 to 573 jobs would be added in the second and final year of construction.

As another example, consider the Algonquin Incremental Market Project (AIM), a pipeline being expanded by Spectra Energy and impacting five states, Pennslvania, New York, Connecticut, Massachusetts and Rhode Island. According to Spectra's website, the AIM project includes over 20 miles of 42-inch diameter new pipeline in New York and Connecticut, over 9 miles of 16-inch diameter pipeline in Connecticut, another 1.3 miles of 12-inch diameter loop pipeline in Connecticut and 2 miles of 36-inch extension pipeline also in Connecticut, and 5.1 miles of new 16-inch and 24-inch diameter lateral pipeline in Massachusetts. The AIM project also includes six new compressor units at five existing compressor stations in New York , Connecticut and Rhode Island, modification to an existing compressor station in Connecticut, a new metering station in Connecticut and two in Massachusetts and modifications to existing metering stations in New York, Connecticut and Massachusetts. (See

http://www.spectraenergy.com/Operations/US-Natural-Gas-Operations/New-Projects-US/Algonquin-Incremental-Market-AIM-Project/). FERC's Draft EIS confirms that few jobs would be created by the AIM project. It is stated that after construction, Algonquin would add only three full-time permanent workers for operation of the proposed and modified facilities. This is far fewer than the 98 operations jobs estimated by ES&D for PennEast. Will there really be 32 times more jobs ongoing at the PennEast Pipeline which is to be about 114 miles long and 36-inch diameter, through four counties in NJ and six counties in PA, compared to the AIM expansion which includes new 42" diameter high-pressure pipeline crossing under Hudson River and continuing through New York State and into Connecticut, Rhode Island, and Massachusetts, a total of 37.6 miles of new pipeline? And bear in mind that the AIM project (and jobs estimate) also includes 6 new or expanded compressor stations, 24 existing metering and regulating stations, and construction of 3 new metering and regulating stations.

Another example is the well-publicized Keystone XL pipeline project, a pipeline proposal far more extensive than PennEast. (http://www.transcanada.com/keystone.html) The Perryman Group, a consulting firm hired by TransCanada, concluded that 119,000 jobs would be created by the 1,179 mile 36-inch diameter Keystone XL Pipeline. Cornell University's Global Labor Institute found the Perryman Group study on the Keystone XL Pipeline to be flawed and the employment numbers highly exaggerated. The Cornell report concluded that, "Employment potential from the Keystone XL Pipeline is little to none" [13].

And as a final example, Shell Oil plans to build an ethylene cracker plant in Beaver County, Pennsylvania. (http://stateimpact.npr.org/pennsylvania/topic/ethane-cracker/) A cracker plant separates wet gas and produces ethylene that is in turn used in plastics and other chemical industries. There was competition among West Virginia, Ohio and Pennsylvania, each state hoping that Shell would decide to locate there. There are concerns about the quality of air emissions near the cracker plant, but beyond the air emissions issue, consider the estimated economic impact. Each state offered tax incentives to entice Shell. Pennsylvania created a Keystone Opportunity Zone whereby the plant will pay virtually no taxes to the state for 15 years. There were reports that this plant would create 10,000 construction jobs (note that construction jobs are just during the short-term construction phase) and then the plant would create another 10,000 permanent jobs. The question becomes, were the incentives to have the plant located in PA worth the tax losses and were the assertions of job creation accurate or earnest? The Shell Oil cracker plant would be built on 300 acres. For comparison, another ethylene cracker plant owned by Shell is located in Norco, Louisiana. The Shell website states that this plant is on 1,000 acres and has only about 600 full-time employees. In other words, the Norco cracker plant is on more than three times the acreage, but has only 6% the number of jobs as promised to PA for the corporate tax write off that was given to Shell. It appears that the industry has exaggerated job creation claims in order to secure both tax incentives and other necessary approvals to be located in PA.

The ES&D report created for PennEast is another example of an industry funded study that has obviously overstated job creation many times over. If any jobs will be created by the PennEast Pipeline Project, they will be during construction and such jobs are not sustainable. The oil & gas industry is known for its transient workforce, so it is unlikely that even the few short-term construction jobs would go to local residents. Obviously, pipeline companies are motivated to make grandiose job creation and economic impact claims in order to encourage approval of a project. It is incumbent on state and local decision makers to see through these false claims.

A small amount of job creation by shale gas development and its infrastructure has never been in question. But, the number is so tiny relative to that of all other jobs in the region that aggregate statistical analysis shows that the overall impact is insignificant. TGG has pointed this out as well. They state, "Even if the PennEast Analysis' employment impact estimates were realistic, the employment impact from design and construction of the Project are (a) tiny in the context of the New Jersey and Pennsylvania state economies (less than 0.1% of total NJ jobs); and (b) very short-term." They point out that jobs from actual construction are temporary with an average duration of only 5.2 months (Page 40 of the TGG report).

It should be pointed out that the natural gas industry, including its infrastructure such as pipelines, is highly capital intensive, about ten times more capital intensive than the average American industry. This means that relatively few jobs are created per dollar invested.

Of course, if the number of jobs created is overstated, then the resulting income estimates will also be overstated. So, based on our review of ES&D's methodology, assumptions, and results, we conclude that the employment and income estimates presented in their report are highly exaggerated.

Impacts on Tax Revenue

ES&D present estimates of income tax benefits to Pennsylvania and New Jersey. If the employment and income estimates are exaggerated, as shown above, then income tax benefits will also be exaggerated.

There is a further concern regarding the ES&D approach to estimating income tax impacts. In a footnote, it is stated, "the tax estimates were calculated using each state's published personal income tax collection effective rates, which are currently 2.043% and 3.185% in Pennsylvania and New Jersey, respectively." However, while out of state workers are a significant share of total workers, ES&D included no discussion of adjusting income tax estimates to reflect Pennsylvania and New Jersey laws for handling income tax collection from out of state workers. While Pennsylvania residents are the only out-of-state residents exempt from New Jersey withholdings (Department of Treasury, State of New Jersey), the Commonwealth of Pennsylvania has reciprocal tax agreements with Indiana, Maryland, New Jersey,

Ohio, Virginia and West Virginia (www.revenue.pa.gov). As a result, an accurate economic assessment would reflect the loss of income tax benefits for Pennsylvania and New Jersey for out-of-state resident workers hired by PennEast.

ES&D should have clarified if and how they handled the distribution of workers from different states. Evidence-based assumptions regarding the distribution of out of state workers from different states should have been made. Based on observations in the oil & gas industry generally, many of the workers are from states other than New Jersey or Pennsylvania.

A glaring omission in the ES&D report is discussion of potential property tax payments by PennEast. There have been reports indicating concern by impacted Pennsylvania communities that they will lose out on tax revenue while New Jersey communities will collect additional revenue. (See for example, https://stateimpact.npr.org/pennsylvania/2015/06/11/new-pipeline-could-mean-tax-bonanza-for-nj-towns-but-for-pa-not-so-much/). This obvious omission may be intended to avoid the discussion of whether PennEast intends to request tax abatements, a frequent strategy of pipeline companies. Or the obvious omission may be to avoid a discussion of the potential impacts on property values that can result from pipeline infrastructure projects. It is possible that any increased property tax revenue from PennEast will be offset by declines in property tax revenue due to declines in land values, a topic further discussed later in this analysis.

Impact on the Price of Natural Gas

ES&D claims that, "the primary ongoing impact of PennEast Pipeline will be to expand and stabilize the supply of natural gas in both states, thus leading to a reduced price of natural gas to final customers. Lower natural gas prices will also lead to lower electricity prices as power generation throughout the region becomes more heavily dependent on natural gas as a fuel."

First, according to expert analysis there is no shortage of natural gas currently in the State of New Jersey, and construction of PennEast will in fact result in a 53% surplus of gas in the state. According to noted expert, petroleum engineer, Arthur Berman:

> Natural gas consumption for New Jersey has been relatively flat for the past four years at average rate of 1.8 billion cubic feet of gas per day (Bcf/d), somewhat below the higher levels of the late 1990s. Although consumption increased slightly in 2013 compared to the three previous years, New Jersey cannot be called a growth market…
>
> And Pennsylvania has been a net exporter of natural gas since 2003…

> The proposed PennEast Pipeline would deliver an additional 1 Bcf/d of natural gas to New Jersey potentially creating a 53% supply surplus above the current level of consumption.
>
> (*Professional Opinion of Proposed PennEast Pipeline Project,* Arthur E. Berman, Petroleum Geologist, Labyrinth Consulting Services, Inc., February 26, 2015)

As a result, ES&D's asserted scenario is unlikely to come to pass. If there was going to be an evolution towards greater dependence on natural gas in the state that evolution would already be in the works.

That being said, there are likely to be enormous negative long term economic impacts associated with encouraging any region to become more heavily dependent on natural gas as a fuel, impacts that were not considered by ES&D. These impacts are discussed further below.

The industry often claims that the low price of natural gas makes the commodity attractive to end users, both residential consumers and businesses of all sizes. But the industry never points out that natural gas has a long history of price volatility and that the price may very well increase substantially due to increased demand through LNG exports, the conversion of buildings and vehicles to natural gas, and the new manufacturing plants that are currently taking advantage of low natural gas prices. When the price of natural gas increases dramatically after increased exports and widespread conversion to the fuel for heating, transportation and industrial feedstock, all of the end users will suffer financially. As a result, dependent communities will be locked into a high priced energy source. Bear in mind that the prices of wind, water and sunlight as inputs into an energy system based on renewable energy will always be zero.

The uncertainty resulting from volatility in fossil fuel prices makes for very difficult long-term planning. A report by National Economic Research Associates (NERA), an oil & gas industry-friendly consulting firm, that tries to make the case that increased exports of LNG from the United States will have minimal impact on natural gas price, has been harshly criticized by other industries and environmentalists [14]. The Department of Energy website provides officially submitted comments, some written by industry friendly sources and some by sources independent of the industry (http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/export_study_initial_comments.html)

A study by Charles River Associates (CRA) reached vastly different conclusions than NERA (http://www.crai.com/sites/default/files/publications/CRA_LNG_Study.pdf). CRA estimated several alternative LNG export scenarios and found that their most likely export level scenario would result in a doubling of domestic natural gas prices

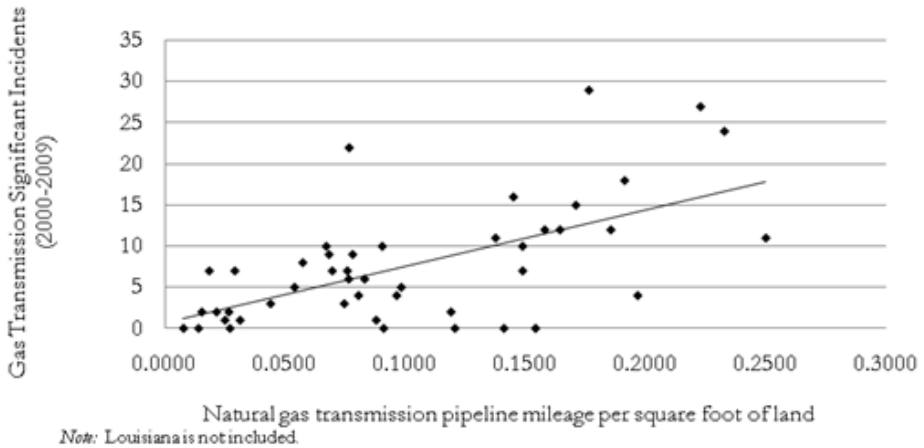
and their high export scenario would result in a tripling of natural gas prices [15].

It should be noted that the supply of natural gas is highly uncertain. There have been vastly different estimates of recoverable shale gas in the US shale plays. If the low estimates are correct, then there will be even further upward pressure on price due to supply constraints.

Ignored Costs

The economic impact analysis conducted by ES&D ignored significant costs that may be passed on to individuals, businesses and communities. As additional natural gas transmission pipelines are built in an area, the risk of significant damaging incidents and/or accidents increases. The following chart, prepared by The National Conference of State Legislatures using PHMSA data, shows the relationship between natural gas transmission pipeline mileage per square foot of land vs. gas transmission significant incidents.

Figure 4. Natural Gas Transmission Pipeline Mileage per Square Foot of Land vs. Gas Transmission Significant Incidents



Note: Louisiana is not included.

Source: Significant incident and natural gas transmission pipeline mileage data gathered from PHMSA Pipeline Safety Program (2010); state land areas gathered from the U.S. Department of Commerce, Bureau of the Census (2000); and author's calculations, 2010.

The risks associated with pipelines are so high that the pipeline companies themselves cannot afford to carry sufficient insurance to cover the risks of property damage and loss of human life in the event of an incident.

The ES&D report lists and briefly describes the corporate partners in the PennEast Project. ES&D points out that each partner has experience in the natural gas industry and in particular, midstream operations. It gives statements for example, on years of operation, numbers of customers and annual revenue. It does not point out the high risk nature of the industry and especially pipelines and the fact that these partners do not carry sufficient insurance in the event of a disaster and the high costs that would be incurred by residents, businesses and communities near the pipeline.

A look at 10-K forms submitted to the SEC by the PennEast corporate partners reveals the high cost risk that falls on communities near pipeline projects. For example, UGI Corporation SEC filing for fiscal year ended September 30, 2012, states:

> **We are subject to operating and litigation risks that may not be covered by our insurance.**
>
> Our business operations in the U.S. and other countries are subject to all of the operating hazards and risks normally incidental to the handling, storage and distribution of combustible products, such as LPG, propane and natural gas, and the generation of electricity. These risks could result in substantial losses due to personal injury and/or loss of life, and severe damage to and destruction of property and equipment arising from explosions and other catastrophic events, including acts of terrorism. As a result, we are sometimes a defendant in legal proceedings and litigation arising in the ordinary course of business. There can be no assurance that our insurance will be adequate to protect us from all material expenses related to pending and future claims or that such levels of insurance will be available in the future at economical prices.

Another example from the AGL Resources Inc. filing with the SEC for fiscal year ended December 31, 2013, states:
(Form 10-K, page 7)

> **Transporting and storing natural gas involves numerous risks that may result in accidents and other operating risks and costs.**
>
> Our gas distribution and storage activities involve a variety of inherent hazards and operating risks, such as leaks, accidents, including third party damages, and mechanical problems, which could cause substantial financial losses. These risks could result in serious

> injury to employees and non-employees, loss of human life, significant damage to property, environmental pollution and impairment of our operations, which in turn could lead to substantial losses to us. In accordance with customary industry practice, we maintain insurance against some, but not all, of these risks and losses. The location of pipelines and storage facilities near populated areas, including residential areas, commercial business centers and industrial sites, could increase the level of damages resulting from these risks. The occurrence of any of these events not fully covered by insurance could adversely affect our financial position and results of operations.

And Spectra Energy, states in its SEC filings,

> There are a variety of hazards and operating risks inherent in natural gas gathering and processing, transmission and storage activities, and crude oil transportation and storage, such as leaks, explosions, mechanical problems, activities of third parties, and damage to pipelines, facilities and equipment caused by hurricanes, tornadoes, floods, fires and other natural disasters, that could cause substantial financial losses. For pipeline and storage assets located near populated areas, including residential areas, commercial business centers, industrial sites and other public gathering areas, the level of damage resulting from these risks could be greater. **We do not maintain insurance coverage against all of these risks and losses**.

In addition to the damage and costs to residents and businesses should an incident or accident inflict life, health and/or property damage, Delaware River Basin (DRB) communities may be additionally harmed. The proposed pipeline will pass through the following six counties: Luzerne, Carbon, Northampton and Bucks Counties in Pennsylvania, and Hunterdon and Mercer Counties in New Jersey. Over 85% of the pipeline right of way will be located in the DRB, a fact not considered by ES&D. The DRB is a highly valuable region as it is a primary source of drinking water for millions of people and it supports a strong tourism industry that is dependent on a safe and clean environment. A major pipeline incident or accident could inflict additional unaccounted for harms on drinking water and water dependent economies.

Costs to Ecosystems

Potential damage both to wetlands and to economic activity that is generated by nature and ecosystems is substantial. The ES&D PennEast "economic impact study" did not attempt to identify the potential economic losses due to such activity.

The value of natural capital and ecosystem services impacted by the PennEast pipeline was not only underestimated, it was totally overlooked. Economic losses

due to impacts on wetlands, forests, farms, air and open water must be considered for an economic impact analysis to be deemed accurate or defensible, especially for an industrial project being proposed in a natural habitat and water resource region such as the DRB.

The University of Delaware issued a study that estimated the value of natural goods and services from the ecosystems in the DRB at $683 billion (net present value using a discount rate of 3% over 100 years) [16]. The net present value contribution of the DRB ecosystems by state are estimated as follows:

New Jersey: $213.4 billion
New York: $113.6 billion
Pennsylvania: $279.6 billion

Waterway and environmental harms are routinely documented for interstate transmission pipeline projects like PennEast. ES&D should have conducted a risk assessment and assigned values to the potential loss of value to ecosystems that may be caused by the PennEast Pipeline.

Impact on Property Values

There is evidence that compressor stations and pipeline projects cause declines in property values of nearby homes. Whenever property values decline, property tax revenues also decline. Local governments rely heavily on property tax revenue. In addition to strains on their usual budget items, a reduction in property tax revenues will mean less income to allocate to increased needs for emergency services that will be called upon when explosions or major leaks occur.

Forensic Appraisal Group, Ltd., experts in condemnation appraisal, state on their website that the property valuation impact of a natural gas transmission pipeline depends on the size of the property, property use, etc, and the impact range could be nominal to substantial, and could be "up to 30% or more of the whole property value." (See http://forensic-appraisal.com/gas_pipelines_q_a) In one of the few peer-reviewed articles about real estate valuation issues with unconventional shale gas development, the authors contend that the more permanent features of unconventional shale gas development are likely to affect property values. Such permanent features would of course include natural gas pipelines [17].

While the oil & gas industry has hired consultants to produce reports that show that pipelines have not impacted property values, such analysis is highly suspect and the conclusions are not at all in line with expectations.

A review of peer-reviewed literature (not industry funded), as well as facts concerning the impact of shale gas development on property values, suggests that

natural gas industry activities are likely to negatively impact property values, despite industry claims to the contrary [2].

In addition, there are multiple studies that show that environmental contamination has significant negative impacts on nearby property values. For example, Taylor, Phaneuf, and Liu [18] used an empirical model to identify the direct impact of environmental contamination on residential housing prices separate from land use externalities. They found the following:

> Commercial properties with no known environmental contamination reduce neighboring residential home values by an average of 2.5 percent. Environmental contamination augments this negative external impact, so that the overall effect is approximately 8 percent. Thus, environmental contamination causes external effects that are more than twice as large as the land use spillovers associated with commercial land use – a substantial amount that is similar to what is found in many other studies

Most of the studies that have attempted to analyze whether proximity to natural gas pipelines has impacted property values are not peer reviewed and are funded by gas transmission companies. Further research is required, but it is clear that with the increased public awareness and concern about pipeline and other gas infrastructure explosions, leaks and accidents, as well as the loss of unfettered use of one's property, and the land transformation associated with pipelines such as tree cutting and other land and vegetation modification, properties near gas infrastructure will become increasingly less desirable and more difficult to sell.

Recent news coverage, including interviews with local realtors, indicates that this is already happening in Pennsylvania. For example, in Lebanon, PA, it was reported that realtors said, "the impact of a pipeline on sales prospects can depend on its proximity to the house, the pressure level of products traveling through the pipeline and whether the property is residential or agricultural" [19].

Recent legal decisions support the notion that landowners are insisting on greater compensation from pipeline companies due to diminution of values of real property with pipelines. And juries are awarding increasing easement values for pipelines [20].

We recognize that real estate appraisers use as comparables similar properties that have sold and they adjust their valuation for certain differences. It is impossible, however, to account for all differences due to the numerous factors that impact a property's selling price.

Many of the studies use the methodology of pairing past sales, but even an alternative methodology such as analyzing the real estate market before and after the construction of a pipeline, is subject to uncertainty, again due to the great

number of factors that can influence real estate purchase decisions. Comparing properties goes well beyond the number of bedrooms and square footage. There are far too many uncertain variables that impact the ability to determine accurate econometric estimate of the impact of pipelines on selling price. Examples of factors beyond bedrooms and square footage include the state of the overall market, an individual's personal reaction to the view, curb appeal, neighbors, schools, layout, condition, etc.

With greater public awareness of climate change, fracking, and all fossil fuel infrastructure impacts, the adverse affect on property values is likely to increase. And, as more and more pipelines are being proposed in the Northeast and Middle Atlantic states, relatively densely populated areas, the risks will multiply and the negative impact on property values will likely become more significant.

Real estate professionals sometimes use the term "stigma" to describe a factor that may reduce property values. Fear of family illness due to emissions from potential leaks or from explosions is certainly a "stigma" that will negatively impact property values near a natural gas pipeline. And PennEast would be no exception.

Health Costs

Numerous acute and chronic health impacts experienced by individuals living and working near compressor stations and pipelines have been documented. (See for example, http://www.environmentalhealthproject.org/wp-content/uploads/2012/03/Compressor-station-emissions-and-health-impacts-02.24.2015.pdf)

Whenever there are negative health impacts, including illnesses and deaths caused by pollutants, there are economic costs. Costs are incurred not only directly by the victims and their families, but costs are incurred by society due to lost time from work and school, declines in productivity, and the use of public resources necessary to provide emergency services and/or health care to impacted individuals.

Economic Costs of Climate Change

The ES&D report describes natural gas as "cleaner burning," and likely to "reduce the risk of price volatility in energy markets". This description is how the gas producers describe their product, but it does not paint an accurate picture of the impacts of increased use of natural gas.

While natural gas produces less carbon dioxide when burned, natural gas extraction and use results in both carbon dioxide and methane emissions (among others) and is far worse for climate change than are renewable energy sources such as wind, water and sunlight.

The gas industry always ignores the fact that natural gas is composed primarily of methane and methane is a far more potent greenhouse gas than carbon dioxide. Methane from natural gas leaks into the atmosphere throughout its production, transmission and delivery. There is a rapidly increasing amount of scientific literature available on this subject. (See for example, http://www.psehealthyenergy.org/data/SS_Methane_Nov2015Final.pdf)

Fracked gas from the Marcellus shale play will be the gas being transmitted in the pipeline. Fracked shale gas is especially harmful to the climate as its greenhouse gas footprint is even larger than that from conventional gas due to additional emissions resulting from flow-back fluids and well completions [21].

Investment in fossil fuel infrastructure, including natural gas pipelines, prolongs and expands the use of natural gas, which due to its highly harmful impact on the climate will exacerbate the economic costs of climate change. There are many different estimates of the economic costs of climate change. One estimate is in the US alone, by 2025, global warming will cost $271 billion per year. This includes severe storm and hurricane damage, real estate loss, energy sector costs, and water costs. This does not include the costs associated with increased morbidity and mortality. So it's a conservative estimate. The World Bank EACC report projected that the cost between 2010 and 2050 of adapting to an approximately 2degree C warmer world by 2050 is in the range of $75 billion to $100 billion per year. (http://siteresources.worldbank.org/INTCC/Resources/EACCReport0928Final.pdf)

It is widely recognized that estimates of economic costs of climate change are conservative because many impacts simply cannot be measured. For example, while the cost of increased fires can be estimated by what it would cost to put them out, one does not know the extent of damage to property and loss of human life that would be caused by the fires.

The Union of Concerned Scientists has prepared an assessment of how climate change would impact the state of Pennsylvania. (http://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/Exec-Summary_Climate-Change-in-Pennsylvania.pdf)

Rutgers University has prepared an assessment of how climate change would impact the State of New Jersey. (http://njadapt.rutgers.edu/climate-impacts-in-new-jersey)

A comprehensive economic impact assessment for the PennEast Pipeline Project would take into account the costs to both Pennsylvania and New Jersey due to climate change that will be caused by the increased greenhouse gas emissions resulting from the Project.

Conclusion

The "economic impact analysis" conducted by ES&D for the PennEast Pipeline Company exaggerates economic benefits and ignores significant economic costs which, in most cases, are not mentioned at all. The economic impact analysis conducted by ES&D is incomplete, inaccurate and unreliable.

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NOTES

[1] Studies of economic impact of shale gas development funded by the oil & gas industry or groups that represent the industry include the following:

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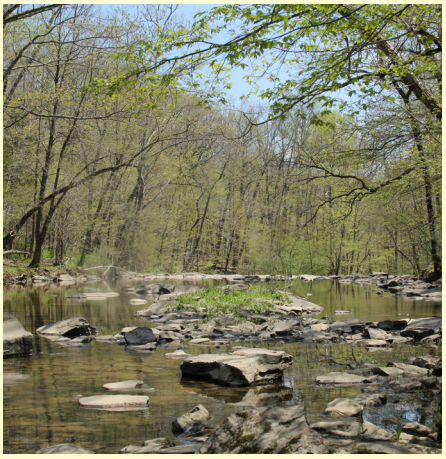
SUMMARY

Expert Report on the PennEast Pipeline Project Economic Impact Analysis for New Jersey and Pennsylvania

Presented to the New Jersey Conservation Foundation by Ian Goodman & Brigid Rowan

November 4, 2015



In their expert report, The Goodman Group, Ltd. (TGG) evaluates the economic impact study (PennEast Pipeline Project Economic Impact Analysis, referred to in this study as the PennEast Analysis) prepared for the PennEast Pipeline Company and co-authored by Econsult Solutions, Inc. and Drexel University School of Economics. TGG's evaluation demonstrates that the PennEast Analysis significantly overstates the Total Jobs (which PennEast estimated at 12,160) from designing and building the pipeline. Specifically, TGG concludes that **the PennEast Analysis has overstated these Total Jobs by approximately two thirds or more**.

Furthermore, it should be noted that these jobs are very short-term in nature. Actual construction would occur over a one-year period (late 2016-late 2017) with activity and jobs concentrated into only six months (early January-early July 2017). Most of the employment impacts (total onsite and offsite jobs) would take place during the same period. Direct Onsite Construction jobs have an average duration of 5.2 months. And half or more of Direct Onsite Construction labor for PennEast would be non-local (residing outside NJ and PA).

TGG's review of employment impact studies for other comparable gas pipelines in the Northeast US shows that the PennEast Analysis multiplier (10.7 jobs per $1 million project cost for all workers) is an outlier with respect to comparable pipelines. Specifically, the multipliers for other similar gas pipelines are only 8-36% of the PennEast Analysis multiplier. TGG therefore concludes that the PennEast Analysis has significantly overstated the Total Jobs numbers (by approximately two thirds or more) based on:

- **our review of employment impact studies for other comparable gas pipelines in the Northeast US;**
- **our evaluation of the PennEast Analysis job estimates and the internal inconsistencies in the PennEast Analysis; and**
- **our review and extensive experience with best practices in employment impact studies, notably for pipelines and other energy projects.**

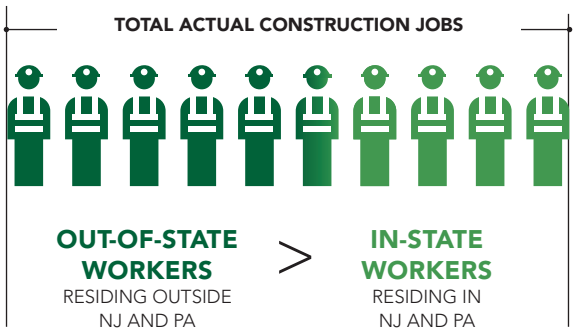
Direct Onsite Construction Jobs

5 MONTHS

Actual construction jobs last on average 5 months.

50% OR MORE

of actual construction jobs go to out-of-state workers

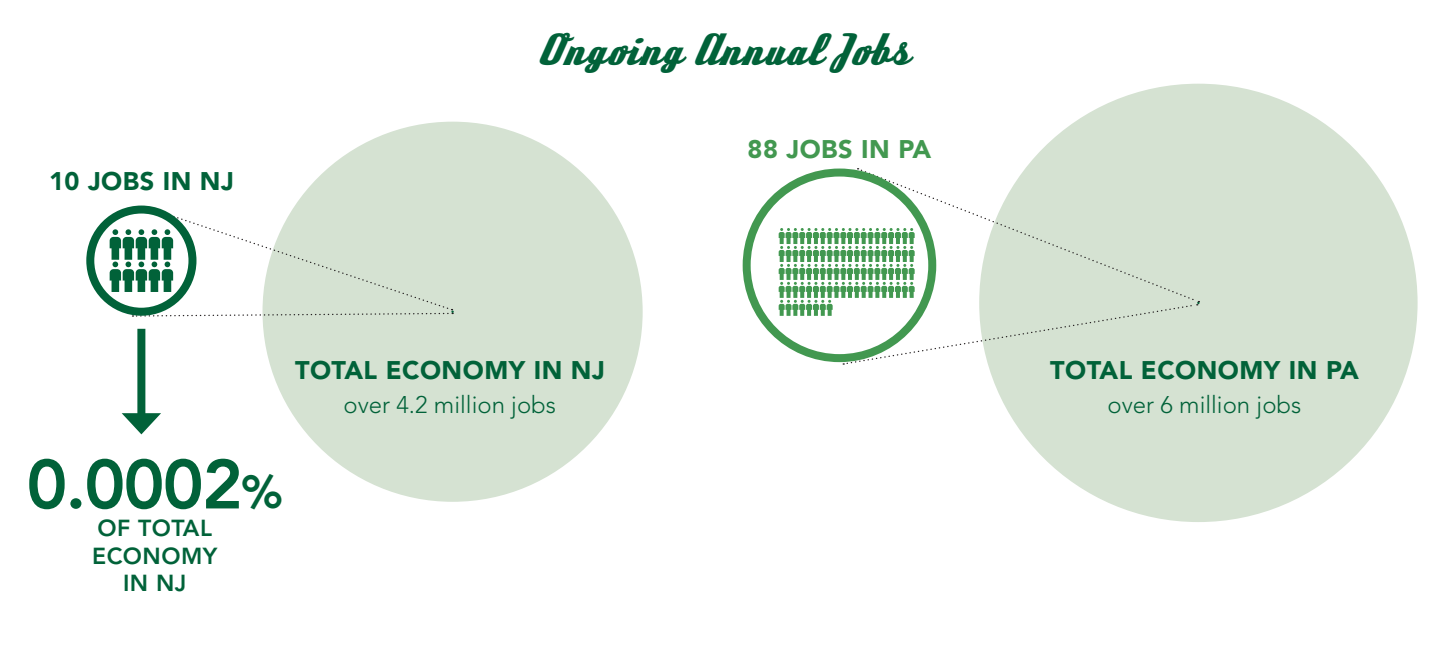


"TGG's evaluation demonstrates that the PennEast Analysis significantly overstates the Total Jobs (which PennEast estimated at 12,160) from designing and building the pipeline. Specifically, TGG concludes that **the PennEast Analysis has overstated these Total Jobs by approximately two thirds or more**."

The TGG Report also evaluates employment impacts from ongoing activities to operate and maintain the pipeline and related facilities. According to the PennEast Analysis, annual jobs from operations (including spinoffs) are 98 in total with 88 in Pennsylvania and 10 in New Jersey. TGG concludes that even using the PennEast estimates, pipeline operations result in very small expenditures (and employment impacts) and have very little positive impact on the economy, especially in New Jersey. But as low as they are, the PennEast estimates of annual jobs from operations may still be overstated. Other pipeline studies (notably for comparable Northeast US gas pipelines reviewed by TGG) estimate substantially lower job impacts from operations.

Finally, TGG also finds that even if the PennEast Analysis' employment impact estimates were realistic:

- the employment impacts from the design and construction of the Project are
  - (a) tiny in the context of the New Jersey and Pennsylvania state economies (less than 0.1% of total New Jersey jobs); and
  - (b) very short-term (mainly from actual construction and related spin-offs which occur over a one year period (mostly in 2017), but are concentrated into only six months);
- the employment impacts from ongoing activities to operate and maintain the pipeline are infinitesimally small, especially in the context of the New Jersey economy (10 jobs or about 0.0002% of total state jobs).



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The full report is available at njconservation.org/docs/PennEastEconomicReport.pdf

Expert Report on the PennEast Pipeline Project Economic Impact Analysis for New Jersey and Pennsylvania

Presented to the New Jersey Conservation Foundation

by Ian Goodman and Brigid Rowan

the goodman group, ltd.
www.thegoodman.com

November 4, 2015

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1 Executive Summary

In this report, The Goodman Group, Ltd. (TGG) evaluates the economic impact study (PennEast Pipeline Project Economic Impact Analysis, referred to in this study as the PennEast Analysis) prepared for the PennEast Pipeline Company, LLC (PennEast) and co-authored by Econsult Solutions, Inc. and Drexel University School of Economics. TGG's evaluation demonstrates that the PennEast Analysis significantly overstates the Total Jobs (estimated at 12,160) from designing and building the pipeline. Specifically, TGG concludes that **the PennEast Analysis has overstated these Total Jobs by approximately two thirds or more.**

Furthermore, it should be noted that these jobs are very short-term in nature. Actual construction would occur over a one-year period (late 2016-late 2017) with activity and jobs concentrated into only six months (early January-early July 2017). Most of the employment impacts (total onsite and offsite jobs) would take place during the same period. Half or more of Direct Onsite Construction labor for PennEast would be non-local (residing outside New Jersey and Pennsylvania).

TGG's review of employment impact studies for other comparable gas pipelines in the Northeast US shows that the PennEast Analysis multiplier (10.7 jobs per $1 million project cost for all workers) is an outlier with respect to comparable pipelines. Specifically, the multipliers for other similar gas pipelines are only 8-36% of the PennEast Analysis multiplier. TGG therefore concludes that the PennEast Analysis has significantly overstated the Total Jobs numbers (by approximately two thirds or more) based on:

- our review of employment impact studies for other comparable gas pipelines in the Northeast US;
- our evaluation of the PennEast Analysis job estimates and the internal inconsistencies in the PennEast Analysis; and
- our review and extensive experience with best practices in employment impact studies, notably for pipelines and other energy projects. (Sections 3 and 4)

The TGG Report also evaluates employment impacts from ongoing activities to operate and maintain the pipeline and related facilities. According to the PennEast Analysis, annual jobs from operations (including spinoffs) are 98 in total with 88 in Pennsylvania and 10 in New Jersey. TGG concludes that even using the PennEast estimates, pipeline operations result in very small expenditures (and employment impacts) and have very little positive impact on the economy, especially in New Jersey. But as low as

they are, the PennEast estimates of annual jobs from operations may still be overstated. Other pipeline studies (notably for comparable Northeast US gas pipelines reviewed by TGG) estimate substantially lower job impacts from operations. (Section 4)

Finally, TGG also finds that even if the PennEast Analysis' employment impact estimates were realistic:

- the employment impacts from the design and construction of the Project are (a) tiny in the context of the New Jersey and Pennsylvania state economies (less than 0.1% of total New Jersey jobs); and (b) very short-term (mainly from actual construction and related spin-offs which occur over a one year period (mostly in 2017), but are concentrated into only six months); (Section 3.3.1 and Appendix A);
- the employment impacts from ongoing activities to operate and maintain the pipeline are infinitesimally small, especially in the context of the New Jersey economy (10 jobs or about 0.0002% of total state jobs). (Section 5.2)

Key findings of this report are summarized as infographs in Figures 1 and 2 in Section 1.1.

Figure 1, The Great Pipeline Jobs Mystery, illustrates two major internal inconsistencies in the PennEast Analysis' job estimates:

- A major disjuncture between Direct Onsite Construction Jobs (2,500) and Total Jobs (12,160).
- A significant internal inconsistency in PennEast's documentation between (a) estimates for Direct Onsite Construction Jobs (2,500) and Total Jobs (12,160); and (b) estimates for "construction" (6,000) and "other" (5,210) jobs in the Six-County Region.

These inconsistencies reveal that the PennEast analysis failed to perform a basic check to verify the reasonableness of the results from its economic modeling exercise. (Section 3.3.2)

Figure 2, Estimated Total Job Impacts from Building Northeast US Gas Pipeline Projects, compares employment impacts from PennEast (as estimated by the PennEast Analysis) to those of four similar gas pipeline projects in the Northeast US. **Figure 2** provides a graphic illustration that the PennEast Analysis multiplier is an outlier with respect to comparable pipelines. As indicated above, based on this comparison, as well as our review of the internal inconsistencies of the PennEast Analysis and our extensive experience with best practices in employment impact studies, TGG concludes the PennEast Analysis has significantly overstated the Total Jobs numbers. (Section 4)

1.1 Figures

For the convenience of the reader, the complete group of infographs (Figures 1-2) is provided on the following pages.

Figure 1, The Great Pipeline Jobs Mystery, illustrates the internal inconsistencies in the PennEast's Job Estimates. These inconsistencies are examined in Section 3.3.2.

Figure 2, Estimated Total Job Impacts from Building Northeast US Gas Pipeline Projects, compares employment impacts from PennEast (as estimated by the PennEast Analysis) to those of four other comparable gas pipeline projects in the Northeast US. Figure 2 is described in Section 4. Appendix B provides detailed sources and notes for each of the pipelines in Figure 2.

FIGURE 1

THE GREAT PIPELINE JOBS MYSTERY

Revealing Internal Inconsistencies in PennEast's Job Estimates

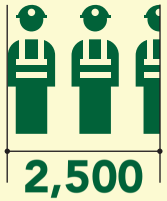
= 1,000 JOBS

ACCORDING TO **THE PENNEAST WEBSITE OVERVIEW**

"The project is expected to

CREATE 2,500 LOCAL JOBS

during construction, which is expected to take approximately seven months to complete."[1]



2,500

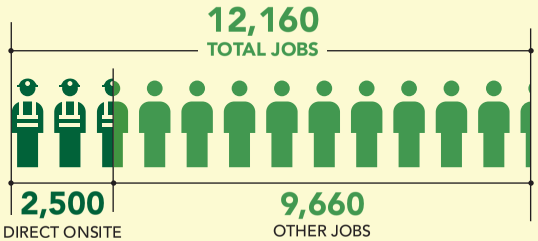
DIRECT ONSITE CONSTRUCTION JOBS OVER 7 MONTHS

?

ACCORDING TO **PENNEAST'S ANALYSIS**

In NJ and PA combined, the Project is expected to

SUPPORT 12,160 JOBS.[2]



?

ACCORDING TO **PENNEAST'S ANALYSIS**

In the six-county region, the Project is estimated to

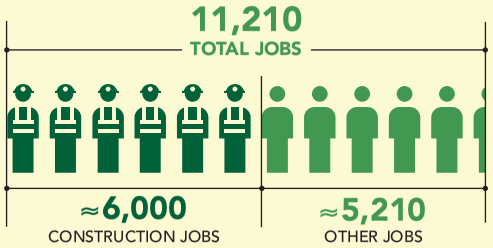
SUPPORT 11,210 JOBS.[3]

AND **THE PENNEAST WEBSITE ECONOMIC IMPACT FACT SHEET**

"Within the six-county region,

SLIGHTLY LESS THAN HALF

of the employment impact will occur in industries other than construction, including: food services, landscaping, legal services and the real estate establishment."[4]



1. http://penneastpipeline.com/overview/.
2. p. 11.
3. p. 11.
4. Economic Impact of the PennEast Pipeline's Construction and Operation Fact Sheet, http://penneastpipeline.com/DrexelFactSheet/.

FIGURE 2

ESTIMATED TOTAL JOB IMPACTS

from Building Northeast US Gas Pipeline Projects

NOTE 1: The average duration of jobs is 1 year for all estimates except the PennEast Analysis, which did not explain the duration of estimated jobs.

NOTE 2: Total jobs for in-state residents were not provided for PennEast nor for Northeast Supply Link. Total jobs for all workers were not provided for Atlantic Sunrise.

2 Introduction

2.1 Objectives of the TGG Report

The New Jersey Conservation Foundation retained the services of The Goodman Group, Ltd. (TGG) to produce an independent expert report (TGG Report) on the PennEast Pipeline Project Economic Impact Analysis for New Jersey and Pennsylvania. The objective of this expert report is to evaluate the economic impact study (PennEast Pipeline Project Economic Impact Analysis, referred to in this study as the PennEast Analysis) prepared for the PennEast Pipeline Company, LLC (PennEast) and co-authored by Econsult Solutions, Inc. and Drexel University School of Economics.

2.2 TGG's Approach

TGG's approach is to review and evaluate the key sections of the PennEast Analysis relating to employment impacts of the Project from (a) Capital Infrastructure Economic Impacts (i.e. employment related to capital investment to design and construct the pipeline); and (b) Ongoing Economic Impacts (i.e. employment impacts related to the ongoing activities to operate and maintain the pipeline and related facilities). We strengthen our evaluation of the PennEast Analysis by providing a review of employment impact studies for other comparable gas pipelines in the Northeast US. TGG concludes that the PennEast Total Jobs estimate is significantly overstated. This conclusion is based on our review of comparable gas pipeline studies, as well as on our evaluation of the PennEast Analysis job estimates and their internal inconsistencies, and on our extensive experience with best practices in employment impact studies.

2.3 Road Map for the Report

Section 1 is the Executive Summary Section. The current section is Section 2, the Introduction.

Section 3 reviews and evaluates the PennEast Analysis relating to employment impacts of the Project from Capital Infrastructure Economic Impacts (i.e. employment impacts related to capital investment to design and construct the pipeline). Section 3.1 explains Capital Infrastructure Economic Impact and the various job categories used in

employment studies. Section 3.2 summarizes the PennEast Analysis' estimates of employment impacts related to capital investment to design and construct the pipeline. Section 3.3 provides TGG's evaluation of the PennEast Analysis' estimates of employment impacts to design and construct the pipeline. In Section 3.3.1, TGG emphasizes that (a) even if the PennEast employment impact estimates were realistic, the employment impacts from the Project are tiny in the context of the New Jersey and Pennsylvania state economies; and (b) the jobs are very short-term. Section 3.3.2 describes major internal inconsistencies in PennEast's job estimates. These inconsistencies reveal that PennEast has failed to perform a reasonableness test on the results from its economic modeling. Section 3.3.3.1 describes the information gaps in the PennEast Analysis that present challenge for understanding how their estimates were developed.

Despite these information gaps, TGG identified the following possible causes for the internal inconsistencies and overstatement of estimates in the PennEast Analysis:

- The inherent limitations of Input-Output (I-O) modeling and in particular a problematic application of I-O modeling that does not take into account the limitations of the model or perform reasonableness tests on the results. (Section 3.3.3.2)
- Given the nature of pipeline construction, the application of a generic I-O construction sector model leads to overstatement of employment impacts. (Section 3.3.3.3)
- The job impacts estimated by the PennEast Analysis significantly overstate the benefits for local workers residing in New Jersey and Pennsylvania. (Section 3.3.3.4)
- The percentage of in-state spending is overestimated in the PennEast Analysis. (Section 3.3.3.5)
- PennEast Analysis counts some jobs related to the Project that have already been created. (Section 3.3.3.6)
- Total jobs are not presented as annualized jobs. (Section 3.3.3.7).

Section 4 describes Figure 2, which compares employment impacts from PennEast (as estimated by the PennEast Analysis) to those of four other comparable gas pipeline projects in the Northeast US. As indicated above, this review of comparable pipelines provides further evidence that the PennEast Analysis has significantly overstated the Total Jobs numbers.

Section 5 reviews and evaluates Annual Ongoing Economic Impacts (i.e. employment impacts related to the ongoing activities to operate and maintain the pipeline and related

facilities). Section 5.1 summarizes the PennEast Analysis' estimates of employment impacts related to ongoing activities to operate and maintain the pipeline. Section 5.2 provides TGG's evaluation of the PennEast Analysis' estimates in Section 5.1. TGG concludes that employment impacts related to ongoing activities to operate and maintain the pipeline are infinitesimally small, especially in the context of the New Jersey economy (10 jobs or about 0.0002% of total state jobs). But as low as they are, the PennEast Analysis estimates may still be overstated.

Finally Section 6 presents the key conclusions from the TGG Report.

Appendix A contains (a) a more detailed general explanation of the annualization of job estimates; and (b) a more specific discussion of the annualization of Direct Onsite Construction Labor for PennEast project, particularly in the context of the most recent information from the September 2015 PennEast FERC Application. Appendix B provides (a) a description of FERC (United States Federal Energy Regulatory Commission) process and documents for gas pipeline construction projects; and (b) detailed sources and notes for each of the pipelines described in Figure 2.

3 PennEast Analysis: Capital Infrastructure Economic Impacts

3.1 Capital Infrastructure Employment Impacts and Job Categories

Consistent with most studies on pipeline employment impacts, the PennEast Analysis classifies employment impacts of the Project in two categories: Capital Infrastructure Economic Impacts and Ongoing Economic Impacts. Employment impacts related to Capital Infrastructure are the employment impacts related to capital investment to design and construct the pipeline. Put more simply, these are the temporary jobs related to the design and construction of the Project. These temporary jobs represent the majority of the jobs relating to the Project expenditures.

Jobs related to the design and construction of the Project include both onsite and offsite jobs. The PennEast job estimates include a very wide range of spin-offs throughout the supply chain and economy. Put simply, in addition to the jobs onsite (Direct Onsite Construction jobs), these employment estimates include jobs offsite:

- direct design, engineering, permitting, and support jobs;
- upstream jobs in the supply chain, providing services, materials and other inputs (also known as indirect jobs); and
- downstream jobs as workers spend income from jobs upstream, offsite and onsite (also known as induced jobs).

Offsite jobs are widely dispersed in sectors throughout the economy, as well as geographically.[1] So it is not feasible to directly count the jobs for spin-offs, especially for a project that has not yet been built. Instead, jobs with spin-offs are estimated based on an economic model, which is a highly simplified representation of how the economy actually operates.[2]

[1] Onsite jobs are tied to project locations; jobs elsewhere (offsite, upstream, and downstream) can be located in other states and countries. And even if jobs are located in-state, the labor supply for these jobs (especially for onsite construction) may be workers from other states. Assumptions related to in-state workers and in-state respending are highly relevant to the PennEast job estimates and will be discussed in Section 3.3.3.

[2] As will be discussed in more detail in subsequent sections, PennEast job estimates including spin-offs were generated using an Input-Output (I-O) model. To estimate employment and other economic spin-off effects, I-O models generate regional economic impact estimates by tracing the industries involved in a study region throughout successive rounds of supply linkages. At each step, they trace the portion of the inputs required from each industry, which are supplied locally (within the regional economy being (footnote continued on next page)

Employment impacts related to Ongoing Economic Impacts are the "permanent" jobs related to the operation and maintenance of the Project. The jobs from operation of the Project are tiny; Ongoing Economic Impacts will be discussed in Section 5. The PennEast Analysis (pp. 13-14, 16) claims that the Project will also have Ongoing Annual Economic Impact in terms of energy cost savings, but does not specify the amount of these cost savings and related job impacts. So except as discussed in footnote 48, the TGG Report does not consider Ongoing Annual Economic Impact as it relates to energy cost savings.

The current section first describes PennEast's Estimates for the Capital Infrastructure employment impacts, i.e. the temporary jobs related to the design and construction of the project. TGG then provides its evaluation of PennEast's Estimates.

3.2 PennEast's Estimates

Section 3.2 of the PennEast Analysis (p. 8) explains that:

> The economic impact from the Project's expenditures can be modeled by constructing an input-output model. This was done using IMPLAN, an industry standard input-output model software program. Such models are designed to estimate two sets of spillover impacts from direct expenditures:
>
> - The indirect effect, which measures the multiplier effect from the purchase of goods and services from local vendors; and
> - The induced effect, which measures the multiplier effect from the spending of labor income by employees within a particular geography.[3]

(footnote continued from previous page)
modeled). Input-Output analyses consider a wide range of job impacts and include the following categories of effects:

- Direct Effects: first round impacts of a set of expenditures, i.e. those occurring before the involvement of supporting supply linkages;
- Indirect Effects: impacts generated through subsequent purchases by suppliers of materials and services to sustain the original activities;
- Induced Effects: impacts generated by workers spending incomes earned through direct and indirect employment activities;
- Total Effects: the sum of the direct, indirect, and induced effects.

[3] See preceding footnote for a more detailed generic explanation of the categories of effects considered by I-O models. See also Section A.3 Economic Impact Model, Appendix A, PennEast Analysis (pp. A-2 to A-5) for a discussion the report's economic modeling. Section 3.3.3 of the current report will evaluate the PennEast's Analysis' use of I-O modeling and related assumptions.

Table 3.1 of the PennEast Analysis (p. 10) provides Design and Construction Expenditure Inputs for PennEast's Economic Impact Model. The Total Project Expenditure is $1,193 million, of which Total Construction Labor Expenditure is $733 million.

Table 3.2 (p. 11) provides Direct Output, Indirect and Induced Output (in dollars); Employment Supported (jobs); and Labor Income Supported (in dollars), respectively broken down by Total Impact in Pennsylvania and New Jersey, Six-County Region,[4] and Commonwealth of Pennsylvania and State of New Jersey respectively.

Table 3.2 of the PennEast Analysis (p. 11) provides the following specific and relevant information concerning the employment impacts related to the design and construction of the Project:

- 12,160 jobs for Pennsylvania and New Jersey
- 11,210 jobs for the Six-County Region
- 9,290 jobs for Pennsylvania
- 2,870 jobs for New Jersey.

The above job estimates are based on the PennEast Analysis Input-Output modeling.

A fact sheet for the PennEast Analysis on the PennEast website also indicates the following:

> PennEast will support 12,160 jobs, of which a large portion will be related to the construction industry. Hundreds of architectural and engineering jobs in several related industries will also be supported. Within the six-county region, slightly less than half of the employment impact will occur in industries other than construction, including: food services, landscaping, legal services, and the real estate establishment.[5]

None of the job numbers in Table 3.2 (Total, Six-County Region, Pennsylvania or New Jersey) is broken down by category of job (direct, indirect, induced).[6] Nor is the duration provided for these temporary jobs. TGG was unable to find this information in any other PennEast documents reviewed. While the PennEast Analysis provides an abstract

[4] The Six-County area that the Project traverses (Hunterdon and Mercer Counties (in New Jersey) and Luzerne, Carbon, and Northampton Counties (in Pennsylvania)).
[5] Economic Impact of the PennEast Pipeline's Construction and Operation Fact Sheet. PennEast Pipeline website. Accessed August 25, 2015. http://penneastpipeline.com/DrexelFactSheet/
[6] PennEast Analysis, p. 11.

discussion of multipliers,[7] no concrete employment multipliers are provided in the Analysis. Moreover, the PennEast Analysis methodology is also poorly documented making it impossible to know how these estimates were developed. These information gaps will be discussed in more detail in Section 3.3.3.1.

As explained above, the PennEast Analysis estimates the project will support 11,210 jobs in the Six-County Region (and 12,160 jobs in New Jersey and Pennsylvania), with about half of these jobs in construction. Meanwhile, according to the PennEast website overview, "[t]he project is expected to create 2,500 local jobs during construction, which is expected to take approximately seven months to complete."[8] This figure of 2,500 jobs matches an estimate by PennEast for Direct Onsite Construction labor, as reported to FERC in April 2015. Prior to filing its September 2015 FERC Application, PennEast has provided various estimates ranging from 2,000 to 2,500 workers for Direct Onsite Construction Labor.

The September 2015 FERC Application now estimates 2,660 workers for Direct Onsite Construction Labor; duration of jobs for these workers would be very short-term (averaging 5.2 months). These estimates will be further discussed in Appendix A.[9]

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[7] Section A.2 Application, Appendix A, PennEast Analysis (pp. A-1 to A-2). Multipliers with be discussed in Section 3.3.3.1.

[8] The PennEast Pipeline Project Overview. PennEast Pipeline website. Accessed September 1, 2015. http://penneastpipeline.com/overview/

In another (apparently earlier) version of Project Overview, the project is estimated to create 2,000 local jobs during construction that will take approximately seven months to complete. Factsheet: PennEast Pipeline Overview. PennEast Pipeline website. Accessed September 1, 2015. http://penneastpipeline.com/wp-content/uploads/2015/01/PennEast_Overview_11-7-14.pdf

[9] In a pre-filing draft submission to FERC, PennEast estimates a workforce of 625 workers at each of 4 construction spreads, for a total of 2,500 workers. Duration of these jobs is not specified, and it is unclear whether the estimated number of workers is peak or average workforce. Resource Report 5 (Pre-filing Draft April 2015, Penn East submission to FERC in Docket PF15-1), pp. 5-3-5-4. http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13844811
See Appendix B (p. 47) of this report, for explanation of FERC Process and Documents for Natural Gas Pipeline Construction Projects.

In a later revised pre-filing draft submission to FERC, PennEast estimates a construction workforce of approximately 2,300 workers. Draft Resource Report 1, General Project Description, Revised Draft July 2015, p. 1-86. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13946534

As documented above and in footnote 8, prior to filing its September 2015 FERC submission, PennEast has provided various estimates ranging from 2,000 to 2,500 workers during construction. PennEast has stated that construction will take about seven months to complete, but it did not specify how many workers will be needed for how long.

As will be further discussed in Appendix A of this report, in its September 2015 Application to FERC, PennEast estimates a workforce of 665 workers at each of 4 construction spreads, for a total of 2,660 workers. It is clear the estimated number of workers is peak workforce; the average workforce would be much smaller. Construction will occur over a one year period (late 2016-late 2017), but activity and jobs are concentrated into only six months (early January-early July 2017). Based on the PennEast estimates in the September 2015 FERC Application (Table 5.3-3, pp. 5-4 – 5-5), TGG has derived that (footnote continued on next page)

PennEast does not estimate Direct Onsite Construction Jobs based on the PennEast Analysis Input-Output modeling. Instead, PennEast estimates Direct Onsite Construction Jobs based on the detailed design/engineering/costing process required to develop a pipeline project. Direct Onsite Construction jobs are easier to measure than offsite jobs. Therefore, estimates for these jobs are generally more accurate than estimates for offsite jobs.[10]

3.3 TGG's Evaluation

This section presents TGG's evaluation of the PennEast Employment Impact Estimates.

3.3.1 Employment Impacts from Building PennEast Are Tiny and Short-Term

First, it should be understood that even if the PennEast Analysis' employment impact estimates were realistic, the employment impacts from the Project are tiny in the context of the New Jersey and Pennsylvania state economies. The PennEast Analysis estimates 2,870 total jobs (i.e. onsite and offsite) from design and construction in NJ and 9,290 total jobs from design and construction in PA.[11] However, NJ has more than 4 million total jobs, and PA has more than 6 million total jobs.[12] Therefore, even using

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(footnote continued from previous page)
the average workforce (over the entire one-year construction period) is only 1,158 workers. Given a peak workforce of 2,660 workers and average workforce of 1,158 workers over 1 year (equivalent to 1158 average annual jobs), TGG has calculated that the average duration of Direct Onsite Construction jobs is 5.2 months (1158 average jobs/2660 peak jobs=5.2 months/12 months). Resource Report 5 (September 2015, Penn East submission to FERC in Docket CP15-558), Section 5.3.2, pp. 5-3-5-5. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13995678

Note: According to INGAA (Interstate Natural Gas Association of America), "a typical interstate, long-haul (long-distance) pipeline project is constructed in manageable sections known as construction spreads that use highly specialized and qualified work crews. Each crew has its own set of responsibilities." (Building Interstate Natural Gas Pipelines: A Primer, p. 25, http://www.ingaa.org/file.aspx?id=19618)

[10] As further discussed in Appendix A, the PennEast estimate of Direct Onsite Construction jobs is based on detailed project planning, including determining how many workers would be needed during each week of the construction period. Companies developing pipeline projects typically provide detailed estimates of Direct Onsite Construction jobs as part of their submissions to FERC.

Meanwhile, as indicated in Section 3.1, offsite jobs are widely dispersed in sectors throughout the economy and geographically and cannot be directly counted, especially for a project that has not been built. As such, they are estimated based on an economic model, which is a highly simplified representation of how the economy works. There is substantial judgment, uncertainty and controversy related to how offsite jobs are estimated.

[11] The state abbreviations for New Jersey and Pennsylvania, i.e. NJ and PA, are often used for brevity throughout this report.

[12] NJ has over 4.5 million workers and over 4.2 million jobs; PA has over 6.4 million workers and over 6.0 million jobs. http://www.bls.gov/eag/eag.nj.htm http://www.bls.gov/eag/eag.pa.htm

PennEast's own inflated estimates, the short-term employment benefits from building PennEast in NJ are less than 0.1% of total state jobs.

Moreover any jobs related to building the Project are very short-term. Based on estimates from the September 2015 FERC Application, TGG has calculated that jobs from actual construction have a duration averaging only 5.2 months.[13] Spinoffs from actual construction will also be short in duration. There are some additional jobs prior to actual construction (such as for design and engineering), but these job impacts are also small and of short-term duration.

Based on the schedule provided by PennEast, the prebuild period is in 2014-2016, with almost all of the actual construction in 2017, concentrated in a six-month period.[14] So while total jobs relating to development and building the Project will be spread over a 4-year period 2014-2017, most will occur in 2017.

According to PennEast's September 2015 FERC Application, actual construction will occur over a one-year period (late 2016-late 2017) with activity and jobs concentrated into only six months (early January-early July 2017). Most of the employment impacts (i.e. the total onsite and offsite jobs) will take place during the same period.

The following subsections (3.3.2 and 3.3.3) highlight the inconsistencies and missing information in the PennEast Analysis and examine why the PennEast estimates for employment impacts related to the Construction Phase are likely inflated.

3.3.2 Internal Inconsistencies in PennEast Job Estimates

Figure 1, The Great Pipeline Jobs Mystery: Revealing Internal Inconsistencies in PennEast's Job Estimates (see Section 1.1), illustrates two major inconsistencies related to the PennEast Analysis:

1. A major disjuncture between Direct Onsite Construction Jobs and Total Jobs.
2. A significant internal inconsistency in PennEast's documentation between (a) estimates for Direct Onsite Construction Jobs and Total Jobs; and (b) estimates for "construction" and "other" jobs in the Six-County Region.

[13] See footnote 9.
[14] The PennEast Pipeline Project Overview. PennEast Pipeline website. Accessed September 1, 2015. http://penneastpipeline.com/overview/; and Resource Report 5, Socioeconomics, September 2015, Table 5.3-3: Construction Workforce Schedule Breakdown by Duration, pp. 5-4-5-5 http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13995678.
Note: in the previous reference (part of PennEast's September 2015 Application to FERC), PennEast estimates that there will be a small amount of construction in late 2016 (October to early December).

1. Major Disjuncture Between Direct Onsite Construction Jobs and Total Jobs

In Figure 1, the first and second boxes provide a clear illustration of the major disjuncture between the very low number of Direct Onsite Construction jobs and the very high number of Total Jobs (which includes mainly offsite jobs).

As discussed in the previous section, according to the PennEast website overview, "[t]he project is expected to create 2,500 local jobs during construction, which is expected to take approximately seven months to complete."[15] This figure of 2,500 jobs matches an estimate by PennEast for Direct Onsite Construction labor, as reported to FERC, but PennEast has provided various estimates ranging from 2,000 to 2,660 workers during construction.[16]

However, Table 3.2 of the PennEast Analysis (p. 11) indicates that the total employment impact related to the design and construction of the Project in Pennsylvania and New Jersey is 12,160. In other words, the Total Jobs (Direct Onsite Construction Jobs and Offsite Direct Jobs, as well as offsite upstream (indirect) and downstream (induced)) from the Project are estimated by PennEast at 12,160.

Figure 1 compares (a) the 2,500 Direct Onsite Construction Jobs (based on PennEast's estimates of workers on site, as reported to FERC) with (b) the 12,160 Total Jobs related to design and construction labor for the PennEast Analysis (based on Input-Output modeling).

It is a mystery how 2,500 Direct Onsite Construction Jobs can result in 12,160 Total Jobs. For every Direct Onsite Construction Job to build the pipeline, PennEast is estimating that there are almost five (i.e. 4.9) Additional Offsite Jobs generated. Additional Offsite Jobs are defined as other direct offsite construction jobs and upstream jobs providing services and materials, as well as downstream jobs from respending of wages. (See Section 3.1 for a more detailed discussion of the breakdown of Total Jobs.)

An estimate of 4.9 Additional Offsite Jobs is much higher than what is normally expected for comparable pipelines. As will be demonstrated in Section 4, job studies for comparable pipelines typically estimate much lower job impacts per dollar expended compared to the PennEast Analysis.

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[15] The PennEast Pipeline Project Overview. PennEast Pipeline website. Accessed September 1, 2015. http://penneastpipeline.com/overview/

[16] The PennEast Analysis does not provide an estimate for the number of Direct Onsite Construction Jobs; however information on Construction Labor requirements is provided in other PennEast documentation, including documents submitted to FERC. In other PennEast documentation (see footnotes 8 and 9), Direct Onsite Construction Labor is estimated to require between 2,000-2,660 workers.

As such, the Total Jobs estimate of 12,160 for the design and construction of the pipeline appears to be significantly inflated.

Estimates of the Additional Offsite Jobs vary according to the specific characteristics of the gas pipeline considered. In particular, these estimates depend on how labor-intense the construction is in terms of Additional Offsite Jobs versus Onsite Jobs.

The relative labor intensity of gas pipelines can vary based on numerous characteristics, including:

- project design and budget (notably the mix of Direct Onsite Construction and other project inputs including materials and services), which are affected by project characteristics, including:
    - mix of pipeline versus other facilities (including compressor stations, and meter and regulator stations)
    - mix of new facilities, versus expansion/modification of existing facilities
    - pipeline diameter
    - terrain
    - proximity to populated and other sensitive areas
    - amount and complexity of permitting, design, and construction
- the extent to which project inputs are sourced and produced in-state
- respending (notably, the extent to which labor income is spent in-state and results in in-state jobs)
- relative labor income per job (notably for Direct Onsite Construction, versus other jobs, such as from responding).

In general, pipeline projects will result in more spinoffs/offsite jobs in states like Texas, which have the following characteristics:

- large and diverse economy
- extensive in-state supply chain and workforce for pipeline projects
- high labor income per job for Direct Onsite Construction and relatively low labor income for other jobs, such as from respending.

But Pennsylvania and especially New Jersey do not have enough of these characteristics, such that pipeline projects in these states will not typically result in a high level of spinoffs/offsite jobs. Likewise, the economies in other Northeast US states are broadly similar to Pennsylvania and especially New Jersey, and also do not have the characteristics that result in a high level of spinoffs for pipeline projects.

The above discussion of the labor intensity of gas pipelines further reinforces TGG's assessment that 4.9 Additional Offsite Jobs for each Direct Onsite Construction Job is unusually high. TGG's review of employment impact studies for other comparable gas pipelines in the US Northeast (which will be provided in Section 4) demonstrates that job studies for comparable pipelines typically estimate much lower job impacts per dollar expended compared to the PennEast Analysis.

We note that New Jersey observers have also been confused by the disjuncture between the 2,500 Direct Onsite Construction Jobs and the 12,160 Total Jobs. A February 2015 article entitled "PennEast natural gas pipeline economic study questioned: Is it 12,160 or 2,500 jobs?" in the Times of Trenton/nj.com focused on this same mystery:

> For months during public meetings, PennEast company representatives said it was going to take about 2,000 construction workers to build its proposed $1.2 billion natural gas pipeline from Northeastern Pennsylvania to Mercer County.
>
> But on Monday, PennEast -- a consortium of major East Coast natural gas providers - released a study backed by Drexel University's business school saying the construction of the bi-state pipeline would "support" 12,160 jobs.
>
> The difference comes from the definition of "support."
>
> The project would employ 2,500 temporary construction workers to actually build the pipeline, a task expected to take about seven months, said to Patricia Kornick, PennEast spokeswoman.
>
> The remainder of the 9,960 [sic][17] jobs cited in the Drexel study are ancillary positions created by the $1.6 billion in economic activity generated by the construction, Kornick said.
>
> "The other jobs [sic] be across other supporting industries," Kornick said. "There would be consulting and architectural, food services and other sectors."
>
> For instance, if the operator of a taco truck pulled up to a construction area to feed hungry workers at lunchtime, that operator would be counted as one of the 12,160 jobs "supported" by the a pipeline, under the formula employed by the Drexel study.
>
> "That would fall under the food services category," Kornick said.[18]

[17] 12,160 minus 2,500 = 9,690 not 9,960.
[18] "PennEast natural gas pipeline economic study questioned: Is it 12,160 or 2,500 jobs?" Times of Trenton/NJ.com, February 14, 2015. Accessed August 31, 2015. http://www.nj.com/mercer/index.ssf/2015/02/penneast_pipeline_would_create_just_2500_temporary.html

The article highlights that it is simply not credible that the original 2,500 Direct Onsite Construction Jobs generated a total of 12,160, including "ancillary positions" of 9,690[19] jobs. This defies common sense and is inconsistent with employment impacts from comparable pipeline studies, as will be shown in Section 4.

2. Significant Internal Inconsistency in PennEast's Documentation Regarding Construction Jobs and Other Jobs

In addition to the disjuncture between Direct Onsite Construction Jobs and Total Jobs, there is also significant internal inconsistency in PennEast's documentation between (a) estimates for Direct Onsite Construction Jobs and Total Jobs; and (b) estimates for "construction" and "other" jobs in the Six-County Region (as will be further detailed below).

This internal inconsistency is illustrated in Figure 1 (between the second and third boxes).

As mentioned in the previous section, a fact sheet for the PennEast Analysis on the PennEast website indicates the following:

> PennEast will support 12,160 jobs, of which a large portion will be related to the construction industry. Hundreds of architectural and engineering jobs in several related industries will also be supported. Within the six-county region, slightly less than half of the employment impact will occur in industries other than construction, including: food services, landscaping, legal services, and the real estate establishment.[20]

According to Table 3.2 of the PennEast Analysis (p. 11), Total Jobs in the Six-County Region are estimated at 11,210. Therefore TGG has assumed that PennEast is implying that approximately 6,000 (of these 11,210 jobs) will be in construction and about 5,210 ("slightly less than half" of the 11,210) will be in other industries.

Even if the 6,000 construction jobs are assumed to include jobs offsite as well as onsite, there is a considerable disjuncture between 6,000 construction jobs and 2,500 Direct Onsite Construction Jobs. This would imply that there are more construction jobs offsite than onsite jobs, which seems highly unlikely.

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[19] As explained in the preceding footnote, 12,160 minus 2,500 = 9,690 not 9,960.
[20] Economic Impact of the PennEast Pipeline's Construction and Operation Fact Sheet. PennEast Pipeline website. Accessed August 25, 2015. http://penneastpipeline.com/DrexelFactSheet/

FERC Staff has also identified this inconsistency in PennEast's construction job numbers. In its Information Request 4 to PennEast on May 29, 2015 in regard to the PennEast Analysis, FERC Staff asked the following:[21]

> Many commenters expressed concern about the conclusions of the Econsult Solutions Inc. and Drexel University economic impact analysis, which estimates that construction of the Project would support a total of 12,160 jobs. The fact sheet on PennEast's web site states that "slightly less than half (of these jobs) would be in industries other than construction." This implies that more than 6,000 jobs would be in the construction sector. This appears to conflict with other estimates presented in draft Resource Report 5 of 2,500 people employed during construction. Explain this apparent discrepancy.

In conclusion, the internal inconsistencies discussed in this section reveal that PennEast failed to perform a basic check to verify the reasonableness of the results from its economic modeling exercise (particularly for the 12,160 Total Jobs) by comparing these to other estimates for construction jobs in the company's own documents. In the following section, TGG offers some potential explanation for these internal inconsistencies and the overstatement of employment estimates in the PennEast Analysis.

3.3.3 Explaining the Internal Inconsistencies and Overstatement of Job Estimates in PennEast Analysis

3.3.3.1 Information Gaps in the PennEast Analysis

Before we outline possible causes for the internal inconsistencies and overstatement in the employment impact estimates related to Capital Infrastructure Investment, this section discusses the information gaps in the PennEast Analysis. These information gaps present a challenge for understanding how the PennEast estimates were developed.

No Breakdown of Job Numbers by Category of Employment

As discussed in Section 3.1, the PennEast Analysis provides job numbers related to the design and construction of the Project by various geographical regions (Total, Six-County Region, Pennsylvania, New Jersey), but fails to provide a breakdown of these numbers by job category (either in terms of direct, indirect and induced jobs; or in terms of direct onsite construction and other offsite jobs (i.e. direct offsite construction jobs, upstream jobs (indirect jobs) or downstream jobs (respending)).[22] A breakdown of

[21] http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=13890804
[22] See Section 3.1.

employment estimates by job category is considered a best practice and is commonly provided in other employment impact studies.

No Definition of Jobs and No Duration for Temporary Jobs

The PennEast Analysis fails to provide a definition of what a job constitutes. In particular, the Analysis fails to provide a duration for the 12,160 temporary jobs. TGG was unable to find this information in any other PennEast documents reviewed.

The failure to provide a duration for the 12,160 temporary jobs is highly problematic because without a duration, it is impossible to:

- evaluate with certainty the employment benefits estimated for the Project;
- compare the employment benefits estimated for the Project with the benefits estimated in employment impact studies for other pipelines.

Various jobs can be of various durations, so it is useful to define them by expressing them in terms of a standard measure. There are several standard measures including (a) average annual jobs, (b) job-years/person-years, and (c) Full-Time Equivalents (FTEs). These various measures can differ a bit in their precise definition and calculation, but in general they are measured in terms of 1 job for 1 worker for 1 year. The annualization of job estimates is common in other pipeline studies and allows for jobs of varying duration to be meaningfully compared. Job-years/person-years and FTEs have been used in employment studies of natural gas pipelines comparable to PennEast, including Atlantic Sunrise and Northeast Supply Link. The Average annual jobs measure was used by the US Department of State in its Final Supplementary Environmental Impact Statement (FSEIS) for Keystone XL.[23] As will be discussed in Appendix A, the annualization of employment benefits is considered a best practice in employment impact studies. Annualization of PennEast jobs will be revisited in Appendix A.

We note that Econsult Solutions Inc. (lead author of the PennEast Analysis) has also published an economic impact study on another pipeline in Pennsylvania (Sunoco Logistics' Mariner East Projects for natural gas liquids).[24] The Mariner East study was released just four days before the February 9, 2015 release of the PennEast Analysis, and it is in some ways very similar to the PennEast Analysis. However, the job numbers

[23] http://keystonepipeline-xl.state.gov/documents/organization/221186.pdf pp. 4.10-13-4.10-15.
[24] The Economic Impact of Sunoco Logistics' Mariner East Projects in Pennsylvania, Econsult Solutions Inc., February 5, 2015, p. 7. Accessed September 4, 2015. http://www.econsultsolutions.com/wp-content/uploads/Sunoco-Logistics-Mariner-East-Economic-Impact-Report.pdf

for Mariner East are expressed in FTEs.[25] Therefore Econsult is familiar with this best practice in employment impact analysis, but chose not to present the PennEast job numbers in this standard and meaningful manner.

No Job Multipliers

While the PennEast Analysis provides an abstract discussion of multipliers,[26] no concrete employment multipliers are provided in the Analysis.[27] In the examination of the employment impacts of pipeline projects, a useful multiplier (and summary metric) is jobs per dollar (typically in terms jobs per $1 million project cost). Multipliers facilitate comparison of results within and across studies. With results expressed in terms of multipliers, projects (and other activities) with differing levels of spending can be compared to determine relative intensity of impacts.

While the PennEast Analysis does not present any of its results in terms of multipliers, an overall multiplier for the Potential Economic Impact from Design and Construction of the Project can easily be derived from Tables 3.1 and 3.2. Table 3.2 provides the Total Employment Impact of the Project (12,160 jobs) and Table 3.1 provides the total project expenditure for Design and Construction ($1,193 million). The overall multiplier for the Potential Economic Impact from Design and Construction of the Project would be 10.2 jobs per $1 million project cost.[28] Figure 2 (Section 1.1) as described in Section 4, will present the multipliers for a number of comparable natural gas pipelines in the Northeast.

Poorly Documented Methodology

The PennEast Analysis has not provided adequate documentation of the methodology used in its economic modeling, making it impossible to understand how the company

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[25] The Mariner East study (pp. 6, 7, 12) specifically identifies job numbers as FTEs. The Mariner East study (pp. 8-9) also provides a breakdown of job numbers by category (direct, indirect and induced).

[26] Section A.2 Application, Appendix A, PennEast Analysis (pp. A-1 to A-2).

[27] The PennEast Analysis does not provide employment multipliers for Capital Infrastructure Investment (expenditures to design and construct the Project). Nor does the PennEast Analysis provide multipliers for Ongoing Annual Operations (expenditures to operate and maintain the Project). But as discussed in footnote 48, the PennEast Analysis (p. 14) does provide a multiplier for Additional Economic Benefits (energy cost savings): 9 jobs per $1 million of increased disposable income derived from energy cost savings.

[28] As further discussed in Section 4 and Appendix A, in the September 2015 PennEast FERC Application, PennEast has now updated its cost estimate for building the Project. The Project is estimated to cost $1,131 million. (Application for Certificate of Public Convenience and Necessity, September 24, 2015 ("Certificate Application"), Exhibit K (Cost of Facilities), PDF p. 176. Accessed October 13, 2015. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13995667.

Given that PennEast has not updated the Total Employment Impact of the Project (12,160 jobs) in the September 2015 FERC Application, the overall multiplier for the Potential Economic Impact from Design and Construction of the Project with the updated Project Cost Estimate is 10.7 jobs per $1 million.

developed its employment estimates. While the PennEast Analysis provides some information about its methodology for modeling employment impacts,[29] the discussion is not sufficient to explain how the estimates were derived or all of the assumptions used. Nor does the methodology provided help to resolve the inconsistencies described in Section 3.3.2.

Despite the information gaps described in this section, TGG has nonetheless identified a number of assumptions in the PennEast Analysis, which may explain the inconsistencies in PennEast's estimates, as well as the overstatement of the employment impact estimates related to Capital Infrastructure Investment (i.e. the construction phase). The following sections will discuss possible causes for the inconsistencies and overstatement in the employment impact estimates.

3.3.3.2 Limitations of I-O Modeling and Overstatement of PennEast Estimates

As outlined in Section 3.2, the PennEast Analysis is based on IMPLAN, an input-output (I-O) model.

Application of Generic I-O Construction Sector Model Leads to Overstatement of Employment Impacts of Pipeline Construction

For pipeline projects such as PennEast, input-output analysis can substantially overestimate jobs, especially for direct onsite construction. Input-output models provide only limited disaggregation for the large and diverse construction sector. Pipeline construction is grouped together with many other types of construction.[30] But compared with other types of construction, pipeline projects such as PennEast are very specialized, distinctive, and atypical; pipelines result in fewer jobs, but the jobs onsite are very highly paid.[31]

[29] Section A.3 Economic Impact Model, Appendix A, PennEast Analysis (pp. A-2 to A-5).
[30] IMPLAN Industry 58 (Construction of other new nonresidential structures) includes all types of pipelines (natural gas, oil, water, and sewer), as well as a variety of other structures (including billboards, fencing, outdoor swimming pools, and waste disposal).
[31] PennEast is a large diameter, high-pressure gas pipeline. Pipeline construction for project such as PennEast is highly mechanized, with a sizable proportion of the onsite construction workers in high skill/high wage specialties such as welding. Due to the nature of pipeline construction (outdoors, weather/terrain sensitive, ranging over considerable distances, very schedule constrained), pipeline construction workers typically have a long workweek (e.g., 10 hours/day, 6 days/week, 60 hours/week). The graphic in Appendix A (PennEast FERC Application Number of Direct Onsite Construction Workers by Two-Week Time Period) further reinforces the very short-term nature and the condensed schedule of the pipeline construction work.

Simply put, construction labor expenditures[32] on pipeline projects result in a small number of highly-paid Direct Onsite Construction Jobs. However, if construction labor expenditures are input into a more generic I-O construction sector model (such as IMPLAN Industry 58), the model will estimate a higher number of lower-paid construction jobs.

Given the overstatement of the PennEast job estimates, as well as the inconsistencies in PennEast documentation concerning construction job estimates, it is quite possible that the PennEast Analysis is based on a more generic I-O construction sector model (such as IMPLAN Industry 58). This problem will be further discussed in Section 3.3.3.3.

I-O Tends to Overstate Employment Impacts in a Tighter Labor Market

Another key limitation of I-O models is that they are highly simplified representations of how the economy actually operates, and the results of these models tend to represent the higher end of a range of potential employment impacts. The reason for this is that I-O models assume that there will be no supply constraints for labor and other resources and that people employed as a result of the proposed project would otherwise be unemployed. Employment impact estimates generated with I-O models tend to overstate actual net job impacts, especially in a context of tighter labor market conditions. When the economy is closer to full employment (as is increasingly the case in New Jersey and Pennsylvania with the economy in recovery), I-O models will tend to overestimate employment impacts, and particularly overstate spinoff effects. This is especially true of respending employment impacts in a tight economy (since respending is always the most challenging to meaningfully model).

Put another way, when the economy is closer to full utilization of available workers and other resources, overall economic activity and employment are constrained. Adding a new activity (such as building a pipeline) is more likely to displace some other new or existing activity, such that the potential net increase in jobs due to the new activity will be less than estimated by an I-O model.

[32] It should be understood that construction labor on pipeline projects typically involves contractors, rather than direct employees of pipeline companies. Hence, the "labor" category in pipeline construction cost estimates is typically payments to contractors, rather than payments directly to construction workers. Moreover, payments to contractors (construction companies) include Direct Onsite Construction labor costs, but can also include other sizable compensation, such as for construction company profit, overhead, use of company-owned equipment.

I-O is Inputs-Driven and Prone to Garbage In, Garbage Out Problems

I-O models are also inputs-driven; and the output from an I-O model can only be as good as its inputs. In other words, the principal of “garbage in, garbage out” applies. An I-O model will unquestioningly process flawed input data ("garbage in") and produce unrealistic (even nonsensical) output ("garbage out"). So if the inputs are flawed (perhaps due to unrealistic assumptions), then the model will produce results that are flawed and unrealistic.

Judicious I-O Modeling Can Produce Reasonable Employment Studies but Reasonableness Checks Are Required

In TGG’s review of comparable gas pipelines in the Northeast (discussed in Section 4), we have noted that it is possible to use I-O modeling more judiciously in order to develop reasonable employment impact estimates. More sophisticated employment studies take the nature of pipeline construction into account and rely on the pipeline company’s own estimates for Direct Onsite Construction Jobs, and/or customize the I-O model to better reflect the nature of pipeline construction. Generally speaking, pipeline company estimates of Direct Onsite Construction Jobs (based on the detailed design/engineering/costing process required to develop a pipeline project) are much more reliable than estimates based on a more generic I-O construction sector model.

The better employment studies also take into account either implicitly or explicitly the limitations of I-O related to the tightness of the labor market and respending. These studies also have explicit and reasonable assumptions regarding the percentage of local workers and local respending.

The limitations of I-O modeling are very relevant for analysis of pipeline projects and specifically PennEast. If the I-O modeling is not used judiciously, employment studies (such as the PennEast Analysis) can generate highly overstated job numbers, which are not reflective of the potential real world impacts. Therefore, reasonableness checks are necessary, as well as a check for consistency related to other company estimates (e.g. an estimate of Direct Onsite Construction Jobs not based on an I-O model). It would appear that the PennEast Analysis has failed to perform this kind of reasonableness check. Moreover, as will be discussed in following subsections, not only did the PennEast Analysis fail to take into account the limitations of the I-O model, but it has also made unrealistic assumptions about local labor and local respending that further overstate the total job numbers.

3.3.3.3 Overstatement of Jobs per Dollar of Labor Income

As outlined in the previous subsection, given the nature of pipeline construction, the application of a generic I-O construction sector model leads to overstatement of employment impacts. Pipeline projects produce a small number of highly-paid Direct Onsite Construction Jobs. However, if construction labor expenditures are input into a more generic I-O construction sector model, the model will generate a higher number of lower-paid construction jobs.

The inconsistencies and overstatement in the PennEast job estimates may be partly explained by a problematic application of a more generic I-O construction sector model. This section describes how the inconsistencies identified in Section 3.3.2 can be partly explained by the overstatement of jobs per dollar of labor income.

As discussed in Section 3.3.2 and illustrated in Figure 1, there are two major inconsistencies related to the PennEast Analysis:

1. A major disjuncture between Direct Onsite Construction Jobs and Total Jobs
2. A significant internal inconsistency in PennEast's documentation between (a) estimates for Direct Onsite Construction Jobs and Total Jobs; and (b) estimates from construction and other jobs.

The first inconsistency addresses the mystery how the 2,500 Direct Onsite Construction Jobs (estimated on PennEast's website and in its FERC submission) results in 12,160 Total Jobs (according to the PennEast Analysis). Therefore the Total Jobs number appears to be highly inflated compared to the original Direct Onsite Construction Jobs.

The second inconsistency relates a significant internal inconsistency in PennEast's documentation between (a) estimates for Direct Onsite Construction Jobs and Total Jobs (i.e. 2,500 and 12,160); and (b) estimates for "construction" and "other" jobs in the Six-County Region. According to a fact sheet on the PennEast website, less than half of the employment impact in the Six-County Region (estimated to be 11,210 jobs) would occur in jobs other than construction.

According to this logic, just over half the jobs (approximately 6,000 jobs) would occur in construction with the remaining jobs in other fields (approximately 5,210). The 6,000 jobs are highly inconsistent with 2,500 Direct Onsite Construction Jobs that have been estimated by PennEast outside the model. It is quite possible that this inflated construction job number (and the internal inconsistencies in PennEast's estimates) are, at least in part, the result of a problematic application of the I-O model (i.e. inputting construction labor expenditures into a more generic I-O construction sector model,

which generates a higher number of lower-paid jobs, rather than the smaller number of higher-paid jobs that result from pipeline construction).

In summary, it possible and perhaps likely that the PennEast Analysis has inflated the employment estimates, and specifically direct jobs, by assuming an unrealistically low labor income per job.

3.3.3.4 Employment Benefits for Local Workers in NJ and PA Significantly Overstated

The job impacts estimated by the PennEast Analysis significantly overstate the benefits for local workers residing in NJ and PA. When estimating job impacts for NJ and PA, the PennEast Analysis includes employment for workers from out-of-state. Much of the construction workforce for the Project would come from outside of NJ and PA. These non-local workers would only be in-state temporarily (for part of one year) building the Project. The employment benefits (direct/indirect/induced) reported in the PennEast Analysis[33] would not all go to workers from NJ and PA.

The PennEast Analysis (p. 10) acknowledges that "[t]he workforce for the Project is likely to be comprised of personnel from across the country due to the specialized nature of pipeline construction." But the PennEast Analysis does not specify what proportion of workers is assumed to come from out-of-state, stating that the "geographic distribution of construction workers is not finalized at this time."

Based on our review of other comparable gas pipeline projects in the Northeast US, TGG assumes that half or more of Direct Onsite Construction labor for PennEast will be non-local (residing outside NJ and PA). We also note that the PennEast Analysis assumes that only 10% of materials expenditures will be sourced locally in the Six-County Region along the pipeline routing in NJ and PA (footnote 8, p. 10, PennEast Analysis). This assumption does not appear to be unreasonable. Local spending on materials ($24 million in NJ and PA[34] and perhaps about $6 million in NJ alone) is too small to provide a substantial benefit in the context of the NJ and PA state economies.[35]

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[33] PennEast Analysis, Table 3.2 (p. 11) (Employment Supported – Jobs) for NJ and PA for construction and design.
[34] PennEast Analysis, Table 3.1 (p. 10) (Materials – Modeled Direct Expenditure).
[35] Local spending in NJ on materials (about $6 million dollars) would be only 0.01% of overall economic activity in NJ and is therefore too small to have a substantial impact on the NJ economy. NJ GSP (Gross State Product, a measure of overall economic activity) was about $549 billion in 2014 and is forecasted to grow by about 2% annually (in real terms, not including inflation).
http://www.bea.gov/newsreleases/regional/gdp_state/2015/pdf/gsp0615.pdf
http://recon.rutgers.edu/wp-content/uploads/2014/03/recon-execsum-oct2015.pdf

3.3.3.5 Percentage of In-State Spending Is Overestimated

Another key issue when evaluating the employment benefits of the Project for NJ and PA is spending by non-local (i.e. out-of-state) workers and how this affects the economy locally (in NJ and PA). The job impacts estimated by the PennEast Analysis include induced effects from spending of labor income; consumer spending (notably by workers on PennEast) is estimated to result in some added employment (such as in restaurants and retail).

Hence, in estimating local job impacts (in NJ and PA), it matters to what extent money is spent locally, and in turn this is affected by whether workers are local or from out-of-state. Put simply, workers from out-of-state are less likely to spend their earnings in-state. As explained in the PennEast Analysis (p. 10):

> […] [I]t is necessary to account for the non-resident construction workers who spend a portion of their income outside of the region. For example, a construction worker from Texas who moves to Pennsylvania for six months of construction work will not spend his entire income in the area. It is likely the construction worker will spend a portion of that income in Texas. […] It is estimated that 25 percent of the disposable income of the construction workforce will be spent outside of Pennsylvania and New Jersey.

It is unclear whether the PennEast Analysis is implying that 25% of the disposable income of the construction workforce overall or that 25% of the disposable income of the non-resident construction workforce will be spent out-of-state. In either case, the actual percentage spent out-of-state is likely to be higher than 25%.[36]

As discussed in the previous subsection, TGG has assumed that out-of-state workers would spend 50% or more of their income out-of-state. The September 2015 PennEast FERC Application indicates that actual construction will occur over a one-year period,

[36] In TGG's review of comparable gas pipelines in the Northeast, we found many parallels between the Massachusetts section of the Northeast Energy Direct (NED) project and the PennEast project. The NED analysis considers local spending by both local and non-local workers, and the NED assumptions are much more realistic than the PennEast assumptions. NED assumes pipeline construction workers spend $800/week for local living expenses such as temporary housing and meals. Meanwhile NED (like a number of other comparable studies) assumes labor income per week per worker is quite high, about $3900 ($65/hour for 60 hours per week of work). So local living expenses are assumed to be only about 20% of labor income. Labor income includes taxes and benefits. Assuming disposable income is 50% or more of labor income, local living expenses would be 40% or less of disposable income.

In our review of the comparable gas pipelines, TGG has determined that other employment impact studies also assume local spending of $800/week by non-local workers for lodging, meals, and sundries. This provides further confirmation that workers from outside NJ and PA would spend most of their compensation outside of NJ and PA.

but is concentrated into only six months; duration of Direct Onsite Construction jobs would be very short-term, averaging only 5.2 months.[37] Thus, out-of-state workers will be in NJ and PA for only a few months (or less), and they will likely spend a large amount of this time working with limited opportunity to spend money locally. [38] Meanwhile, 50% or more of construction workers are likely to come from out-of-state.

Thus, a more realistic estimate would imply that over 25% of the disposable income of the construction workforce overall and over 50% of the disposable income of the non-resident construction workforce would be spent out-of-state. If the proportion of out-of-state workers is higher than 50% (which is quite possible), then the percent of the disposable income of the construction workforce spent out-of-state will be even higher.

Conversely, this implies that less than 75% of the disposable income of the construction force overall and less than 50% of the disposable income of the non-resident construction workforce will be spent in-state. If the proportion of out-of-state workers is higher than 50% (which is quite possible), then the percent of the disposable income of the construction workforce spent in-state will be even lower.

Moreover, the non-local workers are typically more specialized and higher paid workers (i.e. inspectors and other pipeline construction specialists), and therefore this will also increase the out-of-state disposable income expenditures.

The implication once again is that PennEast is making assumptions that will increase the estimate of the employment impact benefits.

3.3.3.6 The PennEast Analysis Counts Some Jobs That Have Already Been Created

Given the development schedule discussed above, some of the PennEast project budget has already been spent, and some jobs related to the Project have already been created. And by the time a decision is made by FERC on whether to allow construction to proceed (in late 2016),[39] even more of the project budget will have been spent and even more of the jobs related to the Project will already have been created. While the Project is unlikely to have significant expenditures prior to the main construction phase in 2017, the employment impacts from the PennEast Analysis consider the entire

[37] See Appendix A.
[38] Pipeline construction for projects such as PennEast is undertaken by crews of highly specialized workers with a typically long workweek (e.g., 10 hours/day, 6 days/week, 60 hours/week). See footnotes 9 and 31. Some workers may be onsite for only a small portion of the overall construction period, notably for specialized short-duration tasks.
[39] PennEast has requested that FERC issue a decision approving construction by December 1, 2016 in order to enable a project in-service date of November 1, 2017. https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13654024 pp. 1-3.

project. As such, the PennEast Analysis counts some jobs that have already been created. An alternate more realistic consideration of the employment impact benefits for NJ and PA should consider only new job creation from the Project, and would discount expenditures (and jobs) prior to the main construction phase.

3.3.3.7 Failure to Present Total Jobs as Annualized Jobs

The failure of the PennEast Analysis to define a job and particularly to provide a duration for the 12,160 temporary jobs (as discussed above in Section 3.3.3.1) is not in itself a flawed assumption that was input into the I-O model. However, if the average duration of these temporary 12,160 jobs is less than one year, then the failure to annualize these 12,160 jobs would be misleading and would inflate the employment impact. Put more simply, if the estimated 12,160 Total Jobs are for less than one year, they could be equivalent to substantially less than 12,000 annual jobs.

If the average duration of the jobs estimated in the PennEast Analysis is seven months (matching the duration indicated in the PennEast website overview for the estimated 2,500 Direct Onsite Construction jobs), the 12,160 Total Jobs estimated in the PennEast Analysis are equivalent to about 7,100 annual jobs.[40]

If the average duration of the jobs estimated in the PennEast Analysis is only 5.2 months (matching the duration based on the PennEast FERC Application for the estimated 2,660 peak Direct Onsite Construction jobs), the 12,160 Total Jobs estimated in the PennEast Analysis are equivalent to about 5,300 annual jobs.[41] As discussed in Section 3.3.3.1, the more relevant flaw in the PennEast study related to annualization is that the study fails to specify the duration of the Total Jobs estimated, so the total number of annual jobs remains unclear. It is therefore problematic to evaluate the true employment impacts of the Project and to compare these with other studies.

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[40] 12,160 workers for 7 months are equivalent to 7,093 average annual jobs (=12,160*7/12). See Section 3.2 and specifically footnote 8 for discussion of the PennEast website overview and estimated construction jobs.

[41] 12,160 workers for 5.2 months are equivalent to 5,270 average annual jobs (=12,160*5.2/12). As discussed in Section 3.3.1 and Appendix A, the September 2015 PennEast FERC Application indicates that actual construction will occur over a one-year period, but is concentrated into only six months. The PennEast FERC Application estimates there will be 2,660 peak Direct Onsite Construction jobs, but the duration of these jobs would be very short-term, averaging only 5.2 months; 2,660 peak jobs is equivalent to only 1,158 average annual direct construction jobs.

4 Employment Impacts for Comparable Pipelines

Section 3 examined the claims of the PennEast Analysis regarding Capital Infrastructure Economic Impacts (i.e., employment impacts related to capital investment to design and construct the pipeline). TGG's evaluation revealed a number of internal inconsistencies in PennEast's documents concerning job estimates. We also concluded that the Total Jobs estimate (12,160) for designing and building the pipelines was inflated. TGG then examined possible causes for the inconsistences and the overstatement in the employment impact estimates. In particular, the report explained how the limitations of input-output modeling in combination with a series of unrealistic assumptions could produce highly inflated job numbers. We also examined a number of the unrealistic assumptions from the PennEast Analysis to expose possible reasons why the model produced such inflated job numbers.

In this section, TGG reviews the employment impact studies for other comparable gas pipelines in the Northeast US. Our review demonstrates that the PennEast Analysis job multiplier[42] (10.7 jobs per $1 million project cost for all workers) is an outlier with respect to comparable pipelines. Specifically, the multipliers for other similar gas pipelines are only 8-36% of the PennEast Analysis multiplier. This review strongly supports TGG's conclusion that the PennEast Analysis has significantly overstated the Total Jobs related to designing and building the pipeline.

This section focuses on the information summarized in Figure 2, Estimated Total Job Impacts from Building Northeast US Gas Pipeline Projects (contained in Section 1.1). Figure 2 compares the employment impacts from PennEast with the employment impacts from four other comparable Northeast US Gas Pipeline Projects: Atlantic Sunrise, Northeast Supply Link, Northeast Energy Direct (NED), and Constitution.[43] Two multipliers are presented for PennEast: the first multiplier, 10.2 jobs per $1 million project cost is based on the PennEast Analysis Total Jobs estimate (12,160) with the PennEast Analysis Project Cost Estimate ($1,193 million). The second multiplier, 10.7 jobs per $1 million project cost is based on the PennEast Analysis Total Jobs estimate

[42] As will be explained in this section, the 10.7 multiplier is derived from the Total Jobs Estimate of 12,160 in the PennEast Analysis and the recently updated Project Cost Estimate of $1,131 million from the September 2015 PennEast FERC Application.

[43] TGG notes that the data in Figure 2 is presented in terms of nominal dollars. Converting the data into real dollars would not significantly change the results. All of the pipelines projects being compared are of similar vintage, with project in-service dates from 2013 to 2018. PennEast, Atlantic Sunrise, and Northeast Energy Direct (the three largest projects in Figure 2) have project in-service dates in 2017 and 2018.

(12,160) with the updated Project Cost Estimate from the September 2015 PennEast FERC Application ($1,131 million).[44]

In the September 2015 PennEast FERC Application, PennEast has now updated its cost estimate for building the Project. The Project is estimated to cost $1,131 million. Given that PennEast has not updated the Total Employment Impact of the Project (12,160 jobs) in the September 2015 FERC Application, the overall multiplier for the Potential Economic Impact from Design and Construction of the Project with the updated Project Cost Estimate is 10.7 jobs per $1 million.

Appendix B provides detailed sources and notes for each of the pipelines described in Figure 2.

Figure 2 clearly demonstrates that both of the PennEast Analysis job multipliers for all workers (based on the Total Jobs claims of the PennEast Analysis and the original and updated Project Costs Estimates) are much higher (at 10.2 and 10.7 jobs per $1 million respectively) than the job multipliers for each of the other four comparable gas pipelines described. This comparison shows that PennEast Analysis job multipliers for all workers are likely significantly overstated (and this in turn is the result of significantly overstated Total Jobs). The concept and derivation of the multipliers in Figure 2 is explained in this section.

In the Northeast US, there are many natural gas pipeline projects in various stages of development (proposed, under construction or recently completed). Construction of interstate gas pipelines is subject to an extensive review process at the US Federal Energy Regulatory Commission (FERC). As part of the FERC review process, there is considerable public information regarding economic impacts of gas pipelines comparable to PennEast. Appendix B contains links to publicly available FERC documents for PennEast and comparable gas pipelines. TGG has reviewed these documents to obtain employment impact information for PennEast and comparable gas pipelines in Figure 2.

TGG also reviewed economic impact studies based on Input-Output modeling for comparable gas pipelines. From these studies and other information sources related to the pipelines (provided in Appendix B), we calculated job multipliers for PennEast and other comparable gas pipelines.

[44] Application for Certificate of Public Convenience and Necessity, September 24, 2015 ("Certificate Application"), Exhibit K (Cost of Facilities), PDF p. 176. Accessed October 13, 2015. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13995667.

In the examination of the employment impacts of pipeline projects, a useful multiplier (and summary metric) is jobs per dollar (typically in terms jobs per $1 million project cost). Multipliers facilitate comparison of results within and across studies. With results expressed in terms of multipliers, projects (and other activities) with differing levels of spending can be compared to determine relative intensity of impacts.

Both TGG and the PennEast Analysis agree that project expenditures are a key input in an I-O model. Based on the relationships estimated by the I-O model and other assumptions, the employment analyses estimate employment impacts. The results of the PennEast Analysis and analyses for other pipelines can be usefully compared in terms of multipliers.

The PennEast Analysis does not present any of its results in terms of multipliers. However, overall multiplier for the Potential Economic Impact from Design and Construction of the Project can easily be derived from Tables 3.1 and 3.2. Table 3.2 provides the Total Employment Impact of the Project (12,160 jobs) and Table 3.1 provides the total project expenditure for Design and Construction ($1,193 million). The overall multiplier for the Potential Economic Impact from Design and Construction of the Project would be 10.2 jobs per $1 million project cost.

As indicated above and further discussed in Appendix B, PennEast has now updated its cost estimate for building the Project. In the Application (Exhibit K: Cost of Facilities) submitted to FERC in September 2015, the Project is estimated to cost $1,131 million. The PennEast Analysis has not been updated to be based on the September 2015 Project cost estimate. In its September 2015 Application to FERC, PennEast submitted the same PennEast Analysis document (from February 2015), as was submitted to FERC in April 2015 (as part of the pre-filing process).

Based on the Total Employment Impact of the Project estimated in the PennEast Analysis (12,160 jobs) and the total cost for building the Project estimated in the September 2015 FERC Application ($1,131 million), the most up-to-date overall multiplier for the Potential Economic Impact from Design and Construction of the Project would be 10.7 jobs per $1 million project cost.

As Figure 2 clearly illustrates, the multiplier of 10.7 jobs per $1 million project cost for all workers (from the PennEast Analysis), is an outlier compared to the other comparable Northeast US gas pipelines in Figure 2. The multiplier for Northeast Supply Link (3.9 jobs per $1 million) is only 36% of the PennEast Analysis multiplier. The job multipliers for Constitution (1.5) and Northeast Energy Direct (NED)

in MA (2.0) are only 14-19% of the PennEast Analysis multiplier.[45] This comparison shows that the PennEast Analysis job multiplier for all workers is significantly overstated (and this overstated multiplier is the result of PennEast's significantly overstated Total Jobs estimate).

The PennEast Analysis did not provide Total Jobs for in-state residents (in NJ and PA), so TGG was unable to calculate a job multiplier for in-state residents for the PennEast Analysis. But a comparison of the PennEast Analysis multiplier (for all workers), with the jobs multipliers for other comparable pipelines (for in-state workers), further confirms that the PennEast Analysis has significantly overstated job impacts. The multiplier for Atlantic Sunrise (3.8 jobs per $1 million project cost for in-state residents) is only 36% of the PennEast Analysis multiplier (for all workers). The job multipliers for in-state residents for Constitution (0.9) and Northeast Energy Direct (NED) in MA (1.4) are only 8-13% of the PennEast Analysis multiplier (for all workers). Again, this comparison shows that the PennEast Analysis job multiplier for all workers is significantly overstated (and this in turn is the result of significantly overstated Total Jobs).

In summary, this review of the employment impacts of comparable gas pipelines in the Northeast US shows that the multipliers for other similar gas pipelines are only 8-36% of the PennEast Analysis multiplier. **Specifically, this review strongly supports TGG's conclusion that the PennEast Analysis has overstated the Total Jobs related to designing and building the pipeline by approximately two thirds or more.**

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[45] The PennEast Analysis multiplier of 10.7 jobs/$1 million project cost for all workers is based on the assumption that the PennEast Total Jobs claim is for 12,160 **annual** jobs. But as discussed in Sections 3.3.3.1 and 3.3.3.7 and Appendix A, the PennEast Analysis fails to specify a duration for the 12,160 temporary jobs; if the estimated 12,160 Total Jobs are for less than one year, they could be equivalent to substantially less than 12,000 annual jobs.

If the average duration of the jobs estimated in the PennEast Analysis is seven months (matching the duration indicated in the PennEast website overview for the estimated 2,500 Direct Onsite Construction jobs), the 12,160 Total jobs estimated in the PennEast Analysis are equivalent to about 7,100 annual jobs. See Section 3.3.3.7 and specifically footnote 40. If Average Annual Total Jobs from the Project are estimated to be 7,100, then the PennEast Analysis multiplier (with the updated Project Cost Estimate) would be 6.3 jobs per $1 million project cost for all workers (7,100 jobs/$1,131 million).

If the average duration of the jobs estimated in the PennEast Analysis is only 5.2 months (matching the duration calculated based on the PennEast FERC Application for the estimated 2,660 peak Direct Onsite Construction jobs), the 12,160 Total Jobs estimated in the PennEast Analysis is equivalent to about 5,300 annual jobs. See Section 3.3.3.7 and specifically footnote 41. If Average Annual Total Jobs from the Project are estimated to be 5,300, then the PennEast Analysis multiplier (with the updated Project Cost Estimate) would be 4.7 jobs per $1 million project cost for all workers (5,300 jobs/$1,131 million).

TGG would conclude that multipliers of 4.7 and especially 6.3 are high and still outliers compared to the multipliers of the other comparable gas pipelines in the Northeast US, but not nearly as overstated as the PennEast Analysis 10.7 jobs per $1 million multiplier.

The conclusion that the PennEast Analysis has significantly overstated the Total Jobs numbers (by approximately two thirds or more) is based on:

- our review of employment impact studies for other comparable gas pipelines in the Northeast US;
- our evaluation of the PennEast Analysis job estimates and the internal inconsistencies in the PennEast Analysis; and
- our review and extensive experience with best practices in employment impact studies, notably for pipelines and other energy projects.

5 Ongoing Annual Economic Impacts

As set out in Section 3.1, consistent with other studies on pipeline employment impacts, the PennEast Analysis groups the employment impacts of the Project into two categories: Capital Infrastructure Economic Impacts and Ongoing Economic Impacts. Employment impacts related to Capital Infrastructure are those related to the capital investment to design and construct the pipeline. These temporary jobs related to the design and construction of the Project, which represent the majority of the jobs associated with PennEast expenditures, have been discussed at length in Sections 3 to 4.

Employment impacts associated with Ongoing Annual Economic Impacts are employment impacts related to the ongoing activities to operate and maintain the pipeline and related facilities (e.g. compressor stations) once PennEast goes into service.[46] These "permanent" jobs are long-term annual jobs that last over the lifetime of the Project.[47]

PennEast Analysis (Section 4.1, p. 13) claims that the Project will have "significant" Ongoing Annual Economic Impact in two ways:

> 1. Operating, maintaining, and inspecting the physical pipeline and its facilities will require the creation of long-term jobs and the purchase of additional materials. This, in turn, will spur economic activity in the Six-County Region (Section 4.2).
>
> 2. As new natural gas supply is introduced to the market, prices of natural gas and electricity are likely to decrease. This translates into savings on energy bills that will then result in additional household income for residents of Pennsylvania and New Jersey, which will induce spending in multiple industries in both states creating an additional economic impact (Section 4.3).

The TGG Report only considers Ongoing Annual Economic Impact as it relates to the ongoing activities to operate and maintain the pipeline and related facilities.[48]

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[46] For brevity and simplicity, this section sometimes refers to ongoing activities as "operations", with related and "operating" costs and jobs. But it should be understood that once a pipeline enters service, ongoing activities include both operations and maintenance, and that the costs and jobs relating to these activities involve both operations and maintenance.

[47] Natural gas pipeline projects are typically designed and operated to remain in-service for 30 years or more.

[48] The PennEast Analysis (pp. 14, 16) claims that natural gas and electricity consumers in New Jersey and Pennsylvania will have lower costs due to the Project, without specifying the amount of these cost (footnote continued on next page)

5.1 PennEast's Estimates

According to the PennEast Analysis (p. 14, Tables 4-1 and 4-2), total annual operating expenditures are $13.2 million (with $2.4 million for labor); these expenditures are almost all in PA versus NJ ($12.6 million in PA versus just $0.6 million in NJ). Annual jobs from operations (including spinoffs) are 98 in total, with 88 in PA and 10 in NJ; 80 of the estimated 98 jobs are within the Six-County Region traversed by PennEast.

5.2 TGG's Evaluation

For pipelines, operating costs are typically very small relative to construction costs. Pipelines are highly mechanized and automated. Operations typically require a very small number of workers, but these workers are highly skilled and highly paid.

For PennEast (in both NJ and PA), estimated annual operating costs ($13.2 million) are equivalent to only 1.1% of construction costs ($1,193 million). And in NJ, estimated annual operating costs ($0.6 million) are equivalent to only 0.2% of construction costs ($298 million).[49] Given the small annual operating costs, job impacts are also quite small, especially in NJ.

Only a small portion of annual operating costs are directly for labor. PennEast labor costs ($2.4 million) are only 18% of total annual operating costs ($13.2 million). Likewise, only a small portion of the estimated jobs from operations are direct jobs and specifically employees of PennEast. While not provided in the PennEast Analysis, PennEast in reports to FERC elsewhere estimates that there will be about 24

(footnote continued from previous page)
savings and related job impacts. So except as discussed below, the TGG Report does not consider Ongoing Annual Economic Impact as it relates to energy cost savings.

The PennEast Analysis (p. 16) uses IMPLAN to estimate a jobs multiplier for energy cost savings: 9 jobs per $1 million of increased disposable household income derived from energy cost savings. TGG concludes that this multiplier does not provide a reliable measure of Ongoing Annual Economic Impact as it relates to energy cost savings. In New Jersey and especially in Pennsylvania, most natural gas and electricity is consumed by businesses (commercial and industrial customers). Thus, energy cost savings will mainly result in additional business income, rather than additional household income. For a variety of reasons, respending of energy savings by businesses will typically result in fewer in-state jobs per dollar, compared with respending by households.

[49] In PA, estimated annual operating costs ($12.6 million) are equivalent to only 1.4% of construction costs ($895 million). The PennEast Analysis does provide a breakdown of total construction costs by state, but the estimated expenditures within NJ and PA ($890 million) are about 25% in NJ and 75% in PA. Thus, in this report, it has also been assumed that total estimated PennEast construction costs ($1,193 million) are 25% in NJ ($298 million) and 75% in PA ($898 million).

employees directly hired by the Project for ongoing operations and maintenance.[50] Thus, most of the estimated 98 annual jobs from operations (including spin-offs) are other jobs (contractors and upstream jobs in the supply chain providing services and materials and downstream jobs from respending on wages).

Even using the PennEast estimates, pipeline operations result in very small expenditures and have very little positive impact on the economy, especially in NJ. Pipeline operations are estimated to result in only 10 jobs (including spin-offs) in NJ, which has more than 4.2 million total jobs. 10 "permanent" jobs from PennEast would be about 0.0002% of total NJ jobs (about 2 PennEast jobs per 1 million total jobs).

But as low as they are, the PennEast estimates of annual jobs from operations (Direct Employees and Total Jobs including spinoffs) may still be overstated. Other pipeline studies (notably for comparable Northeast US Gas Pipeline Projects included in Figure 2 and discussed in Section 4 and Appendix B) estimate substantially lower job impacts from operations.

PennEast claims there will be 24 employees directly hired. Meanwhile, as documented in Appendix B, Atlantic Sunrise in PA has only 15 in-state employees, despite being a much larger project than PennEast. Constitution and Northeast Energy Direct (NED) in MA each have only 7 employees, but are similar in scale (or perhaps a bit smaller) than PennEast. The entire NED Project is much larger than PennEast, with operations across 5 Northeast states, but NED has only 26 employees (2 more than PennEast),

The PennEast total job estimates are also high relative to other pipelines. As also documented in Appendix B, the jobs study for Atlantic Sunrise estimates that in addition to the 15 in-state employees, there will be another 14 (indirect and induced) jobs, for a total of 29 jobs. Likewise, the jobs study for Constitution estimates there will be 5 other "spillover" jobs in addition to the 7 employees, for a total of 12 jobs.

So relative to other pipelines (and scaled for size of operations), PennEast is claimed to have both substantially more employees, and substantially more other jobs including spin-offs.

That said, it is possible that job impacts from operations will be somewhat higher for PennEast than might be expected based on other Northeast US Gas Pipeline Projects. These other projects are typically operated by companies (notably Williams/Transco

[50] Penn East submission to FERC in Docket PF15-1, Draft Resource Report 5, Socioeconomics, April 2015, pp. 5-3, 5-18. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13844811
Annual cost per employee is about $100,000 (including taxes and benefits; $2.4 million annual cost for labor for about 24 employees).

and Kinder Morgan/Tennessee) that operate large pipeline networks in the Northeast and elsewhere. Moreover, some of these other projects include substantial components, which involve the expansion/modifications of existing facilities. Thus, these other projects may benefit from economies of scale and scope, such as being able to share employees, contractors, and other inputs with other operations of the pipeline company. Also, as part of large pipeline systems, typically based in and operated from Texas, some of the job impacts from these other pipeline projects may be outside of the states where the project is located.

Meanwhile, PennEast appears to be more of a stand-alone new pipeline project. And PennEast would be operated by UGI Energy Services (UGIES), a Pennsylvania-based company.

Nonetheless, as was also the case for the PennEast Analysis of jobs related construction, the estimates of jobs related to operations are substantially higher than would be expected based on job estimates for other comparable pipelines. Moreover, the PennEast Analysis does not provide adequate documentation to support its results.[51]

[51] For example, as shown in PennEast Analysis Figure 4.1 (p. 15), 21% of the estimated jobs are in Natural Gas Distribution. This would appear to be the IMPLAN Industry 50, which is retail gas utilities (local distribution companies). Meanwhile, interstate gas pipelines are part of IMPLAN Industry 413 (Pipeline Transportation). UGIES is part of UGI http://www.ugicorp.com/, which also includes retail gas utility operations, but it is unclear why the operating costs of the PennEast gas pipeline have been modeled in IMPLAN as retail gas utility operations.

6 Conclusions

TGG's Main Conclusions on Temporary and Ongoing Annual Employment Impacts

1. **Temporary Jobs:** The PennEast Analysis has significantly overstated the Total Jobs (i.e. temporary jobs estimated at 12,160) for the design and construction of the Project by approximately two-thirds or more. This key conclusion is based on:
    a. TGG's review of employment impact studies for other comparable gas pipelines in the Northeast US;
    b. TGG's evaluation of the PennEast Analysis job estimates and the internal inconsistencies in the PennEast Analysis; and
    c. TGG's review and extensive experience with best practices in employment impact studies, notably for pipelines and other energy projects.

2. **Ongoing Annual Jobs**: The TGG Report only considers Ongoing Annual Economic Impact as it relates to the ongoing activities to operate and maintain the pipeline and related facilities. Annual jobs from operations (including spinoffs) are 98 in total, with 88 in PA and 10 in NJ.

    In reports to FERC, PennEast estimates that there would be 24 employees directly hired by the Project for ongoing operations and maintenance. Therefore, most of the estimated 98 annual jobs from operations (including spin-offs) are other jobs (contractors and upstream jobs in the supply chain providing services and materials and downstream jobs from respending on wages). TGG concludes that even using the PennEast estimates, pipeline operations result in very small expenditures (and employment impacts) and have very little positive impact on the economy, especially in NJ. But as low as they are, the PennEast estimates of annual jobs from operations (Direct Employees and Total Jobs including spinoffs) may still be overstated. Other pipeline studies (notably for comparable Northeast US Gas Pipeline Projects included in Figure 2) estimate substantially lower job impacts from operations.

Other Conclusions on Capital Infrastructure Economic Impacts (i.e. Temporary Jobs)

TGG's evaluation of the PennEast Project Economic Analysis (PennEast Analysis) related to the design and construction of the Project also concludes the following:

1. Even if the PennEast Analysis' employment impact estimates were realistic, the employment impacts from the design and construction of the Project are (a) tiny in the context of the New Jersey and Pennsylvania state economies (less than 0.1% of total NJ jobs); and (b) very short-term. Actual construction would occur over a one-year period (late 2016-late 2017) with activity and jobs concentrated into only six months (early January-early July 2017). Most of the employment impacts (total onsite and offsite jobs) would take place during the same period.

2. Jobs from actual construction have an average duration of only 5.2 months. Moreover, TGG estimates that half or more of the Direct Onsite Construction labor would come from outside NJ and PA with a significant proportion of the spinoff employment benefits also going out-of-state.

3. There are two major internal inconsistencies in PennEast's Jobs Estimates, which are illustrated in Figure 1:
    a. A major disjuncture between Direct Onsite Construction Jobs (2,500) and Total Jobs (12,160).
    b. A significant internal inconsistency in PennEast's documentation between (a) estimates for Direct Onsite Construction Jobs (2,500) and Total Jobs (12,160); and (b) estimates for "construction" (6,000) and "other" (5,210) jobs in the Six-County Region.

    These inconsistencies reveal that the PennEast analysis failed to perform a basic check to verify the reasonableness of the results from its economic modeling exercise.

4. There are a number of information gaps in the PennEast Analysis that present a challenge for understanding how their estimates were developed. The failure to provide a duration for the Total Jobs estimate is particularly problematic because without a duration, it is impossible to evaluate with certainty the employment benefits estimated for the Project. As such, TGG carefully analyzed the duration and timing details for the actual construction jobs in the PennEast's September 2015 FERC Application in order to better evaluate the PennEast Analysis' employment estimates. Moreover, despite the significant information gaps in the PennEast Analysis, TGG identified the following possible causes for the internal inconsistencies and overstatement of estimates in the PennEast Analysis:
    a. The inherent limitations of Input-Output (I-O) modeling and in particular a problematic application of I-O modeling that does not take into account the limitations of the model or perform reasonableness tests on the results.
    b. Given the nature of pipeline construction, the application of a generic I-O construction sector model leads to overstatement of employment impacts.

c. The job impacts estimated by the PennEast Analysis significantly overstate the benefits for local workers residing in NJ and PA.
d. The percentage of in-state spending is overestimated in the PennEast Analysis.
e. PennEast Analysis counts some jobs related to the Project that have already been created.
f. Total jobs are not presented as annualized jobs.

Employment Impacts for Comparable Pipelines

Figure 2 compares the employment impacts from the PennEast Analysis with the employment impacts from four other comparable Northeast US Gas Pipeline Projects. **As Figure 2 clearly illustrates, the multiplier of 10.7 jobs per $1 million project cost for all workers (from the PennEast Analysis), is an outlier compared to the other comparable Northeast US gas pipelines in Figure 2.**

In summary, TGG's review of the employment impacts of comparable gas pipelines in the Northeast US shows that the multipliers for other similar gas pipelines are only 8-36% of the PennEast Analysis multiplier. **Specifically, this review strongly supports TGG's conclusion that the PennEast Analysis has overstated the Total Jobs related to designing and building the pipeline by approximately two thirds or more.**

Appendix A: Annualization of Job Estimates

This Appendix provides a more detailed general explanation of the annualization of job estimates as a best practice in employment impact studies. The general explanation is followed by a more specific discussion of annualization of Direct Onsite Construction Labor for the PennEast project, particularly in the context of the most recent information from the September 2015 PennEast FERC Application.

Annualization of Job Estimates: A Best Practice for Employment Impact Studies

As indicated in Sections 3.3.3.1 and 3.3.3.7, PennEast has failed to provide a definition of what a job constitutes and, in particular, to provide a duration for the 12,160 Total Jobs estimate (which are temporary jobs).

As explained in Section 3.3.3.1, the failure to provide a duration for the 12,160 temporary jobs is highly problematic because without a duration, it is impossible to:

- evaluate with certainty the employment benefits estimated for the Project;
- compare the employment benefits estimated for the Project with the benefits estimated in employment impact studies for other pipelines.

Various jobs can be of various durations, and it is useful to define them by expressing them in terms of a standard measure, which can include (a) average annual jobs, (b) job-years/person-years, and (c) Full-Time Equivalents (FTEs). These various measures can differ a bit in their precise definition and calculation, but in general they are measured in terms of 1 job for 1 worker for 1 year.

In our review and experience of best practices in employment impact studies, the annualization of job estimates is common in other pipeline studies and allows for employment impacts to be compared. Job-years/person-years and FTEs have been used in employment studies of natural gas pipelines comparable to PennEast, including Atlantic Sunrise and Northeast Supply Link. The Average annual jobs measure was used by the US Department of State in its Final Supplementary Environmental Impact Statement (FSEIS) for Keystone XL.

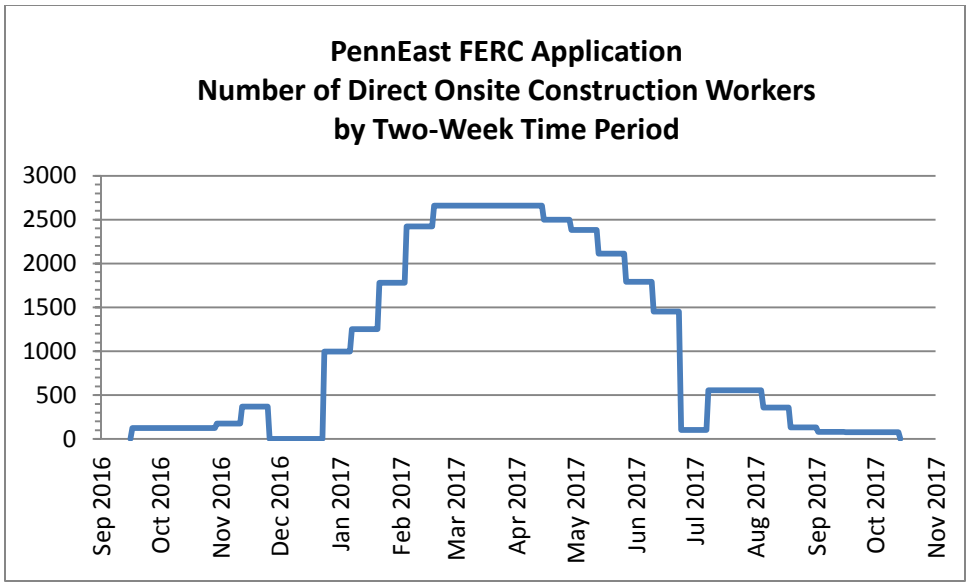
Annualization of Direct Onsite Construction Labor for the PennEast Project

As discussed in Section 3.2, PennEast has claimed that the Project will create jobs for 2,500 construction workers during construction, which is expected to take approximately seven months to complete. 2,500 jobs for seven months are equivalent to about 1,450 average annual jobs.[52]

But prior to the September 2015 PennEast FERC Application, PennEast has also provided various estimates from 2,000 to 2,500 workers. As discussed in footnotes 8 and 9, it was unclear from the earlier PennEast documentation (Project Overview on the website and pre-filing draft submissions to FERC from April and July 2015) if the 2,000 to 2,500 worker estimates represented an average or a peak. If the 2,000 to 2,500 workers represented a peak (versus an average), then the average number of Direct Onsite Construction workers would be lower. Therefore the annualized number of Direct Onsite Construction workers would be lower than 1,450 average annual jobs.

Compared with any of the previously available information, the September 2015 PennEast FERC Application provides much more detail on Direct Onsite Construction Labor: the number of workers is specified, as is the duration and timing of these jobs. TGG has reviewed this new information carefully because this detail is essential to the evaluation of employment benefits. As discussed in this report (and particularly in Section 3.3.3.1, the PennEast Analysis has failed to provide this key information. The FERC Application estimates for Onsite Construction Workers are shown in the graphic below.[53]

[52] 2500 workers for 7 months are equivalent to 1458 average annual jobs (=2,500*7/12).
[53] Source: Resource Report 5, Socioeconomics, September 2015, Table 5.3-3: Construction Workforce Schedule Breakdown by Duration, pp. 5-4-5-5.
http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13995678



In the recent FERC Application, PennEast now estimates a workforce of 665 workers at each of 4 construction spreads[54], for a total of 2,660 workers. This is the peak workforce, which is required for only eight weeks (early March-late April 2017); the average workforce is much lower. Construction will be spread over one year, averaging 1,158 workers, for a total of 1,158 annual jobs.[55] Construction will occur during 42 weeks of 2017 (early January-late October, averaging 1,394 workers), plus 10 weeks of 2016 (October-early December, averaging only 182 workers).

