U.S. DOT
Pipeline and Hazardous Materials Safety Administration
"Pipeline Safety Information Grants to Communities – Technical Assistance Grants (TAG)"
Grant Agreement - DTPH56-09-SN-0003

Submission Date: March 17, 2011

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Article IV: Deliverables:
Final Report
Environmental and Safety Evaluation/Proposed AES Gas Pipeline, Bradford Glen Subdivision, West Bradford Township, Chester County, Pennsylvania – Report by GTS Technologies, Inc. – CD submission
Federal Financial Form 425 – attached separately

Bradford Glen Homeowners Association (BGHOA) is a not for profit organization which represents 490 single-family homeowners and associated common area. One of the charges of the Association is to maintain the safety and accessibility of the common area. It is further charged with disseminating information that will directly affect the Members of the Association.

Specific Objective

This project funded technical assistance with safety analysis of transmission pipeline issues affecting the Association and Member's property. This Grant advanced the knowledge of pipeline safety through safety analysis, environmental impacts, land use and planning considerations, improved communication between facility owners, state and local representatives.

Expected Program Outputs

Safety analysis and environmental assessment: GTS Technologies, Inc. (GTS) was contracted to perform the safety analysis and environmental assessment. GTS is a professional consulting firm specializing in the geo-sciences that provides high-quality comprehensive solutions and services in geo-technology, geo-environmental, civil/site engineering and field surveys. Due to the extensive nature of the assessment, their report is attached as a CD. The table of contents and list of appendices is given in Appendix 1 and 2.

Land Plan Use: the common area of the community is dedicated open space for the enjoyment of the members and accessible to the public. In this capacity this open space must be safely maintained. To that end an ongoing assessment by member volunteers has been initiated to identify and prioritize open space issues. Maps generated by GTS are being utilized for location of issues including:

- dead or dying trees
- erosion degradation
- sink holes
- utility right-of-way (ROW) location and maintenance
- homeowner property clarification
- landscape maintenance contract and
- general community beautification plans

Specific accomplishments during this grant period as they relate to pipeline safety have included:

- The collaboration with PECO for their High tension ROW that crosses over the proposed AES and current Columbia Gas pipeline. Work has begun on the transition from scrub brush to upland meadow. This is a two year project underwritten and undertaken completely by PECO. The result of this effort will result in less maintenance by PECO, improved erosion control, diversification of wildlife habitat, community beautification and safe accessibility for PECO, pipeline, other utilities and the public.

Figure 1 - PECO ROW prior to transition

Figure 2 - PECO ROW after scrub brush removal

- During the initial walk through with GTS personnel, a test well was discovered in a storm water streambed that parallels the gas pipeline ROW. The HOA contacted Aqua PA to inform them of the situation. Aqua PA subsequently sealed the well for compliance.

Figure 3 - AquaPA Testwell in storm water drainage basin

- Columbia Gas and RCN Metro have co-located facilities in a ROW that traverses the HOA Common Area and is the proposed co-location for the AES Sparrows Point gas pipeline. At one location there is severe erosion across the ROW. The HOA facilitated a meeting between Columbia Gas, RCN Metro, affected neighbors, PHMSA, conservation district and political representatives to assess and cooperate on remediating the issue. Maps generated by GTS helped delineate the pipeline ROW. The companies have agreed that remediation is their responsibility in their ROW. The HOA agrees storm water inflow is their responsibility. Both agreed to work together to mitigate the situation that will result in elimination of the erosion. Work is anticipated to begin in summer 2011.

Figure 4 - Depth of erosion in Columbia Gas pipeline ROW

Communication: findings and information were disseminated to the Members and the public about their role in fostering the safety and reliability of pipeline operations and to strengthen the depth and quality of participation in pipeline safety matters and official proceedings. Specifically,

- Newsletter articles went out four times over the past year and a half updating the Members on the Grant activities.
- Four outreach events were in collaboration with two other Chester County, PA TAG Recipients: Safety, Agriculture, Villages and Environment (S.A.V.E.) and West Whiteland. Since these events were organized by these recipients a summary is given in their TAG Final Report. BGHOA participated as an Exhibitor displaying GTS generated maps and

AES engineering drawings thus informing citizens of areas and complexities on pipeline encroachment in an High Consequence Area.