Given a peak workforce of 2,660 workers and average workforce of 1,158 workers over 1 year (equivalent to 1,158 average annual jobs), TGG has calculated that the average duration of Direct Onsite Construction jobs is 5.2 months (1,158 average jobs/2,660 peak jobs=5.2 months/12 months).

The Direct Construction Labor derived from the estimates in the FERC Application (1,158 annual jobs) is thus equivalent to 2,660 jobs (the peak workforce) for a duration averaging about 5.2 months.[56]

While construction is spread over one year (52 weeks of work, with 4 weeks winter break early December 2016 to early January 2017), over 90% of annual jobs occur

[54] See end of footnote 9 for the definition of construction spreads.
[55] Based on the PennEast estimates in the September 2015 FERC Application (see footnote 53), TGG has derived that the average workforce (over the entire one-year construction period) is only 1,158 workers.
[56] In terms of average annual jobs, this is equivalent to 2,000 workers for 7 months (= 1,167 average annual jobs = 2,000*7/12).

within the six month-long core construction period (early January-early July 2017), averaging about 2,100 workers for six months, or about 1,050 annual jobs.

Meanwhile, during the other six months with construction (October-early December 2016, and early July-late October 2017), activity is much lower, averaging about 220 workers for six months, or about 110 annual jobs.

The jobs related to building PennEast are very short-term and occur mainly during a brief construction period. Construction will occur over a one-year period (late 2016-late 2017), but activity and jobs are concentrated into only six months (early January-early July 2017).

Appendix B: Sources and Notes for Figure 2 (Estimated Total Job Impacts from Building Northeast US Gas Pipeline Projects)

This Appendix provides sources and notes for Figure 2, entitled Estimated Total Job Impacts from Building Northeast US Gas Pipeline Projects (contained in Section 1.1 and described in Section 4). Figure 2 compares the employment impacts related to the design and construction of PennEast (as estimated in the PennEast Analysis) with the employment impacts estimated for four other comparable Northeast US Gas Pipeline Projects: Atlantic Sunrise, Northeast Supply Link, Northeast Energy Direct and Constitution.[57] This Appendix provides sources and notes for each of the pipelines described in Figure 2.

[57] To the extent possible, for the pipelines reviewed in Figure 2, this Appendix also provides information on the employment impacts associated with Ongoing Annual Economic Impacts (i.e. employment impacts related to the ongoing activities to operate and maintain the pipeline and related facilities). For the sake of brevity, these jobs are classified in this Appendix as "Operating Phase Jobs."

Preamble: FERC Process and Documents for Natural Gas Pipeline Construction Projects

Most of the sources for Figure 2 are documents from pipeline companies submitted to FERC (United States Federal Energy Regulatory Commission http://www.ferc.gov/). FERC regulates the construction of interstate natural gas pipelines. To obtain authorization to construct an interstate transmission pipeline, the pipeline company must first file an application for a Certificate of Public Convenience and Necessity (Certificate Application).

The Certificate Application is an extensive document. Among other things, the Certificate Application contains a description of the new facilities, need for the project, detailed maps, schedules, and various environmental reports. This information details the various studies and analyses that have been conducted to determine what effect construction and operation could potentially have on the environment and community. The environmental reports include an analysis of route alternatives, as well as an analysis of potential impacts to water resources, vegetation and wildlife, cultural resources, socioeconomics (including jobs), soils, geology and land use.

When a pipeline company is ready to begin preparing its Certificate Application, it typically initiates what is known as the FERC pre-filing process. As part of the pre-filing process, the pipeline company submits draft versions of the environmental reports that are required as part of the Certificate Application. The pre-filing process includes some procedures for involvement by citizens, government entities and other interested parties during the design stage of a proposed project.

Once the pre-filing process begins, a Pre-Filing (PF) Docket Number is assigned by FERC. All documents and correspondence submitted to or issued by FERC regarding the project during the pre-filing process can be accessed by referencing the Pre-Filing (PF) Docket Number on FERC's website: http://elibrary.ferc.gov/.

When the Certificate Application is filed, a Certificate Proceeding (CP) Docket Number is assigned by FERC. All documents and correspondence submitted to or issued by FERC regarding the project during the Certificate Proceeding can be accessed by referencing the Certificate Proceeding (CP) Docket Number on FERC's website: http://elibrary.ferc.gov/.

The rest of this Appendix consists of sources and notes for each of the pipelines described in Figure 2.

PennEast Pipeline Project

Project Websites:

PennEast Pipeline: http://penneastpipeline.com/

Spectra Energy PennEast Project: http://www.spectraenergy.com/Operations/New-Projects-and-Our-Process/New-Projects-in-US/PennEast-Pipeline-Project/

Project Owner/Constructor/Operator: Joint Venture of AGL Resources, NJR Pipeline Company, PSEG Power, South Jersey Industries, Spectra Energy Partners, and UGI Energy Services (UGIES). UGIES is the project manager for development of the project and will operate the pipeline

Sources: Project Websites.

Project Facilities, Cost, and Jobs:

FERC Docket PF15-1

Draft Resource Report 1, General Project Description, Revised Draft July 2015, especially pp. 1-9-1-15; 1-61-1-70.
http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13946534

Draft Resource Report 5, Socioeconomics, April 2015, especially pp. 5-1; 5-3-5-9; 5-18.
http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13844811

Appendix M (Economic Impact Report and Analysis: PennEast Pipeline Project Economic Impact Analysis. Econsult Solutions and Drexel University School of Economics. February 9, 2015 ("PennEast Analysis").
http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13844817

FERC Docket CP15-558

Application for Certificate of Public Convenience and Necessity, September 24, 2015 ("Certificate Application"), especially Exhibit K (Cost of Facilities)
http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13995667

Resource Report 1, General Project Description, September 2015, especially pp. 1-6; 1-10-1-17; 1-52-1-53; 1-63-1-89;1-110.
http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13995668

Resource Report 5, Socioeconomics, September 2015, especially pp. 5-1; 5-3-5-5; 5-7-5-10; 5-22. [58] http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13995678

Appendix M (Economic Impact Report and Analysis: PennEast Pipeline Project Economic Impact Analysis. Econsult Solutions and Drexel University School of Economics. February 9, 2015 ("PennEast Analysis"). http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13995753

Project Schedule:

FERC Docket PF15-1 (and other Information Publicly Available Prior to September 2015 FERC Application)

Construction Start Date: Spring 2017 (prior to large scale construction starting in Spring 2017, there is limited activity relating to winter tree clearing, notably in areas with sensitive habitat).

Project In-Service Date: November 2017

Sources:

PennEast Analysis, pp. 4, 10, 13;

PennEast Pre-Filing Letter, October 7, 2014, pp. 2-3: https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13654024

> PennEast […] requests issuance of a final environmental document on or before August 1, 2016, and a certificate order on or before December 1, 2016.
>
> Adhering to this timeline will allow for receipt of any remaining applicable permits and authorizations necessary for PennEast to begin pre-construction activities, including the orderly mobilization of contractors and materials and the resolution of any outstanding landowner issues, in the fourth quarter of 2016 in order to complete winter tree clearing and allow for full commencement of construction in the second quarter of 2017. Timely commencement of these activities in late 2016 is critical to meet the Project's in-service date of November 1, 2017.

[58] See Appendix A of this report for the September 2015 PennEast FERC Application (Resource Report 5, pp. 5-3-5-5) estimates of Direct Onsite Construction Labor, including the number of workers by two-week time period.

Draft Resource Report 1, General Project Description, Revised Draft July 2015, p. 1-61; http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13946534

PennEast Project Website Overview: http://penneastpipeline.com/overview/

> […] [P]ipeline construction will begin in spring 2017. The project is expected to create 2,500 local jobs during construction, which is expected to take approximately seven months to complete.

FERC Docket CP15-558

Construction Start Date: October 2016/Spring 2017 (between October 2016 and Spring 2017, a smaller number of workers conduct construction in compliance with certain timing restrictions (including tree clearing that that is time restricted related to threatened and endangered species; installation of horizontal directional drill (HDD) segments (notably crossing of Lehigh River after water levels have receded in late 2016); and contractor yard preparation); large scale mainline pipeline and facilities construction starts Spring 2017)

Project In-Service Date: November 2017 (Gas transportation for shippers to commence by November 1, 2017, with all Project facilities in-service by late November 2017)

Sources:

Certificate Application, September 24, 2015, p. 7
http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13995667

> PennEast respectfully requests the authorizations proposed herein by August 1, 2016. An order by this date will allow for timely commencement of construction that is critical for PennEast to comply with seasonal construction limitations and still meet the Project's in-service date of November 1, 2017.

Resource Report 1, General Project Description, September 2015, pp. 1-63-1-64.
http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13995668

Resource Report 5, Socioeconomics, September 2015, pp. 5-3-5-5.[59]
http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13995678

Notes:

[59] See footnote 58.

During most of the time period when this report was being prepared by TGG (August to October, 2015), the PennEast Project was still in the pre-filing process at FERC. Thus, the PennEast Project (including design and other aspects that affect job impacts) was still being finalized for submittal to FERC of its Certificate Application. On September 24, 2015, PennEast submitted to FERC its Application for Certificate of Public Convenience and Necessity.

As elaborated upon below, the PennEast Analysis is based on a February 2015 Project cost estimate and design: $1,193 million for 114 miles of pipeline. In its September 2015 Application to FERC, PennEast updated the Project cost estimate and design: $1,131 million for 118 miles of pipeline.

The PennEast Analysis has not been updated to be based on the September 2015 Project cost estimate and design. In its September 2015 Application to FERC, PennEast submitted the same PennEast Analysis document (from February 2015), as was submitted to FERC in April 2015 (as part of the pre-filing process).

The jobs estimate in the PennEast Analysis is for constructing 114 miles of pipeline (primarily 36" diameter) and other facilities in NJ and PA, with a total estimated cost of $1,193 million (PennEast Analysis, pp. 4, 9-10). The PennEast Analysis (pp. 9-11) assumes that about $890 million of this total cost will be expended in NJ and PA, with $220 million in NJ and $670 million in PA. About 25% of total in-state expenditures are in NJ and about 75% in PA. Likewise, the PennEast Analysis (p. 11) estimates that about 25% of PennEast jobs are in NJ and 75% in PA (12,160 Total Jobs in NJ+PA; 2,870 total jobs in NJ; 9,290 total jobs in PA).

The PennEast Analysis is based on a February 2015 Project cost estimate and design; since then, the project cost estimate and design have been updated.[60]

As described in the Application (Exhibit K: Cost of Facilities) submitted to FERC in September 2015, PennEast is now estimated to cost $1,131 million.

As described in the Resource Report 1 submitted to FERC in September 2015, PennEast now includes 118 miles of pipeline and other facilities in NJ and PA:

- PennEast Mainline Route (114.0 miles 36" new pipeline in NJ and PA; 36.2 miles in NJ (Hunterdon and Mercer Counties); 77.8 miles in PA (Luzerne, Carbon, Northampton, and Bucks Counties))
- Hellertown Lateral (2.1 miles 24" new pipeline in Northampton County, PA)

[60] Resource Report 5, September 2015, p. 5-9, which specifies that Project cost estimates have changed since February 2015, due to updated unit cost estimates and Project scope changes.

- Gilbert Lateral (0.6 miles 12” new pipeline in Hunterdon County, NJ)
- Lambertville Lateral (1.4 miles 36” new pipeline in Hunterdon County, NJ)
- all new associated aboveground facilities (1 new compressor station in PA (Carbon County); various interconnects, launchers, receivers, and mainline block valves in NJ and PA).

Operating Phase Jobs:

See Section 5 of this Report for the PennEast Analysis’ estimate of operating phase jobs, as well as TGG’s evaluation of this estimate. According to the PennEast Analysis, annual jobs from operations (including spinoffs) are 98 in total, with 88 in PA and 10 in NJ; 80 of the estimated 98 jobs are within the Six-County Region traversed by PennEast.

Atlantic Sunrise Pipeline Project

Project Website: http://atlanticsunriseexpansion.com/

Project Owner/Constructor/Operator: Transcontinental Gas Pipe Line Company (Transco). Transco is a 10,200-mile natural gas pipeline system, extending across approximately 2,000 miles from South Texas and the offshore Gulf of Mexico to New York City. Transco is the nation's largest-volume interstate natural gas pipeline system, and is a large-scale Owner/Constructor/Operator of natural gas pipelines in the Northeast US, including NJ, PA, and NY. Transco is owned by Williams, a large energy infrastructure company primarily involved in activities relating to natural gas in the US and Canada.

Project Facilities, Cost, and Jobs:

FERC Docket CP15-138:

Application for Certificate of Public Convenience and Necessity, March 31, 2015 ("Certificate Application"), especially Exhibit K (Cost of Facilities)
http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13820971

Resource Report 1, General Project Description, March 2015, especially pp. 1-1-1-19.
http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13820974

Resource Report 5, Socioeconomics, March 2015, especially pp. 5-2-5-3; 5-10-5-12; 5-28
Appendix 5A (Economic Impacts of the Atlantic Sunrise Pipeline Project. Blumsack, Seth and Andrew Kleit, Penn State University. January 9, 2015 ("Penn State Study"), especially pp. 2-3; 27-28.
http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13820998

Construction Schedule:

Construction Start Date: July 2016

Project In-Service Date: July 2017

Sources: Certificate Application, p. 1; Resource Report 5, p. 5-2.

Notes:

Atlantic Sunrise is a large and complex project, both absolutely and in comparison with PennEast. The entire Atlantic Sunrise Project has a total estimated cost of $2,588 million, and includes facilities in PA, MD, VA, NC, and SC. The Penn State Study jobs

estimate for Atlantic Sunrise (8,122 total jobs in PA) is for constructing pipeline and other facilities in PA. As now designed, these facilities in PA include 221 miles of pipeline and have a total estimated cost of $2,099 million:

- Central Penn Line (CPL) North (57 miles 30” new pipeline),
- CPL South (125 miles 42” new pipeline),
- Chapman Loop (3 miles 36” pipeline loop),
- Unity Loop (9 miles 42” pipeline loop), and
- all new associated aboveground facilities (2 compressor stations (in Columbia and Wyoming Counties), 2 meter stations, and 3 regulator stations).

The Penn State Study jobs estimate for Atlantic Sunrise in PA is for an earlier project design, which also included one additional meter station (Owego) in PA. Assuming a cost of $21 million for this additional meter station, the Penn State Study jobs estimate for Atlantic Sunrise in PA is for facilities with a total cost of $2,120 million ($2,099 million for facilities in current project design + $21 million for Owego Meter Station). As explained in Resource Report 5 (pp. 5-1; 5-11-5-12), small changes in project design (such as removing the Owego Meter Station) do not significantly affect project cost and job impacts.

Operating Phase Jobs:

Atlantic Sunrise (Resource Report 5, p. 5-11) estimates that 15 full time permanent positions will be needed to operate and maintain the pipeline, compressor stations, and related facilities. The Penn State Study (pp. 27-28) incorporates this estimate as Direct Jobs, specifically in Columbia and Wyoming Counties where new compressor stations are located and the operational workforce will be based. Annual Labor Income per Direct Employee is about $76,000.

In addition to these Direct Jobs, the Penn State Study estimates there will 14 other jobs (Indirect and Induced) in Columbia and Wyoming Counties. Thus, the Penn State Study estimates 29 total annual jobs for the operations phase of Atlantic Sunrise.

Northeast Supply Link Pipeline Project

Project Owner/Constructor/Operator: Transcontinental Gas Pipe Line Company (Transco). Transco is a 10,200-mile natural gas pipeline system, extending across approximately 2,000 miles from South Texas and the offshore Gulf of Mexico to New York City. Transco is the nation's largest-volume interstate natural gas pipeline system, and is a large-scale Owner/Constructor/Operator of natural gas pipelines in the Northeast US, including NJ, PA, and NY. Transco is owned by Williams, a large energy infrastructure company primarily involved in activities relating to natural gas in the US and Canada.

Project Facilities, Cost, and Jobs:

FERC Docket CP12-30:

Application for Certificate of Public Convenience and Necessity, December 14, 2011 ("Certificate Application"), especially Exhibit K (Cost of Facilities) http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=12840054

Resource Report 1, General Project Description, December 2011, especially pp. 1-1-1-14. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=12840055

Resource Report 5, Socioeconomics, December 2011, especially pp. 5-1-5-4; 5-7-5-8. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=12840060

Resource Report 5, Attachment 5A (Economic Impact Studies):

- Economic Impacts of Pipeline System Expansion in Four Pennsylvania Counties (Revision 01-Removed Renovo Loop Impact and added Leidy Gas Odorization Upgrade). Institute for Public Policy and Economic Development. May 2012 ("IPPED Study"), especially p. 4;
- Economic Impacts of the Proposed Transcontinental Gas Pipeline Company, LLC Pipeline System Expansion in New Jersey and Selected Counties (Revised Estimates-April 2012). Seneca, Joseph J. et al. Rutgers, The State University of New Jersey, Edward J. Bloustein School of Public Planning and Public Policy. April 2012 ("Rutgers Study"), especially pp. i, 6.

http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=12975808

Construction Schedule:

Estimated Schedule (assumed in estimates of Project Cost and Jobs):

Construction Start Date: November 2012/April 2013 (between November 2012 and March 2013, a small number of workers conduct tree clearing that that is time restricted related to threatened and endangered species; large scale construction starts April 2013)

Project In-Service Date: November 2013

Sources: Certificate Application, pp. 1-2; Resource Report 5, p. 5-7-5-8.

Actual Project In-Service Date: September 2013 (half of capacity)/November 2013 (half of capacity)

Source: Williams Press Release, November 4, 2013
http://investor.williams.com/press-release/williams/williams-partners-brings-transco-northeast-supply-link-expansion-full-service

Comments: The estimates of Project Cost and Jobs in Figure 2 for Northeast Supply Link are based on estimates (including estimated construction schedule) provided in the FERC Certificate Proceeding prior to actual project construction. As explained above, actual construction has differed from the scheduled November 2013 in-service date estimated prior to project construction (for a November 2013 in-service date). Half of Northeast Supply Link capacity was brought in-service three months ahead of schedule, and the other half was in-service on schedule. Information on changes in construction schedule is provided here for completeness and context, but it should be understood that the estimates of Project Cost and Jobs in Figure 2 are based on the project schedule estimated prior to project construction, rather than the subsequently revised schedule.

Notes:

The entire Northeast Supply Link Project has a total estimated cost of $341 million, and includes facilities in NJ, PA, and NY.

The Rutgers Study jobs estimate for Northeast Supply Link in NJ (696 total jobs) is for constructing pipeline and other facilities in NJ. The IPPED Study jobs estimate for Northeast Supply Link in PA (574 total jobs) is for constructing pipeline and other facilities in PA. Thus, the total jobs estimate for Northeast Supply Link in NJ and PA is 1,270 total jobs (696 total jobs in NJ (Rutgers Study) + 574 total jobs in PA (IPPED Study)).

The total jobs estimate for Northeast Supply Link in NJ and PA is for constructing 12.5 miles of pipeline and other facilities in NJ and PA, which have a total estimated cost of $325 million:

- Muncy, Palmerton, and Stanton Loops (12 miles 36” and 42” pipeline loop, estimated cost $152 million),
- Caldwell B Replacement (0.5 miles 36” pipeline replacement, estimated cost $10 million),
- Caldwell Uprate (26 miles 36” pipeline pressure uprate, estimated cost $18 million), and
- aboveground facilities (1 new compressor station; 1 new electrical substation; modifications to 2 compressor stations, 4 meter and regulator stations, and other facilities; total estimated cost $145 million).

Northeast Supply Link did not provide an economic impact study and total jobs estimate for constructing facilities in NY, which have a total estimated cost of $16 million:

- Long Island Extension Uprate (estimated cost $4 million),
- aboveground facilities (modifications to 2 meter and regulator stations and 1 other facility (estimated cost for meter stations, regulators, and other modifications is $50 million for the entire Northeast Supply Link project in NJ, PA, and NY; assuming 76% of this project cost is in NJ and PA, and 24% in NY, the estimated cost in NY is $12 million).

Northeast Energy Direct (NED) Pipeline Project

Project Website: http://northeastenergyfuture.com/ http://www.kindermorgan.com/pages/business/gas_pipelines/east/neenergydirect/default.aspx

Project Owner/Constructor/Operator: Tennessee Gas Pipeline Company ("Tennessee" or "TGP"). Tennessee is a 11,900-mile natural gas pipeline system, extending across approximately 2,000 miles from South Texas and the offshore Gulf of Mexico to the New York City and Boston areas. Tennessee is a large-scale Owner/Constructor/Operator of natural gas pipelines across the Northeast US, including NJ, PA, NY, CT, MA, NH, and RI. Tennessee is owned by Kinder Morgan, the largest energy infrastructure company in North America.

Project Facilities, Cost, and Jobs:

FERC Docket PF14-22:

Draft Resource Report 1, General Project Description, July 2015, especially pp. 1-1-1-9; 1-13-1-24. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13939503

Draft Resource Report 5, Socioeconomics, July 2015, especially pp. 5-1; 5-3-5-4; 5-24-5-28. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13939513

Recent Documents Not Yet Submitted to FERC:

The Economic Impact on Massachusetts of the Proposed Northeast Energy Direct Pipeline. Bachman, Paul, et al. Beacon Hill Institute at Suffolk University. June 2015 ("BHI Study", funded by Kinder Morgan (the Owner/Constructor/Operator of NED)), especially pp. 3, 9-12. http://www.kindermorgan.com/content/docs/NED_Beacon_Hill_Study.pdf http://www.beaconhill.org/BHIStudies/NED-Pipeline2015/BHI-NortheastDirect2015-0619.pdf http://www.beaconhill.org/BHIStudies/NED-Pipeline2015/FINAL-PressRelease-BHI-PR-NEDPipe-2015-0624.pdf

Press Releases:

"Kinder Morgan Approves Proceeding with Tennessee Gas Pipeline's Northeast Energy Direct Project," July 16, 2015. http://www.kindermorgan.com/content/docs/PR_NEEnergy_Direct.pdf

"Kinder Morgan Increases Quarterly Dividend to $0.49 Per Share, up 14%," July 15, 2015 http://news.kindermorgan.com/press-release/all/kinder-morgan-increases-quarterly-dividend-049-share-14

Project Schedule:

Construction Start Date: January 2017

Project In-Service Date: November 2018 (November 2019 for 300 Line Looping in CT)

Annual Seasonal Activity Levels: Most project construction will occur over a two-year period (2017-2018), with a much smaller amount of construction in 2019 (for 300 Line Looping in CT). In all three years, construction activity will be mainly in the summer/warmer weather months, with the peak summer Direct Onsite Construction workforce more than twice as large as average annual workforce

Sources: Resource Report 1, p. 1-3; Resource Report 5, pp. 5-1, 5-30.

Notes:

During the time period while this report was being prepared by TGG (August to October, 2015), the Northeast Energy Direct (NED) Project was still in the pre-filing process at FERC. Thus, the NED Project (including design and other aspects that affect job impacts) is still being finalized for submittal to FERC of an Application for Certificate of Public Convenience and Necessity.

The Northeast Energy Direct (NED) Project is a very large and complex project, both absolutely and in comparison with PennEast. As most recently described in the Draft Resource Reports submitted to FERC in July 2015, the entire NED Project includes 418 miles of pipeline and other facilities in PA, NY, CT, MA, and NH:

- Pennsylvania to Wright (132 miles 30” new pipeline in PA and NY)
- Wright to Dracut (188 miles 30” new pipeline in NY, MA, and NH)
- 300 Line Looping (39 miles 36” pipeline loops in PA; 15 miles 24” pipeline loops in CT)
- Laterals (44 miles 12”, 20”, 24”, and 30” laterals in MA and NH)
- associated aboveground facilities (9 new compressor station; 13 new meter stations; modifications to 1 compressor station and 12 meter stations; and other facilities).

As stated in Press Releases (July 15 and 16, 2015), the entire NED Project is estimated to cost approximately $5 billion, including $3.3 billion for the Market Path sections (from Wright to Dracut and Laterals beyond).

The NED Project includes extensive facilities in 5 Northeast US states (PA, NY, CT, MA, and NH). But to date, an economic impact study and total jobs estimate has been provided for only one state: the BHI Study for MA. As further discussed later in these Notes, economic impact studies and total job estimates for NED in other states may be provided subsequently, but they are not now publicly available.

The jobs estimate in the BHI Study is for constructing 101 miles of pipeline and other facilities in MA:

- Wright to Dracut (64 miles 30" new pipeline)
- Laterals (9 miles 12", 8 miles 20", 21 miles 24", and 1 mile 30")
- aboveground facilities (3 new compressor station; 9 new meter stations; modifications to 11 meter stations; and other facilities).

As stated in the BHI Study (pp. 3, 9, 12), NED in MA has an estimated total cost of $1,300 million, with the following job impacts:

- 1,713 Total Jobs, including
- 680 Direct Onsite Construction Jobs, and
- 1,033 Other Jobs (1,713 Total Jobs - 680 Direct Onsite Construction jobs), which include:
    - other direct jobs (design, engineering, permitting, and support jobs, typically offsite),
    - upstream jobs in the supply chain, providing services, materials and other inputs (also known as indirect jobs); and
    - downstream jobs as workers spend income from jobs upstream, offsite and onsite (also known as induced jobs).

The BHI Study used IMPLAN (input-output analysis) to estimate the economic impact (jobs, labor income, and value added) of NED in MA. But the BHI Study estimates of Direct Onsite Construction Jobs and labor income are based on data from Kinder Morgan (the Owner/Constructor/Operator of NED) for onsite labor on each construction spread, rather than generic IMPLAN estimates for the construction sector.

The BHI Study estimate of Direct Onsite Construction Jobs (680 jobs) matches the Draft Resource Report 5 (pp. 5-25-5-26) estimate of construction jobs in MA for local workers. These Direct Onsite Construction Jobs are for more than 1 year, with a weighted average duration of 60 weeks.

As discussed above (in the Section on Project Schedule/Actual and Seasonal Activity Levels), NED construction in MA will occur over a two-year period (2017-2018), mainly in the summer/warmer weather months. NED Direct Onsite Construction Jobs are estimated to have a duration averaging 60 weeks, which is equivalent to 30 weeks per year (during the warmer weather months) for two years (2017-2018).

Thus, for NED in MA, the estimated 680 Direct Onsite Construction Jobs (for 60 weeks) are equivalent to 785 annual jobs for 52 weeks (680*60/52).

The above jobs estimate includes only construction workers residing in MA. As stated in Draft Resource Report 5 (pp. 5-23-5-26), construction workers are estimated to reside 50% locally, and the payroll for local construction workers is 50% of the payroll for all construction workers. So in addition to the Direct Onsite Construction Jobs for local workers residing in MA (680 jobs, equivalent to 785 annual jobs), there is an equal number of construction jobs for non-local workers (680 jobs, equivalent to 785 annual jobs).

As documented in Draft Resource Report 5 (pp. 5-25-5-26), Direct Onsite Construction Jobs (in MA, as well as in PA, NY, CT, and NH) have very high income per job, due to both a high hourly rate, and high hours per week, typically averaging:

- $65/hour (total labor income including benefits and taxes)
- 60 hours/week (10 hours/day, 6 days/week)
- $3,900/week (total labor income including benefits and taxes).

The BHI Study estimate of Labor Income for Direct Onsite Construction Jobs in MA ($159 million) matches the Draft Resource Report 5 (pp. 5-25-5-26) estimate of Labor Income for construction jobs in MA for local workers. Labor Income per job averages over $200,000 for Direct Onsite Construction workers on NED in MA ($159 million/680 jobs for 60 weeks is over $233,000 per job for 60 weeks; $159 million/785 annual jobs for 52 weeks is over $202,000 per annual job for 52 weeks). These results are consistent with the estimates for NED described above: labor income per worker averaging $3,900/week ($65/hour for 60 hours/week).

Direct Onsite Construction Jobs in other states along the NED routing (PA, NY, CT, and NH) have similarly high labor income per worker, consistent with income averaging $3900 per week and over $200,000 per year (based on 52 weeks of work).

The BHI Study does not indicate whether the estimated 1,033 other jobs are annual jobs. The BHI Study used IMPLAN to estimate other jobs, and IMPLAN typically estimates employment in terms of annual jobs.

Assuming these 1,033 other jobs are annual jobs, the total jobs estimate for NED in MA for all workers is 2,603 annual jobs:

= jobs for workers residing in MA + jobs for Onsite Construction workers residing elsewhere

= 1,033 other jobs for workers residing in MA + 785 Direct Onsite Construction Jobs for local workers residing in MA + 785 Direct Onsite Construction Jobs for workers residing elsewhere.

Also assuming these 1,033 other jobs are annual jobs, the total jobs estimate for NED in MA for in-state workers residing in MA is 1,818 jobs:

= jobs for workers residing in MA
= 1,033 other jobs for workers residing in MA + 785 Direct Onsite Construction Jobs for local workers residing in MA.

As mentioned earlier in these Notes, the NED Project includes extensive facilities in 5 Northeast US states (PA, NY, CT, MA, and NH), but an economic impact study and total jobs estimate has only been provided for MA. Studies and total job estimates for NED in other states may be provided subsequently, but they are not now available.

Kinder Morgan (the Owner/Constructor/Operator of NED) was funding the New Hampshire Center for Public Policy Studies (NHCPPS) to perform an economic impact study for NED in NH, with terms of engagement for NHCPPS to retain full control over the design and editorial content of the study and report. However this agreement has now been terminated owing to a disagreement over its terms, and NHCPPS is not aware of any other organization contemplating this kind of study at the present time.
http://www.policyblognh.org/policy_blog_nh/2015/02/a-new-research-project-for-the-center.html
http://www.policyblognh.org/policy_blog_nh/2015/04/update-on-our-pipeline-project.html

Operating Phase Jobs:

NED (Resource Report 5, pp. 5-26-5-28) estimates that 26 new full time local employees will be added for operation of the NED facilities, with estimated average salaries ranging from $51,500 to $110,000. These jobs would be located in the 4 Northeast US states along the NED routing:

PA: 4 jobs (average annual income per job $75,000)
NY: 10 jobs (average annual income per job $78,500)
MA: 7 jobs (average annual income per job $98,200)
NH: 5 jobs (average annual income per job $87,000)

Pipelines employees have high average annual incomes. These are high-skill, specialized, technical jobs, with titles including:

Damage Prevention
Operations Specialist
Corrosion
Technicians (Measurement, Engineering, Equipment and Controls)
Supervisors (Operations, Corrosion)
Controls Engineer.

As noted by NED (Resource Report 5, p. 5-26), in addition to Direct Employees, there will be some benefits to local economies, via contractors and workers involved in pipeline operations (including maintenance and repair):

> [L]ocal economies will also benefit from routine operations and maintenance activities, including vegetation clearing on the ROW and repairs of pipeline and compressor station facilities, as well as including plumbers, painters, electricians, and other trades/services associated with normal operations of compressor stations […].

But NED does not quantify these benefits in terms of other jobs relating to pipeline operations. The BHI Study for NED in MA estimates jobs relating to pipeline construction, but does not estimate jobs relating to operations.

Constitution Pipeline Project

Project Website: http://constitutionpipeline.com/

Project Owner/Constructor/Operator: Joint Venture of Williams Partners (Williams), Cabot Pipeline Holdings (an independent gas producer), Piedmont Constitution Pipeline Company (subsidiary of Piedmont Natural Gas Company), and Capital Energy Ventures (subsidiary of WGL Holdings). Williams is a large energy infrastructure company primarily involved in activities relating to natural gas in the US and Canada. Williams has a 41% ownership share in Constitution, and is constructing and operating the project. Williams also owns Transcontinental Gas Pipe Line Company (Transco). Transco is a 10,200-mile natural gas pipeline system, extending across approximately 2000 miles from South Texas and the offshore Gulf of Mexico to New York City. Transco is the nation's largest-volume interstate natural gas pipeline system, and is a large-scale Owner/Constructor/Operator of natural gas pipelines in the Northeast US, including NJ, PA, and NY.

Project Facilities, Cost and Jobs:

FERC Docket CP13-499:

Application for Certificate of Public Convenience and Necessity, June 13, 2013 ("Certificate Application"), especially Exhibit K (Cost of Facilities) http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13282099 http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13282102;

Resource Report 1, General Project Description, November 2013 (Supplement to June 13, 2013 and July 24, 2013 Environmental Reports), especially pp. 1-3-1-11. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13391257

Resource Report 5, Socioeconomics, November 2013 (Supplement to June 13, 2013 and July 24, 2013 Environmental Reports), especially pp. 5-1; 5-19-5-11; Appendix 5A (The Economic Impact of the Constitution Pipeline. Gardner, Kent and Scott Sittig. Center for Governmental Research (CGR). June 2013 ("CGR Study")), especially pp. 2-9. http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13391263

Construction Schedule:

Estimated Schedule (assumed in estimates of Project Cost and Jobs):

Construction Start Date: June 2014/September 2014 (between June 2014 and September 2014, a small number of workers construction on protected

streams/waterbodies winter timing restrictions related to trout; large scale construction starts September 2014)

Project In-Service Date: March 2015

Sources: Certificate Application, p. 2; Resource Report 5, p. 5-9-5-11.

Revised Schedule:

Construction Start Date: Late Summer 2015

Project In-Service Date: Second Half 2016

Source: Constitution Project Website http://constitutionpipeline.com/

Comments: The estimates of Project Cost and Jobs in Figure 2 for Constitution are based on estimates (including estimated construction schedule) provided in the FERC Certificate Proceeding prior to project construction. As explained above, actual construction has differed from the schedule estimated prior to project construction. Construction start and project in-service have been delayed by over a year. Information on changes in construction schedule is provided here for completeness and context, but it should be understood that the estimates of Project Cost and Jobs in Figure 2 are based on the project schedule estimated prior to project construction, rather than the subsequently revised schedule.

Notes:

The entire Constitution Project has a total estimated cost of $683 million, and includes facilities in PA and NY:

- Pipeline (124 miles 30" new pipeline),
- associated aboveground facilities (1 new meter station, 1 new meter and regulator station, and other facilities).

As stated in Resource Report 5 (p. 5-9-5-11) and the CGR Study (pp. 4-8), Constitution (including both PA and NY) has the following job impacts:

- 1,575 Total Jobs, including
- 1,300 Direct Onsite Construction Jobs, and
- 275 Other Jobs (1,575 Total Jobs - 1,300 Direct Onsite Construction Jobs; other jobs include "spillover effects", including:
    - upstream jobs in the supply chain, providing services, materials and other inputs (also known as indirect jobs); and
    - downstream jobs as workers spend income from jobs upstream, offsite and onsite (also known as induced jobs).

The CGR Study used IMPLAN (input-output analysis) to estimate the economic impact (jobs and labor income, and value added) for Constitution in PA and NY. But the CGR Study estimates of Direct Onsite Construction Jobs and labor income are based on data from Williams (Joint Owner/Constructor/Operator of Constitution) for onsite labor on each construction spread, rather than generic IMPLAN estimates for the construction sector.

The CGR Study estimate of Direct Onsite Construction Jobs (1,300 jobs) matches the Resource Report 5 (p. 5-10) estimates of construction jobs for local and non-local workers. These 1,300 Direct Onsite Construction Jobs are for less than 1 year, with duration per construction spread ranging 26-33 weeks, and a weighted average duration of 29.4 weeks. Thus, the 1,300 Direct Onsite Construction Jobs for 29.4 weeks are equivalent to 735 annual jobs for 52 weeks (1,300*29.4/52).

The above job estimates include all construction workers, residing in PA, NY, and elsewhere. As stated in Resource Report 5 (p. 5-9) and the CGR Study (p. 5), construction workers are estimated to reside 25% locally in 5 PA and NY counties along the pipeline routing, 25% in-state elsewhere in PA and NY, and 50% out-of-state. Only 50% of the Direct Onsite Construction Jobs are for in-state workers; so for workers residing in PA and NY, Constitution is estimated to have 650 Direct Onsite Construction Jobs (1,300 jobs * 0.5), equivalent to 368 annual jobs (735 jobs* 0.5=367.5 jobs).

As documented in Resource Report 5 (pp. 5-11) and the CGR Study (p. 7), Direct Onsite Construction Jobs (in PA and NY) have very high income per job. Labor Income per annual job averages over $175,000 for Direct Onsite Construction workers ($1,300 million/1,300 jobs for 29.4 weeks is $100,000 per job for 29.4 weeks; $1,300 million/735 annual jobs for 52 weeks is over $176,000 per annual job for 52 weeks). Stated another way, labor income per Direct Onsite Construction worker averages $3,400/week.

These estimates for labor income per Direct Onsite Construction Job on the Constitution Project (in PA and NY) are broadly similar to the estimates for the Northeast Energy Direct (NED) Project (in PA, NY, CT, MA, and NH). As discussed in the Notes above for NED, labor income per Direct Onsite Construction worker on NED averages $3,900 per week and over $200,000 per year (based on 52 weeks of work).

The CGR Study does not indicate whether the estimated 275 other jobs are annual jobs. The CGR Study used IMPLAN (input-output analysis) to estimate other jobs, and IMPLAN typically estimates employment in terms of annual jobs.

Assuming these 275 other jobs are annual jobs, the total jobs estimate for Constitution (in PA and NY) for all workers is 1,010 annual jobs:

= jobs for workers residing in PA and NY + jobs for Onsite Construction workers residing elsewhere
= 275 other jobs for workers residing in PA and NY + 367.5 Direct Onsite Construction Jobs for workers residing in PA and NY + 367.5 Direct Onsite Construction Jobs for workers residing elsewhere.

Also assuming these 275 other jobs are annual jobs, the total jobs estimate for Constitution (in PA and NY) for in-state workers residing in PA and NY is 643 annual jobs:
= jobs for workers residing in PA and NY
= 275 other jobs for workers residing in PA and NY + 367.5 Direct Onsite Construction Jobs for workers residing in PA and NY.

Resource Report 5 (p. 5-9) states that the duration of the 275 other jobs will be tied to the duration of project construction. As explained above, Constitution is estimated to have duration per construction spread ranging 26-33 weeks and averaging 29.4 weeks. This would indicate that the 275 other jobs are equivalent to only 155 annual jobs (275*29.4/52).

Assuming only 155 other annual jobs, the total jobs estimate for Constitution (in PA and NY) for all workers is 890 annual jobs:
= jobs for workers residing in PA and NY + jobs for Onsite Construction workers residing elsewhere
= 155 other jobs for workers residing in PA and NY + 367.5 Direct Onsite Construction Jobs for workers residing in PA and NY + 367.5 Direct Onsite Construction Jobs for workers residing elsewhere.

Also assuming only 155 other annual jobs, the total jobs estimate for Constitution (in PA and NY) for in-state workers residing in PA and NY is 523 annual jobs:
= jobs for workers residing in PA and NY
= 155 other jobs for workers residing in PA and NY + 367.5 Direct Onsite Construction Jobs for workers residing in PA and NY.

Operating Phase Jobs:

Constitution (Resource Report 5, p. 5-13) estimates that 7 new full time local employees will be needed to operate and maintain the pipeline; these employees will work along the entire pipeline routing in both PA and NY; additional operational needs will be met using existing staff in surrounding area and Houston:

> These local employees will conduct the operation and maintenance functions. These workers will be responsible for the entire pipeline (all counties). The majority of these workers are expected to be located near the central point of the pipeline at an operations warehouse. The staff may be working at one of the two meter stations, and on any given day, they may be anywhere along the pipeline. Additional operational needs will be met using existing staff located in surrounding areas and Houston, Texas.

Constitution will be operated by Williams. Williams owns Transco, a large-scale operator of natural gas pipelines extending from Texas to the Northeast US, including NJ, PA, and NY. Williams/Transco is based in and operated from Texas. Thus, Williams/Transco can to some extent utilize existing staff based elsewhere in Northeast and in Texas to operate Constitution.

The CGR (p. 8) incorporates the estimate of 7 new full time local employees as 7 Direct Jobs, including 2 in PA and 5 in NY. Annual Labor Income per Direct Employee is about $72,500.

In addition to these Direct Jobs, the CGR Study estimates there will 5 other jobs ("spillover impact"), including 1 in PA and 4 in NY. Thus, the CGR Study estimates 12 total annual jobs for the operations phase of Constitution.

KEY-LOG. economics LLC

Research and strategy for the land community.

To: Interested Parties
From: Sonia Wang and Spencer Phillips, Ph.D.
Date: 3/11/2015
Subject: Review of INGAA Foundation Report, "Pipeline Impact to Property Value and Property Insurability"

The Interstate Natural Gas Association of America (INGAA) Foundation, Inc., has released another report on the impacts of pipelines on property values and property insurability.[1] Like a previous report using the same methods, the report claims that pipelines have no measurable impact on property values of homes of any type, regardless of the age or size of the transmission line. The report quantitatively analyzes two pipelines in Ohio, plus one each in Virginia, New Jersey, Pennsylvania, and Mississippi.

Like its similar 2001 study,[2] this new study has many flaws in methods and uses the same, incorrect assumptions.[3] The authors attempt to compare prices for properties "adjacent to" a pipeline with the price of properties "off" the pipeline. The trouble in each of their case studies, however, is that the definition of "adjacent to" ignores the potential impact of health and safety risks that may be depressing property values for a majority (and in some cases, all) of the properties considered. Specifically, and for most of the properties, the authors fail to account for the fact that many of the "off" properties analyzed are in fact included in the evacuation zone of the pipeline, which would mean the study is not truly distinguishing between properties potentially affected by the pipeline and those beyond the danger zone.

- For the Texas Gas Transmission in Ohio, based on the lowest estimated pressure (PSI) for a 26" pipeline, 25 of the 31 (81%) "off" properties are actually located in the evacuation zone (615.5 feet). [4,5]

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[1] Integra Realty Resources. 2016. "Pipeline Impact to Property Value and Property Insurability." 2016.01. Interstate Natural Gas Association of America (INGAA) Foundation, Inc. http://www.ingaa.org/PropertyValues.aspx.

[2] Allen, Williford & Seale Inc. 2001. "Natural Gas Pipeline Impact Study." F-2001-02. Interstate Natural Gas Association of America (INGAA) Foundation, Inc.

[3] The flaws in the 2001 study are described in Phillips, Bottorff and Wang, 2016, Economic Costs of the Atlantic Coast Pipeline: Effects on Property Value, Ecosystem Services, and Economic Development in Western and Central Virginia, Charlottesville, VA: Key-Log Economics available at keylogeconomics.com.

[4] In most cases, we were able to estimate the evacuation zone based on the diameter and operating pressure given for the pipeline. The Pipeline Association for Public Awareness provides a lookup table with these evacuation zones. For pipelines that fall between the sizes or pressures given,, we interpolated the evacuation zone from the available information. (See Appendix C of "Pipeline Emergency Response Guidelines," Pipeline Association for Public Awareness, 2007, www.pipelineawareness.org.)

[5] For this pipeline, we used the lowest estimated pressure because the exact PSI was not noted in the study or available from other sources. This estimate is the most conservative and it is likely the evacuation is actually larger, meaning even more of the "off" properties listed are, in effect, near the pipeline.

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- For the REX-EAST pipeline in Ohio, based on a max operating PSI of 1480 for a 42" pipeline, 5 of the 9 (56%) "off" properties are actually located in the EVAC zone (3683.8 feet).
- For the Transcontinental Gas Pipeline in New Jersey, based on the max operating PSI of 1480 for a 42" pipeline, ALL "off" properties are actually located in the EVAC zone (3683.8 ft).
- For the Gulf South Transmission Pipeline in Mississippi, based on the lowest estimated operating PSI of 100 for a 30" pipeline, 9 out of the 17 (53%) "off" properties are actually located in the EVAC zone (684 ft).[4]
- For the Transco (Williams) Pipeline in Virginia and the Williams Natural Gas Pipelines in Pennsylvania, the authors do not report the distance away from the pipeline, rather there is just a yes or no regarding whether or not the property is abutting the right of way. Assuming the authors methods, while flawed, are at least consistent from one case study to the next within the paper, it is likely that 50% or more of the comparison properties (those not abutting the right-of way) are in fact within the evacuation zone and, therefore, are not materially different from those abutting the right-of-way from the perspective of health and safety effects on property value.

In summary, while any econometric evaluation of differences in market prices requires comparing observed prices of things that are different in some way, the INGAA study is merely reporting that there is little difference in the price of things that are not materially different. The authors should be comparing apples to oranges, but instead they compare oranges to oranges.

In addition, the INGAA study suffers from a more serious flaw in that the authors do not state whether or not the purchasers of any of the properties analyzed were aware of the properties' proximity to a pipeline. If a market price is to be taken as a signal of economic value, then the price must arise from a transaction in which both buyers and sellers have full information about the property being sold. But proximity to natural gas pipelines is not typically something that sellers and realtors are required to disclose. If buyers in the study were unaware that they were buying a property near a natural gas pipeline, then one cannot legitimately conclude that their offer prices reflect the effect of the presence or absence of a pipeline on property value.

As a result of these flaws, it is impossible to conclude from INGAA's study that a property value effect does not exist. Other, more appropriate/robust studies, like the study by Hansen, Benson, and Hagen (2006)[6] actually reinforce the conclusion that when buyers do know about a nearby pipeline, market prices drop. These authors found that property values fell after a deadly 1999 liquid petroleum pipeline explosion in Bellingham, Washington. They also found that the negative effect on prices diminished over time. This makes perfect sense if, as is likely, information about the explosion dissipated once the explosion and its aftermath left the evening news and the physical damage from the explosion had been repaired.

Similarly, Kielisch (2015) concludes that when buyers are aware that a property is near a pipeline, their willingness to buy the property and their average offer prices drop significantly.[7] In his systematic

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[6] Hansen, Julia L., Earl D. Benson, and Daniel A. Hagen. 2006. "Environmental Hazards and Residential Property Values: Evidence from a Major Pipeline Event." Land Economics 82 (4): 529–41.

[7] Kielisch, Kurt. 2015. "Study on the Impact of Natural Gas Transmission Pipelines." Forensic Appraisal Group, Ltd.

review of studies were buyers, Realtors, or appraisers were aware of properties' proximity to natural gas pipelines, He found, in brief, that

- 68% of Realtors believe the presence of a pipeline would decrease residential property value, with 56% of Realtors estimating a decrease in value between 5% and 10%.
- 70% of Realtors believe a pipeline would cause an increase in the time it takes to sell a home.
- 62.2% of buyers in a different study stated that they would no longer buy a property with/on a pipeline ROW at any price. Of the remainder, half (18.9%) stated that they would still buy the property, but only at a price 21% below what would otherwise be the market price. The other 18.9% said the pipeline would have no effect on the price they would offer. Not incidentally, the survey participants were informed that the risks of "accidental explosions, terrorist threats, tampering, and the inability to detect leaks" were "extremely rare" (2015, p. 7).

  This translates into a reduction in expected value of 10.5% for those who proceed to buy the home. If you consider that the 62% of buyers who drop out are effectively reducing their offer prices by 100%, the expected reduction in offer price for <u>all</u> potential buyers 66.2%.
- Based on five "impact studies" in which appraisals of smaller properties with and without pipelines were compared, "the average impact [on value] due to the presence of a gas transmission pipeline is -11.6%" (p. 11).

Clearly when one considers property transactions in which one's eyes are open to the presence or or proximity to a pipeline, market prices fall because the properties are less attractive and valuable to their would-be or actual new owners.

In conclusion, the recent INGAA study does not provide conceptually or empirically valid results regarding the effect of natural gas pipelines on property value. Citizens local government officials and FERC should be looking to the best available information from studies such as those referenced here.

HydroQuest

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June 8, 2012

Attn. Maya K. van Rossum
the Delaware Riverkeeper
Delaware Riverkeeper Network
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Bristol, PA 19007

RE: **Hydrologic and Environmental Rationale to Bury Gas Pipelines using Horizontal Directional Drilling Technology at Stream and River Crossings**

Ms. van Rossum,

Introduction

At issue is whether replacement of Transcontinental Gas Pipeline Company, LLC (Transco) 30-inch diameter gas pipelines beneath East Branch Brandywine and Ludwig's Run creeks with 42-inch diameter pipes should be conducted via open trench burial methods or utilizing horizontal directional drilling (HDD) technology. Transco addresses HDD as one of the Design and Construction alternatives, determining that this is not the best alternative for this project. HydroQuest does not agree with the Transco conclusion, and recommends that HDD is the best technological option for crossing the East Brandywine and Ludwig's Run, as well as the unnamed tributaries that are part of this proposed project.

Key issues and factors that should be weighed in the decision regarding the appropriate method of stream crossing are presented below, along with recommendations. While the ultimate HydroQuest recommendation to replace gas pipelines using HDD technology is in this letter cast in terms of the Brandywine Creek area, the recommendation applies equally throughout all of the Delaware River watershed and beyond.

Environmental, Safety and Monetary Risks

There are numerous environmental, safety, and monetary risks associated with open trench burial of gas pipelines (wet, dry, slurry). Open trench burial involves the excavation of sediments for pipeline installation perpendicular to or across streams and their sometimes wide floodplains, along with removal of vegetation and well-established ecosystems. HDD involves the placement of pipelines far below stream corridors without disrupting and fragmenting healthy, viable, ecosystems. It removes the potential

for pipeline exposure and rupture in a safe manner without denuding and modifying streambeds, banks and the adjacent riparian buffer zone. **Where pipeline crossings have already occurred, such as in the Brandywine Creek area, HDD based pipeline replacement will not require again disturbing the creek and its buffer zone.**

There are serious environmental problems associated with pipeline crossings of streams. The most significant risks associated with open trench pipeline burial include unnecessary disruption and fragmentation of riparian ecosystems, potential for explosions, potential introduction of invasive species, potential pipe exposure due to insufficient sediment depth above bedrock for pipe burial placement below potential scour depth (in some cases), the added potential for pipe exposure and rupture associated with lateral channel migration during flood events, additional stream and ecosystem disturbance during remedial activities, and downstream water quality degradation. Financial benefits of HDD pipeline crossings include the elimination of upfront costs of conducting hydrologic/engineering studies needed to assess maximum potential scour depth on all stream reaches targeted for pipeline crossings (see, for example, Doeing et al., 1997) and avoiding significant future expense involved in remediating storm exposed and ruptured pipelines.

Another significant environmental risk associated with both wet and dry trench methods of gas pipeline crossings of rivers and streams is the potential of releasing hydrocarbons or other contaminants directly into surface water and fragile downstream ecosystems. Gas, as it is extracted from a well, may be mixed with hydraulic fracturing fluids. Hydrocarbon-laced condensate or natural gas liquids (NGLs) associated with natural gas (e.g., benzene) may degrade downstream drinking water supplies as well as underlying aquifers recharged by stream water if pipe rupture occurs. The Brandywine Creek Transco pipeline area is located less than 0.5 miles upstream of a drinking water supply intake. Pipe rupture here might well result in a public health hazard. In the absence of pipe rupture circumstances, massive stream disturbances associated with pipeline installations may result in high total suspended solids (TSS) concentrations for extended periods of time. This may adversely impact and degrade downstream ecosystems, fisheries and water supplies.

Beyond this, open trench pipeline installations may unnaturally alter both stream bank and streambed (i.e., channel) stability, thereby increasing the likelihood of scouring within backfilled pipeline trenches. This is because open trenches themselves, when backfilled, may not be compacted to stable pre-trench sediment permeability conditions. Flooding rivers can scour river bottoms and expose pipelines to powerful water currents and damaging debris. More recently, unusually heavy rains possibly associated with climate change, threaten to increase overall stream degradation and channel migration – thereby exposing shallowly buried pipelines.

Most if not all of these risks can be avoided by using HDD technology to place pipelines far below elevations of maximum channel scour and lateral channel migration, preferably within bedrock where possible. Concern has been raised regarding the use of the clay mineral bentonite to thicken drilling mud during HDD operations. Review of industry

Material Safety Data Sheet (MSDS) ecotoxicologic data specific to bentonite (CETCO, 2012; CAS# 1302-78-9) reveals that the Lethal Concentration (LC50) in water that would kill 50 percent of freshwater fish would require 16,000 mg/l continuously for 96 hours (rainbow trout LC50: 19,000 mg/l, 96 hours), an extremely high and unlikely concentration should leakage or spillage occur. Bentonite has a low solubility in water and does not bio-accumulate. The risks relative to using bentonite during HDD operations appear to be low.

HDD is now sufficiently advanced to the point where it is commonly used to cross beneath streams during gas pipeline installations. The HDD procedure readily removes most potential short and long-term environmental impacts associated with open trench pipeline installations. Thus, it is not necessary to disrupt the physical integrity of stream corridors, their ecosystems and intact fisheries. It should be incumbent upon pipeline companies to adhere to commonly used HDD practices now widely employed in order to minimize their environmental footprint and harm.

Examples of Channel Bed Scouring and Gas Pipeline Failures

Buried pipelines may be exposed by streambed lowering resulting from channel degradation, channel scour, or a combination of the two (Fogg and Hadley, 2007). Scour hole development in streams and rivers adjacent to buried pipelines may expose and damage pipelines, thereby posing a significant threat to the downstream environment. Scour hole development proximal to pipelines is well-documented in both stream and seabed settings. To illustrate this point, a number of pipe exposure and failure instances are documented here. For example, deep scour holes were found adjacent to a 42-inch gas pipeline crossing in a shallow Eems seabed crossing between the Netherlands and Germany (Spiekhout and Russ, 2002). Because of a decrease in the depth of sediment cover, rocks had been dumped on the pipeline several times in the past. The evaluation showed that the pipeline was now situated in what could be regarded as an underwater groyne (i.e., a wall of rocks extending from a riverbank outward into a river to control erosion). Scour hole development occurred due to turbulent flow. In some places the cover was inadequate or completely absent. The responsible authorities had indicated that rock dumping was not to be used again in future.

In 1993, the flooding Gila River in Arizona ruptured a 36-inch pipeline, sending natural-gas bubbling to the surface (Randazzo, 2010). In addition, and also associated with 1993 flooding in Arizona from heavy water releases from San Carlos Lake, several El Paso Natural Gas pipelines, which crossed the Gila River near Coolidge, Winkleman, and Kelvin were "scoured" and uncovered by the force of the water and failed (Wikipedia).

Doeing et al. (1997) further document six gas pipelines in the Gila River Basin that were either exposed on bridges or failed due to stream erosion stemming from January 1993 floods in Arizona. The failures were critical because these were major transmission lines that supplied natural gas to residential and industrial users in whole communities and groups of communities. Stream-based pipe *"(f)ailures were caused not only by vertical*

scour of the streambed but also by bank erosion, lateral channel migration, avulsions, bridge scour, and secondary flows outside the main channel. ... Several of the pipelines in the study failed as a result of a meander migration or avulsion of the stream into previously less active or nonexistent channels." Based on field observations and hydraulic modeling for the 100-year design flood, researchers documented maximum vertical scour to 26.6 feet (8.1 meters) and lateral scour to 6,274 feet (2,050 meters) at some failed pipeline crossings. The results of their analyses provide solid justification to use HDD technology to avoid the costly and environmentally damaging consequences associated with shallow pipe burial as is being proposed by Transco and other pipeline companies in the region.

Clean up associated with pipeline breaks can be extremely expensive. As such, the extra costs of HDD pipeline installation versus open trench pipe burial may be offset both monetarily and in terms of avoiding adverse environmental impacts. For example, Federal officials investigating a July 2011 pipeline break that spilled 1,500 barrels of oil into a Montana river said that few companies take river erosion and other risks into account when evaluating pipeline safety. ExxonMobile expects that cleanup costs associated with fouling an estimated 70 miles of shoreline of the Yellowstone River may cost about $135 million (Billings Gazette, 2012). The Department of Environmental Quality in Montana is also concerned with thousands of pipelines that cross small or intermittent streams.

Fifteen years prior to the above mentioned Yellowstone River spill, a damaging flood event in Texas ruptured eight pipelines and spilled more than 35,000 barrels of oil and oil products into the San Jacinto River (Billings Gazette, 2011). While gas pipelines are not conducting oil, natural gas commonly includes condensates that include hydrocarbons and other pollutants which, if released into the environment, pose an environmental risk (e.g., to potential bog turtle habitat and travel corridors, fisheries, water supplies). Fogg and Hadley (2007) of the Bureau of Land Management recognized and addressed this critical issue:

> *"In 2002, the U.S. Fish and Wildlife Service raised concerns about the potential for flash floods in ephemeral stream channels to rupture natural-gas pipelines and carry toxic condensates to the Green River, which would have deleterious effects on numerous special-status fish species (Figure 1)."*

Photo from Fogg and Hadley (2007) of an exposed pipeline crossing the Green River, Utah. Natural gas pipeline breaks during flooding can release condensate toxic to sensitive fish species. Ludwig's Run and the East Branch of Brandywine Creek are a stocked trout fishery.

Fogg and Hadley (2007) evaluated hydraulic considerations for pipeline crossings stream channels. Their Figure 10, shown below, depicts lateral migration of a stream channel during high water that excavated a section of pipeline under the floodplain that was several feet shallower than at the original stream crossing. Ludwig's Run has had similar lateral migration of the channel.

Photo from Fogg and Hadley (2007) of an exposed pipeline crossing an unnamed western US river. Here, lateral migration of a stream channel during high water excavated a section of pipeline under a floodplain that was several feet shallower than at the original stream crossing.

Talke and Swart (2006) and De La Motte (2004) discuss gas pipelines and how man-made changes and actions have altered channel morphology and changed channel stability in an estuary setting. Soil erosion and channel migration in a low gradient mud flat area reduced the soil cover over a pipeline, resulting in scour hole formation and making the pipeline vulnerable to rupture.

Existing regulations regarding pipe burial depth are wholly insufficient. Federal regulations require that pipelines crossing rivers be buried at least four feet underneath most riverbeds (Billings Gazette, 2011). Kirkbride (2009) states that the East Brandywine Creek pipeline is buried just under a meter below grade. While bridge piers are more readily exposed to stream scouring than pipelines, it is telling that bridge failure analyses have determined that channel scour occurs to depths of up to three times that of maximum river floodwater depth (e.g., scour to 30 feet with a 10 foot floodwater depth). Many hydrologic and geomorphic factors contribute to the assessment of maximum scour depth potential under the wetted invert or base of a stream channel during a 500-year flood event. HDD technology presents the best safety mechanism for insuring preservation of channel integrity, water quality and health of downstream fisheries.

River Crossing Technology & Risks

Pisano et al. (2001) detail state-of-the-art river crossing technology as of 2001 using an annular casing system pressurized with nitrogen, and routine leak detection monitoring. This system could be considered in Pennsylvania river and stream crossings. Aronson et al. (2007) review international industry best practices for Russia/CIS for effective management of pipeline crossings, especially where high quality salmonid fisheries may be involved. A review of their work points out that stream pipeline crossing pose a number of potential environmental risks including an increase in total suspended solids loads with increased sediment transport, alteration of river hydraulics, impact to fisheries, stream stabilization, damage to ecological integrity, and soil erodibility.

HDD, discussed below, presents one of the newest and most effective means of installing gas pipelines below streambeds while minimizing land disturbance and adverse environmental impacts. HDD may be conducted such that land disturbance at pipeline burial locations can be set back from streams beyond floodplains, thereby avoiding infringement into riparian areas inclusive of streambeds and banks. In this manner, areas next to streams can be preserved intact versus being adversely impacted by trenching machinery and open cut trenches extending across streams.

Physical Limits of Horizontal Directional Drilling

Hair (2011) assesses the current state of the art in horizontal directional drilling for pipeline installation. Key factors that potentially limit the feasibility of HDD installation are subsurface conditions, pipe diameter, and drilled length. With a few exceptions, most subsurface geologic materials may be successfully penetrated for HDD installations. "*Experience in the mining industry with raise bores indicates that reaming tools in diameters exceeding anything contemplated for a pipeline (in excess of 10 feet) can be rotated with long strings of drill pipe*." (Hair, 2011). The ream hole must be twelve inches larger than the outside diameter of the pipeline to be pulled through the hole. Hair (2011) addresses the industry's current maximum demonstrated pipe diameter and the routine nature of HDD application:

> "*Demonstrated Maximum Pipe Diameter*
>
> *The feasibility of HDD for installation of very large diameter welded steel pipelines is demonstrated by experience in 2004 on the Cross Island Pipeline Project for The National Gas Company of Trinidad and Tobago. This 56-inch diameter pipeline project included three HDD crossings in lengths of 2,230 feet (680 meters), 2,517 feet (767 meters), and 2,415 feet (736 meters). Seventy-two inch reaming tools were employed.*
>
> ***The explosion of new natural gas transmission pipeline construction over the last three years has made HDD installation of 42-inch diameter pipe common, if not routine.*** (Emphasis added) *This is demonstrated by the fact that,*

in the last three years alone, the author's engineering firm has designed fifty (50) 42-inch HDD crossings with a total length of over twenty miles. The length of eight of these crossings exceeded 4,200 feet (1,300 meters) with the longest exceeding 5,500 feet (1,700 meters)."

Depending on a number of factors including pipe diameter, demonstrated HDD distance, using the drilled intersect technique may make maximum pilot hole lengths of up to 14,000 feet (3,676 meters) achievable (Hair, 2011). Another benefit of HDD is that ice scour damage associated with pipeline landfalls may be avoided (Hair, 2011). Furthermore, rupture of pipelines shallowly buried within stream corridors (i.e., placed in formerly open trenches) will almost certainly require immediate and costly remedial action. In such cases, there will not be sufficient time or resources available to minimize adverse environmental impacts. These impacts are likely to be far-reaching because most pipe ruptures occur during flood events where contaminant dispersal is likely to be great. Unfavorable impacts associated with shallowly buried pipelines argue for using deep HDD methods to avoid degradation of stream corridor ecosystems and habitat fragmentation.

Clearly, with the current state of the art of HDD technology, there is no need to jeopardize stream and river water quality or downstream ecosystems.

HDD Pipeline Endpoints Should be Placed Outside the 500-Year Floodplain

HDD endpoints should be located beyond the 500-year floodplain boundary. Rapid and/or turbulent stream flow has the potential of causing pipeline rupture, as documented in a number of examples provided above. Determination of what flood recurrence interval (e.g., 50-year, 100-year, 500-year) should form the basis of locating HDD endpoints should be based on a statistical assessment of recorded flood events from one or more long-term nearby USGS stream gaging stations. Major flood events are not isolated in nature, instead they tend to occur within broad areas with regional, widespread, storms. As an example of the type of analysis required to assess the flood recurrence intervals associated with major storm systems, HydroQuest hereby provides the results of a statistical assessment conducted for the Schoharie Valley, New York State area. This may be reviewed at: http://hydroquest.com/Schoharie, and is hereby incorporated by reference.

In this example, HydroQuest used long-term peak water year data (102 years) for the Schoharie Creek at Prattsville, inclusive of USGS's peak flow estimate there for the Hurricane Irene storm of 8-28-11. USGS (pers. comm.) estimates the peak flow at Prattsville was between 100,000 cubic feet per second (cfs) and 120,000 cfs. A value of 110,000 cfs was used by HydroQuest to conduct a statistical analysis of the flood return interval associated with floodwaters of Hurricane Irene. The HydroQuest Log-Normal Distribution plot and related statistical data supporting a 500-year flood return are presented at: http://hydroquest.com/Schoharie/. It is important to recognize that a 500-

year flood is a statistically-based number that may, in fact, occur back-to-back in consecutive years. Clearly, regional flooding to 500-year flood return stream stage levels provides a solid basis for placing HDD endpoints outside 500-year floodplains.

Additional support for using 500-year floodplain levels as HDD endpoints comes from the work of Fogg and Hadley (2007) who state that pipelines that cross stream channels on the surface should be located above all possible flood flows that may occur at crossing the site. They also state that at a minimum, pipelines must be located above the 100-year flood elevation and preferably above the 500-year flood elevation. By analogy, buried pipes should be located sufficiently deep so as to not be adversely impacted by scouring under 500-year floodwater depths.

HydroQuest Flood Return Interval Analysis of Brandywine Creek

Preliminary assessment of data from USGS gage 01480700 East Branch Brandywine Creek near Downingtown, PA located 0.83 miles upstream from the pipeline crossing, documents a stream stage of 12.06 feet and discharge of 8,070 cubic feet per second on June 22, 1972 associated with Hurricane Agnes. The watershed area upstream of this gaging station encompasses 60.6 mi^2. If one assumes a roughly similar channel cross-sectional area and floodplain width at the Brandywine pipeline crossing it is possible to assess whether this 12 foot creek depth is likely to be a maximum depth expected to be associated with a storm with a 500-year flood return interval.

HydroQuest evaluated this question by conducting a statistical analysis to determine the likely flood return interval of the 1972 twelve-foot stream depth recorded at the USGS Brandywine gaging station. Forty-six years of annual peak flow data was statistically analyzed. To some unknown degree some of the flow was affected by regulation or diversion. To be valid, each of the four tests conducted had to pass a Chi-Square Test. Type 1 Gumbel distribution and Normal distribution tests failed the Chi-Square Test. Both the Log-Normal distribution and Log-Pearson Type III distribution tests passed, providing a statistically based flood return interval for the 1972 flood of about 50 years. Thus, the 1972 flooding and associated depth of Brandywine Creek is far less than what will certainly occur during 100-year and 500-year flood events. An idea of the relative magnitude of flow difference may be obtained by examining the statistically determined streamflow (discharge (Q) in cubic feet per second: cfs) for different flood return intervals (Tr in years):

Tr (years)	Log-Normal Distribution Q (cfs)	Log-Pearson Type II Distribution Q (cfs)
1.01	643	646
2	2,415	2,412
5	3,895	3,894
10	5,002	5,006
25	6,531	6,546
50	7,758*	7,787
100	9,058	9,105
200	10,437	10,507
500	12,392	12,502
1000	13,979	14,125

*: June 22, 1972 peak stream flow of record was 8,070 cfs with a stage of 12.06 feet.

While comparative measurements of creek cross-sectional area are required both at the USGS gaging station and at the Brandywine pipe crossing to determine flood depths, it is probably reasonable to assume that the 500-year flood has an associated maximum stream depth of at least 15 feet, perhaps more depending on the cross-sectional area at the pipeline crossing. Field work should be conducted to refine this number, inclusive of Rosgen flood depth field characterization methods. Creek depth is one of a number of important factors that influences potential scour depth. Doeing et al. (1997) conducted scour evaluations using a combination of field data and numerical sediment transport models HEC-6 and HEC-2 for 100-year design floods. Based on model assumptions, sediment composition and thickness, channel width, stream discharge, stream velocity, channel curvature, channel morphology, presence of armor layers, field evidence of dunes and anti-dunes, and numerous other factors, they found that potential scour depth varied to depths in excess of 100-year stream flood depths (i.e., Gila River at Duncan). Thus, potential scour depths may equal or exceed maximum 100-year flood water depths. Since 500-year flood return intervals not only will occur but have in recent time (i.e., see Schoharie Creek flood return interval analysis above), it is reasonable to assume that the potential Brandywine scour depth associated with the 50-year return interval flood of 1972 (possibly to at least 12 feet) is far less than the 500-year return interval flood.

Potential Brandywine Scour Depth at the Pipeline Crossing

In the absence of detailed field data and modeling, it would be prudent to assume that potential channel scour depth (not field and model analyzed) may at least equal the maximum 500-year flood stage water column at the Brandywine pipeline crossing, as well as at other pipeline crossings. This 500-year flood depth can be reasonably determined through comparative field survey work of channel cross-sectional areas and flow assumptions (i.e., at the nearby USGS gaging station and at the Brandywine pipeline crossings). In the absence of detailed hydraulic evaluation of the Brandywine pipeline crossing within an as yet un-delineated 500-year floodplain (using methods comparable to that of Doeing et al.), it would not be prudent to bury a replacement pipeline at a depth of less than twice the maximum 50-year stream flood stage. Thus, Brandywine pipeline protection from scour may require burial to at least 24 feet, far below the current 3 foot or so pipe burial depth. Pipe rupture protection would best be accomplished by using HDD technology to isolate gas pipelines far below 500-year floodwater scour depth potential while avoiding channel degradation and habitat fragmentation within the riparian zone.

Important Brandywine Creek Scour Risk

Importantly, if the thickness of sediment cover present below the stream invert (i.e., channel bottom) and above bedrock is less than the potential scour depth, then pipe burial in an open sediment-walled trench will knowingly and unnecessarily place the stream environment and downstream water supply at risk from contaminants released from pipe rupture. Review of the Brandywine Creek 42" Mainline "A" Replacement Alternatives Analysis reveals text in a number of places that imply that the depth to bedrock below the stream invert may be quite shallow. Nowhere in the text is this quantified. **If sediment thickness is less than potential scour depth, then all open trench pipe replacement options should be abandoned.**

Even if there is sufficient sediment thickness to allow replacement pipe to be installed below the maximum potential scour depth, open trench excavations have too many undesirable environmental risks, as discussed above. These risks include exposure to toxic materials released into the environment from pipe ruptures. The HDD alternative section of the alternatives analysis seeks, to a large degree, to downplay this option because of somewhat longer times local residents will be inconvenienced. The alternative option section should be rewritten to include discussion of potential repeated times of inconvenience associated with remedial pipeline replacement activities following pipe exposure and rupture.

Recommendations

Open trench crossings of streams and rivers for gas transmission pipelines may disrupt and adversely impact the physical integrity of stream corridors, their ecosystems and intact fisheries, and stream water quality. Field data collection and modeling are

necessary to determine potential maximum channel scour depth far in advance of initial pipeline burial or replacement burial. It is highly unlikely that the needed data exists for the Brandywine pipeline crossing, otherwise the existing pipeline would have been buried far deeper than it is. Pipeline replacements at stream crossings provide an opportunity to forever remove the numerous environmental and other risks associated with pipeline exposure and rupture that stem from no or inadequate evaluation of scour potential.

The explosion of new natural gas transmission pipeline construction over the last three years has made Horizontal Directional Drilling installation of large-diameter pipe common, if not routine. HydroQuest recommends that all gas transmission pipelines be placed using HDD technology, locating pipe endpoints beyond the limit of 500-year floodplains. While this recommendation is cast in terms of the East Brandywine Creek area, it applies directly throughout all of the Delaware River watershed and beyond.

Should HDD not be contemplated at all new and replacement pipeline crossings of streams and rivers, no open trench pipe burial should occur without full hydrologic and engineering analysis of all the variables discussed in this letter, as well as those addressed in the evaluation methodology used by Doeing et al. (1997) and the hydraulic evaluations of other researchers. To do so would not be prudent and would knowingly place pipelines, residents and the environment at risk. Furthermore, in light of today's knowledge base relative to mechanisms and variables associated with pipeline exposure and rupture, failure to fully evaluate streambed scour potential <u>before</u> installing or replacing pipelines may needlessly place pipeline companies at legal risk.

HydroQuest also recommends that the Horizontal Directional Drilling alternative provided be substantially redone. Instead of being advanced as an alternative riddled with problems, it should be rewritten as the preferred best option that is stated as being "*technically feasible*" with a detailed discussion of how best to overcome any outstanding issues. We suggest that an RFP be put out to obtain HDD design plans and bids from qualified contractors, including John D. Hair of J. D. Hair & Associates, Inc. (see References below).

In addition, the alternatives analysis needs to be rewritten to consider the open trench harms discussed in this comment and to assess the impacts and costs of laying the pipe in a trench that is a minimum of 24 feet below the surface of the creek bed in order to protect against exposure and/or rupture by scour.

Sincerely yours,

Paul A. Rubin
HydroQuest

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June 3, 2016

Ms. Kimberly Bose
Federal Energy Regulatory Commission
Office of the Secretary
888 1st Street, NE
Washington, DC 20428

Re: Docket No. CP15-558 PennEast Pipeline Project

Dear Ms. Bose,

In an expert report submitted by the Delaware Riverkeeper Network on February 11, 2016, nationally recognized expert Arthur Berman challenged the asserted need for the PennEast Pipeline when he observed:

> "The proposed PennEast Pipeline would deliver an additional 1 Bcf/d of natural gas to New Jersey potentially creating a 53% supply surplus above the current level of consumption."
>
> "Because of the lack of demand for Marcellus gas in Pennsylvania and adjacent New Jersey, it is possible that PennEast and its committed suppliers have an unstated intent to send gas to other markets not specified in their proposal…."

It is now clear that our belief is accurate that owners of the PennEast Pipeline Company, LL.C., namely and at least Spectra Energy Partners, had ulterior motives for the gas to be carried by the PennEast Pipeline. It is now clear that partners of the PennEast Pipeline Company, LLC are proposing additional projects that, given their connected ownership, physical connection, contemporaneousness in terms of time and space, and the planned route for the gas – are integral parts of the PennEast Pipeline project and should be considered as part of cumulative impacts of the PennEast Pipeline project and plan. All agencies with a regulatory voice in the review of the proposed PennEast Pipeline must consider these impacts, including such agencies as the Federal Energy Regulatory Commission (FERC), the Delaware River Basin Commission (DRBC), the Pennsylvania Department of Environmental Protection (PADEP), the New Jersey Department of Environmental Protection (NJDEP), the US Army Corps of Engineers (Corps), the US Fish & Wildlife Service (USF&WS), the Environmental Protection Agency and the National Park Service (NPS).

Spectra Energy Partners is a "member company" in PennEast Pipeline Company, LLC and 10% owner of the PennEast Pipeline proposal. Spectra Energy is 100% owner of Texas Eastern Pipeline that will

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be interconnected with PennEast in/around Lambertville, NJ. Spectra Energy is currently planning for and proposing a new project called the Texas Eastern Marcellus to Market project (M2M) in which it clearly identifies, as a primary goal, the redirection and transfer to western markets of gas brought via the PennEast Pipeline that will transfer at/thru the compressor station in Lambertville, NJ. Spectra's M2M project seeks to increase capacity along the Texas Eastern pipeline segment between the Lambertville NJ Compressor Station and Eagle (in Chester County PA) Compressor Station. The M2M project, consists of upgrades to existing lines including some new facilities.

The M2M project sketch map clearly documents Spectra Energy's plan to receive most of its anticipated gas (over 62%) from the PennEast Pipeline. The map also confirms that Spectra Energy plans to send the gas *west* from Lambertville Station into Pennsylvania via its Texas Eastern systems. On its website, Spectra makes very clear that the proposed PennEast pipeline will be the primary source of gas that the M2M project will transport.

Specifically, according to the Spectra Energy website, the new M2M pipeline would receive the majority of its gas, 62.5%, (up to 125,000 dekatherms per day (Dth/d)) from the PennEast pipeline (this equates to over 11% of PennEast's anticipated capacity)

Spectra is also pursuing the proposed Greater Philadelphia Expansion Project. The stated intent of the project is to increase the volume of gas Spectra can transport to the Philadelphia region from the Eagle Compressor Station – the same station that is part of Spectra's proposed M2M Project. The Philadelphia region has been under discussion for an LNG export facility, which is one obvious pathway for future intended export of PennEast Pipeline gas. This export facility must be disclosed and analyzed in addition to the Cove Point LNG export facility already identified by the Delaware Riverkeeper Network and Mr. Berman as a likely recipient of the gas.

The Delaware Riverkeeper Network and Arthur Berman were right. Owners of the PennEast Pipeline Company are clearly planning the PennEast pipeline in order to carry gas to markets that are different than those asserted in the FERC application, including likely overseas markets.

The National Environmental Policy Act clearly requires FERC consideration of these interconnected projects obviously being contemplated and planned for in the same time frame by the same owner for delivery of the same gas. There exists a physical, functional, and temporal nexus that cannot be overlooked and FERC is now fully aware of these additional elements of the PennEast Pipeline project that is before FERC and freely available to the public for review and consideration. Spectra Energy clearly intends and plans for these projects to operate as an interconnected whole, and as such their cumulative impacts must be considered as part of the review of the PennEast Pipeline project and the M2M project when it is actually proposed.

Respectfully,

Maya K. van Rossum

Maya K. van Rossum
the Delaware Riverkeeper

Attachments:

M2M Open Season document

Arthur Berman report regarding PennEast Pipeline need.

M2M 0pen season document can also be viewed at:
https://infopost.spectraenergy.com/GotoLINK/GetLINKdocument.asp?Pipe=10076&Environment=Production&DocumentType=Notice&FileName=Texas+Eastern+Marcellus+to+Market+Project+Open+Season+Notice.pdf&DocumentId=8a7842c94bc5a9a1014be4c38be80670)

Open Season Notice
March 4, 2015 – April 10, 2015

Texas Eastern Marcellus to Market Project

Open Season

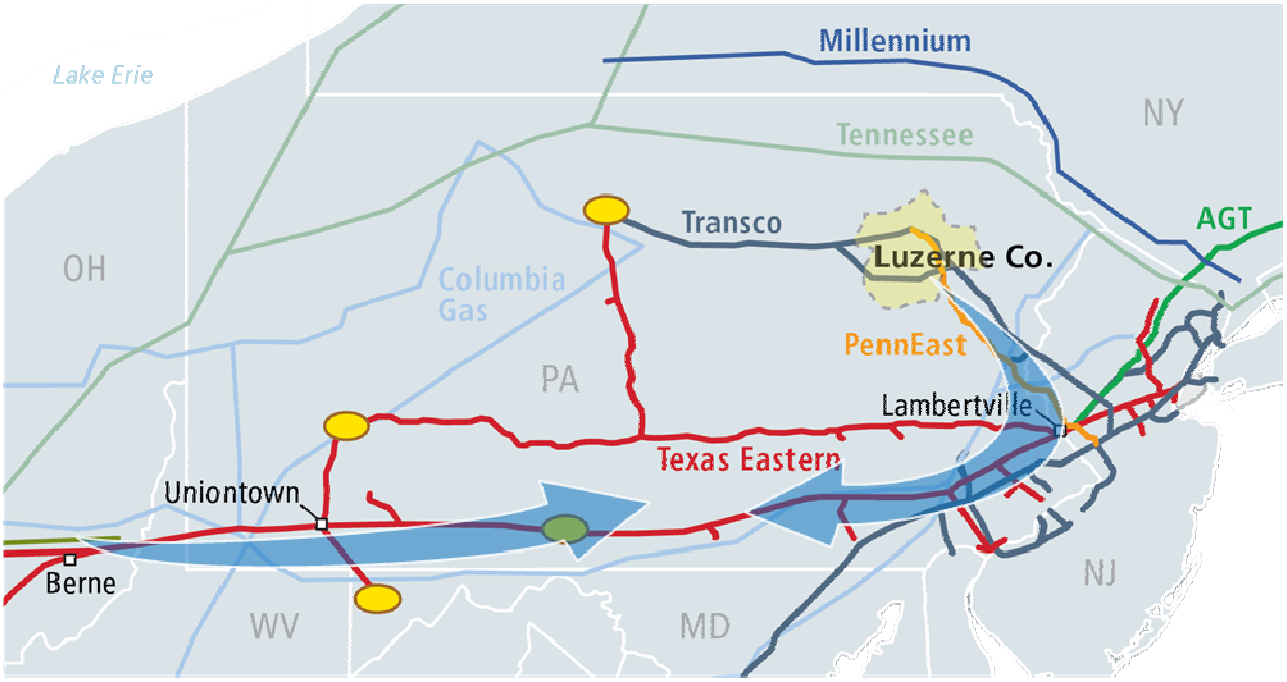
Texas Eastern Transmission, LP ("Texas Eastern"), a leading provider of natural gas transportation service to many of the largest natural gas markets in the United States, is conducting an open season ("Open Season") for its Marcellus to Market Project ("Project"). The Project (also referred to herein as the "Marcellus to Market Project") will provide shippers with an opportunity to obtain firm transportation service to deliver new incremental production from the Appalachian shale supply region to markets in the Northeast. The target in-service date for the Marcellus to Market Project is as early as November 1, 2017.

Texas Eastern will determine the total volume of capacity for the Project based on its evaluation of the bids received during this Open Season. Parties interested in obtaining capacity in this Open Season may submit a Service Request Form for:

- Up to 125,000 Dth/d from Luzerne County, PA;
- Up to 75,000 Dth/d from Texas Eastern-Lambertville or Algonquin Gas Transmission, LLC ("Algonquin")-Ramapo/Mahwah; and
- Additional paths from Texas Eastern Southwestern Appalachia receipt points.

The Project will transport gas to delivery points in Texas Eastern's Market Zone 3 in New Jersey and Pennsylvania, including points with available capacity between Lambertville, NJ and the Market Zone 2/Market Zone 3 border.

Any bidder who submits a valid Service Request Form for at least 75,000 Dth/d with Luzerne County receipt point(s) will be considered an anchor shipper on the Marcellus to Market Project ("Anchor Shipper"), and its capacity request will only be subject to pro-rationing (if necessary) among other Anchor Shipper bids. Anchor Shippers may receive certain rate and rate-related benefits which may not be offered to other potential Project shippers.



Nomination Process

During the Open Season period (beginning at 8:00 a.m., CDT, on March 4, 2015 and ending at 4:00 p.m., CDT, on April 10, 2015), parties interested in obtaining capacity must submit a Service Request Form, which specifies: the party's requested Maximum Daily Quantity (MDQ); contract term (15-year minimum required); primary receipt point(s); and primary delivery point(s). Bidders may request receipt points at Williams Springville; PVR/Regency Wyoming; UGI Auburn; and Transco Leidy Line (all in Luzerne County, PA). As part of the Marcellus to Market Project, bidders may also request capacity from a Texas Eastern – Lambertville, Algonquin-Ramapo or Algonquin-Mahwah receipt point if at least 62.5% of such bidder's total requested receipt capacity is from a Luzerne County receipt. In addition, Texas Eastern may consider one or more additional firm receipt points in Texas Eastern's Market Zone 2 between Berne, OH and Uniontown, PA, provided that bidders may be required to reimburse Texas Eastern for the cost of installing any new proposed receipt points and certain other facilities installed to move gas from these new receipt points to the delivery points. Bidders may request delivery points on Texas Eastern's system in Market Zone 3, including but not limited to: Lambertville, NJ; the existing Marietta, PA interconnect between the Texas Eastern mainline and Texas Eastern's Marietta Extension; the existing Eagle, PA interconnect between the Texas Eastern mainline and Texas Eastern's Philadelphia Lateral; and the Market Zone 3/Market Zone 2 in-line transfer point. Texas Eastern will also consider new proposed delivery points in Market Zone 3, provided that bidders may be required to reimburse Texas Eastern for the cost of installing any new proposed delivery points and certain other facilities installed to move gas to these new delivery points.

Texas Eastern will also consider service offerings to accommodate demand from those shippers who may require additional flexibility to match their unique operational profiles. Shippers who are interested in such options should contact a Texas Eastern representative.

The Service Request Form is included in this Open Season package. The completed Service Request Form must be executed by a duly authorized representative and mailed, faxed, or emailed in PDF format to Texas Eastern's offices at:

5400 Westheimer Court, Houston, TX 77056
Attn: Erin Petkovich, Project Director,
Business Development
EKPetkovich@spectraenergy.com
Fax No. (713) 627-4727

Texas Eastern reserves the right to reject any Service Request Form that is not received on or before the end of the Open Season period.

Contracting for Service

After the Open Season concludes, Texas Eastern representatives will contact all parties who have submitted valid bids and been awarded capacity for the Marcellus to Market Project in order to finalize the terms on which service will be provided.

Project Rates

Project rates will be determined at the conclusion of the Open Season and are dependent upon the final scope of facilities required for the Marcellus to Market Project facilities. Bidders in this Open Season can choose to pay the maximum applicable recourse rate or a negotiated rate to which the bidder and Texas Eastern have mutually agreed.

Capacity Allocation Process

In the event that Texas Eastern has received valid Service Request Forms for a quantity of capacity that exceeds the quantity of capacity that Texas Eastern desires to construct for the Project, then Texas Eastern will allocate such Project capacity first to qualifying Anchor Shippers executing binding Precedent Agreements on or before the May 8, 2015 deadline and next to non-anchor shippers that have executed binding Precedent Agreements on or before the May 8, 2015 deadline. With respect to Anchor Shippers, Texas Eastern will pro-rate capacity, to the extent

necessary, taking into account the MDQ and the quantities at the primary points subscribed under each such binding Precedent Agreement, on a not unduly discriminatory basis. A bidder's status as an Anchor Shipper, and the Anchor Shipper's attendant rights, will continue to apply even if the pro-rated amount of capacity awarded to such bidder is less than 75,000 Dth/d of Luzerne County receipts. If no bidder qualifies as an Anchor Shipper or if there is any remaining capacity after meeting the requirements of any Anchor Shipper(s), Texas Eastern will allocate any remaining capacity to such other (non-Anchor Shipper) bidders on a not unduly discriminatory basis, with Texas Eastern providing priority to Project capacity among the non-anchor shippers based on the quantity of capacity requested at Luzerne County receipts.

To the extent capacity remains in the Project following completion of negotiations with all qualifying bidders in this Open Season, Texas Eastern reserves the right to negotiate mutually acceptable precedent agreements with any potential shipper for the remaining unsubscribed capacity upon request irrespective of deadlines herein for execution of Precedent Agreements.

Limitations and Reservations

Texas Eastern reserves the right to decline to proceed with the Project or any portion of the Project, including all or any portion of the Project for which Texas Eastern has requested bids as part of this Open Season. Texas Eastern reserves the right to proceed with one or more projects that will be defined through the contracting process and to develop alternative projects from the requests received during this Open Season that may be more representative of the timing requested and markets served. Texas Eastern reserves the right to negotiate with only those parties that submit valid bids as part of this Open Season. Texas Eastern also reserves the right to reject any and all bids or requests that do not satisfy the requirements set forth in this Open Season Notice. Without limiting the foregoing, Texas Eastern may, but is not required to, reject any submitted Service Request Form in which the Service Request Form is incomplete, is inconsistent with the terms and conditions outlined in this Open Season, contains additional or modified terms, or is otherwise deficient in any respect. Texas Eastern reserves the right to request a bidder to modify its proposed receipt or delivery point(s), to the extent that Texas Eastern determines that the nominated point(s) will unduly increase the cost of the overall Project or otherwise adversely affect the scope of the Project in light of the other nominations received prior to or as part of this Open Season. Texas Eastern also reserves the right to reject Service Request Forms in the event requesting parties are unable to meet applicable creditworthiness requirements. No Service Request Form submitted in this Open Season shall be binding on Texas Eastern unless and until duly authorized representatives of both a requesting party and Texas Eastern have executed a binding Precedent Agreement. Texas Eastern reserves the right to reject any party's valid Service Request Form in the event a duly authorized representative of such party has not executed a binding Precedent Agreement on or before May 8, 2015.

Communications

At any time during the Open Season, interested parties are encouraged to contact their Texas Eastern account manager or Erin Petkovich at (713) 627-6371 to discuss any questions or to seek additional information.

Spectra Energy Corp (NYSE: SE), a FORTUNE 500 company, is one of North America's premier pipeline and midstream companies. Based in Houston, Texas, the company's operations in the United States and Canada include more than 22,000 miles of natural gas, natural gas liquids, and crude oil pipelines, approximately 305 billion cubic feet (Bcf) of natural gas storage, as well as natural gas gathering and processing, and local distribution operations. Spectra Energy is the general partner of Spectra Energy Partners (NYSE: SEP), one of the largest pipeline master limited partnerships in the United States and owner of the natural gas, natural gas liquids, and crude oil assets in Spectra Energy's U.S. portfolio. The company also has a 50 percent ownership in DCP Midstream, the largest producer of natural gas liquids and one of the largest natural gas gatherers and processors in the United States. Spectra Energy has served North American customers and communities for more than a century. The company's longstanding values are recognized through its inclusion in the Dow Jones Sustainability World and North America Indexes and the Carbon Disclosure Project's Global 500 and S&P 500 Carbon Disclosure Leadership Indexes. For more information, visit www.spectraenergy.com.

Texas Eastern Marcellus to Market Project
Service Request Form
Bidder Information

Company _____

Contact _____

Title _____

Address _____

Telephone _____ Fax _____

Email _____

Contract Requirements

Maximum Daily Quantity (dekatherms): _____

Receipt Point(s)	MDRO (Dth/d)	Delivery Point(s)	MDDO (Dth/d)

Contract Term: *(15-year minimum required)*

Signature of Requester/Customer: _____ Date: _____

Please mail, fax or email a pdf of the completed service request form to:

Erin Petkovich, Project Director, Business Development

Texas Eastern Transmission, LP 713-627- 4727 fax

5400 Westheimer Court EKPetkovich@spectraenergy.com

Houston, TX 77056

Bidders may request receipt point(s) Williams Springville; PVR/Regency Wyoming; UGI Auburn; and Transco Leidy Line (all in Luzerne County, PA). Additional consideration will be given for receipts at Texas Eastern-Lambertville, Algonquin-Ramapo or Algonquin-Mahwah, if at least 62.5% of total requested receipt capacity is from a Luzerne County receipt. Texas Eastern may consider one or more additional firm receipt points on Texas Eastern's Market Zone 2 between Berne, OH and Uniontown, PA. Primary delivery points available for the Project are meter locations in Texas Eastern M3 zone west of Lambertville, NJ that have available meter capacity, with additional delivery points to be considered. The sum of the Maximum Daily Delivery Obligations (MDDO) among all such delivery point(s) must not exceed the MDQ bid.

Field Monitoring Report

Pipeline Construction & Maintenance Irreparably Harms Rivers, Wetlands and Streams.

Addendum to Comment for the PennEast Pipeline

As the result of document reviews and field investigations during construction of three sections of pipeline -- the TGP 300 line upgrade, TGP Northeast Upgrade Project (NEUP), and Columbia 1278 pipeline -- in the Upper Delaware River Basin the Delaware Riverkeeper Network documented:

- over 60 instances where best management practices (BMPs) were not present, inadequate or not functioning or in need of repair, maintenance or reinforcement.
- 4 instances of fueling being conducted in wetlands or near waterbodies.
- dozens of instances of poor signage and staking and mapping errors which sometimes led to impacts off of the permitted Right of Way (ROW), loss of trees outside the ROW, and inaccurate mitigation calculations.
- thermal impacts, extreme (and unreversed) soil compaction, nutrient impacts, benthic invertebrate changes from pipeline cuts, including for streams with exceptional value, high quality and or C-1 anti-degradation classifications.
- discrepancies between pipeline company monthly compliance reports and what work and activities to meet compliance and avoid pollution were actually occurring or not occurring on the ground. We also noted excessive lag time in the filing and/or public release of construction reports making for difficult follow up in the field. We documented too few pipeline inspectors and a lack of oversight person-power assigned by the Federal Energy Regulatory Commission (FERC) for these extensive linear projects that spanned many

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miles and where work was going on simultaneously along the routes with little independent oversight.

Based on first hand observations and monitoring, the Delaware Riverkeeper Network has concluded:

- Interstate natural gas pipeline projects result in a multitude of environmental impacts that inflict high levels of unnecessary ecological damage – this damage is not avoided, nor properly mitigated, despite the resource reports that are drafted or the guidance provided by FERC or other federal or state agencies;
- Violations of environmental laws are common place and an accepted part of interstate pipeline construction – and compliance outweighs penalties and violations to the detriment of the environment and the public;
- Construction problems and potential violations are not properly responded to by the company, by FERC or by other state or federal agencies and mitigation does not undo the harms inflicted -- as a result of both, pipelines inflict enduring and/or repetitive harms on natural resources; and
- Current or proposed guidance from FERC or other regulatory agencies do not prevent, avoid, or otherwise mitigate these ecological and public harms or the multitude of bad practices used by the pipeline companies.

The Delaware Riverkeeper Network generated the technical documents, reports and observations that are the basis of these conclusions during field monitoring along sections of projects where we had access to monitor, which was along limited areas of these pipeline projects during limited periods of time. Delaware Riverkeeper Network staff and volunteers logged over 240 hours in the field observing pipeline construction. For the purpose of this comment, Delaware Riverkeeper Network provides some examples to support our conclusions regarding the impacts of pipeline construction, operation and maintenance on waterways and environments as well as the failure and inability of federal and state agencies to properly regulate and oversee the compliance of pipeline construction projects with environmental and community protection laws. Please note that there are many more examples of errors that occurred during our limited pipeline construction monitoring efforts which resulted in pollution

and degradation to some of the cleanest streams and wetlands in the region. DRN is documenting additional findings in a case study currently under development.

Violations of environmental laws are common place and an accepted part of pipeline construction. Violations are not properly responded to by the company, by FERC, or by other state or federal agencies and mitigation does not undo the harms inflicted. FERC and/or state-empowered agencies fail to undertake responses to violations that either minimize their impacts or provide a deterrent to repetition. As a result, pipelines inflict enduring and repetitive harms on natural resources.

Enduring Harms Remain Unaddressed by Regulatory Agencies During & After Pipeline Construction:

Nutrient impacts, thermal impacts to streams and wetlands, benthic impacts, sedimentation impacts, stormwater impacts, contaminated water wells, forest fragmentation, permanent groundwater hydrology changes and impacts, soil compaction and soil structure changes, soil erosion, off ROW impacts (such as mulching, tree stress/mortality, windthrow), are just some of the issues DRN documented in the field during construction of approved interstate natural gas pipeline projects. Direct field observations of these impacts are documented in the appendices and DRN expert reports included with this field report.[i]

An excerpt from a 2012 DRN Field Correspondence to agencies, discusses the enduring impacts inflicted by pipeline construction despite supposed regulatory agency oversight. This field visit of the TGP 300 line was conducted one year after the pipeline was placed into operation:

> *Delaware Riverkeeper Network scientists walked a section of the 300 Line on Nov 4, Nov 11, and Nov 30th, 2012 that is accessible from DCNR lands of Schocopee Road (AR 9 and AR 9a). We include recent photos of site conditions at the Lackawaxen River 300 Line River Crossing off Rte 590 (Lackawaxen Township) where continued issues persist. It is important to note that the majority of places that DRN scientists had access to observe site conditions, signs of ineffective wetland restoration and E&S violations have persisted even into this late date (TGP 300 line installed and running gas as of November, 2011). There is much of the line that DRN does not have access to so we do not know the current conditions of those locations but Conservation District inspections for*

Pike and Wayne Counties and NOVs issued help indicate the systematic failure of TGP's project as documented in DRN letter correspondence shared prior with USACE.

Field observations along the TGP 300 Line and proposed NEUP line that could have a direct impact on the wetlands for the NEUP project and other questions and concerns we have noted from the TGP Wetland Delineation Report (March 2011) conducted by AECOM Environment are bulleted below and more details follow with photos[ii]:

- *Compaction of soil will ultimately lead to differences in hydrology of the wetlands and streams. Soil samples were taken along the existing 300 Line on November 29, 2012 and simply attempting to dig along the ROW in comparison to digging in the nearby adjacent intact forest indicates severe compaction along the existing ROW. This soil compaction is further illustrated by the lack of vegetation that continues to persist adjacent and near wetlands and elsewhere along the TGP 300 Line. (Note – later lab analysis of these samples taken by consulting experts verified the extremeness of the compaction – showing compaction levels as high as 98%)[iii].*
- *Rough grading in the vicinity and adjacent and within the wetlands has led to in places where matting fabric is located, poor contact with the soil due to the roughness of the soil underneath the matting and lack of raking. Lack of vegetation growth, still a year and half after construction, is noted in these areas which can lead to continued soil erosion that could enter adjacent wetlands.*
- *From the AECOM Wetland Delineation Report (March 2011), it appears that when wetlands are located in temporary work spaces or additional temporary work spaces, TGP considers this to be "no impact" and as a result no acreages are included for these areas that are in fact a big impact. Since these work spaces are often located in mature forested areas and very close to streams and wetlands, the work spaces will require tree removal, soils will be compacted with heavy equipment, and shading will be reduced to nearby waterbodies. Forests will take generations to recover and grow back. These ATWS and TWS areas should be avoided and minimized and the footprint of the ROW should be reduced to the greatest extent possible.*
- *During DRN field recon of the non-colocated section of Loop 323 and other proposed NEUP path, we observed temporary work space (TWS) areas and additional temporary work space (ATWS) areas often located too close to streams and wetlands (less than 25 feet from these sensitive structures). This was observed by the three corner stakes in the field placed by TGP*

that are to delineate TWS and ATWS near the ROW. This placement adjacent these sensitive habitats will affect them negatively. There are also a large number of these work spaces delineated in the field and we question why so much extra space beyond the already very large ROW are needed since they are located in very sensitive wetland and stream areas.

- *ATWS and TWS areas often seem to target very large and mature trees that are found throughout the non-colocated section of Loop 323. By clearing these large mature trees that fulfill a large dense canopy cover, thermal impacts and dissolved oxygen impacts will likely be a result to the surrounding waterbodies and wetlands.*
- *Along the 300 Line off DCNR lands, mulched tree debris is blown into areas of forest and wetland areas located adjacent to the ROW. Mulch can smother the roots of the surrounding trees and cause rodent damage in the winter months. TGP is also then affecting areas outside of the ROW.*
- *The majority of the proposed crossings of the NEUP include open cut trenching technique which will forever change the topography and the hydrology of these Exceptional Value and High Quality wetlands, streams and habitats.*
- *In the field it is difficult to depict the complete boundaries of the proposed ROW based on limited flagging by TGP during DRN field visits, but DRN believes that less of an area should be needed for TGP to insert a 30 inch pipeline adjacent its existing 24 inch line. This point has also been raised by PCCD. Minimizing disturbance and ROW size and work spaces is needed.*
- *The characterization of the Savantine Wetland Complex (W038), an EV wetland that feeds a tributary to Savantine Creek, can be described currently more like a POW rather than its original wetland characterization of a PFO/PSS/PEM as it was classified before construction of TGP. Temperatures of this wetland indicate thermal impacts and the wetland appears to be acting as a heat sink due to its increased depth and lack of vegetation (water temperatures below in Table 1). Summer sampling documented temperatures in the wetland as high as 87.6 F which would not be indicative of other Exceptional Value forested wetlands in the region.*

This wetland complex was cited multiple times by PCCD as having violations associated with construction practices. The lagging restoration, dewatering of the wetland, and potential fill piles within wetland boundaries occurred late in the season on May 13, 2012 when thousands of young amphibians were observed in the wetland after returning from their forested uplands in the spring.

The pipeline was in operation in November 2011 and restoration lagged behind to impact amphibian species in this Exceptional Value wetland – occurring over 6 months after the pipeline was transporting gas. As a result, the wetland was impacted unnecessarily multiple times and during a critical time for breeding and young-of-the-year amphibian species. As noted by PCCD in NOVs, restoration could have occurred much sooner as the winter of 2011 was mild.

Many of the adverse impacts summarized in the report above were identified and reported to FERC and other regulatory agencies specifically during construction of the TGP 300 line. The fact that these degraded conditions persisted one year after construction was complete is inexcusable. The above report resulted in no effective responsive action by FERC or any other regulatory agency to undo or mitigate for the harms inflict.

Reported Violations of Environmental Laws Result in Inadequate Response by Agencies, Resulting in Repeated Offenses:

During construction of the TGP 300 line, the Columbia 1278 line, and the TGP Northaast Upgrade Project, Delaware Riverkeeper Network reported over 60 instances of environmental violations and/or degradation. County Conservation Districts also submitted reports of violations. Consistently, FERC failed to issue notices of violation, to issue stop work orders to require remedy of the situation and/or mitigation, or to issue fines that would serve as a deterrent to future violations. Repeated correspondence with FERC on observed failing E&S controls, compromised or dilapidated E&S controls, lack of flagging and signage for all natural resource features, off ROW impacts, stormwater sediment laden runoff into nearby streams and wetlands, tree cutting or other impacts outside the ROW, illegal mulching, were all documented by DRN.

In addition to Delaware Riverkeeper Network reports, during the Construction of the Project, TGP accumulated at least twenty separate Notices of Violation from the Pike County Conservation District alone. Upon information and belief, the Pike County Conservation District found violations on twenty of its twenty-two site visits between June of 2011 and June of 2012, an astonishing violation rate of over 90%. Additional Notices of Violation were issued by the Wayne County Conservation District in 14 of its 15 site visits. These Notices of Violation included violations for activities including, but not limited to: failures to maintain effective E&S BMPs;

failures to provide temporary stabilization of earth disturbance site; and failures to implement effective E&S Best Management Practices. These failures resulted in situations where "sediment or other pollutant [was] discharged into waters of the Commonwealth" on numerous occasions. For example the following pollution events where described in various PCCD Notices of Violation:

> -Sediment plumes in Swale Brook and pond due to failure to maintain BMPs (6/17/11 inspection). Sediment was observed as far as .75 miles downstream from the pipeline ROW. -Sediment laden water observed flowing down ROW and flowing into wetlands (6/17/11 inspection) - Sediment laden water entering Raymondskill Creek and Sawkill Creek (HQ and EV waterways) that passed through make shift earthen berms & through gaps on compost filter socks. (6/17/11 inspection) -Sediment discharging into Waters of the Commonwealth (6/17/11 inspection)
>
> - At Raymondskill Creek -Grass growth noted in wetlands (which is prohibited) (4/27/12 inspection report) Additionally, according to an April 30, 2012 Notice of Violation, TGP and its environmental inspectors repeatedly did not address the prior violations or needs or actions to remediate the pollution problems that were documented by the Pike County Conservation District. Time and again remediation and corrective actions were promised by TGP to be put on punch lists and addressed, but according to the Pike County Conservation District, prior violation reports were many times ignored by TGP leading to ongoing problems, continued pollution events leading to recurring and repeated harm to special protection streams, exceptional value wetlands, the Delaware State Forest, and public water supply sources

Furthermore, monitors for the FERC funded Compliance Monitoring Program also found numerous violations as a result of construction activity from this project. Specifically, Program monitors found at least 65 instances where an activity "d[id] not meet the definition of acceptable" pursuant to FERC environmental conditions. The Program monitors also found at least six instances where construction activity directly lead to "damage to resources" and "place[d] sensitive resources at unnecessary risk."

While FERC took no significant enforcement action that would have helped minimize and/or mitigate environmental damage as well as result in a deterrent to the ongoing cavalier construction practices of TGP, for the TGP 300 pipeline project, PA DEP announced in Dec, 2014, $800,000 in penalties.[iv] (DRN includes many more examples of harms and impacts observed in the Appendices. Verifications by Conservation Districts are also included.)

Compliance and weekly construction reports submitted by the pipeline companies consistently misrepresent conditions on the ground, FERC fails to exercise proper oversight or to take proper action to prevent repeat occurrences, and lag times on the public record means community monitors only receive information after the fact and that regulatory agencies that may be anticipating and/or relying upon FERC for ensuring environmental compliance are not securing compliance with regulatory mandates, or mitigation for harms inflicted:

The third party compliance monitoring program relied upon by regulators is inadequate with limited third-party compliance staff assigned to broad stretches of linear pipeline areas. For example, along a 40 mile stretch of one pipeline – one Spread located in Pennsylvania (Loops 317, 319, 321, and 323) and a second Spread located in New Jersey (Loops 323 and 325), only two FERC Third-Party Compliance Monitors were assigned to these large areas of pipeline that are segmented out along a large area[v].

The practice and timing of the Compliance Reports by the companies is also lacking in oversight. DRN on numerous occasions, as well as the Pike County Conservation District, conducted inspections of problem areas along a pipeline route only to find that often times, these issues were not addressed by pipeline maintenance crews, despite issues and events being noted as resolved or on the "punch list" by ground crews in the required monthly compliance reports by the pipeline operator.

Furthermore, the FERC weekly summary reports under the Monitoring Environmental Compliance Program and the private pipeline company weekly status reports could be provided to the public and to community monitoring groups in the field faster than the 4-5 day lag time that appears to be the normal lag time between the week of construction events and the reporting being issued on the FERC Docket. If reports were more timely or if there was another method of sharing this information in a faster fashion, some harms could possibly be avoided, especially in

light of major pollution events and storm events where sediment pollution and failure of E&S structures could and do occur. For example, in the case of TGP, the weekly status report spanning construction updates occurring from August 12, 2013 through August 18, 2013 was only submitted to the FERC Docket on August 22 at 4:30pm – this lag time between conditions on the ground and the report on the FERC docket could be shortened to better communicate with the public and volunteer monitors and to better protect natural resources in a more timely fashion.

On multiple occasions DRN found discrepancies between what was reported in weekly compliance reports by a pipeline company and what was actually occurring on the ground and observed by monitors (see Appendices). In the appendices you will note repeated mention of Erosion and Sediment Control problems and needs for improvement and violations by county conservation district staff in written NOVs as well as DRN correspondence stating similar issues that were recurring and not addressed in a timely fashion to avoid harm nor were they addressed in weekly construction reports.

Problems with mapping of natural resources was also observed and not addressed despite repeated reports on problems. For example, a February 8, 2013 field visit by DRN in Montague NJ (see Appendix B) documented in one section of the proposed TGP NEUP pipeline route a series of wetlands and springs (16 waterbodies and 7 wetlands Identified) that failed to have adequate and detailed resource signage to protect this sensitive area, despite a TGP weekly report dated 1/28/13 to 2/3/13 that stated environmental signage was installed in this section of the proposed route. Some limited signs were present but in the case of such a sensitive area with C1 waterways, it's critical that the signage mark all wetlands and springs individually with the proper written wetland markers that outline each of the specific waterbodies. After reporting these discrepancies, DRN returned to the area on 2/17/13 after TGP personnel stated they reinstalled and adjusted signage in this area. The signage in place still lacked important information such as "foot markers" from the alignment sheet and used for placement of signage in the field. This also speaks to monitoring in the field as generic signs with no additional info noting the specific waterbody number, makes it difficult for monitors and construction crews and tree cutters to verify that all waterbodies are accounted for and in this case they were grossly ignored. This area of the pipeline route was monitored multiple times and we reported problems

regularly. There was little action taken by FERC to protect this important and sensitive area which was open trenched despite its unique forested and wetland features.

This specific stretch of the pipeline route also speaks to a problem with re-routes that are allowed by FERC. It would appear that landowners who find themselves along re-routes later in the FERC process do not receive the same notice and consideration as landowners involved along the initial pipeline route. And along those same lines, a reroute through a forested wetland and spring complex with over 23 water features and mature trees where FERC allowed open trenching, seems completely unacceptable especially when HDD and other methods could have been employed and there were multiple reports and documentation provided to FERC about these exceptional water resources.

After public pressure was exerted by DRN and others, one FERC Project Manager did begin to more quickly alert pipeline crew leaders to reports of environmental degradation and/or impending failures of management practices that were likely to result in environmental degradation, which helped to avoid potential sediment problems and E&S control failures for the TGP NEUP pipeline. That being said, it should not be on the public to ensure BMPs are being followed; the presence of only one or two FERC inspection officers in the field along an entire route is sorely inadequate and many more inspectors are needed and required for proper oversight of this industry.

FERC consistently overlooks violations of law and/or degradation of the environment during pipeline construction, and the gap is not well filled by state-empowered regulators, thereby resulting in frequent and persistent pollution events and environmental degradation:

It is the Delaware Riverkeeper Network's experience that FERC consistently ignores reported violations by either the public or Conservation District regulatory employees, demonstrating a cavalier disregard from the repeated harms being inflicted on environmental and public resources by the pipeline construction company. For example, FERC's compliance reports for the TGP 300 line and the Columbia 1278 line rarely listed non-compliance concerns that had been clearly documented, including with photo and/or video proof, by either County Conservation District employees or the public.

By way of contrast for the TGP 300 line and the Columbia 1278 line in Pike County alone conservation district officials cited the following violations from their field visits:

> From 7/26/11 to 6/21/13, there were 21 NOVs for the Tennessee Gas 300 Line Upgrade from PCCD which are identified below:
>
> NOV IR 11-04; NOV IR 11-05; NOV IR 11-06; NOV IR 11-07; NOV IR 11-08; NOV IR 11-09; NOV IR 11-10; NOV IR 11-11; NOV IR 11-12; NOV IR 11-13; NOV IR 11-14; NOV IR 11-16; NOV IR 11-17; NOV IR 11-18; NOV IR 11-19; NOV IR 12-20; NOV IR 12-21; NOV IR 12-22; NOV IR 12-23; NOV IR 12-26; and NOV IR 13-29
>
> Of these 21 NOVs, there were 14 violations for failure to maintain effective E&S BMPS; 14 violations for presenting a potential for pollution to waters of the Commonwealth; 14 violations for discharging sediment or other pollutants into waters; 17 violations for failure to implement effective E&S control BMPs; 2 violations for failure to provide temporary stabilization to earth disturbance; 2 violations for failure to provide permanent stabilization to earth disturbance; and 21 violations of the Clean Streams Law. Altogether, there were a total of 84 violations.
>
> From 6/17/11 to 4/27/12, there were 15 NOVs for the Columbia Line 1278 K which are identified below:
>
> NOV IR 11-04; NOV IR 11-06; NOV IR 11-08; NOV IR 11-10; NOV IR 11-11; NOV IR 11-12; NOV IR 11-13; NOV IR 11-15; NOV IR 11-16; NOV IR 11-17; NOV IR 11-18; NOV IR 11-19; NOV IR 11-20; NOV IR 12-21; and NOV IR 12-22
>
> Of these 15 NOVs, there were 9 violations for failure to maintain effective E&S BMPS; 15 violations for presenting a potential for pollution to waters of the Commonwealth; 9 violations for discharging sediment or other pollutants into waters; 3 violations for failure to implement effective E&S control BMPs; 9 violations for failure to provide temporary stabilization to earth disturbance; 6 violations for failure to comply with permit conditions;

7 violations for failure to implement effective PCSM BMPs; and 15 violations of the Clean Streams Law. Altogether, there were a total of 73 violations.

These two pipelines had a combined total of 157 violations in one County alone. Please note that these numbers are conservative because there could be multiple instances of each violation.

Following is an example of a monitoring field reports and subsequent correspondence of these failures and subsequent and repeated or ignored harms follow to further this assertion:

On June 25, 2013, DRN walked sections within High Point State Park and observed a dewatering structure constructed of hay bales and lined with plastic located near the wetland boundary that was not being utilized to reduce sediment and off ROW impacts. Instead, the pipeline company crew had two hoses from the open pipeline trench spanning across the ROW and running sediment laden water directly into the wetland on the opposite side of the equipment bridge – bypassing the BMP. DRN approached (with security following) to video tape and a contractor was observed franticly trying to cut holes in the bags to put the high pressure hoses into the BMP. To DRN's knowledge, no action was taken by FERC on this direct violation (See Appendix B).

On August 14, 2013, DRN accessed Cummins Creek and documented active construction work within the stream bed after the pipeline company had reported all the sediment discharged into Cummins Creek were addressed and cleaned up prior (See Appendix B). Consequently this area was in a location with extremely steep slopes and time and time again in scoping and in comments the community and DRN stressed the inevitable pollution that would come from cutting mature trees down on such a steep slope to cut a pipeline path. To DRN's knowledge, no action or violation was taken by FERC related to this sediment pollution incident into an Exceptional Value stream.

During the TGP 300 line, violations documented by the Pike County Conservation District included major ongoing, continued and multiple violations and ignored agency orders including like those listed on the 4/30/12 NOV report which cited major recurring violations including:

Failure to implement effective Post Construction Stormwater Management BMPs

Permanent slope breakers do not have permanent outlet structures installed as called out in plans and noted in prior PCCD correspondence and inspection reports.

Failure to provide temporary stabilization of earth disturbance sites

a. Areas throughout ROW have sparse to minimal vegetative growth including on steep slopes

b. Seeps throughout ROW to Vandermaark Creek have caused erosion gullies and concentrated stormwater flows and runoff.

c. Streambanks like that of Sloat Brook displayed bank erosion and sloughing

These examples and summaries of violations confirmed by county agencies helps show violations of environmental laws are common place and an accepted part of pipeline construction and often times pipeline companies do not comply with past agency requests for remediation, leading to continued and repeated requests for action time and time again, that is not pursued by the pipeline crews.

FERC fails to identify and reflect these repeat and/or ongoing violations in its inspection reports, and additionally fails to follow up with actions that would remedy the harms being inflicted and fails to take steps that would deter future violations such as fines or stop work orders until problems are remedied and/or mitigation is implemented.

States often rely on FERC to ensure environmental compliance and definitely count on FERC regulatory mandates to ensure protection of water resources and the environment – in both instances this reliance is misplaced as is amply demonstrated by the Delaware Riverkeeper Network's observations and experiences.

Pipeline construction Causes Severe Harm to the Environment:

The adverse consequences of pipeline construction and maintenance are severe, enduring, and wide ranging.

Along the TGP NEUP pipeline project, DRN conducted spot checks during or shortly after 13 rain events where we had access to observe conditions near the pipeline ROW. In almost every instance, DRN observed areas where sediment control structures were not ideal, overwhelmed, or where sediment was directly discharging off site into adjacent lands, off ROW or into a nearby waterbody or drain that connects to a waterbody. All visits were conducted in areas of high quality or exceptional value waterways locations. Visits were conducted on 5/23/13, 5/28/13, 6/3/13, 6/8/13, 6/11/13, 6/14/13, 7/1/13, 7/28/13, 8/10/13, 8/11/13, 8/12/13, 8/14/13, and 10/7/13 (See Appendices).

March 13, 2013 DRN wrote the Army Corps of Engineers to say:

> *Delaware Riverkeeper Network is writing with photos and video documentation indicating* ***sediment and suspended solids runoff discharging into Wetland038*** *(W038) from TGP's ROW after a rain event on 3/12/13 along the Tennessee Gas Pipeline's 300 upgrade project. This area of TGP's past project was installed and running gas through the new line as of November, 2011. As indicated in past letters to the Corps – one as recently as 3/12/13, W038, located on DCNR lands, has had persistent problems and negative changes to its structure and characteristics due to Tennessee Gas Pipeline construction and lagging restoration practices. This wetland is part of the Craft Brook Complex and is designated Exceptional Value under Chapter 93. This area of the pipeline is still under "temporary restoration status", over a year and four months after the pipeline was installed by TGP*[vi].

<u>Inaccurate mapping, measurements and lack of field flagging/signage and restoration of sensitive wetlands, waterbodies and mature forests:</u>

When mapping is incorrect, larger areas of natural resources are harmed, soils compacted and trees cut and it would appear, there is little accounting for these larger impacts, variances (if there were any requested), or mitigation.

For example, measurements were taken by Delaware Riverkeeper Network on November 6, 2012 of the TGP pipeline ROW (see Appendix A, November 8, 2012 Report) that documented greater than a 200 foot section of disturbance and clearing and in some sections up to 325 feet in width of disturbance in creating the 300 Line ROW. Yet in the 1.8 land requirements section of the TGP 300

Environmental Assessment (CP11-161-000), it is stated," *the 30 inch diameter natural gas pipeline loops would typically require a 100 foot wide construction ROW in upland areas, which would generally consist of 25 feet of existing, permanently maintained ROW, 25 feet of new permanent ROW, and 50 feet of temporary construction workspace. In wetlands, TGP would reduce the construction right-of-way to 75".*

In another communication to FERC, DRN documented inaccurate mapping, lack of field flagging of wetlands, and a failure to properly protect sensitive wetlands and waterways:

> *On March 24, 2013 DRN accessed TGP through land owner's property west of Vandermark Creek (S019) in Milford Township. Laurel Swamp Brook (S020) has three wetlands associated with it W043, W044 and W045 with only W043 listed as impacted.*
>
> *In conclusion, DRN field reports and observations show the following discrepancies and issues with TGP practices or delineations that we feel indicate inadequate protection of these sensitive resources and impacted wetlands that TGP states are not impacted.*
> *1) The tree felling at S059 does not meet the requirements of Section 4.1.1 of the Environmental Construction Plan (ECP).*
> *2) The isolated wetland located near TGP crossing of S059C remains unidentified and not delineated in the construction ROW.*
> *3) Three features associated with Deep Brook S045 (Exceptional Value stream) appear to be connected in a single crossing width of approximately 200' but much larger than the 61' combined for W090/W091 and S045/S045A with S045A having no resource signage in place.*
> *4) W093 is listed as "not impacted" but field observations document this sensitive resource crossing the pipeline ROW.*
> *5) Pink and black flagging used for wetland delineations was observed under felled trees near Crawford Branch but is not listed in the Pa. Bulletin as a wetland crossing at this location.*
> *6) Observations at Laurel Swamp Brook S020 (EV) and three wetlands W043/W044/W045 indicate that W044/W045 have a hydrologic connection with Laurel Swamp and are not "isolated". Resource signage for these wetlands indicates they continue into TGP's ROW and are and will be impacted.*

DRN is unclear how TGP can claim they are limiting disturbance and not impacting these sensitive resources if indeed DRN is documenting such discrepancies in the field[vii].

Temporary work spaces (TWS) and Additional Temporary Work Spaces (ATWS) inflict environmental degradation that is not accounted for and as a result is allowed to inflict harm: The calculations used to determine areas that are considered "temporary" is often flawed as the types of areas impacted are not considered (see above and Appendices). As a result, the pipeline operator is held less accountable to restore these areas or to mitigate for the damage that is far from "temporary" in nature. For example, cutting of a mature forest adjacent a wetland to stack timbers or park equipment may be falsely characterized as temporary by the pipeline operator, but the impact of this practice is permanent due to the loss of mature trees and permanent change in soil structure. Furthermore, TWS or ATWS even in meadow areas or natural areas where trees or shrubs have not been cut, soil structure is changed and this leads to often irreversible compaction.[viii] An existing paved parking lot could be temporary if it were used to park equipment but certainly not a natural field or a forest.

In closing, violations of environmental laws are common place and an accepted part of pipeline construction. The combination of legal and illegal construction, operation and maintenance practices associated with pipelines combine to inflict an incredible, unavoidable, and un-mitigatable level of harm.

Attachments:
Appendix A – DRN Field Reports for Tennessee Gas 300 Line (Restoration Phase) – Dated 10/1/12 to 3/12/2013 (59 pages)
Appendix B – DRN Field Reports for Tennessee Gas Northeast Upgrade Project Dated 7/18/12 to 5/23/13 (60 pages)
Appendix C – DRN Letters to FERC and other agencies Regarding Mapping, Pollution and Construction Concerns from the Field (Subset)
Appendix D –NOV summary table of Pike County Conservation District Inspections and Violations
Appendix E – Selected Expert Reports

[i] 2014 Field Observations of Tennessee Gas Pipeline, Northeast Upgrade Project By Delaware Riverkeeper Network, Preliminary Findings and Excerpt for Penn East Scoping Comments, Feb 27, 2015
[ii] DRN letter to Army Corps of Engineers, Dec 2, 2012, TGP pipeline impacts and threats NEUP could have based on past 300 line project
[iii] Field Evaluation of Soil Compaction Within TGP 300 Line Upgrade Temporary Work Spaces, Meliora Enviromental Design, February 19, 2013

[iv] DEP: $800,000 Settlement Against Tennessee Gas Pipeline For Violations In 4 Counties. Dec, 22, 2014 http://paenvironmentdaily.blogspot.com/2014/12/dep-800000-settlement-against-tennessee.html?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+PaEnvironmentDaily+%28PA+Environment+Daily+Blog%29.
[v] Federal Energy Regulatory Commission Environmental Compliance Monitoring Program, Weekly Summary Report, Northeast Upgrade Project, Docket No.: CP11-161-000 For the Period: August 5 through August 10, 2013.
[vi] DRN letter to Army Corps of Engineers, March 13, 2013, Re Sediment pollution into wetland complex – repeated harms
[vii] DRN letter to FERC, April 5, 2013, Inadequate protections to Sensitive Waterbodies and Wetlands Listed as "Non-Impacted" by TGP
[viii] Field Evaluation of Soil Compaction Within TGP 300 Line Upgrade Temporary Work Spaces, Meliora Enviromental Design, February 19, 2013

Photos taken during recent drive by of Columbia gas line project Pike County. 4-15-2012. Photos taken by Joe Zenes with C533 zoom Kodak camera.

Top photo-Sawkill Creek Crossing (SPA-BMC-001)
Very little re-growth on steep bank above the Sawkill Creek (EV)

Middle photo- Sawkill Creek Crossing (SPA-BMC-001)
Stream bank erosion below steep slope on Sawkill Creek (EV)
Note very low water flow for spring time.

Bottom photo- lack of re-growth from pipe line construction. Taken from Sawkill Road and is in the Sawkill Creek (EV) drainage basin.

On the right of photo shows new septic that was disturbed and replaced for residential home (out of photo to the left) that was in the right of way. Gray area new driveway to house.

Joe Zenes Report 002
April 18, 2012

The following attachments are regarding the Tennessee Pipeline 300 and proposed Northeast Upgrade Project Loop 323.
“Experts Declare Pipeline on DV Property is Safe” (Pike County Dispatch April 5, 2012)
The pipeline is on the recently purchased property by Delaware Valley School District for a new elementary school. This is where the 300 line was to cross the Delaware River. To the best of my knowledge the reason for the 323 loop was there was too much “red tape” to get approved for the crossing at the most northern end of the Delaware Water Gap National Recreation Area and was “easier” to reroute it through undisturbed forests with and cross the River a couple of miles above DWGNRA lands continue through New Jersey until it meets up with the 300 line again. The 323 Loop will have 18 access roads and will result in 70 wetlands and 64 water bodies impacted in both PA (6.33 miles) and NJ (10.1miles)
My understanding is that the 300 line will be extended through the DVSD property to the River but will stop short of crossing the River at the existing ROW for the 300 line. “Safety” brings me to the next section of the report.

Experts Declare Pipeline On DV Property Is Safe

By Lisa Mickles

WESTFALL — A slew of experts on transmission pipeline safety attended the Delaware Valley School District facilities committee meeting last Thursday to assure directors that the location of the new elementary school would be safe for students.

At their most recent board of education meeting, Don Flynn of Burkavage Design Associates presented plans for the new Delaware Valley Elementary School, which is comprised of an 80,000-square-foot, two-story building with 26 classrooms that also allows for expansion in the future. The property consists of a 40-acre parcel located in Milford Township that currently has a Tennessee Gas pipeline on the far edge that is set to be upgraded before the school is built.

Engineer Steve Vitale, who has been an outspoken critic of the proposed location, provided a detailed slideshow presentation and suggested that before the district begins building on the new property, they should consider completing a $10,000 to $20,000 risk assessment study that would provide statistics on potential threats if a pipeline rupture were to occur.

He explained that while it is unlikely it would occur, the district should consider the “what ifs.”

Vitale continuously referred to pipeline safety data from the California Board of Education regarding their requirements that schools be relocated or built away from gas transmission lines. Director Bill Greenlaw reminded Vitale that California has the strictest regulations due to its constant threat of earthquakes.

Tennessee Gas Pipeline (TGP) representatives Bret Metzger and Steven Watkin assured the directors that they would upgrade the pipeline from a Class 1 to Class 3, which seemed to help alleviate Vitale’s prior concerns.

“I am glad to hear this,” he said.

Metzger said they have been in close contact with the school district for several months regarding the district’s plans to build a new school on the property crossed by TGP’s pipeline. The gas transmission line, which crosses Route 6-209 from Altec-Lansing to the Delaware River, would be upgraded to Class 3, which has the highest safety standards over the current 24-inch pipeline.

Alex Dankanich from the U.S. Dept. of Transportation Pipeline and Hazardous Materials Safety Administration or PHMSA, said pipelines are the safest form of transportation for oil and natural gas.

He explained that with the population continuing to grow,

(Continued on page 3)

... Pipeline

(continued from page 1)

transmission lines throughout the United States are consistently being upgraded or built especially since so many people are dependent on fuel.

Dankanich said that based on a comparison of the annual number of accidents resulting in injuries or death, transportation through pipelines is safer than any other form of transportation such as highway, railroad, shipping or planes.

He also noted that the biggest threat to pipeline safety, especially near areas that are populated, is through people digging in the vicinity of pipelines.

Director and Facilities Committee Chair Chuck Pike asked engineer Don Flynn if they had anything in place to protect the area from potential digging during construction. Flynn said they were planning to block off and flag the area before any building would begin. In addition, once the school is built, district maintenance staff would be informed of the exact location by possibly installing a chain link fence and permanently blocking the area off from the public since they don’t plan on using the far end of the property that is closest to the pipeline.

It was also stated that pipelines are built much stronger with many more safety features in place than what was previously done when the pipeline was first constructed several decades ago.

The issue of a proposed new pipeline upgrade route reared its ugly head once again with Vitale urging the school district to contact legislators and oppose the six-mile loop that would be located near the main campus and convalescent home.

Discussion ensued regarding putting pressure on National Park Service (NPS) Superintendent John Donahue to allow the pipeline upgrade on its existing path through the school property. Vitale said there are other cases where pipelines were permitted to run through national park service land exempling Columbia Gas’s recent upgrade that traversed through NPS property. He said there is a small window of opportunity for them to use their governmental influence by contacting legislators before the Federal Energy Regulatory Commission (FERC) makes their final decision on whether or not they will permit the new 6-mile route.

Vitale asked the school district to go directly to the top and urge TGP to use its existing line but also loop the gas line slightly south, about 1,500 feet or so away from the buffer zone, where the school’s athletic fields would be located. He said it would be a win, win situation for the district and save TGP a ton of money since they would not need to install an additional six miles of transmission pipes that would put the pipeline controversy even closer to home since it would affect both school district properties.

Public Utility Commission representative Paul Metro, who attended the meeting through a request from PA Senator Lisa Baker, told the directors that now would be the time to participate by providing comments to FERC on where they would prefer the pipeline to run. He gave an example relating to Chester County and their failure to participate in the process of where a pipeline project was going. He said that ultimately FERC granted approval since no one came forward to object.

For several years, the county has been pushing for FERC to oppose TGP’s request to avoid the park service land and instead use the 6-mile loop. The Pike County Commissioners say that the proposed route would mar the scenic rural character of the mountainside, not to mention, through eminent domain, necessitating taking of private land. Vitale said FERC should be making a decision very soon and when it is done, there is no going back.

“Don’t miss this window of opportunity,” urged Vitale.

(Continued on page 3)

(Photo by Lisa Mickles)

Delaware Valley School Board Director Bill Greenlaw asks Tennessee Gas Pipeline representatives, from back left, Bret Metzger and Steve Watkin, for confirmation that TGP plans on upgrading the current transmission line to a safer standard Class 3 pipeline. Behind Greenlaw from left are assistant Director of Support Services Chris Lordi and Director of Support Services Marvin Eversdyke.

http://riverreporter.com/issues/08-12-04/news-pipeline.html

Company says explosion was part of routine test

MILFORD, PA - The Pike County attorney made three requests in a November 11 letter to the Columbia Gas Transportation and Storage Company after an explosion of the line on November 5.
So far, attorney Thomas Farley has not gotten an answer.
On November 5, a Columbia pipeline near the intersection of I-84 and Route 6 exploded, throwing a large chunk of iron pipe a hundred yards away when the company, in a test, raised the pressure of the line. No one was injured and the gas line was quickly shut down.
Columbia technicians were walking the line at that time. None were near the site of the explosion.
Farley’s first request asked the company to explain the cause of the incident. The second asked how the company intended to repair the pipeline and the surrounding area. The third asked what procedures would be incorporated or adopted by the company to prohibit this incident from occurring again.
“The pipeline runs through a large portion of Pike County,” Farley said. “I specifically asked if Columbia Gas intends to increase the pressure to the line.”
“We are attempting to address each of these concerns,” said Kelly Merritt, company spokesman. “We are working through the U.S. Department of Transportation, who has jurisdiction in these matters, and have been in communication with the Pike County Conservation District.”
There is speculation that the pressure test is a preemptive exploration to move gas, which is potentially available in the Marcellus Shale deposit in Pennsylvania, to market. That gas would have to be transported across the river to the newly constructed Millennium Pipeline, which has a pressure higher than Columbia’s.
Merritt said that the tests were routine and were not related to the transportation of gas to any other pipeline.

http://www.riverreporter.com/issues/08-12-18/news-pipeline.html

Gas pipeline company explains explosion

By TOM KANE

MILFORD, PA – The Columbia Gas Transmission Company (CGTC) sent a letter on December 4 responding to the Pike County Commissioners' concern over the gas pipeline explosion that occurred on November 5 near the intersection of I-84 and Route Six outside of Milford.

The explosion occurred as the company was increasing the pressure on the pipeline under testing protocols. The gas line was immediately closed down. No one was injured, but the explosion occurred within the very sensitive Sawkill Watershed, tearing up some of the topography of the site.

Witnesses compared the geyser to Old Faithful in Yellowstone National Park.

As further requested in the Pike letter, the company also explained how they were repairing the gas line and how they will avoid occurrences of these kinds of explosions in the future.

"In order to determine any and all contributing factors, the investigation will include a full analysis of all the data," said Stan Durany, CGTC regional director.

To avoid any future explosions, the company will resume operations at the pressure approved prior to testing only gradually.

The investigation is being conducted in conjunction with the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), the Pike County Conservation District (PCCD) and the Pennsylvania Department of Environmental Protection (DEP).

"At this time, the best information available is that the issue was limited to that site and the new pipe installed in its place will prevent a reoccurrence," Durany said.

"We are monitoring the movement of heavy equipment across the Sloat Brook and into the wetlands, focusing on the company's attempts to maintain erosion control and the restoration of vegetation before they leave," said Susan Beecher, director of the conservation district. "I must say that they are doing a very good job in handling things at the site."

The company dammed up the creek, diverted the water in another direction and built sediment tanks to control the dirty water, she said.

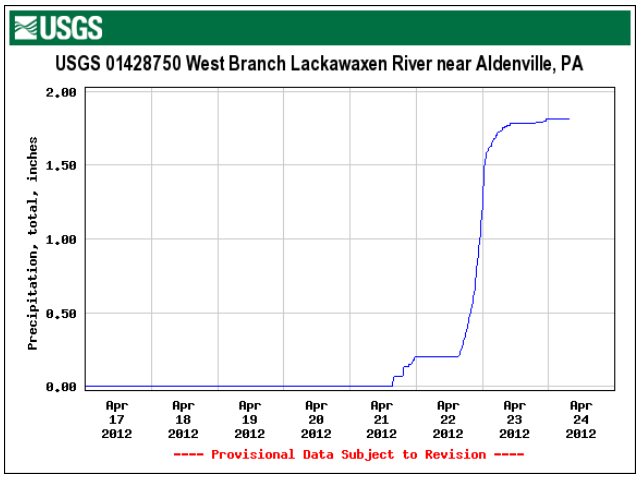
"Besides issuing the permit, we are monitoring the work procedures there," said Mark Carmon, DEP spokesman. "We want to insure that they restore the topography of the watershed. As gas drilling increases in the area, the DEP is putting in place procedures in handling hazardous incidents like this."

Cont. report…My understanding is the explosion they had on the Columbia Line November 5, 2008 was they raised the pressure in a "routine" test because the Millennium Pipe Line has a higher overall pressure. The result was that it blew a large section of the pipe out of the ground. Fortunately the explosion occurred in an unpopulated area. I have great concerns when a pipeline explodes during a "routine test". What will happen if the 300 line is extended through the DVSD property and is dead ended at the River? Will this cause a higher pressure of gas at the end of the line which the DVSD will share the gas line ROW for their driveway into the school property? After watching the speed at which they worked excavating and burying the new lines and the industries lack of compliance when it came to E&S control measures with many violations from the PCCD brings me to the next question…Is there anyone who "inspects" the welds of the many miles of piping noting the industry is training new welders? Does the lack of concern for the environment by the industry transfer to the important job of welding the pipeline together underground? Note that one of the problems with natural gas migration at gas wells is from not properly sealing the wells in concrete.

So is the gas line at the new DVSD property "safe"? Again if they're extending the 300 line to the River through the school district property, why not cross the River at the current ROW for the 300 line instead of cutting a 100 foot swath through 16 miles of undisturbed properties?

Joe Zenes Report 003 Little Walker Road Shohola, Township, Pike County April 24, 2012

On April 19, 22, 2012, I performed a visual assessment by car with photo documentation of Tennessee Pipeline crossings of main roads in Pike County Pa. My observations during the initial assessment noted a wetland with a hard packed dirt road dissecting the width of the wetland. I revisited the site on April 23, 2012 after an average of 1-2 inches of rainfall over the area. I observed runoff flowing down on left side looking west from the road. I did not observe any cross slope cuts on the steep slope above the wetland.



Photos top and bottom left where taken 4/19/12 looking west off of Little Walker Road. Bottom right photo taken 4/22/12 after an average of 1-2 inches of rain over the area.

Joe Zenes Report 004 Raymondskill Road Crossing Columbia Gas Pipeline April 24, 2012

During my travels throughout Pike County during the original construction and upgrade of the Columbia Gas Pipelines on July 3, 2011 I observed sediment entering a wetland where the pipeline crossed Raymondskill Road in Dingmans Township Pike County. I returned to the site after it was stabilized on July 25, 2011 for additional photos. On April 18, and 23, 2012, I performed a visual assessment by car with photo documentation of Columbia Pipeline crossings of main roads in Pike County Pa. My observations during the initial visit (7-3-11) noted and photographed large amounts of sediment on the roads and into the wetland adjacent to the road after a rain event. Below is the information for the wetland impact: WPA-DJC-013

21. (WPA-DJC-013) a 20-inch diameter pipeline crossing of 272 feet of wetlands, temporarily impacting 0.32 acres of PEM wetlands (EV), by means of open trench cut in Dingman Township.

The wetland area now has a shallow trench connecting the wetlands across the ROW. Through my observations I believe these wetlands have been drained and filled for most of the 272 feet allowing water to pass through the ROW through the shallow trench.

Photo Top Left is looking south towards the Raymondskill Creek across the wetlands. Top Right sediment entering wetlands around E&S controls towards the east. Bottom Left is looking north water flowing west to east through a trench. Bottom Right July 25, 2011 is after stabilization looking across wetlands. I'd assume the area without mulch is the 272 feet of wetlands.

The following photos were taken April 18, 2012 during initial assessment of Pike County Road crossings of CGP and TGP pipelines and April 23, 2012 after 1-2 inch average rainfall event over the area.
Top Left shows dry trench between the now separated wetlands. Top Right photo I believe the original wetlands are within the silt fences or area not mulched in the July 25, 2011 photo. The bottom photos are of the trench that drains west to east. Next page bottom photos are trench connecting the wetlands that are now on both sides of the ROW.
Note the steep bank that is to the south side of Raymondskill Creek and the lack of vegetation.
Note the rocky soil on both sides of the trench.

Joe Zenes Report 005 Tennessee Gas Pipeline E-52-217 Pike County April 26, 2012

April 25, 2012 I accessed the Tennessee Gas Pipeline by means of Access Road AR-9A which is located on a portion of DCNR's Delaware State Forest Lands. I entered the pipeline on a ridge where the 300 line ended and where the 323 loop will start. I walked east down the slope and photo documented the wetlands and stream crossing associated with Pinchot Brook before construction of the 323 loop. (L4 035 and L4 036 S010 and S011) I would suggest better delineation and markings of wetland boundaries before construction begins.

Walking west past where I entered the pipeline down a steep slope with slope cuts approached what I believe is *(Wetland Impact W041) A 30" diameter steel natural gas transmission line crossing of approximately 151 feet of PFO/PEM wetland (EV), by means of open trench cut, with temporary wetland impacts of 0.10 acre (Lat: 41°22` 16.5"; Long: -74°50` 51.6") in Milford Township.* It had 2 drain pipes under a temporary road crossing that had evidence of over wash during a rain event with stones and gravel washed over the side of the road base into wetland area. E&S controls on the slope cuts to the east could use better maintenance. Unclear where the wetland delineations are, the crossing is more like stream. Top left shows gravel from over wash across the road into wetland area. Top right is looking east across wetland impact area. Wood mats still in place on left. Bottom photo left is looking downstream (south) of temporary road and right photo looking upstream (north) of road. Slope lacks vegetation and possible erosion problems with jeep trail that was on previous ROW.

April 25, 2012 I accessed the Tennessee Gas Pipeline by means of Access Road AR-9A which is located on a portion of DCNR's Delaware State Forest Lands. I entered the pipeline on a ridge where the 300 line ended and where the 323 loop will start. At this location there are two access roads that run almost parallel to each other AR-9 and AR-9A. The photos below show the original "jeep trail" (AR-9A) across the newly widened 300 line ROW (the narrow green patch to the left of pine tree). The other photo is the new "temporary" access road (AR-9A) with wider "turn cuts". The second "temporary" access road (AR-9) is a continuation of Schocopee Road (I believe is a Milford Township Road). Will the access roads that are no longer needed be restored?

Joe Zenes Report 007 Tennessee Gas Pipeline E-52-217 Pike County April 26, 2012

April 25, 2012 I accessed the Tennessee Gas Pipeline by means of Access Road AR-9A which is located on a portion of DCNR's Delaware State Forest Lands. I entered the pipeline on a ridge where the 300 line ended and where the 323 loop will start. I walked west on the ROW to Craft Brook crossing (S035) and wetland impact area (W039).

12.(Crossing S035) A 30" diameter steel natural gas transmission line across Craft Brook (EV, MF) by means of open trench cut (Lat: 41°22` 24.9"; Long: -74°51` 13.5") in Milford Township. (Wetland Impact W039) A 30" diameter steel natural gas transmission line *41. crossing of approximately 208 feet of POW/PSS wetland (EV), by means of open trench cut, with temporary wetland impacts of 0.55 acre (Lat: 41°22` 23.9"; Long: -74°51` 12.4") in Milford Township.*

On the steep slope approaching Craft Brook (EV) actually 2 streams converge within the ROW which can be seen on USGS Milford Quadrangle 7.5 series, there were slope cuts that I believe could be better maintained as with wetland impact area W041. The temporary access road across Craft Brook and associated wetlands had sections completely washed out with gravel deposited a considerable distance downstream in the stream bed and associated wetlands. It is very confusing where wetlands and stream channels start with silt fences and silt socks not properly working. There is evidence of light colored soil in the water within the wetlands. Wooden mats still buried in wetlands areas. Another area just off of access road AR-9 appears to be wet and may be unidentified wetlands piles of wood mats still on ROW. I again would stress better wetlands delineation and ROW marking for future construction.
Top left photo silt sock not properly maintained. Top right photo was taken looking east of S035 and W039, note the wetland impact was 208' I don't believe the distance between the silt fences are 208' feet at a minimum within that area. Photo also shows <u>where two distinct streams converge at this location not one stream crossing.</u>

Next page top left photo is one of only two markers delineating the wetlands (other knocked down with backfill). Top right photo is looking west across the washout. Center left shows light brown sediment in wetlands. Center right washed out culver pipe and temporary road. Bottom left rolled up topo map/dog for reference. Bottom right reference report 006 ROW clearing appears to be extra wide in some areas on this section of DCRN lands. Note "jeep" trail was original ROW. Photo was taken at AR-9A entrance to ROW looking west across wetland impacts W039 and W041 with crossing S035 in the distance.

WETLAND
BOUNDARY

April 29, 2012 I accessed the Tennessee Gas Pipeline by means of Access Road AR-9 which is located on a portion of DCNR's Delaware State Forest Lands. I walked into where I could see Craft Brook to my east on the downstream side of the pipeline where it crosses S035 (Craft Brook) and wetland impact area W039. I photo documented stone and gravel washed a hundred feet or more down the streambed and associated wetlands. I proceeded to further document the two previous impacted areas with additional photos. I walked west over the next slope to wetland impact area W038. Walking down the slope towards the stream I observed numerous areas about 6" in diameter that appear to be some sort of petroleum based substance that leaked towards the stream. Some areas had mulch on them attempting to cover over spots while others did not.

I revisited the 3 impacted areas of TGP's 300 line with Faith Zerbe on May 4, 2012.

There is a construction window for Sensitive Waterbodies that includes Savantine Creek and Craft Brook, June 1 – Sept. 30. The final grading and cleanup of the construction project during the week ending May12, 2012 appears to be outside the "construction window". When Maya van Rossum, Ed Rogers and myself visited the TGP on May 11, 2012 by access of 9A on DCNR property, heavy construction equipment were performing clean up duties including final grading and had timber mats spanning wetlands W041/W042 which are a tributary to Craft Brook.

PCCD's April 14th email and NOV report on April 11 2012, stated; "Wetland 41, Craft Brook to Upper Limit of Access Road 9 (Winterized Area)-According to Joe Kienzle, Wetland 41 restoration has been completed".
Faith Zerbe and I visited the pipeline at this location on May 4, 2012 and had concerns about the number of amphibians breeding in the wetlands particularly W038 a tributary of Savantine Creek and the fact TGP was about to start final construction and clean-up at a very sensitive time for the critters in their breeding cycle. On the morning of May 12, 2012 additional timber logs were added to the broken timber bridge in wetland W038 that had been broken and sunken within the wetland and had been in that condition since trenching in September 2011. (PCCD NOV reports 11-7 through 11-14) Winterizing continued into October again outside the construction window for these EV wetlands/streams. May 13, 2012 I revisited W038 and found the water to be very muddy with additional timber mats over the broken/damaged ones with mud and debris on travel way threatening more sediment pollution entering the wetland.

Sensitive Waterbodies 300 Line Environmental Assessment pdf. (Page 67/227) Table 2.2.2-1

Waterbodies may be considered sensitive for a number of reasons including, but not limited to, high quality or exceptional value designations, or the presence of impaired water (CWA section 303d) or contaminated sediments. Waterbodies may also be considered sensitive if they are of special interest to a land management agency. Forty-one of the waterbodies that would be crossed by the proposed loops are considered major and/or sensitive (see table 2.2.2-1). On additional major and/or sensitive waterbody would be within the pipeline construction right-of-way but not crossed by the proposed pipeline.

TABLE 2.2.2-1 Sensitive Waterbodies Crossed by the 300 Line Project Loop 323

Milepost	Waterbody Name	Sensitivity	Construction Window	Crossing Method
2.2	Lackawaxen River	HQ, TSF	June 1 - Sept 30	2A or 2B (Aqua Barrier)
4.2	Lords Creek	HQ	June 1 - Sept 30	2A or 2B
4.3	Lords Creek	HQ	June 1 - Sept 30	2A or 2B
10.1	Walker Lake Creek	HQ	June 1 - Sept 30	2A or 2B
11.2	Twin Lakes Creek	HQ	June 1 - Sept 30	2A or 2B
12.7	Savantine Creek	EV	June 1 - Sept 30	2A or 2B
14.3	Craft Brook	EV	June 1 - Sept 30	2A or 2B

Joe Zenes Report 010 Tennessee Gas Pipeline E-52-217 Pike County June 10, 2012

May 12, 2012 I visited the TGP the next day after Maya van Rossum, Ed Rogers and I, Ed shot some video of the pipeline and proposed route through undisturbed lands. We met Susan Beecher PCCD on the pipeline at W038 a unique wetland that flows two different directions out of this one source. We were informed that restoration had begun and wetland W038 would need to be crossed again during this phase of construction. There were previous letters sent out by DRN regarding the amphibians that filled this wetland during their spawning season and a need to protect them. Short discussion took place with Beecher and environmental inspectors on site. May 11, 2012 at 4:30 pm nobody knew when the pump down and crossing of W038 was to take place. DRN was going to try an amphibian rescue before or during the pumping of the wetland was to take place. The following morning I revisited W038 at 10 am and it had been drained and additional wood mats in place.

May 13, 2012 I revisited the TGP that travels through DCNR's Delaware State Forest lands.

- East of Craft Brook S035/W039 wetland was graded and mulched to W041. Wood mats still in place in W041 with grading and final clean-up still in progress to mp 14.9.
- Wood mats did have a filter fabric attached to the underside
- There was a lot of what appears to be fill material in the wetland feature.
- W041 had at one time W042 and S036 also assigned to it but got dropped at some point…it is obvious there is a stream crossing there along with associated wetlands.
- DCNR road on TGP ROW was still washed out at Craft Brook. Craft Brook had several other wetland and waterbody crossing assigned to it at one time. Construction plans listed S035, S037, S038, S039, S040 and S041 with all but S035 listed as not impact…however they were shown in the existing ROW where the road washout took place. There is another wetland that was assigned the number W040 but listed as not impacted but also located within the road washout.
- Appeared to have a number of springs to the west of Craft Brook leading up to Access Road 9 with one prominent spring at the north end of the ROW flowing across the ROW and under the silt fencing and into Craft Brook.
- Areas along the travel lane were disturbed from additional crossings with heavy machinery traversing near and over the water features.
- Standing water had a lot of algae and slimy looking growth.
- There were many wet areas between the upside of Craft Brook to W038 with water running down the existing ROW slope breaks not extended across the entire ROW.
- Wetland W038 had another layer of wood mats extended across it. The "bridge" had layers of mud and debris on it contributing to the sediment laden water.
- No filter fabric attached to this wood mat bridge.
- The water was completely brown with layers of what appear to be fill material within the wetland delineation boundaries on both ends.
- Sediment laden water flowing off ROW and into wetlands.
- Hoses used in draining the wetlands had no special attachments to protect amphibians from getting sucked up into the hoses and pumps, 4 pump/hoses used were still on site.
- The site had considerable sediment pollution with sediment laden water leaving the site with other areas left unprotected to further allow more pollution to enter the associated wetlands.

Joe Zenes Report 011 Tennessee Gas Pipeline E-52-217 Pike County July 16, 2012

The Lackawaxen River crossing of the TGP after restoration completed on June 29, 2012 looking east. Top photo the gravel bar left in the River after final restoration. Bottom photo final restoration…note how much "temporary work space" was needed (2 pipelines marked on top of the hill). Note browned out grasses.

Joe Zenes Report 012 Tennessee Gas Pipeline E-52-217 Pike County July 16, 2012

Bridge across W038 during final restoration. Note Wetland Boundary sign (5-16-12) Bottom photo after final restoration wetland areas backfilled and mulched. (sign removed)

Top photo fill (clay material and pieces of wood mats) saplings and mulch inside wetland boundary. Bottom photo (6-28-12) looking east towards the wetland boundary corner. Also note the “bubbles” in the water.

Joe Zenes Report 013 Tennessee Gas Pipeline E-52-217 Pike County July 16, 2012

DCNR road looking west to AR9 at the top of the hill. In foreground road extends up and over the first slope breaker to the east is where it stops…road to nowhere? Bottom is looking east across Craft Brook complex all culvert pipes remove and gravel road across stream/wetland complex blocking natural flow. Last photo was TGP/DCNR road after washout. 8 culverts went under the road and it still washed out last fall. Note the spring in foreground that flows under the silt fence marking the wetland boundary.

Joe Zenes Report 017 Tennessee Gas Pipeline E-52-217 Pike County July 25, 2012

The top photo is W038 taken looking east 12-16-2008 Bottom photo taken 5-30-12 after final restoration. Lone pine tree on right of photo is west of the eastern wetland boundary. Wetland was 515' in length between silt fences. Turned into a mud puddle where orignally I believe it flowed north and south out of this unique wetland.

Note water clarity top photo taken 4-29-12. Bottom photo taken 6-28-12 Water has been muddy and bubbling since 5-12-12 when wetland was re-bridged for final restoration.

Joe Zenes Report 018 Tennessee Gas Pipeline E-52-217 Pike County July 27, 2012

Top photo shows the wetland boundary of wetland W038 note the clarity of water 4-28-12 other photos taken 6-28-12 note the amount of fill material inside the wetland boundary. The area was mulched with saplings planted down the pipeline where they don't want trees. Last photo is looking east towards the wetland boundary. The last photo you can also see the bubbling action.

Joe Zenes Report 019 Tennessee Gas Pipeline E-52-217 Pike County August 5, 2012

August 2, 2012 I visited the TGP on “Lands of the Commonwealth of Pennsylvania” DCNR property (Delaware State Forest) this is after “final restoration” of the construction project. The “yard” which had heavy equipment stored there since a year ago was completely void of any construction material or machinery.
Top photo-wetland W038 the corner in the foreground is the wetland boundary note the extensive fill within the wetland boundary. Bottom photo debris left floating in what is now a mud hole. Note the bubbling effect since the wood mat bridges were removed more than two months ago.
Page 2 top photo springs above Craft Brook and associated wetlands S035/W039. The springs within the ROW construction are clogged with algae including the orange colored growth. Note the extensive fill within the silt fences (wetland boundaries) grasses brown and elevated above the wetland area in the middle. Middle photo wetland W041 note the amount of fill within the wetland boundaries. Bottom photo W038 pool outside the ROW construction where Maya and Ed Rogers video taped abundance of amphibians on May 11, 2012 and where Faith Zerbe and I observed and recorded the intensity of amphibians breeding on May 4, 2012. Today there are only a few frogs visually present along the fringes.

Joe Zenes Report 020 Tennessee Gas Pipeline Prompton Dam Wayne County September 6, 2012

I visited Prompton Dam off of Rt. 170 an Army Corps Of Engineers project. A source told me that Lattimore Construction of Milford who is doing restorations in Wayne County Pa. for TGP/El Paso was scheduled to remove timber mats (for crossing wetlands and streams) from Prompton Lake. Several timber wood mats (5-8) got loose and were unsecured in the Lake since flooding last year (2011) washed them more than 3 miles downstream. I observed the crew loading up pieces that they are cutting and ferrying them back to the boat launch where the metal rods were being cut out and loaded on to a truck. Talking to the worker on shore they had almost one of the timber mats cut up and shuttled back. They could get about ¼ of the mat onto the row boat at a time. I did walk along the shore and saw where the workers were working a couple hundred yards down the west shore towards the dam.

Photo 100_1637 9-06-12
Prompton Dam folder
Workers cutting up timber mats in handling size pieces.

Photo 100_1635 9-06-12
Prompton Dam folder
Worker Ferrying cut up timber mats back to the boat launch

Photo
100_1643 9-06-12
Prompton Dam
folder
They appear to be about 6 timbers wide or about 48” not sure of the length

Photo
100_1644 9-06-12
Prompton Dam
folder
Timber mats cut up note the metal cutting saw for the metal bolts that tie the timber mats together

Joe Zenes Report 021 Tennessee Gas Pipeline E-52-217 Pike County October 1, 2012

The photo below (100_1839 Rt 434) was taken today 10/01/12 from Rt. 434 of the TGP crossing of Shohola Creek. There appears to be construction activity to the east of Shohola Creek on the steep slope in the vicinity of TGP's ROWs. The bottom photo (100_0213) taken 6-08-12 does not show any construction activity.

Joe Zenes Report 023 Tennessee Gas Pipeline E-52-217 Pike County October 16, 2012

October 11, 2012 I visited the TGP on DCNR property in Pike County, Craft Brook Complex, W041 and isolated pockets of water all had green algae and there were pockets of an orange slime that may be a bacteria that feeds off iron in soils. http://www.umaine.edu/WaterResearch/FieldGuide/inthewater.htm
Question is: whether the increased sunlight and water temperatures caused by the removal of the canopy of mature forests are causing these algae/bacteria blooms. What impacts will they have on the ecosystems further down stream? I have yet to observe these algae blooms in any of the other wetlands and streams I visited that have not yet been impacted by new pipeline construction ROWs.
Craft Brook Complex has two (2) distinct streams but only one with an identification number S035 (Craft Brook EV). Air temperature was averaging about 9.1C, Craft Brook 10.7C and secondary stream within the complex 13.2C or about 4.5 degrees "F" difference of the two streams within the complex.
Top photo 100_2086, bottom 100_2104 (stream channel secondary stream).
DRN folder Photos W039/S035/10/11/12

Joe Zenes Report 024 Tennessee Gas Pipeline E-52-217 Pike County October 16, 2012

October 11, 2012 I re-visited TGP on DCNR property in Pike County. This was a routine observation of post construction of TGP 300 line. W038 an unique wetlands that I believe flowed in two directions before the expansion of the existing ROW construction began. This pipeline was crossed with wood mats for final restorations on May 12, 2012 after requests to put them off due to amphibians mating season. Final restoration was put off several months after the pipeline went into operation sometime in November. Sometime prior to my visit on May 30, 2012 the wood mats used for crossing the wetlands were removed. Since then I have observed and documented bubbling action throughout the body of muddied water that now exists.
DRN/Photos of W038/10/11/12 Top photo 100_2038 Bottom photo 100_2041

November 4, 2012 during a scheduled tour of the TGP on Commonwealth of Pa. lands in Pike County I observed new surveyors markers for the 323 loop of the 300 line. They were markers for temporary workspace (TWS) and additional workspace (ATWS) east towards Pinchot Brook (EV). The new markers were near the end of access road (AR 10 or AR 9A). The new corner markers were in the woods off of the existing ROW and when measuring the distance across the existing and new 30" line from the corner to the end of the clearing across the ROW it was ~250'. The ROW appears to be 1 ½ times larger where construction ended and new construction will begin the next loop. The temporary gravel access road AR 10 has been extended across the entire ROW.

> **1.8 Land Requirements** (Environmental Assessment CP11-161-000)
> Construction of the proposed 30-inch-diameter natural gas pipeline loops would typically require a 100-foot-wide construction right-of-way in upland areas, which would generally consist of 25 feet of existing, permanently maintained right-of-way, 25 feet of new permanent right-of-way, and 50 feet of temporary construction workspace. In wetlands, TGP would reduce the construction right-of-way to 75 feet. Drawings depicting typical pipeline construction cross sections are located in TGP's ECPs. Following construction, TGP would typically retain 25 feet of new permanent right-of-way for the pipeline loop segments.

At the end of AR 10 are three (3) main values/pig launchers that are unsecured in an area that is open to the general public for hunting, hiking among other recreational activities. The EA requires graveling and fencing of the facilities.

> **1.7.3.3 Pig Launchers and Receivers** (Environmental Assessment CP11-161-000)
> Pig launcher and receiver construction would include clearing and grading, installing underground piping, testing the piping, testing the control equipment, cleaning up the work area, graveling the site, and fencing the facilities.
>
> **1.7.3.4 Mainline Valves** (Environmental Assessment CP11-161-000)
> MLV construction would be similar to pig launcher/receiver construction and would include clearing and grading, installing underground piping, testing the piping, testing the control equipment, cleaning up the work area, graveling the site, and fencing the facilities.

The group toured W041 and S035/W039 (Craft Brook Complex) and observed the damage done to these EV wetlands and streams. There still remains fill material within the wetland boundaries, considerable amount of algae growth and disruption of the "natural" flows.

Photo taken 11-04-12
Folder DRN Access Road 9A 100_2140

Main valves are on the right with plastic fencing and new gravel access road continuing across ROW. Note the TWS corner flags back in woods off the existing ROW (yellow flags) when the existing clearing is already over 200'.

Joe Zenes Report 026 Tennessee Gas Pipeline E-52-217 Pike County November 8, 2012

November 6, 2012 on my way to my polling place in Shohola, I stopped and took measurements of the TGP's clear cutting of the pipeline's ROW along the roads in Shohola Township. I believe TGP has started the last stage of "final" restoration, pulling up the silt fencing and fabric socks and any other erosion control devices and covering any bare ground with hay. I also drove into the pipeline on AR 10 and took additional measurements west and east of where the access road meets the pipeline.

> **1.8 Land Requirements** (Environmental Assessment CP11-161-000)
> Construction of the proposed 30-inch-diameter natural gas pipeline loops would typically require a 100-foot-wide construction right-of-way in upland areas, which would generally consist of 25 feet of existing, permanently maintained right-of-way, 25 feet of new permanent right-of-way, and 50 feet of temporary construction workspace. In wetlands, TGP would reduce the construction right-of-way to 75 feet. Drawings depicting typical pipeline construction cross sections are located in TGP's ECPs. Following construction, TGP would typically retain 25 feet of new permanent right-of-way for the pipeline loop segments.

Measurements were taken with a 200' tape measure and estimated from tree line to tree line along the shoulder of the road.

State Road Route 434 west and east sides both ~200 feet
Twp Road Little Walker Road west side 275 feet east side 200+ feet
Twp Road Lake Road south side 325 feet north side 150 feet
State Road Twin Lakes Road west side 275 feet east side 135 feet

DRN folder clear cuts of ROW
Photo 100_2152 11-6-12

Photo taken looking north on Little Walker Road. 200' tape is maxed out and still short of TGP existing ROW. Tree line to tree line ~275'

Top photo next page
Photo 100_2157 11-6-12

East side of Little Walker Road
North-south 200+ feet

Middle Photo
100_2165 (auto corrected for clarity)
Photo taken looking north on State Route Twin Lakes Road 11-6-12
Measurements taken from tree line to tree line ~275'

Bottom photo 100_2163
South side of Lake Road looking west-east ~325' tree line to tree line

November 6, 2012 as a follow-up from taking measurements during the November 4, tour, I drove into the pipeline on AR 10 and took additional measurements west and east of where the access road meets the pipeline I believe TGP has started the last stage of "final" restoration, pulling up the silt fencing and fabric socks and any other erosion control devices and covering any bare ground with hay.

> **1.8 Land Requirements** (Environmental Assessment CP11-161-000)
> Construction of the proposed 30-inch-diameter natural gas pipeline loops would typically require a 100-foot-wide construction right-of-way in upland areas, which would generally consist of 25 feet of existing, permanently maintained right-of-way, 25 feet of new permanent right-of-way, and 50 feet of temporary construction workspace. In wetlands, TGP would reduce the construction right-of-way to 75 feet. Drawings depicting typical pipeline construction cross sections are located in TGP's ECPs. Following construction, TGP would typically retain 25 feet of new permanent right-of-way for the pipeline loop segments.

During the pipeline tour on November 4th I measured 275 feet across AR 10 the width of the ROW from tree line on the north side to TWS corners set back into the woods. November 6th I took additional measurements across the current ROW down to W041.

Joe Zenes Report 028 Tennessee Gas Pipeline E-52-217 Pike County November 14, 2012

After reading Earth Disturbance Inspection Report 12-26 permit ESCGP-1 0009801 by PCCD (S Beecher/E Enslin) I have following comments from my observations during 14 visits to W038 from April to October. Wetland 038 is a unique wetland that flows south towards Savintine Creek (EV) and north into a larger wetland which I believe forms Craft Brook (EV) from TGP's ROW. This wetland is more like a pond (POW) than the PFO/PSS/PEM classifications it had before new construction and has shrunken in size from its original 517' to a size less than half of what it was.

IR-26 fails to recognize the area for re-seeding to the east approach is within the wetland boundary. Top photo DRN W038 4-29-12 100_9259
The wetland boundary started at silt fence in foreground and continues to silt fence in far background. During my 14 visits I have observed and reported (JZ Report 010 6-29-12) fill material within wetland feature on both ends. IR 26 also fails to note that the body of water has a constant bubbling action since the wood timber mats were removed. Note differences in temporary impacts from 2 TGP documents.

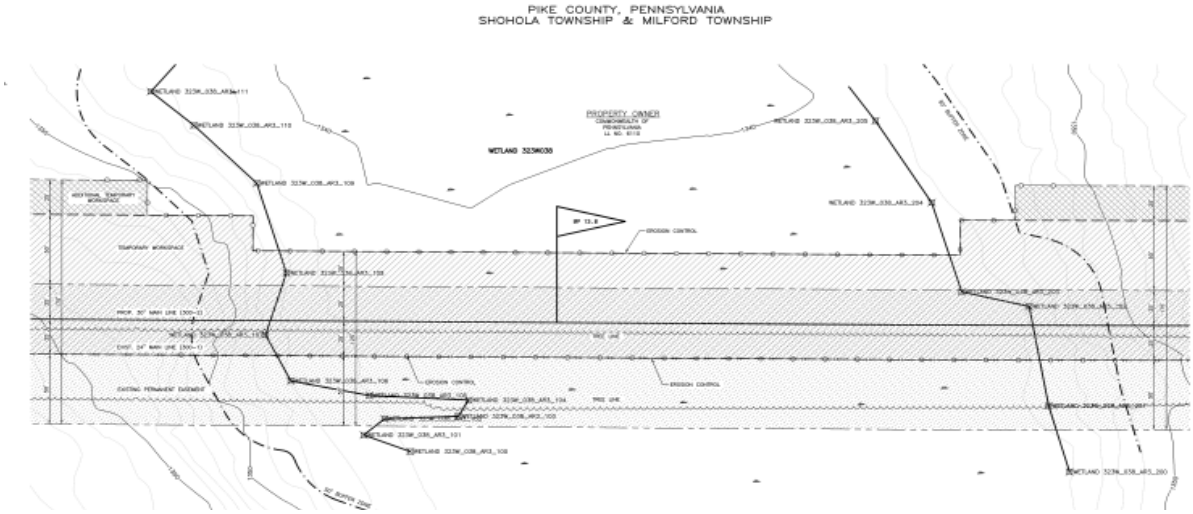
(Wetland Impact W038) A 30" diameter steel natural gas transmission line crossing of approximately 517 feet of PFO/PSS/PEM wetland (EV), by means of open trench cut, with temporary wetland impacts of 1.19 acre (Lat: 41°22` 41.9"; Long: -74°51` 48.6") in Milford Township

WATERBODY/WETLAND IMPACT

WATERBODY/ WETLAND #	TEMP. IMPACT	PERM. IMPACT
323W038	0.84 AC.	0.12 AC.

0.12 acres= 5,227 sq feet or a strip ~10'x 517'
Between silt fencing is 75' x 517' =38,775 sq feet

300 Line Appendix P Wetland Crossings_323 July 17, 2009 Photo PCCD 10/18/12



Joe Zenes Report 029 Tennessee Gas Pipeline E-52-217 Pike County November 14, 2012

Constant bubbling actions in W038 after wood timber crossing mats were removed in May 2012. Note bubbling action stirs up sediment on bottom and brings to surface. W038 is currently more of a POW wetland classification then PEM/PSS/PFO as it was classified before construction of TGP. IR 12-26 by PCCD on 10-18-12 failed to recognize the bubbling action or that areas within wetland boundaries contained backfilled materials and the current size is less than half the 517' it was before construction of TGP.

DRN W038 10-11-12
Photo 100_2038

DRN W038 10-11-12
Photo 100_2041

DRN W038 10-11-12
Photo100_2041

DRN W038 08-02-12
Photo 100_1029

(Wetland Impact W038) A 30" diameter steel natural gas transmission line crossing of approximately 517 feet of PFO/PSS/PEM wetland (EV), by means of open trench cut, with temporary wetland impacts of 1.19 acre (Lat: 41°22` 41.9"; Long: -74°51` 48.6") in Milford Township. (Pa Bulletin E52-217 Vol 41-19)

71.5’ x 531.58=38000ft² = 0.87236ac
West boundary x southern boundary

WATERBODY/WETLAND IMPACT

WATERBODY/ WETLAND #	TEMP. IMPACT	PERM. IMPACT
323W038	0.84 AC.	0.12 AC.

(300 Line Project Appendix P)

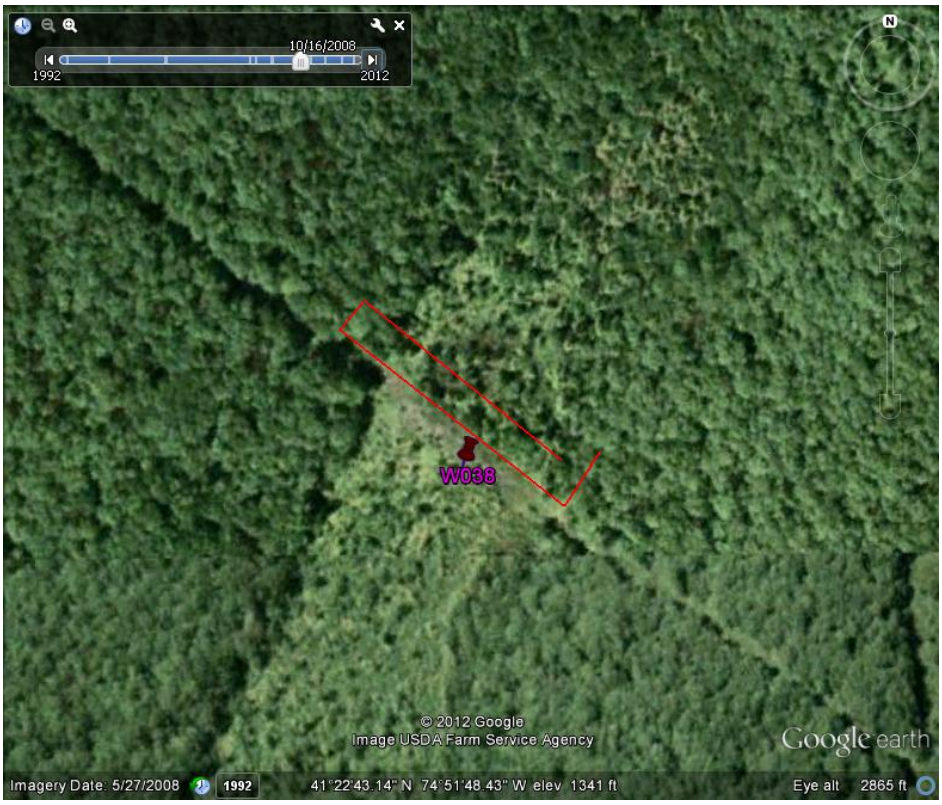
Permanent impact 0.12ac = 5227.2ft²

Before 10-16-2010 and after 9-12-2012 photos of W038 from Google Earth distance measured using ruler tool taken off of visible silt fencing marking the wetland boundaries.

North 474’
East 122.4’
South 531.58’
West 71.5’

In conclusion, measurements taken along the silt fencing marking the wetland boundaries were approximately 0.87 acres, similar to the projected temporary impacted area of 0.84 acres. However, a year later the impacts appear to be permanent; exceeding the 0.12 acres of permanent impact projected by Tennessee Gas Pipeline.

Note: These measurements were solely for the wetland itself, not including the impact from the removal of trees along the uplands of the construction ROW.



Joe Zenes Report 021-1 Tennessee Gas Pipeline E-52-217 Pike County December 11, 2012

I'm adding additional findings to Report 021. The attached Google Earth Images are from the new 9-12-12 image. I took photos of the activity on the TGP on 10-01-12 (Report 021) more than 2 weeks after the new Google image was taken. The new images show construction activity on the steep slope above Shohola Creek worn tire tracks in the soil would indicate to me that the activity had been going on for a period of time. I added 2 other images from what I believe is the Access Road from Twin Lakes Road they were using to access the new construction site. The AR also has a large staging area close to Twin Lakes Road that are active long after final restorations were supposed to be completed.

Using the Google Earth program the AR appears to cross the TGP ROW to the east of the new construction site and travel southwest then north back to the ROW just east of Shohola Creek (EV). DRN staff Faith Zerbe did report my observations to PCCD. I am unaware of any response from PCCD.

N
© 2012 Google
Google earth
Imagery Date: 9/12/2012
1992
41°25'16.32" N 74°56'31.04" W elev 1133 ft
Eye alt 1503 ft

© 2012 Google
Google earth
Imagery Date: 9/12/2012
1992
41°26'14.19" N 74°55'29.53" W elev 1137 ft
Eye alt 1501 ft

January 31, 2013 I accessed TGP via Schocopee Road to monitor a moderate rain event (1" to 1 ½") that occurred over 3 days, January 28-31. My daughter Nicole accompanied me to Tennessee's 300 Line which I have monitored since April 2012. There are currently flooding problems with over wash of DCNR Road across Craft Brook Complex. During repair (June 2012) of washout that occurred during the fall of 2011, the culvert pipes that were under the previous road were removed and a solid road base was built across the complex of streams and wetlands altering the natural flow of Craft Brook ID S035 (EV) and its associated streams and wetlands. The two bottom photos from Wetland Delineation Report (March 2009) have ID's of S038 and S041. Appears culvert pipes which have been removed had separate IDs within Craft Brook Complex.

Photo taken 12-21-12
DNR/ 12-21-12 Rain Event100_2899

Photo taken 1-31-13
DRN/1-31-13 Rain Event 100_3184

323S038 / Craft Brook
Looking north at brook towards existing pipeline ROW.

323S041 / Craft Brook
Looking north at brook towards the existing pipeline ROW.

Joe Zenes Report 031-1 Tennessee Gas Pipeline E-52-217 Pike County January 28, 2013
Attachment Page 2
Pollution event: W038 December 21, 2012

Top left-The waterbar/slope breaker at bottom of slope to the east of W038 holding water on the ROW.
Top right-Green erosion and sediment control mesh between last waterbar and W038 lacks vegetation with sediment laden water in depressions. (Center of photo)
Bottom left-Sediment laden water entering wetlands under E&S silt fencing.
Bottom right sediment laden water in wetland feature (W038)
Note: white spots in photos are snow flakes.

DNR/Photos W038/12-21-12/Rain event 100_2851

DNR/Photos W038/12-21-12/Rain event 100_2852

DNR/Photos W038/12-21-12/Rain event 100_2854

DNR/Photos W038/12-21-12/Rain event 100_2856

Pollution event: W038 December 21, 2012

Stormwater runoff traveling down what was the “existing” ROW (top left photo) upslope and west of W038. I observed the large amount of stormwater flowing across the ROW from more than ¼ mile away from the east side of W038. The stormwater flowed down to the last waterbar near the bottom of the slope on the west side of W038. The waterbar resembled a streambed more then an E&S control exiting the ROW past an additional temporary work space area (ATWS) into a forested area.
Note photos taken approximately 7 hours after steady precipitation had stopped.

Photos in subfolder “runoff westside”

DNR/Photos W038/12-21-12/Rain event 100_2875-1

DNR/Photos W038/12-21-12/Rain event 100_2876

DNR/Photos W038/12-21-12/Rain event 100_2878

DNR/Photos W038/12-21-12/Rain event 100_2877

Pollution event: W038 December 21, 2012

Top left Sediment laden water within boundaries of W038 on the eastside. Note bare root stock now in flooded area.
Top right E&S silt fencing marking southern edge of W038 with sediment laden water in wetland feature W038
Bottom left looking north across W038 sediment laden water in wetland feature E&S controls in disrepair.
Bottom right clean water flowing into W038 from the south right before the E&S controls in photo 100_2884

DNR/Photos W038/12-21-12/Rain event 100_2860

DNR/Photos W038/12-21-12/Rain event 100_2884

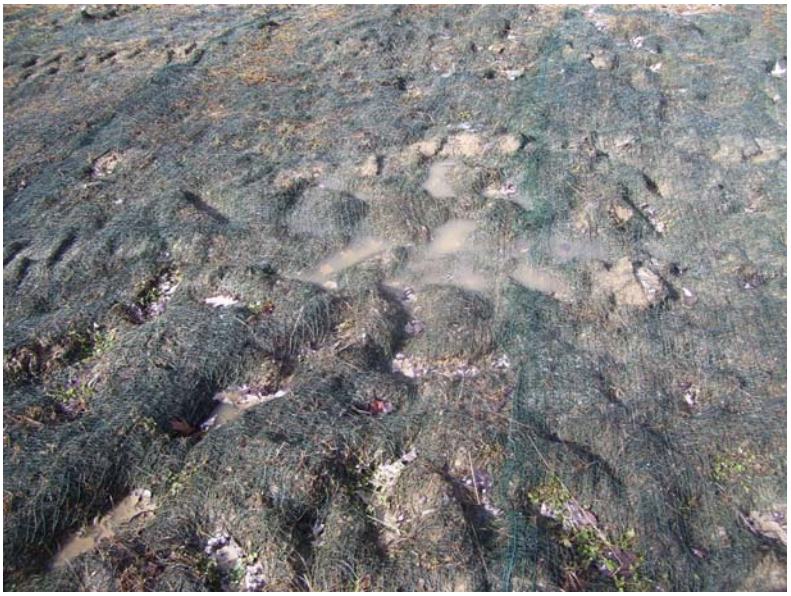
DNR/Photos W038/12-21-12/Rain event 100_2885

DNR/Photos W038/12-21-12/Rain event 100_2888

Joe Zenes Report 032 Tennessee Gas Pipeline E-52-217 Pike County February 1, 2013
Pollution event: W038 January 31, 2013

January 31, 2013 I accessed TGP via Schocopee Road to monitor a moderate rain event (1" to 1 ½") that occurred over 3 days, January 28-31. My daughter Nicole accompanied me down to L4 W038 of Tennessee's 300 line which I have monitored since April 2012. My observations were consistent to what I observed during the 12-21-12 rain event at L4 W038 with similar precipitation totals. (See reports 031) My observations are it appears sediment laden water is entering the wetland on the eastside where there is a lack of vegetated growth where E&S mesh was installed (top left) and seeps under the temporary E&S controls in place (top right). As seen in bottom left photo, clear water is flowing into the wetland from the south side but water on the other side of temporary E&S controls the water is cloudy with sediment (bottom right). My observations indicate the soil on the eastside of the wetlands is light in color and resembles the upland soil outside the wetland boundaries marked by the temporary E&S controls still in place. Photos taken approximately 7-8 hours after precipitation had stopped.

DRN/1-31-13 rain event 100_3131



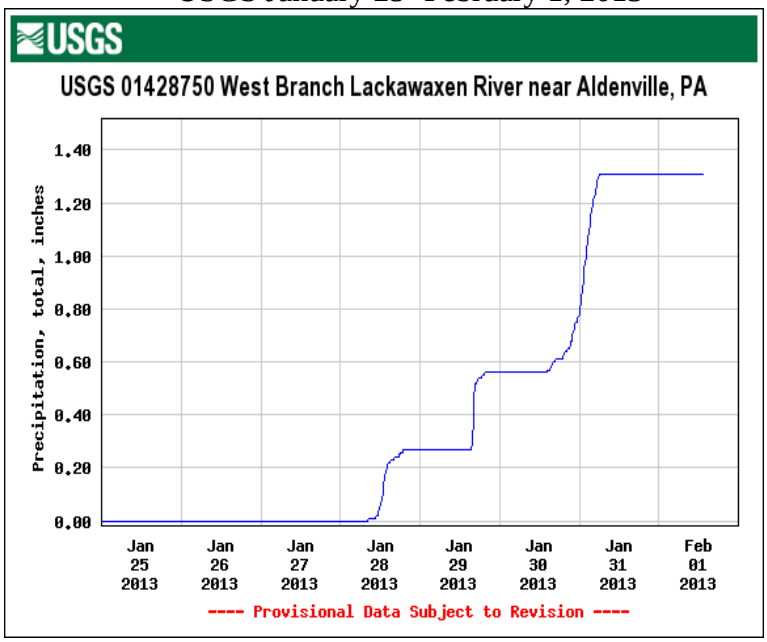
DRN/1-31-13 rain event 100_3134

DRN/1-31-13 rain event 100_3153

DRN/1-31-13 rain event 100_3151

January 31, 2013 I accessed TGP via Schocopee Road to monitor a moderate rain event (1" to 1 ½") that occurred over 3 days, January 28-31. My daughter Nicole accompanied me down to L4 W038 of Tennessee's 300 line which I have monitored since April 2012. My observations were consistent to what I observed during the 12-21-12 rain event at L4 W038 with similar precipitation totals. (See reports 031) My observations are it appears sediment laden water is entering the wetland on the eastside and flows north under the temporary E&S controls in place (top right). Note E&S controls in need of repair. As seen in bottom photos, the cloudy sediment laden water can be observed in wetlands on the north side of the temporary E&S controls marking the wetland boundaries. Photos taken approximately 7-8 hours after precipitation had stopped.

USGS January 25- February 1, 2013



DRN/1-31-13 rain event 100_3138

DRN/1-31-13 rain event 100_3143

DRN/1-31-13 rain event 100_3149

Joe Zenes Report 033 Tennessee Gas Pipeline E-52-217 Pike County February 4, 2013

Spread of *Phragmities australis* (Common Reed)

My observations and photo documentation of W038 confirms the spread of the invasive species know as Phragmities or Common Reed (*Phragmities australis*) The photo top left taken 12/16/2008 was part of the Wetland Delineation Report July 2009 by Tennessee Gas Pipeline for the 300 Line Project. The photo taken 12/16/08 before construction activities shows the lack of phragmities in the existing ROW. Top right photo taken 4/29/12 looking west shows a mature stand on the south side of temporary E&S controls in the previous ROW. Bottom left photo was taken on 5/30/12 as part of my ongoing monitoring of the TGP activities in the Delaware State Forest and other sections of the 300 Line and the NEUP projects. Photo shows new growth spreading into wetlands that lacks the recognizable inflorescences of the older growth. The bottom right photo taken 1/31/13 shows mature plants spreading into wetlands from both sides of the new disturbances to W038. Note how W038 lost its wetland characteristics (PFO PSS PEM) and now resembles an open water pond.

323W038
Looking east at wetland from existing pipeline ROW.

DRN/Photos/W038/4/29/12 100_9253

Looking west across wetland W038

DRN/Photos/W038/5/30/12 100_9947
Looking east across wetland W038

DRN/1/31/13 rain event 100_3127
Looking west across wetland W038

Joe Zenes Report 034 Tennessee Gas Pipeline E-52-217 Pike County February 4, 2013

January 31, 2013 I accessed TGP via Schocopee Road to monitor a moderate rain event (1" to 1 ½") that occurred over 3 days, January 28-31. My daughter Nicole accompanied me to Tennessee's 300 Line which I have monitored since April 2012. My observations were consistent to what I observed during the 12-21-12 rain event along the 300 Line with similar precipitation totals. (See reports 031-32) Photo top left shows sediment deposited on top of clear older ice along the west side of Schocopee Road. Large amounts of stormwater were observed flowing down parts of the previous ROW and the new ROW of TGP. Top right photo is looking west from Schocopee Road and bottom left is looking east across Schocopee Road. Bottom right photo shows sheet flows just east of Schocopee Road being caught up in the downhill waterbar.

DRN/1-31-13 Rain Event 100_3111

DRN/1-31-13 Rain Event 100_3112

DRN/1-31-13 Rain Event 100_3170

DRN/1-31-13 Rain Event 100_3172

January 31, 2013 I accessed TGP via Schocopee Road to monitor a moderate rain event (1" to 1 ½") that occurred over 3 days, January 28-31. My daughter Nicole accompanied me to Tennessee's 300 Line which I have monitored since April 2012. Top left photo is a wetland identified as W038A in the 300 Line Wetland Delineation Report. I believe this was not crossed by the pipeline so therefore was listed as "not impacted". However, ruts left behind by off road vehicles on the previous or existing pipeline ROW serves as a conduit to expedite surface water draining from the wetland area (W038A) down the ROW into the nearest waterbar not allowing for infiltration into the ground. Photos are in sequence looking east from wetland W038A to waterbar. Note how volume increases further downhill to nearest waterbar. Photos taken approximately 10-12 hours after heavy precipitation had stopped.

DRN/1-31-13 Rain Event 100_3155

DRN/1-31-13 Rain Event 100_3157

DRN/1-31-13 Rain Event 100_3159

DRN/1-31-13 Rain Event 100_3162

January 31, 2013 I accessed TGP via Schocopee Road to monitor a moderate rain event (1" to 1 ½") that occurred over 3 days, January 28-31. My daughter Nicole accompanied me to Tennessee's 300 Line which I have monitored since April 2012. Photos show erosion from stormwater runoff in area where soil samples were taken in TWS on the 300 Line ROW. Bottom right photo is the west side of Schocopee Road where sediment laden water collects. This is consistent with conditions documented during the 12-21-12 rain event in proximity of the same location.

DRN/ 1-31-13 Rain Event 100_3118

DRN/ 1-31-13 Rain Event 100_3120

DRN/ 1-31-13 Rain Event 100_3124

DRN/ 1-31-13 Rain Event 100_3171

January 31, 2013 I accessed TGP via Schocopee Road to monitor a moderate rain event (1" to 1 ½") that occurred over 3 days, January 28-31. My daughter Nicole accompanied me to Tennessee's 300 Line which I have monitored since April 2012. My observations indicate moderate volumes of stormwater exiting TGP ROW where a gravel road was built across TGP's ROW. The stormwater is diverted off the ROW and flows along Schocopee Road (AR9) eroding the gravel away and causing ruts to develop along the DCNR roadway.

DNR/1-31-13 Rain Event 100_3170

DNR/1-31-13 Rain Event 100_3173

DNR/1-31-13 Rain Event 100_3176

DNR/1-31-13 Rain Event 100_3178

January 31, 2013 I accessed TGP via Schocopee Road to monitor a moderate rain event (1" to 1 ½") that occurred over 3 days, January 28-31. My daughter Nicole accompanied me to Tennessee's 300 Line which I have monitored since April 2012. There are currently flooding problems with over wash of DCNR Road across Craft Brook Complex. During repair (June 2012) of washout that occurred during the fall of 2011, the culvert pipes that were under the previous road were removed and a solid road base was built across the complex of streams and wetlands altering the natural flow of Craft Brook ID S035 (EV) and its associated streams and wetlands. The two bottom photos from Wetland Delineation Report (March 2009) have ID's of S038 and S041. Appears culvert pipes which have been removed had separate IDs within Craft Brook Complex.

Photo taken 12-21-12
DNR/ 12-21-12 Rain Event100_2899

Photo taken 1-31-13
DRN/1-31-13 Rain Event 100_3184

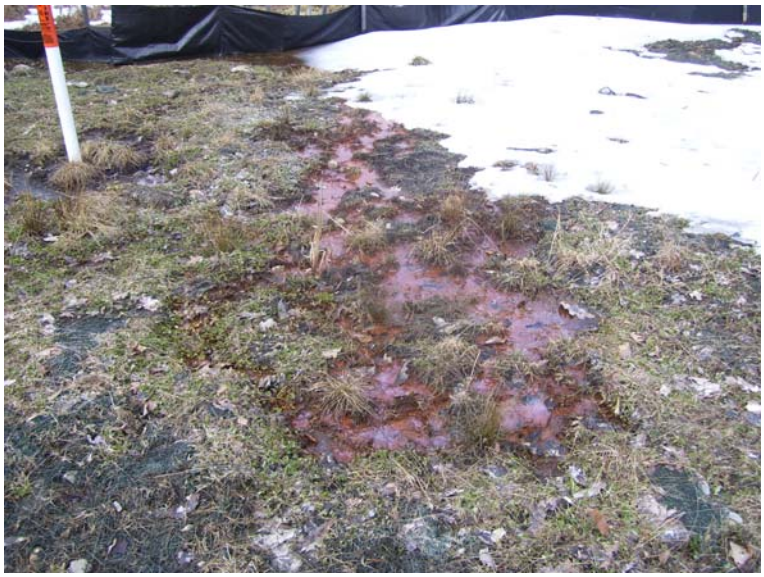
323S038 / Craft Brook
Looking north at brook towards existing pipeline ROW.

323S041 / Craft Brook
Looking north at brook towards the existing pipeline ROW.

Joe Zenes Report 044 Tennessee Gas Pipeline E-52-217 Pike County March 11, 2013
W041/Craft Brook 3/7/13

March 7, 2013 I accessed TGP on DCNR property in Milford Township from AR 10. Tree cutting activities were in progress on the NEUP line. I walked west on the 300 Line down to W041 and Craft Brook Complex. I observed orange and blackish ooze coming out of the ground near markers identifying the pipeline locations close to the E&S controls that were placed along the wetland boundaries. The E&S controls have an additional layer since I last visited the 300 Line and excessive lime spread along the ROW.

DRN Photo100_4349 Eastside of Craft Brook



DRN Photo 100_4348 Ooze coming out of marker

DRN Photo 100_4347

DRN Photo 100_4357 Substance flowing under E&S controls into wetlands

Joe Zenes Report 045 Tennessee Gas Pipeline E-52-217 Pike County March 11, 2013
W041/Craft Brook 3/7/13

March 7, 2013 I accessed TGP on DCNR property in Milford Township from AR 10. Tree cutting activities were in progress on the NEUP line. I walked west on the 300 Line down to W041 and Craft Brook Complex. I observed orange and blackish ooze coming out of the ground near markers identifying the pipeline locations close to the E&S controls that were placed along the wetland boundaries. The E&S controls have an additional layer since I last visited the 300 Line and excessive lime spread along the ROW.

DRN Photo 100_4313 East view of W041

DRN Photo 100_4309

DRN Photo 100_4303 W041 300 Line

DRN Photo 100_4310 300 Line

Joe Zenes Report 046 Tennessee Gas Pipeline E-52-217 Pike County March 12, 2013
W041/Craft Brook 3/7/13

March 7, 2013 I accessed TGP on DCNR property in Milford Township from AR 10. Tree cutting activities were in progress on the NEUP line. I walked west on the 300 Line down to W041 and Craft Brook Complex. I observed orange and blackish ooze coming out of the ground near markers identifying the pipeline locations close to the E&S controls that were placed along the wetland boundaries. The E&S controls have an additional layer since I last visited the 300 Line and excessive lime spread along the ROW.

DRN Photo100_4308 Eastside of W041

DRN Photo 100_4279 Eastside of W041

DRN Photo100_4305 Westside of W041

DRN Photo 100_4308 Westside of W041

Joe Zenes Report 047 Tennessee Gas Pipeline E-52-217 Pike County March 12, 2013
W041/Craft Brook 3/7/13

March 7, 2013 I accessed TGP on DCNR property in Milford Township from AR 10. Tree cutting activities were in progress on the NEUP line. I walked west on the 300 Line down to W041 and Craft Brook Complex. I observed orange and blackish ooze coming out of the ground near markers identifying the pipeline locations close to the E&S controls that were placed along the wetland boundaries. The E&S controls have an additional layer since I last visited the 300 Line and excessive lime spread along the ROW.

Craft Brook (EV) and W041 had noticeable increase in green algae over the past year. This was upstream and downstream of the pipeline. Photos from Craft Brook (S035) 300 Line.

DRN Photo 100_9175 Taken 4-29-12

DRN Photo 100_9999 Taken 6-2-12

DRN Photo 100_4365 Taken 3-7-13

DRN Photo 100_ 4368 Taken 3-7-13

Joe Zenes Report 048 Tennessee Gas Pipeline E-52-217 Pike County March 12, 2013
W041/Craft Brook 3/7/13

March 7, 2013 I accessed TGP on DCNR property in Milford Township from AR 10. Tree cutting activities were in progress on the NEUP line. I walked west on the 300 Line down to W041 and Craft Brook Complex. I observed orange and blackish ooze coming out of the ground near markers identifying the pipeline locations close to the E&S controls that were placed along the wetland boundaries. The E&S controls have an additional layer since I last visited the 300 Line and excessive lime spread along the ROW.

Excessive lime applied at Craft Brook and along the 300 Line. Photos taken 3-7-13

DRN Photo 100_4339 Excessive lime near Craft Brook

DRN Photo 100_4340 lime on "lambs ear plant" *Stachys byzantina*

DRN Photo 100_4372 liming near surface waters

DRN Photo100_ 4376 Approach to Craft Brook (EV)

Joe Zenes Report 049 Tennessee Gas Pipeline E-52-217 Pike County March 14, 2013

3/12/13 Rain Event TGP Access Roads

Monitoring a rain event 3-12-13 on TGP's 300 Line I encounter these sediment and erosion events along previous and current access roads for TGP. The gravel road extended across TGP diverts storm water down Schocopee Road including a moderate flow down the 24" line's ROW.

DRN Photo 100_4456 AR 10 Road to DCNR Gate

DRN Photo 100_4591 Westside Schocopee Road

DRN Photo 100_ 4694 TGP AR 9 (300 Line)

DRN Photo 100_4700 Schocopee Road and AR 9

Joe Zenes Report 051 Tennessee Gas Pipeline E-52-217 Pike County March 14, 2013

3/12/13 Rain Event TGP Waterbars/Slope Breakers

Monitoring a rain event 3-12-13 on TGP's 300 Line I encounter these sediment and erosion events along permanent waterbars located in TGP's 300 Line ROW. The photos were taken after a rain event 3-12-13 west of Schocopee Road where it crosses TGP 300 Line. Photos show sediment laden water collecting in and then discharging from permanent waterbars approximately 3 hours after the rain stopped.

DRN Photo 100_4613

DRN Photo 100_4614

DRN Photo 100_4623

DRN Photo 100_4611

Joe Zenes Report 051 Tennessee Gas Pipeline E-52-217 Pike County March 14, 2013

3/12/13 Rain Event TGP Unidentified Wetland

Monitoring a rain event 3-12-13 on DCNR lands off of Schocopee Road I observed and documented stormwater runoff and sediment near Craft Brook (EV) and an unidentified wetland from the 300 line project. This wetland wasn't identified during construction or restoration of the 300 Line but had resource signage without ID and was documented with other sediment problems during the past year (2012).

DRN Photo 4577 Note wetland sign on ground and sediment in wetlands

DRN Photo100_4578 Sediment flowing under and around E&S controls

DRN Photo 100_4579 Sediment laden water being diverted around E&S controls towards Craft Brook

DRN Photo 100_4582 surface water flowing across the ground towards wetland feature and Craft Brook

Top Photo was taken by myself, 4-25-12 looking **east** across Pinchot Brook S010 and associated wetlands. The wetland crossing is 505' long and waterbody is 42' wide. The other 2 photos I scanned from the Wetland Delineation report NEUP Loop 323 "Site Photographs" Photo 1 (top photo next page) "Northeast view of W036, also associated with S010." Photo 2 (bottom photo next page) "South view of S010, Pinchot Brook also associated with W036." Look carefully all 3 photos taken from the same spot. I feel this is inaccurate information during photographing site locations whether it was intentional or not. The one "Y" tree left center first 2 photos and right center is what I used to determine both photos in Wetland Delineation Report are the same view. These pictures are in the TGP report. My photo you are looking across the "existing" ROW. The new ROW will clear 100' to the left in this photo or basically all the trees on the left in photo. Temporary Work Space and Additional Temporary Work Space are not "temporary" impacts! Note the ROW being used by off road vehicles.

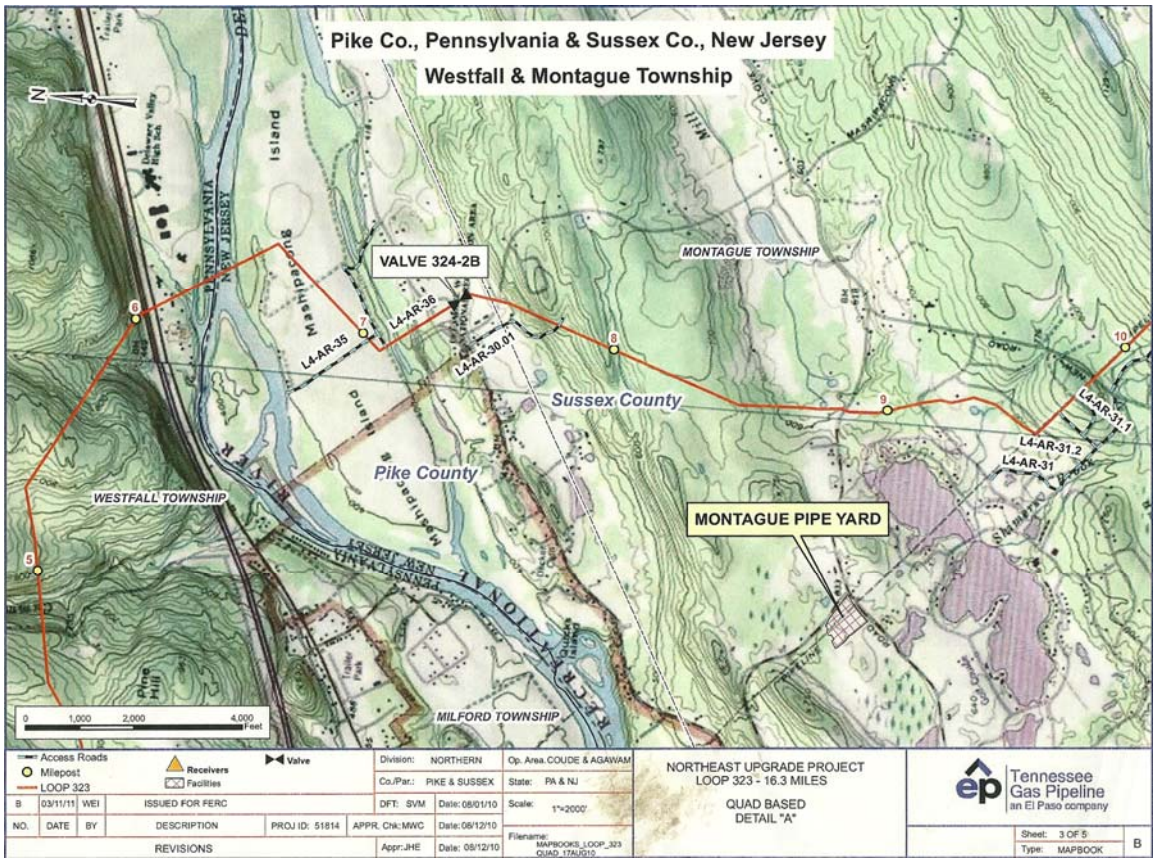
Photo 1: Northeast view of W036, also associated with S010

Photo 2: South view of S010, also associated with W036

Table 2.2-2 states that L4-AR-35 "accesses Mashipacong Island and the Alternate row leading to the Delaware River directional drill site." Map from wetland delineation report for NEUP shows AR-35 going directly to the recently approved water withdrawal site bisecting Mashipacong Island and <u>does not go</u> to the Delaware River crossing further up stream. NPS.Gov map includes the 2 islands on the northern boundary within the DWNRA directly across from the approved withdrawal site in a channel of the River. Note TGP's map is inconsistent with the boundaries on the NPS map and has no access road going to the Delaware River Crossings.

TABLE 2.2-2
ACCESS ROADS ASSOCIATED WITH THE NORTHEAST UPGRADE PROJECT – LOOP 323

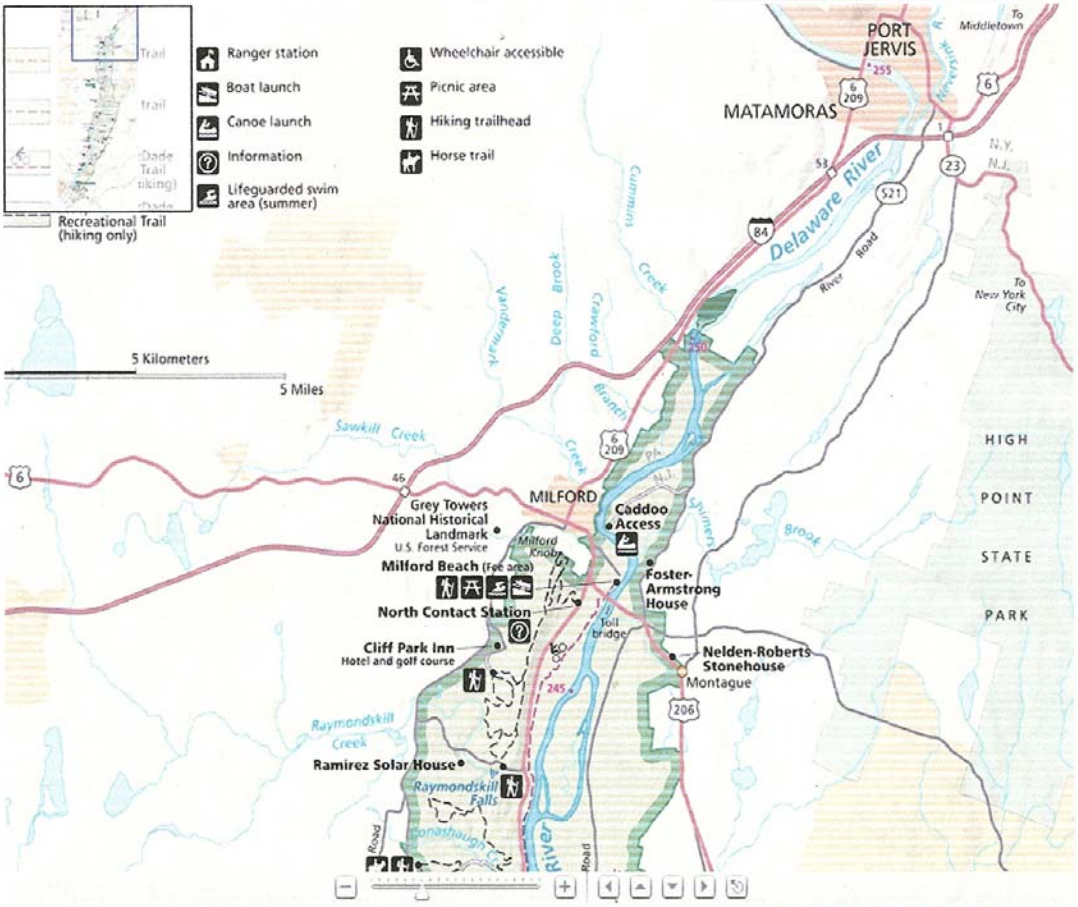
Access Road ID	MP[a]	Township / County	Latitude Longitude	Temporary or Permanent	Length (ft)	Area Affected (acres)	Modifications Required	Comments
L4 AR10	0.03	Milford / Pike	41.37048 -74.84523	TBD	4,920	2.71	Portions to be widened, gravel, tree trimming	Part of the road is good quality gravel and turns into a two-track road with rock-base in areas. Additional rock and side trimming may be required
L4 AR21	1.70	Milford / Pike	41.35471 -74.82138	TBD	882	0.49	Portions to be widened; mats required across existing pipeline	Good quality gravel road
L4 AR21.05	2.12	Milford / Pike	41.351838 -74.814132	TBD	1,495	0.81	Portions to be widened through wooded area	--
L4 AR35	7.13	Montague / Sussex	41.33830 -74.74688	TBD	7,043	3.33	Portions to be graded	Access road is located off of River road. Good rock/gravel road that crosses a low water dam and accesses Mishipcong Island and the Alternate row leading to the Delaware River directional drill site.
L4 AR36	7.24	Montague / Sussex	41.33743 -74.74723	TBD	631	0.26	Portions to be widened and graded	15-feet wide that follows tree line to ROW



nps.gov

Delaware Water Gap Map

close map | print map



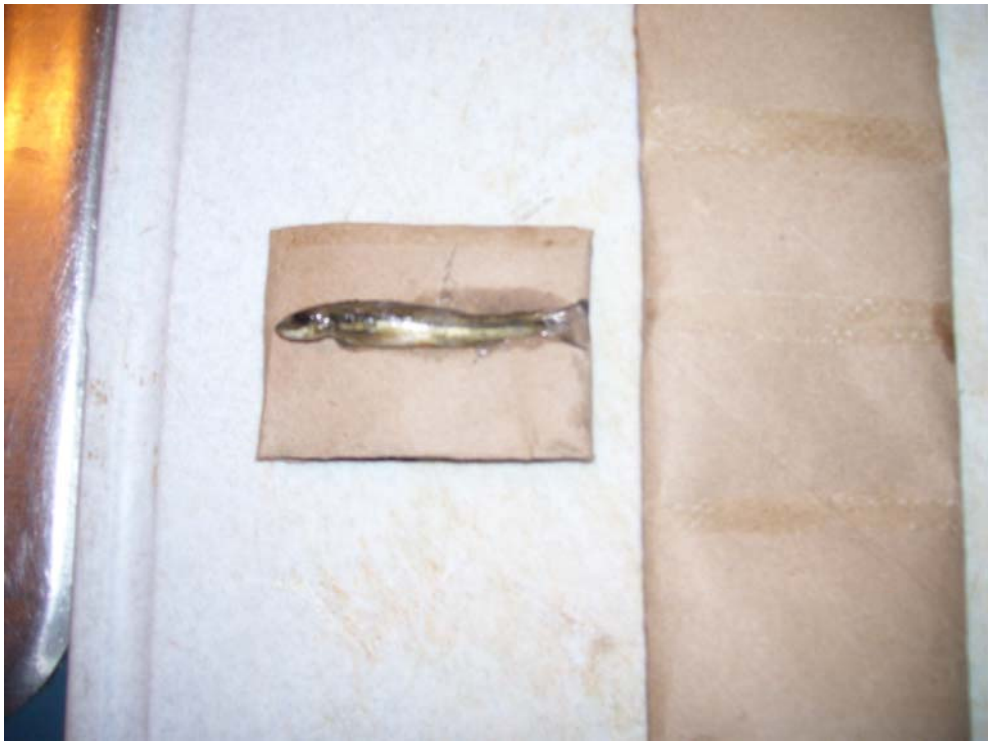
Park Directions Page »

8

NPS 828-2253

Joe Zenes Report 016 Tennessee Gas Pipeline E-52-217 Pike County July 25, 2012

July 22, 2012 visited Pinchot Brook L4 S010 and unnamed tributary of Pinchot Brook S011with 2 associated wetlands L4 W035 and W036. Purpose was to photo document the stream/wetlands pre-construction. I took baseline reading with conductivity meter, TDS, and Salinity along with air and water temperatures. When approaching Pinchot Brook we (daughter Nickie) observed hundreds of small fish. We found a dead fish along the shore and using PAF&B guide identified it as a Bluntnose minnow *Pimephales notatus*. The sample was not preserved very well, distinguishable characteristics were faded and we used what we could to identify it. There are hundreds of maybe a thousand plus fishes in the new ROW construction. I would suggest a fish survey of this 550' waterbody/wetland crossing. These fish were observed during the benthic sampling with Faith Zerbe on 5-26-12. I used a section of a paper towel roll for reference.
Bottom photo note the clarity and flow of the stream this was during an extended heat wave and dry weather.



Top photo green frog “hanging out”
Bottom photo look center(round rock) and left center you can make out little fishes (use zoom)

Joe Zenes Report 022 Tennessee Gas Pipeline Montague/Sussex County NJ October 1, 2012

September 30, 2012, I gained access to TGP in Montague NJ from Mountain Road (L4 AR 30.01) for a field survey and pre-construction documentation of TGP's NEUP. There are no coordinates in appendixes D or E of the Environmental Assessment (EA) for this section of pipeline which travels through New Jersey from the Delaware River (mp 6.4) across High Point State Park to the end of the 323 loop (16.3). My field survey which focused on mp 7.9 to mp 8.2 on appendix A maps (EA) which has ten (10) waterbodies listed in appendix D and eight (8) wetlands in appendix E. I identified and marked fifteen (15) waterbodies with my GPS unit. Appendix D lists ten (10) waterbodies with no identification numbers except for approximate mile post numbers. I was able to identify seven (7) wetland areas, one (1) not on appendix E and did not locate two (2) from the list.

*Waterbodies from 9/30/12 field survey listed randomly.

Appendix D	Field Survey 9/30/12	Appendix E	Field Survey 9/30/12
7.9 UNT to UN Backwater DR	S105	7.9 L4 W110	L4 W110
7.9 UNT to UN Backwater DR	S106	8.0 L4 W111	L4 W111
8.0 UNT to UN Backwater DR	S107B	8.0 L4 W114	L4 W114
8.0 UNT to UN Backwater DR	S108A	8.0 L4 W115	L4 W115
8.0 UNT to UN Backwater DR	S108	8.0 L4 W117	L4 W117 Didn't find
8.1 UNT to UN Backwater DR	S108B	8.1 L4 W118	L4 W118
8.1 UNT to UN Backwater DR	S110	8.1 L4 W112	L4 W112
8.1 UNT to UN Backwater DR	S111A107 C	8.2 L4 W119	L4 W119 Didn't find
8.1 UNT to UN Backwater DR	S11A	L4 W113 Missing	L4 W113
8.2 UNT to UN Backwater DR	S111E		
	S111F		
	S111D		
	S108 B		
	S111C		
	S111B		
	S107C		

All the waterbodies and wetlands listed from the field survey are all located at the bottom of the mountain on a flat area approximately 100' wide. The waterbodies are primarily springs bubbling up from the ground at the bottom of the mountain and the wetlands are scattered about over the 0.3 miles (mp 7.9 to 8.2). The pipeline (white flags) looks like it will be along the base of the mountain in this stretch with most workspace in the flat area to the west of the pipeline and will cut across all these waterbodies and wetlands with as little as 10'-20' separating many of these features.

Photo (100_1762) shows spring well house within permanent easement.

Photo (100_1782) shows large mature tree in Temporary Workspace.

Photo (100_1819) shows waterbody in Temporary Workspace

Note corners of TWS in photos.

Joe Zenes Report 036 Tennessee Gas Pipeline NEUP (Pa) February 10, 2013

Field Visit 1-30-13

During my pre-construction monitoring and photo documentation of the NEUP I have the following comments from observations and research of the documents.

Table A-Waterbody crossings associated with NEUP Loops 321 and 323 (Pike Co) Pa Bulletin Chapter 93 Water Quality Designation/Fishery Classification

Timing restrictions differ between loop 321 and 323

HQ-CWF/Class A Wild Trout Oct. 1-Apr. 1 loop 321

HQ-CWF/MF/Wild Trout Oct. 1-Dec. 31 loop 323

EV MF/Wild Trout Oct. 1 Dec. 31 loop 323

Note-I believe wild trout in part is what makes a Class A Stream…but the HQ streams in loop 321 have stricter restrictions than the EV and HQ streams with wild trout in loop 323.

Field visit 1-30-13 Access road AR10 had been recently flagged from Schocopee Road to MP 0.0 Note same access road used during 300 line construction ID was changed from AR 10 –AR 9A and gravel road was extended across pipeline after construction of 300 Line went into service.

Existing pipeline marked with small yellow flags but also has a Temporary Work Space (TWS) stake in the center of existing pipeline every 100' with some intermittent stakes eastward for approximately 5100' where workspace, wetland, stream flagging and delineations and ID's stopped. So TWS starts on top of the existing pipeline in the center of the existing ROW. Note- existing pipeline is recognized by a noticeable hump the majority of the existing pipeline across the River and along the NJ existing ROW. Note a citizen off of Foster Hill said the pipeline that's just a few feet from his barn is less than a foot under the surface.

L4 W035-was part of Wetland Delineation Report (WDR) March 2011 but was omitted from Notices Pa Bulletin (NPAB) Note my field observations identified L4-W035 with it extending into existing permanent easement which is marked by stakes with white/yellow flagging.

L4 W036-crossing length 504' (NPAB) observations in field have wetland ID signs L4 W036 at mp 0.17 and mp 0.35 or 0.18 miles which equals 950.40' this was confirmed with alignment sheets (PDF 20120808-5072 (274769000)) page 20/45 and notes provided. "9+47 entered wetland L4-W036" "18+51 exited wetland L4-W036" this information was included on stakes identifying TWS down the center of existing 24" pipeline Note the first number represents 100' increments from the start of the NEUP so 9+00 to18+00 would be 900 ft

8+41 P.I. < 10°15'21" RT.

→ 9+47 ENTER WETLAND L4 W036

10+52 TOP OF BANK
10+69 CL PINCHOT BROOK, (L4 S010) & PROPERTY LINE

11+11 TOP OF BANK

14+43 P.I. < 6°27'04" RT.

14+86 P.I. < 9°23'30" RT.
15+10 PIPELINE MARKER 26' LT.

17+81 CL TRIBUTARY TO PINCHOT BROOK, (L4 S011) & PROPERTY LINE
17+92 CL TRIBUTARY TO PINCHOT BROOK, (L4 S011) & PROPERTY LINE

18+32 CL TRIBUTARY TO PINCHOT BROOK, (L4 S011) & PROPERTY LINE
→ 18+51 EXIT WETLAND L4 W036

Permanent Existing Easement is 100' at the start of the NEUP (mp 0.0) with flagging off the cleared existing ROW and back into the trees on both sides but at TWS stake TWS 25+00 the Permanent Existing Easement shrinks to 50' or about the width of the cleared existing ROW. I believe the 100' Permanent Existing Easement was used for clearing on the 300 line also. Possibly this is allowing more trees to be cut with larger ROW since they are taking 25' of existing ROW which in some cases the EPE is located in the forested area outside the cleared area.

Areas approaching S010 (Pinchot Brook) and east of S011 (UNT Pinchot Brook) <u>before</u> the Existing Permanent Easement (EPE) is adjusted from 100' to 50' measurements from EPE to ATWS range up to 200' Field measurements 1/30/13- south-north across ROW on DCNR lands (Delaware State Forests)
100' to EPE + 53' to center of pipeline + 50' to northern EPE 200' photo shows tape stretched out 200' from southern most flagging for TWS to the northern extent of EPE (white and yellow flagging) 25' of EPE is in forested area but still 175' from northern edge of cleared ROW to back line of TWS.

DRN/1-30-13 Survey Pinchot 100_3082

Flagging stops before Dimmick Meadow and 2 UNT tributaries of Dimmick Meadow, this is confirmed in TGP's 1/28/13 through 2/3/13 Weekly Status Report "Environmental signage has been installed from mp 0.0 to 1.00 to mp1.50 to2.93" but skips over Dimmick Meadow and its 2 tributaries. The wetland delineation report of March 2011 identified 2 tributaries S013 and S013A but S013A got eliminated in NPAB. I observed 2 distinct stream channels during my field visit 1/30/13. There was no environmental signage or clear delineations of stream(s) or wetlands. The alignment sheets indicate that W038 is entered 63+70 and exits at 66+69 or just short of 300'. NPAB has a crossing width of 210'. The alignment sheets show 2 distinct channels as well as Google Earth Image within the complex but only S013 noticed and referred to as East Branch of Dimmick Meadow.
Notes from the top of alignment sheet (PDF 20120808-5072 (274769000)) page 21/45 for East Branch Dimmick Meadow S013/W038

63+70 ENTER WETLAND L4 W038

65+31 TOP OF BANK
65+36 CL EAST BRANCH OF DIMMICK MEADOW BROOK (L4 S013), PROPERTY LINE
65+43 TOP OF BANK
66+69 EXIT WETLAND L4 W038

55+04 ENTER WETLAND L4 W037
55+67 TOP OF BANK
55+71 EDGE OF WATER
55+77 CL DIMMICK MEADOW BROOK (L4 S012) PROPERTY LINE
55+83 EDGE OF WATER
55+86 TOP OF BANK
56+29 EXIT WETLAND L4 W037

Similar disagreements with S012/W037 "Enter W037 at 55+04 and Exit W037 at 56+29" which is equivalent to 125' NPAB has a crossing length of 72' or a difference of 53'.

Joe Zenes Report 037 Tennessee Gas Pipeline NEUP (NJ) February 11, 2013

Field Visit 2/08/13 Mt. Road AR 30.01

I visited the Montague section of the TGP NEUP using Mountain Road (AR 30.01) and accessed the proposed ROW approximately at mp 7.8 using Mr. Merusi's property as access. I walked to approximately mp 8.2. The TGP weekly report on the NEUP dated 1/28/13 to 2/3/13 stated that environmental signage was installed from mp 7.81-8.11. The table on right is the notes at the top of the alignment sheet page 28/45 for this section. These notes determine where to install resource signage.

At Mr. Merusi's spring house was a Blue Waterbody Sign but no ID number on it. During my survey and mapping in Sept. I identified this as S0105

416+29 ENTER WETLAND L4 W110

416+41 CL SPRING L4 S105
416+44 CL SPRING

416+94 EXIT WETLAND L4 W110

417+66 CL STREAM L4 S106

419+64 ENTER WETLAND L4 W111

420+53 EXIT WETLAND L4 W111

422+54 CL STREAM L4 S107B

422+80 ENTER WETLAND L4 W114
423+01 EXIT WETLAND L4 W114
423+27 ENTER WETLAND L4 W115
423+88 CL STREAM L4 S108A
424+43 ENTER WETLAND L4 W117
424+58 EXIT WETLAND L4 W115
424+69 CL STREAM L4 S108
424+70 EXIT WETLAND L4 W117

425+36 PROPERTY LINE
425+80 ENTER WETLAND L4 W118
426+07 CL CREEK

426+20 CL STREAM L4 S018B

426+42 PROPERTY LINE
426+73 CL STREAM L4 S110
426+77 PROPERTY LINE

427+55 CL STREAM L4 S111A
427+98 CL STREAM L4 S111A

428+36 EXIT WETLAND L4 W118
428+53 ENTER WETLAND L4 W118
428+96 PROPERTY LINE

429+10 CL CREEK
429+31 EXIT WETLAND L4 W118
429+70 ENTER WETLAND L4 W118
429+82 EXIT WETLAND L4 W118
430+48 CL STREAM L4 S111E
430+55 ENTER WETLAND L4 W118

431+24 EXIT WETLAND L4 W118

431+58 P.I. < 28°26'07" LT.
ENTER WETLAND L4 W119
431+66 CL TRAIL (DIRT)
432+08 EXIT WETLAND L4 W119

ID Signage I observed 2/08/13	Signage locations on alignment sheets
W110	W110
W114	W114
W115	W115
W117	W117
Missing	W118 (4)
Missing	W119
No ID (S105)	Missing (sign no ID)
S106	S106
S107A	Missing
S107B	S107B
S108	S108
S018B (Incorrect)	S018B
S110	S110
Missing	S108A
Missing	S111A (2)
Missing	S111E

On September 30, 2012 since there were no coordinates or identification numbers for this new ROW just MP numbers (mp 7.9-8.1) Appendix "D" had 9 Waterbodies and "E" had 7 Wetlands in that 0.3 miles. I marked locations using the surveyor's flags marking the numerous streams and wetlands in this 0.3 miles of new ROW. I identified 16 stream crossings and 7 wetlands. The 2 with (?) were labeled "L" but may been "C" The earlier delineation flagging still in place indicated ID S018B as S108B which I confirmed during the field visit.

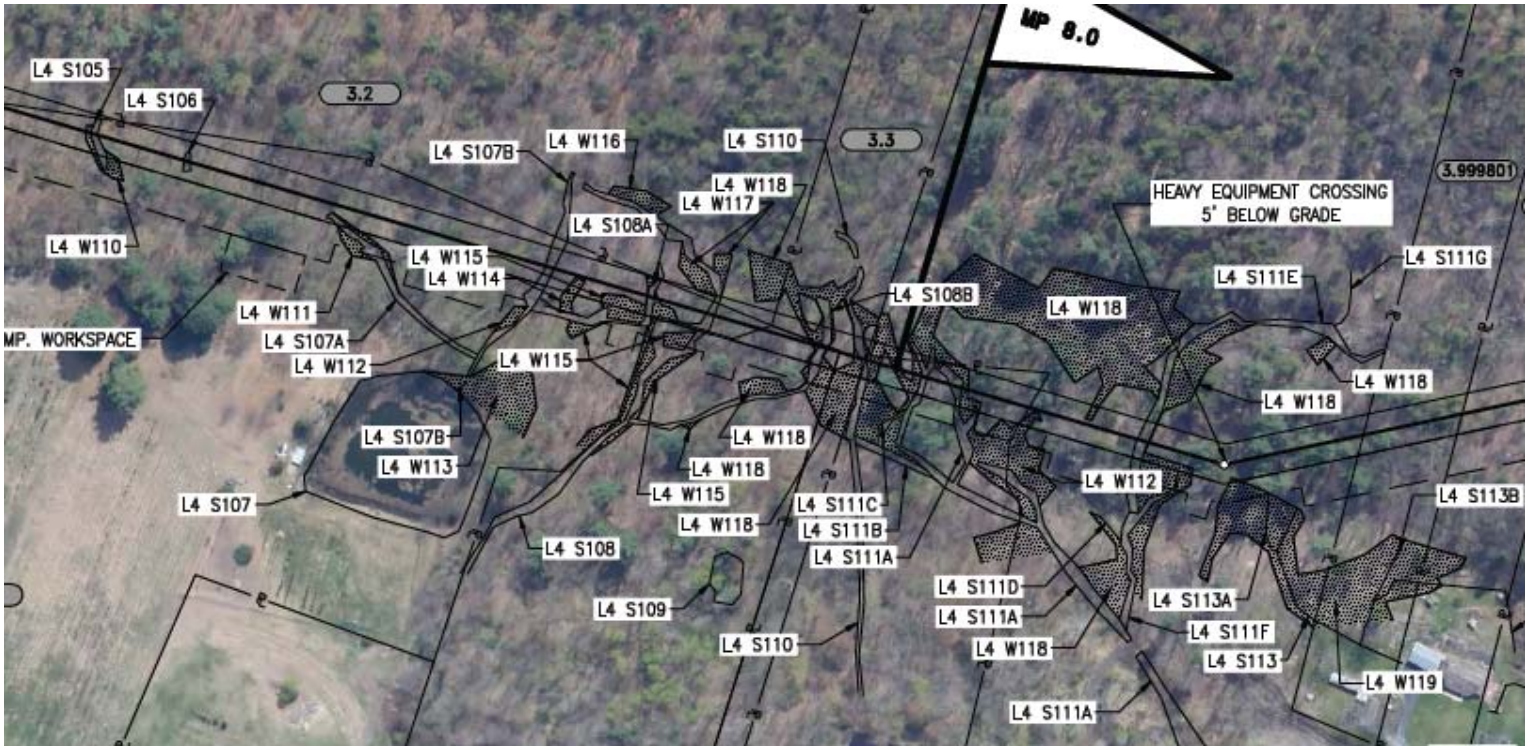
Resources I mapped from 9/30/12 field visit using flagging along proposed ROW

S105	S106	S107	S107A	S107B
S107(?)	S108	S108A	S108B	S110
S111A	S111B	S111(?)	S111D	S111E
S111F	W110	W111	W112	W113
W114	W115	W118		

Here's a partial copy of the alignment sheet for the Montague section off of Mountain Road. I walked to where I could see the turn in the ROW (Heavy equipment crossing 5' below grade) Note how complex this section is. I observed and photographed 4 wetland signs and 7 Waterbody signs (one w/no ID at spring house but believe its S105 (Sensitive Resource signage in place) Where there were Wetland Boundary signs there were no delineation flagging and hard to tell where most started or ended or how wide the crossing actually is. The permanent easements were also poorly marked.

The total footage from alignment sheet from S105 to W119 416+21 to 432+08=1587' add up the wetland footage from 7 wetlands W118 crossed 4 times)=785' or just shy of 50% of total length are wetland crossings plus from the alignment sheet there are 9 stream crossing with 11A being crossed 2 times. My observations are; this section is just about all wetlands from bottom of hillside to the TWS for 0.3 miles and alignment sheets confirm at least half the distance is wetlands plus numerous streams.

FYI- I can count 8 different L4 W118's on alignment sheet but failed to observe any resource signs during my field visit on 2/08/13. The alignment sheet had 4 W118's listed.
The approved access road AR 30.01 was installed but on the end where it meets the pipeline and not at the intersection of Mountain Road and River Road…the coordinates are given at the end where it meets the pipeline. I would hope these Environmental Inspectors would have the common sense to place it at the turnoff of River Road and not where it meets the pipeline. Guess not?



Top left alignment sheets (PDF 20120808-5072 (274769000)) page 28/45 Top right-the TWS will come within few feet of homes of Geo & Ruth Feighner and Emil & Mary Merusi. TWS stake in front of trees from the Merusi home (top right) which is hidden under the canopy of trees on the alignment sheets and just a few feet from Feighner's barn bottom photos. The alignment sheet shows a 50' TWS then a 50' permanent easement and then 2-50' ATWS for a total of 150' of tree clearing up on the steep slope behind the two homes. Note the steepness in photo 100_3293 which will be leveled for "Temporary Work Space" and "Additional TWS".

DRN/2-8-13 survey Mt Road 100_3228

DRN/2-8-13 survey Mt Road 100_3226

DRN/2-8-13 survey Mt Road 100_3293

Joe Zenes Report 037-2 Tennessee Gas Pipeline NEUP (NJ) February 12, 2013

Field Visit 2/08/13 Mt. Road AR 30.01

This was where resource signage was installed back to back "Exit W117" and Waterbody no ID on sign but is a small water fall over solid rock where the center of the pipeline will be installed (bottom photos with white flagging) so 25' on both sides will take it to the top to where the big rock sets (permanent easement white/yellow flag on tree) disrupting the natural flow of this stream. Note wetland sign on slope 100_3269

DRN/2-8-13 Survey Mt. Road 100_3266

DRN/2-8-13 Survey Mt. Road 100_3267

DRN/2-8-13 Survey Mt. Road 100_3269

DRN/2-8-13 Survey Mt. Road 100_3268

Field Visit 2/08/13 Mt. Road AR 30.01

Note top left photo Beech tree with white flagging is center of pipeline and 4 smaller streams come together to form one right in the middle of the permanent easement also there's a TWS at the point of confluence. Top right is a TWS stake at the location of an unmarked spring. Bottom photos are where signage stops. Note how this area has numerous springs forming small streams which are direct tributaries of the Delaware River.

DRN/2-8-13 Survey Mt. Road 100_3284

DRN/2-8-13 Survey Mt. Road 100_3259

DRN/2-8-13 Survey Mt. Road 100_3278

DRN/2-8-13 Survey Mt. Road 100_3279

Note active spring house with Sensitive Resource signage that will be in the permanent easement just uphill from the center of pipeline. Waterbody signage with no ID number installed on center line of pipeline. Wetland stakes in place without proper resource signage, stakes are marked 417+62 alignment sheets do not indicate entering or exiting a wetland at that marker. Bottom right note Wetland Boundary signage leaning against a rock up on hillside, no delineation flagging with signage

DRN/2-8-13 Survey Mt Road 100_3237

DRN/2-8-13 Survey Mt Road 100_3242

DRN/2-8-13 Survey Mt Road 100_3244

DRN/2-8-13 Survey Mt Road 100_3258

88+11 MLV 324-2A

88+42 ENTER WETLAND L4 W040
89+02 PIPELINE MARKER 25' LT.
89+05 VALVE FENCE CORNER (CHAINLINK) 10' LT, BEGIN PARALLEL
89+10 FENCE GATE
89+58 PROPERTY LINE
89+75 VALVE FENCE CORNER (CHAINLINK) 10' LT., END PARALLEL
90+64 P.I. < 0°05'38" RT.

93+70 P.I. < 2°37'02" LT., LEACH FIELD 86' RT.
93+79 EXIT WETLAND L4 W040
94+00 CORNER OF HOUSE 81' RT.
94+77 EDGE OF DRIVEWAY (GRAVEL) 49' RT.
94+99 GUY ANCHOR 67' RT.
95+07 POWER POLE 64' RT.
95+14 ENTER WETLAND L4 W041
95+73 PIPELINE MARKER 26' LT.
95+78 PIPELINE MARKER & COLUMBIA GAS PIPELINE 26' LT.
95+80 PIPELINE MARKER 54' LT.
96+00 EDGE OF DRIVEWAY (GRAVEL), BEGIN DRIVEWAY ON LINE)
96+09 CL DRAIN (BEGIN PARALLEL) 6' LT.
96+24 P.I. < 6°18'11" LT.
96+40 P.I. < 7°42'47" LT.
96+52 EXIT WETLAND L4 W041
96+56 P.I. < 1°02'57" LT.
97+05 P.I. < 4°05'03" LT.
97+53 END OF 12" CULVERT 9' LT.
97+86 SHED 60' LT.

The Pa. Bulletin Vol. 42, NO.49, December 8, 2012 Wetland Crossing # 35 L4 W041 has a crossing length of 22'. Photos 100_3328/100_3329 shows Wetland W041 spans across the cleared ROW of Columbia Gas Pipeline where it intersects the Tennessee Gas Pipeline NEUP. The alignment sheet for this section has wetland boundary signs located at 95+14 Enter Wetland L4 W041 and 96+52 Exit Wetland L4 W041 (photo 100_3324) The distance on the alignment sheet using figures and diagram provided has the crossing of 138' considerable more than the 22' listed on page 7481 of the Pa Bulletin. Note photos are of W041, no photos of W040 no access.
L4 W40 (#34) to the west has a crossing length of 380' listed in the Pa Bulletin, the alignment sheet Enters Wetland L4 W40 at 88+42 and Exits L4 W040 at 93+79 or 537' these figures listed on the alignment sheet are for placement of resource signage that's been installed by Environmental Inspectors as of TGP's Weekly Report 1/28 2/3/13.

The crossing length for L4 W041 Pa. Bulletin is 22' Alignment Sheet 138'
The crossing length for L4 W040 Pa. Bulletin is 380' Alignment Sheet 537'

DRN/Firetower Road Survey 100_3324 Looking West TGP

Alignment Sheet Appendix C Page 21/45
CP11-161 20120808-5072 (27476900)

DRN/Firetower Road Survey 100_3328 Northwest view

DRN/Firetower Road Survey 100_3329 North view

Joe Zenes Report 039 Tennessee Gas Pipeline NEUP (NJ) February 22, 2013

Field Visit 2/17/13 Mt. Road AR 30.01

Re-TGP weekly report on re-installed signage.

This information was sent to DRN staff in email 2/22/13 10:21 am.
Many of the resource signage is marked with mile posts (MP). The alignment sheets (Appendix C) use foot markers i.e. 00+00 is the start of the NEUP a mile 5,280 feet would be 52+80. MP's are not identified in the field and can be much more inaccurate then foot markers
Map Appendix A shows the pipeline travels in a southwest direction in the mp 7.9-8.2 section in Montague NJ.
Table 1 on right is extracted from Appendix C alignment sheet 20120808-5072(27476900)

416+29 ENTER WETLAND L4 W110

416+41 CL SPRING L4 S105
416+44 CL SPRING

416+94 EXIT WETLAND L4 W110

417+66 CL STREAM L4 S106

419+64 ENTER WETLAND L4 W111

420+53 EXIT WETLAND L4 W111

422+54 CL STREAM L4 S107B

422+80 ENTER WETLAND L4 W114
423+01 EXIT WETLAND L4 W114
423+27 ENTER WETLAND L4 W115
423+88 CL STREAM L4 S108A
424+43 ENTER WETLAND L4 W117
424+58 EXIT WETLAND L4 W115
424+69 CL STREAM L4 S108
424+70 EXIT WETLAND L4 W117

425+36 PROPERTY LINE
425+80 ENTER WETLAND L4 W118
426+07 CL CREEK

426+20 CL STREAM L4 S018B
426+42 PROPERTY LINE
426+73 CL STREAM L4 S110
426+77 PROPERTY LINE

427+55 CL STREAM L4 S111A
427+98 CL STREAM L4 S111A

428+36 EXIT WETLAND L4 W118
428+53 ENTER WETLAND L4 W118
428+96 PROPERTY LINE
429+10 CL CREEK
429+31 EXIT WETLAND L4 W118
429+70 ENTER WETLAND L4 W118
429+82 EXIT WETLAND L4 W118
430+48 CL STREAM L4 S111E
430+55 ENTER WETLAND L4 W118

431+24 EXIT WETLAND L4 W118

431+58 P.I. < 28°26'07" LT.
ENTER WETLAND L4 W119
431+66 CL TRAIL (DIRT)
432+08 EXIT WETLAND L4 W119

TGP's weekly report February 21, 2013 responding to February 13, 2013 DRN letter states; the direction of view in TGP photo #1 was north my observations would indicate a southwest view looking into the sun with mountain on left side. In the description view of stream S108B, photo shows two streams with signage but lacking signage on the other side of the second stream in background.

TGP Photo #2 has a view more south than west (mountain on left) shadows indicate before noon. View of wetland W110 and stream S105, I ***don't*** see a Waterbody sign marking S105. Alignment sheets enter W110 at 416+29 and exit W110 at 416+94 or 65' long, however alignment sheet also has an unidentified spring at 416+44 and S105 at 416+41 or in between the wetland signage (see Table 1) photo shows one wetland sign and a waterbody sign (blue sign in the back ground) facing towards the stream; my point is no waterbody signage for the stream from the angle of TGP photo and should have a S0105 sign 12' (W110 416+29 S105 416+41) in front of the W110 and the S105 would be across the stream if they used the foot markers to install the resource signage.

Note S105 flows from Mr. Merusi's spring house that has a yellow Sensitive Resource sign posted at it. DRN/2-17-13 100_3484

TGP Photo #3 S113A is not listed in the notes on alignment sheet for a resource signage. 8.18 miles equals 43190 feet or 431+90 Table 1 does not have S113A listed at 431+90.

TGP Photo #4 No foot markers on signage just MP 8.03 marker. Mile posts are not used in the field for installing resource signage the alignment sheets use foot markers are on stakes marking every hundred feet at the TWS so every hundred feet is a "TWS 00.00 TWS 01+00 TWS 02+00" stake that is what is use in the field 8.03 = 42398' or 423+98 alignment sheet has S108A listed at 423+88 10' feet can mean a lot over the course of miles of construction workspace that is limited to 75' at resource locations.

TGP Photo 5-this sign is correct enter wetland W118 at 425+80 but alignment sheet has 3 other W118's that are listed as the alignment map 20120808-5072(27476900) shows 8 different W118's in this 0.3 miles (mp 7.9-8.1).
Photo 6- I documented several different streams identified as S111A in the field alignment sheet has two listed.

Signage issues from field observations 2/17/13 after re-installment of resource signage by TGP.
Folder DRN/2-17-13 Signage Montague

100_3420-3421 Mud with rutting on access to pipeline 412+60 (Sediment issue at access road AR 30.01)
100_3422 Stake identifying placement for Wetland Sign 416+44 Alignment sheet has unidentified spring at that location back of Wetland Boundary sign installed right next to it.
100_3423 Stake for Wetland sign 417+62 Alignment sheet has no resource at that location
100_3424 Waterbody sign S0107A with no location markers
100_3425 The other S107A with no location markers
100_3428 Pink flagging laying on the ground (initial survey marker) "L4 W111 start" my field observations from 2-8-13 or 2-17-13 did not find signage installed for W111 (Enter at 419+64 Exit 420+53)
100_3429 Initial survey tape removed and discarded on ground, no way to double check signage with survey markers and Resource signage in the field
100_3431 Wetland Boundary signage W114 422+80 mp 8.01
100_3432 Wetland Boundary signage W114 423+01 mp 8.01
Note foot markers indicate 21' crossing with the same mp marker of 8.01 foot markers are what are used in the field for installing signage mile posts are approximate and used for larger scale mapping
100_3433 Wetland Boundary signage W115 423+27 mp 8.02 (enter on alignment sheet)
100_3435 Wetland Boundary signage Enter W117 424+43 mp 8.04
100_3436 Wetland Boundary signage Exit W115 424+58 mp 8.02
100_3437 Wetland Boundary signage Exit W117 424+70 no mp marker (signage is installed on same stake as a Waterbody sign facing intoW117)
Enter W115 at 423+27 mp 8.02 Exit W115 424+58 mp 8.02 foot markers indicate 116' and mps are the same mp 8.02.
Enter W117 424+43 mp 8.04 (in between Wetland Boundary foot markers for W115)
Exit W117 424+70 Note-mp for W117 is 8.04 (0.01 equals 52') Enter and Exit W115 at mp 8.02
100_3440 Number of Waterbody signage scattered through this area
100_3441 Wetland Boundary signage W118 425+80 mp 8.06 (alignment sheet Exit W118 428+36 or ***256'***) Exit W118 was not observed in field on 2-17-13
100_3442 Waterbody signage S108B mp 8.07 no foot markers on signage
100_3443 Permanent Easement stake 426+00 (used for my reference point in field)
100_3444 Waterbody signage S108B mp 8.07 different sign no foot markers
100_3446 Waterbody signage S110 426+63 mp 8.08 Alignment sheet has installation point at 426+73
10' difference can mean a lot with tree clearing
100_3449 Waterbody signage S111A mp 8.10 no foot markers on signage
100_3450 Unidentified spring with no resource signage
100_3452-3453 Initial survey flagging for W118 on the ground with no Resource signage installed at location
100_3454 Location of initial survey flagging (pink flagging from previous photos 100_3452-3453
100_3455 Stream no Resource signage
100_3456 Initial survey flagging on the ground for S111A
100_3458 Waterbody signage S111A mp 8.10 no foot markers
100_3459 Waterbody signage S111A mp 8.11 427+98
100_3460 Waterbody signage S111A no mp or foot markers on signage
100_3461 Waterbody signage S111A no mp or foot markers on signage
100_3462 Waterbody signage S111A no mp or foot markers on signage (different than others has snow by it)
100_3463 Two streams without Resource signage
100_3464 Stream with no Resource signage
100_3465 Stream with no Resource signage
100_3466 Stream with no Resource signage
100_3467 Waterbody signage S112 no mp or foot markers ***not listed in Table 1 or on alignment sheet map***

Signage issues from field observations 2/17/13 after re-installment of resource signage by TGP.

Folder DRN/2-17-13 Signage Montague

100_3469 Wetland Boundary signage Exit W118 429+82 mp 8.14

100_3470 Wetland Boundary signage Enter W118 429+70 mp 8.14

W118 was listed on alignment sheet 4 times for Resource signage (see descriptions of photos 100_3441 and 100_3452-100_3454) I only observed 3 Resource signs one entering at 425+80 with no Exit signage observed, plus the one listed above with an Enter and Exit. I also observed initial survey flagging on the ground with no Resource signage installed. Note Resource signage usually installed on center line and does not accurately reflect the erratic nature of wetlands in the field. The W118 on the alignment sheet shows a much larger wetland in that location than the 12' at the center line.

100_3472 Waterbody signage S111E 430+48 mp 8.15 Alignment sheet does not show S111 only 7 tributaries (W111A-G) S111E appears to be way upstream and separated from the other S111 tributaries.

100_3474 Wetland Boundary signage Enter W118 430+55 mp 8.15 I didn't observe Exit signage for this W118

See comments for 100_3470 this would be an additional W118 with Enter signage but no Exit signage

100_3477 Waterbody signage STA 425++46 No Resource signage listed in Table 1 for this location

100_3478 Waterbody signage S108 no mp or foot markers on signage Note waterfall over solid rock at location

100_3479 Waterbody signage S108 no mp or foot markers on signage

100_3480 Waterbody signage S108 no mp or foot markers on signage

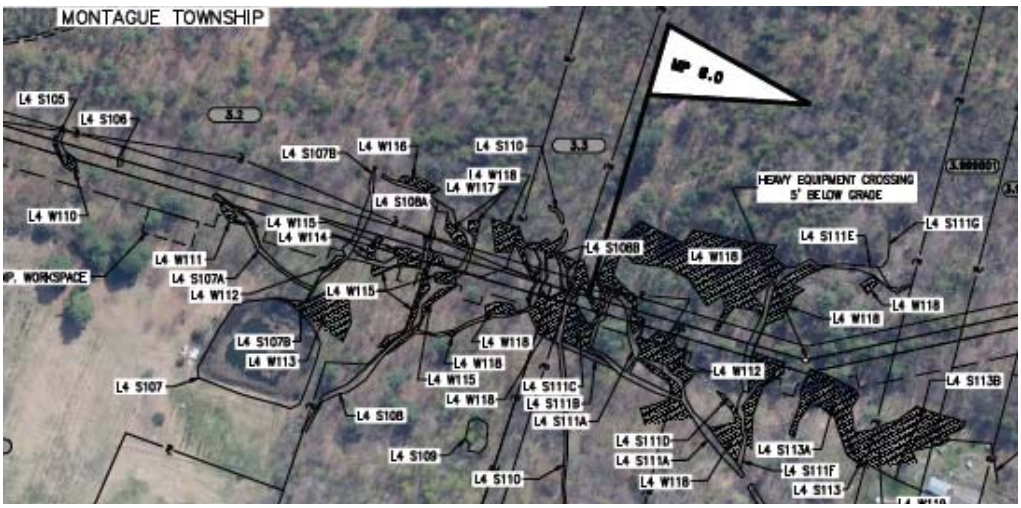
100_3481 Waterbody signage S108 no mp or foot markers on signage (S108 signage in 4 different locations)

100_3483 Permanent Easement flagging (yellow and white) removed and discarded on the ground

100_3484 Active spring house (S105) Sensitive Resource is in the Permanent Easement at mp 7.89

Conclusion: My field visit 2/17/13 reveals severe Resource signage problems from mp 7.89 to mp 8.15 or 0.26 miles which is approximately 1,372 feet. September 30, 2012 I mapped and identified resources in this area using the initial survey flagging in place at that time. My field report 037 2/11/12 that was submitted to FERC and ACOE along with a letter from Delaware Riverkeeper Network 2/12/13 contained a Table: Resources mapped from 9/30/12 field visit. I identified 16 waterbody and 7 wetland crossings in this small section of proposed ROW. Resource signage for many of these resources were not observed on 2/8/13 or on 2/17/13 this after TGP personnel reinstalled and adjusted signage in this area. The signage in place is lacking important information such as "foot markers" which are located on the alignment sheet and used for placement of signage in the field. Some signage has mile posts (mp) but is an approximate marker used on larger maps and is not represented in the field. Resources from my initial mapping are still missing. Signage is duplicated in the field for single resources. Wetlands overlap in the field with other wetlands. No wetland delineations in the field. The permanent easement markers and other initial survey flagging has been removed and discarded on the ground. Resources observed in the field lack resource signage. On 2/20/13 the day before TGP's weekly status report, I was refused access to that area even though I have Emil Merusi's permission to be on his land. 2/17/13 when I took additional photos of signage issues with several TGP personnel on site, I was allowed complete access.

The alignment sheet map shows how complex this area is with many streams, springs and wetlands in these 0.26 miles. Tree cutting has begun in this area with inadequate resource signage. It is extremely important that all these sensitive resources be correctly identified, marked and delineated in the field to assure that these resources are restored to their pre-construction condition as required.



Joe Zenes Report 040 Tennessee Gas Pipeline NEUP (Pa.) March 3, 2013

Field Visits 2/24/13 and 3/2/13 Evergreen Stream

2/24/13 Faith Zerbe is observed measuring from a white surveyor's flag (CL 9/10/12) to center of the stream (22'). Faith and I did a field visit to verify surveyor's flagging was not installed along L4 S059C from my previous field visit 2/19/13. No surveyor flagging or work space staking was observed except white surveyor's flagging marking a center line (CL). I revisited this area on 3/2/13 Temporary Work Space stakes with foot markers were installed approximately every 100' on **both sides** of the now cleared TGP ROW.