- A community event was held at the West Brandywine Fire hall with 21 people in attendance. The event featured an overview of the BGHOA Grant and its objectives. In addition Professor Kenneth Kristl, Widener University of Law, Environmental Law Department gave an overview of the proceedings associated with the AES Sparrows Point project. Finally Russell Donnelly, LNG Opposition Team spoke about the advocacy efforts in Maryland related to the AES proposed pipeline.
- The West Bradford Days Community celebration allowed BGHOA to have a booth to display maps generated by GTS and distribute general information about pipeline safety and community involvement.
- A public meeting held at West Bradford Township sponsored by the BGHOA with participation from Rep. Ross and Sen. Dinniman gave an overview of the Grant activities and how government response is proceeding on gas pipelines in Chester County.
- The Radnor Township Town hall meeting sponsored by the League of Women Voters with participation from PHMSA informed participants on pipeline safety methodology and criteria. BGHOA spoke about issues that the community has an influence on and how to participate including intervention, 811 call and establishing improved communication with facility owners.
- As an Exhibitor at the Marcellus Shale Summit at The Penn Stater, State College, PA, BGHOA was the only representative for an entire community affected by natural gas pipelines. A summary is given in Appendix 3.

<u>Expenditure Of Funds</u>

This project was estimated to cost $50,500, with $500 supplied by the HOA and $50,000 supplied by this Grant as outlined in the original Budget Narrative. The attached SF-425 summarizes the expenditures and income associated with the Grant money.
The break-down of Grant and BGHOA expenditures is:

	ACTUAL	**BUDGET**
Personnel	N/A	N/A
Fringe Benefits	N/A	N/A
Travel	N/A	N/A
Equipment	N/A	N/A
Supplies	$1,128.41	$1,000.00
Contractual	$49,323.98	$47,000.00
Other	$2,256.83	$2,500.00
Indirect Charge	N/A	N/A
Total Expenses – Grant	$50,000.00	$50,000.00
Total Expenses – HOA	$2,709.22	$500.00
Total project expenses	$52,709.22	$50,500.00

GTS Technologies, Inc.

Environmental and Safety Evaluation
Proposed AES Gas Pipeline
West Bradford Township
Chester County, PA
December 29, 2010

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2010 Marcellus Summit – BGHOA TAG EXHIBIT

This is the third annual Summit held at The Penn Stater in State College, PA. It is a three day event that covers all aspects of the natural gas industry. My introduction into this Summit began in 2009 as a registrant as a consultant for a private company. The 2010 participation was as an Exhibitor representing the Bradford Glen HOA TAG. My observations and comparison between these two years include:

- Significant increase in Municipality representation
- More specialized consulting companies
- Legislature diversity including Federal, State and Local representatives
- More testing and safety companies as exhibitors
- Increase in legal representatives focused on landowner's rights

While I did not attend all panels or presentations some of the 2010 topics included:

- Creating Community Partnerships
- State Shale Perspective
- Legislation Updates
- Grant initiatives related to Marcellus Shale
- Regulatory and Industry Perspectives

Bradford Glen HOA was the only non-government, grassroots, non-profit exhibitor at this summit. We were well received more as a curiosity display which allowed discussion of how individuals and stakeholders need to approach the NG industry and processes. In particular, I was able to explain that the HOA is not concerned with the entire pipeline but focused on the issues that directly affect the HOA community in a high consequence area (HCA). Those issues included environmental, Class I vs. Class 3 sighting, how information differs from Federal to State submissions, communication between communities and companies and safety. Visitors to the Exhibit included investment consultants, attorneys, engineers, educators, pipeline companies and municipality representatives. The overall feedback was "good for you", "good luck", "that's interesting", "thanks for helping the public understand".

It is recommended that PHMSA promote these outreach activities specifically with industry conferences to its Grantees as well as sponsoring landowners to participate in understanding the immensity of NG process.

Respectfully submitted,

Lisa Van Houten
Facilitator
TAG for Bradford Glen HOA

ENVIRONMENTAL AND SAFETY EVALUATION

PROPOSED AES GAS PIPELINE
BRADFORD GLEN SUBDIVISION
WEST BRADFORD TOWNSHIP
CHESTER COUNTY, PENNSYLVANIA

September 21, 2010
Revised December 29, 2010

ENVIRONMENTAL AND SAFETY EVALUATION

PROPOSED AES GAS PIPELINE
BRADFORD GLEN SUBDIVISION
WEST BRADFORD TOWNSHIP
CHESTER COUNTY, PENNSYLVANIA

September 21, 2010
Revised December 29, 2010

Prepared for:

Ms. Lisa Van Houten, President
Bradford Glen Homeowners Association
West Bradford Township
Chester County, Pennsylvania

Prepared by:

GEO-Technical Services, Inc.
d/b/a GTS Technologies, Inc.
441 Friendship Road
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1.0 INTRODUCTION

This report presents the results of an Environmental and Safety Evaluation conducted by GTS Technologies, Inc. (GTS) for the Proposed AES Gas Pipeline (the Pipeline). This Environmental Evaluation has been completed at the request of the Bradford Glen Homeowners Association (HOA). The Bradford Glen development is located in West Bradford Township, Chester County, Pennsylvania.