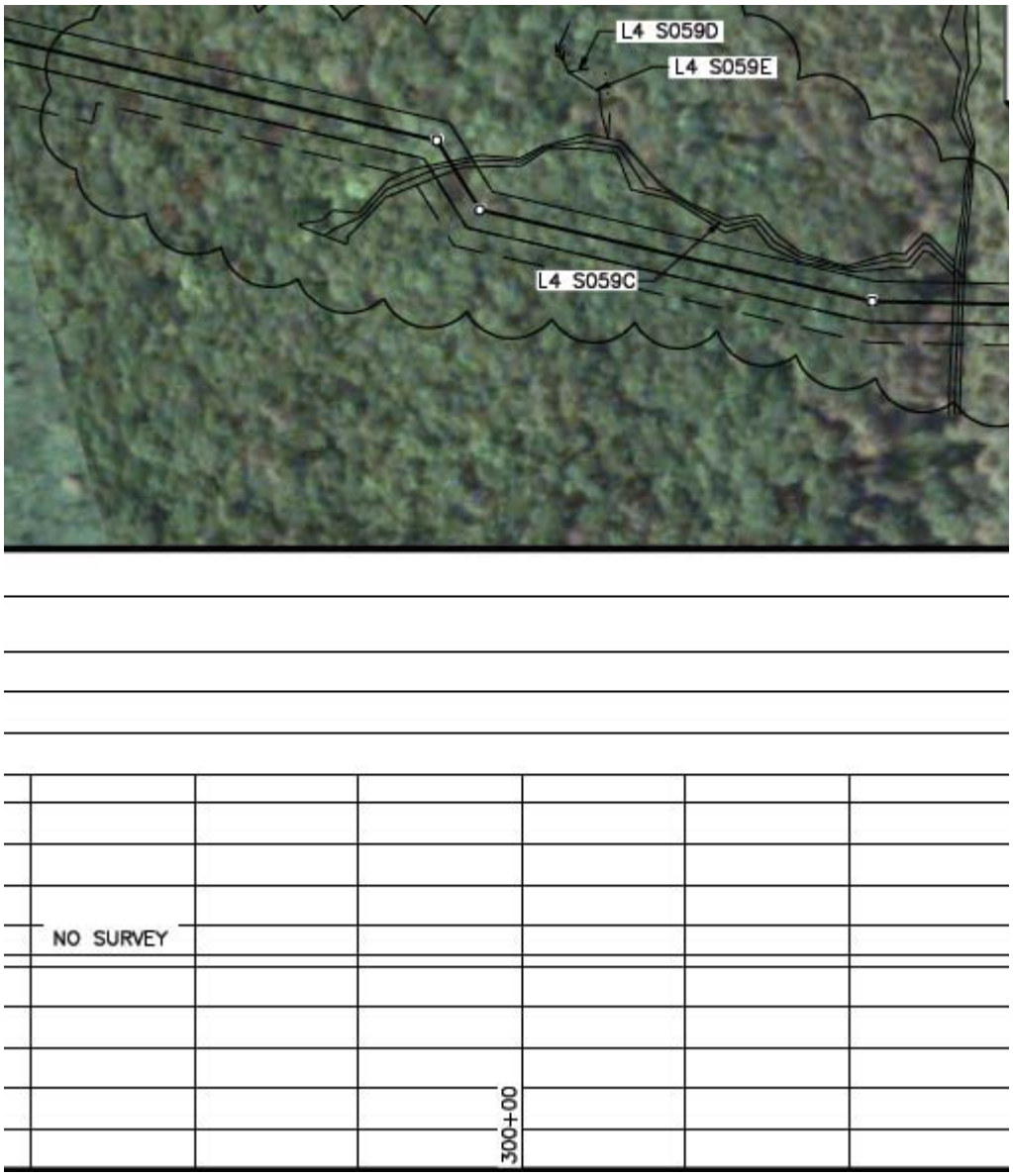
DRN/2-24-13 Evergreen Faith/100_3964
CL of pipeline to center of S059C is 22'

DRN/3-2-13 Evergreen/100_4213
TWS Stake 306+00 in center of stream

DRN/3-2-13 Evergreen/100_4225
TWS Stake 307+00 on opposite ROW from S059C

DRN/3-2-13 Evergreen/100_4216
Trees felled using TWS Stakes on both sides of the ROW

Page 2 a copied section of alignment sheet for this area adjacent to L4 S059C
CP11-161 8/8/12-20120808-5072(27476900) Appendix C Alignment sheets



Joe Zenes Report 041 Tennessee Gas Pipeline NEUP (Pa) March 8, 2013

Field Visit 3/7/13 AR 10 DCNR property

March 7, 2013 I accessed TGP on DCNR property at the point where the 300 line ends and NEUP begins. Tree cutters were just finishing, I heard them say that was the last tree and vehicles were gone when I returned to parking location. Since I have been monitoring resource signage prior to tree cutting this area on DCNR property is the only location where blue blaze marks and pink flagging is used to mark trees not to be removed. This was not observed in any other locations through Pa or NJ that I visited since resource signage was started. As reported in previous reports that surveying and signage installation was almost simultaneously with tree felling activities. With a 5 week delay in the tree felling schedule, the surveying and resource signage personnel had additional time to complete these important tasks for tree felling well ahead of the tree cutters. The following photos of tree felling activities are taken on the 300 Line side of AR 10. Each side of AR10 is now cleared for 250' from tree line to TWS stakes on 300 Line and NEUP at AR10.

DRN Photo 100_4255 Tree with Blue Blaze cut

DRN Photo 100_4254 location of tree on 300 Line side

DRN Photo 100_4256 trees cut off of permanent easement on 300 Line

DRN 100_ 4510 Duchess and trees cut outside the ROW of the 300 Line west of the valves

Joe Zenes Report 041-1 Tennessee Gas Pipeline NEUP (Pa) March 8, 2013

Field Visit 3/7/13 AR 10 DCNR property

March 7, 2013 I accessed TGP on DCNR property at the point where the 300 line ends and NEUP begins. Since I have been monitoring resource signage prior to tree cutting this area on DCNR property is the only location where blue blaze marks and pink flagging was used to mark trees not to be removed. This was not observed in any other locations through Pa or NJ that I visited since resource signage started. As reported in previous reports that surveying and signage installation was almost simultaneously with tree felling activities and was inaccurate and deficient. With a 5 week delay in the tree felling schedule, the surveying and resource signage personnel had ample time to complete these important tasks for tree felling well ahead of the tree cutters. The following photos of tree felling activities are taken on the TGP at AR10. Each side of AR10 is now cleared for 250' from tree line to TWS stakes on both sides of AR10 and TWS extends approximately 450' across AR10 into the 300 Line section. Note ATWS adjacent to both sides of W041 and large area at the end.

Google Earth image 9/12/12 is of where the 300 Line ends (mp 14.9) and the NEUP starts (mp 0.0) at AR10 (grey strip). November 6, 2012 measurements were taken at several locations with help by a volunteer monitor. Wetland W041 boundary markers can be seen as black strips (E&S controls) measurements taken tree line to tree line.

Table Field Measurements 11/6/12

Wetland W041	Westside of AR10	Eastside of AR10
Westside boundary 146'	Middle of hill at waterbar 200'	East of AR 10 200'
Across W041 103'	Top of hill at waterbar 200'	End of cleared ROW 235'
Eastside boundary 140'	West of AR10 200'	Existing ROW 45'

Report 041-1 Field Visit 3/7/13 AR 10 DCNR Property

Measurements are approximate taken with a 200 foot tape with exact locations of tree line varying. During the construction phase of Loop 323/300 Line tree clearing extended approximately 300' past the end of permitted length (mp 14.9) across AR 10 into the NEUP section which was not approved at that time. The Google Earth image shows the large area (200' by 300') east of AR 10 cleared as of 9/12/12.

TGP Environmental Construction Plans call for a workspace reduction of 75' at wetland boundaries; however measurements taken in the field on 11/6/12 had measurements of 146' and 140' at E&S controls still in place marking wetland boundaries at W041 and 103' across the center. Note the reason for E&S controls still in place as of 3/7/13 on Loop 323/300 Line is it is still in "Temporary Condition" associated with construction 15 months after the pipeline went into operation November 2011.

Tree felling was just finishing on this section on 3/7/13. Temporary Work Space (TWS) for the NEUP extended past AR 10 to the west to the first waterbar with additional trees being cut outside of the permanent easement of the 300 Line. The eastside of AR 10 also had additional trees cut 50' into the forest creating distances of 250' on both sides of AR 10. So the 300 Line encroached into the NEUP with clearing and now the NEUP is encroaching into the 300 Line felling trees outside the permanent easement for TWS beyond the current 200' width before the recent tree felling. TGP Environmental Construction Plan states upland areas will typically consist of 100' wide corridor which will be 50' of permanent ROW and 50' of TWS and construction ROW in Wetland and Waterbody areas will be 75' wide (ECP 2.0 Site Description).

My field observations and measurements indicate the Row as it currently exists is much larger at W041 and AR 10 then the permitted width in the ECP 2.0 Site descriptions. With plenty of workspace already cleared TGP encroached on the 300 Line and felled another 50' x 150' of trees for TWS outside of the Permanent Easement. TGP encroached on the NEUP by approximately 300' x 200' during construction of the 300 Line and cut an additional 50' of trees for TWS for the NEUP project making the total width approximately 250' of workspace.

DRN Photo 100_4501 looking North clearing is approximately 250' from TWS stake across ROW

DRN Photo 100_4520 looking Southeast across AR 10 TWS extends 50' past the 300 Line Permanent Easement

Joe Zenes Report 041-2 Tennessee Gas Pipeline NEUP (Pa) March 9, 2013

Field Visit 3/7/13 AR 10 DCNR property

March 7, 2013 I accessed TGP on DCNR property at the location where the 300 line ends and NEUP begins. Since I have been monitoring resource signage prior to tree cutting this area on DCNR property is the only location where blue blaze marks and pink flagging was used to mark trees not to be removed. This was not observed in any other locations through Pa or NJ that I visited since resource signage started. As reported in previous reports that surveying and signage installation was almost simultaneously with tree felling activities and was inaccurate and deficient.

The first wetland listed for the NEUP is L4 W035 and was identified in the Wetland Delineation Report March 2011 and NJ Individual Freshwater Wetlands Permit October 2011. W035 is listed as "not impacted" in the Wetland Delineation Report and NJ Wetlands Permit. Field observations confirmed the identity of W035 and it is located adjacent just north of the permanent easement. The boundaries of W035 were not clearly marked and difficult to tell how far it extends towards the existing ROW. Since surveying of workspaces has been completed an ATWS is located on the north side of the existing 24" pipeline and just west of where the pipeline enters W036 (9+47). Pre-construction monitoring of this section I have observed and documented a moderate frequent flow down the ROW in the general area of this ATWS and the 2 wetlands W035 and W036. The surface flow enters Pinchot Brook (S010) in a relatively short distance. Directly across from the ATWS are a TWS and an ATWS attached to the TWS. During a field visit 11/6/12 measurements were taken with the help of a volunteer measuring the existing permanent easement first and then from TWS to the back of the ATWS. The distance between the permanent easements was 100' and TWS measured 153' with an additional 25'(178') for the second ATWS at this location in close proximity of W035/W036 with the back edge relativity close to the open marsh of S010 downstream of the ROW.

In the first 900' of the NEUP after tree felling was completed for this section there is a clearing for TWS approximately 250' wide by 450' long encroaching into the 300 Line at AR10 and an area 178' wide and estimated to be more than 100' long of TWS adjacent to W036 and close proximity to S010.

DRN Photo 100_4407 taken from W035 across 178' of ATWS/TWS

DRN Photo 100_4401 taken looking east at 178' of ATWS/TWS adjacent to W036

Joe Zenes Report 041-3 Tennessee Gas Pipeline NEUP (Pa) March 9, 2013

Field Visit 3/7/13 AR 10 DCNR property

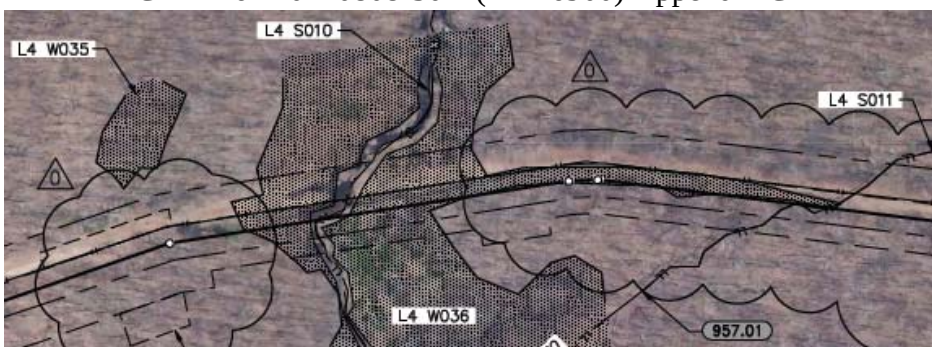
March 7, 2013 I accessed TGP on DCNR property at the location where the 300 line ends and NEUP begins. Since I have been monitoring resource signage prior to tree cutting this area on DCNR property is the only location where blue blaze marks and pink flagging was used to mark trees not to be removed. This was not observed in any other locations through Pa or NJ that I visited since resource signage started. As reported in previous reports that surveying and signage installation was almost simultaneously with tree felling activities and was inaccurate and deficient.

Approaching Pinchot Brook (S010) a No Refueling sign was installed in between W035 and W036. I visited Pinchot Brook several times over the past year and observed and documented surface water flowing down the existing permanent easement into Pinchot Brook from the west. Since resource signage is installed on the center of the pipeline I don't believe the installation of the Wetland Boundary sign for W036 accurately represents the actual wetland boundaries in the field. My observations had surface water and saturated soils closer to the TGP marker (orange and white post) in photo 100_3806 looking east. Note where the snow is melted starting to the right of the No Refueling sign from water that comes to the surface and flows down the existing ROW. Photo 100_3816 was taken looking west from the location of the Wetland Boundary signage for W036. Note the pattern of the snow line; the indent by TGP marker can be seen in the top of photo 100_3816 with moderate flow and green vegetation beyond where Duchess is looking and consistent with melted snow line east to Pinchot Brook.

Photos taken 2/23/13.

CP11-161 20120808-5072(27476900) Appendix C

The shaded area of alignment sheet is W036 that has resource signage at 903' apart. Pa Bulletin has a 505' crossing of W036 by TGP. The greenish area (wetland area) in ROW just left and outside of W036 shaded area would support my conclusion that signage for W036 is not accurately installed or delineated with my field observations.



Joe Zenes Report 041-4 Tennessee Gas Pipeline NEUP (Pa) March 10, 2013

Field Visit 3/7/13 AR 10 DCNR property

March 7, 2013 I accessed TGP on DCNR property at the location where the 300 line ends and NEUP begins. Since I have been monitoring resource signage prior to tree cutting this area on DCNR property is the <u>only</u> location where blue blaze marks and pink flagging was used to mark trees not to be removed. This was not observed in any other locations through Pa or NJ that I visited since resource signage started. As reported in previous reports that surveying and signage installation was almost simultaneously with tree felling activities and was inaccurate and deficient.

Resource signage for Pinchot Brook (S010) had been removed from its previously installed location. The resource signage on 2/23/13 just prior to tree felling activities had signage back to back as were other signage across Pinchot Brook which is associated with W036.A stake with TWS 11+00 remains in the stream at the location. TWS within W036 expanded beyond the 75' construction work area on eastside of Pinchot Brook (see photo 100_4412). TWS stake in the middle Pinchot Brook and associated wetland W036.

DRN Photo 100_3812 pre-tree clearing

DRN Photo 100_3814 TWS 11+00

DRN Photo 100_4412 TWS stake in wetland tree cutting in background beyond the 75'

DRN Photo 100_4415 TWS stake set in stream stake installed on top of the 24" pipeline (yellow flag)

Joe Zenes Report 041-5 Tennessee Gas Pipeline NEUP (Pa) March 10, 2013

Field Visit 3/7/13 AR 10 DCNR property

March 7, 2013 I accessed TGP on DCNR property at the location where the 300 line ends and NEUP begins. Since I have been monitoring resource signage prior to tree cutting this area on DCNR property is the <u>only</u> location where blue blaze marks and pink flagging was used to mark trees not to be removed. This was not observed in any other locations through Pa or NJ that I visited since resource signage started. As reported in previous reports that surveying and signage installation was almost simultaneously with tree felling activities and was inaccurate and deficient.

TWS was taken on the eastside of Pinchot Brook within the wetland boundaries. The additional workspace extends past the 75' work area for wetland and stream crossings. In the first 1100' of the NEUP after tree felling was completed for this section there is a clearing for TWS approximately 250' wide by 450' long encroaching into the 300 Line at AR10 and an area 178' wide and estimated to be more than 100' long of TWS on west side of S010, and on the eastside TWS is approximately 125' by an estimated 100'

DRN Photo 100_4425 additional TWS within boundaries of W036 (903' crossing)

DRN Photo 100_4451 TWS outside the wetland 75' workspace for wetlands and streams

DRN Photo 100_4452 TWS adjacent to wetlands and S010/S011 beyond the 75' workspace

DRN Photo 100_4470 Flagging can be confusing after tree felling especially at resource locations

Joe Zenes Report 041-6 Tennessee Gas Pipeline NEUP (Pa) March 10, 2013

Field Visit 3/7/13 AR 10 DCNR property

March 7, 2013 I accessed TGP on DCNR property at the location where the 300 line ends and NEUP begins. Since I have been monitoring resource signage prior to tree cutting this area on DCNR property is the <u>only</u> location where blue blaze marks and pink flagging was used to mark trees not to be removed. This was not observed in any other locations through Pa or NJ that I visited since resource signage started. As reported in previous reports that surveying and signage installation was almost simultaneously with tree felling activities and was inaccurate and deficient.

DCNR property is the only locations that had blue blazes and flagging on trees not to be cut. The following photos are from the first 0.35 miles of the NEUP.

DRN Photo 100_3819 taken 2-23-13 (eastside of S010)

DRN Photo 100_4420 taken 3-7-13

DRN Photo 100_ 4252 Blue Blaze Mark tree outside permanent easement of 300 Line

DRN Photo 100_4254 tree outside the permanent easement Inspectors vehicle parked on AR10

March 7, 2013 I accessed TGP on DCNR property at the location where the 300 line ends and NEUP begins. Since I have been monitoring resource signage prior to tree cutting this area on DCNR property is the only location where blue blaze marks and pink flagging was used to mark trees not to be removed. This was not observed in any other locations through Pa or NJ that I visited since resource signage started. As reported in previous reports that surveying and signage installation was almost simultaneously with tree felling activities and was inaccurate and deficient.

DCNR property is the only locations that had blue blazes and flagging on trees not to be cut. Photos of corner trees on AR 10 on the 300 Line that were cut for the NEUP as TWS

DRN Photo 100_1964 taken 10-11-12

DRN Photo 100_2144 taken 11-4-12

DRN Photo 100_4504 taken 3-7-13

DRN Photo 100_4253 taken 3-7-13

Joe Zenes Report 041-7 Tennessee Gas Pipeline NEUP (Pa) March 10, 2013

Field Visit 3/7/13 AR 10 DCNR property

March 7, 2013 I accessed TGP on DCNR property at the location where the 300 line ends and NEUP begins. Since I have been monitoring resource signage prior to tree cutting this area on DCNR property is the <u>only</u> location where blue blaze marks and pink flagging was used to mark trees not to be removed. This was not observed in any other locations through Pa or NJ that I visited since resource signage started. As reported in previous reports that surveying and signage installation was almost simultaneously with tree felling activities and was inaccurate and deficient.

DCNR property is the only locations that had blue blazes and flagging on trees not to be cut. The following photos are from the first 0.35 miles of the NEUP.

DRN Photo 100_4452 tree with pink flagging cut in in TWS extending past 75' within wetland boundaries

DRN Photo 100_4462 tree with blue blaze and pink flagging (oak in foreground)

DRN 100_4451 Marked trees cut

DRN Photo 100_4467 blue blaze tree cut

March 7, 2013 I accessed TGP on DCNR property at the location where the 300 line ends and NEUP begins. Since I have been monitoring resource signage prior to tree cutting this area on DCNR property is the only location where blue blaze marks and pink flagging was used to mark trees not to be removed. This was not observed in any other locations through Pa or NJ that I visited since resource signage started. As reported in previous reports that surveying and signage installation was almost simultaneously with tree felling activities and was inaccurate and deficient.

DCNR property is the only locations that had blue blazes and flagging on trees not to be cut. The following photos are marked trees cut from the first 0.35 miles of the NEUP.

DRN Photo 100_4471

DRN Photo 100_4477

DRN Photo 100_4474

DRN Photo 100_4475

March 7, 2013 I accessed TGP on DCNR property at the location where the 300 line ends and NEUP begins. Since I have been monitoring resource signage prior to tree cutting this area on DCNR property is the only location where blue blaze marks and pink flagging was used to mark trees not to be removed. This was not observed in any other locations through Pa or NJ that I visited since resource signage started. As reported in previous reports that surveying and signage installation was almost simultaneously with tree felling activities and was inaccurate and deficient.

The marked trees that were cut are from what I observed surrounding Pinchot Brook and associated wetland W036. No way to be sure how many other marked trees got cut, blue blazes may be buried under trees. If this marked area has this much irresponsible cutting practices, how many perimeter trees have been cut where there has been inadequate resource signage and perimeter flagging documented on the NEUP.

DRN Photo 100_4479

DRN Photo 100_4480 Flagging on cut tree

DRN Photo100_4483 Pink flagging around tree

DRN Photo100_4499 Pink flagging on ground stump out of line with pink flagging marking boundary

Joe Zenes Report 042 Tennessee Gas Pipeline NEUP (Pa) March 11, 2013
S011 Tributary of Pinchot Brook (EV)

Resource signage for S011 does not accurately show its location in the field. S011 flows onto the ROW and then follows ROW to Pinchot Brook. The stream channel appears to be changed by the existing original pipeline now flowing down the ROW.

DRN Photo 100_3075 taken 1-30-13

DRN Photo 100_ 3915 taken 2-23-13

DRN Photo 100_4413 S011 entering S010
Looking east across Pinchot Brook taken 3-7-13

DRN Photo 100_4438 S011 flowing down ROW
Looking west towards Pinchot Brook taken 3-7-13

Joe Zenes Report 050 Laurel Swamp Brook March 14, 2013

Isolated wetlands W044-W045

Photos taken 12-16-12 of workspaces surveyed but before resource signage was installed and wetlands identified but not clearly delineated. Wetlands W044-W045 are listed as Isolated Wetlands "Not crossed by pipeline in workspace only". Field observations and documentation shows these wetlands are associated with Laurel Swamp Brook (S020). Photo 100_2805 has wetland identification flagging (pink/black) hanging in foreground with S020 to the left. DRN volunteer standing next to mature oak tree in photo 100_2816 with wetland flagging hanging in foreground in TWS space. The bottom photos show W044 in ATWS/TWS corner markers can be seen in the background. My observations indicate these two wetlands are connected and are associated with S020 and <u>not isolated</u> as listed in Wetland Delineation Report March 2011.

DRN Photo 100_2805 Eastside of Laurel Brook

DRN Photo 100_2816 W045

DRN Photo 100_2817 W044

DRN Photo 100_2818 W044

Joe Zenes Report 043-3 Tennessee Gas Pipeline NEUP (Pa) March 25, 2013
Workspaces and Wetlands "Not impacted"

March 22, 2013 I accessed Deep Brook (S045) and UNT of Deep Brook (S045A) from Route 84 and followed construction ROW east towards Crawford Branch (S046). W091 is adjacent to W090 the partial notes are from the alignment sheet (20120808-5072 (27476900)) page 23/45 shows that W090 does not extend to the west bank of Deep Brook S045 and does not have S045A listed as a TGP crossing. Field observations has W091 extending to the east to foot marker 194+00 connecting these associated wetlands and waterbodies for approximately 200' to the top of west bank S045 at 192+12. Pa Bulletin 12/8/12 has a combined total crossing width of only 61' permitted for these 4 resources. No field delineations for W090/W091 other than resource signage along the northern edge of ROW.

192+12 TOP OF BANK
192+22 CL DEEP BROOK (L4 S045), PROPERTY LINE
192+31 TOP OF BANK
192+39 ENTER WETLAND L4 W090
192+73 EXIT WETLAND L4 W090

193+18 ENTER WETLAND L4 W091
193+51 EXIT WETLAND L4 W091

DRN Photo100_4758 W091 west boundary

DRN Photo 100_4761 looking west towards W090/S045
Note green/blue signage towards stream stake is 193+00.

DRN Photo100_4765 looking west from east boundary W091

DRN Photo 100_4767 194+00

Table 4.3-2 Wetland Delineation Report March 2011

Resource ID	Mile Post	Comments
W035	Mp 0.16	Not impacted
W040	Mp 1.73	Isolated wetland feature
W041	Mp 1.81	Isolated wetland feature
W044	Mp 2.86	Isolated wetland feature/not crossed by pipeline in workspace only
W045	Mp 2.89	Not crossed by pipeline in workspace only
W092	Mp 3.86	Not impacted
W093	Mp 3.91	Not crossed by pipeline in workspace only
W094	Mp 3.97	Isolated not impacted
W101	Mp 5.11	Not impacted
Isolated WL	Mp 5.70	Isolated wetland mapped by FZ/JZ 8/24/12
S013A	Mp 1.22	Associated with W039 not crossed in workspace only
S014	Mp 1.91	Doesn't cross pipeline in workspace only
S015	Mp 2.04	Adjacent to W042/not impacted
S017	Mp 2.02	Adjacent to W042/not impacted

1) W035 not delineated is adjacent to an ATWS and close proximity to Pinchot Brook Complex
2) W040 is a 380' crossing near Vantine Creek upstream from Milford's water supply
3) W041 intersects CGP and field observations have it longer than the 22' listed and upstream Vantine Creek
4) W044 associated with Laurel Brook (EV) not delineated during tree felling 2/15/13
5) W045 associated with Laurel Brook (EV) not delineated during tree felling 2/15/13
6) W092 associated with Deep Brook (EV) not delineated during tree felling 2/15/13
7) W093 not crossed by pipeline in workspace only (not visited by DRN staff)
8) W094 Isolated not impacted (not visited by DRN staff)
9) W101 Not impacted but associated with W102, S056, S057 and S058 complex of streams and wetlands
10) Isolated wetland mapped by FZ/JZ 8/24/13 No signage or delineated prior to tree felling 2/24/13
11) Tributary of Dimmick Meadow (EV) not crossed in workspace only (2 streams cross pipeline in field)
12) S014 doesn't cross pipeline in workspace only/associated with W042
13) S015 Adjacent to W042 part of the Vantine complex feeds Milford's water supply
14) S017 Adjacent to W042 part of the Vantine complex feeds Milford's water supply
15) ATWS on stream bank of Vandermark Creek (EV)

Table 2.2-8
16) S059C is an UNT of the Delaware River not Cummins Creek
17) S059C crosses pipeline multiply times (stream parallels pipeline with TWS stake in stream)
18) S059 is an UNT of the Delaware River not Cummins Creek
19) Rosetown Creek is not crossed by the pipeline is enters the Delaware River 2 miles north

Table 2.2-8 Waterbodies Associated with the NEUP in Pa. (NJ FFW permit) October 2011

Table 2.2-8
Waterbodies Associated with the Northeast Upgrade Project in Pennsylvania – Loop 323

Waterbody ID	Waterbody Name (where applicable)[a]	Approximate MP[b]	Latitude Longitude	Township / County	Quadrangle	Type[c]	Water Crossing Length[d] (feet)	FERC Class[e]	Ch. 93 Water Quality Designation / Fishery Classification[f]	Timing Restriction[f]	Crossing Method[g]	Comment
L4 S046	Crawford Branch	4.24	41.35111 -74.7889	Westfall / Pike	Milford	I	22	I	HQ-CWF	N/A	II	Field surveyed spring 2011.
L4 S055	Cummins Creek	4.9	41.35378 -74.7662	Westfall / Pike	Milford	P	32	I	HQ-CWF	N/A	II	Due to no-access; portions were digitized and will be field-delineated during Spring 2011 surveys -
L4 S056	UNT Cummins Creek	5.18	41.35453 -74.7609	Westfall / Pike	Milford	I	30	I	HQ-CWF	N/A	II	-
L4 S057	UNT Cummins Creek	5.22	41.35484 -74.7601	Westfall / Pike	Milford	I	5	MI	HQ-CWF	N/A	II	
L4 S058	UNT Cummins Creek	5.25	41.3547 -74.7596	Westfall / Pike	Milford	I	2	MI	HQ-CWF	N/A	II	Associated with W102
L4 S059C	UNT to Cummins Creek	5.72	41.35213 -74.7516	Westfall / Pike	Port Jervis South	I	19	I	HQ-CWF	N/A	II	L4 S059C crosses pipeline multiple times-
L4 S059C	UNT to Cummins Creek	5.74	41.35194 -74.7512	Westfall / Pike	Port Jervis South	I	65	I	HQ-CWF	N/A	II	L4 S059C crosses pipeline multiple times
L4 S059C	UNT to Cummins Creek	5.77	41.35173 -74.7506	Westfall / Pike	Port Jervis South	I	6	MI	HQ-CWF	N/A	II	L4 S059C crosses pipeline multiple times
L4 S059C	UNT to Cummins Creek	5.81	41.35149 -74.75	Westfall / Pike	Port Jervis South	I	17	I	HQ-CWF	N/A	II	L4 S059C crosses pipeline multiple times
L4 S059C	UNT to Cummins Creek	5.82	41.35144 -74.7499	Westfall / Pike	Port Jervis South	I	25	I	HQ-CWF	N/A	II	L4 S059C crosses pipeline multiple times
L4 S059	UNT to Cummins Creek	5.82	41.35139 -74.7498	Westfall / Pike	Port Jervis South	P	10	MI	HQ-CWF	N/A	II	-
L4 S047A	Rosetown Creek (Tributary 05267 to Delaware River)	6.29	41.34801 -74.7448	Westfall / Pike	Port Jervis South	I	37	I	HQ-CWF	N/A	HDD	-

Joe Zenes Report 043-1 Tennessee Gas Pipeline NEUP (Pa) March 25, 2013
Workspaces and Wetlands "Not impacted"

March 22, 2013 I accessed the UNT (S059) of the Delaware River from Route 84 to where TGP crosses S059. After tree felling was completed a number of trees and logs still remain in the steep gorge of S059. On the south side of S059 TGP's construction ROW parallels S059C with trees cut right up to the stream's channel which is a steep slope draining down to S059C which TGP crosses further upstream.
No signage or identification of a wetland Faith Zerbe and I mapped on 8/24/12 where TGP crosses S059C.

DRN Photo 100_4705 looking south
S059C is on right of tree clearing

DRN Photo 100_1413 8/24/12 Wetland identified in field but not listed in TGP permits/plans

DRN Photo 100_4710 felled trees in S059 gorge

DRN Photo100_4721 volunteer looking across S059 at S059C with tree felling paralleling stream on right

Joe Zenes Report 043-2 Tennessee Gas Pipeline NEUP (Pa) March 25, 2013
Workspaces and Wetlands "Not impacted"

March 22, 2013 I accessed Deep Brook (S045) and UNT of Deep Brook (S045A) from Route 84. TGP crosses S045/S045A. S045A is a small stream parallel to S045 at the crossing and is associated with W090. W090 is listed as a 21' wide crossing spanning both sides of S045 which is listed as a 20' wide crossing. Alignment sheets (20120808-5072 (27476900)) does not show W090 extending to the west of S045 or show S045A which does not have resource signage at TGP crossing. No delineation of W090 in the field confusing where W090 ends or where S045A begins but W090 is much larger than 21' wide crossing or a foot wider than S045 crossing width of 20'.

DRN Photo 100_4734 S045A <u>no resource signage</u>

DRN Photo 100_4737 S045A buried under felled trees

DRN Photo 100_4742 W090 signage west side of S045

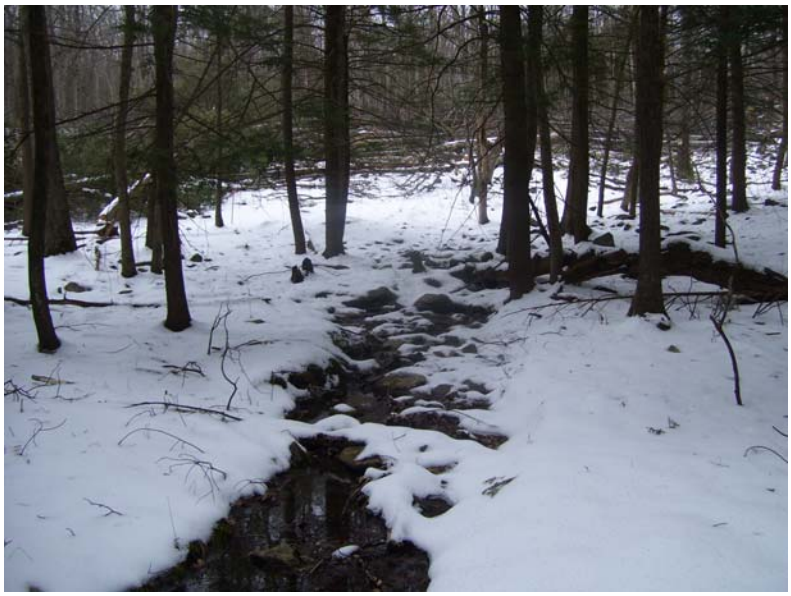
DRN Photo 100_4744 signage on east side of S045
Same ID for W090 on both sides of S045 with no field delineation other than the resource signage

Joe Zenes Report 043-4 Tennessee Gas Pipeline NEUP (Pa) March 25, 2013
Workspaces and Wetlands "Not impacted"

March 22, 2013 I accessed Deep Brook (S045) and UNT of Deep Brook (S045A) from Route 84 and followed construction ROW east towards Crawford Branch (S046). W093 is listed as "not crossed by pipeline workspace only". I believe an unidentified stream exiting south of TGP's ROW is connected to W093 under the pile of felled trees. Field observations has surface water downhill from W093 resource signage crossing woods road in TGP's ROW and exits as an unidentified stream. No field delineations for W093 and no identification for the stream exiting ROW however I believe they are connected crossing TGP's ROW.

DRN Photo 100_4836 view northeast

DRN Photo 100_4833 view northeast



DRN Photo 100_4787 surface water crossing ROW

DRN Photo 100_4788 view southwest

March 22, 2013 I accessed Deep Brook (S045) and UNT of Deep Brook (S045A) from Route 84 and followed construction ROW east towards Crawford Branch (S046). W093 is listed as "not crossed by pipeline workspace only". Photo100_4792 shows Duchie drinking surface water at uprooted tree where photo 100_4796 shows volunteer standing between resource signage for W093 and uprooted tree with surface water flowing into ROW above where it crosses woods road on page 1 photo 100_4787 "surface water crossing ROW". Field observations has surface water extending outward from resource signage for W093 and that W093 does cross into ROW and is larger than signage indicates and impacted by pipeline.

DRN Photo100_4792 Duchie drinking surface water

DRN Photo 100_4796 west view of uprooted tree

DRN Photo 100_4798 surface water clearly flowing into ROW

DRN Photo 100_4800 surface water above the wetland boundary signage

March 22, 2013 I accessed Deep Brook (S045) and UNT of Deep Brook (S045A) from Route 84 and followed construction ROW east towards Crawford Branch (S046). W093 is listed as "not crossed by pipeline workspace only". Photos 100_4825 and 100_4775 note contrast between open clearing and forested wetland. Photos 100_ 4813 and 100_4810 has pink and black wetland delineation flagging in the middle of ROW tree felling with no resource signage or other identification associated with flagging.

DRN Photo 100_4825 W093 flowing into ROW

DRN Photo 100_4775 unidentified stream flowing out of ROW view south from ROW

DRN Photo 100_4813 unidentified wetland in ROW

DRN Photo 100_4810 wetland flagging (pink/black) in the middle of ROW west of Crawford Branch

Joe Zenes Report 043-5 Tennessee Gas Pipeline NEUP (Pa) April 2, 2013

Workspaces and Wetlands "Not impacted"

March 24, 2013 I accessed TGP through land owner's property west of Vandermark Creek (S019) in Milford Township. Laurel Swamp Brook (S020) has 3 wetlands associated with it W043, W044 and W045 with only W043 listed as impacted. Field observations before and after tree felling indicates wetlands W044 and W045 are crossed by the pipeline and <u>will be impacted</u>. They are listed as "isolated" but field observations show they are just upstream and have a hydrologic connection with Laurel Swamp Brook.

DRN Photo 100_4862 W043 extends across S020

DRN Photo 100_4863 East view wetland signage continuing upslope of S020 along existing ROW

DRN Photo 100_4874 Cut trees piled in W044

DRN Photo 100_4882 West view W045

March 24, 2013 I accessed TGP through land owner's property west of Vandermark Creek (S019) in Milford Township. Laurel Swamp Brook (S020) has 3 wetlands associated with it W043, W044 and W045 with only W043 listed as impacted. Field observations before and after tree felling indicates wetlands W044 and W045 are crossed by the pipeline and will be impacted. Wetland boundary signs are adjacent to existing ROW where wetlands delineation and observations show they are also physically on opposite side of ROW. They are listed as "isolated" but field observations show they are just upstream and have a hydrologic connection with Laurel Swamp Brook. W044 is buried under felled trees and can't be physically located.

DRN Photo 100_4896 W045

DRN Photo100_4900 W045 Workspace in wetland

DRN Photo 100_4903 W045 Delineation Flagging

DRN Photo 100_4905 W045 Flowing into ROW

Joe Zenes Report 053 Tennessee Gas Pipeline NEUP (NJ) April 7, 2013
Workspaces and Wetlands "Not impacted"

April 6, 2013 I accessed TGP in High Point State Park at Sawmill Road. Silt fencing barriers are lining the road, I believe they are the "exclosures" to keep turtles and other amphibians out of the construction work areas as they come out of hibernation. The tree clearing where TGP crosses Sawmill Road on the Westside measured over 200'. They cleared a whole new ROW to the south of the existing line instead of paralleling the 24" line as shown in the alignment sheet 20120808-5072(27476900) page 34/45 below. The alignment sheet shows a very narrow workspace with the 30" line next to the existing 24" line.

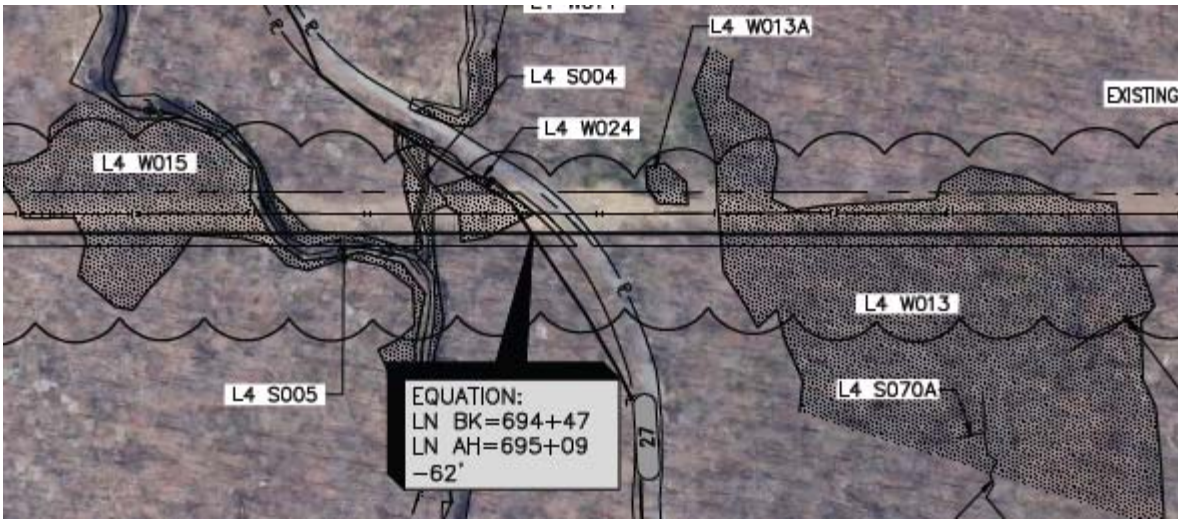


Photo 100_4955 shows the existing 24" line on the other side of my car and a 200' tape measurer stretched out to its maximum length. Photo 100_4983 shows the existing ROW to the far right of photo the 24" line is on the other side of my car. TGP cut a "new" ROW (estimate 100+ feet and several hundred feet deep) off the existing ROW leaving a narrow strip of trees where the alignment sheet shows the narrow construction ROW. The alignment sheet shows the 30" line to the north of the big bend of Big Flat Brook (S005) but it is actually to the south and approximately 100' wide where it crosses the Big Flat Brook.

DRN Photo 100_4955 looking north Sawmill Rd

DRN Photo 100_ 4983 looking west across Sawmill Rd

Joe Zenes Report 053-1 Tennessee Gas Pipeline NEUP (NJ) April 9, 2013
Workspaces and Wetlands "Not impacted"

April 6, 2013 I accessed TGP in High Point State Park at Sawmill Road. Silt fencing barriers are lining the road, I believe they are the "exclosures" to keep turtles and other amphibians out of the construction work areas as they come out of hibernation. The tree clearing where TGP crosses Sawmill Road on the Westside measured over 200'. They cleared a whole new ROW to the south of the existing line instead of paralleling the 24" line as shown in the alignment sheet 20120808-5072(27476900) page 34/45 below. The alignment sheet shows a very narrow workspace with the 30" line next to the existing 24" line.

FWW Permit Environmental Report October 2011 Appendix C Table 2.2-9 "Waterbodies associated with the NEUP in NJ Loop 323" has L4 S005 Big Flat Brook mp 13.13 associated with W014. Table 2.3-7 "Wetlands associated with the NEUP Loop 323" does not have L4 W014 listed as a crossing but is shown on alignment sheet and crosses the pipeline ROW.

Alignment sheet also shows L4 W024 is entered at 693+61 and exits at 695+14 Table 2.3-7 does not list L4 W024 as being in the project area.

L4 W013A has resource signage in the field but not in table 2.3-7 or on the alignment sheets.

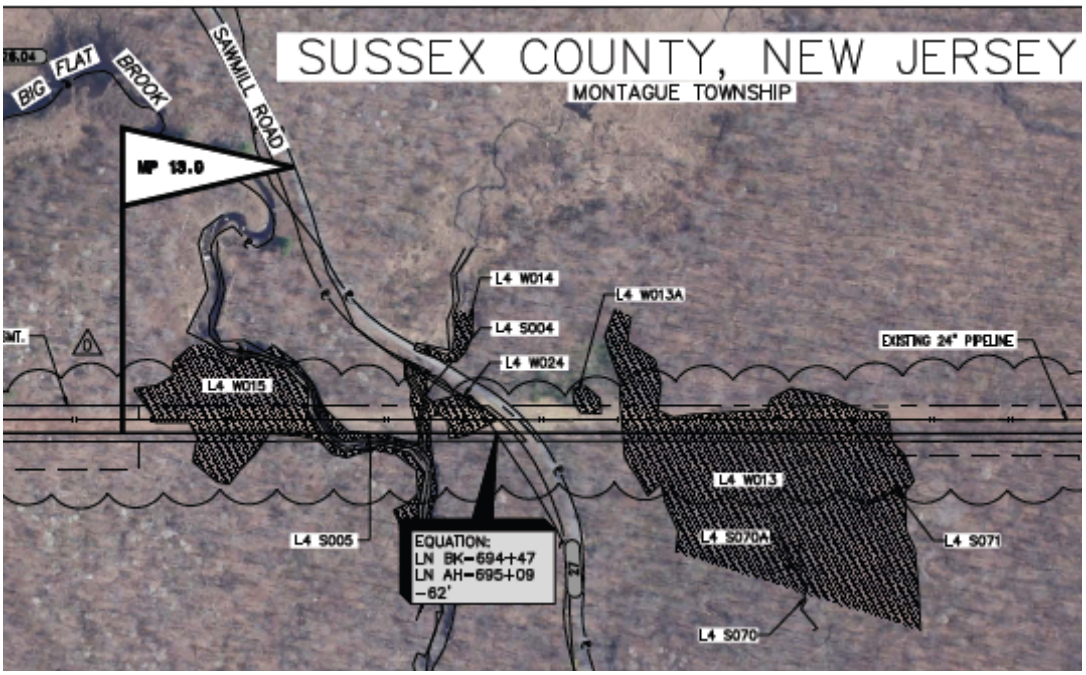
Resource signage in place and on the alignment sheet for S004 but not listed in Table 2.2-9 of FWW Permit

Notes alignment sheet

688+26 ENTER WETLAND L4 W015

691+31 TOP OF BANK
691+42 CL BIG FLAT BROOK L4 S005, PROPERTY LINE
691+53 TOP OF BANK
692+88 EXIT WETLAND L4 W015
693+03 ENTER WETLAND L4 W015
693+15 CL STREAM (L4 S004)
693+30 EXIT WETLAND L4 W015
693+61 ENTER WETLAND L4 W024
EQUATION 694+47 BK= 695+09 AHD (−62')
695+14 EXIT WETLAND L4 W024
695+18 VENT PIPE 24' LT.
695+40 PROPERTY LINE, EDGE OF ROW
695+53 EDGE OF ROAD
695+63 CL SAWMILL ROAD (ASPHALT)
695+65 VENT PIPE 24' LT.
695+74 EDGE OF ROAD
695+83 PROPERTY LINE & EDGE OF ROW
697+31 GUARD RAIL
697+31 GATE 8' LT.
697+38 ENTER WETLAND L4 W013

702+48 EXIT WETLAND L4 W013



DRN Photo 100_4952 W024 Wetland Boundary
W024 is not listed in Table 2.3-7 FWW Permit

DRN Photo 100_4979 W013A Wetland Boundary
W013A is not listed in Table 2.3-7 or alignment sheet

DRN Photo 100_4984 S004 Waterbody
S004 is not listed in Table 2.2-9 FWW Permit

DRN Photo 100_4983 “New” ROW
South of Existing ROW-Construction area >200’
View looking west across Sawmill Road

FWW Permit October 2011

Table 2.2-7 Wetlands associated with NEUP in NJ-Loop 323

Resource ID	Mile Post	Comments
L4 W060A	7.25	Associated with S050
L4 W060B	7.30	Isolated wetland/not crossed by *wetland* (?) in workspace only
L4 W060	7.32	Associated with S030
L4 W061	7.37	Associated with S032
L4 W110	7.88	Crossing length 5’
L4 W111	7.95	Crossing length 0’
L4 W114	8.01	Crossing length 0’
L4 W115	8.03	Crossing length 6’
L4 W117	8.04	Crossing length 0’
L4 W118	8.07	Crossing length 68’
L4 W112	8.13	Crossing length 1’
L4 W119	8.18	Crossing length 0'
L4 W121	9.20	Crossing length 198’
Weider Road		Crosses road then goes through Montague pipeyard
L4 W057	9.43	Crossing length 289’
L4 W033	9.56	Crossing length 106’
L4 W065	9.67	Crossing length 48’
L4 W058	9.82	Crossing length110’
L4 W059	9.91	Crossing length 175’
L4 W075	10.04	Associated with S034, S034A, S034B, and S034C
L4 W076	10.24	Isolated wetland feature/Not crossed by pipeline in workspace only
L4 W077	10.35	Associated with S034, S034A, S034B, and S034C
L4 W063	10.43	Crossing length 366’
L4 W063D	10.49	Crossing length 6’
L4 W078	10.56	Associated with S040
L4 W030	10.67	Crossing length 229’
L4 W031	10.96	Crossing length 244’
L4 W025	11.31	Crossing length 207’
L4 W026	11.45	Isolated wetland feature/in workspace only
L4 W027	11.6	Associated with Shimers Brook
L4 W028	11.83	Isolated wetland feature/in workspace only
L4 W029	11.89	Crossing length 250’
L4 W032	11.93	Crossing length 62’
L4 W022	12.21	Not impacted
L4 W021	12.32	Crossing length 410’
L4 W020	12.50	Associated with S006
L4 W019	12.63	Not crossed by pipeline in workspace only
L4 W018	12.68	Not crossed by pipeline in workspace only
L4 W017	12.81	Isolated wetland feature
L4 W016	12.90	Crossing length 639’
L4 W015	13.10	Associated with S005
L4 W013	13.26	Crossing length 484’
L4 W011	13.90	Associated with S003
L4 W009	14.12	Associated with S002/S002A

Resource ID	Mile Post	Comments
L4 W008	14.24	Not crossed by pipeline in workspace only
L4 W008A	14.25	Workspace only
L4 W005	14.88	
L4 W003	15.50	Not crossed by pipeline in workspace only
L4 W002A	15.56	
L4 W002	16.04	Not crossed by pipeline in workspace only

FWW Permit October 2011
Table 2.2-9 Waterbodies associated with NEUP in NJ-Loop 323

Waterbody ID	Waterbody	Mile Posts	Timing restrictions	Comments
L4 S049	UNT Delaware River	6.57	N/A	Backwater area of Delaware River
L4 S050	UNT Delaware River	7.24	N/A	Associated with W060A
L4 S030	Unnamed Backwater	7.32	July 1-May 1	Associated with W060
L4 S105	UNT of Unnamed Backwater	7.89	July 1-May 1	Associated with W110
L4 S106	UNT of Unnamed Backwater	7.91	July 1-May 1	
L4 S107B	UNT of Unnamed Backwater	8.00	July 1-May 1	Associated with W112/W113
L4 S108A	UNT of Unnamed Backwater	8.03	July 1-May 1	Associated with W115
L4 S108	UNT of Unnamed Backwater	8.04	July 1-May 1	Associated with W115/W116/W117
L4 S108B	UNT of Unnamed Backwater	8.07	July 1-May 1	Associated with W118
L4 S110	UNT of Unnamed Backwater	8.08	July 1-May 1	Associated with W118
L4 S111A	UNT of Unnamed Backwater	8.10	July 1-May 1	Associated with W118
L4 S111A	UNT of Unnamed Backwater	8.10	July 1-May 1	Associated with W118
L4 S111E	UNT of Unnamed Backwater	8.15	July 1-May 1	Associated with W118
L4 S114	UNT of Unnamed Backwater	8.38	July 1-May 1	
	TGP Crosses Weider Road			
L4 S033	UNT Shimers Brook	9.44	March16-Sept 14	Associated with W057
L4 S036	Unnamed pond	9.93	July 1-May 1	
L4 S008	Holiday Lake	10.01	July 1-May 1	
L4 S034A	UNT to Shimers Brook UNT	9.98	March16-Sept 14	Associated with W075
L4 S034B	UNT to Shimers Brook UNT	10.02	March16-Sept 14	Associated with W075
L4 S035	Shimers Brook	10.34	March16-Sept 14	Associated with W077
L4 S035C	UNT to Shimers Brook UNT	10.35	March16-Sept 14	Associated with W077/Workspace only
L4 S035B	UNT to Shimers Brook UNT	10.36	March16-Sept 14	Associated with W077/Workspace only
L4 S040	Shimers Brook	10.56	March16-Sept 14	Associated with W078
L4 S062	Shimers Brook UNT	11.64	March16-Sept 14	
L4 S006	Parker Brook	12.47	March16-Sept 14	Associated with W020
L4 S005	Big Flat Brook	13.13	July 1-May 1	Associated with W014
L4 S003	Big Flat Brook UNT	13.91	July 1-May 1	Associated with W011
L4 S002	UNT to Big Flat Brook UNT	14.14	July 1-May 1	Associated with W009/S002A/S002B
L4 S001	Clove Brook UNT	14.63	July 1-May 1	Associated with W007
L4 S075	UNT Papakating Creek	15.59		Associated with W002A

Joe Zenes Report 056 Tennessee Gas Pipeline NEUP (NJ) April 9, 2013

Adjustment in the Length of Pipeline Loop 323

The attached table and Loop 323 section are from the Environmental Assessment.
Note in Table 2.4.3-1 High Point State Park starts at MP 10.0 also in the attached paragraph 323 Loop.

The FWW Permit Table 2.2-9 Waterbodies Associated with the NEUP in NJ-Loop 323 has L4 S008 (Holiday Lake) in High Point Country Club a private development and golf course at MP 10.1…

MP 10.01 would put Holiday Lake in High Point State Park approximately a mile away.

That would put L4S034A/W034B (several wetlands also) on the golf course and in Holiday Lake in the FWW Permit. 0.10 mile is 528' so they would come out of Holiday Lake at approximately mp 10.20 .

Table 2.2-9
Waterbodies Associated with the Northeast Upgrade Project in New Jersey – Loop 323

Waterbody ID	Waterbody Name (where applicable)[a]	Approximate MP[b]	Latitude Longitude	Township / County	Quadrangle	Type[c]	Water Crossing Length[d] (feet)	FERC Class[e]	Water Quality / Fishery Classification[f]	Timing Restriction[g]	Crossing Method[h]	Comment
L4 S008	Holliday Lake	10.01	41.30917 -74.7398	Montague / Sussex	Milford	Pond	1,151	MA	FW2-NT	July 1 - May 1	I	-
L4 S034A	Unnamed tributary to Shimers Brook UNT	9.98	41.30116	Montague / Sussex	Milford	I	13	I	FW2-TPC1	March 16 – September 14	I or II	Associated with W075
L4 S034B	Unnamed tributary to Shimer's Brook UNT	10.02	41.30073 -74.7444	Montague / Sussex	Milford	I	9	MI	FW1-TPC1	March 16 – September 14	I or II	Associated with W075

Loop 323

No Net Loss

As described below, several state-owned lands would be affected by the Project. Construction and tree removal on state-owned land would trigger New Jersey's NNRA. The NNRA states that trees must be replaced when they are removed during development projects involving 0.5 acre or more (NJDEP, 2011a). While the requirements of the act typically only apply to state entities, TGP has committed to complying with state requirements for these areas, which would involve the development of a reforestation plan for the tree impacts associated with the Project (NJDEP, 2011a).

High Point State Park

Loop 323 would cross High Point State Park at various locations between MPs 10.0 and 14.4 (see table 2.4.3-1). The park, which is managed by the NJDEP, Division of Parks and Forestry, is named for the highest peak in the State of New Jersey and part of the Kittatinny Mountain Range. Although not near the Project area, the park hosts the High Point Monument, a 220-foot-tall structure that offers views of the Pocono Mountains, the Catskill Mountains, and the Wallkill River Valley. Common recreational activities and facilities available to the public within High Point State Park includes camping, picnicking, hiking, mountain biking, horseback riding, cross-country skiing, snowshoeing, dog sledding, snowmobiling fishing, a homeowner firewood plan, interpretive educational programs, boating, and hunting. Peak use of the park is between June and August, with periodic high-use periods during the winter associated with ice fishing, snow shoeing, and cross-country skiing (NJDEP, 2011b). Within the park, Loop 323 would cross the Sawmill Loop Trail, the Appalachian Trail (MP 14.4; discussed below), and an unnamed trail, as well as several waterbodies, including Shimer's Brook (MP 10.6), Parker Brook (MP 12.5), and Big Flat Brook (MP 13.1). The nearest campground is located over 1.0 mile from the Project.

TABLE 2.4.3-1

Recreation and Special Interest Areas Crossed by the Project

State/Milepost	Name of Area	Land Ownership/ Management	Crossing Length (feet)	Area Affected (acres) Const. [a]	Area Affected (acres) Oper. [b]
Pennsylvania					
Loop 317					
0.2 – 0.4	Susquehanna River Water Trail, North Branch Section and Susquehanna River	State of Pennsylvania, Department of Conservation and Natural Resources, Bureau of Forestry/National Park Service (trail and waterbody) and Susquehanna Greenway Partnership (trail)	1,196	0.0 [d]	0.0 [d]
3.1	U.S. Route 6 Grand Army of the Republic Highway Recreational Trail	Pennsylvania Department of Transportation/Grand Army of the Republic Highway Association	291	0.0	0.0
Loop 323					
0.0 – 0.9	Delaware State Forest	State of Pennsylvania/ Department of Conservation and Natural Resources, Bureau of Forestry	4,655	10.9	2.6
New Jersey					
Loop 323					
14.4	Appalachian National Scenic Trail	State of New Jersey/New Jersey Department of Environmental Protection (NJDEP), Division of Parks and Forestry	2	<0.1	<0.1
10.0 – 10.3 10.5 – 10.9 11.1 – 11.9 11.9 – 13.2 13.2 – 14.4	High Point State Park	State of New Jersey/NJDEP, Division of Parks and Forestry	20,256	44.1	7.0
Loop 325					
0.0 – 7.6	Highlands Region	Various/NJDEP	40,311	83.4	14.8
0.0 – 0.2 0.5 – 1.1	Long Pond Ironworks State Park	State of New Jersey/NJDEP, Division of Parks and Forestry	4,174	8.1	1.0
0.2 – 0.5	Monksville Reservoir	State of New Jersey/NJDEP	1,419	0.0 [d]	0.0 [d]
1.2 – 1.6	Waterview (Green Acres Program Property)	Passaic River Coalition	2,100	4.9	1.2
1.6 – 2.0	(Green Acres Program Property)	Passaic River Coalition	1,766	4.0	1.0
2.6 – 3.2	Wanaque Reservoir Watershed Property	North Jersey District Water Supply Commission	3,080	6.8	1.5
3.3 – 3.4 [c]	Baseball field	Borough of Ringwood	525	1.2	0.3
3.4 – 3.5 3.5 – 7.0	Ringwood State Park (partial Green Acres Program Property)	State of New Jersey/NJDEP, Division of Parks and Forestry	19,352	41.4	6.2
7.0 – 7.5	Ramapo Valley County Reservation (Green Acres Program Property)	Bergen County, Department of Parks	2,600	6.0	1.5

[a] Assumes a 100-foot-wide construction right-of-way, which includes 25 feet of existing permanent right-of-way, 25 feet of new permanent right-of-way, and 50 feet of temporary construction workspace.

[b] Assumes 25 feet of new permanent right-of-way.

[c] Includes mainline valve 328-2, which would be installed adjacent to the baseball field.

[d] Direct impacts on the area would be avoided by use of the horizontal directional drill method.

Joe Zenes Report 057 Tennessee Gas Pipeline NEUP (NJ) May 19, 2013
Construction in Timing Restriction Areas

May 17, 2013 I visited land adjacent to TGP's ROW from the end of Mountain Road in Montague NJ. DRN representatives have written permission to access these properties adjacent to the ROW. This section of pipeline has several sensitive resources that are UNTs of Unnamed Backwater of the Delaware River and have "Timing Restrictions" for construction activities. The Timing Restrictions are July 1-May 1 when "construction activity can occur". Resource signage has been a continual problem in this area with several reports filed with inadequate with incomplete information.

1) The wetland delineation report Appendix "D" has 11 UNT to Unnamed Backwater of the Delaware River listed under Waterbody Name with no ID numbers assigned to them. Appendix "E" Wetlands lists 9 wetlands with no ID numbers assigned to them.
This is consistent with Tables 2.2-7 and 2.2-9 of the FWW Permit October 2011

2) September 29, 2012 I performed a survey of these waterbodies/wetlands using a GPS unit I mapped 25 resources identifying them by ID numbers using blue survey flags in the field, 16 waterbodies and 9 wetlands. See Report 022

3) Below is from the FWW Permit under Endangered and Threatened Special Conditions and has 31 Delaware River tributaries no wetlands listed.

#2

In order to protect **wood turtle (*Glyptemys insculpta*)** and its habitat **downstream of the following locations: Delaware River tributaries: L4 S105, L4 S106, L4 S107, L4 S107B, L4 S107C, L4 S108A, L4 S108B, L4 S110, L4 S111, L4 S111C, L4 S111A, L4 S111E, L4 S111F, L4 S111G, L4 S112, L4 S113, L4 S113A, L4 S113B, L4 S113C, L4 S113D, L4 S114, L4 S114A, L4 S114B, L4 S114C, L4 S114D, L4 S115, L4 S116, L4 S118, L4 S119, L4 S119A, L4 S119B; Shimers Brook tributaries: L4 S033, L4 S036A, L4 S036; Clove Brook tributary: L4 AR50 S007; the permittee must employ the most stringent soil erosion and sediment control BMPs available to ensure that there is no increase in sedimentation or turbidity downstream of the construction site.**

See Picasa Album "Inadequate Signage" for condition of Resource Signage after "Tree Felling" and prior to this stage of construction.

The rock construction entrance off of Mountain Road is a fine crusher dust which I don't believe meet specifications for size of rock that is required. The crusher dust does nothing to help remove mud/dirt from the tires of construction vehicles and resulted in dust particles to enter the air when trucks entered and left the site.
Picasa album Construction activity Merusi P1000650, 652, 653, 654, 655

Grading and clearing was taking place from the access road along the ROW towards Weider Road. Two pieces of equipment were operating in the ROW; a skidder and an excavator with logging and dump trailer trucks entering and exiting the site. The excavator was removing stumps, piling brush and tree debris as timber mats were being laid. The operator's vehicles were parked on the ROW in front of Mr. Merusi's backdoor, one pickup had a fuel tank on the back. I didn't observe any special areas for fueling especially with secondary spill containment areas. No supervisor/inspector on site.

Picasa album Construction activity Merusi P1000639-647

Perimeter E&S silt fence had been partially installed along the west or downhill side of the site but no controls where logs and debris were being staged for loading and transportation from the site. A skidder would take the pre-fabricated timber mats along the travel way and dropped them and then grab trees to haul back to the staging area. The uphill side lacks adequate E&S controls as is where the workspace is where these temporary bridges are being installed. I observed the excavator grubbing up this soil and just laying the timbers on the fresh soil with root and tree debris then packing it down banging it with the bucket. They had a couple resources staked out with a mix of; single layer of silt fencing, hay bales, some staked some not, fabric under some of the timbers with plywood side boards but limited protection to the waterbodies with all the open ground. I observed only the two equipment operators on site crossing these highly sensitive resources.

Picasa Album Signage

Waterbody L4 S105 flows from a fresh water spring house that's associated with L4 W110 wetland. Photos P1000516-521 627-633 shows the current condition of these 2 Sensitive Resources;

1) Timber bridge installed with sideboards but single layer of silt fencing, downstream side encloses the wetland but does not allow for the outlet of S105.
2) I didn't observe S106 or signage for it.
3) I observed signage for S107C but is not listed on FWW Permit 2011
4) The area ahead of the excavator had signage still trashed under the trees
5) E&S controls appear to be installed after the earth disturbance while clearing/grubbing
6) One wetland area had un-staked hay bales in disturbed soils
7) The grading appears to be eliminating and alternating this series of Sensitive Resources

Picasa Albums Stream and Pond

Photos of waterbodies adjacent to or just in front of the active construction equipment and pond photos show where a slight light coloring in the inlet to the pond and contributing waterbodies. Note the weather has been extremely dry so very little problems with sediment other than dust particles.

Conclusion:
My observations reveal poor use of BMP's in an area that the FWW Permit states TGP "must employ the most stringent E&S controls available to ensure that there is NO increase in sediment and turbidity downstream of the construction site." I don't believe that crusher dust is an approved E&S method (stone size) at the construction entrance. The amount of un-stabilized soil is certainly a pollution threat to these sensitive resources of the Delaware River. I believe construction activity is continuing is this area with timing restriction with clearing/grubbing and grading going on in and along these sensitive resources.

Joe Zenes Report 058 Tennessee Gas Pipeline NEUP (NJ) May 22, 2013
L4 S035 Shimer Brook HPSP

Picasa folder 5-21-13 Shimer Brook HPSP

I accessed L 4 S035 Shimer Brook in High Point State Park to find trenches open prior to pipe being delivered to ROW. There is considerable amount of disturbed soils without temporary stabilization allowing for possible sediment to enter the stream. The stream bank has been graded and cut down for easier access for construction equipment along ROW.

The ECP section 5.13.1.5 Clearing/Grading states; if “grading is necessary to install equipment bridges, the exposed soils shall be immediately stabilized”.

The equipment bridge E&S controls are in need of repairs; sections of side boards are missing, the ends of equipment bridge have inadequate E&S controls and can be potential areas for sediment to enter the stream.

Joe Zenes Report 059 Tennessee Gas Pipeline NEUP (NJ) May 23, 2013
Draining Wetlands HPSP

Picasa folders 5-22-13 Wetlands HPSP

Picasa folders 5/22/13 HPSP Draining Wetlands /5/22/13 Draining Wetlands 2nd one

I accessed L 4 S035 High Point State Park from Ridge/Sawmill Roads to find trenches open prior to pipe being delivered to ROW. There is considerable amount of disturbed soils without temporary stabilization allowing for possible sediment to enter the stream. There are 2 trenches dug below wetland areas that are filled with water and overflowing at bottom of the trench.

Picasa folder 5/22/13 Solid Cribbing across W020/S006

Additional timber cribbing installed across Parker Brook S006 and associated wetland W020 (663' crossing)…timbers coated with sediment, no sideboards on equipment bridge. Additional timbers appear to be damming up wetlands/stream. It doesn't appear the west side of wetland has cement coated pipes…plain coated pipes extend into wetlands on west side.

Picasa folder 5-22-13 Ridge Rd crossing

The road has mud on it several hundred ft past the crossing, pipe trucks and the like enter ROW off of Sawmill drop their loads and proceed to Ridge Road and turn right to keep construction vehicles moving. The Porto John sits on ATWS TGP cut a perfect mature White Oak down for sitting a Porto John stump still visible…HPSP they area supposed to conserve tree cutting they have a zero net lose of trees. Open pits lacking adequate safety fencing along a State Park Road with Holiday weekend approaching. The worker is cleaning the tracks of the excavator in the wetland area with bucket lifting the machine is on the existing pipeline. Again considerable amount of workspace at Ridge Road.

Picasa folder 5-22-13 Wetland Disturbances

Wetland disturbance on both sides silt fencing in W020. Timber mats are laying on the wetland soils cause mud to ooze up and splash onto the silt fencing in W021 when equipment drives over it causing muddy water to flow through wetland.

Picasa folder 5-22-13 Sawmill Road crossing

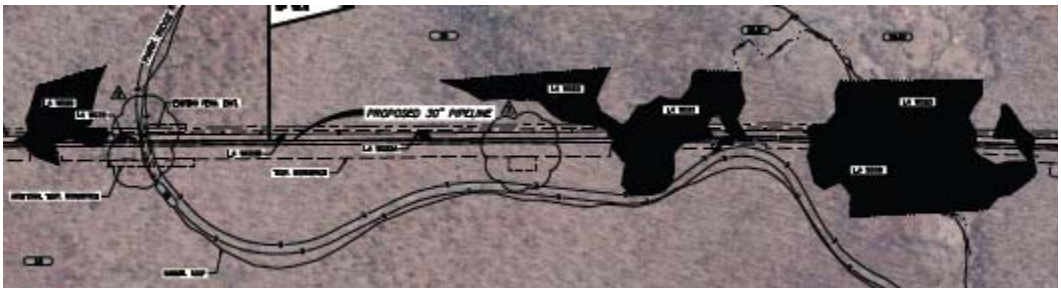
A complete new ROW was cleared even though the new pipe is crossing under the next to the existing pipeline. I believe several wetlands have be compromised and not listed on the FWW permit. Resource signage was in place and not on the FWW permit in this area. The large disturbance is located along S005 Big Flat Brook that has the July 1-May 1 timing restrictions. Open pits from the boring with inadequate fencing along the State Park Road on a Holiday weekend. Top soil looks like wetland soils grubbed up…appears to have a considerable amount of tree debris mixed in. Other photos show the additional construction workspace/ROW where it co-locates with the existing pipeline further to the west.

Picasa folder 5-22-13 inadequate E&S controls

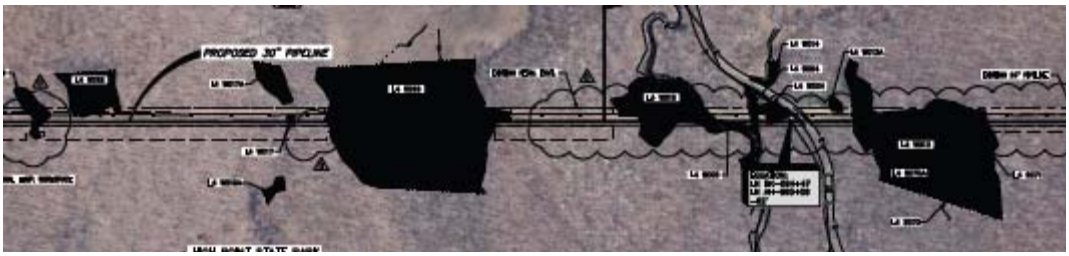
Hay bales are not staked down, wetland resource signage missing and stake knocked down. Several areas have rocks against silt fencing. Green filter socks don't appear to have adequate compost in them. There are many locations for sediment to enter wetlands from timber bridges.

Below are the alignment sheets for 5-22-13 Report 059

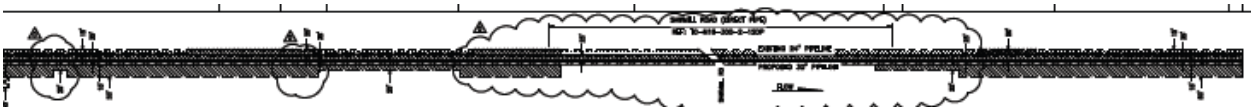
Appendix C alignment sheet page 33/45 Parker Brook west to Ridge Road crossing.



Appendix C alignment sheet page 34/45 Parker Brook/W020 east to Sawmill Road crossing



The look down showing 75' workspace at Sawmill Road crossing page 34/45



August 2, 2013

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

Re: Tennessee Gas Pipeline Company, L.L.C., Docket No. CP11-161-000
Northeast Upgrade Project – Refueling within 100' of a wetland

Dear Ms. Bose,

Delaware Riverkeeper Network (DRN) is submitting a complaint regarding observations of pipeline construction equipment refueling operations occurring within 100' of a high quality wetland. The fueling activity took place on the Tennessee Gas Pipeline (TGP) Northeast Upgrade Project Loop 321 off of Westcolang Road (Pike County, PA). This is a follow up in writing of the original incident shared with Commission staff on July 18, 2013. Commission staff provided the concern to TGP and TGP responded to the concern in their subsequent weekly report. DRN believes TGP response did not reflect the facts on-the-ground.

Additional information and documentation of the incident is outlined in this letter and photographs to support DRN's observations. At approximately 8am July 18, 2013, DRN observed a fuel truck and a service vehicle parked on timber mats that cross a wetland and that were adjacent to a "NO REFUELING' sign and a "WETLAND BOUNDARY" sign on the west side of the road as can be seen in photo 1 in the following photo album:

https://picasaweb.google.com/lh/sredir?uname=105703332397473503863&target=ALBUM&id=5901978432377824833&authkey=Gv1sRgCMHlxtW04bObWQ&invite=CLH6kMwM&feat=email

Reinforced silt fencing was partially installed around the portable bathroom, but E&S controls were not observed anywhere else at this location including around the fuel truck or wetlands. There were no clear markers of where the wetlands and sensitive habitat began or ended; the two vehicles could possibly have been parked directly over the wetlands indicated by the timber mats. This location also lacked the orange safety fencing that is required at a public road crossing.

TGP claims in their Weekly Status Report July 15, 2013 through July 21, 2013 that this incident was approved by the Environmental Inspector due to "congestion on the ROW" (excerpt from TGP report below).

DELAWARE RIVERKEEPER NETWORK
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<u>Weekly Status Report Reporting Period: July 15, 2013 through July 21, 2013</u>
The Commission received a report regarding a re-fueling operation that was potentially conducted within 100 feet of a wetland adjacent to the crossing of Westcolang Road (MP 7.96) on Loop 321. Upon investigation, Tennessee determined that the onsite environmental inspector ("EI") had approved the re-fueling operation at this location on a site-specific basis due to congestion on the ROW and the large distance to the next approved re-fueling site. This exception was conducted under the approval of the EI, and in accordance with the Project's Environmental Construction Plan - Pennsylvania. The EI was present during the re-fueling operation, in which a "two-man" system was utilized, such that one person was stationed at the shut-off valve and the other was operating the nozzle. An absorbent diaper was placed on the ground surface as a precautionary measure and the nozzle was wiped before and after the re-fueling operations. The EI confirmed that absolutely no fuel was spilled.

TGP also claimed that there was an Environmental Inspector (EI) on site, and photo 5 shows three workers standing by the fuel truck. DRN agrees that TGP was utilizing the "2 man approach" with one worker with hand near the valve area and one worker with the nozzle and a third worker standing nearby as seen in photo 4/7 and close up in photo 5/7. But DRN does not believe any of these workers in the pictures were the EI who TGP claims was overseeing the refueling operation that was taking place in the no refueling area. We request that TGP identify the EI in the photos if this is incorrect. Photo 2/7 shows the worker directing the excavator down the construction ROW.

This location does not appear to fall under the exceptions of Section 7.1.3.1 (see below) refueling operations under the PA ECP because the excavator was able to move to this location so there should have been no hindrance for the fuel truck and white service truck to move to the excavator and other equipment in an approved fueling area. Note photo 7/7 of the close up the fuel hose that had already been deployed that day and coiled up on the ground without any absorbent diaper under it as TGP claimed in their weekly report. Photo 6/7 shows a lubricant hose lying unattended on the ground without any absorbent diapers under that hose adjacent the wetland area. There was also no barrier between the refueling station and the wetlands as seen in photo 1/7 that would have allowed this to fall under exceptions of 7.1.3.1. In fact, the wetland even lacked the ECDs required to protect this sensitive wetland area.

7.1.3.1 Refueling Operations

The Contractor will insure that equipment is refueled and lubricated within the ROW and at least 100 feet away from all waterbodies and wetlands with the following exceptions:

- *sites where moving equipment to refueling stations from pre-fabricated equipment pads is impracticable or where there is a barrier from the waterbody/wetland (i.e., road or railroad);*
- *locations where the waterbody or wetland is located adjacent to a road crossing (from which the equipment can be serviced); and*
- *refueling of immobile equipment including, but not limited to, bending and boring machines, air compressors, padding machines, and hydro-test fill pumps.*

I believe what DRN staff observed July 18, 2013 where TGP loop 321crosses Westcolang Road was gross negligence and in violation of TGP's Environmental Construction Plan.

Sincerely,

Joe Zenes
Delaware Riverkeeper Network

cc Sally Corrigan, Pike County Conservation District

April 5, 2013

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

Re: Tennessee Gas Pipeline Company, L.L.C., Docket No. CP11-161-000 Northeast Upgrade Project - Loop 323 Field Inspections – Inadequate protections to Sensitive Waterbodies and Wetlands Listed as "Non-Impacted" by TGP

Dear Ms. Bose,

As part of Delaware Riverkeeper Network's (DRN's) on going post and pre-construction monitoring of Tennessee Gas Pipeline activities there were several reports following DRN's Report 043 (Workspaces and Wetlands "not impacted") that are summarized in this letter. In summary, DRN has continued to observe outstanding issues, discrepancies, and impacts in the field that have not been addressed by TGP to adequately protect sensitive waterbodies and wetlands proposed to be crossed by the Northeast Upgrade Project along Loop 323. These waterbodies and wetlands are in many cases, designated Exceptional Value or High Quality in Chapter 93 PA Code. Furthermore, DRN disagrees with TGP's premise in the Environmental Assessment that these wetlands and waterbodies will not be impacted or only "temporarily impacted". Our observations and understanding of forest ecology, fragmentation, and soil science concepts is that indeed, these wetlands adjacent and in "temporary" works spaces near the pipeline ROW are and will be impacted and damaged by TGP practices by tree clearing that will increase water temperatures and decrease dissolved oxygen levels due to increased light from cleared mature forest canopy, understory, and shrub layers; increased runoff and hydrologic changes due to soil compaction caused by TGP construction equipment, and forest fragmentation impacts that will negatively affect the surrounding forest as documented by the scientific literature. TGP states that part of their BMP's include a minimized ROW width for NEUP for stream and wetland crossings but past pipelines have used ROWs as small as 35 feet which TGP is not implementing with this project that along some stretches of ROW, is cutting a new pipeline across a large section of non-colocated area that was mature forest canopy until TGP tree cutting began on Feb 15, 2013. The "temporary" work spaces are also wide and lead to permanent damage to the ecosystem with impacted soils and loss of mature forest canopy and these "temporary" work spaces are also often adjacent sensitive waterbodies which decreases the important riparian buffer to these sensitive waterbodies. Below specific observations from field visits on March 22 and 24, 2013. Field reports with photos and supporting information are also accompanying this letter.

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During a field visit on March 22, 2013 of S059 an unnamed tributary of the Delaware River DRN observed felled trees in the gorge of S059. The Environmental Construction Plan (ECP) Section 4.1.1 states "that trees that have fallen into waterbodies shall be removed immediately". However after tree felling has been completed trees still remain in the gorge of S059. The construction ROW parallels S059C a tributary of S059 up a steep slope with tree felling up to the edge of the stream channel. DRN believes having construction that close to the stream channel will have an impact to this waterbody especially since it is on a steep slope downhill of the construction ROW and downed trees could impede flow and cause erosion if large rainfall events affect the region before trees are cleared.

Where TGP proposes to cross S059C there is a wetland that was identified on 8/24/12 by DRN scientists during a survey of features along this section of the proposed ROW. This wetland in the construction ROW still lacks resource signage or identification by surveyors for TGP after tree felling was completed. These same concerns were addressed in a letter dated March 4, 2013, however the wetland still remains unidentified, trees still remain in the stream channel and S059C's water quality is threatened with its close proximity to the construction ROW. TGP surveys where completed at a late date due to no access to large areas of private land so identification and coordinates of features along this section were still missing in late summer of 2012 (See Report 043-1).

On March 22, 2013, DRN accessed Deep Brook (S045) and UNT of Deep Brook (S045A) both Exceptional Value (EV) streams at location where TGP crosses S045/S045A. S045A is a small stream parallel to S045 at the crossing and is associated with W090. W090 is listed as a 21' wide crossing spanning both sides of S045 which is listed as a 20' wide crossing. Alignment sheets (20120808-5072 (27476900)) do not show W090 extending to the west of S045 or show S045A which does not have resource signage at TGP crossing. There is no delineation of W090 in the field confusing where W090 ends or where S045A begins (Report 043-2)

During the March 22 field visit DRN followed the construction ROW east towards Crawford Branch (S046). W091 is adjacent to W090 and field observations has W091 extending to the east to foot marker 194+00 connecting these associated wetlands and waterbodies for approximately 200' to the top of west bank S045 at 192+12. Pa Bulletin 12/8/12 has a combined total crossing width of <u>only 61'</u> permitted for these 4 resources. There are no field delineations for W090/W091 other than resource signage along the northern edge of ROW and no resource signage for S045A. (Report 043-3).

DRN followed the construction ROW east towards Crawford Branch (S046). W093 is listed as "not crossed by pipeline in workspace only". DRN believes an unidentified stream exiting south of TGP's ROW is connected to W093 under the pile of felled trees. Field observations indicates surface water downhill from W093 resource signage crossing woods road in TGP's ROW and exits as an unidentified stream. There are no field delineations for W093 and no identification for the stream exiting the ROW, however DRN believes they are connected and crossing TGP's ROW. (Report 043-4) (Report 043-4a)

Observations close to Crawford Branch shows pink and black wetland delineation flagging in the middle of ROW tree felling with no resource signage or other identification associated with flagging (Report 043-4b).

On March 24, 2013 DRN accessed TGP through land owner's property west of Vandermark Creek (S019) in Milford Township. Laurel Swamp Brook (S020) has three wetlands associated with it W043, W044 and W045 with only W043 listed as impacted. Field observations before and after tree felling indicates wetlands W044 and W045 are crossed by the pipeline and will be impacted. They are listed as "isolated" but field observations show they are just upstream and have a hydrologic connection with Laurel Swamp Brook (Report 043-5). Wetland boundary signs are adjacent to existing ROW where wetlands delineation and

observations show they are also physically sited on opposite side of ROW. W044 is buried under felled trees and cannot be physically located (Report 043-5a).

In conclusion, DRN field reports and observations show the following discrepancies and issues with TGP practices or delineations that we feel indicate inadequate protection of these sensitive resources and impacted wetlands that TGP states are not impacted.

1) The tree felling at S059 does not meet the requirements of Section 4.1.1 of the Environmental Construction Plan (ECP).
2) The isolated wetland located near TGP crossing of S059C remains unidentified and not delineated in the construction ROW.
3) Three features associated with Deep Brook S045 (Exceptional Value stream) appear to be connected in a single crossing width of approximately 200' but much larger than the 61' combined for W090/W091 and S045/S045A with S045A having no resource signage in place.
4) W093 is listed as "not impacted" but field observations document this sensitive resource crossing the pipeline ROW.
5) Pink and black flagging used for wetland delineations was observed under felled trees near Crawford Branch but is not listed in the Pa. Bulletin as a wetland crossing at this location.
6) Observations at Laurel Swamp Brook S020 (EV) and three wetlands W043/W044/W045 indicate that W044/W045 have a hydrologic connection with Laurel Swamp and are not "isolated". Resource signage for these wetlands indicates they continue into TGP's ROW and are and will be impacted.

   DRN is unclear how TGP can claim they are limiting disturbance and not impacting these sensitive resources if indeed DRN is documenting such discrepancies in the field. DRN requests TGP address these matters in their weekly construction report, and provide an updated schedule of when additional resource mapping will be implemented before heavy equipment is allowed on site so that the public will have adequate time to ensure sensitive waterbodies are adequately marked, identified and protected before heavy equipment is allowed on site.

Sincerely,

Joe Zenes
Delaware Riverkeeper Network

cc. US Army Corps of Engineers

DRN Photo 100_4903 W045 Delineation Flagging

DRN Photo 100_4905 W045 Flowing into ROW

DRN Photo 100_4862 W043 extends across S020 water
Note resource signage continuing upslope of stream signage W093

DRN Photo 100_4800 surface above the wetland boundary

DRN Photo 100_4737 S045A buried under east

DRN Photo100_4765 looking west from

Felled trees S045A has no resource signage

boundary of W091 connecting with W090

Impacts of Shale Gas Development on Bat Populations in the Northeastern United States

Indiana bat (*Myotis sodalis*). Photo credit: Bat Conservation International.

A report submitted to

The Delaware Riverkeeper Network

Bristol, PA

by

Bat Conservation International

Austin, TX

June 2012

Report Citation

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Photo accessed February 2012 from http://towneforcongress.com/economy/solutions-with-hydraulic-fracturing/

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BACKGROUND

Natural gas development from shale is rapidly expanding across the US (Ground Water Protection Council GWPC and ALL Consulting 2009). Shale gas reservoirs, or plays, are distributed across the country (Fig 1.) and can be found at depths ranging from 152–4,115 meters (m). The most productive plays include the Barnett, Haynesville, Fayetteville, Woodford and Marcellus Shales (Zoback et al. 2010). In the northeastern US, the Devonian, Marcellus, and Utica shales extend across several states and are located within the Appalachian Basin Province (Coleman et al. 2011).

Figure 1. Location and size of shale gas reservoirs, or plays, in the United States. Source: US Energy Information Administration (USEIA) based on published data.

The process of producing natural gas from shale and other unconventional reservoirs (i.e., formations with low permeability and porosity) requires fracturing the rock formation. In high-volume hydraulic fracturing (HVHF) operations, highly pressurized fluid, consisting of water and various chemicals, is used to create these fractures. Suspended in the fluid is a propping agent, typically sand, which maintains the openings and allows gas to migrate to the well (Carter et al. 1996, Entrekin et al. 2011). To increase the volume of rock accessed by a single vertical well, operators rotate the drill and bore horizontally through the shale bed. Up to fifteen separate HVHF operations are possible per well (Kargbo et al. 2010).

OBJECTIVES

Concerns regarding the potential impacts to humans and the environment have grown in conjunction with the rapid expansion of shale gas development. Issues regarding water withdrawal, water contamination, habitat loss and degradation, impacts to terrestrial and aquatic ecosystems, and greenhouse gas (GHG) emissions surround HVHF operations. Moreover, no data exist on the possible adverse influence these operations have on bat populations. Because of recent concerns regarding rapidly declining bat populations in the northeastern US, there is

increasing concern about the additive effects HVHF operations could have on already imperiled bat species. This report will focus on the environmental effects associated with shale gas development and the potential impacts to bat populations in the region.

ENVIRONMENTAL IMPACTS

Water withdrawal. The HVHF process requires large volumes of water per well to fracture shale formations. Estimates ranging from 2 to 7 million gallons of water are used per operation, depending on conditions of the site (NYDEC 2011, Susquehanna River Basin Commission [SRBC] 2010, US Environmental Protection Agency [USEPA] 2011). In 2006, the estimated 35,000 fractured wells across the US used between 70–140 billion gallons of water, equivalent to the total amount withdrawn from drinking resources each year by 40–80 cities with populations of 50,000 people, or 1–2 cities of 2.5 million people (Halliburton 2008, USEPA 2011). Source water comes from either surface (e.g., streams or lakes) or ground water (e.g., aquifers). Water can be withdrawn from a nearby source or transported by trucks or a pipeline, and stored on-site by large tanks or impoundments (GWPC and ALL Consulting 2009). Because ground and surface water are hydraulically connected, changes in the quantity and quality to one likely influence the other (Winter et al. 1998).

In the northeastern US, shale formations (e.g., Devonian, Marcellus, and Utica) underlie a number of sensitive watersheds, such as the upper Delaware River, a designated Wild and Scenic River that supplies drinking water to >15 million people. Stakeholder concerns include the high rate of water removal from small streams at the headwaters of these watersheds (Maclin et al. 2009, Myers 2009). Withdrawals of large quantities of water at these locations can significantly affect the hydrology and hydrodynamics of surface water resources. Changes in water depth can alter the flow regime, velocity, and temperature of springs, streams and lakes, affecting *in situ* flora and fauna (Zorn et al. 2008). Additionally, removal of significant volumes of water can reduce the dilution effect and increase the concentration of contaminants in surface water (Pennsylvania State University 2010).

Ground water resources (e.g., aquifers) also are tapped for HVHF operations. Rapid withdrawal from aquifers can lower the water table levels, changing water quality by exposing naturally occurring minerals to an oxygen-rich environment, potentially causing chemical changes that alter mineral solubility and mobility, leading to salination of water and other chemical contaminations. Lower water tables also may cause upwelling of lower quality water and other substances (e.g., methane) from deeper within an aquifer and could lead to subsidence or destabilization of the local geology. (USEPA 2011)

Water contamination and toxic exposures. In addition to water, HVHF fluids typically include a combination of additives that serve as friction reducers, cross-linkers, breakers, surfactants, biocides, pH adjusters, scale inhibitors, and gelling agents (New York State Department of Environmental Conservation [NYSDEC] 2010). The goal is to achieve an ideal

viscosity that encourages fracturing of the shale and improves gas flow, while discouraging microbial growth and corrosion which can inhibit recovery efficiency (US Department of Energy [USDOE] 2009). The percentage of chemical additives in a typical HVHF operation is <0.5% by volume but can reach as high as 2% by volume (Soeder and Kappel 2009, NYSDEC 2011). Thus, an HVHF operation using 5 million gallons of water can use 25,000 to 100,000 gallons of chemical additives. The types and concentrations of chemical additive and proppants vary depending on conditions of the specific well being fractured, and companies typically create fracturing fluid tailored to the specifics of the formation and needs of the project (USEPA 2011). The New York State Department of Conservation (2011) lists chemicals proposed for use in the state by shale gas developers, including 235 products in hydraulic fracturing fluids, containing 322 unique chemicals and at least 21 additional compounds.

In 2011, the US House of Representatives Committee on Energy and Commerce launched an investigation examining HVHF practices. The Committee found that "between 2005 and 2009, 14 oil and gas service companies used more than 2,500 additives, containing 750 chemicals and other components", including "29 chemicals that are: (1) known or possible human carcinogens; (2) regulated under the Safe Drinking Water Act for their risks to human health; or (3) listed as hazardous air pollutants under the Clean Air Act" (Waxman 2011). The Committee revealed that over the 4-year period these additives included lead, ethylene glycol, benzene, toluene, and xylene compounds. Moreover, the investigation reported that over 32 million gallons of diesel fuel, one of the only additives regulated by the Safe Drinking Water Act, were injected across nineteen states.

Wastewater is generated during the HVHF process in the form of flowback (i.e., fluid returned to the surface after HVHF has occurred, but before the well is placed into production) and produced water (i.e., the fluid returned after the well is placed into production) (USEPA 2011). During injection, HVHF fluids come in contact with the bedrock, often affecting the mobility of naturally occurring substances in the subsurface, particularly in the hydrocarbon-containing formation. These substances include formation fluids (e.g., brine or sodium chloride; Piggot and Elsworth 1996), gases (e.g., methane, ethane, carbon dioxide, hydrogen sulfide; Zoback et al. 2010), trace elements (e.g., mercury, lead, arsenic; Harper 2008, Leventhal and Hosterman 1982, Tuttle et al. 2009, Vejahati et al. 2010), naturally occurring radioactive material (e.g., radium, thorium, uranium: Leventhal and Hosterman 1982, Harper 2008, Tuttle et al. 2009, Vejahati et al. 2010) and organic material (e.g., acids, polycyclic aromatic hydrocarbons, benzene, toluene, xylene; URS Corporation 2009, NYSDEC 2011). Some of these substances may be liberated from the formation via complex biogeochemical reactions with the chemical additives found in hydraulic fracturing fluid (Long and Angino 1982, Falk et al. 2006). New York tested flowback from Marcellus Shale gas production in Pennsylvania and West Virginia and found 154 chemicals, many of which are health hazards and are regulated via primary and secondary drinking water standards (NYSDEC 2011). A list of chemicals identified in flowback and produce water is presented in USEPA (2011; Table E2).

Estimates for recovery of fracturing fluid in flowback for the Marcellus Shale range from 10–30% (Arthur et al. 2008). The physical and chemical properties of wastewater vary with fracturing fluid, geographic location, geology and time (Veil et al. 2004, Zielinski and Budahn 2007, Zoback et al. 2010, Rowan et al. 2011). During or prior to treatment, flowback and produced water often are retained on-site in storage tanks, open-air impoundments or evaporation ponds (GWPC and ALL Corporation 2009). Later, these fluids are transported to treatment facilities, injected underground, or discharged to waterways and the environment. Underground injection is the primary method of wastewater disposal from all major plays, except for the Marcellus Shale (Horn 2009, Veil 2007, 2010). For some operations, fluids are transported to wastewater treatment at publicly-owned treatment works or commercial wastewater treatment facilities. However, few facilities are capable of treating fluids containing dangerous contaminants (e.g., radioactive materials), brine (high salinity fluids), and unique compounds, which often are expensive to remove, generated by HVHF operations (Veil 2010, US General Accounting Office [USGAO] 2012).

Contamination from wastewater can occur at any time during operations. Large HVHF operations require extensive quantities of supplies, equipment, and vehicles, which may increase the risks of accidental releases, such as spills or leaks. Surface spills or releases can occur as a result of tank ruptures, impoundment failures, overfills, vandalism, accidents, or improper operations. Released fluids also may flow into nearby surface water bodies or infiltrate into the soil and near-surface groundwater (NYSDEC 2011). Entrekin et al. (2011) reported that 80% of Marcellus Shale gas wells are located within 200 m of riparian areas and 100% are within 300 m. Regulating the rapid expansion of HVHF operations is problematic and violations are common (Entrekin et al. 2011). For example, between January 2008 and December 2011 a total of 3,355 violations of environmental laws by 64 different Marcellus Shale gas drilling companies were reported by the Pennsylvania Department of Environmental Protection. Of these, 2,392 violations of these that likely posed a direct threat to our environment and were not reporting or paperwork violations (Staaf 2012).

The ability of naturally occurring but toxic substances or fracturing fluids to reach ground or surface waters is possible if fractures extend beyond the target formation and reach aquifers, or the casing or cement around wells fails causing contaminants to migrate into drinking water (USEPA 2011). Contamination also can occur through mismanagement and improper operating procedures, inadequate waste treatment practices, improper storage, or inadequately constructed impoundments or well casings. Occurrences of improper well construction and operation, allowing subsurface pathways for contaminant migration resulting in water pollution have been reported (State of Colorado Oil and Gas Conservation Commission 2009a, b, c, PADEP 2010, USAEPA 2010, McMahon et al. 2011). A study in the Marcellus Shale region concluded that methane gas was seventeen times higher in water wells closer to natural gas wells. (Osborne et al. 2011). The concentration of methane in these wells fell within the defined action level for hazard mitigation recommended by the US Office of the Interior (Eltschlager et al. 2001).

Sub-lethal impacts of shale gas development also may adversely influence aquatic environments and interfere with ecological interactions, such as whole-stream metabolism, decomposition of organic matter and accrual of macro-invertebrate biomass (Evans-White and Lamerti 2009). Land clearing during well pad and infrastructure (e.g., roads and pipelines) development, and increased road traffic throughout operations can increase sediment runoff into adjacent streams, lakes and wetlands (Williams et al. 2008, Entrekin et al. 2011). Excessive sediment in aquatic habitats results in higher levels of suspended and benthic particles, which may reduce stream flow, alter light, temperature, dissolved oxygen, and pH levels, and degrade spawning habitat for macro-invertebrate insects (Wood and Armitage 1999, Williams et al. 2008). Reductions in feeding efficiencies or the availability and abundance of prey can lead to negative effects on reproduction and growth of higher trophic-level animals (Peckarsky 1984, Sandheinrich and Atchison 1989, Burkhead and Jelks 2001). Moreover the introduction of chemicals associated with shale gas development (i.e., HVHF fluids and wastewater) can lead to a decline in production by eliminating sensitive taxa representing a majority of community growth and or biomass (Woodcock and Huryn 2007).

Habitat loss and degradation. Habitat loss or degradation is commonly associated with anthropogenic activities, including those of the oil and gas industry. Historically, with vertical drilling, one well pad equaled one well, but horizontal drilling allows for multiple wells per well pad (GWPC and ALL Consulting 2009). However, with the rapid expansion of this energy sector, hundreds of thousands of well sites are projected over the next twenty years, many of which are slated for forest habitat. For Marcellus Shale operations in Pennsylvania, an average, 8.8 acres (3.6 hectares [ha]) of habitat are required for each well pad and associated infrastructure (e.g., storage areas, roads and pipeline corridors) (Johnson 2010). The cumulative impact of all operations in a region can result in landscape level changes in habitat. For example, the projected number of wells by 2030 in Pennsylvania alone ranges from 6,000 to 15,000 (Johnson 2010). Given that nearly two thirds of these wells are expected to occur on forest lands, the potential area of forest to be cleared varies from 33,800 acres (13,800 ha) to 83,000 acres (32,700 ha). Additional habitat loss is likely as other formations, such as the Utica Shale, are developed.

Damage to forest habitat can occur from mechanical clearing during site development and from mismanagement of wastewater. At the US Forest Service Fernow Experimental Forest, damage to over two dozen trees and ground vegetation adjacent to a well pad occurred when HF fluid escaped the well bore during drilling (Adams et al. 2011). The release of fluid drifted over the immediate area causing browning of foliage and loss of leaves and ground vegetation. A major component of the HF fluid, and likely cause of damage, at this site was hydrochloric acid (15% by volume). Subsequent to this accident, fluids were experimentally applied to forest patches. Temporal and spatial development of the applications suggested that direct contact and uptake from the soil by the roots resulted in detrimental effects. A total of 147 trees (11 species)

were affected. The application resulted in a much more open canopy than either control or recently burned plots, resulting in significantly more light penetration.

Removal of forest habitat, regardless of method, creates an associated edge effect ranging from 100–300 m into the interior forest stand. Increasing light and wind exposure, and changing temperature can alter vegetation dynamics, causing avoidance by many birds, mammals, reptiles and amphibians (Gibbs 1998, Flashpohler et al. 2001, Marsh and Beckman 2004). Disturbed areas also are more vulnerable to invasive plants (Meeking and McCarthy 2001, Harper et al. 2005). Furthermore, the distribution of clearings will increase forest fragmentation, resulting in species isolation and loss of genetic diversity (Lee et al. 2011). In Pennsylvania, Johnson (2010) estimated an additional 21 acres (8.6 ha) of interior forest habitat would be affected for every 8.8 acres (3.6 ha) of cleared forest for Marcellus Shale development. Thus, a total of direct and indirect impacts to forest habitat could equal 30 acres (12.3 ha) per well pad, resulting in 81,500 to 200,300 acres (33,340–81,940 ha) of forest habitat loss or degradation (Johnson 2010). Drohan et al. (2012) indicated this level of impact was enough to substantially alter the Pennsylvania landscape.

Greenhouse gas emissions. During combustion, natural gas emits less carbon dioxide (a greenhouse gas [GHG]), nitrogen oxide and sulfur oxide (two contaminants contributing to acid rain) than coal (Entrekin et al. 2011). However, during extraction, shale gas development produces considerable amounts of methane, a major component of natural gas and a powerful GHG (Howarth et al. 2011). The amount of fugitive emissions of methane into the atmosphere during HVHF operations compared to conventional operations may contribute more to global warming than other fossil fuel development (USEPA 2010). Howarth et al. (2011) calculate that during the life cycle of an average shale gas well, 3.6–7.9% of the total production of the well is emitted to the atmosphere as methane, which is at least 30% to 50% as great as estimated for a conventional well. Methane dominates the GHG footprint for shale gas on a 20-yr time horizon, contributing 1.4–3 times more than does carbon dioxide emission, resulting in a GHG footprint for shale gas at 22%–43% greater than that for conventional gas.

POTENTIAL IMPACTS TO BATS

Bats of the northeastern US are insectivorous and are the primary consumers of nocturnal arthropods, including many agricultural and forest pests. Given the relatively large volumes of insects consumed (up to 100% of bats body mass/night; Kurta et al. 1989) and extensive foraging home ranges, bats play a major role in suppressing nocturnal insect populations and transporting nutrients across landscapes (Fenton 2003, Jones et al. 2009). Moreover, bats provide an economic benefit by saving US farmers an estimated $22.9 billion (range: $3.7–$53 billion) each year in pesticide use (Boyles et al. 2011). Because of their important role in ecosystem services, bats often are used as indicators of habitat quality (Wickramasinghe et al. 2003, Kalcounis-Rupell et al. 2007, Jones et al. 2009). Bats may serve as the proverbial “canary in the coalmine” because many of their life history traits make them sensitive to human-induced environmental

changes (Estrada et al. 1993, Medellin et al. 2000, Moreno and Halffler 2000, 2001, Estrada and Coates-Estrada 2001a, b, Clarke et al. 2005a, b, Hayes and Loeb 2007, Kunz et al. 2007). Bats have low reproductive potential (i.e., reproducing once per year and typically only having a single pup) and require high adult survivorship to avoid population declines (Barclay and Harder 2003, Podlutsky et al. 2005). Because bats are not able to recover quickly, large-scale changes may put populations at risk (Findley 1993, Henderson et al. 2008).

Historically, contamination from pesticide use and loss or disturbance of suitable habitat contributed to population declines. In recent years, both anthropogenic and natural forces have adversely affected North American bats, particularly in the northeast. Since 2003, wind energy development has resulted in potentially hundreds of thousands of bat fatalities (Kunz et al. 2007, Arnett et al. 2008). Although wind-powered turbines primarily affect migratory tree-roosting bats, cave-roosting species (e.g., little brown bat [*Myotis lucifugus*] and tri-colored bat [*Perimyotis subflavus*]) can compose approximately 20% of fatalities (Arnett et al. 2008). In 2006, the first fatalities from White-nose Syndrome (WNS) were documented in New York. Over the past six years, the fungus (*Geomyces destructans)* causing WNS has spread across nineteen states and killed millions of bats from six different species (Bat Conservation International; www.batcon.org). Little brown bats, once considered common, have shown the greatest mortality of all species affected by WNS (Frick et al. 2010b), but northern long-eared (*M. septentrionalis*), eastern small-footed (*M. leibii*), Indiana (*M. sodalis*), and tricolored bats also have experienced severe mortality (Kunz and Reichard 2011). Turner et al. (2011) estimated an 88% decrease in the total number of hibernating bats, with 98%, 91% and 72% declines in hibernating northern long-eared, little brown bats, and Indiana bats, respectively.

The perilous decline in bat populations is exacerbated by the additive nature of both WNS and numerous anthropogenic activities, possibly including shale gas development (USGS 2009). Coincidentally, the Marcellus Shale lies within the same area as the epicenter of WNS. The impacts associated with natural gas exploration and extraction in this region may further imperil already decimated bat populations (Matteson 2010). Of particular concern are the Indiana bat, currently listed under the Endangered Species Act, the northern long-eared and eastern small-footed, recently petitioned for listing by the Center for Biological Diversity (Matteson 2010), and the little brown bat, a species predicted to be extirpated from a significant proportion of its range by 2026 (Frick et al. 2010b, Kunz and Reichard 2011). Although there are no publicly available studies investigating the impacts of shale gas development on bats, we can infer potentially adverse effects based on other human-induced landscape-level changes.

Water withdrawal. Aquatic habitats play a critical role in the ecology of bats, both as sources of water and insect prey (Racey and Swift 1985, Grindal et al. 1999, Downs and Racey 2006, Hayes and Loeb 2007). Bats have relatively high rates of evaporative water loss, and must obtain much of their intake from available surface water resources (Kurta et al. 1989, 1990, McClean and Speakman 1999, Webb 1995, Neuweiler 2000). Kurta et al. (1989) estimated that bats may drink up to 26% of their daily water intake from open water sources (e.g., ponds or

streams) to maintain water balance. Available water is vital for reproductively active females, particularly lactating bats, which require a sufficient amount of water while nursing young (Johnson et al. 2011). Adams and Hayes (2008) observed lactating female bats drinking 13 times more often than non-reproductive bats. Moreover, studies have shown that pregnant and lactating female bats select foraging areas, in part, based on proximity to water (Speakman et al.1991, McClean and Speakman 1999, Adams and Thibault 2006). For example, Johnson et al. (2011) observed eastern small-footed bat roosts within 500 m from water sources.

Riparian areas and other hydric habitats (e.g., lakes, ponds, and wetlands) are important resources because they support higher concentrations of nocturnal insects (MacGregor and Kiser 1998). Many bat species are opportunistic foragers and select areas where abundant and available prey occur (Thomas 1988, Barclay 1991, Barclay and Brigham 1991, Hart et al. 1993, Krusic and Neefus 1996, Grindal et al. 1999, Broders 2003). Murray and Kurta (2002) found that aquatic insects compose a large proportion of the diets of Indiana bats in the northern part of the species range. Commuting and foraging activity for many species is typically higher in riparian areas than in upland sites (Furlonger et al. 1987, Krusic et al. 1996, Grindal et al. 1999, Zimmerman and Glanz 2000, Seidman and Zabel 2001, Veilleux et al. 2003, Leput 2004, Menzel et al. 2005) and some species spend significant proportions of their nightly activity in these areas (LaVal et al. 1977, Brigham et al. 1992, Barclay 1999, Fellars and Pierson 2001, Waldien and Hayes 2001). Thus, the extensive withdrawal of water resources from the environment, particularly in sensitive areas or areas under drought conditions, will presumably affect roost-site selection and abundance and availability of prey.

Water contamination and toxic exposures. Riparian habitats support large numbers of insects and are prime foraging areas for insectivorous bats (Vaughn et al. 1996,). However, the inflow of heavy metals and other toxins from industrial wastes can adversely affect water quality and the invertebrate community (Mason 1997, Jones et al. 2009). Bats have been observed congregating and drinking from holding ponds at industrial sites (Huie 2002). Clark and Hothem (1991) reported the occurrence of bats dying by asphyxiation after drinking solutions containing cyanide from open holding ponds of gold mining operations. Similarly, open pits containing flowback and produced water associated with HVHF operations could expose bats to toxins, radioactive material and other contaminants.

Exposure to environmental contaminants is a suspected factor in the decline of North American bat species (US Fish and Wildlife Service [USFWS] 1999, Schmidt et al. 2002). Metabolic processes of insectivorous bats are rapid and bats consume large quantities of food relative to their body mass (Kurta et al. 1989, Schmidt et al. 2002). Because dietary accumulation and metabolic capacity increase at higher trophic levels, and because insectivorous bats are apex predators, bats are likely more susceptible to contaminants (Allerya et al. 2000, Eisler and Wiemeyer 2004, Jones et al. 2009). Toxic contamination can occur during normal operations, accidentally or by improper management. In such an event, contaminated drilling mud or water may migrate into caves and fissures used by bats, which can be ingested by

grooming or be inhaled (Adams et al. 2011). Toxins often accumulate in fat, and are more likely to have adverse physiological effects when bats are depleting fat reserves, such as during hibernation, migration, or lactation (Kurta et al. 1989, O'Shea and Clark 2002).

Three heavy metals, cadmium, mercury, and lead, commonly associated toxins in wildlife studies, are contaminants reported in HVHF operations. Cadmium affects a number of systems, including reproductive and renal systems (Chmielnicka et al. 1989, Walker et al. 2007). A paucity of information exists on the occurrence and affect on cadmium in bats. However, Clark et al. (1988) postulated a relationship between cadmium concentrations in the guano of grey bats (*M. grisescens*), a federally endangered species, and kidney lesions. Mercury concentrations in aquatic and terrestrial food webs of the northeastern US are considered detrimental to local bat populations (Driscoll 2007, Osborne et al. 2011). Observed consequences of mercury exposure in mammals include reduced immune function, hormonal changes, impaired function of the central nervous system and motor skill impairment, and reduced reproductive success (Wiener and Spry 1996, Nocera and Taylor 1998, Evers et al. 2004, Schweiger et al. 2006). Lead is the most ubiquitous toxic metal and has been associated with a wide range of toxic effects from neurological, hematological, renal, and reproductive (Goyer 1996). Several studies have reported the potential negative impacts of lead on both wild and captive bats (Zook et al. 1970, Sutton and Wilson 1983, Hariono et al. 1993, Skerratt et al. 1998, Walker et al. 2007), including a possible link between elevated concentrations of lead and still births in big brown and little brown bats (Clark 1979).

Data on the impacts of other toxins and radionuclides on bats is limited (Eisher 1994, Ma and Talmage 2001, O'Shea and Clark 2002). The majority of data on bats and environmental contaminants comes from studies investigating the impacts of pesticides, and, to a lesser extent, heavy metals (O'Shea and Clark 2002, Schmidt et al. 2002). However, if contaminants associated with HVHF operations are introduced into aquatic ecosystems and are readily transferrable through insectivorous food chains, bats will presumably accumulate these substances and potentially suffer adverse effects.

Habitat loss and degradation. Fragmentation is considered a primary threat to global biodiversity (Franklin et al. 2002) and has the potential to directly impact bat populations by limiting essential roosting and foraging resources (Fenton 2003, Safi and Kerth 2004, Lane et al. 2006, Henderson et al. 2008). Anthropogenic changes in ecosystems often result in fragmenting forest landscapes and typically occur at rates dramatically faster than long-lived organisms are capable of adapting, thus disrupting life history cycles and ecological processes (Duchamp and Swihart 2008). Rapid ecosystem changes are associated with population declines in many bat species (Jones et al. 2009, Safi and Kerth 2004). In North America, the result of human-induced changes often results in patchy species distributions rather than range contraction (Pierson 1998). Recent studies have focused on temperate bat communities in greatly modified ecosystems, finding a positive association between bat abundance and diversity, and remnant natural habitat, such as forests and wetlands (Walsh and Harris 1996, Jaberg and Guisan 2001, Russ and

Montgomery 2002, Gehrt and Chelsvig 2004, Duchamp and Swihart 2008). Negative effects on bats from forest cover loss also are well documented from processes such as forest harvesting (Grindal 1996, Patriquin and Barclay 2003) urban expansion (Evelyn et al. 2003, Duchamp et al. 2004, Sparkes et al. 2005a) and agricultural intensification (Russ and Montgomery 2002, Lesinski et al. 2007).

Intact, mature forest stands possess structural features such as snags and large, overstory trees that are vital for cavity- and foliage-roosting bats, respectively (Jung et al. 1999, Cryan et al. 2001, Carter and Feldhamer 2005, Broders et al. 2006, Perry and Thill 2007, O'Keefe et al. 2009). In summer, bats select specific structures that offer protection and appropriate thermoregulatory conditions for survival and development of young (Humphrey et al. 1977). Loss of forest cover and degradation of forested habitats have been cited as part of the decline of Indiana bats (USFWS 1983, Gardner et al. 1990, Garner and Gardner 1992, Drobney and Clawson 1995, Whitaker and Brack 2002). Presence of northern long-eared bats, an interior forest species, is dependent on mature, contiguous deciduous forests for both roosting and foraging habitat (Sasse and Perkins 1996, Hutchinson and Lacki 2000, Lacki and Schwierhojan 2001, Broders and Forbes 2004, Carter and Feldhamer 2005, Broders et al. 2006, Perry et al. 2007, Henderson and Broders 2008). Moreover, this species forages almost exclusively in closed canopy forests and avoids forest gaps and open areas (Owen et al. 2003, Patriquin and Barclay 2003, Schirmacher et al. 2009).

Many forest-dwelling bats frequently switch roosts (Lewis 1995), but tend to remain loyal to specific roosting and foraging areas. Site fidelity is advantageous, allowing bats to become familiar with suitable roost trees and the local spatio-temporal variation in prey abundance and availability, thus decreasing time spent commuting and foraging (Avital and Jablonka 2000, Broders et al. 2006). Studies of Indiana bat roost-site selection show reproductively active females returning to the same home range year after year to establish maternity colonies. (Humphrey et al. 1977, Gardner et al. 1991a, 1991b, Gardner et al. 1996, Callahan et al. 1997, Menzel et al. 2001, Kurta and Murray 2002, Britzke et al. 2003, Whitaker and Sparks 2003, Whitaker et al. 2004). Roost tree reoccupation of up to six years has been documented in a number of studies (Garner et al. 1991b, Whitaker et al. 2004, Barclay and Kurta 2007). Maternity colonies of Indiana bats also appear to be faithful to their foraging areas within and between years (Cope et al. 1974, Humphrey et al. 1977, Gardner et al. 1991a, 1991b, Murray and Kurta 2004, Sparks et al. 2005b). Similarly, northeastern long-eared, eastern small-footed, and tri-colored bats select specific areas, often re-using sites within and among years (Kalcounis and Hecker 1996, Sasse and Pekins 1996, Brigham et al. 1997, O'Donnell and Sedgley 1999, Weller and Zabel 2001, Menzel et al. 2002, Willis and Brigham 2004, Perry and Thill 2007).

The philopatry observed among numerous species requires consideration by natural resource managers who often permit harvesting trees during winter when bats are hibernating, a practice intended to limit directly harmful effects of development (Arnold 2007). However, because females consistently return to the same site(s), this practice may do less to mitigate the

immediate effects of habitat loss than anticipated. Bats, already pregnant, arrive to sites after hibernating for seven months and migrating for up to 500 kilometers (km), at a time of cool, wet weather, which likely limits prey availability (Humphrey et al. 1977, Kurta et al. 1996, Murray 1999). The loss or alteration of forest habitat places additional stress on females, and may increase thermoregulatory costs and potentially disrupt social bonds of a colony (Kurta and Murray 2002). Such impacts have been documented in other bat species. Brigham and Fenton (1986) documented a 56% decline in reproductive success of a big brown bat colony that was excluded from their maternity roost. Sparks et al. (2003), demonstrated that the natural loss of a single primary maternity roost lead to fragmentation of the colony (bats used more roosts and congregated less) the following year after roost loss.

Hibernacula and the habitat surrounding these sites also warrant protection from development, particularly drilling operations. Hibernating bats select sites within caves and mines possessing specific microclimate (e.g., temperature, humidity, and airflow) conditions (Clawson et al. 1980, Tuttle and Kennedy 2002). Alterations to this microclimate, whether natural or human-induced, often render a site less suitable for hibernation (Johnson et al. 2002). Moreover, disturbing bats during winter hibernation may result in additional arousals causing bats to lose fat reserves and possibly abandon the roost. Adams et al. (2011) highlighted the importance of understanding the connectivity of karst geology in proximity to winter hibernacula prior to development. Modifications to the surface habitat surrounding hibernacula also can contribute to changes in microclimate conditions, as well as influence the suitability of foraging characteristics. The landscape surrounding hibernacula supports foraging and roosting needs of large numbers of bats during fall swarming periods, when bats are building up crucial fat reserves to survive the winter (Hall 1962). Areas surrounding hibernacula also provide important summer habitat for male Indiana bats that do not migrate far from the winter roost.

Habitat use by forest bats is complex and varies by species. Bats rely on extensive resources over large areas (Duchamp et al. 2009). The magnitude of shale gas development predicted over the next twenty years is expected to have similar effects on forest landscapes (i.e., habitat loss and degradations) as other anthropogenic activities, but at a much greater level due to the proliferation of projected drilling sites. Therefore, providing conditions necessary to support bat populations will require a combination of designating certain forest areas as off-limits and implementing forest management practices that perpetuate suitable roosting and foraging habitat (Duchamp et al. 2009).

Greenhouse gas emissions. The effects of climate change on bats have not been studied extensively. However, it is believed that insectivorous bats may be among the most affected species because seasonal temperature changes may affect hibernation, food abundance and availability, and recruitment (Jones et al. 2009). Most bat species have specific temperature regimes that are conducive for surviving over half the year in hibernation. For example, Indiana bats hibernate in caves or mines where the ambient temperature is consistently below 10° C (Hall 1962, Meyers 1964, Henshaw 1965, Humphrey 1978, Tuttle and Kennedy 2002). Tuttle and

Kennedy (2002) reported that populations hibernating with temperatures between 3–7.2° C remained stable or increased, whereas populations hibernating at temperatures above or below this range were unstable or declined. With winter conditions expected to become shorter and warmer, disruptions to the mammalian overwintering energy budgets are expected (Gu et al. 2008). Milder winter conditions may force bats to enter hibernacula later than usual, presumably with inadequate fat reserves if food availability decreases in late fall (Matteson 2010). Warmer temperatures in winter also may result in unsustainable arousal frequencies (Humphries et al. 2002). Because arousals account for up to 80% of the energy budget (Thomas 1995) of hibernating bats, any increase in frequency or duration could decrease survivorship.

It has also been posited that changes in temperature may disrupt bat reproductive physiology. In winter, altered temperature regimes may diminish the viability of spermatozoa stored in the female reproductive tract, thus females may not become pregnant upon emergence, or become pregnant too early and undergo embryonic development and parturition earlier in the spring, which may lead to declining recruitment if conditions are not suitable for young (Jones et al. 2009). In summer, dwindling water resources caused by warmer temperatures and reduced precipitation can lead to lower reproductive rates as female are not able to meet their water budget to produce milk for nursing pups (Kurta and Rice 2002, Barclay et al. 2004, Adams and Hayes 2008, Rodenhouse et al. 2009). Adams (2010) observed reductions in reproductive behavior and increases in non-reproductive female bats in years with above average temperature and below average precipitation, conditions similar to predictions of regional climate warming and increased drought.

Changes in precipitation and temperature also are anticipated, thus diminishing water availability during summer and altering the distribution, abundance, and phenology of insects (Hughes 2000, Bale et al. 2002, Parmesan 2003, Menendez 2007, Rodenhouse et al. 2009). Reductions in insect abundance and availability will have detrimental effects on bat populations, particularly during critical periods (i.e., during pregnancy, lactation and fall swarming). Frick et al. (2010a) concluded a direct relationship between cumulative summer precipitation and probability of survivorship in little brown bats.

Climate data indicates we are in a rapid period of change, which already is being observed across a range of ecosystems (Jones et al. 2009). Climate change is likely to affect roosting and foraging behaviors and opportunities, particularly during times when bats are most vulnerable. Anthropogenic activities that increase the global GHG footprint, including HVHF operations, presumably will exacerbate adverse impacts on bat populations. Thus, methods to reduce the fugitive emissions of methane from shale gas development should be explored and implemented.

CONCLUSIONS

Bats are vital in terms of their ecological and economic roles, and are well suited as indicators of environmental health (Fenton 2003, Jones et al. 2009). Worldwide, bats function as pollinators, seed dispersers, and biological controls for nocturnal insects (Kunz and Parsons 2009). In North America, most species are insectivorous and consume large quantities of night-flying insects, many of which are agricultural and forest pests. Regrettably, many bat species are experiencing population declines and range contraction in response to both natural and human-induced environmental stressors (Jones et al. 2009). White-nose Syndrome has decimated hibernating bat populations in northeastern North America, including declines of nearly 98% and 88% in Pennsylvania and New York, respectively (Turner et al. 2011). Species affected include the little brown bat, a once common species, and the federally endangered Indiana bat (Frick et al. 2010b). At least three additional species are being considered for listing (Matteson 2010 Kunz and Reichard 2011). A sense of urgency exists among bat biologists because bats have low reproductive rates and respond slowly to rapid population declines (Barclay and Harder 2005). Compounding the devastation of White-nose Syndrome are human activities associated with the degradation and destruction of suitable habitat and resources for these imperiled species (Kunz and Parsons 2009). As with other industrial practices, shale gas development contributes to water withdrawal and contamination, habitat loss and degradation, and the emission of GHGs resulting in detrimental effects on bat populations and their environment. Immediate action is required to reduce these adverse impacts and to ensure that bats and the ecosystems they serve are considered during shale gas development and production.

Eastern small-footed bat (*Myotis leibii*). Photo credit: Bat Conservation International.

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Pennsylvania Department of Environmental Protection
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May 7, 2012

Re: **Time sensitive** – TGP restoration action should implement on a delayed schedule in order to protect and preserve amphibian species currently active in the proposed areas of activity.

To whom it may concern:

Delaware Riverkeeper Network is writing to alert you to the on-the-ground juvenile amphibian activity currently occurring along Tennessee Gas and Pipeline's ("TGP") 300 Upgrade pipeline and to request agency assistance to re-open or modify TGP's permit construction timeline and operations to protect sensitive wetland habitats and critical amphibian species to ensure a second impact to these wetland areas is not conducted at an important amphibian window currently underway this spring. It is Delaware Riverkeeper Network's understanding (based on correspondence noted in PCCD report) that **Tennessee Gas Pipeline (TGP) plans to begin final stabilization and restoration of the Tennessee 300 Line in Pike County beginning by May 15, 2012 in this sensitive wetlands area so this matter is time sensitive.**

The required stabilization has been delayed by TGP for months on this project despite requests by agencies and the Delaware Riverkeeper Network that have urged TGP to begin final restoration sooner in the mild winter months. Regrettably, TGP failed to undertake the required restoration earlier in the year when there was less ecological activity and so less risk of ongoing ecological harm – specifically we refer to the amphibian mating, reproduction and growth happening now. In light of this changed ecological condition due to the delay in construction, we urge that critical amphibian windows of protection be implemented and the work schedule, methods and operations modified accordingly. It is important to note TGP's 300 line has been in operation since November 2011 and so this required restoration activity could have been conducted in the mild winter months at a less sensitive time and in a more timely fashion to avoid the additional considerations and measures we are seeking.

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Delaware Riverkeeper Network visited three wetland areas along the pipeline corridor in Delaware State Forest and the TGP 300 Line on April 29 and May 4, 2012. These areas are located in anti-degradation special protection watersheds and therefore these wetlands are also protected. Craft Brook is Exceptional Value as is its adjacent wetlands. During these field visits juvenile wood frog tadpoles (*Rana sylvatica*), adult red spotted newts (and juvenile red efts) (*Notophthalmus viridescens*), and American toads (*Bufo americanus)* were visibly present and abundant. In addition DRN staff heard the vocalizations of spring peepers (*Pseudacris crucifer*) in adjacent woodlands indicating likely spring peeper tadpoles are also present in adjacent wetland areas, just less visible in size. This was not a thorough herpetological study and so other species may very well be using these areas too and we would highly recommend a thorough herpetological survey be immediately conducted to determine other species present in this high quality area of the Delaware State Forest.

The wetlands at issue are classified as W038, W039, and W041 by TGP and are accessible from Delaware State Forest off of Schocopee Road northwest of Milford PA, Pike County. DRN requests assistance and guidance from agency wildlife specialists to ensure proper measures are taken in light of the situation and the looming construction date TGP has planned. It is important to note that DRN's understanding (based on the Earth Disturbance Inspection Report signed by PCCD on 4/12/12, Page 3) is that major construction is still planned at these wetland sites that would involve heavy equipment and major ground moving disturbance rather than hand work and more sensitive and minor removal of silt fences and remaining E&S devices. At these wetlands, large wood timber mats submerged and placed throughout the wetlands may need to be removed from the wetlands bottoms – seriously disturbing the wetland and causing major sediment pollution that would impact juvenile tadpoles present in the wetlands. Some photos of these wetlands and the current pipeline conditions are available on Facebook here: http://www.facebook.com/media/set/?set=a.380274482023632.109841.170168039700945&type=3

Discussions on Monday with invertebrate zoologist, Betsy Leppo, of the Pennsylvania Natural Heritage Program who helps coordinate the Pennsylvania seasonal pool registry confirmed that the present timeframe of disturbance to begin on May 15 is one of the worst times to be doing construction in and around high quality wetlands due to the presence of amphibian life and immature aquatic dependent species.

Delaware Riverkeeper Network looks forward to working with the agencies and TGP to address this matter so we can ensure restoration efforts by TGP are done at a time and with measures in place that will not threaten the amphibians in these existing wetlands. DRN has not visited other wetlands located along the pipeline but would ask that other wetlands where amphibian life may be common also be considered and properly protected. The Tennessee Gas Pipeline's 300 line project is disturbing **108.2 acres of wetlands which consist of 39.2 acres of forested wetland and 69.0 acres of non-forested wetlands. Operation of the Project would permanently impact 22.9 acres of wetlands, consisting of 13.6 acres of forested wetlands and 9.3 acres of non-forested wetlands**. This cumulative impact means that sensitivity to the amphibians that rely on these regions is essential to protecting these special protection habitats and watersheds.

Please contact me as soon as possible at 215-369-1188 ext 102 to discuss next steps. We are hopeful that we can work cooperatively to get this matter resolved in the best way possible.

Sincerely,

Maya K. van Rossum
the Delaware Riverkeeper

cc: US Army Corps of Engineers
Susan Beecher, Pike County Conservation District
Bradley Elison, DCNR, Delaware State Forest
Chris Urban, PA Fish and Boat Commission
Carol Collier, Delaware River Basin Commission
U.S Fish and Wildlife Service
Tennessee Gas Company

DRN Comments – Columbia Gas Line 1278 Line K Replacement in Special Protection Waters - DRBC Docket - D-2014-008-1

DRBC states in the DRAFT docket that "*The project was not reviewed by the Commission prior to its construction due to a project screening oversight by Commission staff….DRBC staff visited parts of the pipeline with a Columbia representative Environmental Inspector on Nov 21, 2014. During the field visit, staff observed four water body crossings (Sawkill Creek, Raymondskill Creek and two crossings of the Shingle Kill), a wetland area, a steep slope area, right-of-way in the Delaware State Forest, the Milford Mainline Valve site, the Milford Compressor Station, the Mill Rift Launcher/receiver and the Hook Road Launcher/receiver site.* ***DRBC staff concurs with the FERC inspector's assessment that overall environmental conditions were acceptable.***"

DRBC is woefully too late and its response is not adequate for Columbia 1278 – The Docket states the pipeline project was constructed from May 17, 2011 and began running gas in all segments by October 25, 2011. DRBC's only site visit to the pipeline was conducted on Nov 21, 2014 – over three years after the pipeline project was constructed and running gas through the Delaware River Basin…this is an instance of too late and inadequate site visits by the DRBC and there is great harm to show for this DRBC mishap that should have been regulating this pipeline all along its planning and construction phases to minimize harms and require better remediation and restoration.

Woefully Inadequate Remediation and Restoration --- PCCD states in their April 27, 2012 inspection report that there were "about 50 live stakes planted on the east bank of Sawkill Creek and the south side of the ROW." What other shrub and tree plantings were required and with heavy deer browse pressure in these areas, why was Columbia not ordered to plant larger shrubs and trees to account for natural deer herbivory impacts that are obvious for this region?

DRBC also needs to recognize that "temporary work spaces" along the ROW are far from temporary as Columbia would like to suggest. Soil compaction in these spaces limits groundwater infiltration, changes hydrology and increases stormwater runoff causing irreparable permanent harm.

DRN requests the DRBC at this time require better restoration and remediation by Columbia along this pipeline path in special protection waters in an attempt to minimize the great harm inflicted within the construction ROW, permanent ROW and in the so called temporary work spaces. Activities could include the planting of more native trees along the construction ROW to minimize the overly wide pipeline ROW footprint that was an unnecessary width of 75-100 feet. Stream buffer plantings with native woody shrubs at the 16 stream crossings should be required to begin to repair the damage of these stream cuts and riparian buffer cuts through HQ and EV streams. Plantings should involve larger native stock instead of the small root cuttings and bare roots that have perished from deer browse, as evidenced by field visits in that region

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on other pipeline ROWs. 26 wetlands were cut through, and where forested wetlands were disturbed, plantings of native shrubs in those areas could help minimize the long term harm of the pipeline path. DRBC should also require Columbia to take steps to restore the soil permeability and porosity and reduce the compaction that comes with these large pipeline projects.

Finally, DRBC needs to assess monetary fines that make a meaningful dent in Columbia's practices to encourage Columbia to not repeat this harm. Adequate fines would help reimburse the community for the harms that were inflicted on them from this pipeline project and help with needed restoration and mitigation improvements that are sorely needed to reduce the impact of this permanent scar on the landscape.

The Commission states in the docket, "*DRBC* ***staff reviewed the ECS and Environmental Construction Drawings and determined that the plan fulfills the Non-Point Source Pollution Control Plan requirements for projects located in Special Protection Waters"*** But what about the past harm and violations by Columbia that has clearly been documented time and time again during and after the active construction of the project? Did DRBC talk with or coordinate with other agency staff that documented this harm and violations? Why did DRBC only go out with FERC Environmental Inspectors (EI's) of the Project that are in fact so closely tied to and paid for by the pipeline operator? Did DRBC consult with the local PCCD and Army Corps? The rosy picture of the pipeline construction documented in the Docket simply is not what actually happened with the facts on the ground by regulatory agencies.

During construction of the 1278 Columbia Line K, there were multiple instances where severe violations were detected. For example, a DRN FOIA to the Pike County Conservation District (PCCD), shows PCCD issued multiple Notice of Violations (NOV's) showing the unacceptable harms of this pipeline construction project for the areas of the pipeline they were able to assess.

PCCD issued at least 20 NOVs during a 5/27/11 to 4/30/12 timeframe based on their inspections. DRN also had volunteer monitors on the ground calling in pollution events during rain storms. It's important to note that PCCD was able to only do partial inspections due to hunting seasons and staffing also so one would have to ask how much more of this project may have included violations along its entire route? PCCD Inspections showed violations of the Clean Streams Law and Chapters 92 and/or Chapter 102. Every instance and field visit found multiple and serious Clean Streams Law violations along the inspected pipeline route.
PCCD NOV's were issued on: 5/27/11; 6/9/11; 6/10/11; 6/17/11; 6/20/11; 6/21/11; 6/29/11; 7/7/11; 7/14/11; 7/27/11; 7/29/11; 8/11/11; 8/30/11; 9/9/11; 9/29/11;10/24/11;12/2/11; 12/16/11; 2/27/12; 4/30/12.

Furthermore, according to the 4/30/12 NOV, repeatedly, the pipeline company and its EI's <u>did not</u> address the prior violations or needs or actions to remediate the pollution problems that were documented by the PCCD. Time and time again remediation and corrective actions were promised by the pipeline operator to get put on the pipeline punch lists and fixed, but according to the PCCD prior violation reports, were simply ignored by the pipeline operator leading to ongoing problems, continued pollution and scars leading to recurring and repeated harm to special protection streams, EV wetlands, Delaware State Forest, and public water supply sources. Instead of Columbia addressing these issues, they engaged in a he said she said on the FERC docket challenging the professional guidance of trained erosion and sediment control agency staff in the field. This just helps emphasize the tactics these corporations take to attempt every effort to fight needed remediation and restoration. Which is another reason why close agency scrutiny is required along the pipeline path throughout the construction and remediation process.

Below from PCCD NOV dated 4/30/12

> The inspection(s) revealed that earth disturbance activities at the Columbia Gas Line 1278 Line K Replacement site are in continued violation of the Rules and Regulations of the Department and the Clean Streams Law. Additional violations were documented on inspection reports dated May 27, 2011, June 9, 2011, June 10, 2011, June 17, 2011, June 21-22, 2011, June 24, 2011 and June 27, 2011, July 7, 2011, July 9, 2011, July 14, 2011, July 26, 2011, July 28, 2011, August 9, 2011, August 19, 2011, August 30, 2011, September 7, 2011, September 28, 2011, October 21, 2011, December 1, 2011, December 11, 2011, and February 27, 2012. In addition, previous notices by this office requesting that site conditions and violations be corrected have not been met.

These violations documented by PCCD included major ongoing, continued and multiple violations and ignored agency orders including like those listed on the 4/30/12 NOV report which cited three major recurring violations including:

Failure to implement effective Post Construction Stormwater Management BMPs

Permanent slope breakers do not have permanent outlet structures installed as called out in plans and noted in prior PCCD correspondence and inspection reports.

Failure to provide temporary stabilization of earth disturbance sites

a. Areas throughout ROW have sparse to minimal vegetative growth including on steep slopes
b. Seeps throughout ROW to Vandermaark Creek have caused erosion gullies and concentrated stormwater flows and runoff.
c. Streambanks like that of Sloat Brook displayed bank erosion and sloughing

Site conditions present a potential for pollution to waters of the Commonwealth.

The list of violations goes on and on by PCCD documenting harms throughout the active construction project and after construction. Including the following examples (pulled from various NOVs):

-Sediment plumes in Swale Brook and pond due to failure to maintain BMPs (6/17/11 inspection)
-Sediment laden water observed flowing down ROW and flowing into wetlands (6/17/11 inspection)
-Sediment laden water entering Raymondskill Creek and Sawkill Creek (HQ and EV waterways) that past through make shift earthen berms & through gaps on compost filter socks. (6/17/11 inspection)
-Sediment discharging into Waters of the Commonwealth (6/17/11 inspection)
-At Raymondskill Creek - Grass growth noted in wetlands (which is not allowed) and PCCD conferring with Army Corps to determine if post construction conditions are similar to pre-conditions and that the wetland is being hydrologically supplied appropriately. (4/27/12 inspection report)

We can provide the NOVs we have on file for DRBC if requested as part of the record as the violations go on and on and are too numerous to speak of in my testimony.

DRBC Docket states, "*The Line 1278 replacement project in Pike County, Pennsylvania, impacted 26 wetland areas totaling approximately 3.33 acres. Except for 0.24 acres of forested wetlands that were permanently converted to emergent wetlands, all wetlands were restored to original elevations and contours and the vegetation was allowed to reestablish or was mitigated to preconstruction conditions. Columbia provided mitigation for the 0.24 acres of permanent conversion of forested wetlands to emergent wetlands within the Philadelphia District at the Panther Swamp Site.*"

How does DRBC know that all of the wetlands were restored to preconstruction conditions? Is DRBC taking the word of the EI's beholden to the pipeline company? Did DRBC consult with PCCD or the Army Corps? Did DRBC or the Corps require monitoring pre and post wetlands with elevations to ensure this condition was restored? PCCD states in their 4/27/12 report that PCCD is conferring with Army Corps to

determine if post construction conditions are similar to pre-conditions and that the wetland is being hydrologically supplied appropriately. It appears the local agency has concerns that the wetland have been forever changed. Photos taken by DRN volunteer monitors show wetlands that have a changed flow and elevation due to ground disturbance and the pipeline placement. These hydrological changes and harms are permanent damage to these sensitive habitats.

DRBC Draft Docket states, "*Line 1278 crossed 16 streams in Pike County, Pennsylvania. Additionally, two water bodies were crossed by temporary access roads and three waterbodies were located within the construction area, but not directly crossed. The stream crossings are designated by the PADEP as high quality-cold water fisheries supporting migratory fishes (HQ-CWF, MF) and exceptional value supporting migratory fishes (EV, MF). All water bodies were crossed using the dry crossing method. The dry crossing method utilized temporary dams and flumes or pumps to temporarily divert stream flow around the work area to minimize contact between stream water and the trench excavation and to minimize sediment suspension during construction activities. The pipe was placed a minimum of 5 feet below the streambed. The project did not result in any permanent impacts to streams"*

This simply is not accurate. Irreparable harm impacted these HQ and EV streams where the pipeline cut through. For example, PCCD notes on June 24, 2011, one to four inches of sediment from unmaintained and failing BMP construction practices entered the Sloat Brook and the nearby pond. In this instance the compost filter socks and BMPs were not maintained causing sediment to smother the streambed.

On the same date (June 24, 2011) PCCD found failures of the pump and filter bags being used for the so-called dry crossings – which led to sediment discharging into nearby streams. Mud was built up on the timbers and construction entrances had no rip rap to avoid sediment leaving the site. These are all BMPs outlined in plans but on the ground they simply were not being followed leading to great harm to EV and HQ waterbodies. PCCD goes on to state there could be an un-mapped or unpermitted waterbody crossing near the compressor station. Again – when PCCD was present on site, they continued to find infractions and problems.

July 5, 2015 inspection --- After a hotline call, PCCD found overtopped and malfunctioning BMPs leading to sediment laden water entering Sawkill Creek --- in this instance there was 18-20 inches of sediment inside the BMPs – indicating once again – no routine maintenance by Columbia. The turbidity curtain from the open trench cut on 6/21/11 also remained in Sawkill Creek and the construction entrance rip rap was muddied and not maintained. At Slope Brook, clogged and overtopped BMPs led to pollution entering a wetland (WPA DJC-009). Mud was also entering wetlands along Raymondskille from gaps in the timbers and holes or gaps in the geotextile fabric

July 14, 2011 inspection --- PCCD found sediment in the UNT to the Delaware River and the downstream pond from failing BMPs or lack of BMPs along the pipeline ROW. Vantine Brook jute matting was also not installed correctly as per the approved plan detail maps.

From 7/26/11 PCCD inspection: At UNT to Bushkill Creek: --- the dam and pump methods were being bypassed leading to sediment laden water entering stream ---

At UNT to Bush Kill, PCCD observed trenching in progress through the stream and adjacent wetland. There was no environmental inspector or environmental crew onsite during the inspection. Upstream sand bag coffer was in place between trench and timber bridge with some seepage noted underneath. Downstream coffer in place with some seepage underneath. Sediment-laden water observed in stream channel between the downstream coffer and the pump-around discharge location, but no water was being discharged upon arrival. During inspection, dump truck on bridge being loaded with material excavated from the trench had a tailgate malfunction, resulting in discharge of trench material onto the bridge and into the sump behind the upstream coffer. PCCD observed contractor pumping sediment-laden water from this sump directly to the stream below the downstream coffer. PCCD requested that the pump be shut off and this water be pumped to the dewatering/filtration facility. The dewatering/filtration facility was installed in an adequately vegetated location outside of the stream corridor. PCCD observed a large hole in the filter bag where the pump hose was attached, resulting in pumped water bypassing the filter bag. PCCD notified Henkles & McCoy foreman Chris Powell of the tear and requested a replacement filter bag be installed. Silt fencing installed along edge of right of way, along edge of wetland and along stream was not toed in per standard installation for this BMP. PCCD called Lead EI Richard Shelton and left message regarding site conditions.

July 26, 2011 inspection --- PCCD observed sediment pollution in Swale Brook as far as 0.75 miles downstream from the pipeline ROW construction. A pond on Fisher Lane was also impacted this distance away. PCCD also noted that the stream substrate in the vicinity of the crossing was very sediment laden as opposed to the upstream channel's cobble gravel substrate. PCCD said it did not appear that the top foot of stream substrate was removed during the trenching and segregated and replaced as the final streambed surface during backfilling per the Erosion and Sediment Control Plan.

Conclusion: It is critical and absolutely essential that DRBC requires Columbia now to implement better remediation and restoration of the pipeline path, especially in light of DRBC oversight and failure to become engaged in this destructive pipeline path from its beginning stages.

2014 Field Observations of Tennessee Gas Pipeline, Northeast Upgrade Project
By Nicole Zenes, Delaware Riverkeeper Network

Preliminary Findings and Excerpt for Penn East Scoping Comments

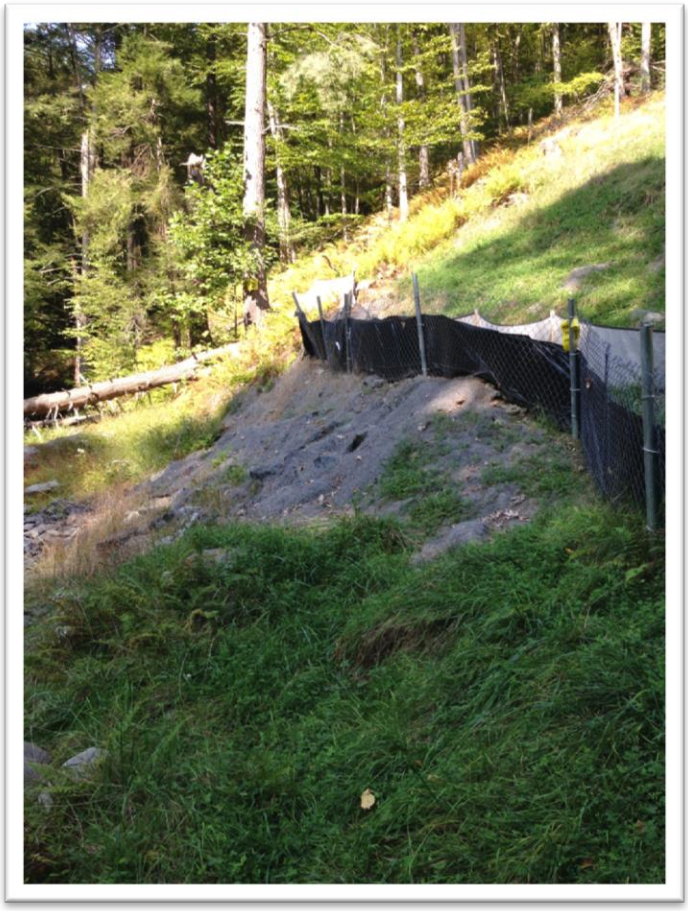
Overview of Study

The fall and summer of 2014 I conducted field work and research under the guidance of Delaware Riverkeeper Network and Princeton University on the effects of clear cutting to build an intrastate natural gas pipeline. I specifically was interested in studying nutrient leaching and loading in streams in Pennsylvania and New Jersey. I conducted 34 field visits at 22 streams that were cut across by the Tennessee Gas Pipeline Northeast Upgrade Project (TGP NEUP). This particular pipeline began tree cutting in mid-February 2013 and construction followed in the spring and summer of 2013. TGP NEUP had constructed and installed the new pipeline and was running natural gas through the new line as of November 2013. Lagging remediation practices and repeated maintenance activities occurred through 2014.

I collected water samples at each pipeline crossing location, recorded stream flow and temperature data, and recorded visual observations. My data and the water samples I collected are still being analyzed at the Princeton University laboratory but I share preliminary observations below for the purposes of the PennEast Scoping period in the hope that FERC examines the full and repeated environmental impacts that could very well occur along the Penn East pipeline route, if approved.

Impacts to Special Protection Streams Along Denuded Steep Slopes

Of the sampled, the section of pipeline that was constructed over Cummins Hill and across Cummins Creek saw the most impact from erosion. The steep slopes that were cleared of mature trees still showed little sign of herbaceous growth on 7/11, 7/14, and 8/14, 2014 during field visits. The slope breakers on the ROW surrounding Cummins Creek were eroding along the perimeter. The water running down the slope breakers pushed the runoff to the side of the ROW creating gullies and stormwater runoff off the ROW and down into the stream. As a result of this erosion and increased stormwater runoff, sediment was observed in riffle habitat of Cummins Creek, which likely impaired aquatic life by smothering the habitat of these animals. This stormwater runoff and lack of regrowth indicates permanent soil compaction on the ROW. Similar locations along temporary work spaces and additional temporary work spaces also had sparse regrowth and soil compaction. The pipeline cut steep mature forested slopes, which has major implications for pollution to the receiving streams at the bottom of such steep slopes. FERC needs to address and evaluate these severe impacts that occur on steep slopes and the resultant pollution that can impact the adjacent streams downslope. Wind throw and damage to adjacent mature trees off the ROW was also observed during these field visits.



Sparse herbaceous growth, soil compaction, evidence of runoff and gullies, and sediment escaping the silt fences and traveling into adjacent Cummins Creek, an Exceptional Value Stream in Pike County, PA.

The steep slopes adjacent locally named Evergreen Stream (UNT to the Delaware River) were also bare during July and August field visits. There was erosion that could be clearly seen along the sides of the ROW here as well. There were uprooted trees from wind throw or erosion or both impacted off the ROW.

Conditions of steep slope adjacent Evergreen Stream, July and August 2014.

Repeated Pipeline Activity Impacts Over Several Seasons Cause Persistent Harm

Continued construction, maintenance, and remediation work at New Road in Montague NJ and other locations resulted in muddy runoff into streams and sediment pollution discharging into nearby streams repeatedly. During the summer of 2014, construction bridges were reinstalled off of New Road resulting in a muddied pit and sediment runoff into the two nearby tributaries of Shimer Brook. The bridges were reinstalled for tree planting resulting in additional and repeated impacts. Below is the link to pictures taken by Joe Zenes on October 29th, 2014, almost year after the pipeline had begun carrying gas.
https://picasaweb.google.com/lh/sredir?uname=105703332397473503863&target=ALBUM&id=6076465536169873505&authkey=Gv1sRgCIn6nOGO1rvHYg&feat=email

Its important to note that these maintenance activities often are added to an existing permit and as far as we can tell the public is not given an opportunity to comment nor are they adverstised in the PA Bulletin.

Lagging tree planting and remediation practices lead to repeated harm over several seasons. This picture was taken Summer of 2014 – almost a year after the new pipeline had been constructed and demonstrates repeated harm due to pipeline timelines and lagging efforts to restore the ROW shortly after its completion in November 2013.

Dewatering and Changes in Hydrology

Streams S002 and S003 at High Point State Park were completely dry by July 23rd whereas on July 9th there was water present. Although rain was sparse in the summer, the streams crossed by the pipeline appeared to have extra impacts. This is most likely due to the slope breakers diverting the natural path of the runoff and the severe soil compaction that limited infiltration. The slope breakers diverted water into the woods where it eroded along the edge of the pipeline. I also documented low streams levels in S004 and S005 at High Point State Park. Herbaceous regrowth in this section was patchy and sparse leaving bare soil. The soil had been compacted to the point where the ground was solid dirt and that vegetation could not colonize. On August 2nd, 2014, I recorded that two streams on the pipeline section from Evergreen to Cummins Creek went dry both of which had been previously flowing. Also August 7th, 2014 observations included a stream drying up off of New Road as well, seen in the picture below.

Dry stream off of New Road along pipeline ROW.

Temperature Impacts

The temperature data collected over the summer was variable. Not all of the streams appeared to have significant changes in the upstream and downstream ROW temperatures that were collected. However, in the streams that had a slower flow rate there was consistently a noticeable difference with warmer temperatures downstream of the ROW. This difference was present even in the mornings, not long after the sunrise. On August 27th, 2014 I collected samples in the afternoon at the Dimmick Creek and East Branch of the Dimmick Creek. There was a 10 degree Fahrenheit difference at the East Branch and 4 degree difference at Dimmick Creek. This indicates that there is a larger effect throughout the day, due to increased sun exposure from the open pipeline ROW cut where trees were removed. Wetlands within the ROW that were monitored for temperature also yielded much hotter temperatures than wetlands not in the ROW.

Nutrient Analysis

My nutrient analysis at this point is incomplete, I have collected approximately 250 samples from July 1st, 2014 to December 26th, 2014 to date. However, I have looked at the data enough to see that there is a difference in some of the streams in terms of their above and below levels of phosphates, nitrates, and sulfates. The differences were found in some streams, which may be correlated to the types of trees that were removed by the pipeline. Some of the streams had very high levels of nitrates in general which could be cause for concern, although I am unsure if they are related to the pipeline construction and more analysis is needed. The Evergreen Stream was the stream where we documented the most dramatic change in nitrate levels. Above the ROW the average nitrate levels were .0638ppm while below the ROW there were average levels of 0.3315ppm. The three tributaries to the Evergreen Stream that were uncut by the pipeline and located upstream of the pipeline ROW had substantially lower nitrate levels than the Evergreen stream cut by the pipeline.

One area in particular that had water chemistry results that stood out was behind Mountain Road. S111F and S111A both showed sulfate levels that were an order of magnitude greater than those present in the majority of the other streams. This may be a result of the blasting that was done in this area during pipeline construction. Literature has shown that blasting of rock that contains sulfates can cause their release into water sources. I would need to confirm the type of rock present in this area before making any conclusions. These samples were taken on July 2nd, 2014.

Below are links to albums showing before and after impacts of the blasting through the stream and pipeline construction behind Mountain Road where overwhelmed BMPs led to sediment leaving the ROW. Sediment-laden water proceeded to flow down the slope and into a stormdrain into a nearby stream. Photos were taken on June 11 and June 22, 2013.

https://picasaweb.google.com/lh/sredir?uname=105703332397473503863&target=ALBUM&id=5888575113132039073&authkey=Gv1sRgCN-Itvynnv3W0QE&feat=email

https://picasaweb.google.com/lh/sredir?uname=105703332397473503863&target=ALBUM&id=5892704912210291553&authkey=Gv1sRgCL6v5Iuw9ty4ngE&feat=email

The albums below include photos on various dates for the two streams that were observed to have high sulfate levels.

https://picasaweb.google.com/lh/sredir?uname=105703332397473503863&target=ALBUM&id=5966886951232696113&authkey=Gv1sRgCNiTnKO7l9_5pQE&feat=email

https://picasaweb.google.com/lh/sredir?uname=105703332397473503863&target=ALBUM&id=5966906652401281905&authkey=Gv1sRgCMzc85n8_saJEA&feat=email

Thermal Heat Impacts from Buried Pipeline & Maintenance Process

Various observers have noted melted snow over the buried pipelines even on very cold days. See the picture below taken west off of Rt 590 at the Lackawaxen River crossing 2-18-15 after a -12 degree day. The snow melt is over the new 30" pipeline which I suspect that the 24" line is now dependent from the 30" line. TGP now comes in and works on the older 24" line as maintenance projects which requires minimal approval usually under an existing PADEP permit and only gets reported the following May as I was told by David Hanobic FERC project manager NEUP.

Winter snow melt over 30 inch buried pipeline, February 18, 2015. Photo by J. Zenes

Maintenance work conducted by TGP on the old 24 inch line in the Fall, 2014. Photo by J. Zenes

Natural Gas Pipeline Pictures

Presented by Maya K. van Rossum, the Delaware Riverkeeper to the Committee on Energy and Commerce

July 9, 2013

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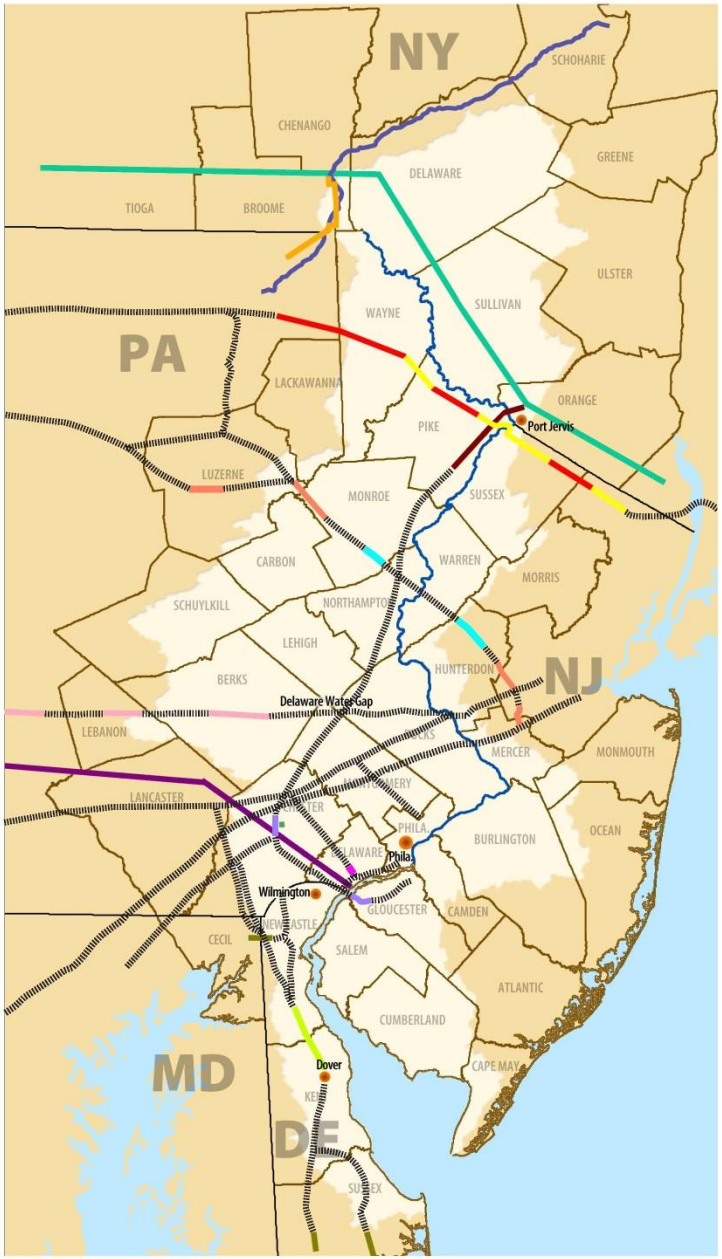
Delaware Riverkeeper Network Documents Pipeline Construction Activity in the Delaware River Basin



Pipeline Projects Currently Planned To Go Through the Delaware River Basin

- Existing Pipelines
- DTE Bluestone Pipeline
- TGP Northeast Upgrade Project
- ESNG Greenspring Project
- Constitution Pipeline
- Transco Leidy Southeast Expansion
- Transco Northeast Supply Link
- Transco Philadelphia Lateral
- Transco Mainline "A" Replacement
- Texas Eastern TEAM 2014 Project
- Columbia East Side Expansion Project
- Sunoco Mariner East Project

Pipeline Projects That Will Potentially Cross the Delaware River Basin

- Transco Northeast Connector (Not Pictured)

Pipeline Projects Constructed Through the Delaware River Basin Since 2011

- Millennium Pipeline
- TGP 300 Line Upgrade Project
- Columbia 1278 K Replacement
- ESNG System Expansion

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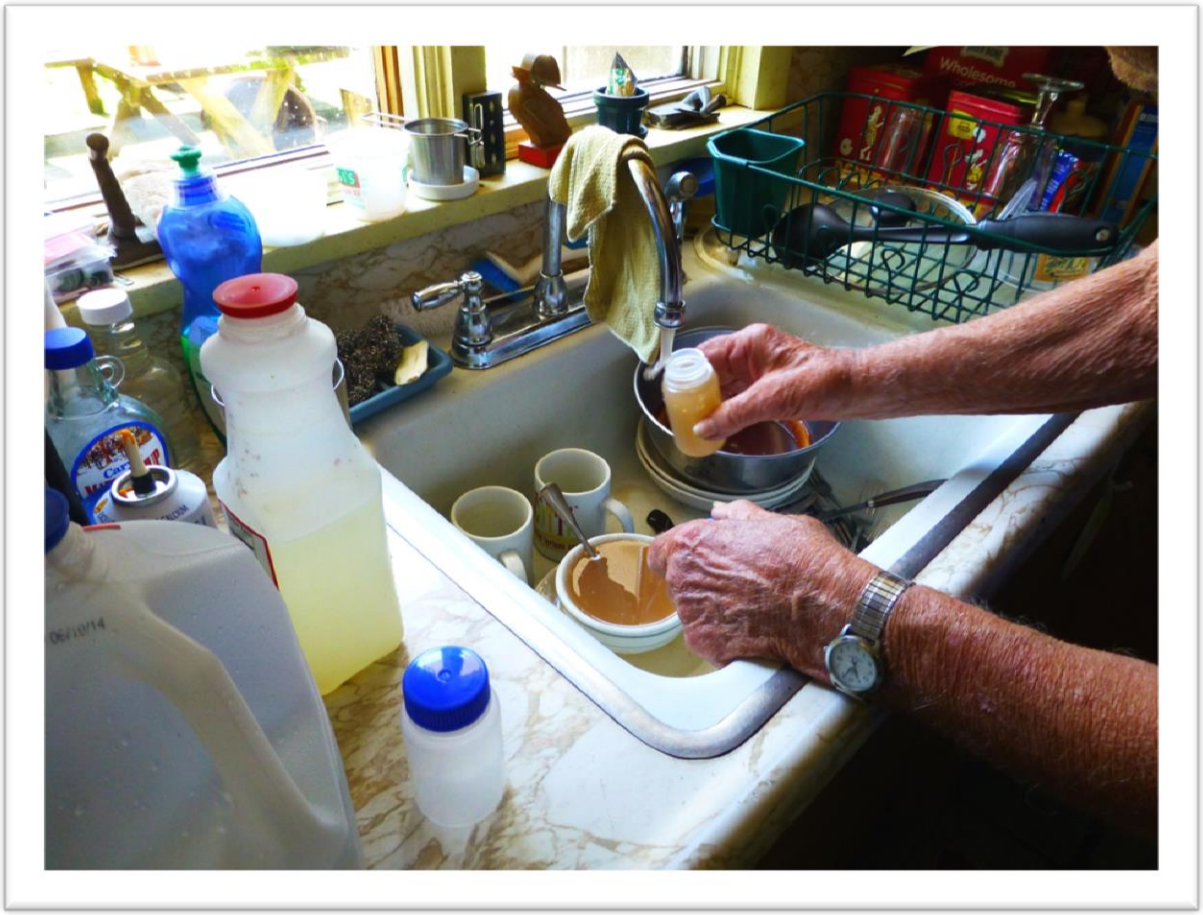

Contaminated Well Due to Pipeline Construction

Pipelines nearby homes can impact well water like in this case that occurred in New Jersey during pipeline construction. June 2013.

Pipeline Cut Through Public Lands

This pipeline path currently under construction passes through High Point State Park in New Jersey. Often public lands had intact and healthy habitat and mature forests before pipeline cuts occur. June, 2013.

Conversion of Forested Landscapes to ROW

Pipelines often cut through forests and steep slopes which require much technical oversight to ensure measures are used to limit impacts. This pipeline cut through Pike County, PA across the Sawkill Creek. June 2011.

Sediment Discharged to Wetlands

Compost filter socks are topped by sediment-laden water causing large discharge of sediment to the adjacent high quality wetland outside the pipeline ROW.

Pipeline ROWs Are Wide and Cut Through All Land Uses

Aerial flyover of a pipeline crossing through multiple counties in Pennsylvania, February 25, 2013.

Overwhelmed and Failing Erosion & Sedimentation Controls

This once forested slope dominated by underground springs and wetlands is a challenging location for a pipeline path with continual issues with stabilization of soils and control of water.

Lagging Recovery

Nine months after this new pipeline began carrying gas, land surface impacts adjacent a high quality tributary to the Delaware River including soil compaction and lack of vegetation growth keep this site in temporary restoration phase. August, 2012

Soil Compaction on ROW

A soil compaction study commissioned by Delaware Riverkeeper Network along a pipeline in Pike County, PA indicated extreme soil compaction along the pipeline ROW in temporary workspace areas which leads to increased stormwater runoff, challenging regrowth conditions, and a likely permanent change to the soil profile.

Waterbody Crossings Are Challenging

Wetlands, streams, and spring crossings are sensitive areas that are challenging places to site pipelines. June, 2013

March 13, 2013

Mr. Sam Reynolds
US Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107
Via Email Transmittal

Re: Wetland Violation – Sediment Discharging into W038 – Tennessee Gas (TGP) 300 Line Upgrade on DCNR lands after Rain Event on 3/12/13

Dear Mr. Reynolds,

Delaware Riverkeeper Network is writing with photos and video documentation indicating **sediment and suspended solids runoff discharging into Wetland038** (W038) from TGP's ROW after a rain event on 3/12/13 along the Tennessee Gas Pipeline's 300 upgrade project. This area of TGP's past project was installed and running gas through the new line as of November, 2011. As indicated in past letters to the Corps – one as recently as 3/12/13, W038, located on DCNR lands, has had persistent problems and negative changes to its structure and characteristics due to Tennessee Gas Pipeline construction and lagging restoration practices. This wetland is part of the Craft Brook Complex and is designated Exceptional Value under Chapter 93. This area of the pipeline is still under "temporary restoration status", over a year and four months after the pipeline was installed by TGP.

Please see the photos, field report, and video below of the 3/12/13 sediment discharge incident. This information is also being shared with Pike County Conservation District. A raw video link for your viewing is provided here: http://youtu.be/kj0ojv5pPbI and was recorded by Joe Zenes, Delaware Riverkeeper Network. It is critical, as indicated in DRN's 2/12/13 letter, that the Corps consider the condition and impacts of this EV wetland and other impacts and concerns shared over the past months in light of the pending 404 permit for the NEUP to avoid future harm. Thank you for your time and consideration.

Sincerely,

Faith Zerbe
Monitoring Director

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Delaware Riverkeeper Network

cc. Sally Corrigan, Pike County Conservation District
Carol Collier, Delaware River Basin Commission

Attachments: Photos from 3.12.13.Taken by Joe Zenes, Delaware Riverkeeper Network

Photos of W038 of the 300 Line taken 5:00 pm 3/12/13 approximately 3 hrs after rain stopped. Water flows North into a big wetland that Craft Brook (EV) originates from. Sediment could be tracked more than 100 yards through the forested wetland 100_4663 represents the quality of the water out of the flow that comes off TGP ROW.

DRN Photo 100_4639 Southeast side W038

of TGP

DRN Photo 100_4658 North

DCNR Photo 100_4665 200' North of TGP

DRN Photo 100_4663 Water away from

main current

Photos of W038 of the 300 Line taken 5:00 pm 3/12/13 approximately 3 hrs after rain stopped.

DRN Photo 100_4634 Northeast corner W038

W038

DRN Photo 100_4656 Northeast corner

DRN Photo 100_4640 Southside clean water entering W038

W038

DRN Photo 100_4638 Eastside

Photos of W038 of the 300 Line taken 5:00 pm 3/12/13 approximately 3 hrs after rain stopped. This wetland had all 3 characteristics PFO, PSS and PEM before TGP – now it is functioning like an open pond.

DRN Photo 100_4670

DRN Photo 100_4662

DRN Photo 100_4641

DRN Photo 100_4679 Looking west

December 2, 2012

Mr. Sam Reynolds
US Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107
Via Email Transmittal

Re: Tennessee Gas Pipeline Wetland Observations – 300 Line & NEUP Proposed Upgrade Line (Loop 323 & Loop 321)

Dear Mr Reynolds,

Delaware Riverkeeper Network is submitting additional field observations for USACE review as it pertains to Tennessee Gas Pipeline's past 300 Line work as well as photo-documentation of the wetlands on the Pennsylvania side that are part of the proposed NEUP project that USACE is currently reviewing. This information is being supplied to supplement the CD and information we shared with USACE prior on September 4 and September 14, 2012. These observations of TGP's past practices and the current condition of the wetlands and surrounding landscape to these High Quality and Exceptional Value wetlands from the 300 Line should provide information on what could occur on the NEUP proposed project if the wetland and stream encroachment permit is approved by USACE using similar construction practices as was conducted on the past 300 Line. Over a year and a half has gone by since construction of TGP's 300 Line initiated and a year since the pipeline went into operation in Pike and Wayne Counties and still there are violations and issues with the 300 Line land, wetlands, and streams that were impacted.

Delaware Riverkeeper Network scientists walked a section of the 300 Line on Nov 4, Nov 11, and Nov 30th, 2012 (to supplement our past visits) that is accessible from DCNR lands of Schocopee Road (AR 9 and AR 9a). We also include recent photos of site conditions at the Lackawaxen River 300 Line River Crossing off Rte 590 (Lackawaxen Township) where continued issues persist. It is important to note that the majority of places that DRN scientists had access to observe site conditions, signs of ineffective wetland restoration and E&S violations have persisted even into this late date. There is much of the line that DRN does not have access to so we do not know the current conditions of those locations but Conservation District inspections for Pike and Wayne Counties and NOVs issued help indicate the systematic failure of TGP's project as documented in DRN letter correspondence shared prior with USACE.

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Field observations along the TGP 300 Line and proposed NEUP line that could have a direct impact on the wetlands for the NEUP project and other questions and concerns we have noted from the TGP Wetland Delineation Report (March 2011) conducted by AECOM Environment are bulleted below and more details follow with photos:

- Compaction of soil will ultimately lead to differences in hydrology of the wetlands and streams. Soil samples were taken along the existing 300 Line on November 29, 2012 and simply attempting to dig along the ROW in comparison to digging in the nearby adjacent intact forest indicates severe compaction along the existing ROW. This soil compaction is further illustrated by the lack of vegetation that continues to persist adjacent and near wetlands and elsewhere along the TGP 300 Line.
- Rough grading in the vicinity and adjacent and within the wetlands has led to in places where matting fabric is located, poor contact with the soil due to the roughness of the soil underneath the matting and lack of raking. Lack of vegetation growth, still a year and half after construction, is noted in these areas still which can lead to continued soil erosion that could enter adjacent wetlands.
- From the AECOM Wetland Delineation Report (March 2011), it appears that when wetlands are located in temporary work spaces or additional temporary work spaces, TGP considers this to be "no impact" and as a result no acreages are included for these areas that are in fact a big impact. Since these work spaces are often located in mature forested areas and often very close to streams and wetlands (see below bullet), the work spaces will require tree removal, soils will be compacted with heavy equipment, and shading will be reduced to nearby waterbodies. Forests will take generations to recover and grow back. These ATWS and TWS areas should be avoided and minimized and the footprint of the ROW should be reduced to the greatest extent possible.
- During DRN field recon of the non-collocated section of Loop 323 and other proposed NEUP path, we observed temporary work space (TWS) areas and additional temporary work space (ATWS) areas often located too close to streams and wetlands (less than 25 feet from these sensitive structures). This was observed by the three corner stakes in the field placed by TGP that are to delineate TWS and ATWS near the ROW. This placement adjacent these sensitive habitats will affect them negatively. There are also a large number of these work spaces delineated in the field and we question why so much extra space beyond the already very large ROW are needed since they are located in very sensitive wetland and stream areas.
- ATWS and TWS areas often seem to target very large and mature trees that are found throughout the non-collacted section of Loop 323. By clearing these large mature trees that fulfill a large dense canopy cover, thermal impacts and dissolved oxygen impacts will likely be a result to the surrounding waterbodies and wetlands.
- Along the 300 Line off DCNR lands, mulched tree debris is blown into areas of forest and wetland areas located adjacent to the ROW. Mulch can smother the roots of the surrounding trees and cause rodent damage in the winter months. TGP is also then affecting areas outside of the ROW.
- The majority of the proposed crossings of the NEUP include open cut trenching technique which will forever change the topography and the hydrology of these Exceptional Value and High Quality wetlands, streams and habitats.
- In the field it is difficult to depict the complete boundaries of the proposed ROW based on limited flagging by TGP during DRN field visits, but DRN believes that less of an area should be needed for TGP to insert a 30 inch pipline adjacent its existing 24 inch line. This point has also been raised by PCCD. Minimizing disturbance and ROW size and work spaces is needed.

Delaware Riverkeeper Network has been assessing and performing both pre-documentation of Tennessee Gas Pipelines's Northeast Upgrade Project (Loop 323 and Loop 321) as well as documentation of locations and sensitive habitats and wetlands along the Tennessee 300 line project.

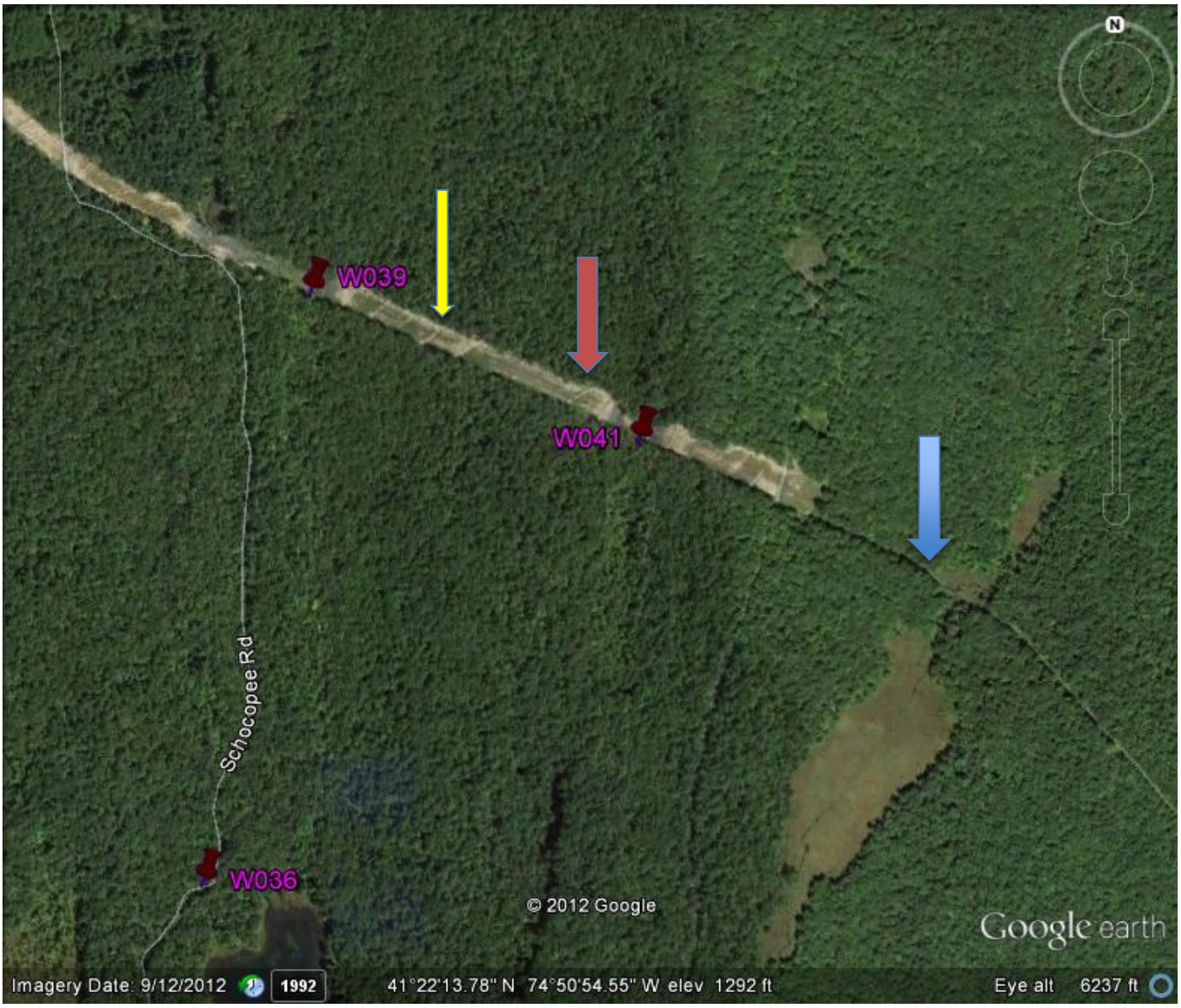
300 Line Project

First, DRN will share information regarding the constructed 300 Line in an effort to highlight continued issues with this project site by TGP. **We believe, using our best professional judgment and observations on site, that with such violations and issues still persisting a year and half after project completion, permitting the NEUP project will not protect the Exceptional Value and High Quality wetlands and streams that would be crossed by TGP's NEUP pipeline project**. With these special protection watersheds being crossed multiple times, how is this cumulative impact being considered and quantified for the project and what permit requirements will ensure the steep slopes, compacted soils, decreased forest cover does not lead to degradation of these special protection streams?

Aerial Images Documenting 300 Line Impact in Comparison to Existing ROW

This image illustrates the western portion and the new cut Tennessee Gas 300 Line (red arrow). Note the significant change in width of the TGP 300 Project. The blue arrow shows the existing ROW that would be widened by the proposed NEUP project. Location: Partially Delaware State Forest Lands, Pike County, PA, north of Pike County Park off Schocopee Road, Milford PA - Accessible from AR 9 and 9a.

Aerial Images Documenting 300 Line Impact in Comparison to Existing ROW



This image illustrates the western portion and the new cut Tennessee Gas 300 Line (red arrow). Note the significant change in width of the TGP 300 Project. The blue arrow shows the existing ROW that would be widened by the proposed NEUP project. The yellow arrow depicts one of several water bars that could permanently change the hydrology of the adjacent wetlands by diverting water away from the wetland. Location: Partially Delaware State Forest Lands, Pike County, PA, north of Pike County Park off Schocopee Road, Milford, PA. Accessible from AR 9 and 9a.

Analysis of Permanent Impact to W038 – Savantine Wetland Complex

According to TGP's 300 Line Project, Appendix P diagrams and documentation of the Savantine Wetland, (Wetland Impact W038) A 30" diameter steel natural gas transmission line crossing of approximately 517 feet of PFO/PSS/PEM wetland (EV), by means of open trench cut, with temporary wetland impacts of 1.19 acre (Lat: 41°22` 41.9"; Long: -74°51` 48.6") in Milford Township. (Pa Bulletin E52-217 Vol 41-19)

71.5' x 531.58=38000ft² = 0.87236ac
West boundary x southern boundary

WATERBODY/WETLAND IMPACT

WATERBODY/ WETLAND #	TEMP. IMPACT	PERM. IMPACT
323W038	0.84 AC.	0.12 AC.

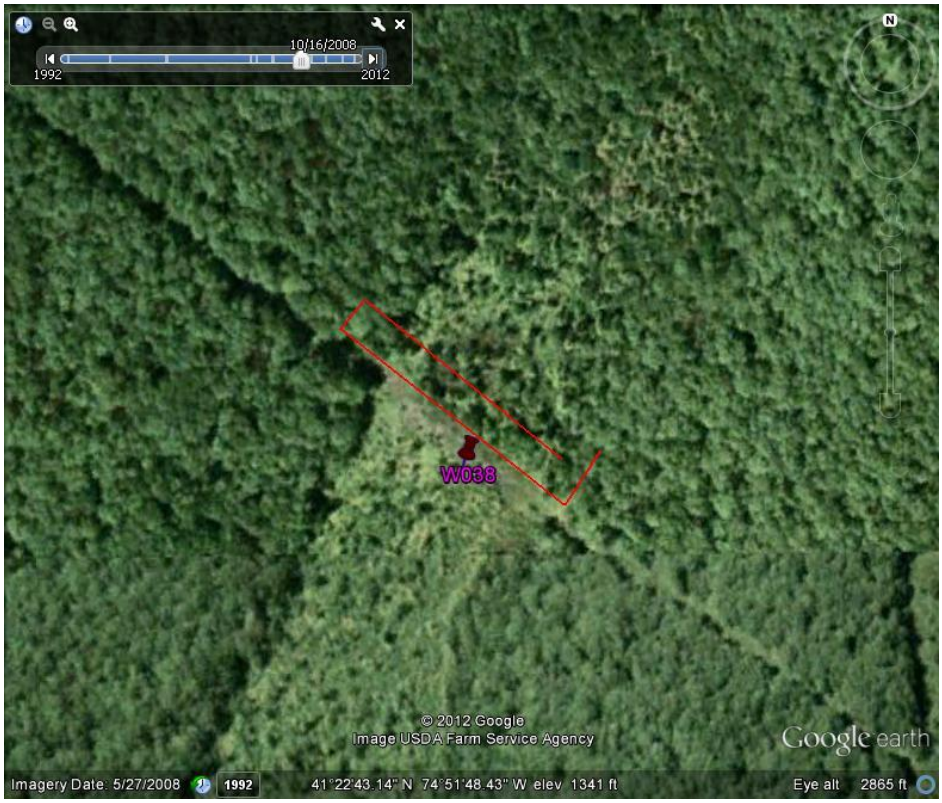
(300 Line Project Appendix P)

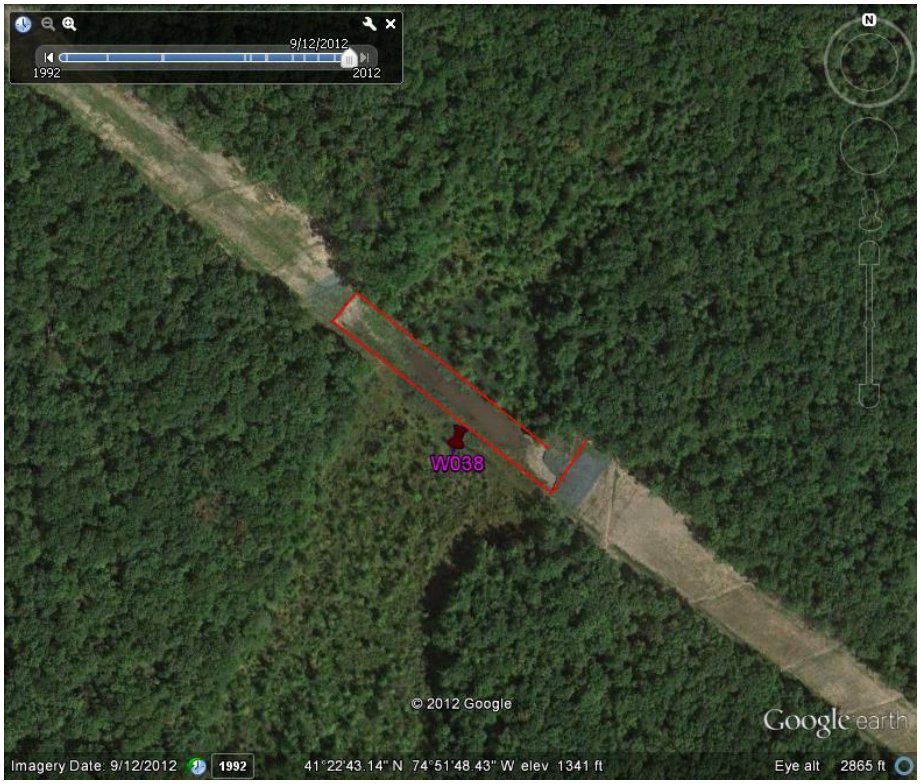
Permanent impact 0.12ac = 5,227.2ft²

Before 10-16-2010 and after 9-12-2012 photos of W038 from Google Earth distance measured using ruler tool taken off of visible silt fencing marking the wetland boundaries.

North 474'
East 122.4'
South 531.58'
West 71.5'

In conclusion, measurements taken along the silt fence marking the wetland boundaries were approximately 0.87 acres, similar to the projected temporary impacted area of 0.84 acres. However, a year later the impacts appear to be permanent; exceeding the 0.12 acres of permanent impact projected by Tennessee Gas Pipeline. The wetland is now an open wetland (POW) rather than a PFO/PSS/PEM and hydrology appears to have changed due to wetland fill and changes in elevation (see photos below). **Note**: These measurements were solely for the wetland itself, not including the impact from the removal of mature and understory trees along the uplands of the construction ROW.





The characterization of the Savantine Wetland Complex (W038), an EV wetland that feeds a tributary to Savantine Creek, can be described currently more like a POW rather than its original wetland characterization of a PFO/PSS/PEM as it was classified before construction of TGP. Temperatures of this wetland indicate thermal impacts and the wetland appears to be acting as a heat sink due to its increased depth and lack of vegetation (water temperatures below in Table 1). Summer sampling documented temperatures in the wetland as high as 87.6 F which would not be indicative of other Exceptional Value forested wetlands in the region.

This wetland complex was cited multiple times by PCCD as having violations associated with construction practices. The lagging restoration, dewatering of the wetland, and potential fill piles within wetland boundaries occurred late in the season on May 13, 2012 when thousands of young amphibians were observed in the wetland after returning from their forested uplands in the spring. The pipeline was in operation in November 2011 and restoration lagged behind to impact amphibian species in this Exceptional Value wetland – occurring over 6 months after the pipeline was transporting gas. As a result, the wetland was impacted unnecessarily multiple times and during a critical time for breeding and young-of-the-year amphibian species. As noted by PCCD in NOVs, restoration could have occurred much sooner as the winter of 2011 was mild.

Photos of W038 below taken 10 am on 5-13-12. There was a pump to dewater wetland that morning to extend the wood mat bridge that was damaged. Pumps, hoses without any filtering device were observed and no E&S controls (double hay bails etc…) - standard procedure for dewatering were not observed.

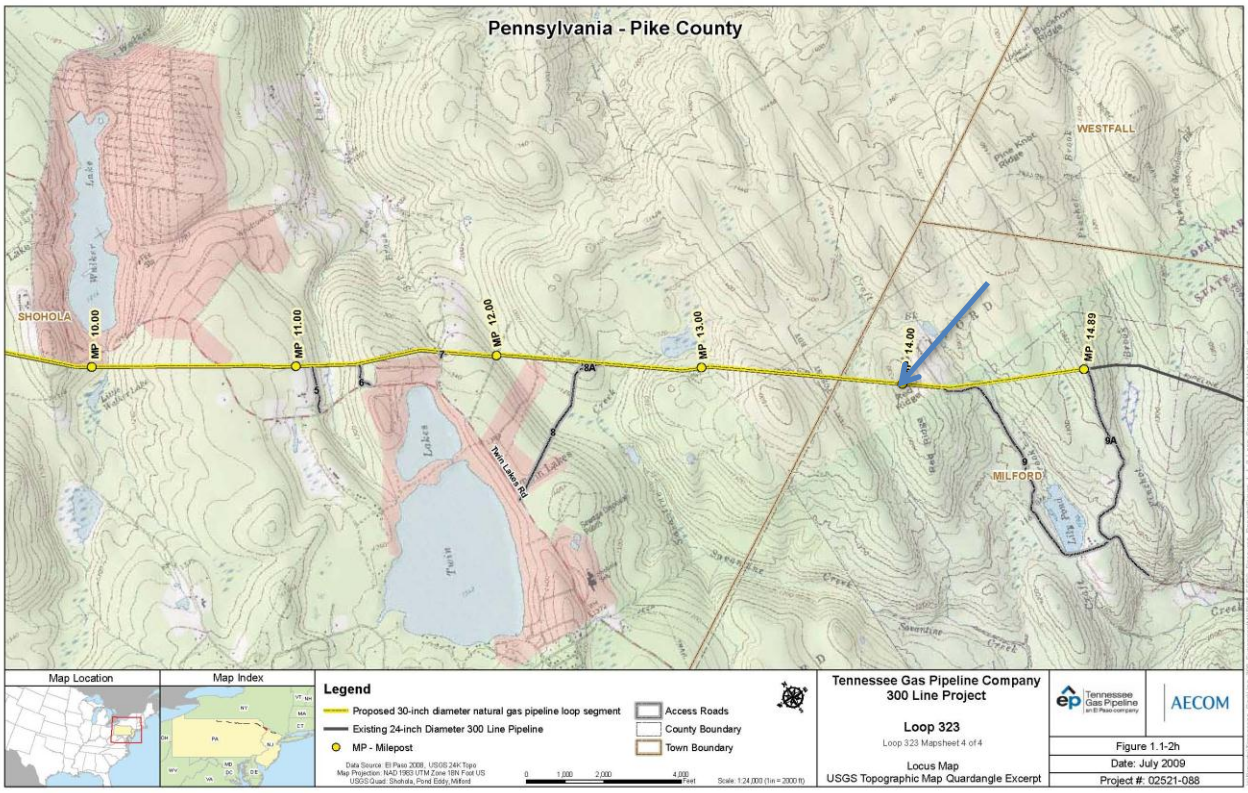
Pump to dewater (top picture). Dewatering of wetland conducted May 13, 2012 – critical amphibian window. Savantine wetland complex, view facing west – after dewatering (bottom picture). 5/13/12

Savantine Wetland Temperatures:

Date	Time	Water Temp (C)	Air Temp (C)	Conductivity (uS/cm)
7/14/12	18:02	30.9 C, 30.8 C (87.6 F, 87.4 F)	24.5 (76.1 F)	75.6, 77.1
8/2/12	11:30	28.4, 28.6 (83.1 F, 83.5 F)	26.0 (78.8 F)	35.1, 34.8
10/11/12	11:00	11.9, 12.0 (53.4 F, 53.6 F)	12.0 (53.6 F)	29.6, 26.2
10/25/2012	9:15	11.6, 11.6 (52.9 F)	12.5 (54.5 F)	16.1, 16.1

Water temperatures taken with a calibrated electronic meter – Lamotte Conductivity/Temp Pocketester

Summer water temperatures collected in the wetland after disturbance are indicative of a warm water fishery rather than a headwater wetland that feeds an unnamed tributary (UNT) to Savantine Creek which flows into Saw Kill Creek, an Exceptional Value Stream and a Class A wild trout stream due to a high biomass of wild trout that live within the Saw Kill Watershed. With the 300 Line project and the NEUP project combined, the Saw Kill and all of its major tributaries are to be crossed by the pipeline (Saw Kill, Savantine, Craft Brook, Pinchot, Dimmick Meadow), putting more stress on this stream which has the highest stream designation available in the state. Exceptional Value streams are not to degrade in water quality – what permit requirements are being implemented to ensure no degradation of this waterbody results of the project and what monitoring will be required of TGP to document pre and post water quality conditions?



Blue arrow denotes location of W038 – the wetland complex that is part of a tributary to Savantine Creek that flows into Saw Kill Creek, an EV stream.

Unexplained Bubbling in Wetland Persists from May 2012 through November 29, 2012

Constant bubbling actions in W038 evident after wood timber crossing mats were removed in May 2012. Note bubbling stirs up sediment on bottom. IR 12-26 by PCCD on 10-18-12 did not note the bubbling action or that areas within wetland boundaries contained backfilled materials **and the current size is less than half the 517' it was before construction of TGP**. PCCD noted wetland issues should be reported to USACE as this was not PCCD jurisdiction (Susan Beecher). As late as November 29, 2012, consistent bubbling of this wetland is still taking place. Peter Demicco, groundwater hydrologist and expert, observed this wetland on November 29th. Mr. Demicco noted if bubbling (presumably methane) was caused by decaying material, this material should have been fully decomposed by this late date if it was natural decomposition. Could there be an issue with the pipeline or a breach?

DRN W038 10-11-12
Photo 100_2038

DRN W038 10-11-12
Photo 100_2041

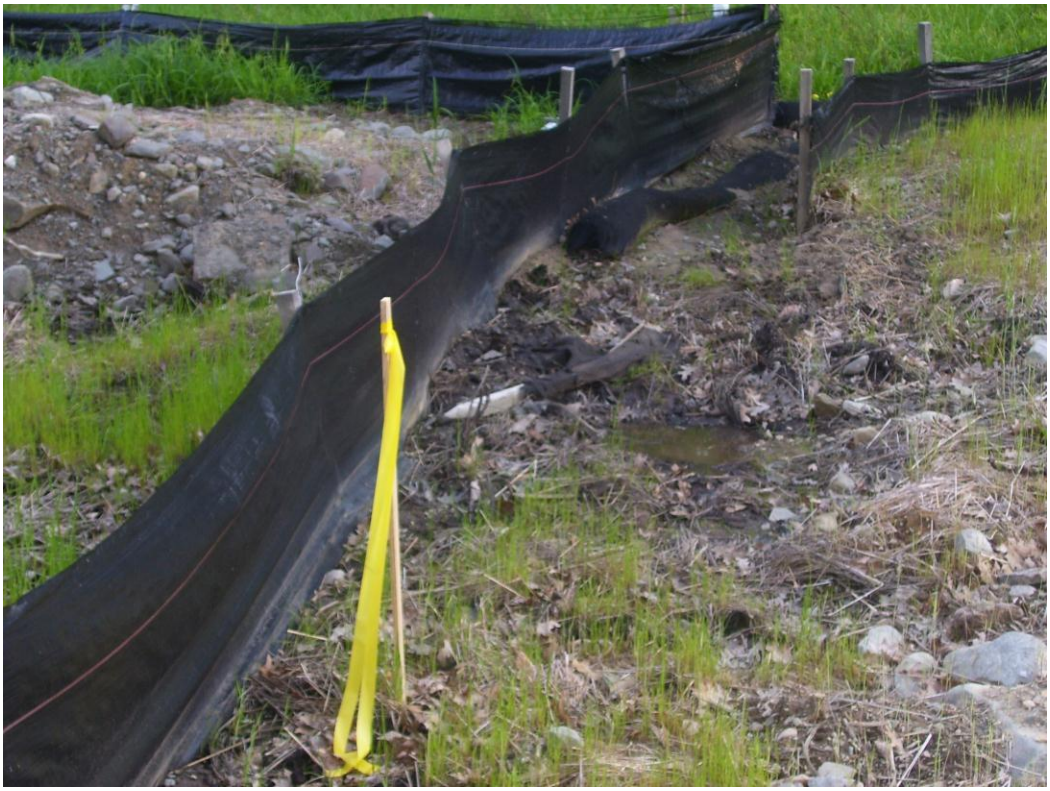
DRN W038 10-11-12
Photo100_2041

DRN W038 08-02-12
Photo 100_1029

Photos: November 29, 2012. Savantine Wetland Complex (W038). Note fill within wetland (red arrow). Note phragmites patch appearing to spread to the north side of the wetland possibly due to disturbance.

May 13, 2012. Phragmites australis patch in old existing ROW. This invasive plant will spread into the remaining new disturbed wetland and expanded ROW if not addressed (see picture above from Nov 29, 2012 field visit where invasive weed appears to have spread on north side of wetland). Studies indicate that Phragmites can change the hydrology of a wetland. Savantine Wetland Complex (W038) – an EV wetland.

Sinking wooden mats – photo taken May 4, 2012. Savantine Wetland Complex (W038). This evening thousands of amphibians were heard calling from the wetland.



Dirt piles stored within wetland boundaries. Savantine W038 complex. Photo taken May 13/16, 2012.

Savantine Wetland (W038). Note ice forming where obvious bubbling of wetland persists six months after disturbance in May, 2012. Photo taken 11/29/12.

Small trees planted in wetland area will likely not survive deer browse and evidence of browse is already evident on many of the small saplings. TGP should be required to plant trees above the browse line.

Large march piles evident along TGP 300 line on DCNR lands - mulch is piled greater than 12 inches in depth adjacent the TGP ROW in many areas along the ROW. In this photo, Kevin Heatley believes wetland areas have been mulched. Photo taken 12/2/12, of Wetland 038a. Heatley standing outside ROW in picture.

Characteristic large mature trees noted in TWS and ATWS areas along non-collacted section of Loop 323. By clearing large trees and forests, thermal impacts to nearby wetlands and waterbodies will develop. Canopy cover will take decades to grow back to existing conditions and impacted and changed soils could impact that growth in the first place. Photo taken 8/24/12. Cummins Hill section of line.

Craft Brook Complex

Photo of 300 Line Crossing at Craft Brook located east of AR-9 on Delaware State Forest. 11/29/*12. Note stream cutting over gravel ROW/trail. This path on the existing TGP ROW was blown out and culverts removed during the summer months (see past information provided in September).*

Wayne County 300 Line Field Reconnaissance

On May 5, 2012 DRN visited sections of the 300 Line located in Wayne County. Findings regarding wetlands and stream encroachment included the following (photos available upon request):

Beech Grove Rd – check dam appears to be impacting wetland flows and draining water off the wetland site and onto the macadam road. Wetland hydrology appears to have changed at this pipeline crossing.

Wayne County Fairgrounds, Dyberry Creek Pipeline Crossing, of Rte 191 (MP 18.5) – soil piles remained in floodplain (Access 10) – erosion and sloughing occurring along the right bank.

Cliff Street – Carly Brook Tributary - Preserved Top Soil Piles evident in agricultural areas – (While areas like the DCNR lands does not require top soil stockpiling which likely results in the poor vegetation growth evident at sites where topsoil is not preserved.)

Proposed NEUP – Loop 323

Macroinvertebrate Monitoring

Delaware Riverkeeper Network conducted macroinvertebrate sampling utilizing PA DEP benthic protocols - sampling approx. 200 feet downstream of proposed pipeline crossings for Pinchot Brook, Dimmick Meadow, Deep Brook, and Crawford Brook on May 26, 2012 to document existing conditions of these tributaries. The pipeline white marker was used to pace 200' downstream of the centerline. Water quality data was also collected at that time and a habitat assessment was conducted. This monitoring was conducted in coordination with PCCD who sampled macroinvertebrates along additional tributaries to be crossed by NEUP. Benthic samples were sent to an approved certified laboratory and a 200 sub-sample was analyzed using DEP's Index of Biotic Integrity. Results indicate very good to excellent conditions for these streams and all streams had a high taxa richness and healthy population of sensitive invertebrates. (Note that sampling was conducted at the very end of the sampling window and earlier sampling likely would have resulted in even more diversity). What permit requirements will ensure this diversity is protected and not degraded? All streams crossed by NEUP on the Pennsylvania side in Pike and Wayne Counties are High Quality or Exceptional Value. Data is available upon request. See attached excel file for data.

Visual Assessment Monitoring

DRN scientists walked the majority of the Pennsylvania portion of the Loop 323 NEUP. We photo documented and video-taped wetland and stream conditions along the entire length. Steep slopes are a major concern along much of the proposed route and the fragmentation that will result with the section of the Loop that is not co-located with the existing ROW is a big concern. The area outside of the ROW (known as the Milford Loop) has limited disturbance in its current state and the addition of a 100 foot new ROW will impact old-growth forest in the area.

Dimmick Meadow Photos

5/5/12 Approaching Dimmick Meadow pipeline ROW – this ROW would be widened with NEUP. Note monotypic understory in existing ROW consisting of predominantly hay-scented fern.

Dimmick Meadow – just downstream of route of NEUP pipeline crossing. Dimmick Meadow is a tributary to Saw Kill Creek, Exceptional Value Streams.

Pinchot Brook Photos

May 26, 2012. Existing ROW across Pinchot Brook. This ROW would be significantly widened. Note already existing stand of invasive phragmites in this wetland along the ROW.

Non Co-Located Section of the NEUP Along Loop 323

Below only a few images with captions showing characteristic wetlands, seeps, and streams within the mature forest along Cummins Hill. All photos include areas that will be cut through directly by the NEUP in areas where no current ROW exists. Based on evidence from the existing ROW and the recent construction of the 300 Line, it is clear that this landscape will be negatively impacted, fragmented, and altered permanently both hydrologically and within the cleared community which is currently mature forest. The EV and HQ streams and wetlands will experience increased water temperatures, increased light and lack of canopy, decreased CPOM and other organic material for macroinvertebrates, and compaction and consolidation of the soil structure, to name just a few of the foreseen impacts. Invasives will also likely take hold leading to decreased diversity in plant life. Protecting headwater streams, such as these, is recognized by stream scientists as an important indicator to effect stream quality farther downstream (Stroud Water Research Center). Hundreds of catalogued photos and video are available upon request.

L4W091 – Palustrine Forested Wetland (PFO)- Pipeline Crossing Length – 16 feet.

Photo taken 5/26/12. Note red arrow denoting white pipeline marker to indicate placement of pipeline.

Based on flagging observed this feature appears to be just upstream of the center line marker to the pipeline. Note blue stream flagging by TGP. Photo taken 5/26/12.

5/26/12 Characteristic woodland spring/wetland indicative of much of the area along the proposed NEUP.

Other observations within the non co-located pipeline ROW that are of concern and that need to be addressed and considered to determine if this permit should be granted include:

- Steep slopes along many of the stream crossings are inevitably going to discharge sediment into nearby streams and wetlands.
- Temporary workspaces and additional temporary work spaces in some instances appear to be targeting very large mature trees within the forest. Is this for timbering purposes? If so this in some instances may be high-grading the forest as cutting the most mature seed trees out of a forest can cause forest degradation for future generations.
- Work space areas are often located too close to streams and wetlands.
- Red efts, leopard frogs, green frogs, ringneck snakes are some of the animals we encountered along the existing ROW.
- Localized areas of Japanese stiltgrass, an invasive plants that will spread dramatically along the pipeline corridor due to this disturbance. This will decrease diversity in the forest and lead to a permanent change. (mile-a-minute weed in small patches also located on the NJ backwaters).
- The majority of these crossings include open cut trenching which will forever change the topography and likely the hydrology of these Exceptional Value and High Quality wetlands, streams and habitats.

- Compaction of soil will ultimately help lead to differences in hydrology of the wetlands and streams. Soil samples were taken along the existing 300 Line on November 29, 2012 and simply attempting to dig along the ROW in comparison to digging in the nearby adjacent intact forest indicated severe compaction along the ROW – which further explains the poor germination of plants.
- Wood turtles have more protections on the New Jersey side than on the Pennsylvania side. This is troubling since wood turtles are also in decline in Pennsylvania.
- TGP states Indiana Brown Bat are only found on the far eastern portion of the ROW and bog turtle Phase I and Phase II surveys conducted were sparse. (this is explained more in a letter to the USFWS).

In closing, please note this is just a portion of the data and information Delaware Riverkeeper Network has for the 300 Line and the NEUP proposed line. We are happy to share more organized photos and video of the NEUP project for Loop 323 and 321 and our observations if it would assist in better protecting and preserving one of the most pristine and intact areas remaining in the Delaware River Basin. Thank you for your time and your attention to this urgent matter. If you have further questions, would like to visit on site, or would like more information, don't hesitate to contact us at 215-369-1188 ext 110.

Sincerely,

Faith Zerbe
Monitoring Director, DRN

Joe Zenes
Environmental Scientist, DRN

cc. EPA Region 3
Carol Collier, Delaware River Basin Commission

Breakout Violations Per Inspection - TGP 300 Line

Cited Violation	Report 11-08 (9/10/11)	Report 11-09 (9/13/11)	Report 11-10 (9/16-17/11)	Report 11-07 (8/31/11)
Failure to maintain effective E&S BMPs	X	X	X	X
Site conditions present a potential for pollution to waters of the Commonwealth	X	X	X	X
Sediment or other pollutant was discharged into waters	X	X	X	X
Failure to implement effective E&S control BMPs	X	X	X	X
Failure to provide temporary stabilization to earth disturbance				
Failure to provide permanent stabilization to earth disturbance				
Violations of Clean Streams Law	X	X	X	X

Summary (*note: likely conservative number since on each site there could be multiple instances of each vi

Failure to maintain effective E&S BMPs	14
Site conditions present a potential for pollution to waters of the Commonwealth	14
Sediment or other pollutant was discharged into waters	14
Failure to implement effective E&S control BMPs	17
Failure to provide temporary stabilization to earth disturbance	2
Failure to provide permanent stabilization to earth disturbance	2
Violations of Clean Streams Law	21
Total*	**84**

***The above violations are from Pike County, PA with a date range from 7/26/11 to 6/21/13**

Report 11-06 (8/24/11)	Report 11-05 (8/15/11)	Report 11-04 (7/26/11)	Report 12-21 (3/15/12)	Report 12-22 (4/11/12)	Report 11-12 (9/26/11)
X		X			X
X		X			X
	X	X	X		X
X	X		X	X	X
X	X	X	X	X	X

es of each violation)

Report 11-11 (9/20,21/12)	Report 11-13 (9/28/11)	Report 11-14 (10/5/11)	Report 11-16 (10/17/11)	Report 11-17 (10/21/11)	Report 11-18 (11/4,5/11)
X	X	X	X	X	X
X	X	X			X
X	X	X	X	X	
X	X	X	X		X
		X			
X	X	X	X	X	X

Report 11-19 (12/13/11)	Report 12-20 (2/15/12)	Report 12-23 (6/6/12)	Report 12-26 (10/18/12)	Report 13-29 (6/21/13)
		X		
X	X	X		
X	X			
		X		
			X	X
X	X	X	X	X

Breakout Violations Per Inspection - Columbia 1278

Cited Violation	Report 11-04 (6/17/11)	Report 11-06 (6/24/11)	Report 11-08 (7/5/11)	Report 11-10 (7/14/11)
Failure to maintain effective E&S BMPs	X	X	X	X
Site conditions present a potential for pollution to waters of the Commonwealth	X	X	X	X
Sediment or other pollutant was discharged into waters	X	X	X	X
Failure to implement effective E&S control BMPs				X
Failure to provide temporary stabilization to earth disturbance				
Failure to provide permanent stabilization to earth disturbance				
Violations of Clean Streams Law	X	X	X	X
Failure to comply with permit conditions				
Failure to implement effective PCSM BMPs				

Summary (*note: likely conservative number since on each site there could be multiple instances of each v

Failure to maintain effective E&S BMPs	9
Site conditions present a potential for pollution to waters of the Commonwealth	15
Sediment or other pollutant was discharged into waters	9
Failure to implement effective E&S control BMPs	3
Failure to provide temporary stabilization to earth disturbance	9
Violations of Clean Streams Law	15
Failure to comply with permit conditions	6
Failure to implement effective PCSM BMPs	7
Total*	**73**

***The above violations are from Pike County, PA with a date range from 6/17/11 to 4/27/12**

Report 11-11 (7/26/11)	Report 11-12 (7/28/11)	Report 11-13 (8/9/11)	Report 11-15 (8/30/11)	Report 11-16 (9/7/11)	Report 11-17 (9/28/11)	Report 11-18 (10/21/11)
X	X	X		X	X	
X	X	X	X	X	X	X
X	X		X	X	X	
X	X					
		X	X	X	X	X
X	X	X	X	X	X	X
			X	X	X	X
				X	X	X

violation)

Report 11-19 (12/1/11)	Report 11-20 (12/14/11)	Report 12-21 (2/22/12)	Report 12-22 (4/27/12)
X	X	X	X
X	X	X	X
X	X	X	X
X	X		
X	X	X	X

Meliora Environmental Design

MEMORANDUM

TO: FAITH ZERBE (DELAWARE RIVERKEEPER NETWORK)

FROM: RUTH SITLER, P.E. (MELIORA DESIGN, LLC) 2/19/13

SUBJECT: FIELD EVALUATION OF SOIL COMPACTION WITHIN TGP 300 LINE UPGRADE PROJECT TEMPORARY WORKSPACES

DATE: 2/19/2013

CC: MICHELE ADAMS, P.E., PRINCIPAL (MELIORA DESIGN, LLC)

BACKGROUND

On December 28, 2012, representatives from Meliora Design, Delaware Riverkeeper Network, and GeoSystems Consultants met on Delaware State Forest lands owned by the Pennsylvania Department of Conservation and Natural Resources (DCNR) in Milford, Pennsylvania, to perform soil sampling for field and laboratory analysis with the purpose of establishing a comparison between the soils affected by construction activities undertaken as part of the Tennessee Gas Pipeline's 300 Line Upgrade Project and adjacent soils left untouched by those activities. All soil samples were taken from DCNR lands (Delaware State Forest), outside the limits of the permanent pipeline Right-of-Way accessible off Schocopee Road.

Soil compaction is the physical consolidation of soil due to applied force (i.e., construction vehicle traffic) that results in degradation of soil structure, limitation of air and water filtration capability, and reduced vegetative growth potential. Heavy construction vehicles, typically having axle loadings in excess of 10 tons, can cause significant compaction to the soil and subsoils, requiring restoration beyond simple tilling and reseeding of surface layers (Wolkowski & Lowery, 2008).

One indicator of soil compaction is bulk (dry) density. Bulk density may be calculated by measuring the dry weight of soil and dividing it by the volume. Table 1 below, adapted from the USDA Natural Resources Conservation Service, illustrates bulk densities in pounds per cubic foot (pcf) that promote and inhibit plant growth for three common soil textures. Soils located within the study area were determined to be a silty-gravel within the temporary workspace and a silty-sand in the adjacent undisturbed areas.

Soil Texture	Ideal bulk densities for plant growth (pcf)	Bulk densities that restrict root growth (pcf)
Sandy	<99.8	>112.3
Silty	<87.4	>103.0
Clayey	<68.6	>91.7

Table 1. Bulk density relationship to plant growth.

METHODS

Bulk densities may be measured in situ as well as in a laboratory setting. During the December 28, 2012, field investigation, in situ bulk density measurements were taken at three locations within TGP 300 Line Upgrade Project temporary workspaces and three locations in adjacent undisturbed (natural) areas. These in situ measurements were collected with a nuclear density gauge. Soil samples were also collected with 10-inch Shelby tubes from five locations within TGP 300 Line Upgrade Project temporary workspaces and five locations in adjacent undisturbed (natural) areas for laboratory testing. The soil samples and resultant density measurements are shown in Table 2 below.
(Note: All soil sampling and testing was performed by GeoSystems Consultants. A copy of the report prepared by GeoSystems Consultants is attached to this memo.)

Sample		In-Place Nuclear Density Test	Laboratory Test Results
		Bulk Density	Bulk Density
		(pcf)	(pcf)
TV-1	Temp. Workspace	92.8	96.3
TV-2	Temp. Workspace	116.0	110.8
TV-5	Temp. Workspace	110.4	107.6
TV-8	Temp. Workspace		102.6
TV-9	Temp. Workspace		111.3
	Average	**106.4**	**105.72**
TV-3	Natural	75.8	101.2
TV-4	Natural	84.4	103.2
TV-6	Natural	90.7	93.5
TV-7	Natural		53.8
TV-10	Natural		82.4
	Average	**83.6**	**86.82**

Table 2. In-site bulk (dry) density measurements within TGP 300 Line Upgrade Project temporary workspaces and adjacent undisturbed (natural) areas.

Additionally, two large grab samples were collected in a clean 5-gallon bucket to provide sufficient material for gradation analysis. Both samples collected were classified as coarse-grained soils comprised of gravel-sand-silt mixtures within the temporary workspace and sand-silt mixtures in the adjacent undisturbed areas.

The values for average bulk densities in Table 2 for samples collected within TGP 300 Line Upgrade Project temporary workspaces exceed the threshold of densities which limit root growth and inhibit vegetation for both sandy and silty soils, as shown in Table 1 above; the same values for samples collected in adjacent undisturbed (natural) areas are well within the ideal range for sustained plant growth. A comparison of these values alone clearly indicates that the soil conditions within the TGP 300 Line Upgrade Project temporary workspaces are prohibitive to plant growth, while undisturbed (natural) areas adjacent to the temporary workspaces are nearly ideal for the establishment of vegetation.

Proctor compaction testing was also performed on each of the two large grab samples collected in accordance with ASTM D698 to determine the optimum water content for and maximum dry density of the sampled soils necessary to achieve maximum compaction. The sample collected within the TGP 300 Line Upgrade Project temporary workspace yielded a maximum dry density 108.1 pcf; the sample collected from the adjacent (undisturbed) area yielded a maximum dry density of 109.0 pcf.

The extent to which a soil in the field is compacted is calculated in terms of "percent compaction." To determine the percent compaction of a given soil, the in situ bulk density (pcf) is divided by the maximum dry density (pcf) then multiplied by 100%. The calculated percent compaction for soils sampled within the TGP 300 Line Upgrade Project temporary workspaces and soils sampled in adjacent undisturbed (natural) areas is presented in Table 3 below.

Sample	In-Place Nuclear Density Test	Laboratory Test	ASTM D 698	Percent Compaction	
	Average Dry Density	Average Dry Density	Maximum Dry Density		
	(pcf)	(pcf)	(pcf)	(In-Place)	(Laboratory)
Temp. Workspace	106.4	105.72	108.1	98.43%	97.80%
Natural	83.6	86.82	109.0	76.70%	79.65%

Table 3. Calculated average percent compaction of soils sampled within TGP 300 Line Upgrade Project NEUP temporary workspaces and adjacent undisturbed (natural) areas.

DISCUSSION

Compaction is often desired and part of construction activities to provide stability and safety of built earthen structures such as dams. For example, earthen levees and dams are typically required to achieve 95% compaction, or greater, at a minimum. (United States Army Corps of Engineers, 2004). Compaction to this extent is required to ensure the integrity of the structure by preventing the potential for air and water movement through filtration.

However, over-compaction adversely affects plant growth, decreases infiltration, and increases runoff.

The Pennsylvania Stormwater Best Management Practices Manual, Chapter 5.6.2 BMP *Minimize Soil Compaction* states "Once natural soils are overly compacted and permeability is drastically reduced, these functions are lost and can never be completely restored… In fact, the runoff response of vegetated areas with highly compacted soils closely resembles that of impervious areas, especially during large storm events."

High compaction limits infiltration thus limiting replenishment of ground water; this limits the amount of water available to seep through the soil into streams that provides the healthy baseflow of the streams. The increased run-off can overburden streams, contribute to streambank erosion, and exacerbate flooding (Tennessee Valley Administration).

Compaction adversely affects the oxygen available for plant roots, adversely affecting plant growth (Costello et al, 1991).

Sometimes topsoil has to be removed and replaced during construction. During placement of soils, loosely laid planting soil naturally settles and is excellent for plant growth. Light compaction of 80-85% ASTM D698 may be reasonably specified for planting soils providing stability of soil on slopes, as well as adequate medium for plant growth (Goldsmith et al, 2001). Compaction of newly placed soils that is over 85% begins to be detrimental to plant health by limiting air pores in the soil, limiting water movement, and limiting root growth.

FINDINGS

The soils within TGP 300 Line Upgrade Project temporary workspaces were found to be severely compacted compared to similar soils in adjacent natural areas. The percent compaction discovered within these temporary workspaces exceeds the compaction required for construction of an earthen dam and is sufficient to inhibit the infiltration of rainfall and increase both the volume and rate of runoff from these areas during storm events. (*Note DRN letter with attachments related to increased runoff during storm events dated 2/7/13.*) A lack of specific guidance and performance standards regarding restoration of disturbed areas under the auspices of permitting by Pennsylvania Department of Environmental Protection (PADEP) has led to severely compacted soils, inadequate to support plant growth, in areas that are currently considered temporarily stabilized (<70% vegetative cover established). Not only do these severely compacted soils not mimic natural conditions, the hydrologic function of the soil is drastically different from any naturally occurring soil in the vicinity and will result in increased volumes of runoff leaving these compacted areas at much higher rates. This is in direct violation of permit conditions applicable to earth disturbance activities regulated by Title 25 Pa. Code Chapter 102.

REFERENCES

ASTM D698-12. *Standard Test Methods for Laboratory COmpaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).*

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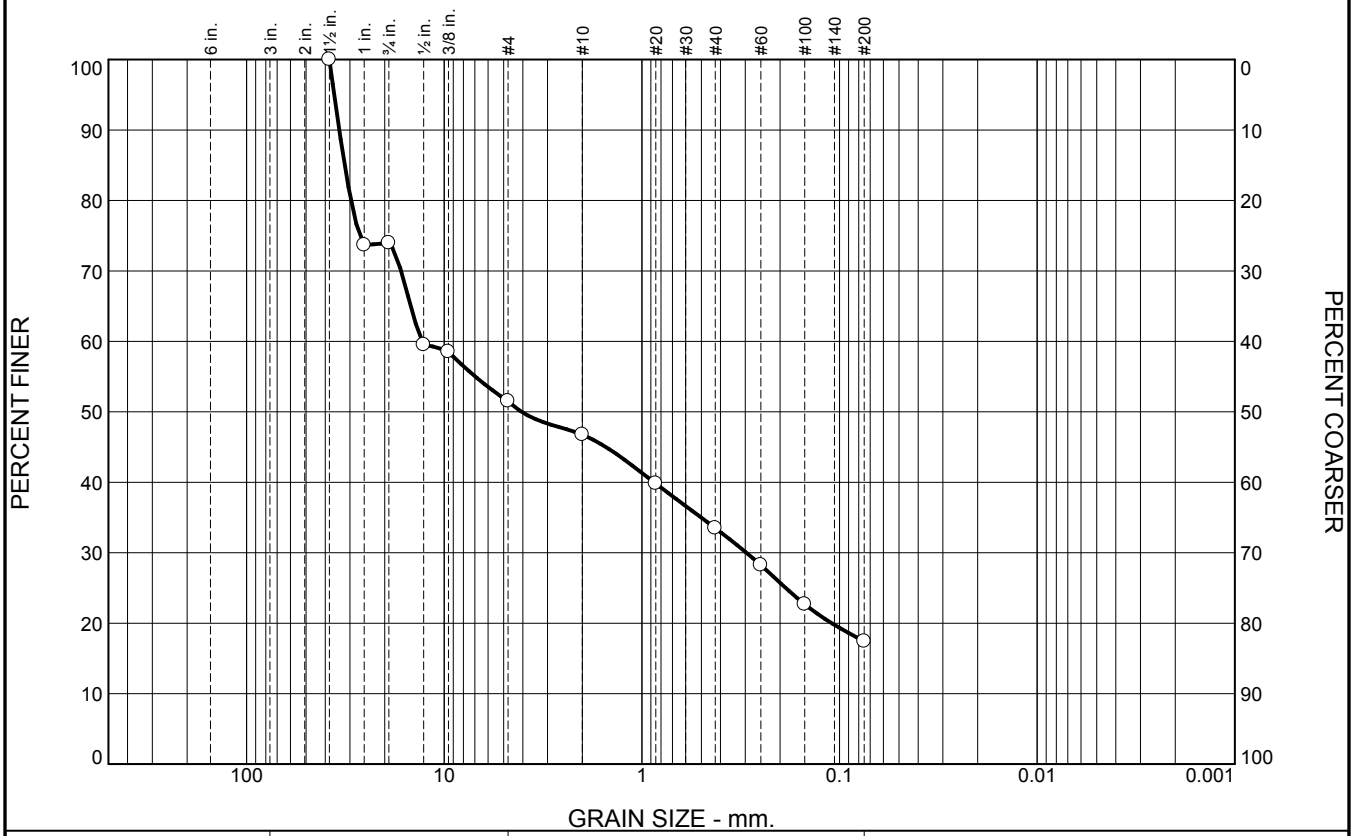
GeoSystems Consultants, Inc.

165 Indiana Avenue, Suite 2
Fort Washington, Pa 19034

Proj No:	2012G207	**Project Name:**	TGP-NEUP	**Client:**	Meliora Design , LLC
Date:	11-Jan-13	**Reviewed By:**	DMH	**Proj Eng:**	Ruth Ayn Sitler, P.E.
File No.	2012G207LS1				

Sample	Description	Type	Location		In-Place Nuclear Density Test			Laboratory Test Results			
			Lat	Long	Dry Density	Wet Density	Moisture	Dry Density	Wet Density	Moisture	Organic Content
					(pcf)	(pcf)	%	(pcf)	(pcf)	%	%
TV-1	Compacted	10-inch Shelby Tube	41.375500	-74.858090	92.8	112.1	20.7	96.3	132.1	27.1	3.9
TV-2	Compacted	10-inch Shelby Tube	41.375525	-74.858169	116.0	133.1	14.4	110.8	143.8	23.0	1.9
TV-3	Natural	10-inch Shelby Tube	41.375703	-74.857933	75.8	106.1	40.1	101.2	113.9	11.1	5.0
TV-4	Natural	10-inch Shelby Tube	41.375703	-74.857940	84.4	105.5	24.2	103.2	137.1	24.7	2.8
TV-5	Compacted	10-inch Shelby Tube	41.374660	-74.856380	110.4	128.9	16.7	107.6	146.9	26.8	3.0
TV-6	Natural	10-inch Shelby Tube	41.374870	-74.856150	90.7	108.1	19.2	93.5	132.4	29.4	2.5
TV-7	Natural	10-inch Shelby Tube	41.374980	-74.855870				53.8	57.9	7.1	5.5
TV-8	Compacted	10-inch Shelby Tube	41.374280	-74.854570				102.6	138.5	25.9	6.6
TV-9	Compacted	10-inch Shelby Tube	41.373990	-74.854550				111.3	154.4	27.9	2.7
TV-10	Natural	10-inch Shelby Tube	41.373691	-74.854785				82.4	123	33.0	6.0
G-1	Natural	Bucket/Grab								35.9	3.0
G-2	Compacted	Bucket/Grab								23.6	3.7

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	26.0	22.5	4.7	13.3	16.1	17.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	73.7		
3/4	74.0		
1/2	59.5		
3/8	58.5		
#4	51.5		
#10	46.8		
#20	39.8		
#40	33.5		
#60	28.2		
#100	22.7		
#200	17.4		

* (no specification provided)

Soil Description

silty gravel with sand with wood

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 33.9420 D_{85}= 31.8605 D_{60}= 12.9432
D_{50}= 4.0559 D_{30}= 0.2958 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GM AASHTO=

Remarks

Source of Sample: Compacted

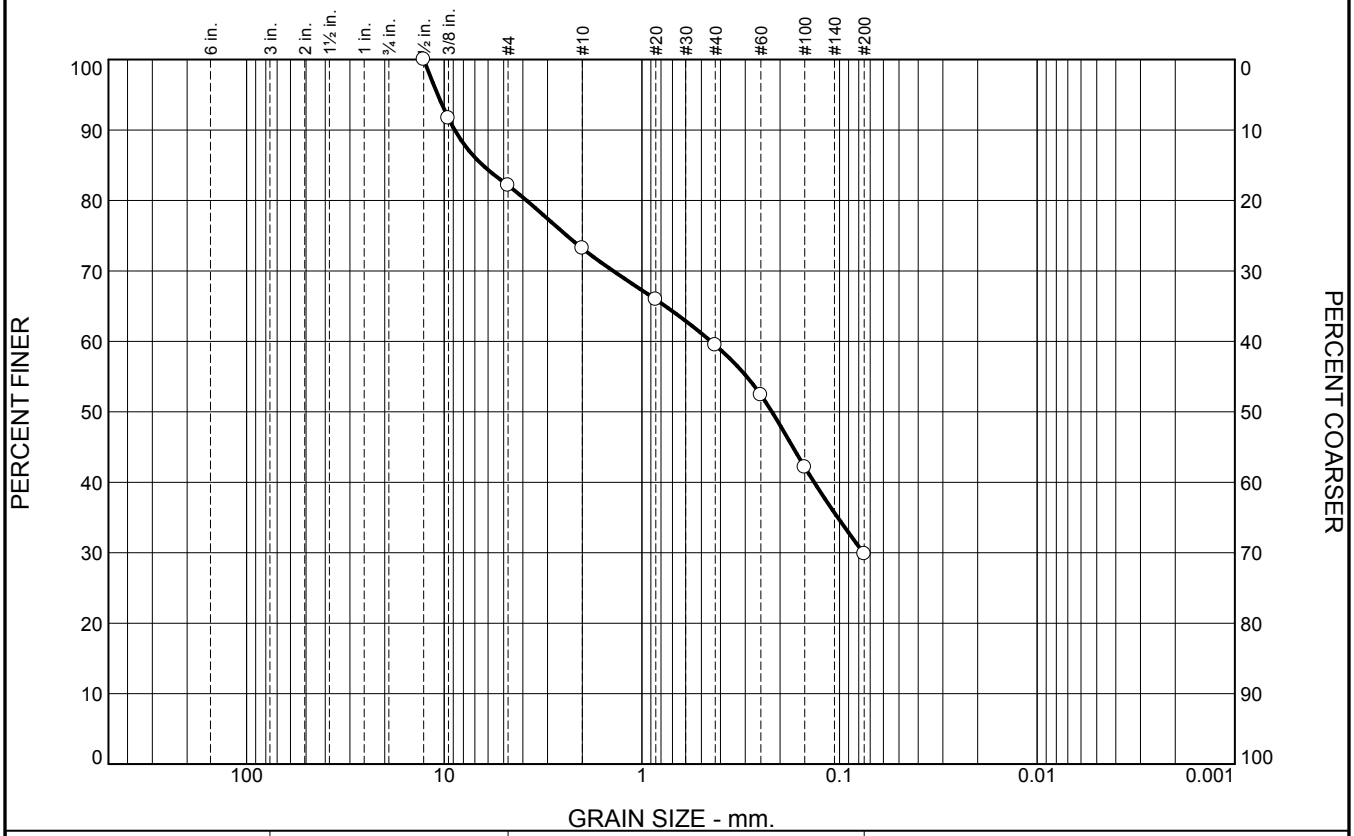
Date: 1/2/2013

GeoSystems Consultants, Inc.
Fort Washington, Pennsylvania

Client: Meliora Designs, Inc
Project: TGP-NEUP
Project No: 2012G207

Tested By: A. Njia **Checked By:** K. Nordeng

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	17.9	8.9	13.7	29.7	29.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2	100.0		
3/8	91.7		
#4	82.1		
#10	73.2		
#20	65.9		
#40	59.5		
#60	52.4		
#100	42.1		
#200	29.8		

* (no specification provided)

Soil Description

Brown silty sand with gravel with wood

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 8.8481 D_{85}= 6.3870 D_{60}= 0.4470
D_{50}= 0.2196 D_{30}= 0.0758 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Source of Sample: Natural (Uncompacted)
Sample Number: Grab

Date: 1/2/2013

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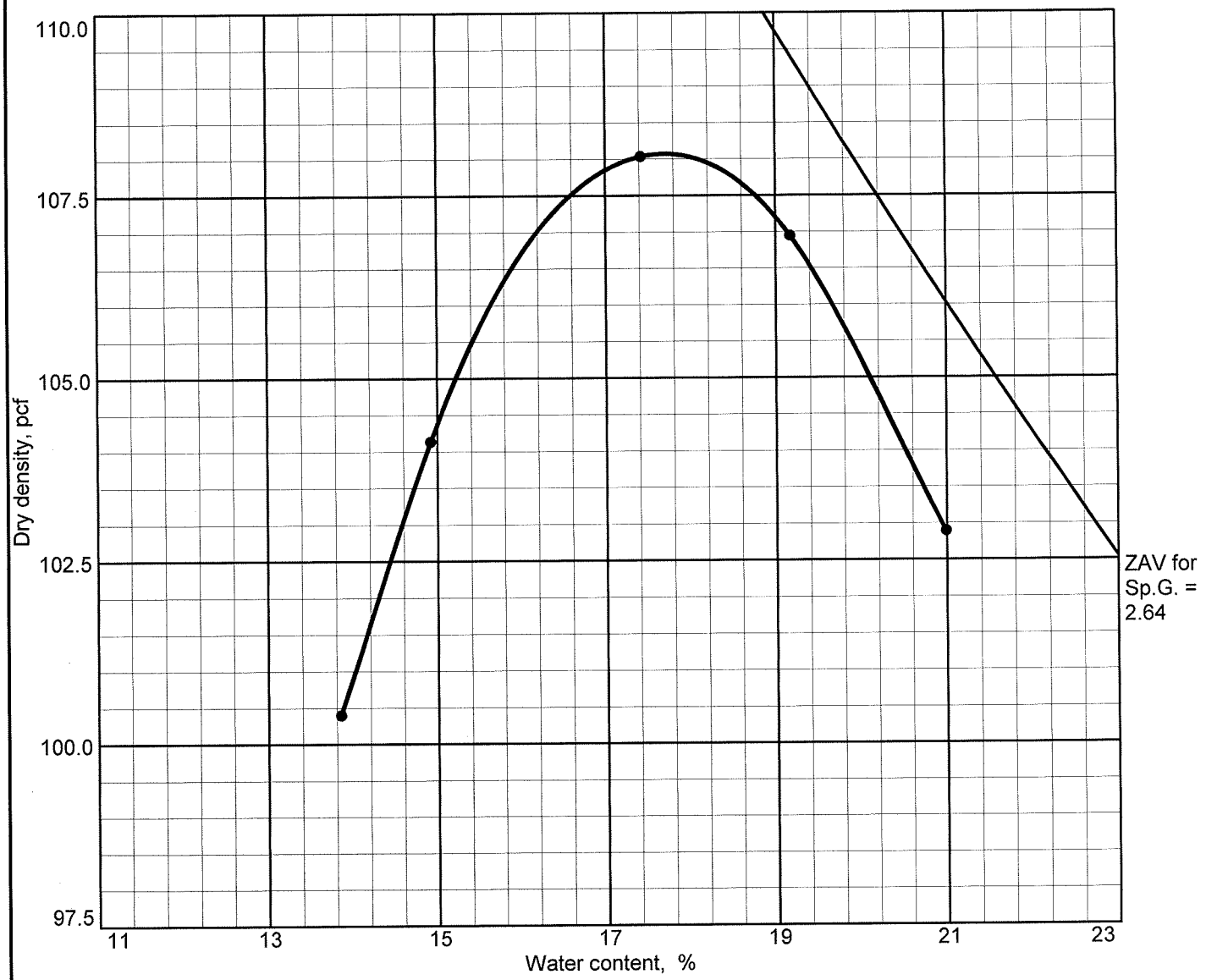
Client: Meliora Designs, Inc
Project: TGP-NEUP

Project No: 2012G207

Tested By: A. Njia **Checked By:** K. Nordeng

COMPACTION TEST REPORT



Test specification: ASTM D 698-91 Procedure B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	GM		23.6	2.64			41.5	17.4

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 108.1 pcf Optimum moisture = 17.7 %	silty gravel with sand with wood

Project No. 2012G207 **Client:** Meliora Designs, Inc
Project: TGP-NEUP

● **Source:** Compacted

Remarks:

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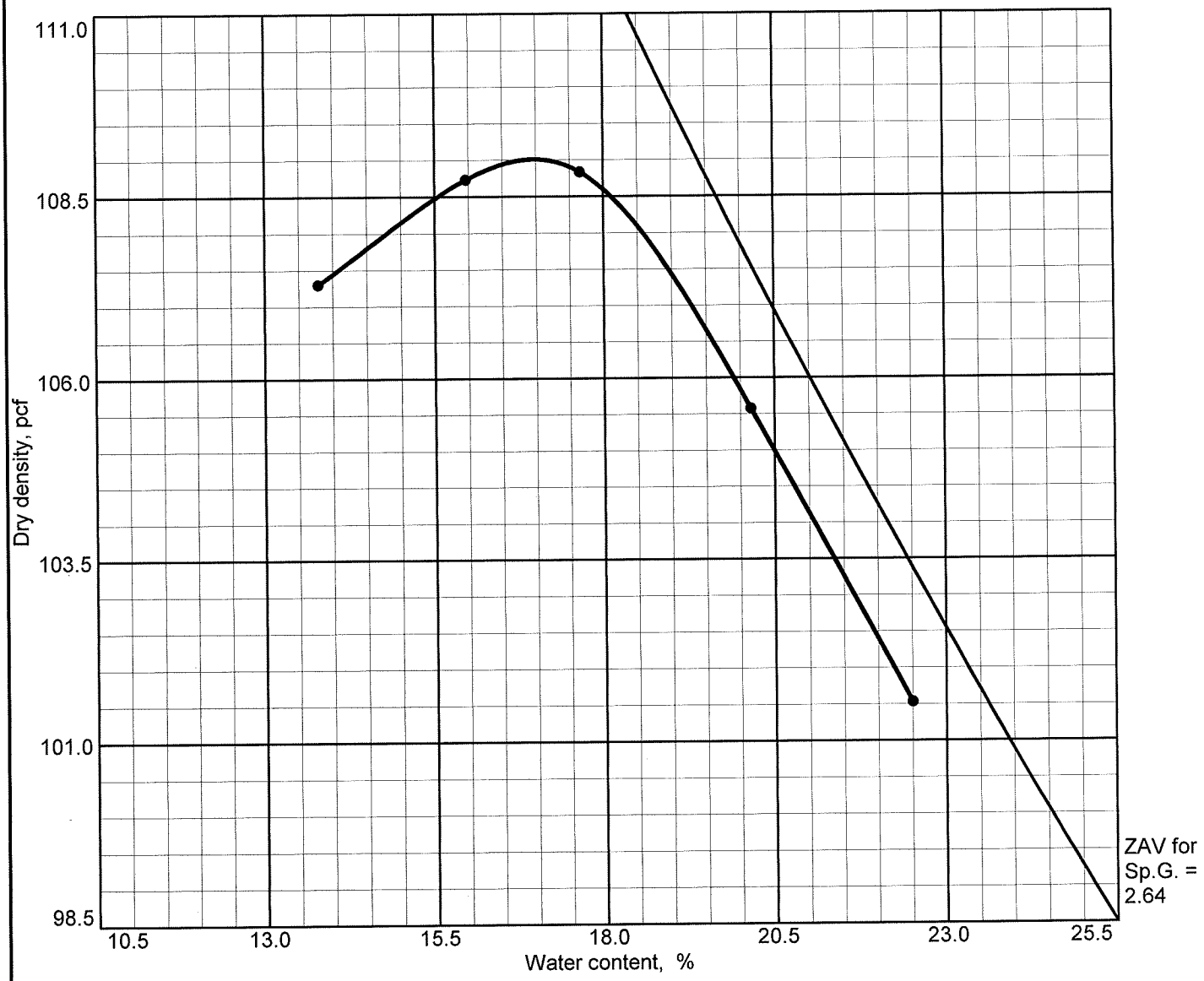
COMPACTION TEST REPORT



Test specification: ASTM D 698-91 Procedure B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
	SM		35.9	2.64			8.3	29.8

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 109.0 pcf Optimum moisture = 17.0 %	Brown silty sand with gravel with wood

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● **Source:** Natural (Uncompacted) **Sample No.:** Grab

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Water Quality Changes on Highland Forest before, during and after Timber Harvesting

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Abstract. Timber harvesting activities associated with the deterioration in water quality, especially for those on weak structured soil. This study showed that average temperature and turbidity arisen during timber harvesting and lowered one year afterwards. pH and conductivity reduced gradually whilst dissolve oxygen ever increased one year after logging compared to the natural condition. Overall, water quality on highland slightly modified during timber harvesting but it came back to normal value one year after disturbances.

Keywords: Water quality, Highland forest, Timber harvesting

1. Introduction

Zulkifli & Rahim (1991) has studied the impact of logging on hydrological parameters. Their study was on logging and forest conversion. They found that commercial logging without instituting necessary conservation measures resulted in significant changes in stream water quality with the most affected parameters were turbidity, suspended solid and iron concentration. In addition, Rahim and Zulkifli (1994) stated that suspended solid and turbidity in the first year after logging increased by 12 and nine-fold. Ruslan and Manan (1980) stated that heavily compacted soil that caused by the heavy machine, the occurrence of surface runoff is rapid. This situation has accelerated the surface erosion which in turn support to the increase in sedimentation into the adjacent receiving stream. Forest cutting was also leads to the increase in soil water storage which support in microbial activities and enhance the decomposition rates (Little & Ohmann, 1988). This situation will facilitate in leaching of various ions which accumulated into the receiving stream and affected water quality status in the stream. A study was conducted to assess the timber harvesting effect on water quality at upper hill dipterocarp forest. This paper is an attempt to clarifying some of the issues with regards to water quality due to timber harvesting.

Marryanna *et al* (2006) through her study in Bukit Tarek Forest Reserve on the changes in chemistry profile of water quality reported that Silica showed significant fluctuation in comparison with the other parameters. It increased up to 0.958 mgl^{-1} in catchment that undergone clear felling compared with control catchment. However, the difference became smaller after the felling to 0.31 mgl^{-1}.The other parameters did not show any obvious difference between control and clear felling catchment. They fluctuated from 0.02 to 0.05 mgl^{-1} during harvesting and returned to almost normal condition after the harvesting. In addition**,** Marryanna *et al* (2007) studied the effect of clear felling timber harvesting at Bukit Tarek Forest Reserve on physical water quality found that pH increased about 1.6%, conductivity 49.2% and turbidity 350.8% during the process

2. Material and Methods

2.1. Plot Description

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This study was conducted at Compartment 44, of the Perak Integrated Timber Complex (PITC) Concession area located in Temenggor Forest Reserve within the Hulu Perak District, Grik, Perak (Figure 1). This area was harvested using available harvesting protocol with some modification. The harvesting protocol being developed was compared with current harvesting practices applied by the Perak Forestry Department, which is based on the Malaysian Selective Management System and reduced impact of logging principles. The major difference between the current and new harvesting protocol is the spatial distribution of the felled trees. The total concession areas cover 9000 hectares consisting of rich lower and upper hill dipterocarp forests. However, Block 5 study area covers 300 ha (Figure 1), which is approximately 600 m to just over 800 m above sea level. It also has a typical monsoon climate characterized by uniformly high temperature and high humidity. Therefore, it is not surprising that Temenggor FR received rain exceeded 3000mm per year at times. Besides, it received less rainfall during months of July and February. Average daily hours of sunshine are usually around 10 to 11 hours with potential evapotranspiration of about 1300 mm. Five catchments have been identified as the treatment blocks. Those catchments vary in areas and water level. One unlogged catchment was selected and monitored as a control plot. The harvesting experiment is part of the Conservation of biological diversity in production forest project funded by Global Environmental Facilities (GEF), International Tropical Timber Organization (ITTO) and the Malaysian Government.

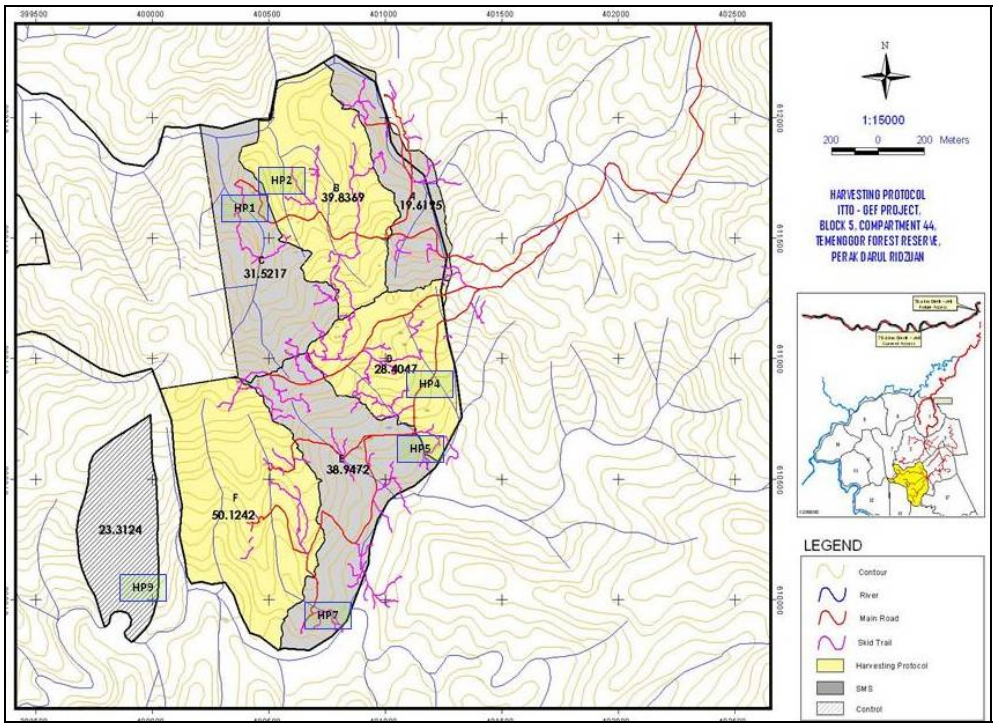

Fig. 1: Location of the study area at Block 5, Compartment 44, Temenggor F.R., Perak

2.2. Water Quality Measurement

Portable water quality sensor was used to collect physical water quality parameters on-site. Selection of the water quality parameter was based on the environmental impact assessment guidelines for forestry produced by the Department of Environment (DOE) (1998). Five parameters measured includes of temperature, pH, conductivity, turbidity and dissolved oxygen (DO). Changes in the stream water quality were evaluated against Interim National Water Quality Standard of DOE. Data was collected at monthly intervals from all monitoring stations since June 2009 until December 2011.

3. Result and Discussion

Table 1 showed that average temperature and turbidity was arisen during timber harvesting and decreased one year afterwards. Difference in temperature only slight (Figure 2) but turbidity risen twice than before logging. Water pH was slightly decreased from 7.12 before harvesting to 6.76 after harvesting while conductivity gradually decreased during and after harvesting. Turbidity level almost back to normal value while DO improved a year after harvesting processes completed. The turn back period of water quality

shown to be shorter compared to previous finding by Zulkifli and Rahim (1991) where it was mentioned that the recovery period of water quality in a catchment under harvesting was three to five years. Hence, the variation of water quality turning period differs at different locality.

Table 1. Average Monthly water quality at Block 5, Compartment 44, Temenggor F.R., Perak

Timber harvesting stage phase	Temperature (°C)	pH	Conductivity (µs/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/l)
Before	22.33	7.12	113.1	10.40	7.10
During	22.66	7.06	102.4	20.67	7.94
After	22.30	6.76	99.6	12.28	8.00

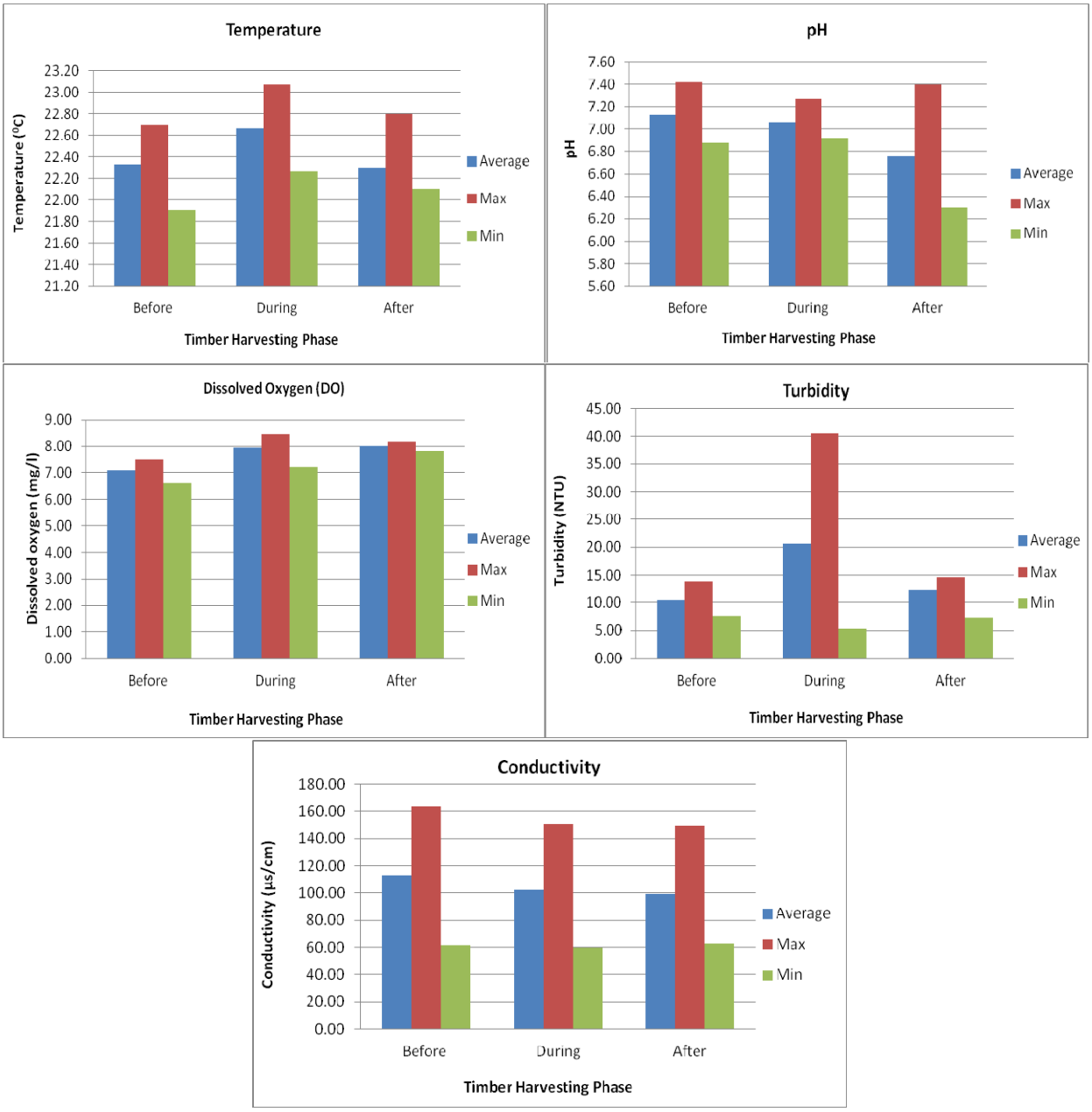

Fig. 2: Changes in water quality parameters before, during and after timber harvesting

In general, most parameters monitored were increased during timber harvesting and decreased a year after harvesting. Major fluctuation shown in turbidity where the maximum value was sharply increased at about three fold compared to before. Highest water temperature recorded during timber harvesting at 22.69 ^{0}C. The average temperature was decreased from 22.33^{0}C (before), 22.66^{0}C (During) and 22.30^{0}C after harvesting completed. pH and conductivity reduced gradually whilst dissolved oxygen ever increased one year after logging compared to the natural condition before it was logged. Average pH of water also decreased from 7.13 (before), 7.06 (during) and 6.76 (after). Variation of maximum and minimum pH value became stable during timber harvesting but it went broader considerably one year after timber harvesting. The average value for conductivity was 113.15 µs/cm (before), 102.40 µs/cm (during) and 99.60 µs/cm (after).

4. Conclusion

This study showed that value in water quality parameters slightly deviated one year after timber harvesting. Since Timber harvesting was the only source of disturbance, the water quality came back to normal when the open surface soil revegetated with the natural plants. At least one year is needed to gain the natural value of water quality on highland soil upon timber harvesting. The finding of this study would be the result of the improved harvesting technique applied in the study area. More comphrensive study should be conducted to verify and strengthen the finding of this study with concern to improve the harvesting technique for more ecosystems friendly.

5. Acknowledgement

The author would like to thanks to the Ministry of Agriculture (MOA) who kindly funded the project grant; the Forestry Department of Peninsular Malaysia and the team members from FRIM for their encouragement and support to this project. The author also thank to GEF/ITTO project that funded the timber harvesting project.

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Effects of Forest Cutting and Herbicide Treatment on Nutrient Budgets in the Hubbard Brook Watershed-Ecosystem

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EFFECTS OF FOREST CUTTING AND HERBICIDE TREATMENT ON NUTRIENT BUDGETS IN THE HUBBARD BROOK WATERSHED-ECOSYSTEM[1]

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(Accepted for publication July 31, 1969)

Abstract. All vegetation on Watershed 2 of the Hubbard Brook Experimental Forest was cut during November and December of 1965, and vegetation regrowth was inhibited for two years by periodic application of herbicides. Annual stream-flow was increased 33 cm or 39% the first year and 27 cm or 28% the second year above the values expected if the watershed were not deforested.

Large increases in streamwater concentration were observed for all major ions, except NH_4^+, $SO_4^=$ and HCO_3^-, approximately five months after the deforestation. Nitrate concentrations were 41-fold higher than the undisturbed condition the first year and 56-fold higher the second. The nitrate concentration in stream water has exceeded, almost continuously, the health levels recommended for drinking water. Sulfate was the only major ion in stream water that decreased in concentration after deforestation. An inverse relationship between sulfate and nitrate concentrations in stream water was observed in both undisturbed and deforested situations. Average streamwater concentrations increased by 417% for Ca^{++}, 408% for Mg^{++}, 1558% for K^+ and 177% for Na^+ during the two years subsequent to deforestation. Budgetary net losses from Watershed 2 in kg/ha-yr were about 142 for NO_3-N, 90 for Ca^{++}, 36 for K^+, 32 for SiO_2-Si, 24 for Al^{+++}, 18 for Mg^{++}, 17 for Na^+, 4 for Cl^-, and 0 for SO_4-S during 1967-68; whereas for an adjacent, undisturbed watershed (W6) net losses were 9.2 for Ca^{++}, 1.6 for K^+, 17 for SiO_2-Si, 3.1 for Al^{+++}, 2.6 for Mg^{++}, 7.0 for Na^+, 0.1 for Cl^-, and 3.3 for SO_4-S. Input of nitrate-nitrogen in precipitation normally exceeds the output in drainage water in the undisturbed ecosystems, and ammonium-nitrogen likewise accumulates in both the undisturbed and deforested ecosystems. Total gross export of dissolved solids, exclusive of organic matter, was about 75 metric tons/km^2 in 1966–67, and 97 metric tons/km^2 in 1967–68, or about 6 to 8 times greater than would be expected for an undisturbed watershed.