The purpose of this report is to review the four proposed alternative locations for the Proposed AES Gas Pipeline. The proposed Pipeline runs from Baltimore, Maryland through a portion of Lancaster County, Pennsylvania and into Chester County, Pennsylvania. This document presents the environmental and safety evaluation of four alternative pipeline locations which affect the Bradford Glen Homeowners Association.

The scope of work completed for this Evaluation included the following:

- Assess and document the pipeline(s) current and proposed location in relation to current utility infrastructure within the HOA property.
- Conduct a detailed analysis of the potential impact radius should the current and/or proposed pipeline have a catastrophic failure in the HCA of the HOA property.
- Compare the safety of alternate routes of the proposed pipeline
- Determine the improvement in safety by utilizing additional shut-off valves near High Consequence Areas (HCAs).
- Develop a land use plan that includes maintenance and safety of current and proposed pipelines within the HOA property.
- Assess environmental impacts associated with proposed pipeline and alternate routes as they pertain to HOA and Member properties.
- Communicated findings and decisions to the Members of the HOA and assist in educating other communities that may be affected by pipelines, current or proposed.

2.0 DESCRIPTION OF EXISTING CONDITIONS

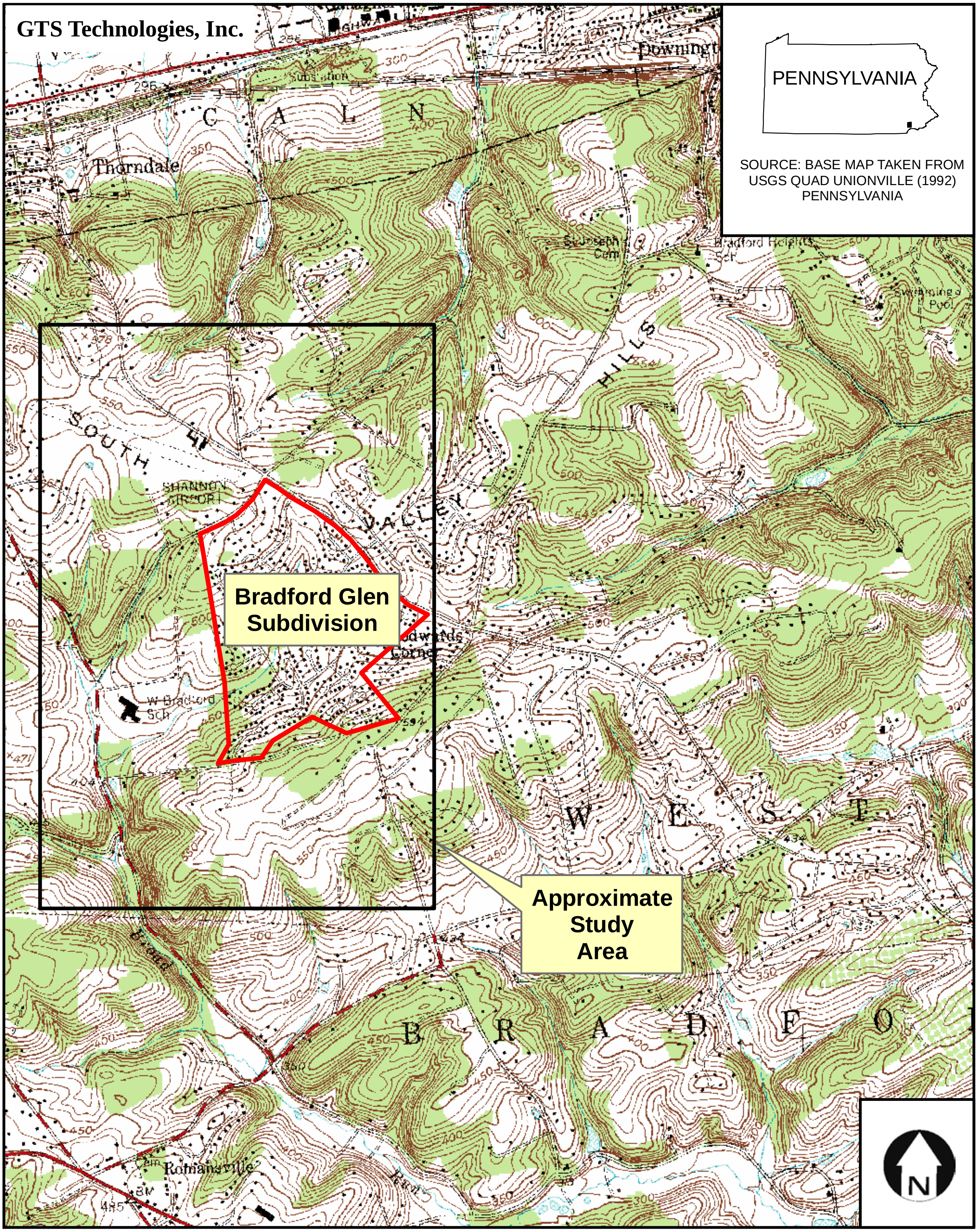
The Bradford Glen Homeowners Association was established in 1988, and represents 490 single-family homes. The Bradford Glen community (the Site) is approximately 211 acres (0.33 square mile) and is located in West Bradford Township, Chester County, Pennsylvania. The development was built in the early 1980's. A central latitude and longitude point for the Site is 39°58'32" North latitude and 75°44'01" West longitude on the Unionville, PA 7.5-minute USGS topographic quadrangle map (Figure 1, Project Location Map). The Site is situated approximately 2.7 miles southwest of Downingtown, Pennsylvania. The site is bordered by Marshallton Thorndale Road to the north, Beacon Hill Road to the east and south, and Poorhouse Road to the west. The proposed AES pipeline alignment follows an exiting utility right-of-way through the site. Several alternative alignments for the pipeline have been proposed. The AES pipeline alignment and the alternatives are shown on an aerial photograph (Figure 2, Proposed and Alternative Pipeline Routes).

2.1 Topography

Review of the Unionville 7.5-minute series topographic quadrangle map (USGS, 1953, photo revised 1992) indicates that the ground surface at the site ranges in elevation ranging from 440 to 590 feet above mean sea level (msl). Surface water runoff on the site is primarily towards a stream in the center of the development which flows south, southwest (towards the intersection of Beacon Hill Road and Broad Run Road).

2.2 Geology

According to the geologic map based on the Unionville, PA U.S.G.S. quadrangle, the site is located in the Piedmont Upland Section of the Piedmont Physiographic Province, which is characterized by broad, rounded to flat-topped hills and shallow valleys. The site is underlain by the Octoraro Formation which is a member of the Wissahickon Formation, albite-chlorite schist (Xwc) (Figure 3, Geology Map). Albite-Chlorite Schist is typically a phyllite, composed chiefly of quartz, feldspar, muscovite, and chlorite. The estimated thickness of the formation is 8,000 to 10,000 feet. Bedding is fissile (<1/2") to thin (1/2-2"), and steeply dipping in most places. Cleavage has a platy pattern. It is well developed, highly abundant, very closely spaced (2"-2'), open, and steeply dipping. It displays an even regularity. Joints are mostly irregular, poorly formed, widely spaced (3-10'), steeply dipping, and open.