The greatly increased export of dissolved nutrients from the deforested ecosystem was due to an alteration of the nitrogen cycle within the ecosystem.

The drainage streams tributary to Hubbard Brook are normally acid, and as a result of deforestation the hydrogen ion content increased by 5–fold (from pH 5.1 to 4.3).

Streamwater temperatures after deforestation were higher than the undisturbed condition during both summer and winter. Also in contrast to the relatively constant temperature in the undisturbed streams, streamwater temperature after deforestation fluctuated 3–4°C during the day in summer.

Electrical conductivity increased about 6–fold in the stream water after deforestation and was much more variable.

Increased streamwater turbidity as a result of the deforestation was negligible, however the particulate matter output was increased about 4–fold. Whereas the particulate matter is normally 50% inorganic materials, after deforestation preliminary estimates indicate that the proportion of inorganic materials increased to 76% of the total particulates.

Supersaturation of dissolved oxygen in stream water from the experimental watersheds is common in all seasons except summer when stream discharge is low. The percent saturation is dependent upon flow rate in the streams.

Sulfate, hydrogen ion and nitrate are major constituents in the precipitation. It is suggested that the increase in average nitrate concentration in precipitation compared to data from 1955–56, as well as the consistent annual increase observed from 1964 to 1968, may be some measure of a general increase in air pollution.

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INTRODUCTION

Management of forest resources is a worldwide consideration. Approximately one-third of the surface of the earth is forested and much of this is managed or deforested by one means or another.

Forests may be temporarily or permanently reduced by wind, insects, fire, and disease or by human activities such as harvesting or management utilizing physical or chemical techniques. Management goals range from simple harvest of wood and wood products, to increased water yields, to military stratagems involving defoliation of extensive forested areas.

Despite the importance of the forest resource, there is very little quantitative information at the ecosystem level of understanding on the biogeochemical interactions and implications resulting from large-scale changes in habitat or vegetation. This gap in our understanding results because it is particularly difficult to get quantitative ecological information that allows predictions about the entire ecosystem. The goal of the Hubbard Brook Ecosystem study is to understand the energy and biogeochemical relationships of northern hardwood forest watershed-ecosystems as completely as possible in order to propose sound land management procedures.

The small watershed approach to the study of hydrologic-nutrient cycle interaction used in our investigations of the Hubbard Brook Experimental Forest (Bormann and Likens 1967) provides an opportunity to deal with complex problems of the ecosystem on an experimental basis. The Hubbard Brook Experimental Forest, maintained and operated by the U.S. Forest Service, is especially well-suited to this approach since ecosystems can be defined as discrete watersheds with similar northern hardwood forest vegetation and a homogeneous bedrock, which forms an impermeable base (Bormann and Likens, 1967; Likens, *et al.*, 1967). Thus, the six small watersheds we have used at Hubbard Brook provide a replicated experimental design for manipulations at the ecosystem level of organization.

All vegetation on Watershed 2 (W2) was cut during the late fall and winter of 1965, and subsequently treated with herbicides in an experiment designed to determine the effect on 1) the quantity of stream water flowing out of the

[1] This is Contribution No. 14 of the Hubbard Brook Ecosystem Study. Financial support for this work was provided by NSF Grants GB 1144, GB 4169, GB 6757, and GB 6742. The senior author acknowledges the use of excellent facilities and resources at the Brookhaven National Laboratory during the preparation of part of this manuscript. Also, we thank J. S. Eaton for special technical assistance, and W. A. Reiners and R. C. Reynolds for critical comments and suggestions. Published as a contribution to the U. S. Program of the International Hydrological Decade, and the International Biological Program.

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watershed, and 2) fundamental chemical relationships within the forest ecosystem, including nutrient relationships and eutrophication of stream water. In effect this experiment was designed to test the homeostatic capacity of the ecosystem to adjust to cutting of the vegetation and herbicide treatment. This paper will discuss the results of this experimental manipulation in comparison to adjacent, undisturbed watershed-ecosystems.

THE HUBBARD BROOK ECOSYSTEM

The hydrology, climate, geology, and topography of the Hubbard Brook Experimental Forest have been reported in detail elsewhere (Likens, *et al.,* 1967).

The climate of this region is dominantly continental. Annual precipitation is about 123 cm (Table 1), of which about one-third to one-fourth is snow. Although precipitation is evenly distributed throughout the year, stream flow is not. Summer and early autumn stream flow is usually low; whereas the peak flows occur in April and November. Loss of water due to deep seepage appears to be minimal in the Hubbard Brook area (Likens, *et al.,* 1967). The bedrock of the area is a medium to coarse-grained sillimanite-zone gneiss of the Littleton Formation and consists of quartz, plagioclase and biotite with lesser amounts of sillimanite. The mantle of till is relatively shallow and has a similar mineral and chemical composition to the bedrock. The soils are podzolic with a pH less than 7. Despite extremely cold winter air temperatures, soil frost seldom forms since insulation is provided by several centimeters of humus and a continuous winter snow cover (Hart *et al.,* 1962).

TABLE 1. Average annual water budgets for Watersheds 1 through 6 of the Hubbard Brook Experimental Forest. Watershed 2 has been excluded from the averages for 1965–68; 1967–68 is based on Watersheds 1, 3, and 6 only

Water Year (1 June-31 May)	Precipitation (P) (cm)	Runoff (R) (cm)	P-R (Evaporation and Transpiration) (cm)
1963-64	117.1	67.7	49.4
1964-65	94.9	48.8	46.1
1965-66	124.5	72.7	51.8
1966-67	132.5	80.6	51.9
1967-68	141.8	89.4	52.4
1963-68	122.2	71.8	50.4
1955-68	122.8	71.9	50.9

METHODS AND PROCEDURES

Precipitation is measured in the experimental watershed with a network of precipitation gauges, approximately 1 for every 12.9 hectares of watershed. Streamflow is measured continuously at stream-gauging stations, which include a V-notch weir or a combination of V-notch weir and San Dimas flume anchored to the bedrock at the base of each watershed.

Weekly samples of precipitation and stream water were obtained from the experimental areas for chemical analysis. Rain and snow were collected in two types of plastic containers, 1) those continuously uncovered or 2) those uncovered only during periods of rain or snow. One-liter samples of stream water were collected in clean polyethylene bottles approximately 10 m above the weir in both the deforested and undisturbed watersheds. Chemical concentrations characterizing a period of time are reported as weighted averages, computed from the total amount of precipitation or streamflow and the total calculated chemical content during the period. Details concerning the methods used in collecting samples of precipitation and stream water, analytical procedures, and measurement of various physical characteristics have been given by Bormann and Likens (1967), Likens, *et al.* (1967), and Fisher, *et al.* (1968).

During November and December of 1965 all trees, saplings and shrubs of W2 (15.6 ha) were cut, dropped in place, and limbed so that no slash was more than 1.5 m above the ground. No roads were made on the watershed and great care was taken to minimize erosion. No timber or other vegetation was removed from the watershed. Regrowth of vegetation was inhibited by aerial application of the herbicide, Bromacil ($C_9H_{13}BrN_2O_2$), at 28 kg/ha on 23 June 1966. Approximately 80% of the mixture applied was Bromacil and 20% was largely inert carrier (H. J. Thome, personal communication). Also, during the summer of 1967, approximately 87 liters of an ester of 2, 4, 5-trichlorophenoxyacetic acid (2, 4, 5-T) was individually applied to scattered regrowths of stump sprouts.

The results reported cover the period immediately following the cutting of the vegetation on W2, 1 January 1966 through 1 June 1968.

HYDROLOGIC PARAMETERS

The annual hydrologic regime at Hubbard Brook has varied greatly since we began our study in 1963 (Table 1). The 1964-65 water-year was exceptionally dry, and 1967–68 was very wet. These fortuitous extremes have provided a wide range of hydrologic conditions for our study of the hydrologic-nutrient cycle interactions.

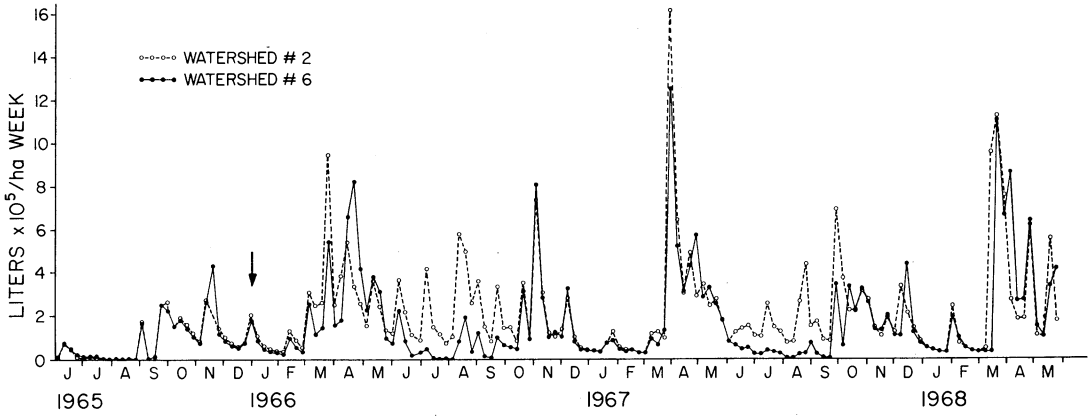

FIG. 1. Average weekly stream water discharge from Watersheds 2 and 6 during 1965–68. The vegetation on Watershed 2 was cut during November and December 1965. The arrow indicates the completion of the cutting.

Chemical input into a watershed from meteorological sources is based in part on the volume of precipitation, thus it is important to determine whether precipitation is distributed randomly throughout the watersheds. Our studies in 1963–64 and 1964–65 indicated no significant difference between rain gauges at different elevations (Likens *et al.*, 1967). Subsequent data indicate that there is generally very little difference in the precipitation pattern with elevation, but one or two storms of high intensity may significantly alter the spatial distribution for total annual precipitation within the area. Since the overall precipitation pattern for 1966–67 and 1967–68 was more variable than previous years, we have calculated the precipitation input for each watershed, for these two years, on the basis of Thiessen averages established for the area (see Thiessen, 1923). In spite of the variation in precipitation and runoff, the amount of water lost by evaporation and transpiration from undisturbed watersheds remained about the same each year during 1963 to 1968 (Table 1).

Cutting the vegetation of W2 produced a significant effect on the distribution of water loss from the watershed. These changes are reported in detail elsewhere (Hornbeck, *et al.*).

The annual runoff in 1967–68 and 1968–69 from the deforested ecosystem increased by 39% and 28%,[3] respectively, over the values expected had the watershed not been cut (Table 2). The greatest difference occurred during June through September, when runoff values were 414% (1966–67) and 380% (1967–68) greater than expected.

[3] The slight discrepancy from data presented by Hornbeck, *et al.*, is due to rounding errors incurred in the conversion of English to metric units.

The increased streamflow during summer is directly attributable to the removal of transpiring surface. In addition to the increased yield of drainage water from the watershed, the snowmelt was advanced a few days and was more rapid, particularly during 1967-68 (Fig. 1; Federer, 1969; Hornbeck and Pierce, 1969).

TABLE 2. Runoff and precipitation for Watershed 2 (cutover) of the Hubbard Brook Experimental Forest, expressed in cm of water. The watershed was clear-cut in November and December of 1965. Predicted values for runoff were calculated from regression analyses established during a pretreatment calibration period. (After Hornbeck, *et al.*, 1970)

	1965-66	1966-67	1967-68
Precipitation	124.6	132.1	138.7
Predicted runoff	(77.7)	(86.5)	(96.7)
Measured runoff	79.9	119.9	123.4
Evaporation and Transpiration	44.7	12.2	15.4

In various experiments throughout the world, with 100% reduction in forest cover by clear-cutting or chemical treatment, stream flow increases averaged about 20 cm the first year after treatment (Hibbert, 1967). Detailed studies at the Coweeta Hydrologic Laboratory, Southeastern Forest Experiment Station in North Carolina showed maximum increases in water yield of about 41 cm during the first year following the complete removal of the hardwood forest vegetation on small watersheds (Hoover, 1944).

PRECIPITATION CHEMISTRY

Sulfate and hydrogen ions are the most abundant constituents (in terms of chemical equivalents) in precipitation falling on the watersheds

TABLE 3. Average weighted ion content of bulk precipitation collected within the Hubbard Brook Experimental Forest from 1 June to 31 May expressed in mg/liter.

	1965-66	1966-67	1967-68
calcium	0.22	0.21	0.20
magnesium	0.04	0.03	0.05
potassium	0.05	0.05	0.05
sodium	0.16	0.10	0.12
aluminum	***	0.1	***
ammonium	0.21	0.18	0.22
hydrogen ion	0.07	0.08	0.07
nitrate	1.41	1.49	1.56
sulfate	3.3	3.1	3.3
chloride	0.21+	0.50##	0.35
bicarbonate	#	#	#
dissolved silica	***	***	***

***Not determined; probably less than 0.1
#Virtually absent
##Based on samples for 9 months. Samples collected from 1 September through 30 November were discarded because plastic screens were used on the collection apparatus (Juang and Johnson 1967; Fisher, *et al.* 1968).
+Calculated for the period September through August (Juang and Johnson, 1967).

at Hubbard Brook. The pH of rain and snow samples is frequently less than 4.0. Nitrate is next in abundance, and significant amounts of ammonium, chloride, sodium and calcium are usually present. Lesser amounts of magnesium, potassium and aluminum are also found (Table 3).

Since precipitation samples are composited over weekly intervals, it is difficult to identify the origin of chemical impurities in individual air masses or storms.

Our chemical input data are based on bulk precipitation, i.e., a mixture of rain or snow and dry fallout (Whitehead and Feth, 1964). We have been concerned with the contributions from dry fallout since the beginning of the study. Juang and Johnson (1967) suggested that dry fallout was a source of chloride in the Hubbard Brook ecosystem. However, based upon comparisons between precipitation collectors that were continuous open (Likens, *et al.*, 1967) and those that opened only during periods of rain or snow (Wong Laboratories, Mark IV), it is clear that the bulk of chemical input to the ecosystem comes in rain and snow. Our attempts to quantify the much smaller contributions from dry fallout have been thus far inconclusive.

Average values for the ion content of precipitation, interpolated from isopleth maps for central New Hampshire (Junge, 1958; Junge and Werby, 1958), do not agree closely with the average weighted concentration of ions measured in precipitation at Hubbard Brook (Table 3). Considering the yearly variation in precipitation chemistry (Likens, *et al.*, 1967; Fisher, *et al.*, 1968; Table 3), and that our samples were taken in 1965–68, it is not surprising that there is not better agreement between our values and those obtained in 1955–56 by Junge and Werby. Our cation values are nearly 50% lower than those reported by Junge (1958) and Junge and Werby (1958); whereas our anion values, with the exception of chloride, are somewhat higher.

Soil and road dust are among the principal sources of base metal ions in local precipitation (*e.g.*, Gambel and Fisher, 1966). In the Hubbard Brook area, the almost total forest cover strongly minimizes the generation of soil dust, thereby reducing the concentration of these ions in the local precipitation.

The weighted concentration of nitrate in precipitation at Hubbard Brook is considerably higher than the concentrations reported by Junge (1958) for New England, and in fact, for most regions of the U. S. Since air pollution can affect the concentration of nitrate in precipitation (*e.g.*, Junge, 1963), our data might reflect some measure of increased air pollution between 1955–56 and 1965–66, and its resultant effect on nutrient budgets in rural as well as urban areas. In this regard it is interesting that our average values for nitrate in precipitation (rain and snow plus dry fallout) has increased each year since 1964; whereas most of the other chemical constituents remained constant or fluctuated slightly (Table 3).

CHEMICAL INPUT THROUGH HERBICIDE APPLICATION

Our nutrient budgets are based on the difference between chemical input in precipitation and output in stream water from the watershed-ecosystems (Bormann and Likens, 1967). Thus, it is important to account for any extraneous chemical inputs to the ecosystem, such as an application of herbicide. Approximately 3650 liters of Bromacil solution were sprayed on the cutover watershed in June 1966. Based on a chemical analysis of the herbicide solution, and assuming complete decomposition, 0.04 Ca^{++}/ha, 0.09 kg Mg^{++}/ha, 0.01 kg K^{+}/ha, 0.11 kg Na^{+}/ha, and 10.6 kg NO_3^{-}/ha were added to the watershed. These are relatively insignificant inputs to the budgets for the deforested watershed. Bromide is equivalent to chloride with the analytical method we use for chloride (Iwasuki *et al.*, 1952). Thus we have calculated a maximum possible input of 3.0 kg/ha to the chloride budget from Bromacil.

Approximately 87 liters of an ester (propylene glycol butyl ether) of 2, 4, 5-T were sprayed on the cutover watershed during the summer of 1967. This herbicide was mixed with water from

the drainage stream of the watershed to produce the spray solution. Chemical analyses of the solution showed that negligible amounts of cations were added to the watershed-ecosystem from this application of herbicide. However we calculated a maximum input of 0.7 kg Cl^-/ha to the watershed from the herbicide solution. Inputs for other anions were negligible.

STREAMWATER PARAMETERS

Temperature

The drainage streams in the undisturbed watersheds during summer are in deep shade beneath the forest canopy; in winter they are under a deep snow pack. Thus, for most of the year, daily stream water temperatures are relatively constant and the annual temperature range is only about 16°C (Figs. 2 and 3).

The altitudinal temperature gradient in stream water varies somewhat in the undisturbed watersheds, and in Watershed 4 during midsummer it is about 5–7°C. At times it may be as much as 12°C, however the steepest portion of this thermal gradient is confined largely to the upper 50 m of the stream (McConnochie and Likens, 1969). Macan (1958) and others have shown that small streams usually warm and reach equilibrium temperatures rapidly, and that the average water temperature approximates the average air temperature. In winter, the altitudinal temperature gradient in streams within the watersheds is not more than 1 or 2°C.

Streamwater temperatures in the deforested watershed (W2) were higher than in the undisturbed watersheds during both summer and winter. In the absence of shade, temperature varied by 3–4°C during the day in summer; the maximum temperature occurred about 1500 hours and the minimum at 0700–0800 hours (Fig. 3). The annual variation was about 18 to 20°C (Fig. 2).

Even though the mean January air temperature is −9°C (U. S. Forest Service, 1964), the streams do not freeze solid. In fact, they are relatively warm below the thick snow pack in winter (Figs. 2 and 3). A thicker snow depth in the stream channel of the deforested watershed could provide more insulation and may account for the somewhat higher streamwater temperature. As mentioned earlier, frost is uncommon in the soils of the watersheds.

The streams seem to have discrete summer and winter temperature regimes with rapid seasonal transitions. Warm-up during the spring is very rapid, occurring mostly in May in the undisturbed situation (Fig. 2).

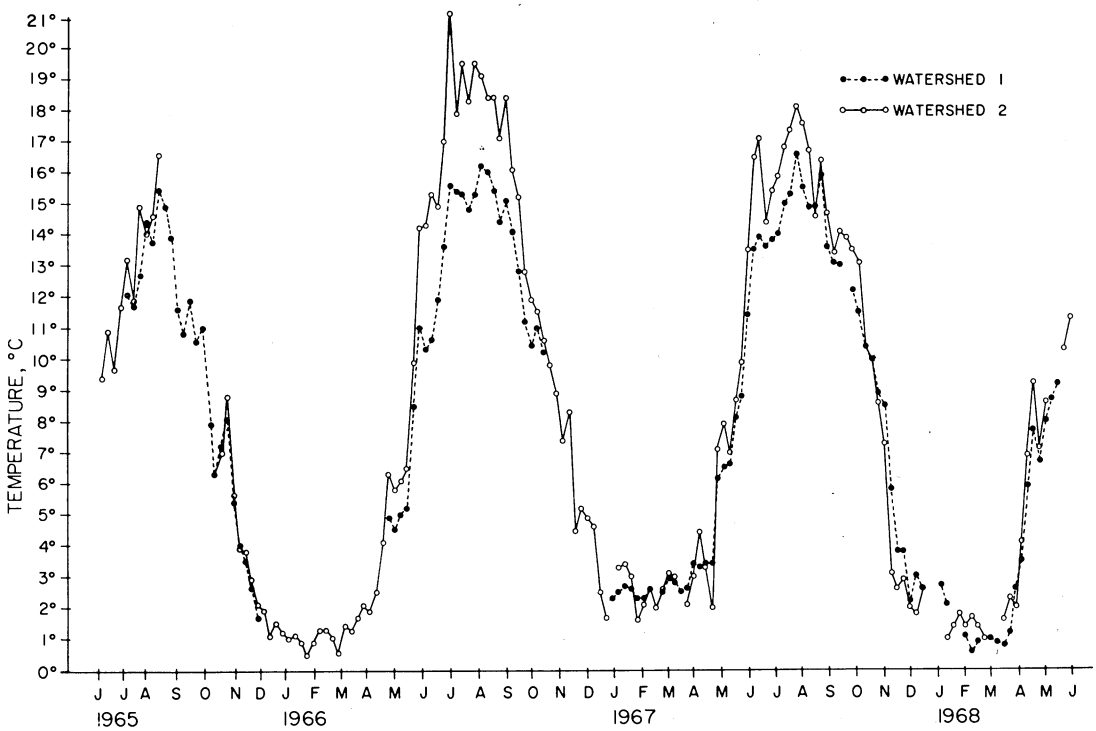

FIG. 2. Mean weekly stream water temperatures in Watersheds 1 and 2 (deforested) during 1965–68. The recording thermometers were located above the weirs in each stream. The points were not connected during periods when the stream discharge was negligible or when the thermograph functioned improperly.

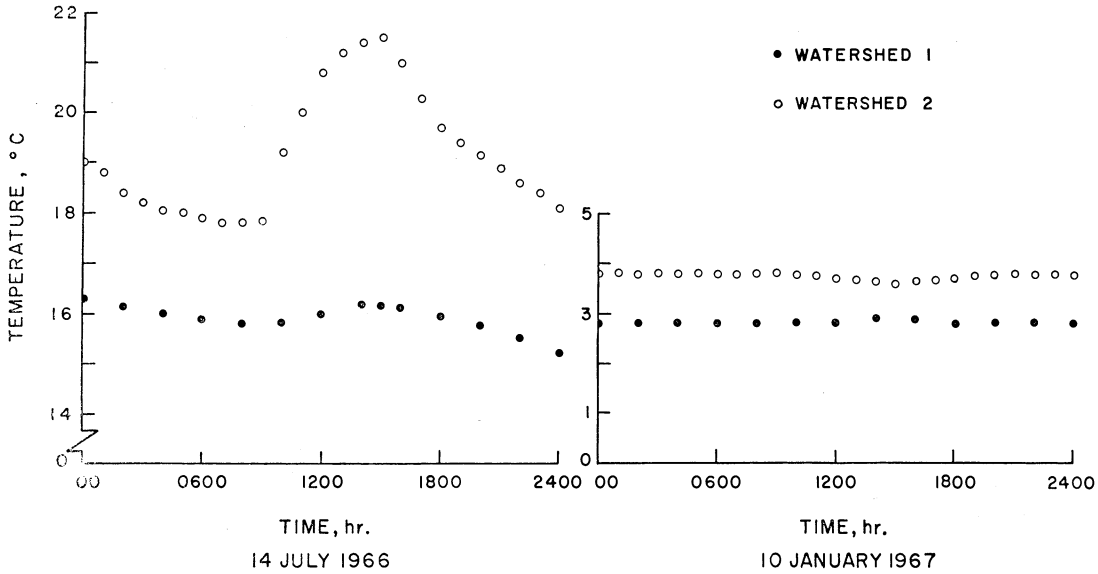

FIG. 3. Mean hourly stream water temperatures during one day in the summer and one day in the winter in Watersheds 1 and 2 (deforested).

DISSOLVED OXYGEN

The stream water from the Hubbard Brook watersheds is normally saturated or slightly supersaturated with dissolved oxygen, except during periods of very low flow, *e.g.,* late summer and early autumn (Fig. 4). There is no apparent seasonal pattern separate from this dependence on discharge. The dissolved oxygen values are adjusted for altitude and streamwater temperature to calculate the percent saturation. Ruttner (1953) indicates that the dissolved oxygen in streams, even in cascading water, should not exceed the saturation equilibrium with air. However, supersaturation of dissolved oxygen has been found by several other workers in natural streams and rivers (*e.g.,* Järnefelt, 1949; Harvey and Cooper, 1962; Minckley, 1963; Woods, 1960). The explanation of the supersaturated condition in streams tributary to Hubbard Brook is not readily apparent, although it may be "forced" to supersaturation by turbulence (Lindroth, 1957; Harvey and Cooper, 1962) or may be a function of the altitudinal temperature gradient in the streams. Photosynthetic organisms are not abundant in these tributary streams, and diel variations in dissolved oxygen are not apparent.

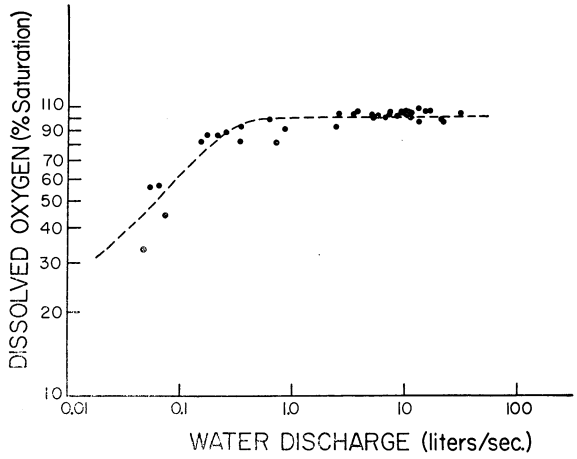

FIG. 4. Relationship between dissolved oxygen and stream water discharge in undisturbed Watershed 3 during 1965–66. The equation for the dashed line is $C = (1 - e^{-(D)(0.0693)})\ 79.26 + 22.59$, where C = dissolved oxygen in % saturation and D = stream discharge in liters/sec. The constants in this equation were determined by linear regression analysis and the F-ratio for the regression line is very highly significant (>0.001).

At low flows the water mostly seeps from one small pool to the next through gravel and organic debris dams. The biological oxygen demand from decaying leaves and other organic debris in the stream is apparently high enough to reduce significantly the dissolved oxygen concentration when flow and turbulence are low. Rapid depletion of dissolved oxygen resulting from decomposition of leaves in small streams has been demonstrated by several workers (see Minckley, 1963).

Increased water yield from the deforested watershed, particularly in the summer months (Fig. 1), results in greater discharge, more turbulence and a constant high level of dissolved oxygen in this stream. Thus, during the summer and autumn large differences in dissolved oxygen concentration may be anticipated between the streams

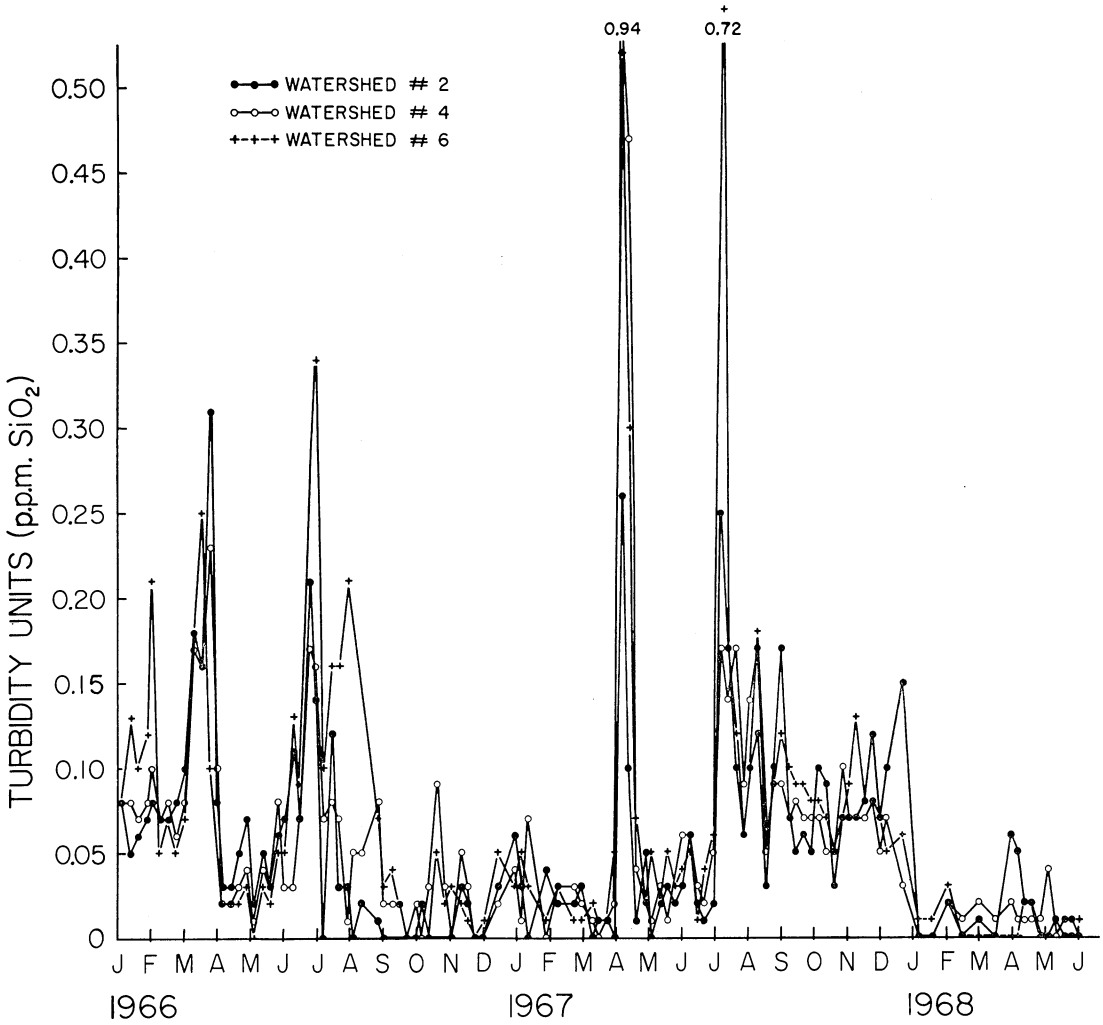

FIG. 5. Turbidity values for stream water from Watersheds 2 (deforested), 4 and 6 during 1966–1968.

in the deforested and undisturbed watersheds. With increased water temperature, sunlight and high concentrations of dissolved oxygen, more rapid decomposition of the organic debris would be expected in the stream of W2.

TURBIDITY

Following disturbance of the vegetation and litter in forested watersheds, drainage waters may become quite turbid as the result of erosion and transport of inorganic and organic matter from the watershed (*e.g.*, Lieberman and Hoover, 1948a; Tebo, 1955). For example, this frequently occurs as a consequence of unregulated commercial logging operations. However, with care and planning, turbidity and sedimentation in drainage streams may be minimized following commercial logging (Hewlett and Hibbert, 1961; Lieberman and Hoover, 1948b; Trimble and Sartz, 1957).

Stream water draining the Hubbard Brook Experimental Forest is very clear, and no obvious differences were noted in the turbidity of the stream water from W2 following the cutting and herbicide treatment of the vegetation (Fig. 5). In fact, the peak turbidity values seemed to be depressed in comparison with values for streams in the undisturbed watersheds. Of the three watersheds compared, W6 showed the greatest extremes in turbidity, and these extreme values were also slightly out-of-phase with changes in the other watersheds (Fig. 5). High values were not always correlated with high runoff values, *e.g.*, during June 1966 and July 1967. All in all, the measurements of turbidity were of little value in assessing the changes in water quality of the stream water of these forested and deforested ecosystems.

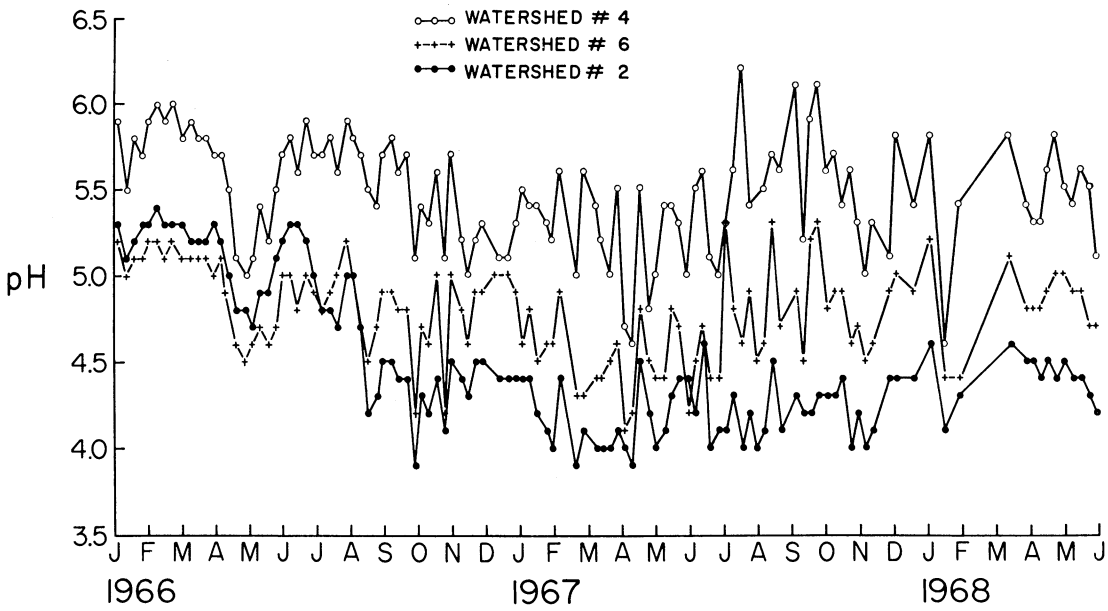

FIG. 6. pH values for stream water from Watersheds 2 (deforested), 4 and 6 during 1966–1968.

PARTICULATE MATTER

Undisturbed forest ecosystems lose relatively little organic and inorganic particulate matter. Average annual losses are about 25 kg/ha-yr., and are about equally divided between organic and inorganic particulate matter (Bormann, *et al.*, 1969). These minor particulate matter losses, about one-sixth of the dissolved substance losses, are attributed to the operation of biotic factors, which 1) decrease the erodability of the ecosystem, 2) decrease the amount of runoff and 3) tend to damp the frequency of high discharge rates.

The influence of these biotic factors has been severely limited by removal of the living vegetation in Watershed 2. Compared to undisturbed Watershed 6, the new conditions in Watershed 2 are reflected by a 4-fold increase in particulate matter in the settling basin above the V-notch weir for the period May 1966 to May 1968. Also, particulate matter output from Watershed 2 is becoming increasingly inorganic in content (76% inorganic, May 1966 to May 1968).

The increased output in particulate matter, and particularly the increased proportion of inorganic materials, from W2 occurred primarily from the unraveling of the stream channel. In many places the banks have been eroded and many of the small debris dams, composed of leaves, twigs, etc., that were common in the undisturbed stream, have worn away, with a subsequent release of trapped inorganic and organic materials. Because these dams no longer exist, and without the annual replenishment of leaves and other organic debris to build new dams, stream water is able to transport much more particulate material downslope. Also, stream channel erosion is increased since the binding action of roots has been reduced, and leaves, which provide a protective cover on the banks, have been removed and not replenished.

pH

Acidic water characterizes the drainage streams from the undisturbed watersheds. This is typical for many streams in New England with podzolic soils (*e.g.*, Anderson and Hawkes, 1958). The pH values are variable throughout the year, but consistently show the same relationship between watersheds (Fig. 6). There was particularly good agreement in pattern between the undisturbed watersheds, W4 and W6, although stream water from W4 was relatively less acidic.

As a result of deforestation, and concurrently with other chemical changes in the drainage waters during June 1966, the hydrogen ion content (calculated from pH measurements) in stream water from W2 increased by 5-fold (Fig. 6). That is, the weighted average pH, decreased from 5.1 during 1965–66 to 4.3 during 1966–67 and 1967–68 (Likens, *et al.*, 1969). During the same period the weighted pH value remained relatively unchanged for W4 and W6.

ELECTRICAL CONDUCTIVITY

Electrical conductivity averages about 20 μmhos/cm^2 at 25°C in stream water of the undis-

TABLE 4. Weighted average concentration in stream water from watersheds 2, 4, and 6 of the Hubbard Brook Experimental Forest, expressed in mg/liter

Ion	W2			W4#		W6		
	1965-66	1966-67	1967-68	1965-66	1966-67	1965-66	1966-67	1967-68
Ca^{++}	1.81*	6.45	7.55	1.82*	1.80	1.36*	1.27	1.28
Mg^{++}	0.37	1.35	1.51	0.41	0.40	0.36	0.35	0.36
K^{+}	0.19	1.92	2.96	0.22	0.24	0.18	0.20	0.26
Na^{+}	0.87	1.51	1.54	1.13	1.10	0.83	0.80	0.93
Al^{+++}	0.22	1.5	2.0	0.12	0.12	0.32	0.33	0.32
NH_4^{+}	0.14	0.07	0.05	0.12	0.06	0.12	0.05	0.02
NO_3^{-}	0.94	38.4	52.9	0.86	0.88	0.85	0.69	1.30
$SO_4^{=}$	6.8	3.8	3.7	6.4	6.2	6.2	6.0	6.1
Cl^{-}	0.54	0.89	0.75	0.56**	0.58	0.57***	0.55	0.56
HCO_3^{-}	0.8	0.1	0	1.6	2.0	0.1	0.2	0.3
SiO_2—aq	4.1	5.6	5.7	5.4	5.5	4.1	4.4	3.8
Total	16.8	61.6	78.7	18.6	18.9	15.0	14.8	15.2

*Values for the initial 7 months of the water-year have been increased by a factor of 1.6 to compensate for analytical interferences (Likens, *et al.*, 1967; Johnson, *et al.*, 1968)
**Juang and Johnson (1967) calculated a value of 0.51 for the period September through August.
***Juang and Johnson calculated a value of 0.50 for the period September through August.
#Data not available for 1967-68.

turbed watersheds and changes very little either on a daily or seasonal basis. This would be expected from the relative constancy of cation and anion concentrations in stream water at Hubbard Brook (Likens, *et al.*, 1967; Fisher, *et al.*, 1968; Johnson, *et al.*, 1969).

In contrast, the conductivity of stream water from the deforested watershed is quite variable, ranging from 65 and 160 μmhos/cm² at 25°C. Usually the conductivity decreased during rain storms. However occasionally the conductivity increased or was unaffected. The hydrogen ion concentration of rain water added to the stream water is important in this regard, as well as other variables such as amount of rainfall, its duration, streamwater discharge, and water content of the soil.

IONS

Ammonium and Nitrate

The ammonium ion occurs in very low concentration in stream water from undisturbed watersheds of the Hubbard Brook Experimental Forest (Fisher, *et al.*, 1968). Essentially no change was observed in the concentration of this ion in drainage water from the deforested watershed. In contrast the nitrate concentration increased from an average weighted value of 0.9 mg/liter prior to cutting of the vegetation, to 53 mg/liter, two years later (Table 4). Measured concentrations soared to 82 mg/liter in October 1967 (Fig. 7). It should be noted that the initial increase (June 1966) in streamwater nitrate concentration in W2 occurred 16 days before the application of the Bromacil and at the same time the nitrate concentration in the stream water from the undisturbed watershed showed the normal late-spring decline (Fig. 7; Bormann, *et al.*, 1968).

Nitrate concentrations in stream water from the undisturbed watersheds, show a pronounced, recurring seasonal pattern (Bormann, *et al.*, 1968; Fisher, *et al.*, 1968). Average monthly concentrations are low (<0.1 mg/1) throughout the summer growing season, increase in November, and reach values as high as 2 mg/liter during the spring (April) thaw (Fig. 8). This variation may be explained by a combination of mechanical and biological effects (Johnson, *et al.*, 1969).

The decline of nitrate concentrations during May and the low concentrations throughout the summer correlate with heavy nutrient demands by the vegetation and increased heterotrophic activity associated with warming of the soil. The winter pattern of NO_3^- concentration may be explained in strictly physical terms, since the input of nitrate in precipitation from November through May largely accounts for nitrate lost in stream water during this period (Bormann, *et al.*, 1968). Also, sublimation and evaporation of water from the snow pack could account for some 15–20% increase in concentration of NO_3^- in the stream water in the spring. Concentration of nitrate in stream water after deforestation show a pattern that is nearly the reciprocal of the undisturbed situation (Fig. 8).

Since yearly input of nitrate-nitrogen in precipitation exceeds losses in stream water in the undisturbed ecosystems (Table 5), the concentration of nitrate in stream water provides no conclusive evidence for nitrification in these un-

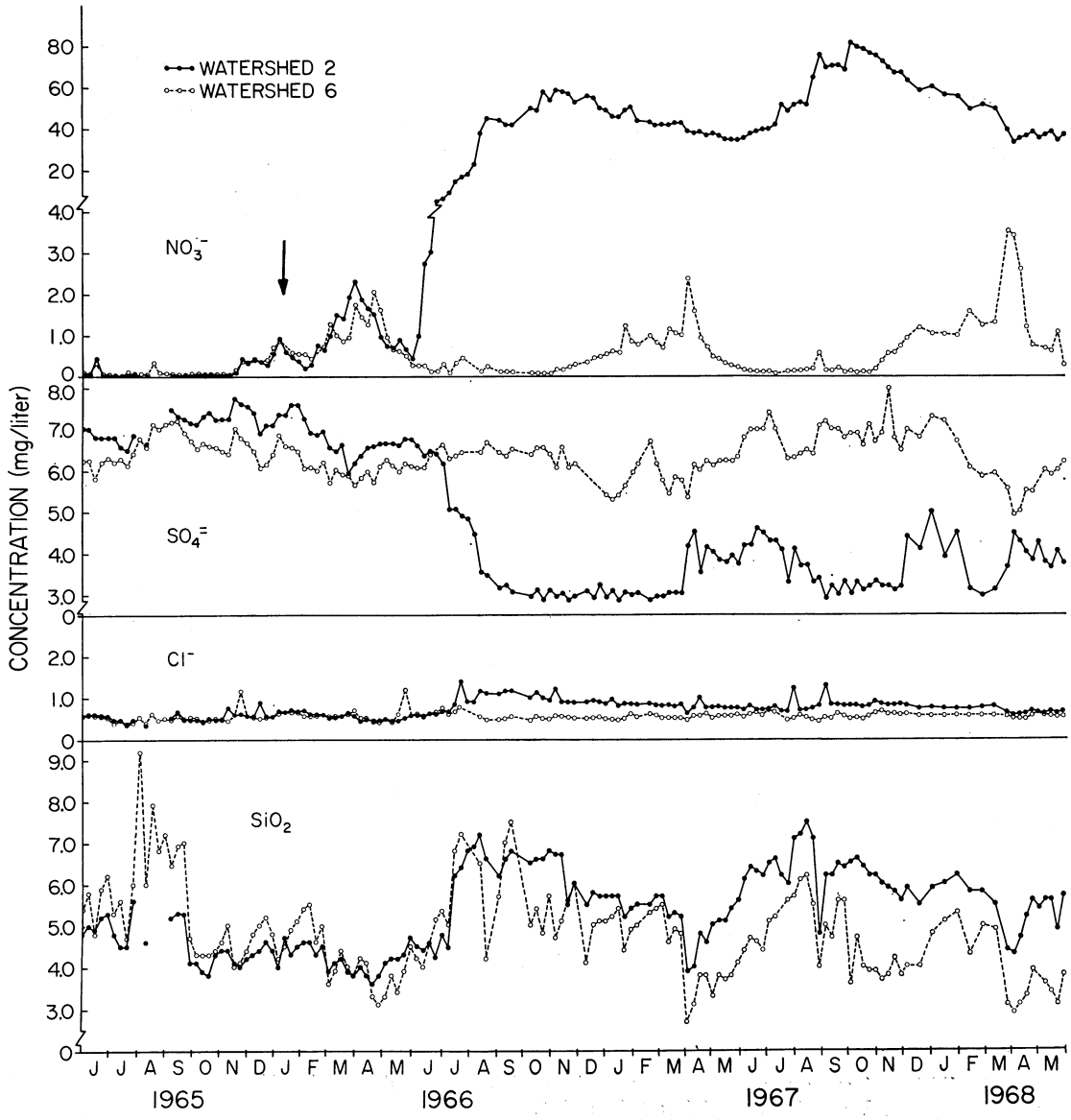

FIG. 7. Measured streamwater concentrations for nitrate, sulfate, chloride and dissolved silica in Watersheds 2 (deforested) and 6. Note the change in scale for the nitrate concentration. The arrow indicates the completion of cutting in W2.

disturbed acid soils. The low levels of ammonia and nitrate in the drainage water of the undisturbed ecosystem (W6) may attest to the efficiency of the oxidation of ammonia to nitrate, and to the efficiency of the vegetation in utilizing nitrate. However, Nye and Greenland (1960) state that growing, acidifying vegetation represses nitrification; thus the vegetation may draw directly on the ammonium pool, and little nitrate may be produced within the undisturbed ecosystem. However, in the absence of forest vegetation, the microflora of the deforested watershed apparently oxidize ammonia to nitrate, and the nitrate is rapidly flushed from the watershed-ecosystem (Bormann, *et al.,* 1968; Likens, *et al.,* 1969).

Many microorganisms convert organic nitrogen into ammonia. The ammonia then may be oxidized to nitrite by bacteria of the genus *Nitrosomonas.* The nitrite may be further oxidized to nitrate by bacteria of the genus *Nitrobacter.* The important end products of these reactions in terms of nutrient losses from the watershed-ecosystem are the increased production of nitrate and hydrogen ions. Increased biological nitrification apparently is the principal factor responsible for

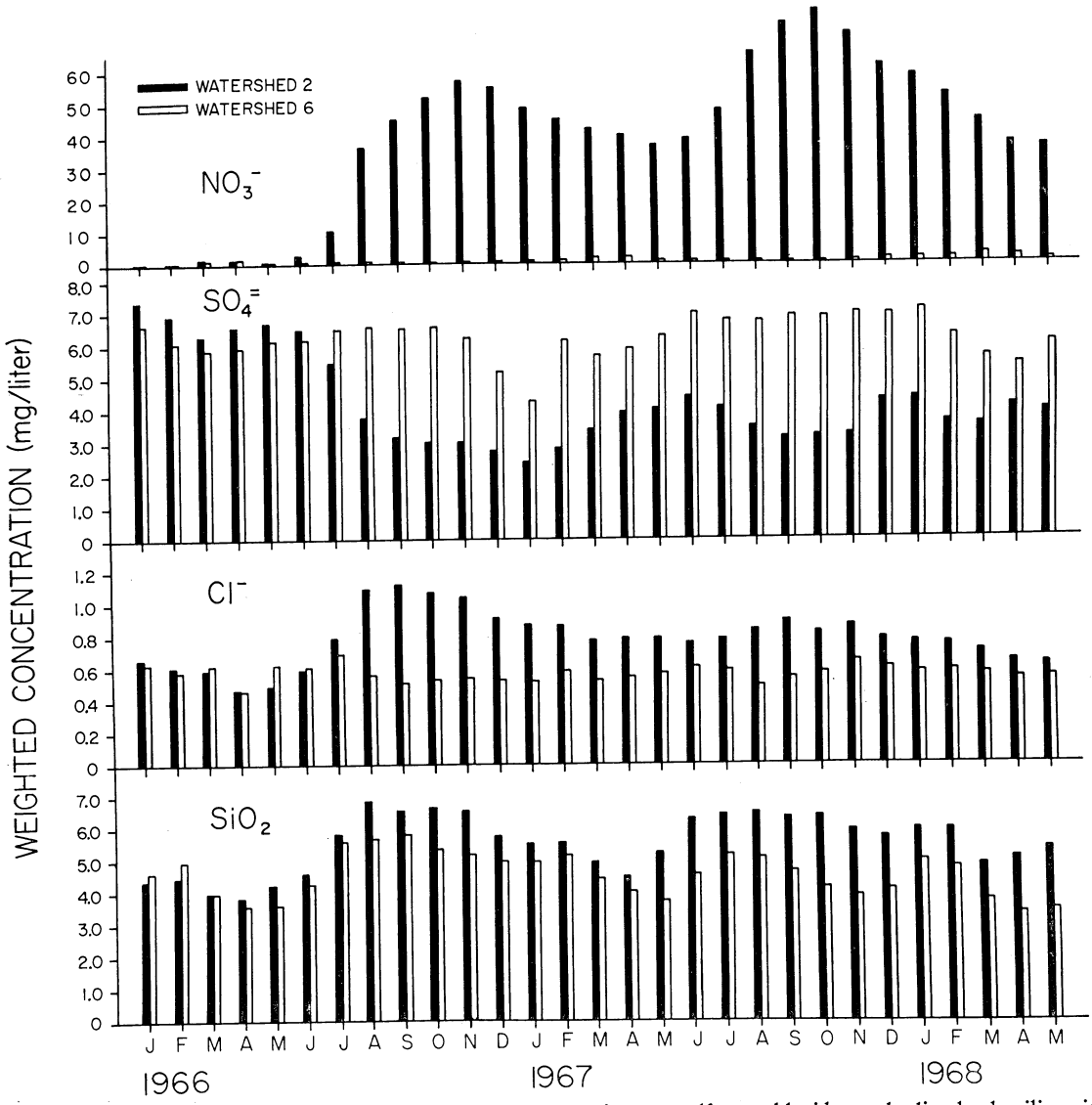

FIG. 8. Weighted average monthly concentrations of nitrate, sulfate, chloride and dissolved silica in stream water from Watersheds 2 (deforested) and 6.

the total flush of ions from the deforested watershed. The increase in the milliequivalent value for nitrate in the water years subsequent to cutting, balances (within 10–15% error limits for the watershed systems) the increased net losses of cations and the decreased net losses of anions (Likens, *et al.,* 1969). This will be discussed in more detail in a later section.

Alexander (1967) indicates that nitrification usually decreases greatly below a pH of 6.0 and becomes negligible at a pH of 5.0. Our data would indicate that this is not the case for our deforested watershed as shown by the increased concentration of nitrate in the drainage water during 1966–68 (Fig. 7), and the low pH of stream waters (Fig. 6) and soils. Also, in comparison with soils under undisturbed forest, bacteria of the genera *Nitrosomonas* and *Nitrobacter* have increased 18-fold and 34-fold, respectively, in the soil of Watershed 2 (Smith, *et al.,* 1968). Other workers have shown nitrification at similarly low pH's (Boswell, 1955; Weber and Gainey, 1962). It may be that we are dealing with relatively little known species of nitrifying bacteria adapted to more acid conditions (*e.g.,* Alexander, 1967).

Sulfate

Sulfate concentration in stream water from the undisturbed watersheds is relatively constant in relation to the highly variable stream discharge

TABLE 5. Nutrient budgets for undisturbed (W6) and cutover (W2) watersheds of the Hubbard Brook Experimental Forest. Values are expressed in kg/ha for the period 1 June to 31 May

Element	W6			W2		
	Input	Output	Net loss or gain	Input	Output	Net loss or gain
	1966-67					
Ca	2.4	10.7	−8.3	2.3	77.3	−75.0
Mg	0.4	2.9	−2.5	0 5	16.2	−15.7
K	0.6	1.7	−1.1	0.5	23.0	−22.5
Na	1.3	6.8	−5.5	1.3	18.1	−16.8
Al	1.4	2.8	−1.4	1.3	18.2	−16.9
NH_4-N	1.9	0.3	+1.6	1.8	0.7	+ 1.1
NO_3-N	4.6	1.3	+3.3	6.8	104	−97.2
SO_4-S	14.4	17.1	−2.7	13.6	15.3	− 1.7
Cl	6.9**	4.6	+2.3	9.5**	10.6	− 1.1
HCO_3-C	*	0.4	−0.4	*	0.2	− 0.2
SiO_2-Si	*	17.2	−17	*	31.3	−31
	1967-68					
Ca	3.0	12.2	−9.2	2.7	93.1	−90.4
Mg	0.8	3.4	−2.6	0.7	18.6	−17.9
K	0.8	2.4	−1.6	0.7	36.5	−35.8
Na	1.8	8.8	−7.0	1.7	19.0	−17.3
Al	*	3.1	−3.1	*	24.5	−24
NH_4-N	2.6	0.2	+2.4	2.4	0.5	+ 1.9
NO_3-N	5.2	2.8	+2.4	4.9	147	−142
SO_4-S	16.0	19.3	−3.3	15.16	15.15	0
Cl	5.2	5.3	−0.1	5.5	9.2	− 3.7
HCO_3-C	*	0.5	−0.5	*	0	0
SiO_2-Si	*	17.0	−17	*	32.6	−32

*Not determined, but very low.
**Based on data for 9 months.

(Figs. 7 and 8; Fisher, *et al.*, 1968); and on close examination the sulfate concentration shows a very small and irregular volume concentration effect (Johnson, *et al.*, 1969). In addition streamwater concentrations of sulfate seem to show some general, recurring seasonal patterns. There is a gradual rise to maximum values in the autumn with lower values during the late winter and early spring. This pattern is nearly the reciprocal of the nitrate pattern (Figs. 7 and 8).

The weighted concentration of $SO_4^=$ in drainage water from the deforested watershed decreased by about 45% in the first year subsequent to cutting and herbicide treatment (Table 4). The decrease in sulfate concentration was somewhat delayed in relation to the increase in nitrate concentration (Fig. 7). The explanation for this decrease in sulfate concentration is complicated and will be elaborated in the section on Nutrient Budgets.

Chloride

Since the quantity of chloride bearing rocks in the Hubbard Brook watershed-ecosystems is small (Juang and Johnson, 1967), and since biological immobilization is small, we expected the weighted concentration of Cl^- in precipitation after correction for evapotranspiration, to balance the concentration in drainage water from undisturbed ecosystems. However, during 1965–66 a higher concentration was found in the stream water of the undisturbed watersheds than could be accounted for by precipitation input (Juang and Johnson, 1967). The excess Cl^- was attributed to the accumulation of Cl^- in the ecosystem by dry removal of aerosols through impaction on the forest canopy. More recent comparisons of the chemical results from precipitation collectors that are continuously open and those that open only during periods of rain or snow are inconclusive, but do not support the dry fallout hypothesis. Data for years subsequent to 1965–66 show that the long-term, mean chloride concentration in stream water is about the same as the average concentration in precipitation, after adjustment for water loss by evapotranspiration (Johnson, *et al.*, 1969). We feel that the problems encountered previously in the chemical analysis and collection of chloride samples (*e.g.*, Fisher *et al.*, 1968) were greatly minimized during 1967–68, and significantly, the chloride input in precipitation balanced the output in stream water in undisturbed W6 (Table 5).

After deforestation of W2, the streamwater concentration of chloride increased, but the increase was somewhat delayed relative to most of the other ions (Fig. 7). The weighted concentration of chloride in drainage waters from W2

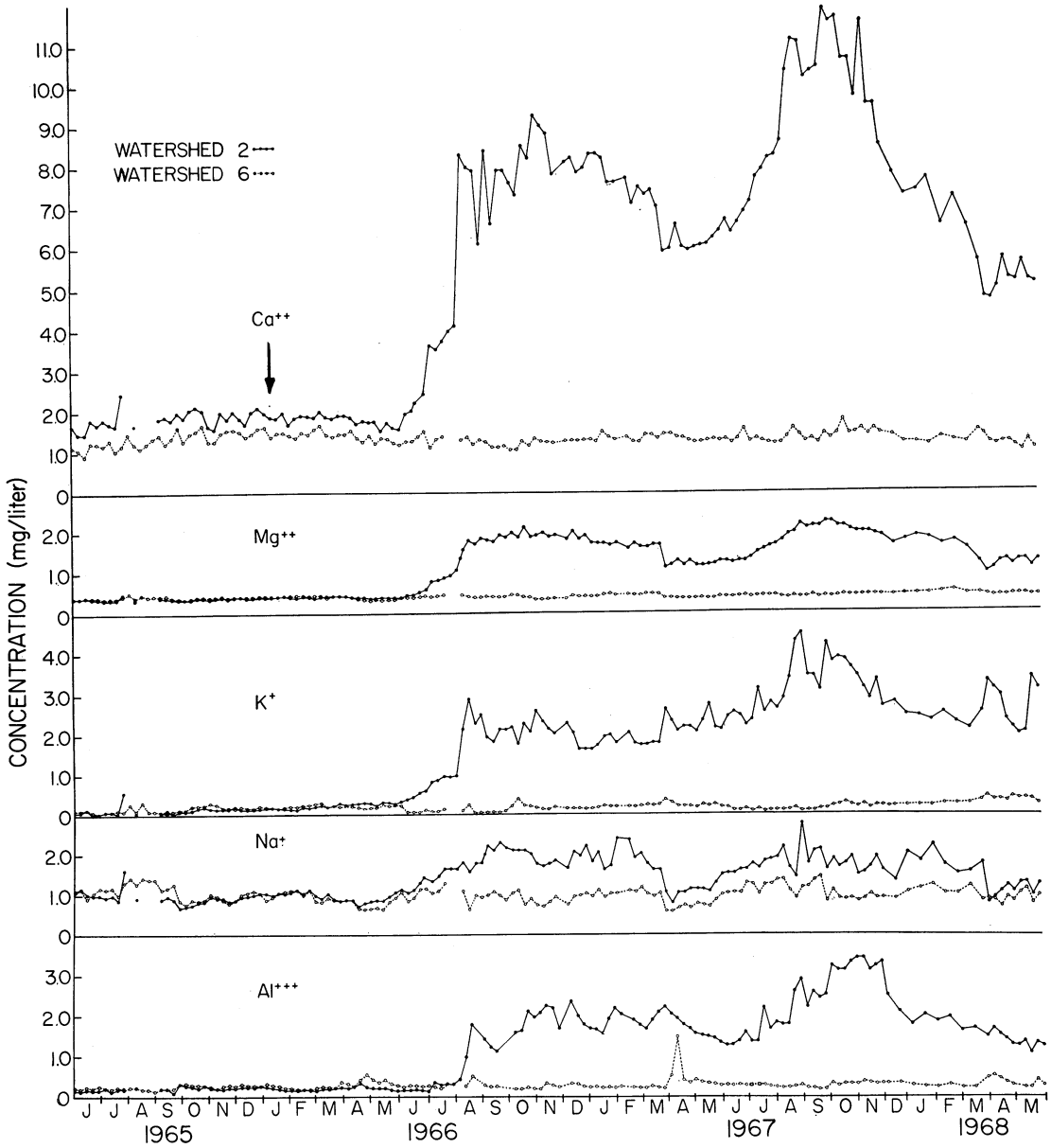

FIG. 9. Measured streamwater concentrations for Ca++, Mg++, K+, Na+, and Al+++ in Watersheds 2 (deforested) and 6. The points were not connected during periods when the stream discharge was negligible. The arrow indicates the completion of cutting in W2.

increased about 65% in the first year (Table 4), indicating the existence of a small chloride reservoir within the ecosystem. A maximum of about 70% of this increased chloride concentration could be explained by the addition of the Bromacil solution to the watershed, however not all of the Bromacil was lost from the watershed during the first year (Pierce, 1969). A continuing but relatively smaller increased chloride concentration also was observed in stream water from W2 during the second year, 1967–68 (Table 4; Fig. 7). Some 30% of the increase in streamwater concentration during 1967–68 may be attributed to the addition of the 2, 4, 5-T solution to the watershed.

Calcium, Magnesium, Potassium and Sodium

The concentration of these cations characteristically has been relatively constant in stream water of the undisturbed watersheds despite the highly variable discharge of water (Likens, *et al.*, 1967). The constancy of magnesium is phenomenal in this regard. The relatively small variations that do occur may be explained by appropriate equations for dilution and concentration, based on

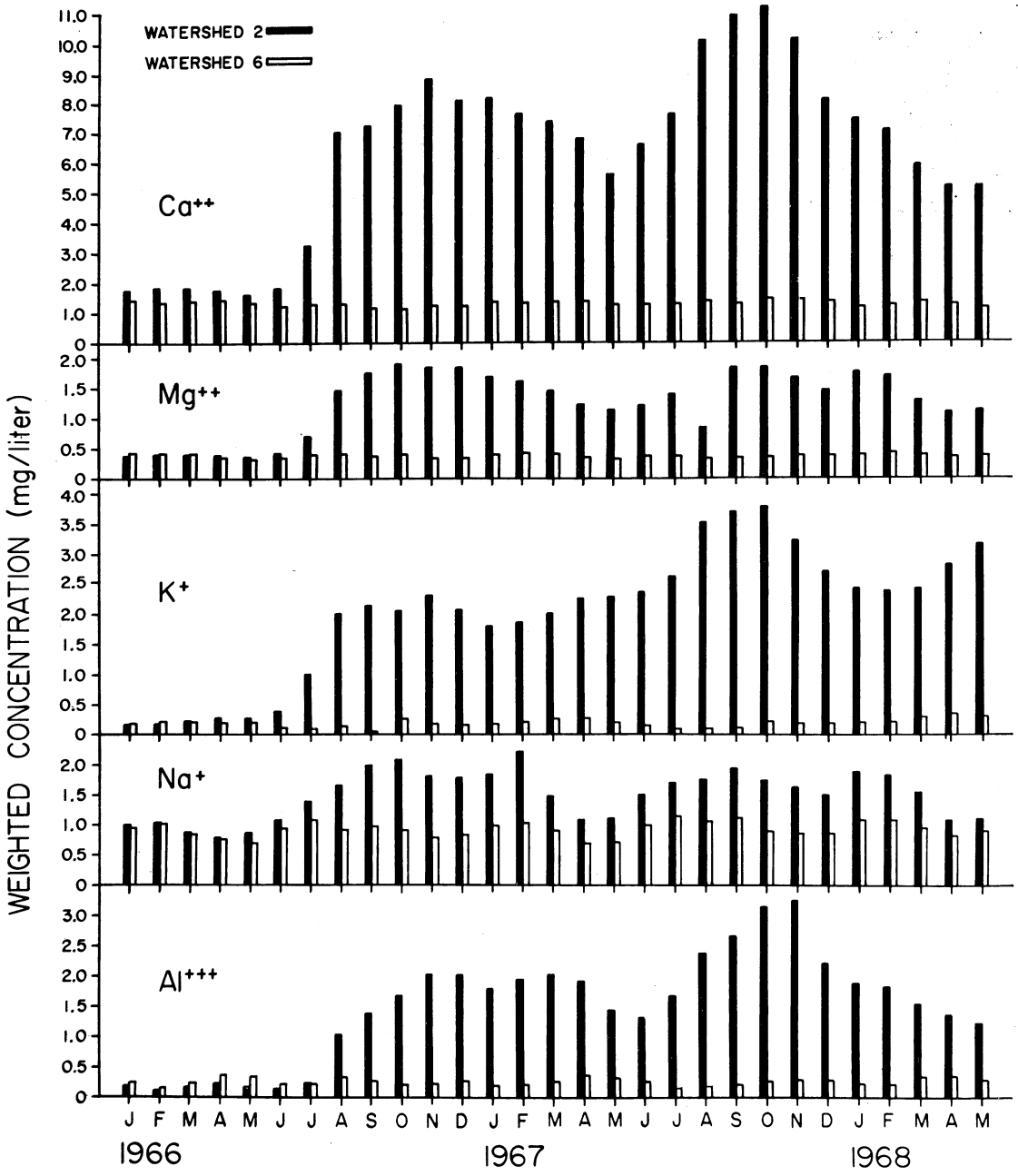

FIG. 10. Weighted average monthly concentrations of Ca^{++}, Mg^{++}, K^{+}, Na^{+}, and Al^{+++} in stream water from Watersheds 2 (deforested) and 6.

water discharge (Johnson, *et al.,* 1969). In the deforested watershed the volume-concentration model still applies but is less important as a controlling factor than the effect of nitrification.

Remarkable increases in average stream water concentration (417% for Ca^{++}, 408% for Mg^{++}, 1558% for K^{+} and 177% for Na^{+}) were observed during the two years subsequent to deforestation (Figs. 9 and 10; Table 4). The increased concentration and resultant net losses of these cations in drainage waters is dependent upon the increased concentration of nitrate and hydrogen ions brought about by nitrification (Likens, *et al.,* 1969). With decreasing pH and available nitrate these cations are more readily mobilized and leached from the watershed. This may occur 1) as the hydrogen ions replace the cations on the humic-clay ion exchange complexes of the soil, 2) as organic compounds are decomposed and 3) as chemical decom-

position of bedrock and till is accelerated. However, since nitrification is occurring in the humic layers of the soil, the excess ions are most likely released from the decay of humic substances (Likens, *et al.,* 1969). This is best shown by the changes in the ratio of Ca:Na in the drainage water of Watershed 2 before and after deforestation. Prior to cutting, the Ca:Na ratio in the stream water of Watershed 2 was 1.6/1.0. This ratio is consistent with that observed in adjacent undisturbed watersheds, and has been attributed to the steady-state chemical weathering of bedrock and till (Johnson, *et al.,* 1968). However, after deforestation, the ratio climbed to an average of 4.8/1.0 for the period 1966–68. More significantly, the Ca:Na ratio for the "excess" ions of the stream (that is, the amount added above the undisturbed condition) is 7.4/1.0. Thus, the net chemical effect of the deforestation was to differentially produce soluble calcium within the ecosystem. Hardwood forest litter is rich in calcium relative to sodium (Ca:Na is >20/1.0; Scott 1955) in contrast to average bedrock for the Hubbard Brook watershed-ecosystems (Ca: Na is 0.9/1.0; Johnson, *et al.,* 1968), suggesting that most of the "excess" ions produced are derived from the bulk decomposition of humic materials (Likens, *et al.,* 1969).

Only a small portion of the 6- to 22-fold increase in net losses of calcium, magnesium and potassium were apparently derived from an accelerated rate of chemical weathering (Table 5). Based on the change in the sodium budget of Watershed 2, and attributing net sodium losses solely to chemical weathering (Johnson, *et al.,* 1968), the chemical decomposition of bedrock and till within Watershed 2 has apparently accelerated no more than 3-fold.

Aluminum

Aluminum concentrations in stream water from the undisturbed watersheds show seasonal pattern and differences between watersheds (Fisher, *et al.,* 1968). Concentrations of aluminum are highest in April during peak runoff (Figs. 9 and 10). In fact, there is a direct relationship between aluminum concentration and stream discharge (Johnson, *et al.,* 1969). Concentration of aluminum in stream water varies with watershed, with W4 lower than the other streams (Table 4). The average stream water concentration for W4 is about 1/3 of the value for W6.

Deforestation resulted in an increased concentration of aluminum in stream water from W2, but the increase was delayed relative to other ions (Figs. 9 and 10). Aluminum concentration increased by 10-fold in two years following deforestation. The primary source for aluminum in the system is the bedrock and till. Hence, the increase in aluminum concentration indicates the importance of decreasing pH on the solubility of common minerals containing aluminum in the soils, especially the clay minerals such as kaolin and vermiculite. The decrease in pH from 5.2 to 4.3, we observed as a result of the deforestation, is critical to the solubility of alumina (*e.g.,* Mason, 1966, p. 167).

Dissolved Silica

Seasonal variations in the concentration of dissolved silica in stream water are inversely correlated with runoff (Johnson, *et al.,* 1969). Maximum streamwater concentrations occur in late summer, whereas minimum concentrations occur during peak flow periods associated with spring thaw. There is apparently a yearly recurring slump in the dissolved silica concentration in August preceding the seasonal decline in September (Fig. 7) for which the explanation is not clear.

After forest cutting the average weighted concentration of dissolved silica increased by about 37%. This increase probably reflects the increased solution or weathering of the geologic substrate, or both.

The relatively new finding that the solubility of amorphorus silica is inversely related to pH between about pH 3 and 7 (see Marshall, 1964, p. 81) partially explains the increase in dissolved silica in stream water from the deforested watershed.

Bicarbonate

Although the bicarbonate ion is normally the most abundant in freshwaters, it is a relatively minor constituent of the acidic runoff water from the undisturbed Hubbard Brook watersheds (Fisher, *et al.,* 1968; Johnson, *et al.,* 1968; Likens, *et al.,* 1969; and Table 4). In fact, it is barely detectable with routine methods in the stream water from W6.

In W2 the measured concentration dropped to nearly zero by the middle of the first year after cutting (1966–67), and concurrently with the decrease in streamwater pH. Thus the weighted value for 1966–67 (Table 4) reflects the conditions during the first part of the water-year and is somewhat misleading as a temporal average for the year. The streamwater concentration is zero for 1967–68 as expected since the average pH was 4.3.

TABLE 6. Dependence of chemical concentration on the volume of water discharged from Watersheds 2 (cut-over) and 6 during 1967–68. Regression lines were fitted to the relationship $y = ax + b$, where $y =$ chemical concentration in mg/liter, $a =$ slope, $x =$ a function of discharge $\left(\frac{1}{1 + \beta D}\right)$, β is a proportionality constant, and D is stream discharge in liters/ha-day, and $b = y$ intercept (Johnson, *et al.*, 1969). The F-ratio for the values given for slope are significant at the 0.01 level

		W2	W6
calcium	slope	ns*	ns
	Y-intercept	—	—
magnesium	slope	ns	ns
	Y-intercept	—	—
sodium	slope	1.08	0.66
	Y-intercept	1.23	0.69
potassium	slope	-1.79	-0.36
	Y-intercept	4.40	0.50
aluminum	slope	ns	-0.34
	Y-intercept	—	0.57
hydrogen	slope	ns	ns
	Y-intercept	—	—
nitrate	slope	ns	-1.63
	Y-intercept	—	1.49
sulfate	slope	ns	ns
	Y-intercept	—	—
chloride	slope	ns	ns
	Y-intercept	—	—
dissolved silica	slope	1.85	3.24
	Y-intercept	5.31	2.78

*Not significant

EFFECT OF NITRIFICATION ON CATION LOSSES

In the undisturbed watersheds, the relatively small variations in cation and anion chemistry may be explained almost entirely by the effects of dilution and concentration as brought about by changes in stream discharge and biological activity (Johnson, *et al.*, 1969). Initially we thought that the large oscillations in streamwater chemistry after deforestation (Figs. 7, 8, 9 and 10) should be explained by this same model. However a regression analysis showed that only sodium, potassium, and dissolved silica were significantly (<0.01) related to discharge of water after deforestation (Table 6).[4] Moreover, the slope of the regression lines and the Y-intercepts for these three elements were changed greatly, relative to the undisturbed situation (Table 6; Johnson, *et al.*, 1969). The correlation coefficients for these regression lines were all less than 0.57, which indicates a great deal of scatter in the points and suggests either experimental error or other important controlling factors. In addition to large changes in the slope and Y-intercept for the solutes that show volume or concentration effects with changes in stream discharge after deforestation (Johnson, *et al.*, 1969), aluminum and nitrate, which usually were related to discharge, no longer show any significant relationship (Table 6). Thus, the increased nitrification after deforestation has swamped the rather small volume and concentration effects of discharge, characteristic of these ions in the undisturbed watersheds.

Regression analyses for each ion on nitrate concentration in stream water showed very high significance (<0.001) for all ions except hydrogen, ammonium and dissolved silica (Table 7). The more important cations (Ca^{++}, Mg^{++}, and Al^{+++}), in terms of milliequivalent values, had extremely high correlation coefficients in the regression analysis; whereas the correlation coefficients were lower for Na^{+} and K^{+} (Table 7; Figs. 11 and 12). Thus, these data show the quantitative importance of nitrification as a major controlling factor in determining the quantity and quality of dissolved materials flushed from the cutover watershed in drainage waters. Thus, in the undisturbed watershed, dilution and concentration effects on water discharge were the principal mechanisms controlling ionic concentrations, while in the deforested watershed nitrification was the more important controlling factor.

TABLE 7. Relationship between the nitrate concentration and other ions in stream water from the cut-over watershed (W2) during 1967–68. Regression lines fitted to the relationship $y = ax + b$, where $y =$ chemical concentration in mg/liter, $a =$ slope, $x =$ concentration of nitrate in mg/liter, and $b = y$ intercept. An F-ratio > 12.6 for the slope is significant at the 0.001 level for these regression analyses

	Slope	Correlation coefficient	F-ratio for slope
magnesium	0.024	0.97	673
calcium	0.137	0.95	424
aluminum	0.044	0.93	279
potassium	0.023	0.60	23.9
sodium	0.014	0.57	20.4
sulfate	-0.023	-0.01	30.4
chloride	0.005	-0.28	21.5
dissolved silica	0.017	0.37	6.8
ammonia	0.0006	-0.28	1.0
hydrogen	0.0003	0.08	0.3

[4] The same pattern of results was obtained for 1966–67, however, the following discussion is based entirely on 1967–68 because of the complexities associated with the sharp chemical transition period that occurred during the water-year of 1966–67 (Figs. 7 and 9).

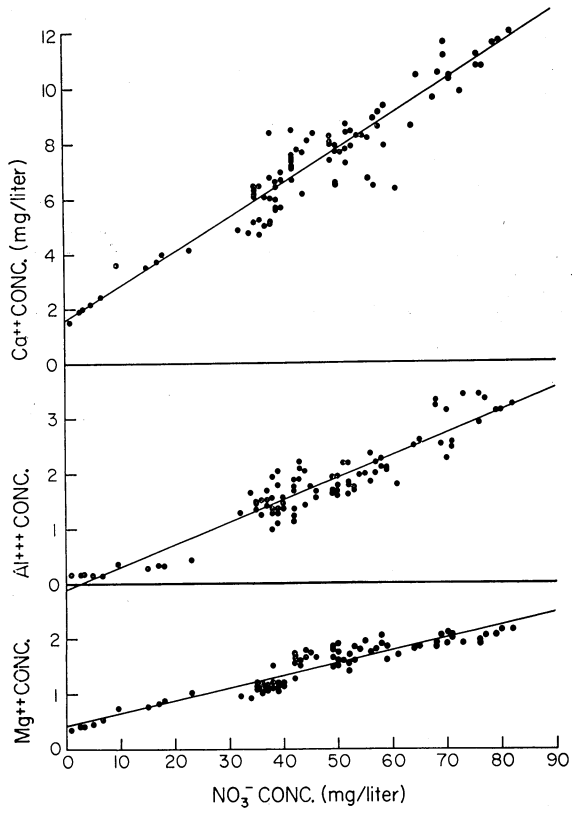

FIG. 11. Relationship between nitrate concentration and calcium, magnesium and aluminum concentrations in stream water from Watershed 2 during 1 June 1966 to 31 May 1968.

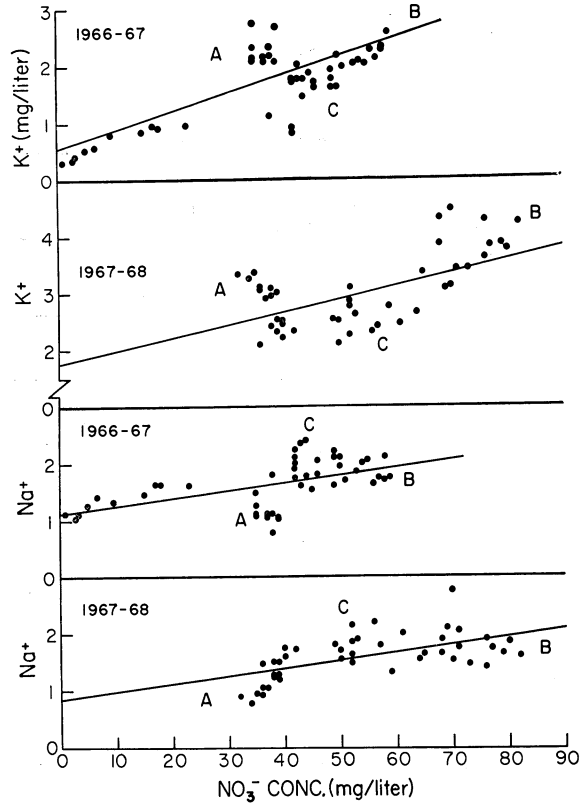

FIG. 12. Relationship between nitrate concentration and sodium and potassium concentrations in stream water from W2 during 1 June 1966 to 31 May 1968. All points in Area A were observed during the period of high spring runoff; points in Area B were observed in relatively high runoff periods in November; and Area C is a mixture of summer and winter points with lesser runoff. The points for nitrate concentrations <25 mg/liter represent the chemical transitional period between undisturbed and deforested conditions (1 June 1966 through 31 July 1966). See text for full explanation.

Plots of the actual points in the regression of Na^+ and K^+ on NO_3^- show an interesting relationship and indicate the relative importance of 1) nitrate concentration and 2) discharge in regulating ionic concentration of stream water (Fig. 12). That is, if the regression line is taken as the reference, points above the line represent concentration of Na^+ or K^+ and points below the line represent dilution of Na^+ or K^+ over that expected for the relationship between each of these cations and nitrate. An analysis of the temporal distribution for these points reveals that this is just the case. The points above the line for K^+ vs. NO_3^- (Area A) are all associated with periods of high spring runoff; Area B is associated with higher runoff periods in November; and Area C is a mixture of summer and winter points with lower runoff values. According to the volume-concentration model for undisturbed watersheds, K^+ concentrations are directly related to volume of water discharge (Table 6; Johnson, *et al.*, 1969).

The reverse is shown for the relationship for Na^+ vs. NO_3^-. Area A, represents the spring runoff period; B is the November period; and C is the summer and winter periods. Sodium is inversely related to the volume of discharge in the undisturbed watersheds (Johnson, *et al.*, 1969; Table 6), and in the cutover watershed (Table 6).

The sodium and potassium were normalized for volume and concentration effects during 1967-68 according to the equations presented by Johnson, *et al.* (1969). As a result, the F-ratio and correlation coefficients for a regression analysis of nitrate and normalized sodium and potassium concentrations were improved. The residual scatter of points about this latter regression line indicates the presence of other minor controlling factors.

The significant slope but poor correlation coefficient for NO_3^- vs. $SO_4^=$ (Table 7) is the result of the marked curvilinear relationship after deforestation shown in Fig. 14.

NUTRIENT BUDGETS

Nutrient budgets for dissolved ions and dissolved silica for the Hubbard Brook watershed-ecosystems were determined from the difference between the meteorologic input per hectare and the geologic output per hectare (Bormann and Likens, 1967). Input was calculated from the product of the ionic concentration (mg/liter) and the volume (liters) of water as precipitation (Likens, *et al.*, 1967 and Fisher, *et al.*, 1968). Additional input from applications of herbicides was added to the precipitation input. Output was calculated as the product of the volume (liters) of water draining from the watershed-ecosystems and its ionic concentration (mg/liter). Budgets for all of the ions and substances measured are given in Table 5.

Net losses were greatly increased after deforestation and herbicide treatment for all ions except ammonium, sulfate, and bicarbonate. Two factors are involved in the removal of nutrients from the deforested watershed: 1) increased runoff and 2) increased ionic concentrations in stream water. If the concentrations had not increased from the undisturbed condition, increased runoff would have accounted for a 39% increase in gross export the first year and a 28% increase the second year after deforestation. However, the gross outputs for 1967–68 were greater than the undisturbed watershed, W6 (Table 5), by 7.6-fold for Ca^{++}, 5.5-fold for Mg^{++}, 15.2-fold for K^{+}, 2.2-fold for Na^{+}, 46-fold for NO_3-N, 1.8-fold for Cl^{-}, 7.9-fold for Al^{+++} and 1.9-fold for SiO_2-Si, clearly indicating that increased stream water concentrations are primarily responsible for the increased nutrient loss from the ecosystem.

Nitrogen losses from W2 after deforestation, although very large already, do not take into account volatilization. Allison (1955) reported volatilization losses averaging 12 percent of the total nitrogen losses from 106 fallow soils. However, denitrification is an anaerobic process and requires a nitrate substrate generated aerobically (Jansson, 1958); consequently, for substantial denitrification to occur in fields, aerobic and anaerobic conditions must exist in close proximity. The large increases in subsurface flow of water from the deforested watershed suggests that such conditions may have been more common than in the undisturbed ecosystem. Moreover, Alexander (1967) points out, "When ammonium oxidation takes place at a pH lower than 5.0 to 5.5, or where the acidity produced in nitrification increases the hydrogen ions to an equivalent extent, the formation of nitrite can lead to a significant chemical volatilization of nitrogen."

Net losses of SO_4-S from the deforested ecosystem were about 40% lower in 1966–67, and 100% lower in 1967–68 than from undisturbed watersheds. In fact, the 1967–68 budget for SO_4-S in W2 was balanced in contrast to the undisturbed situation (Table 5). Precipitation is by far the major source of sulfate for the undisturbed watersheds (Fisher, *et al.*, 1968). Although the amount of sulfate added by precipitation in 1967–68 was increased slightly relative to previous years, the net export of sulfate was zero, with sulfate input in precipitation exactly balancing streamwater export (Table 5). The decreases in streamwater sulfate concentration and gross export from the ecosystem occurred concurrently with the increases in streamwater nitrate concentration and gross export after forest cutting (Figs. 7 and 8).

Average sulfate concentrations in stream water were 3.8 and 3.7 mg/liter during 1966–67 and 1967–68 (Table 4), far below the 6.4 and 6.8 mg/liter values recorded in 1964–65 and 1965–66 before cutting (Fisher, *et al.*, 1968). Much of this change can be explained by two facts, 1) the 39 to 28% increase in streamwater discharge from 1966 to 1968, which resulted from the elimination of transpiration by deforestation, and 2) the elimination of sulfate generation by sources internal to the ecosystem. If the decreases in sulfate concentrations were wholly due to increased runoff after deforestation, concentrations calculated on the basis of expected runoff (*i.e.*, normal for the undisturbed system, Table 2) and measured gross sulfate lost from W2 during 1966–67 and 1967–68 (Table 5), should approximate the weighted streamwater concentrations for the undisturbed period, 1964–66. However, these calculated concentrations (5.3 and 4.7 mg/liter) equal only 79 and 70% respectively of the average weighted concentrations for 1964–66. These differences in concentration may be due to some year-to-year variation, but are largely explained by a sharp reduction in the internal release of sulfate from the ecosystem, which we earlier attributed to chemical weathering and biological activity (Fisher, *et al.*, 1968, Likens, *et al.*, 1969). The average annual internal release of sulfate (i.e., an amount equivalent to net loss) supplies about 10 kg/ha in the undisturbed watersheds (Table 5). Removal of this source of sulfate would account for the lower than expected adjusted sulfate concentrations mentioned above.

Thus, apparently, the normal, relatively small release of $SO_4^=$ from the ecosystem by chemical weathering and microbial activity (Table 5) probably became negligible following forest cutting. There are at least two possible mechanisms, operating simultaneously or separately, which may account for this:

i) There may be decreased oxidation of various sulfur compounds to $SO_4^=$. Waksman (1932) has suggested that a high concentration of nitrate is very toxic to sulfur oxidizing bacteria, such as *Thiobacillus thiooxidans*. This species may be important in sulfate oxidation in the deforested watershed since *T. thiooxidans* is capable of active growth at low pH (Alexander 1967). In the undisturbed watersheds we have observed a highly significant inverse linear relationship between the concentration of nitrate and sulfate in drainage water. This relationship is particularly clear in plots of sulfate concentrations against nitrate concentration using data from November through April, when the vegetation is dormant (Fig. 13). The inverse relationship between NO_3^- and

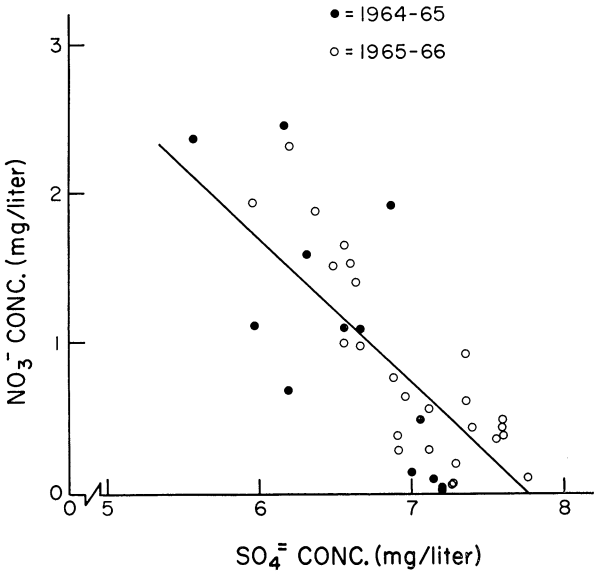

FIG. 13. Relationship between nitrate and sulfate concentrations in stream water from Watershed 2. Data were obtained during November through April of 1964–65 and 1965–66, which was prior to the increase in nitrate concentration resulting from clearing of the forest vegetation (Fig. 7). The F-ratio for this regression line is very highly significant ($p < 0.001$) and the correlation coefficient is 0.79.

$SO_4^=$ concentrations is very obvious in the first water-year after deforestation, 1966–67, when nitrate concentrations in stream water increased from normal (undisturbed) values to very high concentrations (Fig. 14). During the second water-year after cutting, 1967–68, the nitrate concentration in stream water from W2 increased even more, whereas the sulfate concentration decreased very little and coincided with the concentration of sulfate in precipitation after adjustment for water loss by evaporation. Perhaps there is an intricate feedback mechanism between the toxicity of the nitrate concentrations and microbial oxidation of sulfur compounds within the soil. Another possibility is that the number of sulfur oxidizing bacteria have been selectively reduced by the herbicides in the deforested watershed.

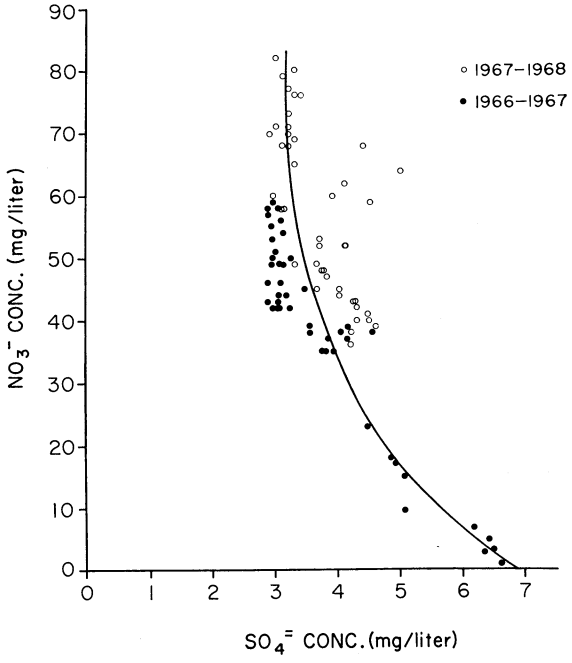

FIG. 14. Relationship between nitrate and sulfate concentrations in stream water from Watershed 2 during 1966–67 and 1967–68. Nitrate values less than 25 mg/liter indicate the chemical transition period (1 June 1966 through 31 July 1966, Fig. 7) between undisturbed and deforested conditions.

ii) Although somewhat unlikely, there may be increased sulfate reduction brought about by more anaerobic conditions, particularly in the lower more inorganic horizons of the soil (*e.g.*, Waksman, 1932). That is, an increased zone of water saturation in the deeper layers and in topographic lows on the cutover watershed probably has less free oxygen than in the undisturbed situation, promoting sulfur reduction. One difficulty, however, is that the growth of the most important sulfur reducing bacteria (*Desulfovibrio* spp.) is greatly retarded by acid conditions (Alexander, 1967). Also, molecular hydrogen released by anaerobic bacterial decomposition of organic matter may be used for the reduction of sulfate (Postgate, 1949; Rankama and Sahama, 1950).

The chloride budget for the undisturbed watershed during 1966–67 showed that input in precipitation exceeded the gross output, whereas the budget was essentially balanced during the 1967–68 water-year (Table 5). However after deforestation, significant net losses of chloride were observed (Table 5). The application of Bromacil in 1966–67 potentially added the equivalent of 3.0 kg Cl/ha or about 50% of the chloride input as precipitation. From the pattern of chloride changes in stream water following the addition of this herbicide (Fig. 7), it would appear that the herbicide and/or its degradation products were lost from the watershed quite gradually throughout the year. Measurements of Bromacil in stream water seemed to confirm this (Pierce, 1969). Since the Bromacil (1966–67) and possibly 2, 4, 5–T (1967–68) were not all flushed from the ecosystem within a year, then the internal release of chloride from the ecosystem probably represented an even greater percentage of the gross annual output (Table 5). Based upon streamwater concentrations in W2 and W6 (Fig. 7), it would appear that the internal reservoir (plus external inputs from herbicides) of chloride within the ecosystem has been essentially exhausted in two years following deforestation.

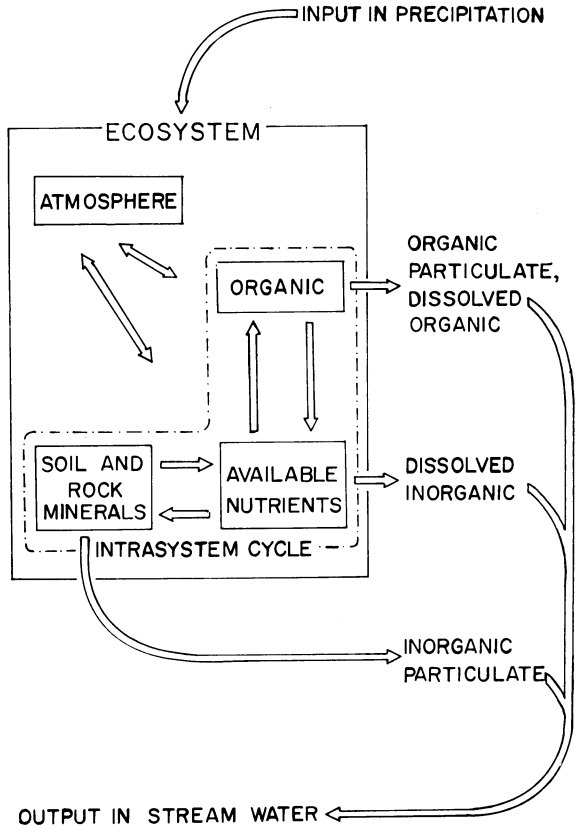

FIG. 15. Diagrammatic model for sites of accumulation and pathways of nutrients in the Hubbard Brook ecosystem (after Bormann, *et al.*, 1969).

GENERAL DISCUSSION AND SIGNIFICANCE

The intrasystem cycle of a terrestrial ecosystem links the organic, available nutrient, and soil and rock mineral compartments through rate processes including decomposition of organic matter, leaching and exudate from the biota, nutrient uptake by the biota, weathering of primary minerals, and formation of new secondary minerals (Fig. 15). The deforestation experiment was designed to test the effects of blockage on a major ecosystem pathway, *i.e.*, nutrient and water uptake by vegetation, on other components of the intrasystem cycle and on the export behavior of the system as a whole. The block was imposed by cutting all of the forest vegetation and subsequently preventing regrowth with herbicides. We hoped that this experimental procedure would provide information about the nature of the homeostatic capacity of the ecosystem. The deforested condition has been maintained since 1 January 1966.

Forest clearing and herbicide treatment had a profound effect on the hydrologic and nutrient relationships of our northern hardwood ecosystem. Annual runoff (water export) increased by some 33 cm or 39% in the first year and 27 cm or 28% in the second year over that expected. Moreover, the discharge pattern was altered so that sustained, higher flows occurred in the summer months and the snow pack melted earlier in the spring. This overall increase in stream runoff is large compared to the average increase (about 20 cm) found for other such experiments throughout the world (Hibbert, 1967), but is less than the maximum increase of 41 cm found for clearcut watersheds in North Carolina (Hoover, 1944).

No previous comprehensive measurements have been made of the homeostatic ability of a watershed-ecosystem to retain nutrients despite major shifts in the hydrologic cycle, including increased discharge, following deforestation (Odum, 1969).

Our results showed that cation and anion export did not change for the first 5 months (winter and spring) after deforestation, but then the ionic concentrations increased spectacularly, and remained at high levels for the 2 years of observation (Tables 4 and 5, Figs. 7, 8, 9 and 10). Annual net losses in kg/ha amounted to about 142 for nitrate-nitrogen, 90 for calcium, 36 for potassium, 32 for dissolved silica, 24 for aluminum, 18 for magnesium, 17 for sodium, and 4 for chlorine during 1967–68. These losses are much

TABLE 8. Comparative net gains or losses of dissolved solids in runoff following clear-cutting of Watershed 2 in the Hubbard Brook Experimental Forest for the period 1 June to 31 May. In metric tons/km²-yr

	1966-67		1967-68	
	W2	*W6*	*W2*	*W6*
Ca	−7.5	−0.8	−9.0	−0.9
K	−2.3	−0.1	−3.6	−0.2
Al	−1.7	−0.1	−2.4	−0.3
Mg	−1.6	−0.3	−1.8	−0.3
Na	−1.7	−0.6	−1.7	−0.7
NH_4	+0.1	+0.2	+0.2	+0.3
NO_3	−43.0	+1.5	−62.8	+1.1
SO_4	−0.5	−0.8	0	−1.0
HCO_3	−0.1	−0.2	0	−0.3
Cl	−0.1	+0.2	−0.4	0
SiO_2−aq.	−6.6	−3.6	−6.9	−3.6
Total	−65.0	−4.6	−88.4	−5.9

greater than for adjacent undisturbed ecosystems (Table 5). Ammonium-nitrogen was essentially unchanged relative to the undisturbed condition during this period and showed an annual net gain of about 1 to 2 kg/ha. In comparison with the undisturbed watershed-ecosystems the greatest changes occurred in nitrate-nitrogen and potassium export. Nitrate-nitrogen is normally accumulated in the undisturbed ecosystem in contrast to this very large export, and the net potassium output increased about 18-fold. The total net export of dissolved inorganic substances from the deforested ecosystem is 14–15 times greater than from the undisturbed ecosystem (Table 8).

The terrestrial ecosystem is one of the ultimate sources of dissolved substances in surface water. The contribution of dissolved solids (gross export) by our undisturbed forest ecosystems, 13.9 metric tons/km² (Bormann, *et al.,* 1969) is only about 25% of the dissolved load predicted by Langbein and Dawdy (1964) for regions with 75 cm of annual runoff. Their estimates were based on data from watersheds of the north Atlantic slope, which probably include areas disturbed by agriculture or logging. The difference between our undisturbed forest ecosystems and the regional prediction is credited in part to the operation of various regulating biotic factors associated with mature undisturbed forest (Bormann, *et al.,* 1969).

Deforestation markedly altered the ecosystem's contribution of dissolved solids to the drainage waters. Total gross export, exclusive of dissolved organic matter, was about 75 metric tons/km² in 1966–67 and 97 metric tons/km² in 1967–68. These figures exceed the regional prediction of Langbein and Dawdy (1964). However, it should be noted that the accelerated export of dissolved substances results primarily from mining the nutrient capital of the ecosystem and cannot be sustained indefinitely.

Surprisingly, the net export of dissolved inorganic substances from the cutover watershed is about double the annual value estimated for particulate matter removed by debris avalanches in the White Mountains (Bormann, *et al.,* 1969). Thus, the effects of deforestation may have almost twice the importance of avalanches in short-term catastrophic transport of inorganic materials downslope in the White Mountains.

Coupled with this increase in gross and net export of dissolved substances, there has been at least a 4-fold increase in the export of inorganic and organic particulate matter from the deforested ecosystem. This increase indicates that the biotic mechanisms that normally minimize erosion and transport (Bormann, *et al.,* 1969) are also becoming less effective.

The greatly increased export of nutrients from the deforested ecosystem resulted primarily from an alteration of the nitrogen cycle within the ecosystem. Whereas in the undisturbed system, nitrogen is cycled conservatively between the living and decaying organic components, in the deforested watershed, nitrate produced by microbial nitrification from decaying organic matter, is rapidly flushed from the system in drainage waters. In fact, the increased nitrate output accounts for the net increase in total cation and anion export from the ecosystem (Likens, *et al.,* 1969). With the increased availability of nitrate ions and hydrogen ions from nitrification, cations are readily leached from the system. Cations are mobilized as hydrogen ions replace them on the various exchange complexes of the soil and as organic and inorganic materials decompose. Based upon the increased output for sodium, chemical decomposition of inorganic materials in the deforested ecosystem is also accelerated by about 3-fold.

If the streamwater concentrations had remained constant after deforestation, increased water output alone would have accounted for 39% of the increased nutrient export the first year and 28% of the increased nutrient export the second year. However, the very large increase in annual export of dissolved solids from the deforested ecosystem occurred primarily because the streamwater concentrations were vastly increased, mostly as a direct result of the increased nitrification. The increased output of nutrients originated predominantly from the organic compartment of the watershed-ecosystem (Fig. 15).

Our study shows that the retention of nutrients within the ecosystem is dependent on constant and efficient cycling between the various components of the intrasystem cycle, *i.e.,* organic, available nutrients, and soil and rock mineral compartments (Fig. 15). Blocking of the pathway of nutrient uptake by destruction of one subcomponent of the organic compartment, *i.e.,* vegetation, leads to greatly accelerated export of the nutrient capital of the ecosystem. From this we may conclude that one aspect of homeostatis of the ecosystem, *i.e.,* maintenance of nutrient capital, is dependent upon the undisturbed functioning of the intrasystem nutrient cycle, and that in this ecosystem no mechanism acts to greatly delay loss of nutrients following sustained destruction of the vegetation.

The increased output of water from the deforested watershed was readily visible during the summer months, however the increased ion and particulate matter concentrations were not. The stream water from the deforested watershed appeared to be just as clear and potable as that from adjacent, undisturbed watersheds. However this was not the case. By August, 1966, the nitrate concentration in stream water exceeded (at times almost doubled) the concentration recommended for drinking water (Public Health Service, 1962).

The high nutrient concentrations, plus the increased amount of solar radiation (absence of forest canopy) and higher temperature in the stream, resulted in significant eutrophication. A dense bloom of *Ulothrix zonata* (Weber and Mohr) Kütz, has been observed during the summers of 1966 and 1967 in the stream of W2. In contrast the undisturbed watershed streams are essentially devoid of algae of any kind. This represents a good example of how an overt change in one component of an ecosystem, alters the structure and function, often unexpectedly, in another part of the same ecosystem or in another interrelated ecosystem. Unless these ecological interrelationships are understood, naive management practices can produce unexpected and possibly widespread deleterious results.

CONCLUSIONS

1. The quantity and quality of drainage waters were significantly altered subsequent to deforestation of a northern hardwoods watershed-ecosystem. All vegetation on Watershed 2 of the Hubbard Brook Experimental Forest was cut, but not removed, during November and December of 1965; and vegetation regrowth was inhibited by periodic application of herbicides.

2. Annual runoff of water exceeded the expected value, if the watershed were undisturbed, by 33 cm or 39% during the first water-year after deforestation and 27 cm or 28% during the second water-year. The greatest increase in water discharge, relative to an undisturbed situation, occurred during June through September, when runoff was 414% (1966–67) and 380% (1967–68) greater than the estimate for the untreated condition.

3. Deforestation resulted in large increases in streamwater concentrations of all major ions except NH_4^+, $SO_4^=$ and HCO_3^-. The increases did not occur until 5 months after the deforestation. The greatest increase in streamwater ionic concentration after deforestation was observed for nitrate, which increased by 41-fold the first year and 56-fold the second year above the undisturbed condition.

4. Sulfate was the only major ion in stream water from Watershed 2 that decreased in concentration after deforestation. The 45% decrease the first year (1966–67) resulted mostly from increased runoff of water and by eliminating the generation of sulfate within the ecosystem. The concentration of sulfate in stream water during 1967–68 equalled the concentration in precipitation after adjustment for water loss by evaporation. Sulfate concentrations were inversely related to nitrate concentrations in stream water in both undisturbed and deforested watersheds.

5. In the undisturbed watersheds the stream water can be characterized as a very dilute solution of sulfuric acid (pH about 5.1 for W2); whereas after deforestation the stream water from Watershed 2 became a relatively stronger nitric acid solution (pH 4.3), considerably enriched in metallic ions and dissolved silica.

6. The increase in average nitrate concentration in precipitation for the Hubbard Brook area compared to data from 1955–56, as well as the consistent annual increase observed from 1964–1968, may be some measure of a general increase in air pollution.

7. The greatly increased export of dissolved nutrients from the deforested ecosystem was due to an alteration of the nitrogen cycle within the ecosystem. Whereas nitrogen is normally conserved in the undisturbed ecosystem, in the deforested ecosystem nitrate is rapidly flushed from the system in drainage water. The mobilization of nitrate from decaying organic matter, presumably by increased microbial nitrification, quantitatively accounted for the net increase in

total cation and anion export from the deforested ecosystem.

8. Increased availability of nitrate and hydrogen ions resulted from nitrification. Cations were mobilized as hydrogen ions replaced them on various exchange complexes of the soil and as organic and inorganic materials were decomposed. Chemical decomposition of inorganic materials in the deforested ecosystem was accelerated about 3-fold. However, the bulk of the nutrient export from the deforested watershed originated from the organic compartment of the ecosystem.

9. The total net export of dissolved inorganic substances from the deforested ecosystem was 14–15 times greater than from undisturbed ecosystems. The increased export occurred because the streamwater concentrations were vastly increased, primarily as a direct result of the increased nitrification, and to a much lesser extent because the amount of stream water was increased.

10. The deforestation experiment resulted in significant pollution of the drainage stream from the ecosystem. Since August, 1966, the nitrate concentration in stream water has exceeded, almost continuously, the maximum concentration recommended for drinking water. As a result of the increased temperature, light and nutrient concentrations, and in sharp contrast to the undisturbed watersheds, a dense bloom of algae has appeared each year during the summer in the stream from Watershed 2.

11. Nutrient cycling is closely geared to all components of the ecosystem; decomposition is adjusted to nutrient uptake, uptake is adjusted to decomposition, and both influence chemical weathering. Conservation of nutrients within the ecosystem depends upon a functional balance within the intrasystem cycle of the ecosystem. The uptake of water and nutrients by vegetation is critical to this balance.

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DRINKING WATER, ARSENIC, AND NATURAL GAS PIPELINES

Geochemical conditions for release of arsenic from geologic materials

By Julia L. Barringer, PhD

ARSENIC IN LOCAL ROCKS

Arsenic in rocks; NJ/PA Piedmont

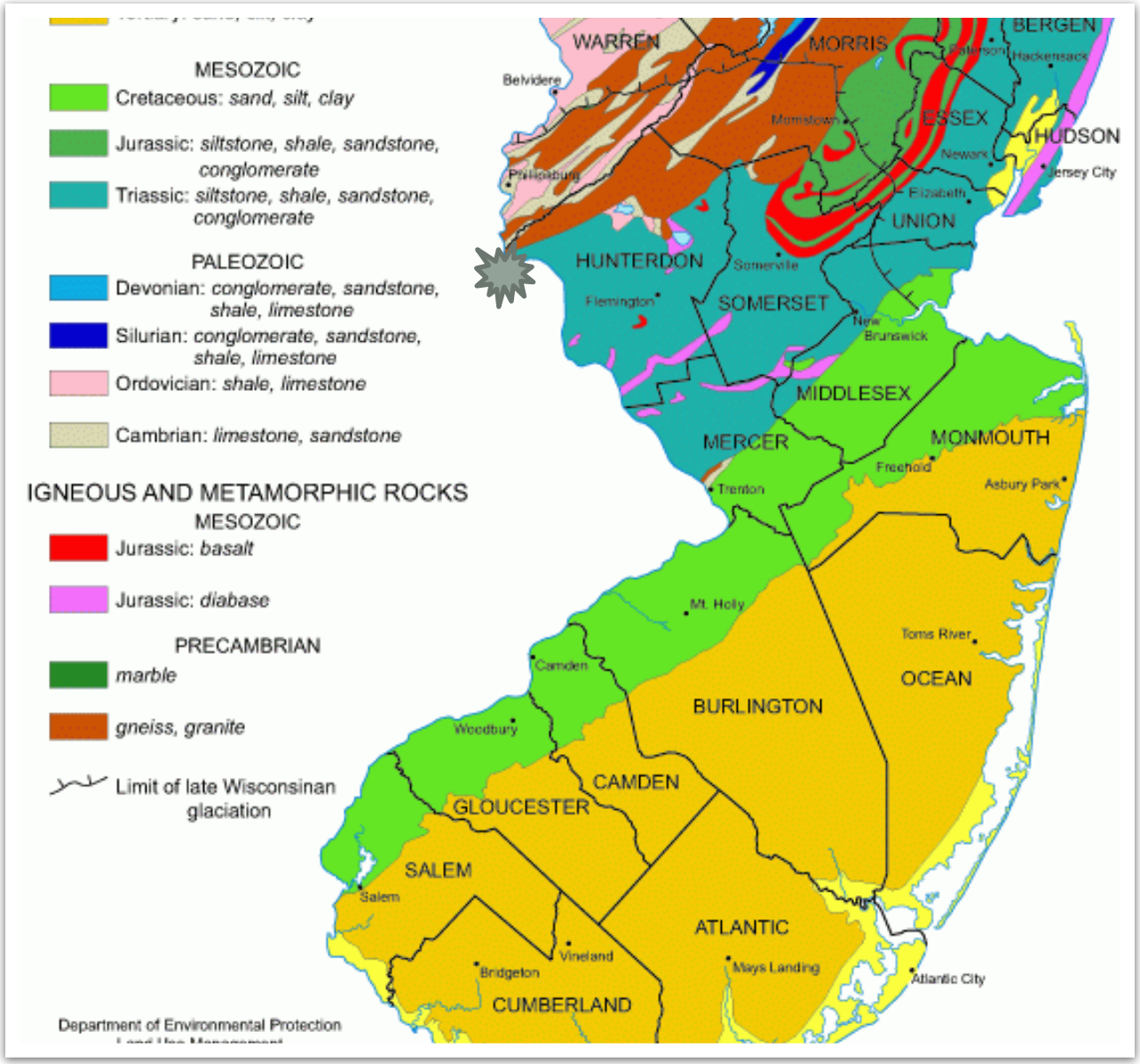
- From northern Hunterdon County through part of Mercer County in New Jersey, and through Bucks County in Pennsylvania, the Delaware River is underlain by rocks of Mesozoic age (~235-190 m.y.).
- These form fractured rock aquifers.
- The most areally extensive sedimentary units are the Lockatong and Passaic Formations.
- The Lockatong Formation is composed mostly of dark mudstones, shales and siltstones which contain As-rich minerals (pyrite and arsenopyrite).
- The Passaic Formation is mostly red shale with some dark siltstones and shales; As in this formation is mainly associated with iron oxide and hydroxide minerals.

In New Jersey:

The Mesozoic rocks of the Piedmont that underlie the Delaware River extend from northern Hunterdon County to just above Trenton.

The proposed pipeline route is through these rock formations.

✸ = pipeline rte. crossing into NJ.



Arsenic in Piedmont rocks and water

In the Lockatong Formation, pyrite can contain As in excess of 200 mg/kg, and in arsenopyrite (below), even greater amounts are present. Mobility of this As can result in groundwater concentrations that exceed 200 μg/L (more than 20 x the EPA MCL of 10 μg/L).

In the Passaic Formation, much As is sorbed to iron oxides (below) and hydroxides; As contents of the rocks are found to range from 4.5 to 14.8 mg/kg. In ground water , As concentrations range widely, from < 5 μg/L to >> 10 μg/L.

ARSENIC CHEMISTRY

Arsenic (As) chemistry

- Arsenic exists in elemental and ionic form; most prevalent ionic forms of As are As^{3+} , As^{5+}, and As^{3-} (the latter in some minerals and as a gas).
- (For ions, a positive valence state indicates loss of electrons; a negative state indicates gain; oppositely charged ions attract each other.)
- In an aqueous environment, As^{3+} and As^{5+} combine with oxygen and hydrogen to form arsenite and arsenate
- Arsenite is found to be more toxic than arsenate.

Electrochemistry: “redox” reactions

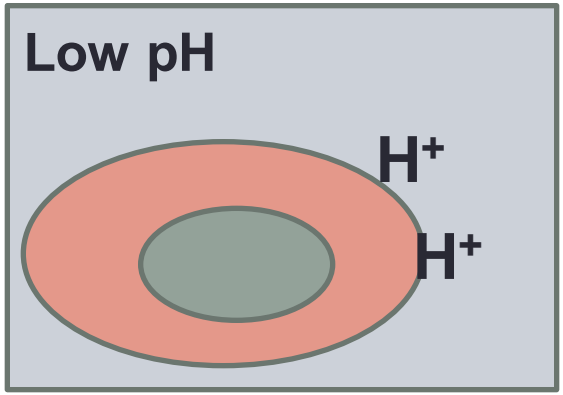
- The redox state of the surrounding environment affects the ionic form, and, thus, the mobility, of As.
- (The word “Redox” is a contraction of the terms “reduction” and “oxidation.”)
- A redox reaction is one in which electrons (or **e**$^-$, which are negatively charged) are passed from one atom to another.
- Oxygen (O_2) is a strong oxidizer; by gaining **e**$^-$, it causes another element, like iron (Fe) to lose **e**$^-$ and become a positively charged ion, such as Fe^{2+} or Fe^{3+}.
- Hydrogen sulfide(H_2S) is an example of a reducer; by losing **e**$^-$, it causes another element or ion to gain **e**$^-$, becoming either negatively charged, or less positively charged.

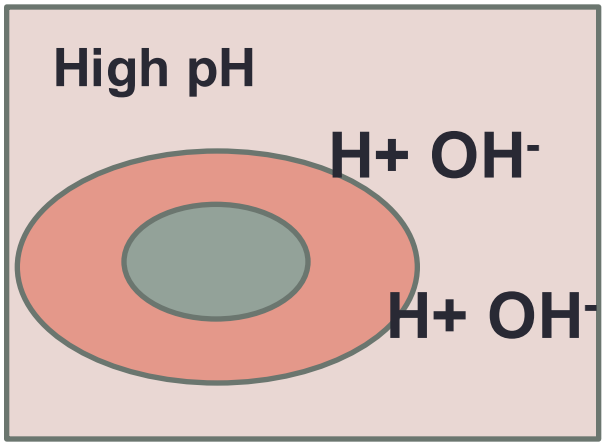
Role of pH in As mobility in water

- (pH is the negative logarithm of hydrogen ion activity.)
- pH less than 7 is considered acidic. pH greater than 7 is considered alkaline (or basic).
- Low pH (acidic) water contains more hydrogen ion (H^+) than it does hydroxyl ion (OH^-).
- The converse is true—high pH water (alkaline) contains more OH^- ion than H^+ ion.
- At pH 7 (neutral pH), these ion concentrations are equal.
- Because the forms of arsenate and arsenite change with pH (combining with more or fewer H^+ ions), their combining and sorptive tendencies change.

Sorption can lead to As sequestration, but particles with sorbed As may still be mobile.

- Mineral surfaces (e.g. iron and aluminum oxides, clays) have ion exchange sites: at low pH such sites attract H^+ ions. At high pH, OH^- ions are attracted.
- The H+ ions attract negatively charged ions (such as arsenate), which sorb to the surfaces.
- Arsenate sorbs to mineral surfaces until a buildup of OH^- ions neutralizes the exchange sites (high pH).
- Arsenite has no charge except at high pH, so tends to sorb weakly or not at all at the pHs of most natural waters.



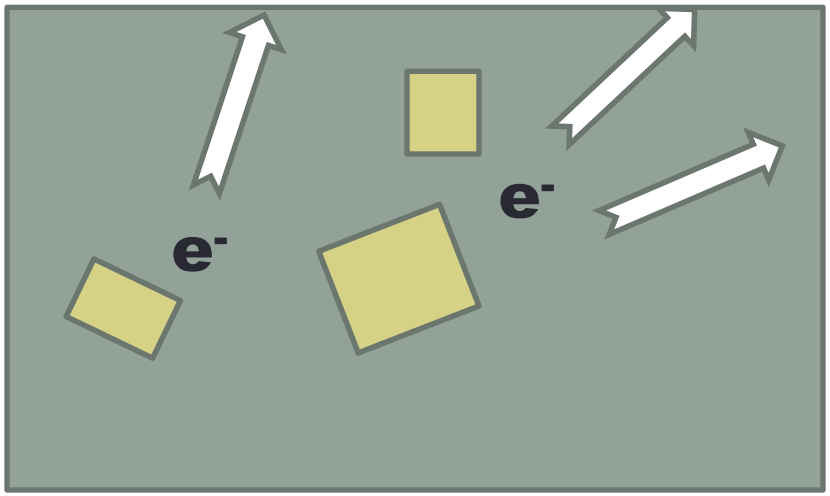


ARSENIC MOBILIZATION

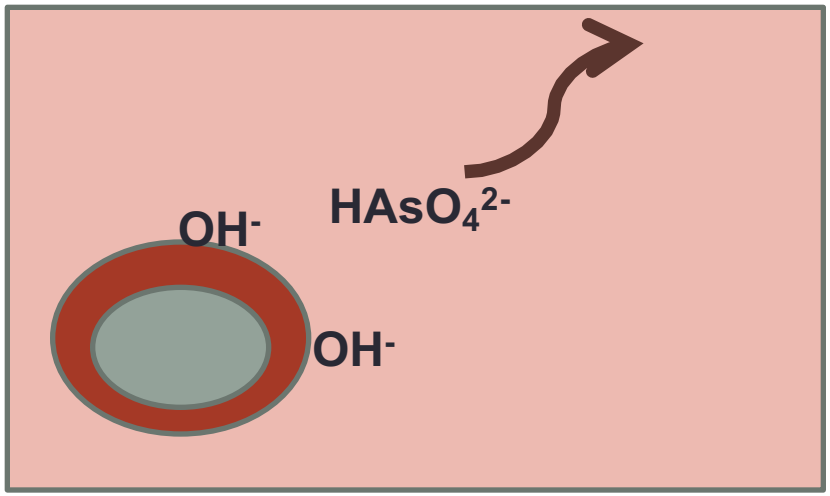
Biogeochemical processes

Arsenic can be released from the two Piedmont geologic formations by different mechanisms

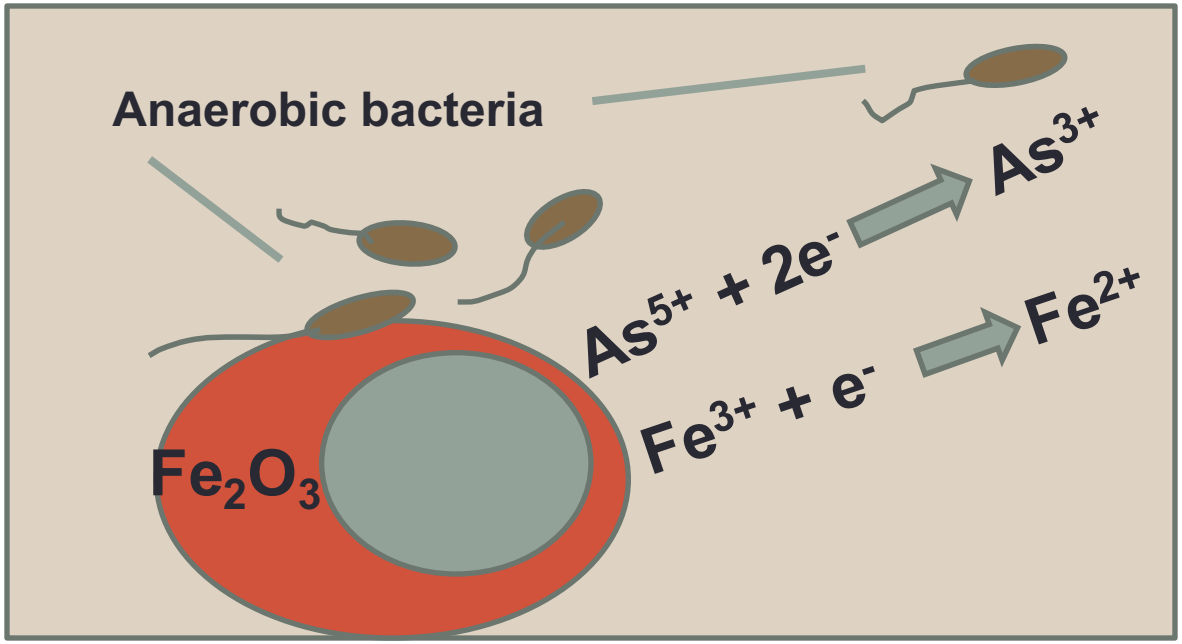
In the Lockatong Formation, with O_2 introduced, As is released from pyrite (FeS_2) and arsenopyrite (FeAsS) as the sulfide and arsenide is oxidized (typically by microbes).



In the Passaic Formation, As (as arsenate) that is sorbed to iron oxide coatings is desorbed as the pH of ground water in rock pores and joints increases above ~8.



The geochemical environment in part of the rock aquifer can become reducing (oxygen depleted) due to microbes as they degrade organic matter. Fe and As can be reduced and mobilized into ground water.



Reduction of both Fe and As typically is microbially mediated; there are bacteria that reduce Fe and/or As.

SUMMARY. Important parts of the biogeochemical release processes for As:

1. Microbial reduction of Fe in iron oxides and hydroxides leads to mineral dissolution and release of sorbed arsenate to water.
2. Microbial reduction of arsenate (containing As^{5+}) to arsenite (As^{3+}) results in more toxic As^{3+} becoming mobile in water.
3. Microbial oxidation of sulfide minerals results in release of As.

Soil characteristics and drainage

- Soils developed on Passaic and Lockatong Fm. Rocks tend to be clay-rich.
- Drainage through these soils can be slow.
- Saturated conditions may be present at or near land surface.
- Saturated conditions can lead to reducing environments within soils and shallow bedrock, and also can be found beneath streambeds.
- Anaerobic microbes capable of reducing Fe and As may be present.
- Inputs from adjacent septic systems may enhance growth of microbial communities.

Path of released As to streams

- As (as As^{3+}) released from Piedmont rocks to shallow ground water below streambeds enters streams in discharge (Mumford et al. 2015)
- In New Jersey streams, released Fe^{2+} and As^{3+} are shown to be oxidized. Fe precipitates as Fe hydroxides and As sorbs or co-precipitates (Barringer et al., 2010; Mumford et al., 2012).
- Some As $^{3+}$ may persist in streamwater, however.
- During high flow, the load of As-bearing sediments in streamwater increases (Barringer et al., 2011).

SUMMARY. Changes to the geochemical environment that promote release of arsenic from geologic materials:

1. Soil- and ground-water pH above 8 (promotes desorption of arsenate).

2. Reducing environment (promotes growth of anaerobic bacteria that reduce arsenic and iron to mobile forms).

3. Slightly oxidizing conditions in former reducing environment (promotes microbial oxidation of pyrite and arsenopyrite and solubilization of arsenic).

HUMAN-INDUCED CHANGES TO GEOCHEMICAL ENVIRONMENTS THAT CAN MOBILIZE ARSENIC

Disturbance of soils and rock formations can bring the following changes to the geochemical environment of soil and aquifer:

- Introduction of oxygen—promoting oxidation of pyrite and arsenopyrite.
- Mobilization of organic carbon—supplying organic carbon for microbial metabolism, which can lead to:

(a) microbially induced reducing environments and

(b) development of communities of Fe- and As-reducing microbes.

(c) possible non-microbial reduction of As as organic compounds act as electron shuttles.