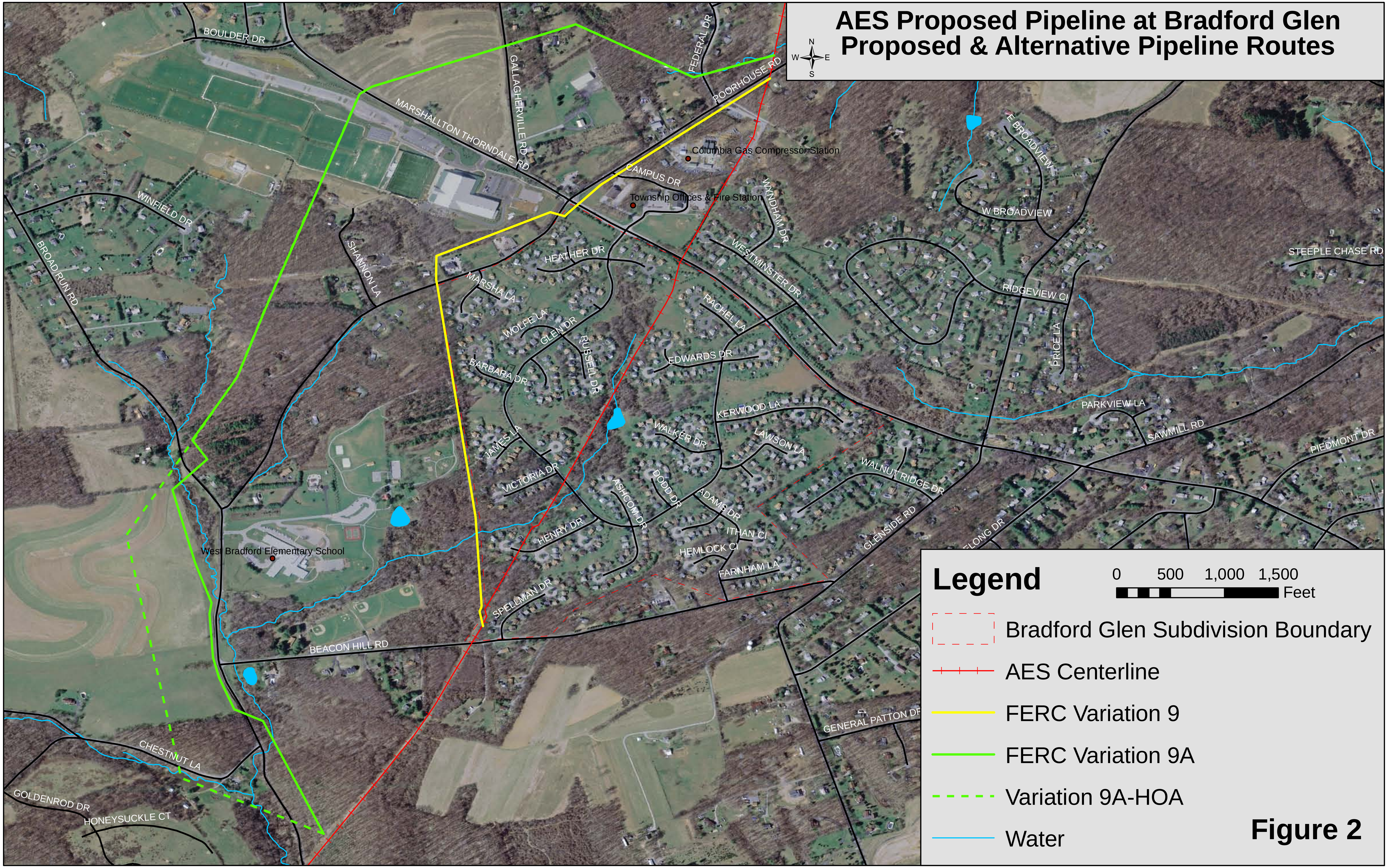
PROJECT LOCATION MAP

Bradford Glen at Victoria Crossing
West Bradford Township
Chester County, PA

0 600 1,200 2,400 ft.

SEPT 2010

FIGURE
1


AES Proposed Pipeline at Bradford Glen
Proposed & Alternative Pipeline Routes
N
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E
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BOULDER DR
MARSHALLTON THORNDALE RD
GALLAGHERVILLE RD
FEDERAL DR
POORHOUSE RD
Columbia Gas Compressor Station
CAMPUS DR
Township Offices & Fire Station
WYNDHAM DR
E BROADVIEW
W BROADVIEW
WINFIELD DR
BROAD RUN RD
SHANNON LA
HEATHER DR
MARSHA LA
WESTMINSTER DR
RACHEL LA
RIDGEVIEW CI
STEEPLE CHASE RD
WOLFE LA
GLEN DR
RUSSELL DR
BARBARA DR
EDWARDS DR
PRICE LA
KERWOOD LA
PARKVIEW LA
SAWMILL RD
PIEDMONT DR
JAMES LA
WALKER DR
LAWSON LA
WALNUT RIDGE DR
VICTORIA DR
ASHCOM DR
DODD DR
ADAMS DR
HENRY DR
ITHAN CI
GLENSIDE RD
HEMLOCK CI
FARNHAM LA
West Bradford Elementary School
SPELLMAN DR
BEACON HILL RD
CHESTNUT LA
GOLDENROD DR
HONEYSUCKLE CT
GENERAL PATTON DR
Legend
0 500 1,000 1,500 Feet
Bradford Glen Subdivision Boundary
AES Centerline
FERC Variation 9
FERC Variation 9A
Variation 9A-HOA
Water
Figure 2

AES Proposed Pipeline at Bradford Glen Geology Map

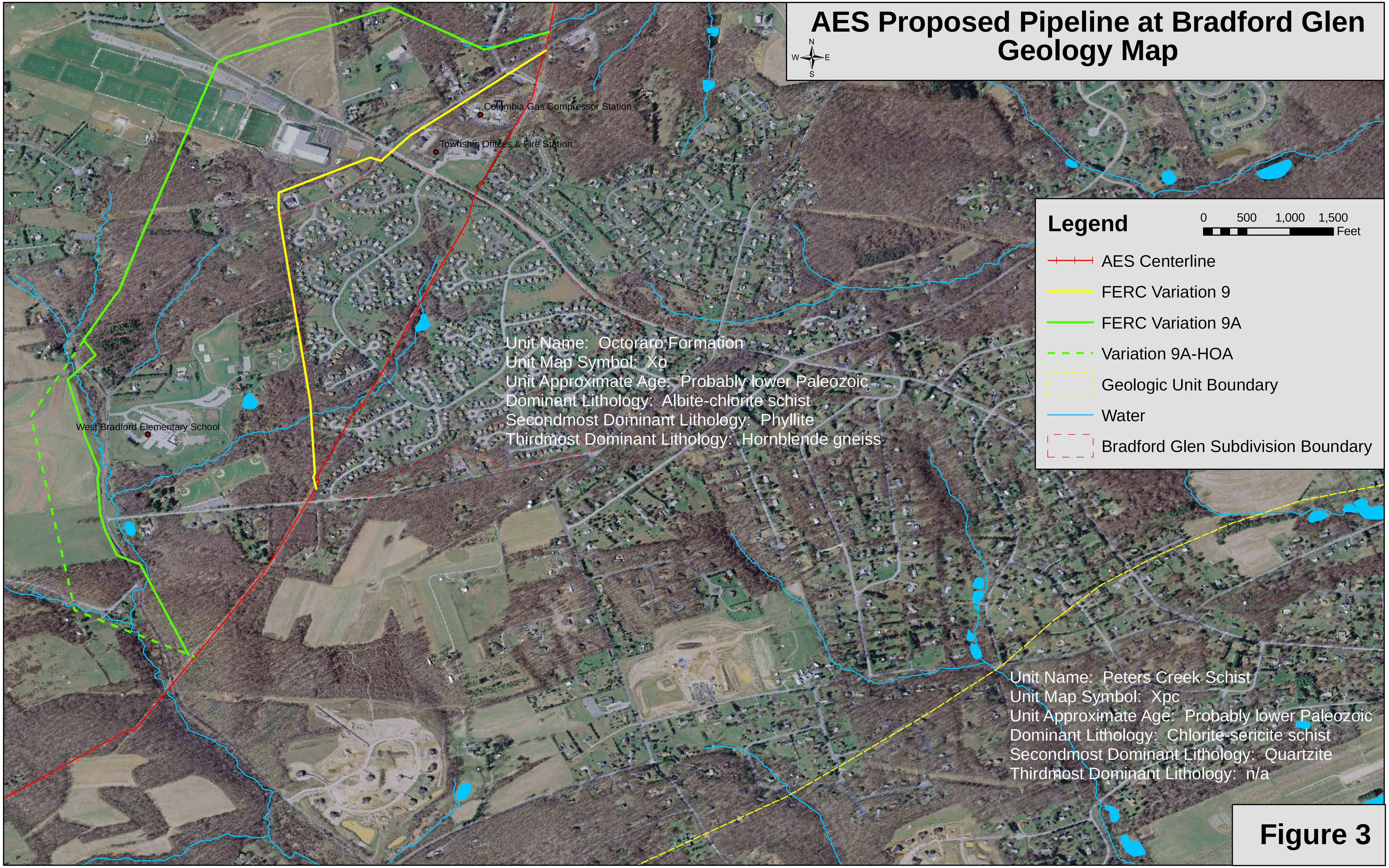


Figure 3

The formation is moderately resistant to weathering. It is often highly weathered to a moderate (1-4') depth, resulting in uneven, hackly, small sized, plate-like rubble at the base of exposures. The overlying mantle is thin (0-5'). The formation forms undulating hills of medium relief. Natural slopes are moderately steep and stable. Excavation is moderately easy. Excavation is difficult in unweathered rock. The drilling rate is moderate. Cut-slope stability is fair, in part, due to partial disintegration of the rock when it is exposed to moisture for a relatively short time. Drainage maintenance may be required. Foundation stability is good. Rock should be excavated to sound material. The formation is a good source of fill.