Hydrologic considerations: Creation of a 4-ft. deep trench for a pipeline can alter movement of water through soils and rock.

- The trench may act as a conduit for soil water, moving water along it that would otherwise flow to shallow ground water (affecting recharge), and may funnel contaminants to streams.
- In areas adjacent to wetlands, a trench has the potential for intercepting shallow ground-water flow to the wetland, thus reducing the water supply to the wetland.

Human introduction of materials that change the geochemical environment include:

- Introduction of alkaline materials like cement in which components such as OH^- attract H^+ ions and thus raise pH of surrounding pore waters (soil water and ground water).
- Raising pH promotes desorption of arsenate.

Additional introductions:

- Creation of a reducing zone around installed pipe through cathodic corrosion protection.
- A reducing environment stimulates growth of anaerobic bacteria that can reduce and mobilize Fe and As from surrounding rocks.

Further considerations:

- Epoxy coatings on pipes, at relevant pHs (8-9), initially can leach organic compounds to water. These include methyl isobutyl ketone (MIBK), and various BTEX compounds. (see table 10 below; from Permeation and Leaching; USEPA, 2002)
- Whether leaching occurs over time may not be known.

Table 10
72-Hour Epoxy Resin Leaching Results

Coating	BTEX (mg/L)	TOC (mg/L)
Epoxy 1	13.2	166
Epoxy 2	4.9	34
Epoxy 3	48.0	279
Epoxy 4	0.2	345
Epoxy 5	25.6	143

Possible introduction of organic compounds is an issue with regard to water quality because:

1. Some of the compounds released may be regulated contaminants (BTEX, for example);
2. Introduction of organic carbon (TOC) could stimulate growth of microbial communities that can create a reducing environment wherein some microbes reduce Fe and As in geologic materials;
3. Fe and As (as the more toxic arsenite) could become mobile in surrounding waters.

SUMMARY

- Disturbance of soils and shallow aquifer materials can substantially alter shallow hydrologic processes.
- Introduction of pipeline protection materials could change the geochemical environment such that biogeochemical reactions take place that release arsenic from geologic materials to soil pore waters and shallow ground water.
- Arsenic-affected pore waters can then discharge to streams.

SOME CONCLUDING THOUGHTS:

1. The Piedmont Mesozoic rocks (Lockatong and Passaic Formations) can be thought of as infinite sources of arsenic.
2. It only takes a small amount of arsenic to be released to produce arsenic concentrations in water that exceed drinking-water standards.

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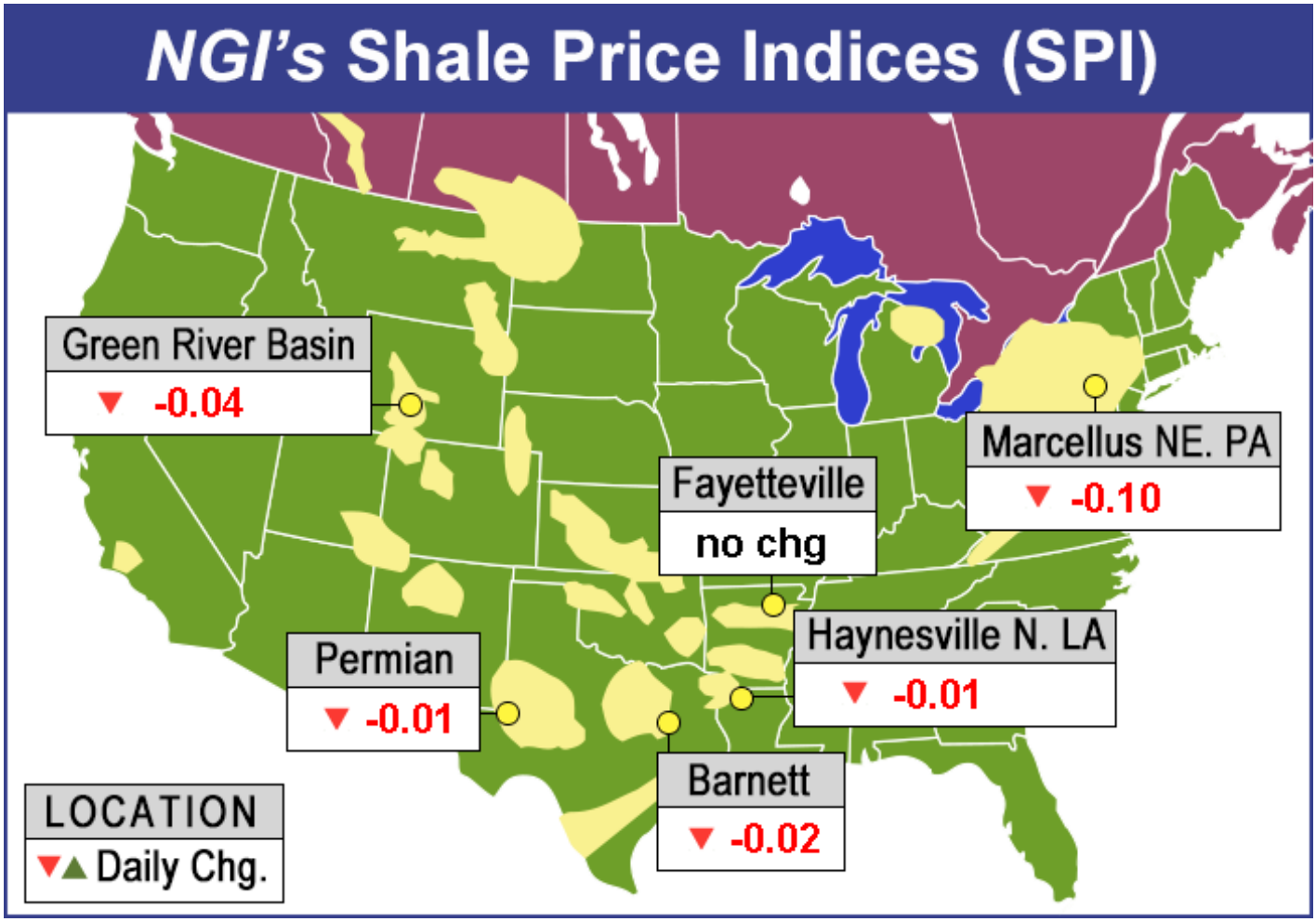

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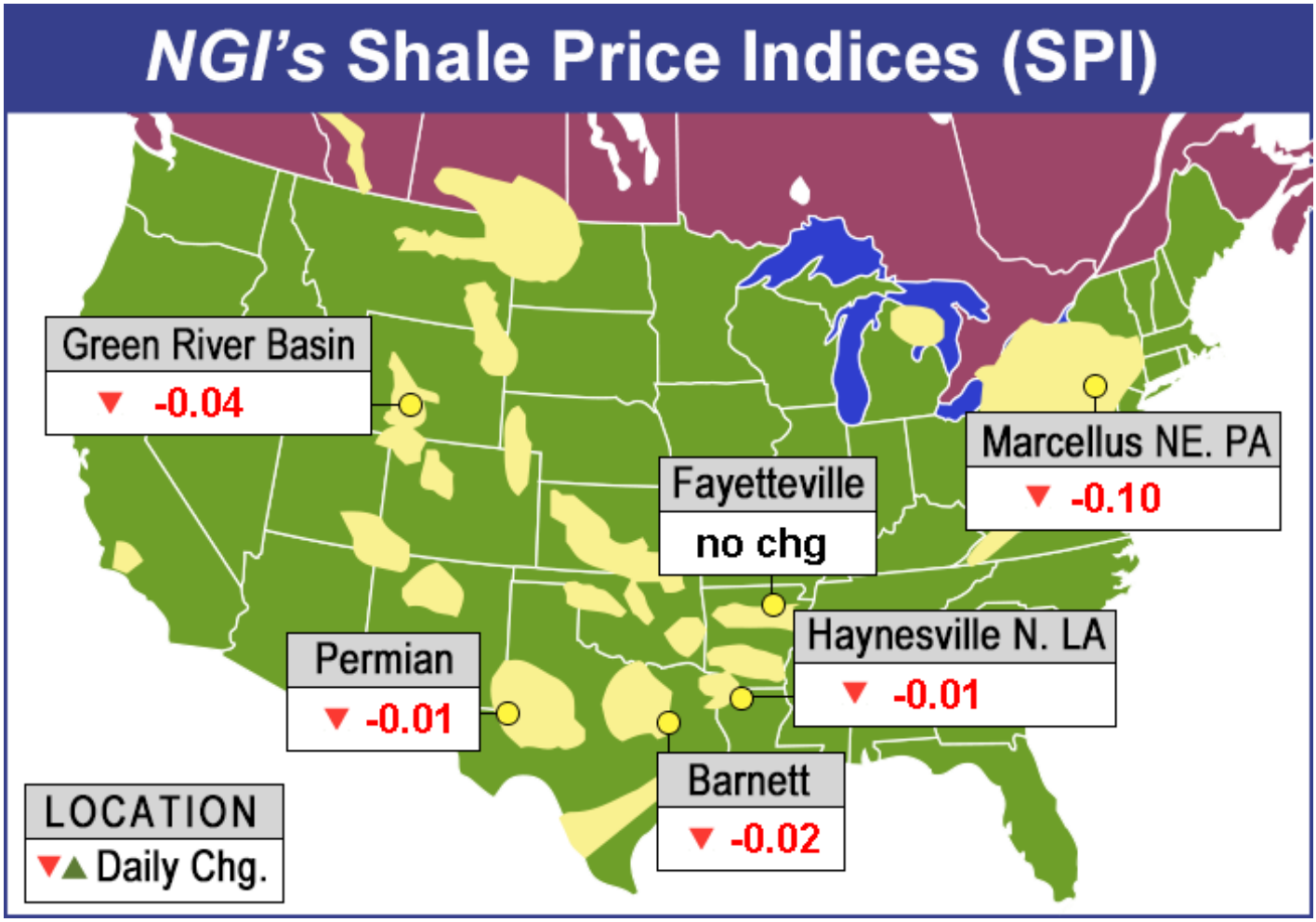
U.S. Unconventional Basin Rig Count
1Q2016 Earnings Calls List & Coverage



NGI's Shale Basin Prices (Subscriber Content)
U.S. Unconventional Basin Rig Count
1Q2016 Earnings Calls List & Coverage

NGI's NatGas Prices - Biggest Movers		
Daily	Iroquois Zone 2	-0.40
Weekly	Kingsgate	+0.53
Bidweek	Algonquin Citygate	-0.41
Shale	Marcellus - NE PA: Tenn	-0.12

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Jeremiah Shelor
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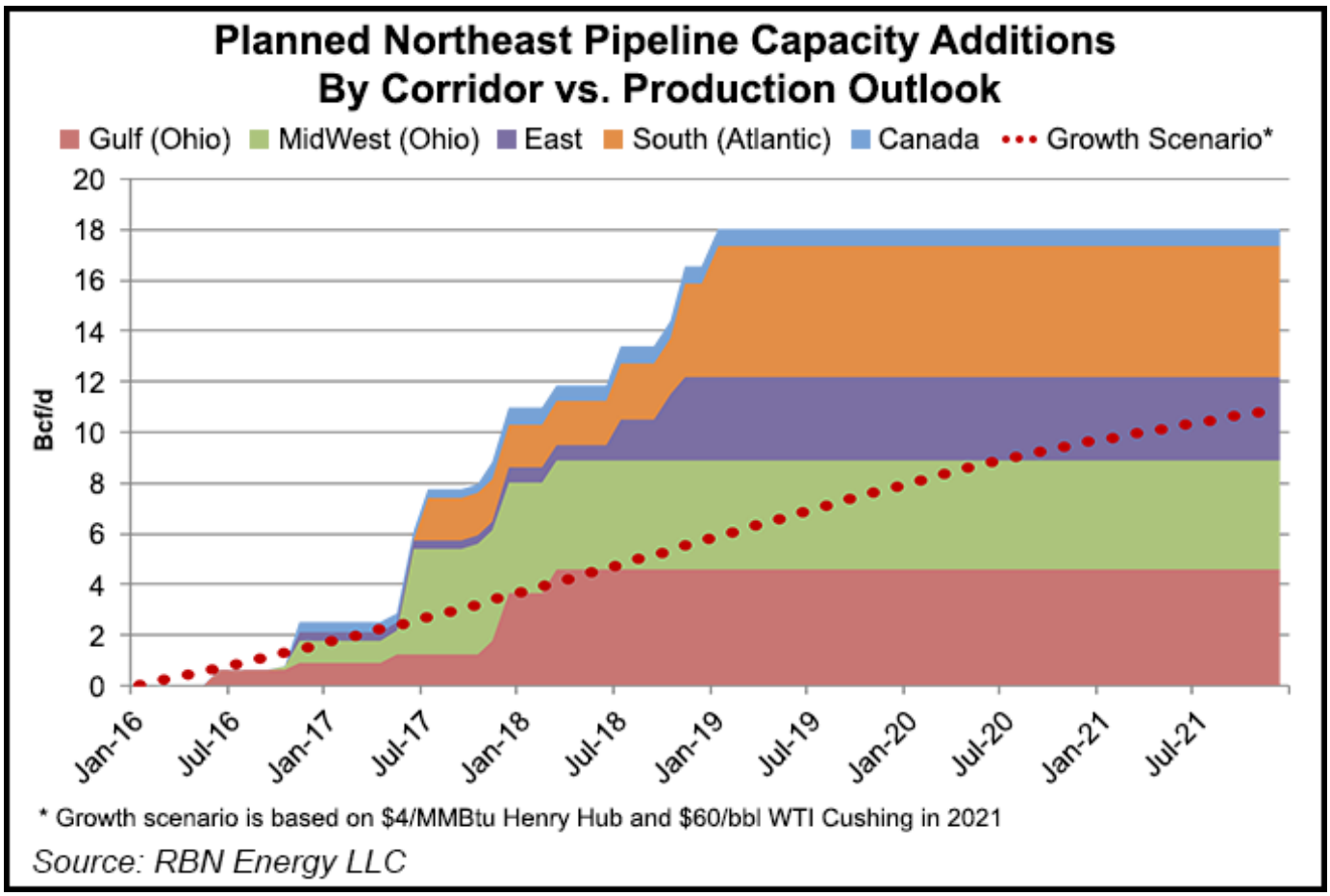

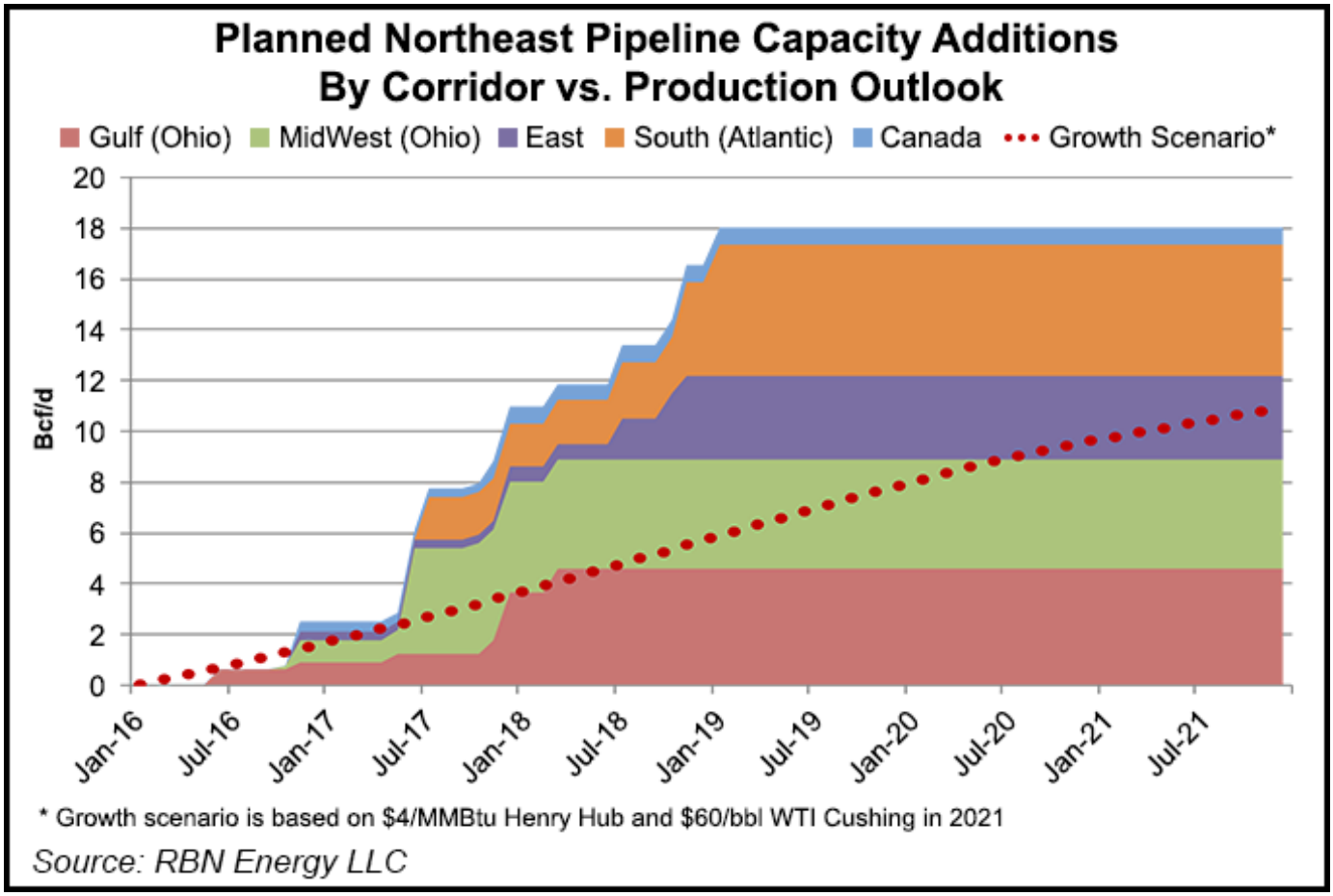

The need for more takeaway capacity out of the Marcellus and Utica shales has become a common refrain, but with a long list of projects on tap the Northeast could be headed for a pipeline overbuild, according to RBN Energy LLC President Rusty Braziel.

Speaking to attendees at the 21st Annual LDC Gas Forums Northeast conference in Boston Tuesday, Braziel said an evaluation of price and production scenarios through 2021 suggests the industry is planning too many pipelines to relieve the region's current capacity constraints.

"Is it possible that we could build too much takeaway capacity out of the" Marcellus and Utica? "It's certainly happened in about every other segment of the energy business over the last few years," Braziel said.

Braziel said his firm estimated Northeast production through 2021 by taking a range of price scenarios and determining what producers would be likely to drill and how many drilled but uncompleted (DUC) wells they would put into service.

RBN's most aggressive growth scenario, based on 2021 prices of $4/MMBtu Henry Hub and $60/bbl West Texas Intermediate, would see the Marcellus and Utica increase production by 11 Bcf/d over the next five years.

Meanwhile, add up all the major proposed Marcellus/Utica takeaway projects headed to the East (3.3 Bcf/d), to the Midwest (4.3 Bcf/d), to the Gulf of Mexico (4.5 Bcf/d), to the South along the Atlantic Coast (5.2 Bcf/d) and to Canada (.65 Bcf/d) and it equals 18 Bcf/d of new capacity by 2019.

"Could prices be higher, and could [the growth scenario] be higher because prices are higher? Yes, it could. Could pipes be delayed? Absolutely," Braziel said. Ultimately the discrepancy between the growth projections and planned capacity "means that there are a lot of things that could go right or wrong depending on your perspective on all of this...If you're looking at this from the standpoint of a company committing or considering commitments to any pipelines, firm pipeline capacity, 20-year deals, you just might want to think long and hard about whether [an overbuild] could happen."

Braziel drew parallels between the current state of shale hydrocarbon commodities markets and the housing market crash during the Great Recession.

"What we're really seeing is the tail end of a bubble, and what's actually happened is that bubble attracted billions of dollars worth of infrastructure investment that now has to be worked off," he said. "It's entirely possible that that could be the world that we're into now, that it's this world of infrastructure investment that we're dealing with right now and that this has a lot to do with what we're seeing happening up in the Northeast."

Basis differentials at Appalachian Basin trading points still point to a need for more pipelines, Braziel said. It may come down to which projects pull from the remaining active areas within the basin, he said.

"Due to localized transportation or capacity constraints, that means a lot of these pipes are going to be needed anyway. Growth is in very narrow pockets, so we're going to need some of these pipes," Braziel said. "That means if you're looking at one of those pipes that is not in one of these narrow pockets, then that pipeline might be at risk."

Of the 15 counties responsible "for the vast majority" of drilling activity in Pennsylvania, Ohio and West Virginia, "there's only been nine of those counties that have anything going on today...It's a very concentrated market with not much drilling going on. Of course, there are the DUCs. So there are certainly DUCs coming back, but the majority of the DUCs, guess what? The good DUCs are coming back in those very same counties...There's a lot of other DUCs that are scattered about in those other counties that were drilled quite some time ago. They're probably not coming back. The economics are not so good. We like to call them the dead DUCs."

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Recent Articles by Jeremiah Shelor

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Natural Gas Intelligence (NGI), is a leading provider of natural gas, shale news and market information for the deregulated North American natural gas industry. Since the first issue of Natural Gas Intelligence was published in 1981, NGI has provided key pricing and data relied upon daily by thousands of industry participants in the U.S, Canada and Mexico as well as Central and South America, Europe and Asia.

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RIVER VALUES

The Value of a Clean and Healthy Delaware River

Delaware RIVERKEEPER® Network

April 2010

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The Value of a Clean and Healthy Delaware River

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The Delaware Riverkeeper is an individual who is the lead voice for the Delaware River, championing the rights of the Delaware River and its streams as members of our community.

The Delaware Riverkeeper is assisted by seasoned professionals and a network of members, volunteers and supporters. Together they are the Delaware Riverkeeper Network, and together they stand as vigilant protectors and defenders of the River, its tributaries and watershed.

Established in 1988 upon the appointment of the Delaware Riverkeeper, the Delaware Riverkeeper Network (DRN) is the only advocacy organization working throughout the entire Delaware River Watershed. DRN is committed to restoring the watershed's natural balance where it has been lost and ensuring its preservation where it still exists.

The Delaware Riverkeeper Network's focus is the ecological health and integrity of the river ecosystem recognizing we best protect ourselves only when we best protect our River.

The Delaware Riverkeeper Network works to:

- ✓ Protect and defend the Delaware River through advocacy and enforcement;
- ✓ Inform, organize, activate and strengthen citizens and communities that appreciate and rely upon the River, its tributaries and watershed and want to get involved for their protection and restoration;
- ✓ Monitor the health of the River and tributary streams – gathering reliable data that is then used to bring about meaningful change;
- ✓ Secure and enforce strong legal protections for waterways and associated ecosystems;
- ✓ Restore damaged streams and ecosystems; and
- ✓ Ensure that the voice of the River is heard and its needs are given highest priority in all decision making.

To learn more about the Delaware Riverkeeper Network, to support our work, and/or to become an active member visit our website or contact our office.

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DELAWARE RIVERKEEPER®

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Forward
Maya K. van Rossum
the Delaware Riverkeeper

The Delaware River is the last major free-flowing River in the eastern United States. It flows for 330 miles through 4 states, 42 counties and 838 municipalities. Rather than serving as a dividing line among these communities, the Delaware River is a unifying element in the landscape. Throughout history and today, communities within the region regardless of political boundaries have been drawn together by this River, recognizing it as a living resource that supports their lives.

Recreationally, there is no off-season for the Delaware. In the warmer months you can find folks enjoying the River at all hours of the day or night -- fishing, boating, swimming, birding or just idly sitting on its banks and watching it flow by. Even in the coldest winter months kayakers and die-hard anglers are out there enjoying the River and its Bay. Preserving and enhancing the health of the River is critical for sustaining these recreational uses and protecting the local economies that rely on them.

The rich ecological history of the river region, still evidenced today, has not only been critical to the success of the recreational uses and associated eco-tourism, but has been the foundation upon which the region's culture and sense of identity has evolved. Historic and ongoing community vigilance has preserved unique cliff formations overlooking the River; natural islands, rapids, a remarkably well-established green riparian buffer including wetlands, and magnificent and unparalleled ecological phenomena including the arrival of hundreds of thousands of migratory shorebirds coming to feast on the eggs of the Horseshoe Crab, a species that has lived and spawned in our Delaware Bay since before the dinosaurs.

Many reaches of the River are still graced with the presence and history of the Native Americans. It is well documented that the Lenape and Minisink lived, fished, travelled and traded along the banks of the Delaware River.

Additionally, the Delaware River holds a special place in the European history of this country and is viewed by many as the place where America was born. Washington crossed the Delaware River and fought the Battle of Trenton on the banks of the Delaware. It was this battle which was the turning point for the American Revolution and the birth of our nation.

The sense of community created by the Delaware River has harmonized otherwise diverse and disparate voices in support of the River's protection and restoration. Still, more needs to be done.

There was a time in the mid-20th century when the Delaware River had become so polluted that it prevented migration of the historically important Shad upriver to spawn. Implementation of environmental laws and concerted action by concerned citizens and communities restored the River's water quality and ecosystems and supported the return of the Shad to the Delaware River.

While the pollution-induced fish block is now gone, the Delaware River today suffers different problems than in the past. Toxic and other legal and illegal pollution discharges to the River continue; damaging development that floods our communities, pollutes our waterways, and destroys sensitive and important ecosystems continue and are on the rise; the funding of structural flood control options and allowing communities to build, remain and grow in floodplains and in the path of dangerous floods are still the norm; the use of outdated technologies that degrade our clean water or needlessly kill billions of fish is still accepted; the proliferation of industrial activities such as natural gas extraction threatens water resources; overharvesting species, spoiling habitats, and scouring river bottoms continue – all this to accomplish goals that could be better achieved in other ways without such irrevocable harm. In short, many continue to treat our River and its ecological communities as though they are disposable.

But our River is not disposable, it is priceless and irreplaceable.

Access to pure, life-sustaining water that supports diverse and healthy aquatic communities is an inalienable right of all beings, and of the Delaware River itself. The Delaware River and the watershed it supports is our opportunity to receive the benefits of this inalienable right. No one entity, person, corporation, industry, town, county or state, has the right to use the Delaware River or any of the streams that feed it in a way that harms others or infringes on this right.

Protecting, respecting and restoring a clean, healthy and free flowing Delaware River provides the greatest level of protection, healthy growth and quality of life to our communities. A healthy Delaware River including floodplains, flows, tributaries, aquifers and habitats protects our communities from flood damages and drought, provides clean and abundant drinking water at a sustainable level to our communities, supports growing businesses of all types, supports healthy commerce, encourages both commercial and recreational fisheries providing safe food, creates vibrant recreation, encourages growing ecotourism, increases the marketability and market value of our homes, and makes our communities more desirable places to live and be.

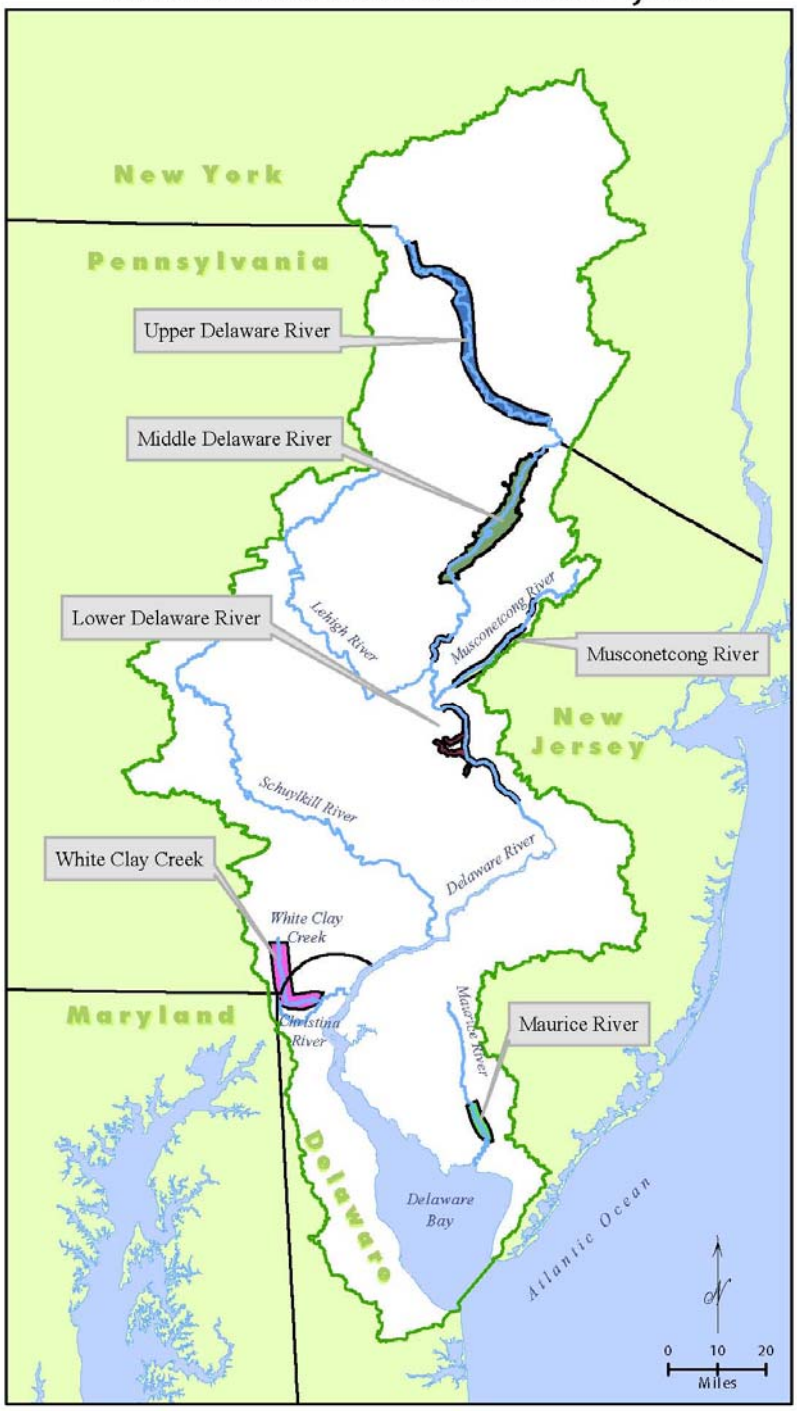
This report is designed to document and demonstrate many of the unrecognized values and benefits that a healthy Delaware River brings to our communities, to help people make River protection among their highest priorities, and to expand and enhance appreciation for the beauty and the power of a healthy Delaware River.

The most important take-away from this report is that the Delaware River is a living ecosystem rich in beauty, culture, and community that needs to be protected and, where necessary, restored to continue to be the vibrant and contributing member of our community we all desire and need.

Thank you for your role in appreciating, protecting and restoring the Delaware River, its streams and watershed. It is your care, your voice and your action to Remember the River every day and in all you do that will make the difference.

Maya K. van Rossum
the Delaware Riverkeeper

Stretches of the Delaware River and its Tributaries Included in the National Wild and Scenic Rivers System



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Property Values

Property Values

- Clean Rivers Increase Property Values
- Healthy Environments Protect Our Communities
- Businesses Benefit from Attractive Waterfronts

❖ Clean Rivers Increase Property Values

A healthy River, free flowing and free from pollution, enhances the economic value of homes, businesses and communities by and through which it flows. An injured system does the opposite. It creates damage and decreases values. River communities need to grow and thrive in a way that protects and maintains healthy river systems to ensure maximum economic and personal benefit.

From the late 16th century throughout the early 20th century, decades of industrial and residential waste dumped directly into the Delaware River began taking its toll on the population. Water pollution in the Delaware River caused outbreaks of dangerous and deadly diseases including cholera and yellow fever.[1] The pollution became unsightly causing pungent and sickening odors. The many cities and towns lining the Delaware misused the River by using it as their personal and commercial sewer line.[2]

Because of this River abuse, people who could afford it began building country estates and vacationing spots outside of populated cities. Communities such as Washington Crossing, Pennsylvania and Riverton, New Jersey began as summer retreat villages founded by city dwellers from Philadelphia, Trenton, Camden, and New York who wanted to have a Delaware River summer home partially to avoid the risk of waterborne illness which was at its highest in the summer months.[3] Some of the oldest and more glamorous 19th century homes along the Delaware River have become privately owned Inns and restaurants that are still used today.[4]

In recent years, as the pollution in the Delaware has declined, communities are starting to turn back to the River for its beauty, recognizing that life by a clean river is not only desirable but can be economically valuable. Maintaining natural areas, trees, wildlife, and a healthy streamside helps to increase property values by reducing pollution, lessening the threats and impacts of flooding and by increasing property and community aesthetics.

RIVERTON, NJ HISTORIC MANSIONS WERE BUILT FACING THE RIVER RATHER THAN THE STREET. MOST OF THESE STATELY HOMES ARE STILL INHABITED OR HAVE BECOME INNS AND RESTAURANTS TAKING ADVANTAGE OF THE RIVER VIEW.

While the property value of a home or business is dependent upon several factors, it is largely influenced by the features either on or nearby the site. A *Money* magazine survey found that clean water and clean air are two of the most important factors Americans consider in choosing a place to live.[5] Living near a stream, creek or river increases property value. "Ocean, lake, and riverfront properties often sell or rent for several times the value of similar properties located inland."[6] A case study from the Maine Agricultural and Forest Experiment Station compared property values for homes facing clean water versus water

considered dirty or unclean. The study shows that property located near a high quality water body has a higher market value than if the water body has lower water quality and that in some cases the entire market value premium (increase) resulting from the waterfront location can be lost as the result of declining water quality.[7]

Many waterfront properties have benefited from measures to clean up the Delaware River and its tributaries including the tidal stretch. For example, the Residences at Dockside in Philadelphia and Christiana Landing in Wilmington are selling condominiums featuring a waterfront view for up to $1.5 million.[8] In downtown Wilmington, the waterfront has been completely modernized with new town homes, restaurants, museums, and shopping in an effort to stimulate a city renaissance providing access to the River.[9] These are big changes in cities where only a few decades ago the River was blocked off and primarily used by industries and port operations. Aesthetically appealing and clean rivers are an asset to property values along the Delaware.

❖ Healthy Environments Protect Our Communities

Trees, shrubs and naturalized lands, whether along a water body or inland, provide a number of benefits in addition to increased market value and marketability of properties. They provide critical protections to the health of our streams and rivers as well as to our communities through pollution filtering, flooding and natural disaster protection, and erosion prevention.

Healthy Environments are Pollution Filters

Vegetation such as trees, shrubs, and deep rooted plants, filter pollution out of water runoff, protecting our streams from potential contamination and our communities from the cost of cleanup. Sediment and pollutants are trapped by the structure of a forest floor and by plant communities. The natural vegetation slows the flow of runoff, allowing a greater opportunity for sediment and pollutants to settle and/or be absorbed by plants and soils, before the runoff enters a stream, wetlands or other waterway. At the same time, plants via their root systems take up pollutants.[10] Nitrogen, phosphorous, pesticides, sediment, sulfates, calcium, magnesium, and herbicides are among the many contaminants that healthy plant communities can remove from runoff before it is allowed to pollute our streams and water supplies.[11] Trees absorb air pollution and help maintain air quality. The shade provided by trees reduces heat, which reduces cooling costs for property owners and protects aquatic life.

BUFFER. VEGETATED STREAMS PROVIDE POLLUTION FILTERS, FLOOD PROTECTION, AND EROSION PROTECTION TO MAINTAIN STABLE BANKS

VEGETATED BUFFER

Vegetated buffers are the banks and adjacent lands of waterways and wetlands with trees, shrubs, and deep rooted plants that act to prevent erosion and trap sediment, while providing habitat, food, and shade for aquatic life and animals, acting as natural filters for pollutants, absorbing floodwaters and providing distance needed to protect communities from flooding

Whether you live along a body of water or inland, naturalizing your property to receive all of these benefits also increases the value of your home and property. In a survey conducted by the National Association of Home Builders, 43% of home buyers paid a premium of up to $3,000, 30% paid premiums of $3,000 to $5,000, and 27% paid premiums of over $5,000 for homes with trees.[12] "Two regional economic surveys documented that conserving forests on residential and commercial sites enhanced property values by an average of 6 to 15% and increased the rate at which units were sold or leased."[13]

Living nearby healthy plant ecosystems also increases property values. One study found that homes within 1,500 feet of a park sold for $1,600 more than properties further away from naturalized areas.[14] Similarly, the study found that property values go up for homes within 1,500 feet of a wetland by an average of $37 per acre.[15] "Pennypack Park in Philadelphia is credited with a 38% increase in the value of a nearby property."[16]

Not only are homeowners economically benefitted when they plant trees on their properties, but the host communities are too. "It has been conservatively estimated that over $1.5 billion per year is generated in tax revenue for communities in the U.S. due to the value of privately-owned trees on residential property."[17]

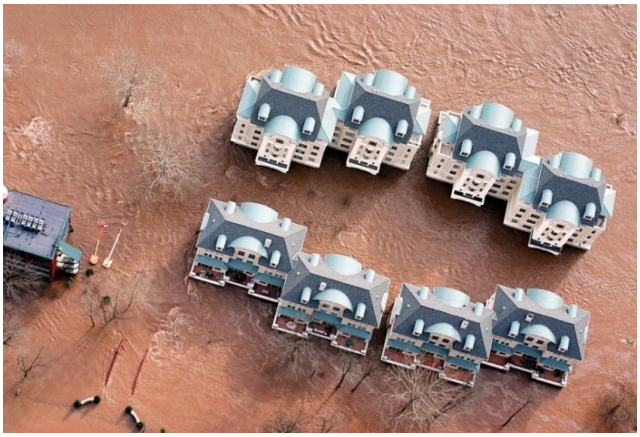
Healthy Environments Protect Us from Natural Disasters

Flooding in the watershed causes significant damage to public property, private property, and measurable economic injury for towns and cities. Hurricanes, severe thunderstorms, heavy rains, and snowstorms affect the Delaware River watershed and its residents. In areas lacking proper floodplain protection and riparian buffers, high water levels can create dangerous situations that are devastating emotionally, physically and financially, while resulting in damage to residents, communities, the River and all who rely upon it.

"Floods have been, and continue to be, the most destructive natural hazard in terms of economic loss to the nation, as well as the cause of hundreds of deaths in communities across the nation"

….. testimony from William O. Jenkins, Director of Homeland Security and Justice, 2004

Vegetated areas encourage the infiltration of rainfall, protecting the region from the impacts of flooding and drought. The infiltrated water replenishes groundwater, which in turn provides healthy base flow to streams and the River, and feeds drinking water aquifers. Soaking this water into the ground also means it does not turn into non-natural stormwater runoff that contributes to flooding. Using manmade structures to try to prevent stormwater runoff and flooding is costly and much less effective than supporting the same action by nature.



NEW HOPE, PA CONDOMINIUMS INUNDATED DURING THE JUNE 2006 FLOOD. THESE RESIDENCES WERE BUILT BETWEEN THE DELAWARE CANAL AND RIVER, IN A FRAGILE ENVIRONMENT SURROUNDED BY WATER WITH NO RIPARIAN BUFFERS OR PROTECTION FROM OR FOR THE RIVER.

Flood response and emergency services costs are of increasing concern to our region and nation. In its long history, Delaware River flooding has not only cost homeowners and municipalities millions of dollars, but the taxpayers of the entire state and nation pay the price. Responding to a flood requires a variety of emergency service operations and personnel including police and fire departments, local and county municipal services, and cleanup efforts. After a flood, communities must be provided temporary housing, food, and water. There must also be an investment of time and resources in providing ongoing information and assistance to flooded communities. Clean up after a flood often requires "hundreds of workers to renovate and repair, or tear down and dispose of, damaged or destroyed structures and materials."[18] Flooding destroys public and private utilities. Repairing damaged power lines, roads and bridges, gas pipelines, water treatment and storage facilities, and heating and cooling systems can make the cost of clean-up insupportable.

NOT ONLY DOES PROPERTY SUFFER DURING FLOOD EVENTS, BUT THE RIVER SUFFERS AS WELL. ALTHOUGH FLOODS ARE A NATURALLY OCCURRING PROCESS FOR RIVERS, NON NATURAL STRUCTURES, LITTER, AND ANYTHIING THAT FLOOD WATERS COME IN CONTACT WITH IS CARRIED INTO THE RIVER, POLLUTING IT.

Other often unrealized expenses include health threats, and the cost of lost food and polluted drinking water. Repair, renovation and demolition operations that must occur in the wake of a flood often generate airborne asbestos mineral fiber that can cause chronic lung diseases or cancer.[19] Inhalation of asbestos can cause lung disease that can be fatal.[20] Lead is another dangerous toxin that can be released during repair, renovation or demolition operations. If inhaled or ingested, lead can cause damage to the nervous system, to the kidneys, to blood forming organs and to the reproductive system.[21]

After a flood, it is recommended that foods that came into contact with flood waters be discarded, and that all water should be considered unsafe until communities have been notified otherwise. These can be costly hardships for communities recovering from a flood.[22] Flooding can result in the growth and transmission of fungi such as mildew, mold, rusts and yeasts which can cause illnesses.[23] Some forms of the fungi can cause skin, respiratory and other disorders.[24] Waterborne illnesses caused by bacteria, viruses and protozoa in drinking water are additional concerns in the wake of a flood.[25]

Flooding pollutes rivers with accumulated chemicals and debris from roadways and cities. Thunderstorms and hurricanes often lead to “Boil Water Advisories” as the result of sewage overflows at water treatment facilities. It is recommended that people boil all water for at least three minutes before consuming, making ice, feeding pets, washing dishes, brushing teeth, or rinsing food. These advisories can be expensive, as well as the added cost of having to buy treated/filtered water. When flooding occurs, recreation is halted and ecotourism harmed. The loss of business to a community or region can be significant.

In developed areas, rainwater rushes off impervious surfaces such as parking lots, roads, rooftops, hard-packed and chemically treated turf lawns, playing fields, golf courses and unstable farm fields into detention basins and storm systems that dump it, generally untreated, directly into streams, wetlands, lakes, and rivers and onto downstream communities. As development increases, the volume of stormwater increases and flooding worsens.

In natural forests and meadows, rainwater is absorbed into vegetated soils, feeding plant life, recharging aquifers and wetlands and maintaining stream base flow and waterway health. The volume of stormwater runoff is reduced. Naturally vegetated areas protect communities from increasing flood damages, the need for flood response services, and the need for flood damage payouts.

HIDDEN COSTS OF FLOODING

Floods bring serious emotional harm to affected homeowners and communities in crisis. Following a flood disaster, people are engaged in the response and helping one another to cope. Later, feelings of panic, anger, anxiety, disorientation, and despair emerge. The full force of emotions often hit after the flood waters have receded. Exhaustion, grief, desperation and depression can then set in.

The prolonged stress caused in the wake of a flood can lead to difficulty sleeping, irritability and outbursts of anger, difficulty concentrating, painful emotions, or post traumatic stress disorder.

Children can be more deeply affected than adults, experiencing nightmares, fear, anxiety, increased physical pain such as headaches and stomach aches, a decline in their academic performance, difficulty sleeping, even suicidal tendencies.

Accessed June 9, 2008 West Virginia Division of Homeland Security and Emergency Management www.wvdhsem.gov

TINICUM, PA DRN RECEIVED FUNDING TO DEVELOP RESTORATION AND MANAGEMENT PLANS FOR 2 MILES OF TINICUM AND RAPP CREEK. THE PLANS WILL ADDRESS INCREASES IN STORMWATER RUNOFF, FLOODING, STREAM BANK EROSION AND THE LOSS OF RIPARIAN BUFFERS. TREES AND WOODY SHRUBS NATURALLY PROVIDE FLOOD FLOW REDUCTION.

A loss of tree cover over a 15 year period (1985 to 2000) in Bucks, Montgomery, Delaware, and Chester Counties, Pennsylvania and Mercer, Burlington, Camden and Gloucester Counties, New Jersey, reduced the ability of the Delaware watershed region's urban forests to "detain almost 53 million cubic feet of stormwater, a service valued at $105 million."[26] Despite that diminishment, this same region "stored 2.9 billion cubic feet of stormwater in 2000, valued at $5.9 billion."[27]

Existing tree cover was found to prevent 65 million cubic feet of stormwater runoff in the Big Timber Creek watershed (New Jersey) saving the community $3.3 billion in stormwater infrastructure. In the Cobbs Creek watershed (Pennsylvania) existing tree cover prevented 20 million cubic feet of stormwater runoff saving the community $1 billion in stormwater infrastructure. [28]

In the Mill Creek watershed (New Jersey) existing tree cover prevented 6.7 million cubic feet of stormwater runoff saving the community $350 million in stormwater infrastructure. And in the Frankford-Tacony watershed (Pennsylvania) existing tree cover prevented 38 million cubic feet of stormwater runoff saving the community $2 billion in stormwater infrastructure. This tremendous savings translates into $176,052,455 per year of benefit/savings for this part of the Delaware River watershed community. [29]

VALLEY CREEK, CHESTER COUNTY, DRN ASSISTED OPEN LAND CONSERVANCY AND RESTORED THIS STREAM REACH WHICH HAD BEEN DEVASTATED BY EROSION.

FLOODPLAIN

The floodplain is the low, flat, periodically flooded area adjacent to rivers, lakes, and oceans. Natural floodplains absorb water, filter it, and help it to infiltrate the soil rejuvenating groundwater aquifers for drinking water.

Calculating the benefits of trees on a site-by-site basis further demonstrates that healthy, vegetated watersheds can provide dramatic cost savings for communities. A 3.41 acre commercial site in the Tacony watershed (Pennsylvania) with 2% tree cover and 97% impervious cover provides no stormwater benefits. By comparison, a single family site, 3.19 acres, with a 30% tree cover "provides $5,454 in stormwater savings".[30]In communities serviced by combined sewer and stormwater systems, where the cost to build additional stormwater infrastructure storage costs approximately $52 per cubic foot (as compared to areas served by separate stormwater systems where the cost ranges at $2 per cubic foot for stormwater construction), a 30% tree canopy on a 5 acre residential development site can save over $308,000.[31]

To reap the benefits of living near a water way, it is important not to encroach on it. While locating homes and certain businesses (such as restaurants, hotels, etc.) with a water view enhances their value, placing them too close to the water does the opposite. Buildings and other structures located too close to our waterways are at risk of flooding and resulting flood damages.

Houses located within the floodplain have lower market values than equivalent houses located outside the floodplain.[32] The reduction in value between the two can be as much as 4 to 12% with an average 5.8% reduction in value.[33] Recent flooding creates an even greater reduction in property values.[34]

BUCKS COUNTY, PA. BANK EROSION FROM EXCESSIVE RUNOFF IN TINICUM CREEK. THE SEDIMENT FROM THIS BANK RUNS DOWNSTREAM MUDDYING THE WATER, SMOTHERING STREAM BOTTOM HABITAT, AND SUFFOCATING FISH, MUSSELS AND OTHER AQUATIC LIFE.

A location in the floodplain reduces the value of the home for the seller, and also increases the costs for the buyer. Homeowners located in the floodplain are required to purchase flood insurance. They are also responsible for uncovered expenses associated with cleanup after a flood, and the costs of having to relocate after a flood, temporarily or long term.

Homes and businesses located in the floodplain increase polluted runoff because of this proximity to the waterway. The removal of native vegetation and the creation of impervious surfaces increases runoff that carries into the water every contaminant found there. For instance, homes that meet the minimum standards for floodplain construction can still place an unoccupied garage, driveway, and parking lot in the floodplain. Every time it rains, grease, oil, and any chemicals stored or used in a garage are washed into the river. And in floods, motor vehicles, lawn mowers, and other typical equipment kept in a garage or shed are swept in the floodwaters, sometimes taking the shed along as well.

Infringement on the floodplain reduces river values. Downstream and neighboring communities and businesses lose the enjoyment of beautiful, healthy and clean streams and their risk of flood damage is increased.

While avoiding construction in the floodplain will reduce flood damages and while reducing development impact through effective stormwater management and less impervious surface will reduce the volume of runoff, rivers and streams will always flood their floodplains. As part of the river system natural flood plains provide immense value by allowing river flooding to occur as part of the normal life cycle of a waterway.

Flood damage claims for three major flood events in the Delaware River Watershed

September 2004: 1,313 claims totaling $46 million
April 2005: 1,977 claims totaling $73 million
June 2006: 3,045 claims totaling $107 million

http://www.state.nj.us/drbc/Flood_Website/floodclaims_home.htm

Healthy Environments Prevent Erosion

Naturalized areas along a water body help prevent the erosion of public and private lands, including the undermining of bridges and roadways. Protection of our streams is much more cost effective than having to restore them once damage is done.

Streams are formed over time by the forces of nature. A stream's physical structure shifts naturally over time but often is forced to change more dramatically or unnaturally due to human intrusion such as increased water runoff, roads, dams, levees, or floodplain disturbance. A vegetated buffer along a waterway protects and supports the banks and other critical parts of a stream's make-up, allowing it to resist erosive forces and remain stable. Forested buffers are the glue that holds together nature's design. The roots hold the riparian lands in place, maintaining the hydraulic roughness of the bank, slowing flow velocities in the stream near the bank.[35] Also, the absorption ability of a vegetated buffer, especially when it contains a mix of woody shrubs and trees, slows down the water in high stream flows and soaks up water, reducing in-stream channel velocity and volume during storm events thereby reducing damage to the stream and preventing non-natural erosion. [36]

In Ohio, the Department of Transportation found that on average it costs between $3-$10 per linear foot to preserve a stream, while it costs almost $300 per linear foot to restore it.[37] Protecting our floodplains and buffer areas keeps people from building in the floodplain where they are vulnerable to floods and flood damages while at the same time protecting our public and private lands from being literally washed away.

WETLANDS ARE FILTERS AND BUFFERS FOR RISING WATER LEVELS. THIS AREA IS ALONG BEAVER CREEK, A TRIBUTARY OF OLDMANS CREEK, A NEW JERSEY TRIBUTARY OF THE DELAWARE RIVER.

Protection from the Effects of Global Climate Change

Global climate change is a major threat to our region, nation, and earth. A recent report entitled "Confronting Climate Change in the U.S. Northeast" and an associated New Jersey specific *Executive Summary* found that under one conservative emissions scenario, by the end of the century New Jersey is expected to lose virtually all of its snow cover; that "the frequency and severity of heavy rainfall events is expected to rise"; and that the frequency of short term drought (one to three months) is projected to increase.[38] In addition, global climate change is expected to dramatically increase the number of days over 100 degrees communities in our region experience. In the coming decades, communities nearby Philadelphia will begin to experience in the range of 10 days to 30 days that are over 100°.[39]

Scientists have determined that carbon dioxide, a major greenhouse gas, contributes significantly to global climate change.[40] Trees are an important part of the solution. Trees store carbon in their leaves, stems, branches, and roots.[41] Other plants, dead plant material, and the organic matter found on the forest floor and in forest soils also store carbon.[42] Protecting our forests to protect our rivers also helps protect us from global climate change.

A forest which has not been previously logged and has a closed canopy, stores about 250 tons of carbon per hectare in its vegetation and soil.[43] Rather than acting as a sink for carbon, this same area if converted to agriculture becomes a source of carbon, releasing about 200 tons of carbon per hectare.[44] Forests with an open canopy store about 115 tons of carbon per hectare. The same forests release about 29 to 39 tons per hectare if converted to agriculture.[45] The social costs of emitting carbon (calculated as damage avoided) is about $34 per ton.[46] The US Forest Service Northeastern Research Station estimated that forest carbon storage in New Jersey at approximately 38.3 tons per hectare. This means that the 126,606 hectares of NJ State Parks and Forests store 4,849,009 tons of carbon[47] which would, at the $34 per ton figure, provide over $164 million in damage avoidance.

Restoring our floodplains by creating forested buffers along our rivers and streams protects communities from the expected increase in flooding that will accompany changing weather patterns and increased rise of sea level that will result from global climate change. At the same time it provides the quality of vegetation that can be part of the solution for reducing the advance of global climate change by sequestering carbon and filtering air pollution.

NATIVE RIPARIAN PLANTS, GRASSES, AND TREES HELP TO RESTORE DAMAGED STREAMS STRENGTHENING THE BANKS AND CREATING ROOT SYSTEMS.

❖ Businesses Benefit from Attractive Waterfronts

A clean and healthy Delaware River increases the appeal of commercial properties and businesses that benefit from the River as an attraction. On a nice day, people are drawn to the River; riverfront businesses gain an increase in customers and foot traffic based on their location. Riverfront restaurants, art galleries, inns, Bed and Breakfasts, charter fishing boats, coffee shops, and retail shops all benefit from a proximity to the River and parks when they are clean and attractive.

NEW HOPE, PA. THE LANDING RESTAURANT FEATURES RIVERSIDE DINING WITH VIEWS OF LAMBERTVILLE, N.J AND THE DELAWARE RIVER.

Restaurants

At the riverfront in downtown Philadelphia, Moshulu has transformed a historic four masted sailing ship from the early 20th century into a fine dining restaurant docked at Penn's Landing. The restaurant is one of many fine dining experiences that may be enjoyed along the Delaware River. The Spirit of Philadelphia is a riverboat cruise that combines the beauty of the River, the spirit of the City, and a buffet dinner and a show for around $65 per person. River cruises like this one are not uncommon to the Delaware River.[48] The Liberty Belle docked in the Navy Yard offers a similar experience and can be rented out for weddings or other large events for up to 600 people; people pay more than $6,000 for this Mississippi style riverboat to enjoy their evening on the River.[49]

NEW HOPE-LAMBERTVILLE BRIDGE. PEDESTRIANS CAN WALK OVER THE DELAWARE RIVER FOR SHOPPING AND DINING ON EITHER SIDE OF THE RIVER. GOURMET RESTAURANTS, ANTIQUE SHOPS, CRAFT GALLERIES, SALON BOUTIQUES, AND UNIQUE JEWELRY STORES BENEFIT FROM A STEADY FLOW OF CUSTOMERS.

Along the lower Delaware the Bucks Bounty, Bridge Café, Landing Restaurant, Indian Rock Inn, and Center Bridge Inn are all restaurants that people drive to from miles away to enjoy the views of the River, the sounds of the water, and the aesthetics of nature and history.[50] Restaurants along the Delaware River in Lambertville and New Hope are able to attract visitors throughout the region for the scenic river views, walkable bridge, and historic towns.

Rojo's Roastery in Lambertville brews organic and fair trade coffee for pedestrians that stroll in from walking along the River and through town. The River Horse Brewery in Lambertville uses water directly from the Lambertville Reservoir of Swan Creek, a tributary of the Delaware River. The microbrewery has been located along the banks of the Delaware River since 1996 and distributes all natural beer throughout the northeast, Delaware, and Maryland.[51]

Case Study: The Delaware River Art Gallery
Yardley, PA

The Delaware River Art Gallery holds exclusive and historic pieces of artwork that focus on the life and beauty of the Delaware River, mostly by local artists. Located in historic Yardley, Pennsylvania the Gallery celebrates life on the Delaware as well as the beauty of the River itself.

Dale Woodward, owner of the Delaware River Art Gallery says that although much of the business comes from people strolling along the River through Yardley who decide they want to remember the view of the Delaware through art, even more business comes from the people who actually live in the area. Residents of Yardley enjoy daily views of the Delaware, a River many of them have grown up on, and artwork of the River is a prized possession.

Inns and Hotels

The Black Bass Inn was one of the first taverns in Bucks County. It is located in the river town of Lumberville.[52] Currently, the Black Bass resides as an upscale restaurant and inn.[53] Situated close to the Delaware, people come to the restaurant for the views of the River below. The Lumberville footbridge connects the town to Bulls Island State Park for an after dinner stroll or as a take out for kayakers and canoeists wanting a good meal.[54]

Chestnut Hill Inn on the Delaware consists of two romantic Victorian houses overlooking the scenic river in Milford, Hunterdon County, NJ.[55] The guest rooms exude a sense of warmth and romance no matter what season you visit. All rooms have access to the beautiful riverfront terraced gardens, deck, and dock. River access is nearby so guests can bring their boat, canoe, kayak or tube. Many guests enjoy bringing their lunch or dinner back to the Inn to dine along the River's edge.

CHESTNUT HILL INN ALONG THE DELAWARE RIVER IN MILFORD, NJ INNS LIKE CHESTNUT HILL ARE APPEALING BECAUSE OF THEIR PROXIMITY TO THE RIVER AND THE BEAUTY AND ACTIVITIES THE RIVER PROVIDE. *PHOTO*

The Bucks County Bed and Breakfast Association of Pennsylvania is supported by many Delaware River bed and breakfasts throughout Bucks County. Most of the inns and restaurants are restored homes built in the 19th century and contain the river charm people seek for getaways, retreats, and important events.[56]

The Lambertville Station Inn located along the Delaware River in Lambertville, New Jersey offers waterfront lodging, dining, activities, and a ballroom ideal for weddings and receptions.[57] Every room located at the Inn has a scenic waterfront view. The ballroom is made of three glass walls offering river observation from every angle, giving the inside an impression of the outdoors.

Among the many hotels, lodges, and inns throughout the watershed, accommodations along the River with a waterfront view are priced higher than hotels without. (see figure: 1)

Figure 1: Hotel Room Prices With and Without a River View

Figure 1 shows a range of hotels along the Delaware River that offer both views of the riverfront and rooms without views of the riverfront. The range between the two demonstrates that people are willing to pay more for a view of the River. At the Cape May Grand Hotel located near the mouth of the Delaware Bay, a room with a waterfront view costs $227 per night, while a view on the opposite side of the same hotel costs only $192 for the same night.[58] The Hyatt Regency in Philadelphia also increases the price on rooms with a view, charging $247 for a king size bedroom without a River view as compared to $282 for a king size bedroom on the waterfront.[59] Up river at the Bridgeton House in Upper Black Eddy, prices can be found for nearly $100 more with a Delaware River view.[60] And the historic Penn's View hotel in Philadelphia charges $289 for its rooms with a Delaware River view, which are also suite style rooms; the lower level rooms can be purchased for as low as $145 per night; a difference of $144.[61]

River Recreation

- The Broad Array of Recreation on the Delaware River
- Diverse Boating for Recreation and Sport
- Swimming and Biking Along the Delaware
- Leisure Fishing
- Birding and Wildlife Watching
- Parks and Wildlife Refuges
- Community Attractions Focused on Enticing Ecotourism

The Broad Array of Recreation on the Delaware River

Recreation is fundamental to individual, family and community quality of life. Recreation provides jobs, stimulates and supports the economy, brings tourists and outside revenue into the region, and it enhances the quality of life of those enjoying it.

On the Delaware River recreational possibilities abound and include all types of boating, fishing, bird watching, hiking, biking, tubing, jogging, swimming, camping, and wildlife viewing. Keeping the river healthy, and restoring health where it has been lost, will allow these recreational activities to prosper.

PADDLER CROSSING A DELAWARE RIVER CANAL OVERFLOW IN SMITHFIELD, PA ON THE DELAWARE RIVERKEEPER NETWORK'S NOVEMBER 2008 BUSINESSMAN'S CANOE TRIP. *PHOTO CREDIT: ELIZABETH AZZOLINA 2007*

Outdoor recreation keeps people physically and mentally healthy and productive, enhancing the body and the mind. In a survey of Delaware River Valley visitors,[62] almost all recreationists stated that the River provided a source of mental and physical refreshment.

Many rural river towns are supported by seasonal tourist revenue.[63] Recreation is a $730 billion annual contribution to the United States economy.[64] In New York, New Jersey, and Pennsylvania alone, the total economic contribution of outdoor recreation exceeds $38 million annually, generating over 350 thousand jobs and adding additional economic sales and tax revenues of more than $32 million.[65]

RECREATION

Recreation along the Delaware River includes boating, fishing, bird watching, hiking, biking, tubing, jogging, swimming, camping, and wildlife viewing.

CANOEING THE DELAWARE RIVER AT FRENCHTOWN, NJ DRN HOLDS AN ANNUAL BUSINESSMAN'S CANOE TRIP IN THE FALL FOR MEMBERS AND STAFF TO ENJOY THE RIVER BEFORE WINTER AND WHILE THE LEAVES ARE BRIGHT AND COLORFUL. *PHOTO CREDIT: ELIZABETH AZZOLINA 2007*

According to the Outdoor Industry Foundation, "more Americans paddle (canoe, kayak, raft) than play soccer", and "more Americans camp than play basketball".[66] The U.S. Fish & Wildlife Service reports that in 2006 fishing was the "favorite recreational activity in the United States" with 13% of the population 16 and older (29.9 million anglers) spending an average of 17 days fishing in that year alone.[67] As a result, in 2006, "anglers spent more than $40 billion on trips, equipment, licenses and other items to support their fishing activities." [68] Of this, 44% ($17.8 billion) was spent on items related to their trips, including food, lodging and transportation. [69]

These national trends and figures are consistent in the Delaware Valley. According to the New Jersey Department of Fish and Wildlife, New Jersey state parks received 12 million visits in one year (1994) statewide, with wildlife recreation, fishing and hunting responsible for 75,000 jobs and generating $5 billion in retail sales.[70] Valley Forge Historical Park, through which the Schuylkill River and tributary streams flow, created 1.23 million recreation visits in 2001 with park visitors spending "$33.3 million dollars within an hour's driving distance of the park, generating $10.4 million in direct personal income (wages and salaries) for local residents and supporting 713 jobs in the area."[71]

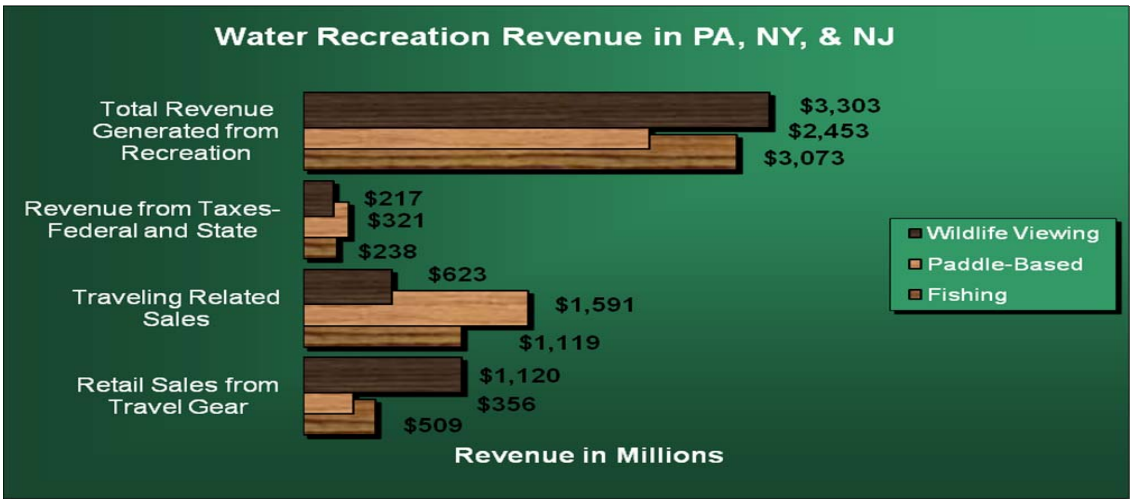


Figure 2 Water Recreation Revenue in PA, NY, & NJ

For many, the Delaware River evokes a "strong feeling of affection, loyalty, and attachment".[72] Visitors are attracted to the Delaware River for recreation because of its vicinity to major eastern metropolitan areas as well as its "clean river water, exceptional trout, shad, and eel fisheries, and wildlife to observe."[73]

The most popular River activities include boating, fishing, and bird watching. The total economic contribution of fishing in Pennsylvania, New York, and New Jersey exceeds $3 million.[74] Another $2.5 million is supplied from paddle based boating.[75] Nearly $2 million is spent on the gear to support these industries with another $3 million generated from related travel.[76] In addition, nearly $750,000 is generated in state and federal taxes on all of these water recreation income streams.[77] **Figure 2** shows how the amount of money spent on recreation purposes breaks down specifically in the tri-state area.

❖ Diverse Boating for Recreation and Sport

- ***The Delaware is the longest un-dammed river east of the Mississippi, extending 330 miles from the confluence of its East and West branches at Hancock, New York to the mouth of the Delaware Bay where it meets the Atlantic Ocean. Because the Delaware is undammed, it is ideal for popular recreational activities such as canoeing and kayaking. The River is fed by 216 tributaries, the largest being the Schuylkill and Lehigh Rivers in Pennsylvania and the Musconetcong in New Jersey. Boating options throughout the watershed include canoeing, kayaking, rafting, jet skiing, motorboats, paddleboats, different types of historic riverboats and sailing. Even in urban areas, such as the Philadelphia and Camden waterfronts, the popularity of paddle sports is increasing as evidenced by the recent creation of the Tidal Water Trail maps series, public access points, and points of interest.***

Rowing on the Schuylkill

Boating recreation has a recognized history in the watershed. For example, the Schuylkill River traces its rowing culture as far back as the 1830's.[78] Each year the Schuylkill Navy hosts numerous regattas along the Schuylkill including the Dad Vail, the largest collegiate rowing event in the nation.[79] In response to the atmosphere of professional rowing of the 19th century, and the gambling and corruption that plagued the sport, the Schuylkill Navy was formed in 1858 to promote amateur rowing and establish rules of behavior.

Today, the Schuylkill Navy is the oldest amateur athletic governing body in the United States and is made up of ten clubs on Boathouse Row as well as high school and college rowing programs.[80] In 1938, Philadelphia Girls' Rowing Club, the first boat club on the Schuylkill for women, was organized.[81] The first Schuylkill men's club to organize a women's rowing team was Vesper in 1970.[82]

DINGMANS FERRY, PA AMERICAN CANOE ASSOCIATION HELPING DRN ORGANIZE THE ANNUAL UNITED NATIONS INTERNATIONAL SCHOOL FRESHMAN CLASS CANOE AND CAMPING TRIP ON THE DELAWARE.

PHILADELPHIA, PA ST. JOSEPH UNIVERSITY WOMEN'S ROW TEAM SCHUYLKILL RIVER. ROWING HAS A LONG HISTORY ON THE MAIN STEM SCHUYLKILL RIVER. *PHOTO CREDIT: PATRICK CONOLLY 2007*

The presence of the Schuylkill Navy and the clubs along Boathouse Row nurtured excellence in amateur rowing for decades. Vesper Boat club, organized in 1865, won gold medals in the eight-oared shell event at the 1900, 1904 and 1964 Olympics.[83]

Elite level rowers and world class coaches continue to be attracted to the Schuylkill to train. Rowers training in Philadelphia are earning spots on national and Olympic teams including the 5 Philadelphia-area rowers who represented the United States at the 2008 Olympics in Beijing.[84]

In addition to dual competitions among local college crews, more than 20 regattas are held on the Schuylkill each year from April through November.[85] These regattas include the Independence Day Regatta, the largest summer club regatta in the United States (over 1,400 competitors in 2008)[86]; the Dad Vail, the largest collegiate rowing event in the nation (over 3,000 competitors in 2008)[87]; and the Stotesbury Cup, the largest high school regatta in the world (over 5,000 competitors from 177 high school teams in the United States and Canada in 2008).[88] With thousands of competitors coming to the region for multiple day visits, these regattas result in a significant economic impact for the Philadelphia area. Rowing has become such a strong force in the region that clubs and competitions have expanded to other Delaware River tributaries with regattas now being held on the Cooper River in New Jersey and the Christina River in Delaware.

PHILADELPHIA, PA BOATHOUSE ROW THE SCHUYLKILL REMAINS HEAVILY USED FOR COMPETITIONS INCLUDING NATIONAL REGATTAS AND OTHER ROWING EVENTS. PHOTO CREDIT: GREGORY MELLE

The boat clubs that comprise Boathouse Row have been registered as a National Historic Landmark since 1987.[89] Boathouse Row has become an iconic image for the City of Philadelphia and tours offering a glimpse into the competitive world of Philadelphia rowing have become an important component of Philadelphia tourism.[90]

Whitewater Kayaking

Those who enjoy whitewater particularly enjoy the Delaware River's upper reaches. In 1986 the Upper Delaware attracted 232,000 whitewater paddlers who spent $13.3 million, adding $6.2 million to the local economy and supporting 291 jobs.[91] The Water Gap is a tremendous resource for whitewater paddlers. In 1986 this reach of the River was responsible for attracting 135,400 whitewater paddlers who spent $6,929,000, contributing $3,695,200 of local economic value and supporting 156 jobs.[92]

BUCKS COUNTY, PA TWICE A YEAR RELEASES FROM NOCKAMIXON LAKE TO TOHICKON CREEK CREATES A GREAT WHITEWATER EXPERIENCE THAT IS A FAVORITE AMONG WHITEWATER PADDLERS AND CANOEISTS.

Canoeing on the Delaware

There are more than 20 canoe liveries along the Delaware River, some of which employ over 200 people and have annual attendances of around 60,000-70,000 people.[93] The liveries offer a variety of options including canoeing, kayaking, tubing, and rafting. Tubing at Bucks County River Country costs $18 a trip and whole families can go rafting for $40-$50 a day (2006).[94] With an annual attendance of 60,000 people,[95] this creates estimated gross revenue of between $648,000 and $3 million.

Canoe liveries throughout the watershed cater to family fun. There are few other full day activities that families may experience together for as little as $50. These activities allow for education and appreciation of the River while relaxing, fishing, reading, and sunbathing.

Clean and healthy water is essential for the survival of canoeing businesses. The threat of pollution or contaminated water turns many families away for health and safety reasons. When it was learned that the Village of Deposit was discharging 450,000 gallons per day of chlorinated raw sewage into the Delaware River during the summer months (July-August), 2006, it was recognized immediately as a threat to recreation along the River. An alert about the discharge from the Delaware Riverkeeper Network inspired numerous calls for immediate action. Calls to regulatory agencies, letters from the community, and news

articles about the discharge and its threat to the community and recreation prompted swift action from the agencies to stop the discharge. This type of pollution incident can damage the river's reputation even after the event is abated.

Flooding along the Delaware River in recent years has closed down canoe and boating liveries for weeks at a time. Peak livery operations last only 3 months out of the year, so summer flooding threatens these small businesses with relatively small profit margins.[96] High waters can be dangerous for boaters and swimmers by causing rapid water flow and adding obstacles and debris to the current.

Keeping the riversides and a campgrounds clean are important in attracting tourists to the region. Recognizing this Kittatinny Canoes near the Delaware Water Gap National Recreation Area hosts an annual river litter clean up that brings in people from all over the watershed to pull tires, paper, plastic bottles, and roadway trash from the River.

DELAWARE WATERGAP FOR THE PAST 18 YEARS, DELAWARE RIVERKEEPER NETWORK HAS ORGANIZED A 3 DAY CANOE AND CAMPING TRIP FOR THE FRESHMAN CLASS OF THE UNITED NATIONS INTERNATIONAL SCHOOL FROM NYC. FOR MANY IN THE GROUP OF 100+, IT IS THEIR FIRST TIME IN A CANOE OR CAMPING IN THE WOODS.

Location	Canoe Liveries
Pennsylvania	Adventure Sports Canoe & Raft Trips Bucks County River Country Chamberlain Canoes Kittatinny Canoes Pack Shack Adventures Portland Outfitters River Country Shawnee Canoe Trips Shohola Campground Soaring Eagle Campgrounds Sylvania Tree Farm Camping Two River Junction
New Jersey	Delaware River Rafting & Canoeing Delaware River Tubing GreenWave Paddling Lazy River Outpost Paint Island Canoe & Kayak Phillipsburg River Outpost
New York	Ascalona Campground Catskill Mountain Canoe and Jon Boat Rentals Cedar Rapids Kayak & Canoe Outfitters Inc Deer Run Rustic Campground Delaware River Trips Indian Head Canoes & Rafts Jerry's Three River Campground and Canoes Landers River Trips Red Barn Family Campground Silver Canoe Rentals Upper Delaware Campgrounds, Inc. Whitewater Willies Raft & Canoe Rentals, Inc. Wild & Scenic River Tours & Rentals

Figure 3: Canoe Liveries Along the Delaware River Main Stem[97]

Whitewater clubs and paddling clubs throughout New York take advantage of the nearby river attractions. The Canoe and Kayak Club of New York plans trips almost every weekend of the fall, spring and summer through Upper Delaware tributaries and headwater streams.[97] The Mongaup and Lehigh Rivers are favorites for clubs that frequent both the Delaware and Hudson River watersheds.[98]

To the delight of Whitewater enthusiasts, Lake Nockamixon makes 2 whitewater releases each year into the Tohickon Creek at Ralph Stover State Park in Bucks County, Pennsylvania.[99] The course can be challenging for even the most avid kayakers. The creek contains several drop-offs, high rock cliffs, class III and IV rapids, and some of the most beautiful landscapes in southeastern Pennsylvania.[100] Boundless Philadelphia, a Philadelphia based tourism website warns, "don't be surprised to find the water somewhat crowded." "This is a favorite among paddlers all over the Northeastern US."[101]

Kayakers and paddlers take advantage of the still water reservoirs in New York and the upper Delaware. The Swinging Bridge reservoir and Mongaup Falls reservoir together span almost 1000 acres.[102] These recreational hot spots are free to paddlers and hikers; anglers can catch Largemouth Bass, Chain Pickerel, and Panfish.[103] The Mongaup Falls reservoir is trout stocked.[104] The Mongaup Falls Reservoir Park is known as a prime location for Bald Eagle watching and contains designated bird observation areas. [105]

Case Study: Canoe Designer and Photographer Harold Deal

Harold Deal's ancestors have been residents of the Delaware River for centuries. One of those ancestors, Daniel Bray, collected Durham boats for General Washington's army allowing them to cross the Delaware River aiding in our country's independence. Harold has grown up on the Delaware and knows its ebbs and flows in all seasons. He once continuously paddled the 200 miles from Hancock to Trenton without any sleep or rest. This intimate knowledge gained from the flow of the Delaware River and its tributaries enabled him to become a semi-professional paddler, designing and building prototype models for performance canoes and paddles used for recreational paddling and racing. Harold's whitewater skills led to 24 first-place finishes at Whitewater Open Canoe National Championship events held around the United States.

"After so many years of paddling, I know how a canoe's shape will respond in the dynamics of a flowing river. My relationship with boating manufacturers from recreational paddling and whitewater racing over the years allowed me to develop and market my own concepts for canoes and paddles that are being produced today", said Deal.

Deal lives along the Delaware River in Upper Mount Bethel Township with his wife Bets. He is able to keep an eye on the river and regularly frequents his favorite sections of the Delaware and its tributaries year round. "Living in close proximity to the river has allowed me to immerse myself in a way of life that is connected with the water. Bets and I have a deep appreciation for wildlife and the natural outdoors, and the importance of preserving a clean and healthy watershed system".

Boating of all types is important for residents of the watershed and tourists. Tourists are attracted to the region; historic attractions are maintained; jobs are created; and valued recreation, vacation, environmental education and family interactions are nurtured along the River.

BRISTOL, PA THE BRISTOL RIVERBOAT QUEEN DOCKED ALONGSIDE THE DELAWARE RIVERFRONT IS A REPLICA STEAMBOAT THAT TOURS THE MANSIONS OF BRISTOL AND BURLINGTON, NJ

Historic Riverboats

Riverboats are a part of the Delaware River's history and offer another kind of boating attraction. Canal boat tours in New Hope and Easton, Pennsylvania keep that history alive. Wells Ferry in New Hope, Pennsylvania offers scenic, narrated tours of the Delaware River's history.[106] Coryell's Ferry, also in New Hope offers narrated tours on a boat with a paddlewheel that departs every 45 minutes in May through October.[107]

In Burlington, New Jersey, county officials have attempted to spark tourism through offering a historical riverboat tour on the Bristol Riverboat Queen, a replica steamboat. What began as a one day event has transformed into a regular summertime weekend adventure. More than 1,500 people showed interest in the tour of the Burlington and Bristol mansions and factories that can only be viewed from the River itself.[108] The boat holds 100 people, and every trip is filled to capacity.[109]

The Bucks County Riverboat Company offers a 52-foot long pontoon boat for scenic and historic rides along the Delaware while serving dinner for more than 70 guests at a time. The pontoon boat can be chartered for special events at a cost of $1,375 for four hours.[110] It is rented out regularly on weekends throughout the summertime months. This riverboat and the Delaware River Steamboat floating classroom offer environmental education seminars for local public and private schools, families, college students, and youth groups.[111]

❖ Swimming and Biking along the Delaware

The Delaware is a safe and fun haven for swimmers and the canal towpaths create perfect biking trails. Swimmers enjoy Delaware River and tributary waters at a number of locations that may not be official access points, but community-made put-ins where kids and adults can appreciate the cool water during the hot summer.

CAPE HENLOPEN, DE KIDS SWIMMING DURING DELAWARE RIVERKEEPER NETWORK'S ANNUAL MEMBERS DAY AT THE BAY DAY AT THE BEACH. THE BAY OFFERS MORE SECLUSION THAN THE JERSEY SHORE, WITH JUST AS MUCH FUN.

Some popular Delaware River swimming holes are located at Bulls Island just north of New Hope and Lambertville, Farview in Stroudsburg, Flatbrook and Milford swimming holes in Milford, and at the Trestle Bridge in Columbia, New Jersey.[112] Popular swimming lakes include Crater Lake and Highlands Natural Pool.[113] Creeks and brooks with reportedly good swimming spots are at the Devils Pool on Cresheim Creek in Mt. Airy Pennsylvania, the Brandywine in Chadd's Ford, and Otter Hole in the Posts Brook in New Jersey.[114] The Musconetcong Wild and Scenic River enters the Delaware at Riegelsville, New Jersey and plays host to popular swimming holes throughout its length. Some of these lakes and swimming holes are in the most beautiful secluded spots of the watershed. Many have warnings about jumping from high up into shallow water and watching out for dams or big rocks.[115] After heavy rain, due to polluted runoff, many areas are better left off limits for swimming and other water contact recreation for approximately two days to allow water quality to clear up.

Besides swimming holes, there are also a few remaining Delaware River beaches where swimming continues. Historically, swimming in the River was a popular summertime activity. Smithfield Beach and Milford Beach in Milford, Pennsylvania maintains a lifeguard on duty during the summer months. In the Delaware Bay, Cape Henlopen, Dewey Beach, Cape May, and several other spots are popular for tidal salt water beaches without the crowds of the Jersey Shore or Delaware beach hotspots. To many towns, beaches are a vital part of the local economy.

Bicyclists have a number of scenic options that take them close to water. The Delaware and Raritan Canal trail is a perfect bicycling adventure. It travels along the historic Delaware River canal towpath for 27 miles from Frenchtown to Trenton, New Jersey.[116] The canal on the Pennsylvania side of the River offers a similar experience close to the water for over 60 miles from Easton to Bristol.[117] Bikers, runners, and families with strollers, appreciate the trails. The River to River scenic Bicycle tour from Montgomery County to Bucks County, Pennsylvania offers both recreational and professional cyclists with 25-, 50-, or 100-mile cycling routes along roads through scenic old towns, rivers, and parks.[118]

The Delaware River Scenic Byway is a scenic driving experience traveling along Route 29 between Trenton and Frenchtown, New Jersey, and along Route 32 that parallels the River through Bucks County in Pennsylvania. Motorcyclists and bicyclists also enjoy the scenic rides and views[119] and cycling opportunities continue to expand from the Poconos (the MacDade Trail) to the Camden City Waterfront (Camden Greenway Trails).

❖ Leisure Fishing

The Delaware River is known for its world class fisheries. Both commercial and recreational fishing abound on the River and help support local economies. Fish commonly found in the Delaware River include Striped Bass, Trout, and Large and Smallmouth Bass. Other fish present in the River include Weakfish, American Shad, Sturgeon, Catfish, Pike, Bullhead, Perch, Walleye, and Sunfish. A 1996 survey found that 31,390 anglers spent 265,970 days fishing just the New York reaches of the Delaware River.[120]

Shad Fishing

The American Shad is deeply rooted in the foundation of the cities and towns throughout the Delaware River watershed. The Shad is a "major part of the river's ecology and has played an important role in the river's early commercialization, development, and tourism."[121] American Shad are born in freshwater. After hatching in spring, they feed on plankton and aquatic insects before migrating towards the ocean.[122] After four to seven years in the ocean the Shad return to their place of birth to spawn in the fresh waters of the Delaware River and upriver tributaries.[123]

JUVENILE SHAD SEINING. ***PHOTO CREDIT: NJ DIV. OF FISH & WILDLIFE***

The American Shad are celebrated in several cities throughout the watershed during their spring spawn including Fishtown in Philadelphia, Easton, Pennsylvania and Lambertville, New Jersey bringing in people from all over the basin. The annual Shad fishing tournament held each year following the Easton Shadfest charges a $20 entry fee, and with over 1000 competitors in 2006, the tournament raised $20,000 in proceeds.[124] Lambertville's Shadfest has been an annual part of the community for 26 years, attracting 30,000 to 35,000 visitors during the two day event.[125] The Shad population has rebounded from decades ago because of renewed efforts to maintain water quality allowing the Shad to make the spawning journey up the Delaware.[126]

LAMBERTVILLE, NJ DELAWARE RIVERKEEPER NETWORK BOOTH FEATURING A REAL AMERICAN SHAD, MERCHANDISE, AND EDUCATIONAL MATERIAL . ***PHOTO CREDIT: A. WALSH***

Shad enthusiasts express their passion for shad fishing through many avenues. The Delaware River Shad Fisherman's Association actively supports "all things shad", from tournaments to school education, advocacy and lots of fun events. Find them at http://mgfx.com/fishing/assocs/drsfa/ or DRSFA, 3907 Boswell Court, Bethlehem, PA.

Trout Fishing

Trout are a world class Delaware River recreational fishery. While there are no dams on the main stem of the Delaware River, there are significant dams on tributaries. Most notable are a series of three dams on headwater streams to the River. Cannonsville Reservoir Dam is on the West Branch of the Delaware, Pepacton Reservoir Dam is on the East Branch of the Delaware, and the Neversink Reservoir Dam is located on the Neversink River; an Upper Delaware tributary.

These reservoirs were constructed to provide drinking water to New York City (located in the Hudson River Watershed).The tailwaters (the water just below the dam) receiving cold water from Cannonsville and Pepacton are widely known for their Brown and Rainbow Trout populations. While brook trout have been present on these headwater streams well before construction of the dams and historically were abundant on the East and West branches, tributaries and upper main stem Delaware River[127], the trout fishery in the region regained attention in the 1980s "when improved water releases from the water supply reservoirs enhanced the fishery value of these waters."[128] Today there is great debate over how to best manage the releases from the reservoirs in order to best support the trout, and while more can be done to benefit the trout, the fishery maintains its national reputation.

It has been determined that in the Upper Delaware, wild trout fishing resulted in $17.69 million for local business revenue in 1996, that there was $7.25 million of spending by anglers in Delaware County, New York alone, and that about 41% of this spending remained in the local communities surrounding the tail water fisheries area (Hancock, Deposit, Walton, and Village of Downsville).[129] The cycling of this 41% of angler expenditures in the region ultimately results in $29.98 million in local economic activity.[130] Research has also shown that revenues generated by anglers in this region supported 348 jobs with total wages of $3.65 million; and provided $719,350 in local taxes.[131] Other research has shown that multiple towns in the New York reaches of the Delaware River Watershed are benefiting from the clean water and resulting healthy fish populations found in tributary streams.

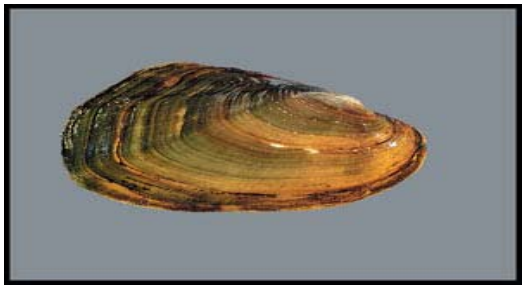
The Beaverkill and Willowemoc Rivers are credited with providing towns such as Roscoe and Livingston Manor with $10 million in annual expenditures from their sport fishery.[132] Friends of the Upper Delaware have reported that the world famous upper Delaware River is a dynamic tourism and economic engine that has not yet reached its potential.[133] They estimate that fly-fishing in the region could generate $58 million per year in economic activity, creating new jobs with virtually no infrastructure or environmental threat, for which there is already a trained work force and where control would remain local.[134]

VALLEY CREEK, PA DRN RESTORATION STAFF COME ACROSS BROOK TROUT AND OTHER WILDLIFE WHILE ASSESSING STREAMS AND CONDUCTING RESTORATION PROJECTS. ***PHOTO CREDIT: DAVE WILLIAMS***

IMPORTANT SPECIES HIGHLIGHT

Dwarf Wedge Mussel (federal endangered)

The mussel is an interesting species. Mussels are *mini filters* cleaning our rivers as the water travels overtop of the rocks and riffles where they hide. The Dwarf Wedge Mussel is special in particular, because it is now *endangered* due to *poor water quality* and *dams* throughout the eastern US. It can only live in *very clean* streams with little *sediment, chemicals*, and a good supply of *coldwater flows* to keep the temperature low even in summer months. The *largest remaining population* of Dwarf Wedge Mussels exists in the Upper Delaware watershed which is good news for *trout anglers*. Not only does mussel presence indicate clean healthy water, but their status as endangered helped remove a dam along the Neversink that threatened their population and continues to protect the waterways from future threats where both species coexist.



Delaware Estuary and Bay Fishing

Fishing in the lower reaches of the Delaware River and Bay is an important aspect of the River and its connection with the community. Children along the docks go crabbing and fish for Herring during the Herring run. Recreational fishermen catch Mackerel, Drumfish, Weakfish, Flounder, Sea Bass, and Striped Bass seasonally in the Delaware Bay.

Urban fishing throughout Philadelphia, Camden, Wilmington and Trenton is a common sight along the River because of available public access and desire from community residents. In 2006, Ron Swegman authored *Philadelphia on the Fly: Tales of an Urban Angler*, a book about the popularity of fly fishing in the Philadelphia area.[135] In it, Swegman tells stories of different rivers and tributaries where he has successfully been fly fishing. Swegman continues to write about urban fishing spots throughout Pennsylvania in his personal blog and Pennsylvania angler forums.[136]

Urban anglers use spots like naturalized piers and docks throughout Philadelphia, as well as urban parks and bridges to go fishing on both the Delaware and its major tributary there, the Schuylkill. Greenways along major roadways and new parks in urban areas like Trenton attract anglers providing them with a relatively inexpensive meal each trip. (see "FISH ADVISORIES" box)

DELAWARE BAY, DE THESE ROCKY OUTCROPS JUTTING INTO THE BAY MAKE A PERFECT FISHING PLATFORM FOR KIDS AND ADULTS WANTING TO CATCH SOME FISH FOR DINNER OR JUST HAVE SOME FUN.

Figure 4 shows the revenue generated from the sale of state fishing licenses within each of the four basin states. In Delaware, the state with the lowest price for a fishing license, revenue of nearly $200,000 was generated in 2003. In Pennsylvania, the state earned nearly $19 million in fishing license revenue from resident and non-resident purchases of fishing licenses. This is not counting all of the 1, 3, and 7 day-passes, or any of the passes simply given away to children at local parks and events. (In Pennsylvania, fishing activities are credited with generating $4.7 billion per year in revenue and supporting 43,000 jobs.[137]) New Jersey brought in almost $4 million in revenue statewide from fishing license sales, and New York, with the highest number of out of state fishing licenses sold, brought in almost $32 million in state revenue.

FISH ADVISORIES

State and National agencies put fish advisories in place in response to contamination found in the fish tissue, generally accumulated from the waters where they live. Because the various responsible agencies do not coordinate or join forces in crafting and releasing fish advisories, in several reaches of the Delaware one side of the River is under advisory for a species while the other is not. Fish advisories impact the perceptions of our River and region and as a result can affect tourism, recreation, and associated commercial activities like dining, overnight stays, and the purchase of associated goods and services. Advisories should be consistent from state to state to both better protect public health and the economies the fish advisories impact. For further rating on fish consumption and the best and worst choices of fish considering environmental factors go to

http://www.edf.org/home.cfm

PHILADELPHIA, PA URBAN FISHERMAN OUTSIDE OF VACANT PHILADELPHIA ELECTRIC COMPANY ON DELAWARE AVE AT PENN TREATY PARK. FISHERMAN CAN ALMOST ALWAYS BE FOUND AT THIS SPOT.

STATE	# Fishing Licenses Sold in 2003	Resident Cost	Non-Resident Cost	Total Revenue (Million)
Delaware 138	R: 17,233 NR: 3,331	$8.50	$15.00	$196,445
Pennsylvania139	R: 777,089 NR: 49,957 O: 67,992	$21.00	$51.00	$18,866,676 (w/o O sales)
New Jersey 140	R: 155,764 NR: 6,763 O: 4,181	$22.50	$34.50	$ 3,738,013 (w/o O sales)
New York 141	R: 842,966 NR: 156,726	$19.00	$40.00	$ 31,882,588

R: Resident NR: Non-Resident O: Other, including lifetime, 3-day, 7-day, and free fishing licenses.

Figure 4: Number of Fishing Licenses Sold in 2003 in Delaware River Basin States

Clean Water for our Food Supply

Fishing the Delaware River is valuable commercially, recreationally and for those families that simply need it to eat. Clean water is critical for supporting the life cycle of fish. But also, it is critical for ensuring that the fish caught from our Rivers are safely edible. Pollutants accumulate in the fat and/or tissue of fish, in some cases building up and increasing in concentration over time. Persistent pollution problems can and do contaminate fish, in some cases making them unsafe to eat.

On the main stem Delaware River there are advisories on more than 9 species of fish.[142] In some sections of the River all fish are subject to advisories.[143] Fish advisories set limits on the amount of contaminated fish species that should be eaten in order to protect individual and community health. Often elderly persons, children and pregnant women are subject to more stringent limits because of their increased vulnerability to contamination. Exposure to the toxins contained in fish tissue, including methyl mercury, PCB's, chlorinated pesticides and dioxins are colorless, odorless, and can not be revealed through appearance of the fish – therefore knowledge and compliance with fish advisories is critical.[144] Before consuming fish from the Delaware River and Bay, it is important to be aware of the current fish consumption advisories for each state. Many fish in the River are unsafe for pregnant women and the elderly because of contaminants that are still making their way into our streams and rivers. Contact your state's environmental protection agency for the most current advisories and warnings.

"United for The River"

The Delaware River Fisherman's Association is an active, fish-loving membership organization for both NJ and PA fisherman. For their many activities and great reports go to: www.drfishermen.com/

Or

To learn about some popular fishing spots in the Delaware River Watershed go to www.delawareriver.net/fishing.

If we were able to eliminate pollution to the level that there were no advisories on the Delaware, not only would we be protecting the health of our communities, but we would be enhancing the fisheries of the Delaware and all who rely on them. It is important to note, the issue isn't just reality, it is also perception. Multiple fish advisories create the perception that the Delaware is not clean or safe – the result could be to impact the desirability of the Delaware as a tourism, recreation or home buying destination, and can affect associated commercial activities like dining, overnight stays, and the purchase of associated goods and services.

❖ Birding and Wildlife Watching

The Delaware River and Bay are home to populations of birds, mammals, reptiles, amphibians, fish, insects, and shellfish surviving and thriving in the functioning ecosystems of the region. The plants and animals within the River and its corridor are a major draw bringing tourists from near and far to vacation and experience the beauty of our River and its natural communities. Many Delaware River plants and animals are nationally significant for health, historical, and economic reasons. All of the species within the River deserve to be respected, protected and preserved if they are to continue to exist for future generations.

Because of the River's free flows, its captivating beauty, its vast natural resources, historical significance, high water quality, premier recreation, and natural open space, in 1978 a majority of the non-tidal Delaware River (73 miles extending from Hancock, New York to Milford, Pennsylvania and 40 miles from just south of Port Jervis, New York to the Delaware Water Gap) was Congressionally designated a National Wild and Scenic River of the United States.[145] In 2000, the Lower Delaware from the Water Gap to Washington Crossing, a stretch of 76 miles, was also granted Wild and Scenic designation due to its extraordinary beauty and health. The abundant wildlife and bird watching opportunities within this nationally significant corridor generate a tremendous volume of ecotourism and related business. Many of the species inhabiting the Lower and Upper Delaware are designated as threatened or endangered, demonstrating the fragility and vulnerability of the ecosystems and ecological communities dependent upon the area. **Figure 5** lists some of the diverse species found here. This table is just a sampling of the interesting and valuable species that can be found in the Delaware River Watershed. (Figure is at the end of this section)

In 2006, over 71 million Americans participated in wildlife watching including photography and observation, spending nearly $45 billion dollars on travel, equipment, food, and lodging.[146] Twenty-three million of the 71 million traveled away from home (more than a mile) to engage in wildlife watching activities.[147] In New Jersey, it has been determined that watchable wildlife attracted 1.9 million participants in a single year.[148]

KEMPTON, PA BIRD WATCHING FROM WITHIN THE HAWK MOUNTAIN SANCTURAY. BIRD WATCHING IS ONE OF THE FASTEST GROWING FORMS OF RECREATION. *PHOTO CREDIT: HAWK MOUNTAIN SANCTUARY*

Wildlife viewing creates nearly 500 thousand jobs nationally, and generates $2.7 billion in federal and state taxes.[149] In Pennsylvania, New York and New Jersey, 31% of the population participates in some form of wildlife viewing.[150] These activities generated an estimated $1 million in retail supply sales, $623 million in trip related sales, $217 million in federal and state taxes, and supported 35,000 jobs.[151]

The total economic contribution of wildlife viewing in the tri-state area exceeded $3 million in the year 2002.[152] The Outdoor Recreation Alliance estimates that New Jersey alone generated nearly $4 billion from wildlife-related recreation in 2006, and reports that New Jersey ranks number six in the amount of economic activity created by in-state wildlife viewing activities.[153]

ONE OF MANY RAPTORS THAT CAN BE SEEN FROM HAWK MOUNTAIN AND OTHER LOCATIONS IN THE DELAWARE VALLEY. RAPTOR POPULATION DECLINES ARE OFTEN DUE TO HABITAT FRAGMENTATION, OR BUILDING HOMES, ROADS, AND RETAIL SPACES ON FORMERLY FORESTED LAND. *PHOTO CREDIT: GEORGE WILLIAMS*

Celebrating Birds is a Lucrative Business

Bird watching has become one of the most lucrative forms of recreation in the watershed because of the avian diversity and wealth of attractive viewing areas. Bald Eagles, Ospreys, Red-Tailed Hawks, and migrating shorebirds such as Sanderlings and the Red Knot *rufa* can all be viewed within the watershed. In addition to being among the most lucrative activities for our region, birding is also among the fastest growing. The Center for Rural Pennsylvania issued a report on nature-based tourism in 2003 which listed bird watching up 155% in Pennsylvania; a greater percentage increase than every other form of recreation measured.[154]

Hawk Mountain in Kempton, Pennsylvania is a wildlife sanctuary for raptors in the Delaware River Watershed (Lehigh River) eastern Pennsylvania. The preserve is the largest protected tract of contiguous forest in Pennsylvania with 13,000 acres of private and public lands.[155] Mountaintop vistas, hiking trails, and over 25,000 Hawks, Eagles, and Falcons bring visitors year round.[156] The Hawk Mountain sanctuary brought in over $850,000 in 2005 from visitor fees, memberships, and retail.[157]

HAWK MOUNTAIN SANCTUARY KEMPTON, PA NOW HAS **13,000** ACRES OF CONTIGOUS FOREST PROTECTED FOR RAPTORS AND OTHER WILDLIFE. *PHOTO CREDIT: HAWK MOUNTAIN SANCTUARY*

Case Study: Nature Photographer Mike Hogan

Michael Hogan, Professional Nature Photographer, has spent decades taking pictures of the Delaware Bay and Pinelands region. His pictures help in tracking invasive species; producing photographic natural resource inventories for counties and municipalities; and using Geographic Integrated Systems (GIS) technology to document where endangered species exist such as Swamp Pink, a gorgeous flowering wetland plant that remains in only a few remote locations throughout New Jersey. Working with the South Jersey Land and Water Trust and the Rutgers Water Resources Program, and using the USDA Stream Visual Assessment Protocol, Michael has visually assessed 300 stream segments in southern New Jersey for stream health and quality.

Nature photography in the region has led Hogan to become an advocate and active environmentalist for preserving open space in New Jersey. “The habitats and ecosystems within New Jersey are keeping my career afloat. If I wasn’t helping to preserve land and wildlife in New Jersey through education, book illustrations, visual stream assessments, and art, I don’t know what I’d be doing right now,” said Hogan.

Michael's large format, landscape photographs are in public, private, and corporate art collections. In addition, Michael has donated his work to various local nonprofit organizations including the Delaware Riverkeeper Network to help them in their fundraising. In 2005, Michael Hogan partnered with author Robert Peterson to create an illustrated book called “The Natural Wonders of Jersey Pine and Shore.” “This book combines years of photographs and prose into one source so that people from all over can see what I see when I’m hiking in the Pinelands or relaxing on the Bay shore” says Hogan. The book was the last from author Robert Peterson who passed away in 2003 just after viewing the final text of the book.

When asked how important southern New Jersey is to him Michael Hogan replied “It’s where I live, it’s what I care about, and it’s my livelihood”.

There are many careers supported by the nature and wildlife of the Delaware River Valley. Michael's work can be viewed on his website www.hoganphoto.com.

The Bald Eagle, an emblem of American freedom, spirit, and pursuit of excellence, currently lives and thrives along the protected Upper Delaware River. Explicit Bald and Golden Eagle protection laws, conservation of Eagle habitat, and the banning of DDT and other poisons have been successful in protecting Upper Delaware Eagles.[158] In the United States, Bald Eagle populations have increased from less than 500 nesting pairs in the 1960’s to more than 5,000 currently.[159]

To celebrate the remarkable comeback of the Bald Eagle, Eagle Fest is an annual winter festival held in Narrowsburg, New York along the scenic Upper Delaware River. The festival draws between 1,500 and 2,500 people from around the region, including residents from New York, Pennsylvania and New Jersey. The local fire Department uses the festival as a successful fundraiser, selling hot dogs and hamburgers; local churches and the Chamber of Commerce help run the event and set up tables for fundraising.

For many local businesses, Eagle Fest brings tourists and visitors to the region in the middle of winter when tourism is relatively low. Festival attendees learn about Bald Eagles and their recovery while they try and catch a glimpse of one flying over the often frozen Delaware River. To broaden appeal, Eagle Fest holds multiple events including lectures, art shows, a live raptor show, Eagle educational exhibits, food, and environmental films. Conservation groups are also invited to participate and share information about their organizational mission and efforts. Ice carvers, wood carvers and other artists are able to exhibit their handy work. Local shops featuring gifts, clothing, antiques, art stores, and even furniture stores not only see greater sales during the event, but see return visitors throughout the year who first came during Eagle Fest. For many local businesses, Eagle Fest brings the best or second best sales day of the year.[160]

In New Jersey, the Cape May Bird Observatory holds a Spring Weekend every year offering guided walks, boat rides, nature tours, book signings, movies, speakers, and birding. At the end of the three-day weekend they hold a World Series of birding to discover how many birds each person has counted over the weekend. More than 200 birds have been spotted flying throughout the nature center's premises.[161] Bird watchers wishing to enter as a single person or team obtain sponsorships where they receive money for every bird they view and proceeds go to the conservation fund of their choice. The event raises more than $500,000 annually to support bird conservation efforts and attracts bird enthusiasts from all over the world.[162]

THE AMERICAN EAGLE THE UNITED STATES EMBLEM WAS NEARLY EXTINCT AFTER THE DECADES OF HEAVY PESTICIDE USE AND DECREASING WATER QUALITY IN WATERWAYS LIKE THE DELAWARE RIVER. ITS REMARKABLE RECOVERY IS AN IMPORTANT SUCCESS; ONE THAT SHOULD BE REPLICATED FOR THE MANY OTHER BIRD SPECIES CURRENTLY IN PERIL THROUGHOUT THE US. *PHOTO CREDIT: DOUGLAS NORTON 2007*

BOWERS BEACH, DE DELWARE BAY IS HOME TO THE WORLDS LARGEST SPAWNING POPULATION OF HORSESHOE CRABS IN THE WORLD. THE HORSESHOE CRAB IS AN ANCIENT SPECIES DATING BACK OVER 350 MILLION YEARS.

Protecting Birds, Food and Habitats

Delaware Bay is home to the largest spawning population of Horseshoe Crabs in the world. The Horseshoe Crab is an ancient species, dating back over 350 million years. Delaware Bay is also critical habitat to more than 400 species of birds and migrating shore birds.[163] Each spring, at least 11 species of birds stop over on the Delaware Bay shore to feed on the eggs of the Horseshoe Crab and thereby fuel their annual spring migration, including the Sanderling, Sandpiper, Red Knot, and Ruddy Turnstone.[164]

It is estimated that between 425,000 and 1,000,000 birds stop in the Delaware Bay as part of their 3,000 to 4,000 mile migratory journey from their wintering grounds in

RED KNOT PHOTO TAKEN DURING THE 2008 RED KNOT MIGRATION. RED KNOTS WERE BEING BANDED SO THAT SCIENTISTS COULD TRACK THEIR QUALITY OF HEALTH AND WEIGHT TO BETTER UNDERSTAND THEIR SURVIVAL.

South America to their breeding grounds in the Arctic.[165] The bird stop over is ecologically timed to coincide with the spawning of the Horseshoe Crabs, their eggs being a critical food source.[166] The eggs of the Horseshoe Crab are so critical that recent declines in their abundance threaten the survival of the Red Knot (Calidris canutus).

In 1982, 95,530 Red Knot were counted on the shores of the Delaware Bay. In 2006 only 13,445 were observed during the same time period[167] and a more recent study continues to show declines and low weight gain for the birds that do arrive to feed on Horseshoe Crab eggs. The Red Knot is now predicted to go extinct because declines in the Horseshoe Crab and

MOORE'S BEACH NJ INTERESTED VOLUNTEERS AND AREA VISITORS WATCH THE ARRIVAL OF THE BIRDS WITH BINOCULARS.

their eggs.[168]
Other shorebirds that rely on Horseshoe Crab eggs, such as Ruddy Turnstone (*Arenaria interpres*), Semipalmated Sandpiper (*Calidris pusilla*), Sanderling (*Calidris alba*), Dunlin (*Calidris alpina*) and Short-Billed Dowitcher (*Limnodromus griseus*), have also declined in numbers on the Delaware Bay migratory stop over. These species and Red Knot make up 99 percent of the shorebird concentration in the Delaware Bay and all are primarily dependent upon Horseshoe Crab eggs for their diet.[169]

The arrival, feasting and migration of the shorebirds supports a multi-million dollar ecotourism industry. Birding and outdoor enthusiasts from all over the world flock to the Delaware Bay shore to watch the spectacular feeding frenzy. During their visit they buy recreational-related goods and services, stay in the region's hotels, and visit parks and patronize restaurants and local shops.[170] According to one report, Horseshoe Crab dependent ecotourism generates between approximately $7 million and $10 million of spending in Cape May, New Jersey alone, and creates 120 to 180 related jobs providing an additional $3 million to $4 million in social welfare value.[171] According to a New Jersey Department of Fish and Wildlife report, the economic value of the Horseshoe Crab and migratory bird phenomenon seasonally for the Delaware Bay shore area is over $11.8 million with over $15 million of economic value generated if other beneficiaries beyond New Jersey are included. Annually, it provides $25 million in benefits to the Delaware Bay shore region and $34 million regionally.[172] Because most of these expenditures occur in the "off-season", it is particularly valuable to local economies.

The fishery use of Horseshoe Crabs as bait for whelk, eel and conch, is highly controversial. Decades of overharvesting and abuse have resulted in a decline in the Horseshoe Crab population to such a level that the Red Knot is predicted to go extinct because of a lack of Horseshoe Crab eggs needed to fuel their annual migration.[173] Since 1989 Horseshoe Crabs in the Delaware Bay have shown a steady decline with the lowest counts taking place in most recent years.[174] To combat this ecological crisis, many are calling for a moratorium on the bait harvest of Horseshoe Crabs in order to allow the Crabs, the eggs and the birds to replenish and restore so that all dependent industries can be supported in the future. New Jersey issued regulations that established a moratorium for 2006 and 2007; and in 2008 passed legislation to keep the moratorium in place until the Red Knot population is restored and stable.

The continuing existence of the Horseshoe Crab and migrating shorebird phenomenon are vital for the related ecotourism industry. Of those surveyed, only 6.6% said that the Horseshoe Crab and shorebird phenomenon was unimportant to their visitor satisfaction. On average those surveyed said they would be willing to pay as much as $212.45 (in decreased annual household income) annually for a program to protect these resources; and that they would "be willing to tolerate no more than 50.7% decline in Horseshoe Crabs and migrant shorebirds

INDICATOR SPECIES

Protecting bird species throughout the basin is important for several reasons. Not only is bird watching one of the most popular and lucrative forms of recreation, bringing in tourists from all over the world, but birds are an *indicator species*. Indicator species represent the overall health status of an area through their population numbers and habitats. Healthy rivers are habitat for healthy bird populations. If bird populations begin declining, it can mean that the over all quality of life for an area may be declining as well. Abundance in bird species is a good sign that land condition and air quality are high enough to support ample birds and bird watchers alike.

before they would cease visiting the Delaware Bay shore area."[175]

Wildlife for Health Protection

Protecting healthy wildlife and aquatic life populations that live in the River provides critical health protections to humans, protections that have economic and social value. A good example is the Horseshoe Crab. The Horseshoe Crabs in Delaware Bay are irreplaceably important to the biomedical industry. In the late 1960's, researchers at Johns Hopkins University demonstrated that special blood properties from Horseshoe Crabs could be used to detect endotoxins.[176] As a result, the U.S. Food and Drug Administration now requires that many intravenous drugs and medical implants be tested for endotoxins using Limulus Amebocyte Lysate (LAL), found exclusively in the blood of Horseshoe Crabs.[177] In addition, LAL is used for detecting diseases including spinal meningitis.[178] No artificial alternatives to the LAL test currently exist.[179] To obtain the blood the Horseshoe Crabs are bled non-lethally,[180] although it has been estimated that between 10 and 15% may die once the Crabs have been returned to their natural environment.[181]

The U.S. Fish and Wildlife Service valued annual revenues associated with the LAL industry at $60 million with the social welfare value at $150 million. One pint of Horseshoe Crab blood is worth $15,000 to the bio-medical industry,[182] and the industry creates between 145 and 195 jobs in each of the regions it operates (Falmouth, Massachusetts, Walkersville, Maryland and Charleston, South Carolina), contributing $73 million to $96 million total to these local economies. [183] Furthermore, the industry is expected to grow between 8-10% annually.[184] The ecotourism and biomedical benefits of Horseshoe Crabs dwarfs their value as bait in the fishing industry in dollars and number of jobs.

BOWERS BEACH, DE. FEMALE HORSESHOE CRAB MAKING ITS WAY BACK TO THE SHORE FROM THE OCEAN. FEMALE HORSESHOE CRABS ARE LARGER THAN MALES BECAUSE THEIR BODIES HAVE GROWN OVER TIME ALLOWING THEM TO CAPTURE MORE SPERM DURING MATING SEASON. HORSESHOE CRAB EGGS ARE THE PRIMARY FOOD SOURCE FOR MANY MIGRATING SHOREBIRDS IN THE DELAWARE BAY.

SPECIAL SPECIES HIGHLIGHT

American Eel meets the Elliptio companata mussel

The American eel deserves recognition for the journey it makes and the impact it has on the Upper Delaware River. Born in the Sargasso Sea (northern Caribbean-Bermuda region), the American eel travels across the Atlantic Ocean, into the Delaware Bay, and up the undammed Delaware River, which retains one of the largest eel populations in the nation.

Not only does the eel perform this epic journey, but it also supports one of the largest mussel populations in the Upper Delaware, the *Elliptio companata,* mussel which relies on the eel for particular components of reproduction. The *Elliptio* can be found in the millions in the Upper Delaware because of the presence of the American eel.

These mussels have an enormous filtration capacity and are able to filter six times the Delaware's average daily summer flow. With almost 2 million mussels per mile, the clean water benefits we receive from this species interaction are invaluable.

SWAMP PINK IS AN ENDANGERED AND SIGNIFICANT SPECIES IN THE DELAWARE VALLEY. IT CAN BE FOUND IN THE SWAMPS AND MARSHES OF THE PINELANDS REGION OF NEW JERSEY. *PHOTO CREDIT: MIKE HOGAN* WWW.HOGANPHOTO.COM

JUVENILE AMERICAN EEL MAKE THE JOURNEY TO THE UPPER DELAWARE RIVER FROM THE SARGASSO SEA AND BECOME THE HOST SPECIES ENABLING THE *ELLIPTIO* MUSSEL TO SURVIVE. MUSSELS IN THE UPPER DELAWARE FILTER 6 TIMES THE AVERAGE FLOW PER DAY. *PHOTO CREDIT: DOUG AND TIM WATTS* WWW.GLOOSKAPANDTHEFROG.COM

Amphibians and Reptiles	Bog turtle (E) Coastal plain leopard frog (E) Eastern mud turtles Loggerhead sea turtle (E) Long-tailed salamander (T) Map turtle Marbled salamander New Jersey chorus frogs (E) Northern diamondback terrapin Red-bellied turtle (T) Timber rattlesnake (E) Wood turtle	**Invertebrates and Insects**	American Oyster Blue Crab Brook Floater (E) Dwarf Wedgemussel (E) Eastern Pearlshell Eastern Pondmussel (E) Horseshoe Crab Mottled Duskywing Northeastern beach tiger beetle (T) Regal fritillary Tawny crescent
Birds	American Bittern (T) Bald Eagle Barred Owl (T) Bobolink (T) Cerulean warbler Cliff Swallow (T) Common Snipe (T) Common nighthawk Coopers Hawk (E) Grasshopper Sparrow (T) Great Blue Heron (T) Least Bittern (T) Louisiana Waterthrush Northern Harrier (T) Northern Goshawk (E) Osprey (E) Peregrine Falcon (E) Red Headed Woodpecker (T) Red Shouldered Hawk (T) Savannah Sparrow (T) Short Eared Owls Upland Sandpiper (T) Yellow-belied Flycatcher (T) Prairie Warbler Ruffed Grouse Marsh Wren	**Plants**	American Purple Vetch Atlantic Sedge (T) Basil Bee-Balm Basil Mountain Mint Bog bluegrass (T) Bush's sedge Eared false-foxglove (E) Grass of parnassus Great St. John's-wart Hemlock Lobelia Lowland brittle fern Missouri goosefoot Nebraska sedge Northern pondweed (E) Pale Indian plantain Prickly pear cactus Rhododendron Serpentine aster (T) Shadblow serviceberry Spreading globeflower (E) Skunk currant (E) Spring coral root Swamp pink (E) Variable sedge (E) Wood aster
Fish	American Shad (T) Alewife American Eel Atlantic Sturgeon (T) Banded Sunfish (E) Bridle Shiner (E) Hickory Shad (E) Ironcolor Shiner (E) Largemouth Bass Muskellunge River Herring Slimy Sculpin Sheild darter Shortnose Sturgeon (E) Smallmouth Bass Striped Bass Tadpole Madtom (E) Threespine Stickleback (E) Trout Walleye Pike White Perch	**Mammals**	Beaver Blackbear Blue whale Bobcat Canada lynx (E) Delmarva fox squirrel (E) Eastern red bat Eastern woodrat (E) Fin whale Harbor porpoise Hoary bat Humpback whale Indiana bat (E) Keen's bat (E) Least shrew (E) Marsh rat Northern long-eared bat (E) Northern right whale River otter Small-footed bat (E) Sperm whale

(T) Federal or State (PA, DE, NJ, NY) Threatened Species (E) Federal or State Endangered Species

Figure 5: Delaware River Significant Species List[186]

❖ Parks and Wildlife Refuges

The Delaware River spans four states. In order to maintain animal habitat, recreational access, and special or significant pieces of land, federal, state and local governments operate and maintain a spectacular array of parks, forests, and wildlife refuges. The national, state, county and local park systems are key elements in the ecotourism businesses and attractions that grace the Delaware River Watershed. The parks provide a public place to view wildlife, canoe, fish, hike, and much more -- they enhance the quality of life for the community, providing job opportunities, and recreational and family activities.

National Parks

Dozens of parks line the banks of the Delaware, with the region's largest federal parks known all over the world. **Figure 6** lists the parks within the Delaware River watershed designated as nationally significant. This includes the nationally recognized Appalachian Trail which stretches from Georgia to Maine, and crosses the Delaware River at the Delaware Water Gap National Recreational Area (DWGNRA.)This crossing of the Delaware River is a "favorite" among the hundreds of people each year who hike the trail from start to finish.[185] The watershed is also home to four national historic sites and two national historic parks and memorials.[186] The United States Department of Agriculture's (USDA) Forest Service has determined that water enhances the value of National Forest Lands nationwide by more than $3.7 billion a year, not including a number of key economic benefits including maintaining the value of fish species or the savings to municipalities with reduced filtration costs as a result of the protected lands.[187]

The Delaware Water Gap National Recreation Area is 67,000 acres and was first acquired by the U.S. Army Corps of Engineers in the 1950's to support construction of the Tocks Island Dam.[188] The dam proposal was defeated after decades of protest and analysis.[189] The land was then transformed into a national recreation area which contains waterfalls, ponds, mountains, river bends, and animals such as Bald Eagles, Black Bears, Timber Rattlesnakes, and Peregrine Falcons.[190] There are a variety of plant species present including Hemlock, Rhododendron, Andropogon gerardii (big bluestem grass) and Prickly Pear Cactus. Water quality in the Delaware River as it flows through the DWGNRA is exceptional, encouraging swimming, fishing, boating, hunting, and hiking.[191]

THE WILD AND SCENIC DELAWARE RIVER. THE DELAWARE RIVER HAS BEEN AWARDED SPECIAL PROTECTION WATERS STATUS BY THE DELAWARE RIVER BASIN COMMISSION. THE HIGHEST LEVEL OF PROTECTION FOR BEING A CLEAN AND VALUABLE RIVER FROM ITS HEADWATERS THROUGH THE WATER GAP AND BELOW FOR 176 MILES. NO OTHER RIVER IN THE U.S. HAS THIS DESIGNATION FOR A LONGER STRETCH. PHOTO CREDIT: PAUL CARLUCCIO

National Park	Park Type	Location
Delaware Water Gap National Recreation Area	National Recreation Area	Bushkill, PA and New Jersey
Independence National Historic Park	National Historic Park	Philadelphia, PA
Valley Forge National Historic Park	National Historic Park	Valley Forge, PA
Upper Delaware Scenic and Recreational River	Scenic and Recreational River	Pike and Wayne,PA Delaware, Orange, and Sullivan, NY
Thaddeus Kosciuszko National Memorial	National Memorial	Philadelphia, PA
Appalachian National Scenic Trail	National Scenic Trail	GA, CT, MA, MD, ME, NC, NH, NJ, NY, PA, TN, VA, VT, WV
Hopewell Furnace National Historic Site	National Historic Site	Elverson, PA
Gloria Dei Church National Historic Site	National Historic Site	Philadelphia, PA
Deshler-Morris House	National Historic Site	Philadelphia, PA
Edgar Allen Poe National Historic Site	National Historic Site	Philadelphia, PA

Figure 6: Nationally Significant Parks in the Delaware River Watershed[192]

The Delaware Water Gap National Recreation Area is one of the most heavily used parks on the East Coast visited by more than 3 million annually.[193] Shared by Pennsylvania and New Jersey, DWGNRA has been home to native people for centuries prior to European settlement. Since about 1988 more than 113,000 historical and aboriginal artifacts have been uncovered.[194] Archaeological sites currently located within DWGNRA help today's archaeologists learn more about the culture and history of the Minisink and other native people as well as the natural history of the region.

CANOEING AT THE DELAWARE WATER GAP. THE WATER IS CLEAN, THE AIR IS FRESH, AND CLIFFS APPEAR THROUGHOUT THE LANDSCAPE. WILDLIFE IS ABUNDANT THROUGHOUT THIS STRETCH MAKING IT THE PERFECT OUTDOOR EXPERIENCE FOR PEOPLE FROM NEW YORK, PHILADELPHIA, AND BEYOND.

In 2007, in recognition of the beauty of the DWGNRA and its 40.6 mile water trail, the Delaware Water Gap National Recreation Area was designated a National Recreation Trail by the Secretary of the Interior.[195] The trail is valued for connecting people with the beauty and values of nature, introducing them to geological formations and a diverse set of wildlife habitats. It is the largest recreation area in the eastern U.S. bringing in revenue to local communities and economies in both Pennsylvania and New Jersey.[196]

National Wildlife Refuges are a special class of parkland set aside specifically to protect animal and plant habitats. Several wildlife refuges exist throughout the watershed. Just south of Philadelphia, the John Heinz National Wildlife Refuge at Tinicum has been set aside to protect the last 200 acres of freshwater tidal marsh in Pennsylvania. It is currently home to over 280 species of birds and is the only place where the "state endangered Red-Bellied Turtle and Southern Leopard Frog can be found".[197] A great amount of effort has been invested in preserving and restoring this natural area which is located in a densely populated region of the watershed.[198] The wildlife preserve allows urban communities to access native plants, wetlands, and aquatic habitats. It also connects urban residents with their natural community. The marshes of the John Heinz Wildlife Refuge capture rainfall and stormwater while filtering out pollution, absorbing flood waters, helping to defend against drought, and providing water quality benefits to the River.[199]

The Cape May National Wildlife Refuge, Delaware Bay Division, protects a large variety of habitat including "salt marsh, forested uplands, forested wetland and vernal pools, shrub/scrub, and grassland"[200] Supawna Meadows National Wildlife Refuge in Pennsville, NJ is part of the Cape May Refuge. It includes 3,000 acres of protected wetlands, mainly for shorebirds, warblers and other migrating birds which use the upland area as valuable resting and feeding habitat.[201]

Bombay Hook is a National Wildlife Refuge in Delaware encompassing 15,000 acres in the Delaware estuary.[202] This refuge connects parts of the Atlantic Flyway, an avian migratory route of global ecological importance. It provides an important resting point and breeding ground for a variety of species including migrating waterfowl, Bald Eagles, Canada Geese, and several species of duck.[203] Bombay Hook is an important home to White-Tailed deer, Woodchucks, Horseshoe Crabs, Bullfrogs, and Tulip Trees.[204] Prime Hook National Wildlife Refuge, located near the western shore of the Delaware Bay, is a 10,0000 acre sanctuary for migrating birds. Outstanding wetlands provide rare habitat for many species of birds and other wildlife, including threatened and endangered species.[205]

The Delaware Estuary's Pea Patch Island is a refuge ideal for wading bird populations and waterfowl, including 2,300 nesting pairs of Heron.[206] The Delaware Bay as a whole is the second largest stopover for migratory birds in the western hemisphere, visited each year by over one million birds.[207]

WORTHINGTON STATE FOREST, NJ WATERFALL ON A TRIBUTARY TO THE MIDDLE DELAWARE WILD AND SCENIC RIVER. PHOTO CREDIT: PAUL CARLUCCIO

State and County Parks

State and county managed parks are also prominent in the watershed. State parks and campgrounds are used regularly by tourists and local residents and are home to a variety of wildlife, trees and plants. "A walk along the 60-mile towpath of the Delaware Canal is a stroll into American History. The Delaware Canal is the only remaining continuously intact canal of the great towpath canal building era of the early and mid-19th century."[208] Before railroads, the canal was a means of transporting people and goods from Pennsylvania to New York and back.[209] Today, 60 miles of the canal has been restored and converted into a nature trail for joggers, bikers, birders and historians.[210] The Delaware Canal State Park, stretching from Easton to Bristol, PA, has protected the riverfront for everyone to enjoy. The Pennsylvania Canal State Park attracts on average nearly 835,000 visitors annually.[211]

On the New Jersey side, the Delaware and Raritan Canal State Park begins at Bulls Island Recreation Area and travels through Washington Crossing State Park linking Frenchtown with New Brunswick.[212] "The 70-mile Delaware and Raritan Canal State Park is one of central New Jersey's most popular recreational corridors for canoeing, camping, jogging, hiking, bicycling, fishing and horseback riding. The canal and the park are part of the National Recreation Trail System. This linear park is also a valuable wildlife corridor connecting fields and forests. A recent bird survey conducted in the park revealed 160 species of birds, almost 90 of which nested in the park."[213]

INTRINSIC VALUE

Intrinsic value is the value of something for more than its measurable qualities. Instead of valuing fish for their ability to be caught or eaten, intrinsic value is the value of the fish simply for existing and not for its services to humans. Intrinsic values and existence values are important to keep in mind when thinking about the importance of biodiversity throughout the watershed. Biodiversity not only has a dollar sign attached to the term, but is important to maintain intrinsically, simply because nature has a right to exist.