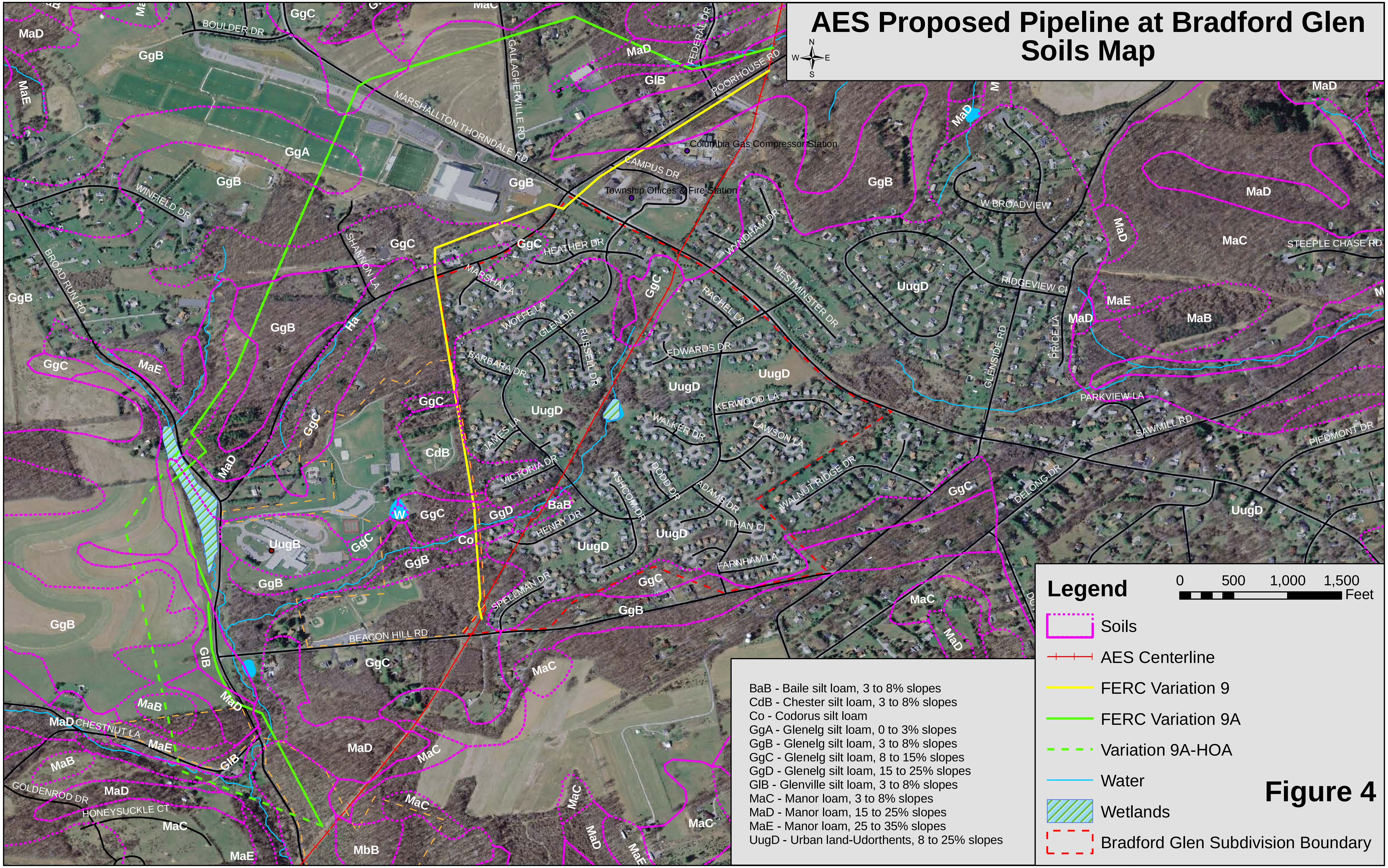
Rock test data was available for the formation. Permeability ranges from 0.2 to 3.0 ft/day. Unconfined compressive ranges from 334 to 830 pounds per square inch for dry, highly decomposed and weathered mica schist. It ranges from 30 to 40 pounds per square inch for wet, highly decomposed and weathered mica schist. It ranges from 1,255 to 3,830 pounds per square inch for dry, unweathered mica schist. Samples were 2 inches in diameter and 2 inches in height. Failure load for hard, mica schist ranges from 59 to 919 tons per square foot (tsf). Failure load for soft, mica schist ranges from 15 to 16 tsf. Permeability test data was provided by the Soil Conservation Service. Compressive strength data was provided by Villanova University. Load test data was provided by Conwell and Company.

Median groundwater yield is 20 gallons per minute. The highest yield can be observed from the fractured, weathered zone at the top of bedrock. Water levels show strong seasonal influence. Water is usually soft and has good quality. Iron can sometimes be a problem. The formation has good surface drainage. Joint and cleavage openings provide a low secondary porosity. Permeability is low.

2.3 Soils

Soils on the Bradford Glen Site were mapped using Web Soil Survey, a tool provided by the National Resource Conservation Service, US Department of Agriculture (Figure 4, Soils Map). The Web Soil Survey indicated that the following soils are mapped on the Site: Urban land (UugD); Chester silt loam, 3-8% slopes (CdB); Glenelg silt loam, 0-3% slopes (GgA); Glenelg silt loam, 3-8% slopes (GgB); Glenelg silt loam, Glenelg silt loam, 8-15% slopes (GgC); Glenelg silt loam, 15-25% slopes (GgD); Manor loam 3-8% slopes (MaB); Manor loam 8-15 pecent slopes (MaC); and Manor loam 15-25 percent slopes (MaD). A brief description of each soil series is given below:

Urban land (UugD) – Udorthents, schist and gneiss complex, 8 to 25 percent slopes. Urban land soils are gently sloping to hilly. Depth to lithic bedrock is 10 to 98 inches. Available water capacity is very low. The typical soil profile is variable. Urban land soils are found in urban areas consisting of pavement, buildings, and other artificially covered areas.