FISHTOWN, PA PENN TREATY PARK IS A HAVEN IN CENTRAL PHILADELPHIA. A NATURAL RIVER'S EDGE, VIEWS OF THE BEN FRANKLIN BRIDGE AND PETTY'S ISLAND, EASY ACCESSIBILITY FOR PEDESTRIANS AND MASS TRANSIT, MEANS THAT THE PARK IS ALWAYS BUSY.

New Jersey State Parks and Forests attract 15 million visitors each year. It is estimated that New Jersey's Parks and Forests generate $807 million a year with park fees accounting for $6 million. Stokes State Forest is located within the New Jersey Sky lands and includes over 15,000 acres of mountains, streams, trails and wildflowers; and is home to a variety of fish, birds, and wildlife.[214] New Jersey Worthington State Park is situated along the Delaware River at the Delaware Water Gap National Recreational Area and has widespread appeal with camping, canoe and boat launches, waterfalls, and forested river refuges.[215]

In Philadelphia, it is estimated that annually, parks provide the city with revenue of $23.3 million for the residents and government of Philadelphia.[216] This methodology for valuing the city parks includes the value of property value, tourism, direct use, health, community cohesion, clean water, and clean air. [217]

Some of the most visited parks in Philadelphia include Fairmount Park, home of Philadelphia's first water treatment reserve.[218] Philadelphia's yellow fever epidemic of the 1790's left City Hall with a need to protect its water supply by purchasing land and setting aside public areas that would protect the Schuylkill River and surrounding land from development.[219] The park is now 92,000 acres providing drinking water protection, as well as an enhanced opportunity for events, public recreation, and environmental education.[220] Historical records indicate that Penn Treaty Park along the Delaware River in Philadelphia is the site where William Penn may have signed a peace treaty with the Lenape Indians, but where we know they met in a peaceful and respectful way in the 17th century.[221] The Park remains today reminding us of the peaceful relationship between the two peoples at that time.

Numerous small city parks throughout Philadelphia provide naturally green areas that benefit the urban community in a variety of ways. Some have become city gardens, teaching kids how to plant, nurture and cultivate the earth. Others are just a nice place to rest, play with your pets, or enjoy time with the family. These small urban parks are vital for communities to retain a connection with nature that enhances quality of life amidst the city land.

Native plants, like wildlife, are themselves an attraction to our parks and region generating interest and visitors. The Prickly Pear cactus is a notable Delaware River species. It is most often found in desert ecosystems like the Mojave; however it can also be found on some of the south facing cliffs in the Delaware River region, while the northern face of the same cliff can be covered in flora and fauna typically found in arctic-alpine climates. The differences in landscape between the northern and southern sections of the same cliff are an attraction bringing visitors to local parks on foot and by boat.

PRICKLY PEAR CACTUS IN BLOOM IN NEW JERSEY. THE CACTUS CAN BE FOUND THROUGHOUT THE DELAWARE RIVER WATERSHED FROM THE PINES BARRENS TO THE JOHN HEINZ WILDLIFE NATIONAL REFUGE TO CLIFFS ALONG THE UPPER REACHES OF THE RIVER.

DEPUE ISLAND IN THE DELAWARE WATER GAP, RIVER MILE 215. OVER 100 ISLANDS EXIST IN THE DELAWARE, SOME DEVELOPED AS GOLF COURSES, ONE AS A BOY SCOUT CAMP, BUT MOST ARE UNDEVELOPED FORESTS AND HABITAT PERFECT FOR A LUNCH BREAK STOP DURING A PADDLE.

"GIMME SOME SPACE"

The value of open space from a wildlife, recreation and quality of life perspective has fueled local efforts to purchase and protect natural lands from development. From 1961 to 1995, the New Jersey Green Acres program set aside $1.4 billion for land acquisition and park development for open space and wildlife. Since 1998, funding was guaranteed for the program, set aside by the Garden State Preservation Trust Act. The Trust was depleted in 2009, but a new Bond or other stable source of funding is being developed in the state. NJ officials have also recognized the importance of protecting riparian lands for ecosystem services including water quality and flood protection. The state has approved a Blue Acres program which would invest funds in protecting open space along the Delaware and other river systems.

In Bucks County Pennsylvania, voters overwhelmingly approved spending $59 million towards preserving open space throughout the county in 1997. Since then, more than 15,000 acres have been protected establishing new parks, preserving agricultural land, providing natural habitat for wildlife, improving historical buildings and grounds, and rejuvenating the Delaware River waterfront.

Other public land preservation programs are active in all the River's Watershad States. In addition, private non-profit conservation organizations dedicate millions towards preserving land from development.

For more information on the benefit of open space go to:

The Benefit of State Investments in Preservation Programs, April 15, 2009.
http://njkeepitgreen.org/resources.htm

Community Benefits of Open Space, The Trust for Public Land http://www.njkeepitgreen.org/

Economic Benefits of Conserved Rivers: An Annotated Bibliography, National Park Service June, 2001

CAPE HENLOPEN STATE PARK DELAWARE BAY AT SUNSET. VISITORS CAN CAMP ON THE BEACH AND WATCH WATERFOWL WHILE THE SUN SETS.

The State of Delaware is home to 18 parks including historical parks, nature preserves, state forests, and scenic vistas.[222] Delaware is known for its unmatched wading bird populations. Marshes, wetlands, and the Delaware River estuary provide habitat to rare bird species specific to the Delaware region.[223] Delaware visitors can experience beaches, rivers, nature trails, greenways, and farms. State parks in Delaware include activities such as whale and dolphin watching.[224] Cape Henlopen State Park, which borders the Delaware Bay, allows visitors to camp on its beaches and visit the nature center which provides activities year round.[225] Each year Delaware's Cape Henlopen attracts over 1 million visitors.[226]

The Catskill Mountains in New York are the headwaters of the Delaware River. Catskill State Park is a vast 300,000 acres spanning Sullivan, Ulster, Delaware, and Greene Counties in New York.[227] Its size has grown considerably since its founding in 1894 at 30,000 acres.[228] The park contains ponds, waterfalls, meadows, streams, cliffs, and 98 mountain peaks over 3,000 feet high forming an "impressive skyline." [229] Catskill State Park is a great place to visit for hiking with hundreds of miles of trails and abandoned roads. "Today, it serves as watershed, recreation area, and ecological scenic reserve." [230]

Campgrounds along the Delaware River provide access to river resources and recreation including rafting, canoeing, kayaking, fishing and wildlife viewing. Natural, low impact campgrounds retain the atmosphere and essence of nature that many campers seek. Campgrounds throughout the watershed range in size and amenities, and are an important part of the ecotourism experience. RV campsites generally have hook ups to electricity, increasing the amount of amenities campers have while enjoying the outdoors. For example, Lander's River Trips and Campground has four different campgrounds to choose from, allowing for all types of campers. Some enjoy the peaceful quiet sounds by the campfire, while others want restaurants and amenities after a long day on the River. Dingmans and Kittatinny campgrounds both offer whitewater rapids within their stretch of the River ideal for kayakers. Sylvania Tree Farm is a secluded 1,200 acre estate in the Upper Delaware Wild and Scenic stretch of the River,[231] and within the Wild & Scenic River corridor. It offers a nature campsite right on the River where one can enjoy the peaceful flowing water all night and come across interesting wildlife including bears. There are also secluded cabins set back in the woods away from the River's edge.[232] Bull's Island Recreation Area, located on Route 29 (River Road) in Hunterdon County, NJ, and within the Delaware and Rartan State Park, offers 43 rustic campsites on the Island, each with a fire ring and picnic table open April 11–October 31. With a boat ramp on the Island, the site is perfect for overnight canoe-campers.[233]

DELAWARE RIVER CAMPSITE ALONG THE DELAWARE. THE NATIONAL PARK SERVICE HAS CREATED FIRST COME FIRST SERVE CAMSITES THROUGHOUT MANY OF THEIR PARKS FOR HIKERS AND BOATERS TO REST.

Campground	Location	Price	Nearby Attraction	Amenities
Dingman's Campground	Dingman's Ferry, PA	$28/ Night	Waterfalls, Appalachian Trail	Hiking, Nature and Biking Trails, Fishing, Canoeing[234]
Worthington State Forest	Warren County, Old Mine Road Delaware Water Gap	$15/ Night	6,000 acres within the DWGNRA, Sunfish Pond, Old Copper Mine Trail	Fishing and Boating, Hiking the Appalachian Trail, Picnicking[235]
Lander's River Trips and Campground	Narrowsburg, NY	$16/ Night	4 campgrounds with River Views, Fort Delaware, Skinner's Falls (waterfalls)	Boating, Fishing, Hiking, Kayaking, Rafting, Playgrounds[236]
Kittatinny Campground	Barryville, NY	$10/ Night	Mountains, Delaware River Whitewater	Whitewater Rafting, Kayaking, Trout Fishing, Hiking, Horseshoes, Volleyball[237]
Cape Henlopen	Lewes, DE	$31/ Night	Six miles of beach, WWII Observation Tower, Lewes Ferry	Beach Camping, Bike Trails, Bird Watching, Swimming, Disc Golf, Ferry Service[238]
Sylvania Tree Farm	Lackawaxen, PA	$25/ Night	Skiing, Horseback riding, Balloon rides, Delaware River Whitewater	Fishing, Hiking, Camping, Swimming[239]
Bull's Island Recreation Area	Stockton, NJ	$20/ Night	Borders river and canal, lush vegetation on the Island. Nearby towns Lambertville, NJ and New Hope, PA	Fishing, River and Canal access, Swimming, Historic foot bridge to PA

Figure 7: Campgrounds bordering the Delaware River

❖ Community Attractions and Ecotourism

Enhancing the natural assets of a community to increase ecotourism can be a low-cost, high-benefit solution for bringing in extra people and dollars to an area. Several communities in the watershed have already been successful in this endeavor, while others are just beginning.

In Pennsylvania, Bucks County is distinguishing itself as an ecotourism destination. Wineries, breweries, local coffee houses, nature parks, historic hotels, museums, bed and breakfasts and Delaware River access points all bring visitors to the area.[240] Places like the Bowman's Hill Wildflower Preserve, 1000 acres with over 134 native plant species near New Hope provide opportunities for day trips as well as complementing longer stays.[241] Visitors to the area supply revenue to local businesses and keep the importance of preservation and conservation of resources at the forefront of county planning.[242]

The State of Delaware has attracted tourists through creative activities such as the "Biking Inn to Inn" – an excursion that combines recreation, wildlife viewing, exercise, and Delaware's history on a 30-45 mile biking tour.[243] The trip stops at three different historic Delaware Bed and Breakfasts along countryside back roads. Other Delaware ecotourist adventures include bird-watching along the Atlantic Flyway, sport-fishing, horseback riding, antique shopping, arts and culture, fine dining, shopping, and visits to historic locations. [244]

BLUE TORTILLA RESTAURANT IN NEW HOPE, PA THE HISTORIC BUILDINGS, PEDESTRIAN FRIENDLY WALKWAYS, AND RIVERFRONT ACCESS ALL BRING TOURISTS TO THE AREA FOR SHOPPING, DINING, AND RECREATION.

Small river towns throughout the watershed bring in visitors each year to celebrate the river. In Frenchtown New Jersey, "*River Fest* first started to commemorate the role of the Delaware River in local history, and to support the preservation of the river and the surrounding environment"[245] River Fest, sponsored by the Frenchtown Business and Professional Association is considered Frenchtown's largest annual event.[246] In Knowlton, New Jersey, River Fest is "an annual Musical Event that celebrates music and nature next to the Delaware River."[247] In Narrowsburg, New York, River Fest is about promoting the Arts and Environment, featuring speakers that promote river conservation education. Lambertville's Shad Fest brings 30,000-35,000 visitors each year to the small historic river town. In Easton, Pennsylvania the Annual Forks of the Delaware Shad Fishing Tournament and Festival is held every year in Scott Park, attracting enthusiastic shad lovers from all around.

Peters Valley, a small village tucked away in Sussex County, is an art retreat for artisans and crafters.[248] The Peters Valley Craft Center has 8 art studios which include blacksmithing, ceramics, structural fibers, metals, photography, and woodworking.[249] Once a year they hold an annual craft fair in September featuring local crafters using inspiration from the Valley's surroundings.[250]

ECOTOURISM

Ecotourism is responsible travel to natural areas that helps conserve the environment and improve the welfare of local residents. Ecotourism is a major component of each of the basin states economy. Ecotourism supports local economies through retail sales, restaurants, lodging, and services provided. Ecotourism is the fastest growing sector of the travel industry, and therefore countries all over the world and states throughout the U.S. are quickly changing marketing systems to promote their remaining natural and historical areas.

The Delaware County Riverfront Ramble is a weekend long festival featuring music, canoe racing, environmental education, and pirate and fishing shows for families and people of all ages.[251] Riverfront Ramble promotes the Delaware River as a destination location. In 2007, after only 3 years, the event attracted approximately 22,000 people and was expanded to cover 2 days in order to attract overnight visitors and therefore increased proceeds for participating communities.[252] In 2008 the Riverfront Ramble had events in 6 locations lining the Delaware shore including Market Square Memorial Park in Marcus Hook, Delaware, John Heinz National Wildlife Refuge, and the Governor Printz Park in Tinicum, Pennsylvania and several other Delaware River shore stops. Ferry and free boat rides connect the 6 locations with shuttle services to get you back to your start.

THREATS TO ECOTOURISM

Improper handling and treatment of sewage, inappropriate and uncontrolled development, industrial air pollution, and water pollution from all sources including industry, roads, farms, cities, and neighborhoods threaten regional ecotourism opportunities for small towns and counties. A recent university study found that illnesses associated with swimming in contaminated water costs the public more than $3 million per year through the loss of tourism dollars as well as health care related costs, legal fees, and cleanup. Poor environments diminish the public's ability to fish, swim, bird watch, canoe, and experience our public parks and reserves.

Big cities benefit from the draw and beauty of a clean and healthy Delaware River. Philadelphia is home to a variety of events that boast its river areas as an attraction. Boating events include the Philadelphia Canoe Club's 'Philadelphia Fall Classic', a 10,000 meter canoe, kayak, outrigger and surf ski race [253] and the Philadelphia International Dragon Boat Festival featuring more than 100 teams racing fiberglass dragon boats on the Schuylkill River.[254]

Maintaining the nature and history of towns along the Delaware River makes them tourist locations that bring in additional revenue for the entire community. This idea is what led to Cumberland County New Jersey publishing a "Vision & Implementation Strategy for Economic Development & Conservation" in 1996. The report "was born out of a need to find a common agenda; one that would provide both economic development opportunities and preserve the County's natural heritage. Eco-tourism is here. It is happening today in Cumberland County. It is one way to expand the economy, create jobs, and protect the natural resource base that is so important to the area's quality of life." [255] Other communities have published similar reports, created brochures, or are developing strategies to enhance the natural and cultural assets already existing within their borders.

WASHINGTON CROSSING STATE PARK. PA. ECOTOURISM, SUCH AS WILDLIFE OBSERVATION INCLUDING THIS EASTERN TIGER SWALLOWTAIL BUTTERFLY. BRING ECOTOURISTS INTO A REGION REQUIRING MASSIVE INFRASTRUCTURE, ROAD BUILDING, OR HIGH RISE HOTELS. THE KEY IS PROPERLY MARKETING THE UNIQUE AND VALUABLE NATURAL RESOURCES AN AREA ALREADY CONTAINS.

Recognizing the value of recreation to our communities, and its dependence on clean water, beautiful and scenic vistas, and natural areas, it is important that we take action to protect the quality of our river water, our river corridors, and the natural areas in the watershed. Clean water increases park attendance and recreation revenue. Every type of river recreation is diminished if the health of the Delaware River diminishes. With the jobs and economy supported by recreation and ecotourism, it is vital that the community place a high value on the protection and restoration of the River and its surroundings.

The River as an Employer

The River as an Employer

- Commercial Fisheries as Employers
- Agriculture and the River
- Where our Drinking Water Comes From
- Industry on the Delaware
- Water and Commercial Use
- Delaware River Ports

❖ Commercial Fisheries as Employers

The Delaware River watershed supports diverse interests and purposes. A clean and healthy Delaware River creates and supports. To support the diversity and quality of jobs the Delaware needs to be clean, healthy and free-flowing.

"In 1991, over 9 billion pounds of fish and shellfish with a value of over $3 billion were harvested by commercial fishermen in the United States."[256] This commercial catch includes freshwater species as well as ocean catches, but it is estimated that nearly three-quarters of all commercially harvested fish and shellfish depend directly on coastal estuaries and river basins for spawning grounds or nurseries. The Delaware River and Bay provide temporary home and spawning ground for species that are later harvested for use all over the eastern U.S. In the late 19th century, the Delaware River had the largest annual commercial fish catch of any river on the Atlantic coast. But over-fishing and/or pollution has often threatened the fish of the Delaware River including Shortnose Sturgeon, Atlantic Sturgeon, River Herring (including Blueback and Alewife), Striped Bass, and American Shad.[257]

SHAD ARE MAKING THEIR WAY BACK UP THE DELAWARE AND ITS TRIBUTARIES AGAIN BECAUSE CLEAN WATER IS ALLOWING THEM TO RETURN TO THEIR SPAWNING GROUNDS AFTER A LIFE IN THE ATLANTIC OCEAN. *PHOTO CREDIT: ART EASTON 2008*

Early European settlers wrote letters home telling their families and friends about the bounties of fish within the Delaware River and tributaries, at sizes often much larger than typically found in Europe.[258] Tales of almost effortless fishing and brush netting fish into crates became well known in the Delaware River Valley.[259]

By the mid-20th century, a combination of an increasing human population, loss of natural forest wetlands, and inadequate sewage and industrial waste treatment created an ecological barrier, a 20-mile oxygen dead zone that impeded the ability of fish to migrate upriver to spawn in the Philadelphia/Camden portion of the River.[260] Improved technologies and laws that required their use, including the Federal Clean Water Act of 1972, forced the cleanup of a variety of pollution sources to the River. As a result, the nutrient pollution which was the primary cause of the River's oxygen problem was largely abated, allowing fish to once again migrate upstream from the ocean and lower stretches of the estuary.

SHAD FISHING: LUMBERVILLE, PA
PHOTO CREDIT: ART EASTON 2008

Today, a viable commercial fishery is still maintained along the Delaware River and Bay. In 1998, statewide, New Jersey's commercial fisheries harvested 196 million pounds at a value of $90.9 million statewide; New York harvested 57.5 million pounds at a value of $84.3 million; and Delaware harvested 7.8 million pounds at a value of $5.6 million.[261] According to New Jersey's Department of Fish and Wildlife, efforts to clean up rivers and reservoirs have created the best trout fishery New Jersey has ever had.[262] Striped Bass has been declared recovered in the Delaware River by the Atlantic States Marine Fisheries Commission compared to historic levels.[263] American Shad have also recovered enough to support commercial fishing in the Delaware River, although not enough to supply the current demand.[264] Other species commercially caught from the Bay and tributary waters include Alewife, Atlantic Croaker, Blueback Herring, Carp, Spot, Striped Bass, White Perch and Blue Crab.[265]

Lewis Shad Commercial Fishery

The Lewis Shad commercial fishery has survived in the Delaware River for over 108 years. A family run business located above the head of tide in Lambertville, NJ, the Lewis Shad fishery is the oldest commercial shad fishery on the Delaware River.[266] Although its annual shad catches no longer support commercial demand in the Philadelphia and New York markets, this family fishery remains in operation, still using the same fishing methods and practices it used when it first began.[267] The Shad catch is very low, but the family continues their traditions to keep Shad fishermen trained and ready for when the Shad return in greater numbers.[268] The traditional practices used by the Lewis Shad fishery are demonstrated every year at the Lambertville Shad Fest and are a big draw for those in attendance. Each year Shad make the journey up river from the ocean with the fishery improving as water quality and obstacles to migration improve in the Delaware River.[269]

Lewis' approach to the shad market demonstrates a strong conservation ethic. "We don't try to catch enough even to sell to the markets of Philadelphia and New York," said Lewis. "We try not to catch more than we can sell right here. For the price you get in the markets, the fish are more valuable going up the river. A shad roe that you might get 50 cents a pound for in the market, might spawn 150,000 eggs; big difference in value there."[270]

Shellfisheries

Shellfish are also part of the economy sustained by the Delaware River. In 1880, the Delaware Bay brought in a harvest of 2.4 million bushels of oysters. In the 1930's, more than 1 million bushels were harvested. Numbers decreased as natural surfaces in the Bay were reduced, limiting the places where oysters can attach and grow. In the late 1950's, MSX (Multinucleated Sphere unknown affinity X), a deadly shellfish disease, depleted 90-95% of the oyster population in the Bay.[271] After minimal recovery and decades of building resistance to the disease, Dermo (Perkinsus marinus), a second shellfish parasitic disease, again decimated the oyster population in 1980.[272]

While Dermo continues to plague the adult oyster population, the Delaware Bay Oyster Restoration Task Force (a total of 12 public and private agencies from NJ and DE including representatives from Rutgers University, the New Jersey Department of Environmental Protection, the Delaware Department of Natural Resources and Environmental Control, the Delaware River Basin Commission, and the Delaware River Bay Authority) have invested heavily in efforts to restore the Bay's oyster populations and the oyster industry. Since 2005, as much as $5 million of federal funds have been invested to restore the oyster beds of the Delaware Bay.[273]In 2004, $1.55 million worth of oysters were landed on the New Jersey side

of the Bay.[274] In 2006 it was reported that oyster harvesting generated $535,000 of income for harvesters, and a total $3 million of economic benefit locally.[275] Numbers of oysters and successful shell placement and economic benefits continue to markedly increase. The estimated overall economic impact to the industry for 2007 is estimated at $80 million.

OYSTER LARVAE REQUIRE A CLEAN, HARD SURFACE UPON WHICH THEY CAN ATTACH OR "RECRUIT." DUE TO A STORAGE OF THESE NATURAL RESOURCES, THE DELAWARE BAY OYSTER RESTORATION TASK FORCE HAS "PLANTED" SURF CLAM, OCEAN QUAHOG, AND MARYLAND OYSTER SHELL IN AN EFFORT TO REVITALIZE THE DELAWARE BAY OYSTER POLLUTION. PHOTO CREDIT: BAYSHORE DISCOVERY PROJECT.

Case Study: Backwoods Angler Fishing Guides

Blaine Mengel Jr. and Associate Guide Chris Gorsuch know the Delaware River up and down. Both are Delaware River fishing guides for a company called The Backwoods Angler, a fishing guide service owned and operated by Blaine. In operation since 2000, this guide service is based on a healthy catch & release smallmouth bass fishery. Their range spans from Belvidere, NJ north and south.

People come from Pennsylvania, New Jersey, New York, and all over the U.S. to experience the Delaware River. "People are amazed to find such a clean and scenic valuable resource within such a close distance to a metropolis like NYC" said Chris Gorsuch, Associate Guide. The Backwater Angler offers both kayaking trips and jet boat trips from 4-8 hours long for groups of 1-2 people. "We regularly see a variety of turtles, beaver, deer, eagles, osprey, great blue heron and other water fowl; we have even had a number of black bear sightings in the past few years along the banks of the Delaware," Gorsuch reports.

As Gorsuch explains, "Our business is truly sustained by the River and its ecosystem. It is a delicate balance, the aquatic plants, insects and invertebrates all thrive in clean water. These insects and other minnows such as darters, provide the forage that sustains a healthy smallmouth bass population. Without a healthy fish population, there are no eagles, no osprey, no blue heron, and without a quality fishery there are no fishing guides. We have to be able to take people to where the fish are, and understand what parts of the river offer the best fishing opportunities depending on the time of year and the water flow. A healthy Delaware is vital to our being able to do this. Without clean water, we don't have jobs".

There are only a handful of fishing guides along the Delaware; most are trout guides in the West Branch Delaware River. Backwoods Angler operates 7 days a week 12 months out of the year, and successfully gets about 500-600 people out on the River annually. To learn more about the Backwoods Angler Fishing Guide Service, visit their website at www.backwoodsangler.com

Dylan Hechendorn and his father Darin booked the Backwoods Angler guide service in early August. This was Dylan's first Delaware River Smallmouth. His dad says; "Dylan's hooked for life!"

Additional Commercial Businesses

Many businesses throughout the watershed are supported by the River, but aren't directly along its banks. The Crab Connection in Little Creek, Delaware sells fresh seasonal seafood as well as bait for Delaware Bay fishermen.[277] In Easton, Pennsylvania Laini Abraham has created a Pocket Guide to tourism in the area and along the River, and runs a tourist shop in the downtown district providing information to recreationists and visitors to the River and City of Easton from throughout the region.[278]

BOWERS BEACH, DE CAPTAIN SONNY SULLIVAN CUTTING BAIT FOR SONNY'S BAIT AND TACKLE SHOP THAT CATERS TO RECREATIONAL AND COMMERCIAL FISHERIES.

BOWERS BEACH , DE RUSSELL'S CHARTER FISHING BOAT MISS SHYANNE TAKES A GROUP OUT ON A FISHING TOUR ON THE DELAWARE.

Charter boats and charter fishing companies thrive in all seasons along the Delaware Bay. Russell's Charter Fishing, Inc. in Bowers Beach, Delaware takes tourists and locals out into the Bay to fish for whatever is in season. Captain Sonny Sullivan owns a bait and tackle shop in Bowers Beach supplying the necessities to Charter fishing boats while also using his own boat to catch bait for sale at his shop.

The Philadelphia seafood market, located in the Italian Market at 9th and Washington, is "the oldest and largest working outdoor market in the United States". The outdoor market supplies seasonal fresh fish and shellfish from the Delaware River and Bay, as well as from other waterways around the world.[279] Similarly the Reading Terminal Market in downtown Philadelphia brings thousands out each weekend to buy locally grown produce, fresh meats, and fish from the Delaware River.[280]

The Delaware's commercial fishery doesn't just provide jobs, it supports a way of life. It is a historic and present day culture that is unique unto itself and worthy of respect and protection, not only for the dollars it generates, but for the culture it brings.

❖ Agriculture and the River

Agriculture has a long history in the Delaware River Valley. Pennsylvania is known for its dairy; New Jersey for its peaches, tomatoes, cranberries and blueberries; New York homesteads for their maple syrup, sheep, eggs, and dairy cows; and Delaware State for its poultry.

Farming Culture

There are thousands of farms throughout the basin providing local restaurants and farm markets with an abundance of local produce, vegetables, grass-fed meat, eggs, dairy products, and more. In New Jersey, "Jersey Fresh" has become emblematic of family farming and marketing throughout the state. Water

BEDMINSTER, BUCKS COUNTY, PA PRESERVED FARMSTEAD, ONE OF 917 FARMS IN BUCKS COUNTY PRESERVED TO ENSURE THE RURAL HERITAGE AND FARMING TRADITIONS OF THE REGION.

provided by the Delaware River system and the unique river valley soils throughout the basin have supported the farming tradition in each of the basin states producing a wide variety of foods, goods, and jobs.

In 2006, the Bucks County Open Space Task Force celebrated preserving its 100th farm. Today, Bucks County, Pennsylvania, has over 917 farms containing more than 76,000 acres and generating over $60 million in agricultural products.[281] Preserving farmland provides a sense of identity for the county. Historic barns and outbuildings, grazing livestock, and open fields continue to define the character of the county while, when managed appropriately, helps to maintain meadowlands, streambeds, and forests for natural habitat. [282]

Monmouth County, New Jersey recently preserved its 10,000th acre of farmland, and is the seventh county in the state to do so. The Gerald Rottkamp Farm in Cumberland County, New Jersey produces sweet corn, tomatoes, peppers, melons, and blueberries, and uses 2,200 gallons of water per day from the Delaware River. Likewise, other farms throughout the state and the basin rely on the Delaware River its tributaries and agriculture to provide irrigation and to sustain farming traditions.[283]

NEW JERSEY FARM MARKET RT 48 SALEM COUNTY. "JERSEY FRESH" HAS BECOME EMBLEMATIC OF NEW JERSEY AGRICULTURE THROUGHOUT THE STATE.

Buying Local

Agriculture close to or within urban areas is also uniquely valuable and important. It creates green spaces for trees and water filtration, while providing a local food supply to urban residents. Local farms provide educational opportunities for children and decrease the amount of transportation needed to supply homes, local groceries, restaurants, stores and markets with fresh produce.

JERSEY FRESH RED POTATOES SOLD IN SALEM COUNTY FOR $2.50 A BOX

In agriculture, contamination of water sources could lead to sickness and infection of both humans who consume the food and to livestock that use the water for drinking. Pre-treating irrigation water is a costly endeavor.

Current methods of irrigation take in water from the River and apply it directly onto agricultural fields. Many agricultural fields use ground water wells for irrigation rather than direct surface water intakes, but contamination can still happen. The importance of clean water in irrigation was proven in the fall of 2006 when over one hundred people became sick after consuming spinach that was irrigated with contaminated water in California. The irrigation sources were infected from fertilizer runoff and animal waste.[284]

For a great guide to New Jersey food, see Edible Jersey, a quarterly magazine that celebrates "local foods from the Garden State, Season by Season." (www.ediblejersey.com)

Livestock and Factory Farming

Agriculture is a significant part of the Delaware River watershed economy and culture. While watershed farmers need to do their part to protect the streams and rivers of the watershed; the watershed community needs to do its part to support local farmers with clean water and community support.

Many livestock and farm animals drink from the water provided by the Delaware River and its tributaries. Clean water is needed in order for them to stay healthy and sanitary. "High levels of sulfates in drinking water can contribute to decreased egg production in chickens."[285] "Many species of animals are susceptible to nitrate poisoning, especially cattle", which has been associated with miscarriage and other reproductive problems, anorexia, lower blood pressure, and reduced lactation for dairy cattle."[286]

CONFINED ANIMAL FACTORY FARM BEING INUNDATED WITH FLOOD WATERS. THE FARM'S LAGOONS CONTAIN MANURE AND CONTAMINANTS THAT, WHEN FLOODED OR OVERTOPPED, POLLUTE THE NEARBY WATERWAY.

And agriculture must take due care to ensure that it does not itself become a source of pollution to waterways in the watershed. Animal agriculture produces byproducts like manure and chemical waste that should be properly treated, recycled as fertilizer or compost and kept away from waterways. Rain washes livestock waste containing bacteria and pathogens into water sources. Excessive nutrients from animal byproducts destroy river habitats by creating excessive algal blooms resulting in reduced oxygen levels that suffocate fish and impact wildlife. Livestock should always be kept away from streams and rivers.

WITHOUT FENCING, EVEN SMALL ANIMAL OPERATIONS CAN DEGRADE STREAM QUALITY.

Every effort should be made to avoid the operation of confined animal feeding operations (CAFO's) or factory farms in our watershed and communities. Factory farms introduce a variety of chemicals, pharmaceuticals, growth hormones, antibiotics, bacteria and contaminants onto the land and into the nearest waterway.[287] Factory farms create water, noise and odor pollution, and they inflict morally reprehensible abuse on the animals they house. Preventing the construction and operation of factory farms is one important strategy for protecting drinking water supplies, the environment and communities.

❖ Where our Drinking Water Comes From

A clean and healthy Delaware River, including the River's corridor, provide for our basic human needs: water, food, safety and health. About 5 percent of the U.S. population or 15 million people rely on the Delaware River for their drinking water supply. Major cities and small communities alike drink from the River.

NEVERSINK RIVER, NY THE NORTHERN REACHES OF THE DELAWARE RIVER WATERSHED HELP TO SUPPLY MILLIONS OF NEW YORKERS. PHOTO CREDIT: DAN L. PERLMAN/ECOLIBRARY.ORG

The Philadelphia Water Department has three drinking water treatment plants that draw water from the Delaware and Schuylkill Rivers. The Baxter plant, which draws an average of 200 million gallons a day from the mainstream Delaware, provides drinking water to 60% of Philadelphia's population, as well as serving a portion of lower Bucks County. The Belmont and Queen Lane treatment plants together draw an average of 110 million gallons per day (40 MGD and 70 MGD respectively) from the Schuylkill River to support the other 40% of Philadelphia's drinking water needs.[288] Not all of the 15 million people drinking Delaware River water live in the watershed, in fact a large portion live in other River basins. Residents of central New Jersey reside in the Raritan River Basin, and New York City residents are in the Hudson River Basin – yet both drink water supplied by the Delaware River.

Clean Drinking Water

Clean Delaware River water, free from toxins, bacteria, pathogens, mercury, PCB's, and various other known and unknown chemicals is critical for supporting a healthy drinking water supply for residents throughout the watershed as well as business and commercial uses. The health impacts of water contamination for both humans and wildlife range from acute illness, to diseases such as cancer and metabolic disorders. Waterborne diseases are a major problem in surface water. Gastroenteritis, acute respiratory symptoms, and dermatitis are among the acute illnesses that can result from contaminated drinking water.[289] Both ground and surface water can become polluted with pesticides, petrochemicals, bacteria, nutrients, synthetic organics, acidification, heavy metals, chemicals (manmade and naturally occurring), and waste products. Toxins and contaminants have serious health consequences when consumed. Accidental pollution releases, legally permitted pollution discharges, illegal discharges, as well as pollution washed from the land during rain events are all potential sources of contamination of our drinking water supply.

In 2008, The Associated Press reported that 56 pharmaceuticals or byproducts have been found in Philadelphia's drinking water supply.[290] According to authorities this issue may not be a major issue now, but over time and without fully understanding where the byproducts are originating, it could be a substantial threat.[291]

Cleaning Dirty Water: Water Treatment

The cost of water treatment is high. Maintaining our drinking water supplies to the highest specifications of water safety and cleanliness not only provides health and quality of life benefits but it also ensures a more cost effective source of drinking water. In New York, residents have long enjoyed the untreated, high quality waters from the upper Delaware River system. In 1996, New York City faced the choice of building a water filtration plant to filter its water supply, or of protecting the watershed that drains to the City's drinking water reservoirs in order to maintain its high quality drinking water. Economically, the decision was an easy one. The cost of building and operating a water filtration plant would cost the City $6 to $8 billion at that time.[292] Rather than invest in a water filtration facility, New York City, with the support of the U.S. Environmental Protection Agency (EPA), entered into its Watershed Memorandum of

NEW YORK CITY DECIDED TO PRESERVE RIPARIAN LAND IN THE UPPER DELAWARE TO MAINTAIN CLEAN WATER VS. BUILDING A MUILT- BILLION WATER FILTRATION PLANT. *PHOTO CREDIT: JON NAIL*

Agreement in 2007. The Watershed Plan that was created invested in protecting riparian buffer zones and watershed lands around their City's reservoirs in order to help protect their water source from non-point source pollution, including nutrients and pesticides resulting from stormwater runoff, septic tanks and agriculture.[293] The City invested in repairing and installing community sewage treatment plants throughout the counties that drain to their reservoirs. Protecting the watershed was estimated to only cost the City around $1 to $1.5 billion dollars with $250 million invested in acquiring land and setting aside special protection areas.[294] This land purchase has been complemented by regulatory protections (New York City's Rules and Regulations for the Protection from Contamination, Degradation, and Pollution of the NYC Water Supply and its sources Chapter 18 and landowner incentives for land protection.[295]

The watershed program choice has not only provided New York City with some of the cleanest and best tasting water nationwide, but it has provided tremendous benefits to the Delaware River as a whole, reducing the level of pollution that is dumped into the system from deforestation and development.

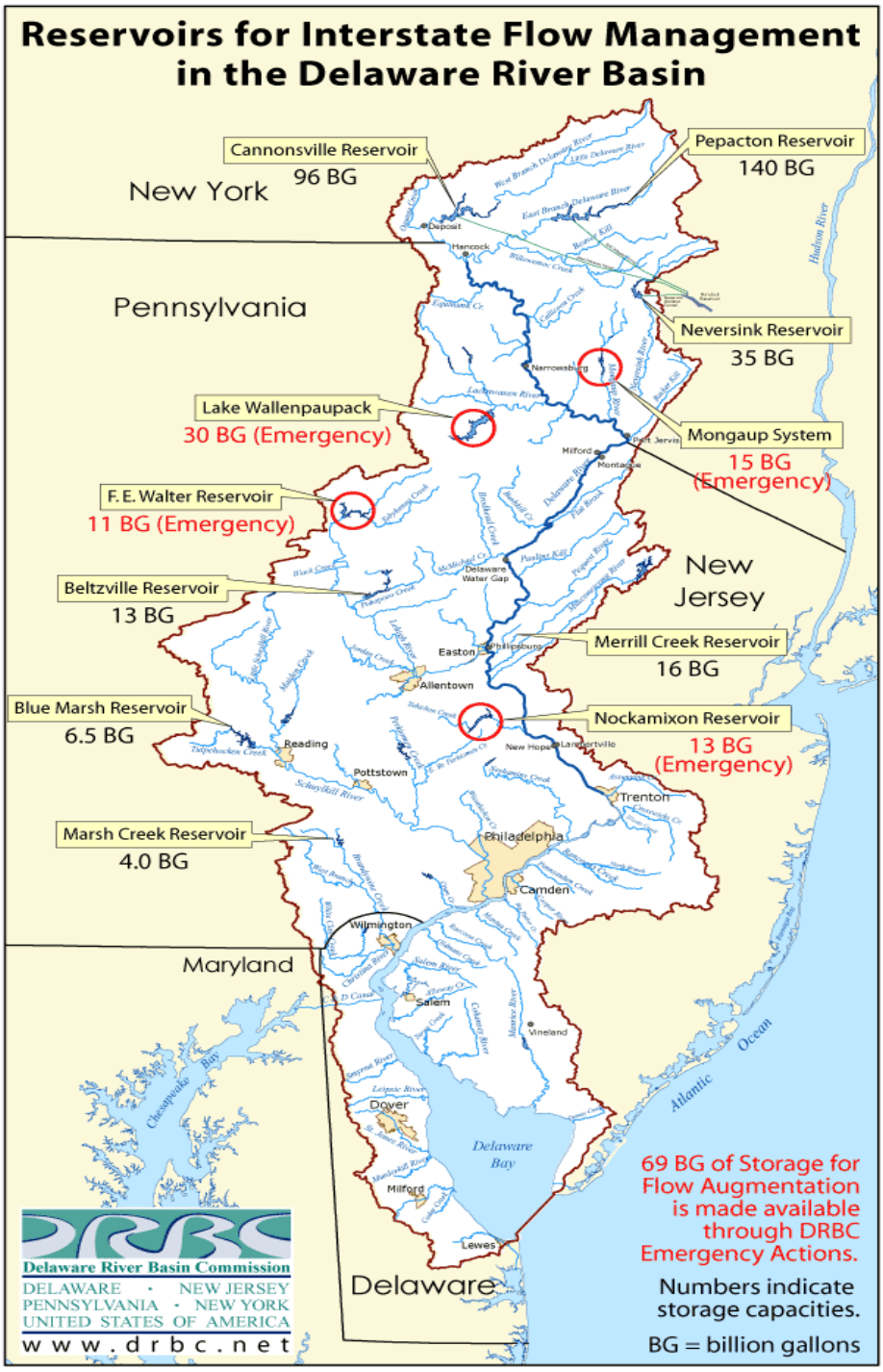
Today it is estimated that building a water filtration plant could total as much as $10-20 Billion; New York City residents' annual water bills would increase by at least 11.5%. This would make the average water bill $699, annually.[296] Protecting the watershed is still the most cost effective and attractive solution for the City.

"…clean water is the fuel that powers the nation's economic engine."

EPA United States Environmental Protection Agency

Researchers in other communities recognize the benefits of watershed protection from a community water supply and pollution prevention perspective, finding that every $1 invested in watershed protection could save between $7.50 and $200 in costs for new filtration and water treatment facilities.[297] "In 1991, the cost of treating contaminated water was estimated to be $10-$15 per month for a family of three."[298] Communities in Washington D.C. spend as much as $3 to $5 per pound to remove nitrogen from wastewater, a process that forested buffers provide naturally.[299]

NEW YORK CITY'S WATER SUPPLY SYSTEM



The map above shows some of the water storage reservoirs along the Delaware. These reservoirs hold the public supply of water used for drinking, cleaning, lawn care, and for industries such as food production and automobile manufacturing. Several communities manage their own water supply through reservoir operations including Wilmington and Newark in Delaware, Bethlehem, Pennsylvania, and the largest water user from our basin, New York City, which exports water from the headwaters of the Delaware River. Other communities in addition to Philadelphia take in water directly from the River including: Morrisville, Trenton, Burlington, and Bristol.

❖ Industry on the River

Although industry has changed along the Delaware River over the years, the River has always been a fundamental resource for the economy that spurred the growth of Philadelphia, Camden, Wilmington, Trenton, and even New York City. Industries throughout the watershed continue to bring young talented professionals and families into the region, but the River is what keeps that industry viable and its employees' quality of life high.

Industrial Beginnings

Starting in the 1760's, timber rafting was a way of transporting thousands of harvested trees from the Upper Delaware forests of New York, Pennsylvania, and New Jersey into Philadelphia and Camden. Timber from the valley fueled shipbuilding, one of the first major Delaware River industries.[300] Other historical Delaware River industries include lumber and paper mills, tanneries, stone quarries, especially bluestone, cement-making, iron, and rubber. Many of these industries relied primarily on the River and estuary for transportation, including coal which traveled down the Lehigh into the Port of Richmond just north of Philadelphia.[301] The anthracite coal industry began in the early 19th century in the headwaters of the Schuylkill River to fuel the industrial revolution.

Many historic Delaware River industries played a large part in the demise of water quality between Trenton and Philadelphia, the decline reached its peak in the 1940's and 50's.

In the Mid to late 1800's upper Delaware River timber harvesting and tanneries that stripped tannic acid from the bark of the region's mature trees devastated the River. What was once an idyllic intact forest brimming with trout-filled streams was transformed into a logged wasteland with a river polluted by acid and choked with sediment. Many tributary streams were utterly destroyed.

Declining quality made the River an unreliable source of water. Federal laws and a greater appreciation of the River for multiple purposes resulted in the cleaning up of the Delaware River, which revived industrial reliance for water supply on the Delaware, leading to greater job security and better health for its many workers. The industries that dominate the River's edges have changed over the decades.

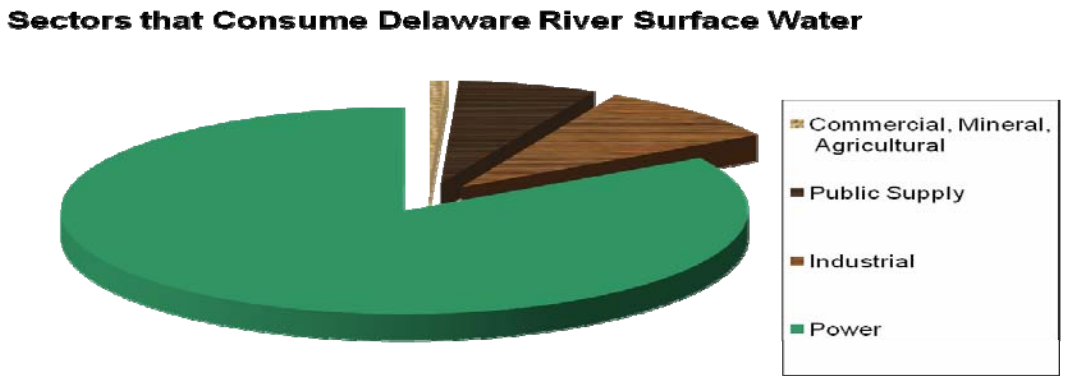


Figure 8: Sectors that Consume Delaware River Surface Water

Today's River Industries

Today, water is an essential factor in industrial production, productivity and transport. The largest water consumers on the Delaware today are electricity generation facilities, or the power industry. The power industry takes in three times more water than all other major water consumers combined, including public water supply, agriculture, and commercial businesses. **Figure 8** lists the four sectors of commercial Delaware River surface water consumers. [302]

Every year the Salem Nuclear Generating Station kills over 3 billion Delaware River fish including:

- Over 59 million Blueback Herring
- Over 77 million Weakfish
- Over 134 million Atlantic Croaker
- Over 412 million White Perch
- Over 448 million Striped Bass
- Over 2 billion Bay Anchovy

The US Fish and Wildlife Service, in a letter dated January 10, 2001, characterizes the loss of aquatic organisms at Salem as "ecologically significant. In addition, conditional mortality rates for some Representative Important Species (RIS) are high enough to be of serious concern."

The power industry consumes approximately 5.674 billion gallons per day of Delaware River surface water,[303] primarily used for cooling purposes. Because most power generating facilities along the Delaware River intake water through underwater pipes, it is important that the water remain clean and clear of unnatural debris. In April of 2007, a cooling water intake at PSE&G was forced to shut down after screens on its water intake system became clogged with assorted River debris.[304]

PSE&G is a native New Jersey electric service provider that supplies electricity for over 75% of New Jersey from Bergen, to Gloucester Counties. PSE&G employs over 10,500 people throughout its state wide service area, providing jobs for highly skilled engineers and nuclear technicians as well as hourly positions of all kinds.[305] PSE&G takes in more than three billion gallons of water per day from the Delaware River for cooling purposes.[306]

Exelon takes in over one billion gallons per day from the Delaware River and employs thousands of men and women throughout the region.[307] Power companies strategically locate themselves along bodies of water. A dependable flow of water is essential for power plants to remain viable.

Figure 9 shows the five largest Delaware River consumers; four of which are power companies.[308] Connectiv, Exelon, PSE&G, and Reliant are all power companies with a combined water intake of more than 55 billion gallons of water per day.[309] Premcor is an oil refining facility that takes in 355 million gallons per day of Delaware River surface water.[310]

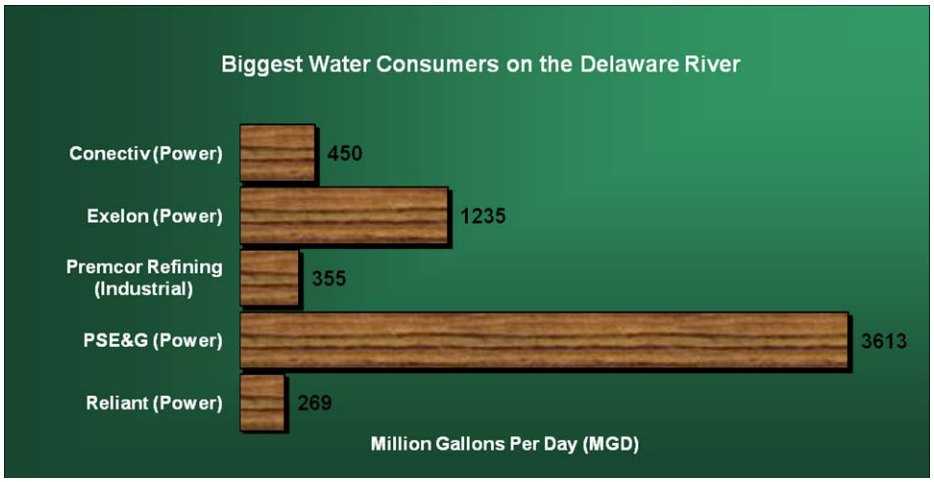


Figure 9: Five Largest Delaware River Consumers

Being the biggest water consumers on the Delaware brings with it a high level of responsibility, ensuring that their use of the River water is done so as to minimize any adverse impacts they might have on the ecosystem or others who rely on the River. PSE&G's Salem facility kills over 3 billion Delaware River fish a year including Weakfish, Bay Anchovy, Shad, and more. If PSE&G were to change the cooling water technology at the facility it could reduce those fish kills by over 95% and use 95% less Delaware River water. In addition to the ecological impacts, the commercial and recreational fishing industries and workers are forced to compete with electric generating stations for their livelihood — a day's catch. Fishing industries are dependent on a healthy and growing fish population in the Delaware Estuary and Bay and it is incumbent on PSE&G, Exelon and all other power companies to respect the right and need of others who mutually rely on the River.

Other industries that today rely on Delaware River surface water include steel manufacturing, chemical companies, paper mills, cement production facilities, and oil refineries. Chemicals are manufactured at DuPont with locations in New Jersey and Delaware. Although clean water is an essential component of DuPont's operations, DuPont's Chamber Works facility in Deepwater New Jersey is the single largest discharger of hazardous waste effluent in New Jersey.[311] Industries like this do not help the River or region, but actually hurt the long term growth of the environment and economy. Rohm and Haas (now Dow Chemical) is a chemical company based out of Philadelphia. According to the industry, chemical manufacturing and research requires a reliable water source: "Water is the single most important chemical compound".[312] The higher the level of initial contamination of the water, the more effort that must be applied before research and production can begin.

INDUSTRIAL TOWERS IN THE BACKGROUND OF A SCENIC RIVER VIEW.

Water is a basic and essential component to the local production of paper towels, tissues, copy paper and notepads. Companies such as Scott paper operating on the Delaware River since the mid 1800's rely on plentiful, good quality water.

Why Industry Needs Clean Water

"Contaminated water can increase industrial expenses as it causes steam electric power plants to operate less efficiently, clogs cooling equipment, corrodes pipes, and increases the rate at which pumps and other equipment wear out".[313] In November of 2008, industries along the Monongahela River flowing through Pittsburgh, Pennsylvania noticed "significantly higher water treatment costs" after microscopic contaminants, Total Dissolved Solids (TDS), were found at high levels.[314] The Pennsylvania Department of Environmental Protection said it received several reports from industries about equipment problems and increased filtering costs to protect expensive steam boilers and turbines as well as drinking water filtration plant problems that led to water so high in TDS that it couldn't be effectively filtered. 325,000 consumers were advised to switch to bottled water for weeks and again for a period in 2009. A power industry spokesman said utility treatment costs increased because very clean water is needed for power generating facilities.

Many industries and businesses depend on the River for transportation today. Approximately 3000 cargo vessels travel the River annually.[315] About 85% of the east coast oil imports come up through the Delaware Bay and River[316]. Debris impairs the ability of ships for these and other industries located along the river to safely transport and deliver their cargo, making it important to keep damaging debris out of the water.

In Philadelphia and South Jersey, the Delaware River Port Authority (DRPA) launched a “Green Ports” program with South Jersey Port Corporation (SJPC) and the Philadelphia Regional Port Authority (PRPA). The DRPA is a regional transportation and development agency that owns and operates the Benjamin Franklin, Walt Whitman, Commodore Barry and Betsy Ross bridges, PATCO, the Philadelphia Cruise Terminal and the RiverLink Ferry.[317] Initiatives to “green the ports” in several U. S. port cities have led to success economically and environmentally. Los Angeles, Mayor Antonio Villaraigosa and the mayor of neighboring Long Beach, launched a campaign to clean up port activities and reduce air emissions and water pollution. "We believe the only way to grow the port is to green the port," says Villaraigosa. "And the only way to green the port is to grow the port...."[318]

❖ Water and Commercial Use

Other commercial users of Delaware River surface water include the small businesses of the watershed like restaurants and hotels.

Hotels, restaurants, small businesses, and real estate operations rely on the Delaware River for their drinking water, wash water, maintaining their landscaping and grounds and to support onsite recreational uses including filling and maintaining swimming pools. Clean water is also fundamentally important for real estate in order to sell properties. Either real or perceived contamination, litter, garbage, or murky river conditions can influence buyer interest and the final selling price of property.

Some of the largest private consumers of Delaware River water are Waterworks Condominiums in Philadelphia, USS Real Estate owned by U.S. Steel, and River Winds in West Deptford Township, New Jersey.[319] Even the Philadelphia Airport takes in water to maintain the grounds, keep runways and airplanes clean, provide bathroom facilities for thousands of people moving throughout the airport each day, and to run the many restaurants and kitchens located within the facility.

As with all users of the River, it is important that commercial sources that benefit from a clean and healthy Delaware River do their part to protect and restore that same clean water. Their ability to do so is all about the choices they make for their day to day operations.

❖ Delaware River Ports

The ports of Philadelphia and Camden make up the busiest freshwater port in the world with annual revenue of $19 billion.[320] Over 70 million tons of cargo per year move through the ports at Philadelphia, PA; Camden, Gloucester City, and Salem, NJ; and Willington, DE Historically, cities such as Philadelphia and Trenton were created and supported by the products supplied through the ports. Raw timber and coal went out, and processed goods came in.

“Delaware River ports employ 4,056 workers who earn $326 million.” [321]When one looks at the additional jobs and worker spending associated with these jobs the Delaware River ports are said to support “12,121 jobs and $772 million in labor income, generating $2.4 billion in economic output.” [322] The ports are well known for staple products like fruits, cashews, and cocoa beans, and contain the number one perishables port on the east coast. Oil comes in from the Middle East and meat comes in from Chile, Argentina, and Australia. Delaware River ports make up the largest North American port for steel, paper, and meat imports as well as the largest importer of cocoa and fruit on the east coast.[323] The Port of Wilmington is one of the busiest container ports on the Delaware River handling Dole and Chiquita.[324]

A deepened main navigation channel is not needed to support this vibrant port, or new business. The success of the Delaware River ports lies in developing them as a strong niche port. In recent years record growth has been reported for the Delaware River ports, without the prospect of a deepened channel.[325] While deepening the Delaware is not needed for a vital and growing port, it would threaten the other uses of the River with contamination, losing jobs and income, as well as diminishing the health of the River for others, including the people who drink and eat from it.

VIEW OF THE NAVY SHIPYARD AT SUNSET. THE PORTS ARE SHIPPING AND RECIEVING CORRIDORS FOR INTERNATIONAL TRADE AND COMMERCE. MOSTLY OIL TANKERS, WE ALSO RECEIVE PERISHABLE FOODS AND CONSUMER GOODS.

Why it Needs to be Clean Water

In the 1940's and 1950's the Delaware River was filled with sewage and garbage that clogged boat engines of incoming and outgoing ships peeling the paint from their sides, hindering traffic and port employment.[326] In 2004, a large oil tanker carrying thick Venezuelan crude oil hit two submerged objects lying on the River's bottom: an old anchor and pipe. The objects ripped two gashes in the tanker's hull resulting in an oil spill of 265,000 gallons. The Athos I oil spill forced the ports to completely shut down for a period of days. The Coast Guard and others were forced to invest more than $84 million dollars to clean up the toxic crude which impacted 115 miles of River and 280 miles of shoreline with oil, as well as over 16,500 birds and other wildlife.[327]

Keeping the ports healthy and functioning is important to the region's economy. The supplies that come into the ports provide jobs for watershed residents, overseas manufacturers, ship captains and their workforce, port receiving and distribution, inland transportation like truckers and railroad personnel, and all of the local suppliers relying on the products like restaurants, Hershey's chocolate factory, steel manufacturers, and more. It is important that we keep our river clean so we do not jeopardize job security or the health of these workers. Accidents and fuel or cargo spills cause injuries, death, damage to public health and the environment, and serious economic harm. It is critical that all policies, procedures and steps be taken to avoid short term catastrophic events as well as long term degradation and harm. Maintaining our port as a source of reliable employment for hundreds of thousands of workers is a priority for the region and requires a clean and healthy River.

In Philadelphia and South Jersey, the Delaware River Port Authority (DRPA) launched a "Green Ports" program with South Jersey Port Corporation (SJPC) and the Philadelphia Regional Port Authority (PRPA). The DRPA is a regional transportation and development agency that owns and operates the Benjamin Franklin, Walt Whitman, Commodore Barry and Betsy Ross bridges, PATCO, the Philadelphia Cruise Terminal and the RiverLink Ferry.[328] Initiatives to "green the ports" in several U. S. port cities have

led to success economically and environmentally. Los Angeles, Mayor Antonio Villaraigosa and the mayor of neighboring Long Beach, launched a campaign to clean up port activities and reduce air emissions and water pollution. "We believe the only way to grow the port is to green the port," says Villaraigosa. "And the only way to green the port is to grow the port...."[329]

ABOVE LEFT: AFTER THE ATHOS I OIL SPILL TEAMS FROM ALL OVER THE REGION TOOK PART IN THE CLEAN UP EFFORTS TO WASH BIRDS AND STOP THE FLOW OF OIL FROM THE SPILL SITE. PHOTO CREDIT: DAVID SWANSON PHILADELPHIA INQUIRER: ABOVE RIGHT: ATHOS I PHOTO CREDIT: DANIELLE DEMARINO BOTTOM RIGHT: OIL SOAKED GOOSE FROM ATHOS 1 SPILL PHOTO CREDIT: DAN PRAN/THE NEW YORK TIMES

Cultural & Historic Value

- Native Americans
- European Movement and American Independence
- Historical Sites and Reenactments

Native Americans

The Delaware River holds a spiritual and cultural significance to those living within the watershed and beyond. Native Americans from the valley continue to meet and spread their stories and history to the community.

Pre-dating European settlement, Native Americans, the Lenape, inhabited the land along the Delaware River and Bay. Their "Lenapehoking" (land of the Lenape) encompassed southern Connecticut, New York, all of New Jersey, eastern Pennsylvania, and Delaware.[330] The Lenape made canoes and used the Delaware River for both transportation and sustenance.[331]

Today, archaeologists from American University's Department of Anthropology have found more than 55,000 Lenape artifacts from 25% of what is believed to be the total site area in the upper Delaware River Valley region. Archeological evidence of the region's native people and their settlements have been found up and down the River and its Watershed. There has even been some findings that may prove ancient cultures that pre-date the Lenape.

More recently, prehistoric Native American artifacts were found along the Delaware River in Philadelphia, at the site of the proposed Sugar House casino. Common artifacts found at Native American archaeological sites include arrowheads and other tools used during the time the Lenape inhabited the area.[332] Museums throughout the Basin describe Lenape history and culture. The Delaware River still holds a very spiritual and cultural connection to their descendents. The River is a link to the life and spirit cherished by the Lenape.

ED FELL SERVED AS PRESIDENT OF THE NATIVE AMERICAN ALLIANCE OF BUCKS COUNTY FOR MANY YEARS UNTIL HIS PASSING IN 2009. THE ALLIANCE CONTINUES TO HOLD REGULAR MEETINGS EDUCATING OUR YOUTH ABOUT NATIVE CULTURES OF THE PAST AND ENSURING NATIVE AMERICAN CULTURE LIVES ON IN THE DELAWARE VALLEY.

❖ European Movement and American Independence

With such a long history, the Delaware River valley holds significant opportunities for people looking to rediscover events of the past. From the formation of the River to the first human settlement, its colonial history, the revolutionary war, and more recent accomplishments, several places of interest bring in visitors year round. Many historic sites are located along the Delaware River or one of its tributaries. Keeping the water clean as it flows past and through these sites entices people to continue visiting them. A bad smell, dirty water, or degraded streams detract from the historic presence of a site.

Henry Hudson was the first European to discover the Delaware River when he and the crew of the Dutch Half Moon entered the mouth of Delaware Bay on August 28, 1609. They quickly ran aground in the Bay, making a u-turn that allowed Lenapes to enjoy a little more time before settlers intruded.[333] The English discovered the Delaware the following year, and Dutch, Swedish, Finnish, German and other settlers from Europe followed over the next 166 years.[334]

BATTLE OF TRENTON REENACTMENT. ***PHOTO CREDIT: PAUL CARLUCCIO***

Today, the site where George Washington crossed the Delaware on December 25th 1776, is one of the most heavily visited locations on the River, particularly on Christmas Day when this event is reenacted. On the other side of the River in Trenton, NJ, there are annual reenactments of the Battle of Trenton which ensued on Christmas night, and the second Battle of Trenton that occurred seven days later. These reenactments and Revolutionary War reenactments attract reenactors and visitors from all over the country.

History Telling

Valley Forge Park along the Schuylkill River is also a heavily visited site. Valley Forge housed Washington's army during the harsh winter of 1777.[335] Historic details mixed with recreational possibilities and nature centers, provide people of all ages and interests with an exciting day-long outing. People come from all over to visit many of the historic sites where reenactments occur, and where markers describe the event and its significance.

OLD BARRACKS MUSEUM, TRENTON N.J. BATTLE OF TRENTON REENACTMENT. ***PHOTO CREDIT: PAUL CARLUCCIO***

In the Estuary portion of the River, Fort Delaware is a famous historic site located on Pea Patch Island claimed to have grown from a cargo of peas that was lost overboard by the Dutch. Pea Patch Island today offers historic reenactments from the days when it was used as a Union prison during the Civil War.[336] In addition, the Island offers ferry rides, hiking trails, and an observation platform from which to view nine different species of birds, including Herons, Egrets, and Ibis.

Historic Sites and Reenactments	Where	Details
Minisink Archaeological Site	Bushkill, PA	Archaeologists have been making discoveries at this site for decades. More than 55,000 artifacts have been found in only 25% of the total site area. Arrowheads, relics, and details of early people continue to bring out new questions about the area's history.[337]
Valley Forge National Park	Forge, PA	Visit the encampment where Washington's army rested through the winter of 1777 during the Revolutionary War[338]
Washington Crossing the Delaware	Washington Crossing, PA	This famous site hosts annual reenactments of General George Washington crossing the Delaware River toward Trenton during the Christmas holiday bringing thousands of visitors[339]
Battle of Trenton	Trenton, NJ	The Battle of Trenton reenactments feature soldiers dressed in Revolutionary War era uniforms and traditional weaponry marching along the streets of Trenton, New Jersey.[340]
Pea Patch Island	Fort Delaware, DE	This well known site holds reenactments of the days when the island was used as a prison during the Civil War. Today it is also home to a protected wildlife preserve for numerous waterfowl species[341]

Figure 10: Historic Sites and Public Reenactments along the Delaware River

Historic Figures from the Delaware Valley

After becoming famous, Zane Grey, one of the nation's favorite Western authors from the early 20th century, moved with his wife Dolly to Lackawanna County, Pennsylvania from New York City.[342] The convergence of the Lackawanna and Delaware Rivers was one of Grey's favorite spots and is where he settled with his family around 1905.[343] The home and farmstead remain at this unique and gorgeous location as a museum for travelers and locals. The museum contains Grey's library and office full of the photos, writings, and books he used while authoring his more than 40 books and essays, the first being "A Day on the Delaware" published in *Recreation Magazine* in 1905.[344]

Another historic attraction in the same reach of the Delaware River is the Roebling Aqueduct. In 1847, John Roebling, future engineer of the Brooklyn Bridge, designed and helped to construct several aqueducts along the Delaware and Hudson canal.[345] The D&H Canal was vital in transporting coal from Pennsylvania mines to New York City, where it helped to fuel the industrial revolution.[346] The only remaining aqueduct of Roebling's is along the Delaware, because of its adaptation to a car bridge in the

early 20th Century.[347] Almost all of the original ironwork, cables, and structures, remain on the Delaware Aqueduct, and other characteristics of the time have been reconstructed so that visitors can see exactly how early transportation by mule labor and water gravity occurred.[348]

In order to maintain the region's history and keep visitors coming to these sites, it is important to keep the neighboring streams and rivers clean. The Delaware River Watershed is a part of America's history. Maintaining this history for future generations to experience is an important aspect in understanding our past and our country's foundation. Keeping the river clean, with a goal of restoring it to the conditions our prehistoric and long-ago ancestors experienced, and ensuring that it is a complement and enticement for viewing and experiencing the local economic historic and cultural offerings of our region is important for education, ecotourism, cultural values, and local economies.

Importance of Clean Water

Importance of Clean Water

"When we best protect and restore the Delaware River is when we best protect and restore ourselves……"

Maya K. van Rossum, the Delaware Riverkeeper

The Delaware River watershed is home to 8 million people and provides drinking water for approximately 15 million. It is a revered recreational resource to boaters, fishers, birdwatchers, nature hikers, swimmers, and sight-seers of all kinds. It is a means of transportation for port industry, and a steady reliable source of water for commercial and industrial operations. The riverbanks serve as habitats for rare and endangered species. The River is an ecosystem to thousands of plant and animal species that have called it home for millions of years. When the River is healthy it helps to protect us from floods, droughts and illness.

A clean Delaware River reduces the cost of water treatment and increases property values for homes and businesses. By protecting and restoring our River we earn tremendous economic and ecological benefits while the quality of life for residents throughout the Delaware River watershed increases.

Once damage has been done to the natural ecosystems of the Delaware River it can be difficult and costly to undo. It has been estimated that restoring the ecosystems necessary to replace the billions of fish and aquatic organisms killed by the Pilgrim Nuclear Generating Station located in Massachusetts would cost at least $140 million.[349]

It is often the case that the cost of the restoration is far less than the value of the natural resource to the community.[350] While the investment may be worth it, it would still have cost far less both in the direct cost of restoration and the opportunity costs during the period of harm, had the resource simply been protected in the first place.

The River is a resource and a member of our community which needs to be preserved for the children and grandchildren of the watershed. It is critical that the Delaware River remain valued so that the entire watershed may benefit ecologically, economically, culturally, and spiritually for decades to come.

One of the most important ways to protect all of the values of the streams and River discussed in this report is to protect the watershed in as natural a condition as possible. This includes protecting and restoring its floodplains in a forested state, protecting its upland forests and terrain, as well as its wetlands and soils. When we protect the watershed to protect the River we see the tremendous community-wide benefits that are received.

This report ends where it began. The most important take away from this report is that the Delaware River is a living ecosystem rich in beauty, culture, and community that needs to be protected and restored in order to continue to be the respected and contributing member of our community we all need and enjoy.

We Need Your Help

We Need Your Help

From its headwaters in the Catskills, the Delaware River flows 375 miles to the Delaware Bay. Its watershed encompasses over 13,539 square miles in the backyard of the most densely populated area of the country. When George Washington crossed the Delaware, he could not have imagined the insults this great river would suffer 200 years later - catastrophic oil and pollution spills, ongoing pollution inputs, the threat of dams and invasive dredging, and many species on the brink of extinction.

Rivers cannot defend themselves, but **the Delaware River does have a voice through the Delaware Riverkeeper and the Delaware Riverkeeper Network.** It is our responsibility and privilege to champion the Delaware River and its streams as members of our communities.

Led by the Delaware Riverkeeper, the Delaware Riverkeeper Network is **a dedicated team of staff and volunteers who defend the River and its tributaries.** For over 20 years, we've watched over the River and its tributaries, combating threats to its health and taking on challenges that endanger the environment our children will inherit. **We are the only river advocacy organization working throughout the Delaware River Valley, and we are making a difference.**

Members make up the backbone of the Delaware Riverkeeper Network, providing strength and resolve for all of our efforts and accomplishments. **Become a member and become part of our efforts to leave a legacy of healthy, vibrant rivers and the communities they support.**

As a member, you will have the satisfaction of knowing your donation is being put to work right here in the Delaware River watershed protecting local streams. You will receive email notices keeping you informed of breaking river protection news as well as opportunities to take action. You will also receive a special river keepsake, a 10% discount at our annual Native Plant Sale held the first weekend in May each year, and invitations to special members-only events.

As a citizen-supported and watershed-based organization, every membership has a profound impact on our ability to support our many successful programs. **Every member really does make a difference in ensuring that the voice of the River is heard.** Every dollar donated expands the number of threats to the River we are able to take on, so please join today. **By joining the Delaware Riverkeeper Network, you will be investing in a healthier future.**

Your membership strengthens us and ensures the voice of the Delaware River and its tributary streams is heard. To become part of the Delaware Riverkeeper Network, join online at *www.delawareriverkeeper.org* or by calling our office at 215-369-1188.

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COMMONWEALTH OF PENNSYLVANIA
ENVIRONMENTAL HEARING BOARD
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THE DELAWARE RIVERKEEPER NETWORK,
MAYA VAN ROSSUM, the Delaware
Riverkeeper, *and* RESPONSIBLE DRILLING
ALLIANCE,

Petitioners,

v.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL
PROTECTION, *and* TENNESSEE GAS
PIPELINE COMPANY,

EHB Docket No. _____

Respondents.

AFFIDAVIT OF PETER M. DEMICCO

Pursuant to 18 Pa. C.S. § 4904, I, Peter M. Demicco, state as follows:

1. I have personal knowledge of the statements contained herein and could competently testify thereto if called as a witness.

2. I have prepared this affidavit to present my professional hydrogeologic opinion on impacts to the groundwater hydrogeology, including wetlands and stream base flow, during, and subsequent to, the installation of natural gas pipelines in Northeast Pennsylvania and New Jersey. The conclusions made herein were based upon a reasonable degree of scientific certainty and arrived at through reliance upon generally accepted scientific principles and methods.

3. My education includes a Bachelor of Science in Geology and Geophysics from the University of Connecticut in 1980 and a Master of Science in Geology from the University of Delaware in 1982 with a specialty in groundwater hydrogeology.

4. My experience includes continuous employment as a groundwater geologist since 1983.

5. My professional geology registrations include Pennsylvania #PG-003690-E, Delaware, Virginia, and American Institute of Professional Geologist.

6. My experience includes an appointment for four years on the State of New Jersey Well Driller's Licensing Board.

7. My experience also includes qualification as an expert witness for New Jersey Superior Courts in several counties in New Jersey.

8. In preparing this affidavit, the documents I reviewed include, but were not limited to, PADEP Water Obstruction & Encroachment Permit DEP Application N0. E52-231 and E64-290 permit approvals for Pike and Wayne Counties respectively, dated November 21, 2012; FERC Docket No. CP11-161-000; Tennessee Gas Pipeline Company Northeast Upgrade Project Environmental Reports; Resource Report No.1, General Project Description; and Resources Report No. 6, Geological Resources.

9. My review indicated that the permit-related documents provided by Tennessee Gas Pipeline or prepared by the Pennsylvania Department of Environmental Protection with respect to the Northeast Upgrade Project contain little analysis of groundwater impacts.

10. I conducted a field inspection on November 29, 2012, along the 300 Line pipeline right-of-way in State Game Lands 209, Stairway Lake Wild Area, Pike County, Pennsylvania. During this field inspection, I made observations pertaining both to Tennessee Gas Pipeline's completed 300 Line Upgrade Project as well as areas that will be part of the proposed Northeast Upgrade Project.

General Observations of Right-of-Way for the 300 Line Upgrade Project and Northeast Upgrade Project:

11. Field conditions on November 29, 2012, were partly sunny with a spotty coverage of snow on the ground. The vegetation growth on the work areas associated with the 300 Line Upgrade Project is best described as thin and incomplete. I noted that the soil at grade contained rock fragments, indicating that subsoil and topsoil had been mixed at some point. Tracks related to heavy equipment, such as a bulldozers, could be observed based on the pattern areas where snow had melted. The soil was nearly impenetrable to a standard shovel. Snow was almost completely melted only over the runoff diversion channels immediately above the positions of the pipelines. I noted ground water springs in numerous locations overs areas of the 300 Line Upgrade Project pipeline installation as well as where only the single older pipeline was located.

12. Areas with forest cover and minimal historic soil disturbance have higher rates of ground water recharge than areas of similar geology where forest has been removed and the soil heavily compacted as observed in the areas of pipeline construction.

13. As I observed in the field, the excavation of the 300 Line Upgrade gas pipeline trench resulted in a mixture of subsoil, weathered bedrock, and bedrock fragments with the topsoil all along the right-of-way portions that I saw. The resulting material is a highly compacted, low permeable soil easily subjected to high rates of runoff and little rainfall infiltration.

14. I have investigated similar excavation of pipeline trenches in similar geologic terrain, which has been observed to expose and remove shallow bedrock opening a pathway for the migration of ground water in the trench excavation.

15. The Northeast Upgrade Project, Environmental Report, Resource Report Number 6 on Geologic Resources described methods of removal of shallow bedrock which includes blasting illustrating the potential extent of bedrock removal.

16. The Northeast Upgrade Project, Environmental Report, Resource Report Number 1 also describes dewatering techniques when ground water enters the excavation. This indicates that the interception and removal of ground water is a normal and expected occurrence.

17. The Northeast Upgrade Project, Environmental Report, Resource Report Number 1 General Project Description (Section 1.3.1.6) states that backfill usually consists of the material originally excavated from the trench; however in some cases additional backfill from other sources are required. Also sand bags and other support materials can be used when the pipe is placed into the trench. Pipeline bedding material can be derived from the excavated material through the use of a shaker bucket providing a cleaner and more uniform material for the base of the pipe. These methods maintain the preferential pathway for ground-water flow along the base of the gas pipeline excavation through the creation of void spaces and use of uniform backfill materials.

18. I observed in the construction area for the 300 Line Upgrade Project, post installation of the gas line, that backfilling had been conducted with homogenized excavated material using heavy equipment that compacted the subsoil and rock mixture. Also, I observed in the field that the mixture along the right-of-way is compacted and nearly impervious to penetration with a shovel. I also noted sparse vegetation indicating the poor quality of the material for plant growth and water infiltration, thereby creating poor conditions for water infiltration and a high degree of likelihood that significant water runoff will occur.

19. The Northeast Upgrade Project, Environmental Report, Resource Report Number 1 states "in areas where topsoil has been segregated, the subsoil will be placed in the trench first and then the topsoil will be placed over the subsoil." This statement indicates that topsoil may not be segregated as appeared in the areas observed on November 29, 2012.

20. I observed groundwater discharging and melting snow in the drainage diversion ditches in the areas above the 300 Line Upgrade gas pipeline trenches, showing active movement of groundwater in the pipeline trenches. Active movement of ground water in the pipeline trenches is further evidence of ground water dewatering in the vicinity of the pipelines.

21. I also observed that the groundwater discharge was not limited to the new pipeline construction, but was also observed in the area where only the pre-existing 24-inch pipeline exists. This illustrates that the preferential flow paths developed in the base of the pipeline excavation creates a long-term ground water drain. Rapid draining of ground water from the pipeline even in the late fall dry season illustrates the loss of water resources that support wetland hydrology and stream base flow in the summer dry season.

Conclusions:

22. As a result of my field observations and my expertise in groundwater geology, I believe that construction of the TGP NEUP pipeline project will permanently alter the hydrologic cycle in the vicinity of the pipeline right-of-way. This alteration will decrease the water resources available to support wetland hydrology and stream base flow in the summer and fall dry season.

23. It is my professional opinion that the TGP NEUP's impacts to ground water resources have not been adequately addressed in the supporting documents for the Water Obstruction and Encroachment Permit that I have reviewed to date. Potential loss of ground

water that is required to support wetland hydrology and stream base flow in the summer and fall dry season has not been addressed.

24. Nearly impervious compacted construction spoils increase rainfall runoff. Nearly impervious compacted construction spoils reduce ground water infiltration. Therefore, based on my observations of the TGP 300 Line and NEUP project areas, as well as my review of the permit documents and associated materials, my professional opinion is that ground water resources will be diminished resulting on negative impacts on wetland hydrology and stream base flow.

25. As I observed in the field, the TGP 300 Line Upgrade pipeline trenches, intercepted shallow groundwater in places, creating preferential paths for dewatering shallow groundwater not just in the disturbed construction areas, but also in areas surrounding the right-of-way, further negatively impacting ground water resources and wetlands.

26. In my professional opinion, evidence that the construction of the 300 Line Upgrade pipeline project has already resulted in permanent changes to wetlands is demonstrated by the elevated temperatures in the W038 wetland recorded by the Delaware Riverkeeper Network.

27. Increased rainfall runoff as a result of compacted soils, and increased drainage of shallow ground water around the pipeline, due to previous and proposed construction practices, will increase surface water flow and groundwater discharge in the wet winter and spring seasons and decrease summer and fall ground water discharge which supports wetland hydrology and stream base flow.

28. In my professional opinion, the permanent result of the construction of the TGP NEUP will be a decrease in the size of wetlands that are supported by ground water discharge through the dry summer and fall periods.

29. Another result of constructing the TGP NEUP will be a decrease in stream base flow that supports aquatic life and trout habitat through the dry summer and fall period in headwater streams. Low temperatures in the streams are required to maintain trout production.

The foregoing is true and correct to the best of my knowledge, information and belief. I understand that any false statements made are subject to the penalties of 42 Pa. C.S. § 4904 relating to unsworn falsification to authorities.

Executed this 17th day of December, 2012.

Peter M Demicco

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Peter M. Demicco

WHITE PAPER:

PIPELINES A SIGNIFICANT SOURCE OF HARM

Recent technological developments, such as high-volume multistage slick-water horizontal hydraulic fracturing, have created a new industry focused on the extraction of natural gas from shale.[1] Currently there is a moratorium on shale gas extraction within the boundaries of the Delaware River Watershed, but if this moratorium (in place under the authority of the Delaware River Basin Commission – DRBC) were lifted, and the ban on fracking in New York were to be reversed, it is estimated that a total of 18,000 to 64,000 wells could be drilled in the Delaware River.[2] But outside of the boundaries of the watershed, particularly in central and western Pennsylvania, shale gas extraction using drilling and fracking technology is proliferating at a rapid pace. Not only are the well pads and methods used to extract shale gas dangerous to human health and the environment, but the development of the supporting infrastructure – in particular the pipeline delivery systems – necessary to move this gas to market is having significant impacts on the environment and communities, including within the boundaries of the Delaware River watershed.

Pipeline delivery systems transport gas from wellhead to the market.[3] The Delaware River Basin is experiencing a surge of infrastructure development designed to move gas from the shale fields of Pennsylvania where drilling is happening to markets in Northeastern and Mid-Atlantic States. A typical pipeline delivery system can be found in figure 1[4].

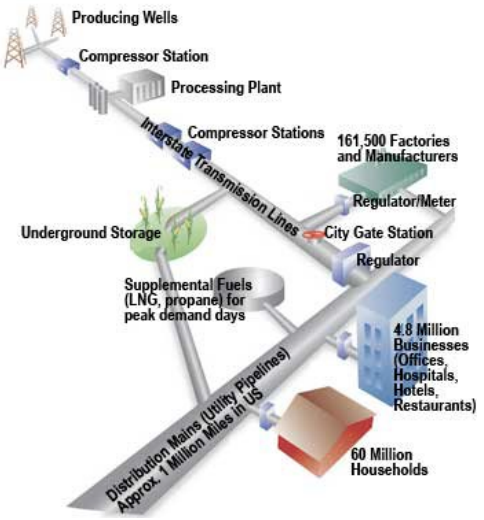

Figure 1: Typical pipeline delivery system.

Based on estimates of gas which is proved, probable and recoverable, experts believe there is only 11 to 21 years of U.S. energy which can be supported by all U.S. natural gas supply.[5] This factual scenario begs the question, whether incurring all of the harms of shale gas extraction and making the huge financial investment in pipeline infrastructure is the best use of limited resources? Aren't we better served investing in the infrastructure that will avoid the ecological harms of shale gas and instead support the perpetual energy that sustainable energy options such as wind, solar and geothermal can provide?

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[1] U.S. Department of Energy, Modern Shale Gas Development In The United States: A Primer, 8 (April 2009).

[2] Estimate was developed using the planning assumptions put forth by DRBC's Expert Report prepared in the Matter of Delaware River Basin Commission Consolidated Adjudicatory Hearing on Natural Gas Exploratory Wells, by Patrick M. O'Dell, P.E., "Potential for Development of Natural Gas Exploratory Wells to Adversely Affect Water Resources of the Delaware River Basin", National Park Service Geologic Resources Division, November 23, 2010, pp. 7-8.

[3] Nels Johnson, et al., Natural Gas Pipelines, The Nature Conservancy, 1 (December 2011).

[4] Image from, http://www.duke-energy.com/pdfs/AGA_pipeline_insert.pdf.)

[5] "What the Frack? Is there really 100 years' worth of natural gas beneath the United States?" by Chris Nelder. Dec 29, 2011. See also "Top Three Reasons Cheap Natural Gas Won't Kill Renewable Energy", By Stephen Lacey, Feb 21, 2012.

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I. The Parts of a Pipeline

The vast majority of natural gas gets to markets through pipelines. Every new natural gas well pad requires at least one gathering pipeline. A gathering line is typically a 6 to 24 inch steel pipe that can be miles long and carries the raw gas at approximately 350 psi. A study in Bradford County Pennsylvania has determined that each well drilled requires at least 1.6 miles of new gathering pipeline to be constructed.[6] Many of the new gathering lines currently under construction, such as a gathering line system built by Chesapeake Energy in central Pennsylvania, are as large as the interstate pipelines and operate at similarly high pressures.[7] This recent increase in the size and scope of gathering lines is becoming more common throughout Pennsylvania. Ultimately, these gathering lines are connected to larger capacity high pressure transmission pipelines that are capable of moving the gas hundreds of miles to their points of delivery.[8] Smaller distribution lines then take the gas from the transmission line to each individual home/end user. A typical well pad and gathering line can be seen in figure 2.[9]

Figure 2: Picture of a well-pad and gathering line located in Amwel Township, Pennsylvania

In addition to the pipelines themselves, compressor stations need to be constructed every 30 to 60 miles in order to boost pressure in the line as it is lost to friction. These compressor stations are usually comprised of multiple engines, generating thousands of horsepower by either burning off some of the natural gas that comes through the pipeline or through separate fuel supplies. Other appurtenant facilities, such as valve shut-off joints and pig launchers (delivery points for pipeline integrity monitoring devices), also need to be constructed and integrated into the system.

One simple way to look at a pipeline delivery system is to picture it as a large sprawling tree: the roots (gathering lines), the trunk (transmission lines), and the branches (distribution lines). As the development of the Marcellus Shale, Utica Shale and Upper Devonian Shale intensifies, the network of pipelines, will significantly grow.

II. Construction Methods

There are three broad categories of construction methods for pipelines crossing water-bodies: "wet" ditch crossing, "dry" ditch crossing or horizontal directional drilling that passes below the waterbody.[10] A "wet" ditch crossing encompasses any dredging construction activity that takes place while the water body continues to flow. "Dry" ditch crossings are aimed at transferring stream flow around the work area and encompass two primary techniques: dam and pump or flume. Horizontal directional drilling (HDD) seeks to avoid the creek cut altogether by tunneling under the waterway. Each technique is associated with a particular set of environmental harms.

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[6] Johnson, et al. *supra* note 3, at 3.
[7] Craig R. Mccoy and Joseph Tanfani, *Similar Pipes, Different Rules*, PHILADELPHIA INQUIRER, available at, http://articles.philly.com/2011-12-12/news/30507185_1_hazardous-materials-safety-administration-pipeline-safety-rules.
[8] *Id*. at 1.
[9] Image available at, http://www.marcellus-shale.us/gas-pipelines.htm (picture of a well-pad and gathering line located in Amwel Township, Pennsylvania).
[10] Johnson, et al. *supra* note 3, at 3.

Wet ditch crossing construction is primarily accomplished through in-stream dredging. While this method is cheaper, quicker, and thus more common, it is also associated with more significant environmental problems than any of the dry ditch techniques. The process for wet ditch crossings involves laying pipe across a stream by digging a ditch from one side of the stream to the other. In some cases, a temporary bridge is installed so the backhoe can dig a trench across the streambed (see Figure 3[11]).[12] This construction occurs *as the stream is flowing*; there is no redirecting or damming of water. There are high releases of sediment, impacts to aquatic ecosystems, and changes in channel morphology.[13]

Figure 3: Picture of wet ditch crossing of the Lackawaxan West Branch River .

In the dam and pump technique, the stream is dammed and water is transferred across the construction site by means of a temporary hose or pipe and pump. This construction isolates and diverts the stream around the pipeline crossing. Problems associated with this technique include: sediment releases during dam construction, dam removal and as water washes over the construction area; slow construction/installation time compared to other construction methods; extended period of in-stream activity and prolonged sediment release; fish salvage may be required from dewatered reach; and a short-term barrier to fish movement is created.[14]

In the flume technique, the stream is dammed and a culvert is installed. The flume pipe is then installed after blasting (if necessary), but before any trenching. Sand bags and plastic sheeting diversion structures or an equivalent setup are often used to divert stream flow through the flume pipe. In addition to the problems posed by the dam and pump method, problems associated with flume pipeline construction include: the flumes becoming short-term barriers to fish passage if the water velocity in the flume pipe is too high or if the flume pipe is perched above the streambed; and the inducement of stream velocities that may create downstream scour.[15]

Horizontal directional drilling is a technique that is similar to the drilling of a horizontal hydraulic fracturing well. A pilot hole is first drilled down to a sufficient depth and then deviated underneath the stream parallel to the ground. The wellbore is then enlarged to a diameter larger than the diameter of pipe to be installed. A prefabricated pipe segment is pulled into the hole, using the same drill rig that bored the initial and enlarged holes. Although directional boring installations do not generate major sediment discharges, the potential for environmental damage due to unexpected releases of drilling mud and borehole cave-ins still exists.[16] If fractures in the drilling substrate are encountered, there is the potential for pressurized drilling fluids to leak out of the borehole and potentially reach the streambed.[17] For example, three separate blowouts or spills caused by Laser Pipeline Co. muddied a high value stream in Susquehanna County where horizontal directional drilling was utilized.[18] In 2013 the Tennessee Gas Pipeline company had a blow out during horizontal directional drilling of its Northeast Upgrade Project that collapsed a local

[11] Picture courtesy of the Delaware Riverkeeper Network, Faith Zerbe, 2011.
[12] James Norman, et al., *Utility Stream Crossing Policy*, ETOWAH AQUATIC HABITAT CONSERVATION PLAN, July 13, 2008, 12.
[13] T.C. Pharris, R.L. Kopla, *Overview of the Design, Construction, and Operation of Interstate Liquid Petroleum Pipelines*, Argonne National Laboratory (2007).
[14] Norman, *supra* note 12
[15] Norman, *supra* note 12 at 13.
[16] Canadian Association of Petroleum Producers, Canadian Energy Pipeline Association, and Canadian Gas Association, *Pipeline Associated Water Crossings*, 1-4 (2005).
[17] *Id*.
[18] Available at, http://thetimes-tribune.com/news/third-spill-at-pipeline-site-sullies-susquehanna-county-creek-1.1186532#axzz1iLfWwIBC.

road in Northern New Jersey[19] and caused a release of drilling muds. Additionally, fluid management problems and cross-contamination of aquifers may be a concern when aquifers of large-volume sources of groundwater under pressure are intersected by the pilot hole.[20] Horizontal directional drilling also requires large areas to be cleared for mud pits, pipe assembly areas, and staging areas and therefore has a significant disturbance footprint.

For a more thorough description of the different pipeline construction techniques, please see "Overview of the Design, Construction, and Operation of Interstate Liquid Petroleum Pipelines," by T.C. Harris and R.L. Kopla.[21]

III. Impacts of Pipeline Construction Activity

There are significant environmental impacts which result from pipeline crossing and construction activities regardless of mitigation techniques used. The list of impacts includes, but is not limited to: erosion and sedimentation, loss of riparian vegetation, habitat loss and fragmentation, air quality impacts, safety concerns, groundwater impacts, soil compaction, increased stormwater runoff, wetland degradation, and cumulative environmental impacts along the length of the project. These impacts to the environment are not limited to the time period in which the right-of-way is disturbed, but can result in long lasting consequences.

Sediment Pollution

Studies documenting the effects of stream crossing construction on aquatic ecosystems identify sediment as a primary stressor for construction on river and stream ecosystems.[22] During the construction of pipeline stream crossings, discrete peaks of high suspended sediment concentration occur due to blasting, trench excavation, and backfilling.[23] For example, the excavation of streambeds can generate persistent plumes of sediment concentration and turbidity.[24] This sedimentation has serious consequences for the benthic invertebrates and fish species whose vitality is crucial for healthy aquatic ecosystems. There have been documented reductions in benthic invertebrate densities, changes to the structure of aquatic communities, changes in fish foraging behavior, reductions in the availability of food, and increases in fish egg mortality rates.[25] In addition to the stream crossing construction activity itself, the associated new road construction increases the risk of erosion and sedimentation.[26]

There are numerous environmental risks associated with open trench burial of gas pipelines (wet, dry, slurry). Open trench burial involves the excavation of sediments for pipeline installation perpendicular to or across streams and their sometimes wide floodplains, along with removal of vegetation and well-established ecosystems. Disruption of the stream channel and banks can cause destabilization of the stream's natural flows, causing channel migration and erosion that are harmful to the stream. [27] The open trench cut method of crossing streams results in sedimentation, impacts to benthic habitat, and can result in changes to stream morphology that can further affect downstream habitats.[28]

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[19] Pipeline work collapses part of Sussex county road near Delaware river, North Jersey.com July 9, 2013. http://www.northjersey.com/news/pipeline-work-collapses-part-of-sussex-county-road-near-delaware-river-1.713363

[20] Canadian Association of Petroleum Producers, Canadian Energy Pipeline Association, and Canadian Gas Association, *Planning Horizontal Directional Drilling for Pipeline Construction*, 6-3 (2004).

[21] T.C. Pharris, R.L. Kopla, *Overview of the Design, Construction, and Operation of Interstate Liquid Petroleum Pipelines*, Argonne National Laboratory (2007).

[22] Scott Read, *Effects of Sediment Released During Open-cut Pipeline Water Crossings,* Canadian Water Resources Journal, 1999, 24: (3) 235-251.

[23] *Id*.

[24] *Id*.

[25] Norman, *supra* note 12, at 9-10.

[26] *En Banc* Hearing of the Pennsylvania Public Utility Commission on Jurisdictional Issues Related to Marcellus Shale Gas Development, Docket No. I-2010-2163461.

[27] Expert Report from HydroQuest, attached.

[28] See Effects of Sediments Released During Open-Cut Pipeline Water Crossings, Canadian Water Resources Journal, Vol. 24, No. 3, 1999.

Sedimentation results from the actual crossing activity itself as well as the removal of vegetation and activity that takes place on the stream-adjacent (riparian) lands. While dam and pump methods, can reduce sediment loadings associated with a wet cut method, there are still sediment releases at levels of concern and impact, and the diversion of the water creates impediments to fish and flows that also have impacts on waterways. Additionally, this method of crossing takes longer, and so it results in longer-term direct impacts to the stream and sediment releases over a prolonged period. Sediment carried in the water column is abrasive and can result in increased erosion downstream.[29] Deposited sediment from construction activities can fill in the interstitial spaces of the streambed, changing its porosity and composition, and thereby increasing embeddedness and reducing riffle area and habitat quality.[30] Furthermore, deposited sediment has the potential to fill in pool areas and reduce stream depth downstream of the construction area.[31]

Impacts to Benthic Invertebrates, Fish Communities and Aquatic Ecosystems

Benthic invertebrates can have higher drift rates during stream crossing construction and reduced densities following open trench cut methods of crossing. Reduced densities can be the result of both the higher drift and the increased sedimentation that affects suitability of habitat resulting from the pipeline installation.[32] Changes in downstream diversity and structure of benthic invertebrate communities can also result. While, in time, the benthic community generally restores, that does not diminish or negate the ecosystem affects during the time of damage including the other cascading affects to other ecosystem services otherwise provided by the invertebrates – including as food for other dependent species, the water quality benefits provided by invertebrates helping with nutrient breakdown, and the breakdown of instream detritus creating food for other species.[33]

Using the open trench cut method of crossing can also affect fish, including direct harm but also by reducing the suitability of habitat including for eggs, juveniles and overwintering.[34] Fish exposed to elevated suspended solids levels can experience reduced feeding rates, physical discomfort or damage from the abrasive materials on their gills, decreased instream visibility, reduced food supply, and increased competition as fish attempt to move to cleaner waters.[35] For example, the filling of riffles not only can have adverse impacts for invertebrates and fish, in terms of taking important habitat, but it can also diminish the ability of the riffles to help create oxygen important for aquatic life.[36] Over time these impacts can depress the immune system of fish, result in lower growth rates, result in increased stress on individuals and populations, cause damage to the gills – all of which can result in a decline in fish and population health and survival rates.[37] This of course all gets compounded by adverse effects to the suitability of habitat for eggs and juveniles necessary to support the overall community and population.[38] Additionally, downstream sedimentation and also disruption of flows during crossing activities can result in areas of the stream that are shallower or dewatered, thereby taking preferred habitat.[39]

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[29] Pipeline Associated Watercourse Crossings, 3rd Edition, publication prepared for CAPP, CEPA, and CGA by Tera Environmental Consultants
[30] Read, *supra* note 22, at 235-251.
[31] Norman, *supra* note 12, at 9-10.
[32] Ibid 1.
[33] See e.g. Sweeney, B. W., et al. 2004. Riparian deforestation, stream narrowing, and loss of stream ecosystem services, PNAS, September 2004; 101: 14132-14137.
[34] Ibid 1.
[35] Pipeline Associated Watercourse Crossings, 3rd Edition, publication prepared for CAPP, CEPA, and CGA by Tera Environmental Consultants
[36] Ibid 1.
[37] Ibid 1.
[38] Ibid 1.
[39] Ibid 1.

Forest and Riparian Buffer Impacts

Pipeline construction results in the loss of riparian (streamside) vegetation.[40] For each of the pipeline construction techniques there is a resulting loss of vegetation and foliage associated with clearing the stream banks. Riparian vegetation is an important part of a healthy ecosystem and protects the land adjoining a waterway which in turn directly affects water quality, water quantity, and stream ecosystem health. A stream corridor is composed of several essential elements including the stream channel as well as associated wetlands and vernal ponds, floodplains, and forests. The body of scientific research indicates that stream buffers, particularly those dominated by woody vegetation that are a minimum 100 feet wide, are instrumental in providing numerous ecological and socioeconomic benefits. [41] Simply put, riparian corridors protect and restore the functionality and integrity of streams. A reduction in streamside healthy and mature streamside vegetation reduces stream shading, increases stream temperature and reduces its suitability for incubation, rearing, foraging and escape habitat.[42] While horizontal directional drilling may move the construction footprint further away from the stream, it too results in vegetative losses and soil compaction that can have direct stream impacts.

The loss of vegetation also makes the stream more susceptible to erosion events, exacerbating the sedimentation impacts of construction. In crossings that result in open forest canopies, increases in channel width, reduced water depth, and reduced meanders have persisted in the years after using an open cut method of installation.[43]

Loss of trees in a watershed, even when there exists a buffer between the cuts and the creek, can still have direct impacts on water quality. A seven-year long hydrological study on water quality demonstrates that cutting trees can increase turbidity in nearby water bodies even if the trees and vegetation are left in place.[44] Another study, also involving leaving cut trees/vegetation in place, demonstrates that even five months after deforestation, nitrates had increased and pH was altered in a water body, adversely impacting water quality.[45]

Habitat Fragmentation

Forest fragmentation and habitat loss is a serious and inevitable consequence of increased pipeline construction activity. When a pipeline cuts its path through a forest the level of harm is increased – the "forest clearing creates an associated edge effect" whereby "increased light and wind exposure creates different vegetation dynamics".[46] Therefore, damage to the forest ecosystem for a 1 mile section of a 100 foot wide pipeline right of way (ROW) will directly impact 12 acres of forest, and it will damage an additional 72 acres of adjacent forest by transforming it from interior habitat to that of forest edge habitat[47] (i.e. an additional 300 feet of forest on either side of the ROW is impacted). This means that when a forest cut is made, for every 1 mile of pipeline (assuming a 100 foot ROW) at least 84 acres of forest habitat are impacted.

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[40] Norman, *supra* note 12, at 8.
[41] See e.g. Newbold et al. 1980, Welsch 1991, Sweeney 1992, Sweeney and Newbold 2014
[42] CAPP (2005), *supra* note 16, at 1-4.
[43] Ibid 1.
[44] *See* Marryanna, L. et al, "Water Quality Response To Clear Felling Trees For Forest Plantation Establishment At Bukit Tarek F.R., Selangor," Vol. 18[1] Journal of Physical Science 33-45 (2007) (experimental plot was clear cut, left in place with a 65.6 foot wide buffer next to river, and river's turbidity increased on-average by 279%).
[45] *See* Likens, G.L. et al., "Effects of Forest Cutting and Herbicide Treatment on Nutrient Budgets in the Hubbard Brook Watershed-Ecosystem" 40 Ecol. Monogr. 23-47 (1970) (study also showed large increases for all major ions, except for ammonium, bicarbonate, and sulfate).
[46] Cara Lee, Brad Stratton, Rebecca Shirer, Ellen Weiss, *An Assessment of the Potential Impacts of High Volume Hydraulic Fracturing (HVHF) on Forest Resources*, The Nature Conservancy, Dec. 19, 2011.
[47] Johnson, *supra note* 3.

The Nature Conservancy has determined that "[t]he expanding pipeline network could eliminate habitat conditions needed by "interior" forest species on between 360,000 and 900,000 acres as new forest edges are created by pipeline right-of-ways."[48]

Interior forest species, such as black-throated blue warblers, salamanders, and many woodland flowers, require shade, humidity, and tree canopy protection that only deep forest environments can provide.[49] For example, the ROW corridor "inhibits the movement of some species, such as forest interior nesting birds, which are reluctant to cross openings where they are more exposed to predators."[50] While some species may be inhibited from travelling up or across an open pipeline ROW, others will readily travel up and over, increasing the level of harm. The clearing of forest for pipelines can also result in the introduction of invasive species (such as Japanese knotweed and hay scented fern) resulting in further decline of native wildlife species, and the creation of microclimates that degrade forest health through sunscald and wind-throw.

Prior to the development of Marcellus shale gas, Pennsylvania was already home to "an estimated 8,600 miles of large diameter natural gas pipeline."[51] The Nature Conservancy has estimated that every shale gas well pad results in approximately 1.65 miles of gathering pipeline.[52] This means that Marcellus shale gas development in Pennsylvania could require 10,000 to 25,000 miles of new gathering pipeline by the year 2030 (depending on whether one is assuming a low or high development scenario.)[53] It is estimated that a third to a half of this new pipeline will be built in the State's forested areas.[54] Nature Conservancy has projected that 60,000 to 150,000 acres of forest will be cleared in the next 20 years for pipeline rights of way.[55]

Air Quality Impacts

Shale gas, its development and use, results in greenhouse gas emissions of carbon dioxide and methane. Compressors and pipelines associated with shale gas are also sources of air pollution including methane, ethane, benzene, toluene, xylene, carbon monoxide and ozone.[56] The greenhouse gas footprint from shale gas during its development, storage and transmission is at best comparable to, and more than likely far worse than, that of other major fossil fuels.[57]

Methane is a primary component of natural gas. While carbon dioxide is the primary greenhouse gas emitted as the result of human activities, methane is the second most prevalent and is known to be significantly more potent than carbon dioxide in its adverse effects on global climate change. Compared to carbon dioxide, methane has a global warming potential that is as much as 34 times higher when considering a 100-year time frame. If a 20-year time frame is used, the figure goes up with the global warming potential of methane being 86 times greater than CO^2. Given that the earth may reach a temperature tipping point in anywhere from 18 to 38 years,[58] it is the 20 year time frame that is the most meaningful and needs to be the basis of present day decision-making.

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[48] Johnson, *supra note* 3.
[49] Johnson, *supra note* 3.
[50] Johnson, *supra note* 3.
[51] Johnson, *supra note* 3.
[52] Johnson, *supra note* 3.
[53] Johnson, *supra note* 3.
[54] Johnson, *supra note* 3.
[55] Johnson, *supra note* 3.
[56] Johnson, *supra note* 3.
[57] R.W. Howarth, R. Santoro, A. Ingraffea, Methane and the greenhouse-gas footprint of natural gas from shale formations, A letter, Climatic Change, March 13, 2011.
[58] R. Howarth, D Shindell, R. Santoro, A. Ingraffea, N. Phillips, A Townsend-Small, Methane Emissions from Natural Gas Systems, Background Paper Prepared for the National Climate Assessment, Reference number 2011-0003, Feb. 25, 2012.

"Natural gas systems are the single largest source of anthropogenic methane emissions in the United States" contributing approximately 40% of the anthropogenic emissions of methane.[59] Emission of methane to the atmosphere during the production and distribution of shale gas contributes to this fossil fuel's climate changing impacts. Methane is released to the atmosphere on multiple occasions during the shale gas extraction process. It has been estimated that "during the life cycle of an average shale-gas well, 3.6 to 7.9% of the total production of the well is emitted to the atmosphere as methane."[60] Among the most recent scientific findings is that as much as 9% of the methane produced while drilling for gas is lost to the atmosphere.[61] While a previous estimation that 4% was lost from the well fields had already raised alarm bells for many;[62] the new figure of 9% is increasing evidence of the massive methane contribution shale gas development provides to the atmosphere.

Additionally, large amounts of methane leak into the atmosphere during the "transport, storage and distribution" phases of the natural gas delivery process including during transmission through interstate pipelines.[63] Even conservative estimates of leakage during gas transmission, storage and distribution have given a range of up to 3.6%.[64] If additional processing is required before the gas can be transported through a pipe then as much as 0.19% more of the gas can be lost.[65] The majority of emissions from the transmission segment come from leaks on compressor components. Leaks of methane from the pipelines are also caused by disturbances from earth movement, the breakdown of joints, corrosion, and natural processes that degrade softer elements in the pipe. After the gas moves through transmission lines, underground distribution pipelines move the gas from the local gas utility/ distribution company to the end user, the residential or commercial customers. High incidence of leaks also occur from underground distributions pipelines especially from older pipelines made of cast iron and unprotected steel. Since Pennsylvania, New Jersey, and New York have the greatest miles of both cast iron and unprotected steel distribution pipelines,[66] leakage from distribution lines may be significant.

Researchers "have found that methane leaks would need to be held to 2% or less in order for natural gas to have less of a climate changing impact than coal due to the life cycle of methane."[67] At leakage above 3.2%[68] natural gas ceases to have any climate advantage over other fossil fuels. As discussed above, the existing leakage rate is likely significantly higher than either of these numbers.

When upstream and downstream emissions are considered along with the increase in shale gas wells over the next 2 decades, the methane emissions from the natural gas industry will increase, by as much as 40 to 60%.[69] Upstream emissions occur during well completion and production at a well site while midstream emissions occur during gas processing. Downstream emissions are those that happen in the storage systems as well as the transmission and distribution pipelines.[70]

Scientists believe that if the earth warms to 1.8°C above what it was between 1890 and 1910 that it will put in play a set of chain reactions that will result in increasing releases of methane to the atmosphere –

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[59] Id.
[60] Howarth, *supra note* 55.
[61] Methane Leaks Erode Green Credentials of Natural Gas, Nature International Weekly Journal of Science, Jan. 2, 2013. See also Howarth, *supra note* 56
[62] Id.
[63] Howarth, *supra note* 56; See also U.S. EPA 1997. Methane Emissions from the Natural Gas Industry. USEPA National Risk Management Research Laboratory, June 1997, EPA-600-SR-96-080.
[64] Howarth, R. W. (2014). A bridge to nowhere: methane emissions and the greenhouse gas footprint of natural gas. Energy Science & Engineering.; See also Howarth, *supra note* 55.
[65] Howarth, *supra note* 55.
[66] U.S. EPA 2014. Improvements needed in EPA efforts to address methane emissions from Natural gas Distribution pipelines. Office of Inspector General. Report 14-P-0324. July 25, 2014.
[67] ***Switching from Coal to Natural Gas Would Do Little for Global Climate, Study Indicates***, UCAR/NCAR Atmos News, Sept 8, 2011.
[68] According to the Environmental Defense Fund
[69] Howarth, *supra note* 56.
[70] Howarth, *supra note* 56.

largely released from the arctic as a result of melting permafrost – which will in turn cause increased warming and its associated impacts.[71] It is posited by scientists that without immediate reductions in methane emissions and black carbon the earth will warm to 1.5°C by 2030 and 2.0°C by 2045/2050 and that this will be the case regardless whether carbon dioxide emissions are reduced or not. And so it is clear that the next few decades are crucial, and that reduction of methane in the near term must be part of any solution.

Exposed Pipelines and Associated Risk of Rupture

Because open trench pipeline installations may unnaturally alter both stream bank and streambed (i.e., channel) stability, there is an increased likelihood of scouring within backfilled pipeline trenches. This is because open trenches themselves, when backfilled, may not be compacted to stable pre-trench sediment permeability conditions. Flooding rivers can scour river bottoms and expose pipelines to powerful water currents and damaging debris. Additionally, unusually heavy rains possibly associated with climate change, threaten to increase overall stream degradation and channel migration – thereby exposing shallowly buried pipelines.

Scouring that exposes pipelines buried in streambeds is well documented. The open trench cut method is likely to set the pipeline shallowly enough that exposure by scour is a real threat. Exposure of the pipeline raises a greater risk of pipeline damage, breakage and pollution; with pipeline breakage resulting in the catastrophic discharge of its contents into the natural stream system. Talke and Swart (2006) and De La Motte (2004) discuss gas pipelines and how man-made changes and actions have altered channel morphology and changed channel stability. Soil erosion and channel migration reduces the soil cover over a pipeline, resulting in scour hole formation and making the pipeline vulnerable to rupture. Lateral migration of stream channels can also heighten the risk of pipeline exposure. Fogg and Hadley (2007) evaluated hydraulic considerations for pipeline crossings stream channels. Their Figure 4 depicts lateral migration of a stream channel during high water that excavated a section of pipeline under the floodplain that was several feet shallower than at the original stream crossing.

Figure 4: Picture of an exposed pipeline crossing an unnamed western US river.

Scour hole development proximal to pipelines is well-documented in both stream and seabed settings.[72] In 1993, the flooding Gila River in Arizona ruptured a 36-inch pipeline, sending natural-gas bubbling to the surface.[73] In addition, and also associated with 1993 flooding in Arizona from heavy water releases from San Carlos Lake, several El Paso Natural Gas pipelines, which crossed the Gila River near Coolidge, Winkleman, and Kelvin were "scoured" and uncovered by the force of the water and failed.[74] Doeing et al. (1997)[75] further document six gas pipelines in the Gila River Basin that were either exposed on bridges or failed due to stream erosion stemming from January 1993 floods in Arizona. The failures were critical because these were major transmission lines that supplied natural gas to residential and industrial users in whole communities and groups of communities. Stream-based pipe *"(f)ailures were caused not only by vertical scour of the streambed but also by bank erosion, lateral channel migration, avulsions,*

[71] Howarth, *supra note* 56.
[72] Fogg, J. and Hadley, H., 2007, Hydraulic Considerations for Pipelines Crossing Stream Channels. Technical Note 423. BLM/ST/ST-07/007+2880. U.S. Department of the Interior, Bureau of Land Management, National Science and Technology Center, Denver, CO. 20 pp. http://www.blm.gov/nstc/library/techno2.htm.
[73] Randazzo, R., 2010, Arizona to assess gas- pipe safety after California blast. The Arizona Republic (9-20-10).
[74] Wikipedia. http://en.wikipedia.org/wiki/Coolidge_Dam
[75] Doeing, B.J., Williams, D.T. and Bradley, J.B., 1997, Gas Pipeline Erosion Failures: January 1993 Floods, Gila River Basin, Arizona. In Storm - Induced Geologic Hazards, Case Histories from the 1992 - 1993 Winter in Southern California and Arizona; Geological Society of America; Reviews in Engineering Geology, Volume XI (ed. Robert A. Larson).

bridge scour, and secondary flows outside the main channel. … Several of the pipelines in the study failed as a result of a meander migration or avulsion of the stream into previously less active or nonexistent channels."[76] Based on field observations and hydraulic modeling for the 100-year design flood, researchers documented maximum vertical scour to 26.6 feet (8.1 meters) and lateral scour to 6,274 feet (2,050 meters) at some failed pipeline crossings.

Federal regulations require that pipelines crossing rivers be buried at least four feet underneath most riverbeds.[77] An expert at HydroQuest has determined that, at a minimum, any pipeline installed using the open trench cut method needs to be installed at least 24 feet below the stream bed in order to prevent exposure from scour.[78] While bridge piers are more readily exposed to stream scouring than pipelines, it is telling that bridge failure analyses have determined that channel scour occurs to depths of up to three times that of maximum river floodwater depth (e.g., scour to 30 feet with a 10 foot floodwater depth).

Another significant environmental risk associated with both wet and dry trench methods of gas pipeline crossings of rivers and streams is the potential of releasing hydrocarbons or other contaminants directly into surface water and fragile downstream ecosystems, including hydro-carbon laced liquids such as benzene that are part of the gas being delivered by the pipeline. Gas, as it is extracted from a well, may be mixed with hydraulic fracturing fluids. Hydrocarbon-laced condensate or natural gas liquids (NGLs) associated with natural gas (e.g., benzene) pose an environmental risk if pipe rupture occurs (e.g., to potential bog turtle habitat and travel corridors, fisheries, downstream drinking water supplies as well as underlying aquifers recharged by stream water). For example, a damaging flood event in Texas ruptured eight pipelines and spilled more than 35,000 barrels of oil and oil products into the San Jacinto River.[79] The Bureau of Land Management recognized and addressed this critical issue: *"In 2002, the U.S. Fish and Wildlife Service raised concerns about the potential for flash floods in ephemeral stream channels to rupture natural-gas pipelines and carry toxic condensates to the Green River, which would have deleterious effects on numerous special-status fish species"*.[80]

Figure 5: Picture of an exposed pipeline crossing the Green River Utah.

Clean up associated with pipeline breaks can be extremely expensive. For example, ExxonMobile expects that cleanup costs associated with fouling an estimated 70 miles of shoreline of the Yellowstone River may cost about $135 million.[81] The Department of Environmental Quality in Montana is also concerned with thousands of pipelines that cross small or intermittent streams. Federal officials investigating a July 2011 pipeline break that spilled 1,500 barrels of oil into a Montana river said that few companies take river erosion and other risks into account when evaluating pipeline safety.

Groundwater Impacts

[76] Id.
[77] Billings Gazette, July 21, 2011: http://billingsgazette.com/news/state-and-regional/montana/article_c8d20d9e-b391-11e0-941f-001cc4c002e0.html
[78] Expert Report from HydroQuest.
[79] Billings Gazette, *supra note* 75.
[80] Fogg and Hadley, *supra note* 70.
[81] Billings Gazette. Feb. 8, 2012: http://billingsgazette.com/news/local/feds-few-pipeline-plans-account-for-river-risks/article_b2ecac80-d313-53c9-a914-906a97aedb9d.html?oCampaign=hottopics

Pipelines have been seen by experts to be conduits for diverting groundwater from its natural path. According to expert observation, pipeline trenches can divert groundwater and as a result "permanently alter the hydrologic cycle in the vicinity of the pipeline right-of-way. This alteration will decrease the water resources available to support wetland hydrology and stream base flow in the summer and fall dry season."[82] For example, observations of the Tennessee Gas Pipeline's 300 Line Upgrade project by a hydrologist determined that "pipeline trenches intercepted shallow groundwater in places, creating preferential paths for dewatering shallow groundwater not just in the disturbed construction areas, but also in areas surrounding the right-of-way, further negatively impacting ground water resources and wetlands."[83] As a result, it was observed that the 300 Line Upgrade pipeline project had "already resulted in permanent changes to wetlands…."[84]

The compacted soils resulting from pipeline construction increase rainfall runoff and reduce ground water infiltration. This can cause further negative impacts on wetland hydrology and stream baseflow in the area of the pipeline.[85] "Increased runoff as a result of compacted soils, and increased drainage of shallow ground water" around a pipeline, due to previous and proposed construction practices, can increase "surface water flow and groundwater discharge in the wet winter and spring seasons and decrease summer and fall ground water discharge which supports wetland hydrology and stream base flow." [86] The result of reduced groundwater discharge during the dry summer and fall months can be to decrease the size of supported wetlands. So the result is too much or too little depending on the time of year. Another result of the altered flows can be to decrease stream base flow that supports aquatic life and trout habitat in headwater streams in the dry summer and fall period.

Wetlands Impacts

Pipeline construction activity requires the clearing of vegetation in and around wetlands having degrading impacts. After a new right-of-way is cleared, or an existing one is expanded, pipeline companies maintain the right-of-way by preventing woody vegetation from re-establishing on the right-of-way. As such, pipeline construction activity that passes through forested wetlands result in the permanent conversion of the forested wetland to an emergent wetland. This conversion adversely impacts the functions and values of a wetland.

Certified wetlands specialists have found a measurable "decrease" or "loss" in functionality as a result of the permanent conversion of forested wetlands to emergent wetlands.[87] For example, a functional conversion of wetlands from forested wetlands to emergent wetlands generally result in decreases to above ground biomass, structural diversity of the wetland, and local climate amelioration.[88] The conversion will also result in a loss of forest interior habitat, visual and aural screening from human activity, suitability of shade-loving plant species, and the production of mast (such as acorns) for wildlife.[89] Moreover, these conversions also result in increased wetland exposure to wind, ice and sun, as well as the localized effects of global warming on biota.[90]

Wetland functions involving drainage patterns, water quantity, and water quality will also be adversely impacted by a functional conversion of forested wetlands to emergent wetlands. Specifically, emergent wetlands provide decreased soil stabilization, streambank anchoring against erosion, nutrient

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[82] Affidavit of Peter M. Demicco, DRN v. PA DEP an TGP NEUP, 2012.
[83] Id.
[84] Id.
[85] Id.
[86] Id.
[87] *See, generally* The Effects of Converting Forest or Scrub Wetlands into Herbaceous Wetlands in Pennsylvania: A Report to the Delaware Riverkeeper Network, Schmid and Company, Inc., Consulting Ecologists (2014), attached.
[88] Id.
[89] Id.
[90] Id.

storage, and temperature maintenance when compared to forested wetlands.[91] As a result, erosion and sedimentation can be expected to increase as a result of the conversion.[92] The function of storm damage shielding can also be expected to decrease as a result of this conversion.[93]

Cumulative Impacts

The large amount of land disturbance created during pipeline construction results in increased stormwater runoff, sedimentation, and erosion of the land and stream channels.

The cumulative impact of multiple construction sites for water crossings on a stream or river has the potential to significantly degrade the quality and flow rate of the waterbody. The capacity of a water system to recover from a multitude of impacts may be exceeded with the detrimental effects of crossing construction becoming permanent.[94] Recurrent stresses on fish, such as those originating from elevated suspended sediment concentrations, will have negative effects on fish health, survival and reproduction.[95]

Broadly speaking, pipeline ROWs have two kinds of impacts: catastrophic events and chronic impacts.[96] Current regulation focuses mainly on preventing or minimizing harms that are of the catastrophic event kind – such as siltation during construction, erosion from runoff, increased stormwater runoff resulting during or after construction; but the larger ecological harms of pipeline construction is not given the same kind of consideration in current regulation. [97] Forest fragmentation, edge effects, adverse impacts to the quality of adjacent forest, the intrusion of invasive species, and the cumulative impacts of shale gas developments that results from and/or is supported by pipeline construction are all issues generally ignored in current regulation.[98] Other harms in need of greater attention in regulation includes the increased soil compaction resulting from current construction practices, the dewatering of groundwater sources, and impacts to the quality of the adjacent forest and biodiversity.

There are serious permanent environmental problems associated with pipelines. Pipelines are significant contributors to air pollution and climate change. Additionally, the potential of pipelines to rupture and leak raises a greater risk of human health concerns and serious water contamination issues. Pipelines also divert and diminish groundwater flows.

Gas pipelines are installed by private competing companies, and there is no regulatory body ensuring that these pipeline delivery systems are rationally designed, apportioned, operated, or maintained. As private companies, each of these operators has competing interests, and thus are characterized by aggressive business strategies rather than norms of shared use, cooperation, and integration. There is a danger this atmosphere will be reflected in not only the pace, size, and scope of development; but also in the way in which it occurs.

The current legal regime is not properly equipped to handle the exponential increase in concentration of pipeline construction in the Delaware River Basin. A number of federal and state agencies have been tasked with monitoring these activities, but to date have simply overseen numerous permit violations, pollution events, and noncompliant construction activity without having issued stop-work orders or appropriate fines to the associated operator. The Delaware River Basin Commission has clear authority to regulate in this arena, as enunciated in Article three of the Delaware River Basin Commission Compact;

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[91] Id.
[92] Id.
[93] Id.
[94] CAPP (2005), *supra* note 16, at 1-4.
[95] CAPP (2005), *supra* note 16, at 1-4
[96] Kevin Heatley, Restoration Ecologist, Professional Review & Comment on Natural Gas Pipeline Impacts to Terrestrial Ecology prepared for Delaware Riverkeeper Network, Sept 5, 2012.
[97] Id.
[98] Id.

however, to date the Commission has failed to exercise this authority but Delaware Riverkeeper Network is working to change that.

For a more expansive overview of potential cumulative environmental impacts please see, Utility Stream Crossing Policy, by James Norman, et al.[99]

Ongoing Impacts of Pipelines

In addition to the immediate impacts of construction, the ROW will need to be maintained and kept clear throughout the lifetime of the pipeline, which can be up to 80 years (See figure 6,[100]). While some companies assert they only keep 50 feet of the original construction ROW open for future monitoring, maintenance and repairs of the pipeline[101], the Delaware Riverkeeper Network has found that interstate transmission lines tend to be much wider – either by design or because the level of compaction that takes place during construction is so dense it prevents restoration of healthy vegetated habitat. And increasingly pipeline companies are planning for wider widths, 100 to 200 feet, to be kept permanently open (free from mature vegetation) for the life of the project.

Figure 6: Picture of a natural gas pipeline construction in Pike County, Pennsylvania.

Pipelines also bring with them compressor stations, necessary for moving the gas within the pipeline, as well as other infrastructure such as shutoff valves. Each compressor station site occupies an "average area of slightly over 5 acres."[102] Thereby increasing further the size of the permanent pipeline footprint.

Additionally the air quality impacts associated with methane leakage, the stormwater runoff and loss of groundwater recharge associated with vegetation loss and soil compaction, the impacts of forest fragmentation and invasive species are also enduring.

IV. Conclusion

With the increase in natural gas drilling activity in Pennsylvania and elsewhere, it can be expected that the surrounding areas will experience a surge in the development of supporting infrastructure. Federal and state agencies – as well as pipeline project sponsors – must be held accountable for addressing the various impacts described above. Pipeline construction and operational activity is a zero-sum game that will result in long lasting impacts to the surrounding environment. It is the mission of the Delaware Riverkeeper Network to protect the natural resources of the Delaware River Basin to the greatest extent possible from the encroachment of fossil fuel development activities.

[99] Norman, *supra* note 12, at 11-13.
[100] Image courtesy of Delaware Riverkeeper Network, Faith Zerbe.
[101] Johnson, *supra note* 3.
[102] Johnson, *supra note* 3.