AES Proposed Pipeline at Bradford Glen
Soils Map
N
S
E
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Legend
0 500 1,000 1,500
Feet
Soils
AES Centerline
FERC Variation 9
FERC Variation 9A
Variation 9A-HOA
Water
Wetlands
Bradford Glen Subdivision Boundary
BaB - Baile silt loam, 3 to 8% slopes
CdB - Chester silt loam, 3 to 8% slopes
Co - Codorus silt loam
GgA - Glenelg silt loam, 0 to 3% slopes
GgB - Glenelg silt loam, 3 to 8% slopes
GgC - Glenelg silt loam, 8 to 15% slopes
GgD - Glenelg silt loam, 15 to 25% slopes
GlB - Glenville silt loam, 3 to 8% slopes
MaC - Manor loam, 3 to 8% slopes
MaD - Manor loam, 15 to 25% slopes
MaE - Manor loam, 25 to 35% slopes
UugD - Urban land-Udorthents, 8 to 25% slopes
Figure 4
Columbia Gas Compressor Station
Township Offices & Fire Station
BOULDER DR
MARSHALLTON THORNDALE RD
GALLAGHERVILLE RD
FEDERAL DR
POORHOUSE RD
CAMPUS DR
WINFIELD DR
BROAD RUN RD
SHANNON LA
HEATHER DR
MARSHA LA
WYNDHAM DR
WESTMINSTER DR
RACHEL LA
W BROADVIEW
RIDGEVIEW CI
STEEPLE CHASE RD
GLENSIDE RD
PRICE LA
PARKVIEW LA
SAWMILL RD
PIEDMONT DR
DELONG DR
WOLFE LA
GLEN DR
RUSSELL DR
BARBARA DR
EDWARDS DR
KERWOOD LA
WALKER DR
LAWSON LA
JAMES LA
VICTORIA DR
ASHOOM DR
DODD DR
ADAMS DR
WALNUT RIDGE DR
ITHAN CI
HENRY DR
FARNHAM LA
SPELLMAN DR
BEACON HILL RD
CHESTNUT LA
GOLDENROD DR
HONEYSUCKLE CT

In previous versions of the Chester County Soil Survey published before the development of the Bradford Glen Subdivision, the Urban Land (UugD) was mapped as several specific soil types. The current Urban Land soils formerly consisted of approximately 60 percent slopes, Glenelg channery silt loam, 3-8 percent slopes, moderately eroded (GeB2), 20 percent slopes, Glenelg channery silt loam, 8-15 percent slopes, moderately eroded (GeC2), and 10 percent slopes Glenelg channery silt loam, 8-15 percent slopes, severely eroded (GeC3). The remaining 10 percent, located mostly in the center portion of the Bradford Glen Site along the tributary, consisted of Wehadkee silt loam (We), Glenville silt loam, 0-3 percent slopes (GnA), Manor very stony loam, 0-8 percent slopes (MmB), and Manor loam, 8-15 percent slopes severely eroded (MgC3).

Chester Silt loam, 3-8 percent slopes (CdB). The Chester series is made up of deep, well-drained, productive soils. The surface layer of these soils is dark brown. The subsoil is strong brown to yellowish red and is friable. These soils are underlain mainly by schist and gneiss, but in places they are underlain by anorthosite, quartz, monzonite, granodiorite, or other igneous rocks. The soils developed from schist are micaceous in the lower part of the B horizon but are more micaceous in the layer just beneath; deep to the parent material, or C horizon, is generally 36 inches. The soils developed on igneous rocks are nearly level, have a deep provils, and are slightly to moderately eroded.

Glenelg silt loam, 0 to 3 percent slopes (GgA), Glenelg silt loam, 3 to 8 percent slopes (GgB), 8 to 15 percent slopes (GgC), and 15 to 25 percent slopes (GgD). The Glenelg silt loam soil series consists of moderately deep, well-drained soils of uplands. The soils developed in material weathered mainly from granite, gneiss, and mica schist. Their surface layer is dark-brown silt loam. Their subsoils are a dark brown to strong brown silt loam, and it contains a little more clay than the surface layer. In some places there are flat channery fragments, as much as 2 inches across in the surface layer. Beneath the subsoil is strong brown or reddish-brown loam that contains bright fragments of mica. The Glenelg soils have moderate available moisture capacity. Permeability and fertility are also moderate. In areas that have not been limed, the soils are acid throughout the profile.

Manor loam 3-8% slopes (MaB), Manor loam 8-15 pecent slopes (MaC), and Manor loam 15-25 percent slopes (MaD). The Manor series consists of shallow, well-drained soils of uplands. The soils occur in both Chester and Delaware Counties, but in Chester County they are more common south of Chester Valley. The parent material of these soils is mostly mica, schist, and gneiss. The schist is fairly soft and weathers easily. The soils formed on schist appear to be deep, but actually they have little development in the B horizon. The soils formed on gneiss are shallow over bedrock in many places. The Manor soils have a dark-brown surface layer. Their subsoil is yellowish red or yellowish brown and is micaceous. In many places the soil has a slippery or greasy feeling caused mainly by the abundance of mica that it contains.

Several of the soils including GeA, GeB, Ch, CdB, GnB, and MgB are classified as prime farmland soils by the National Resource Conservation Service, US Department of Agriculture (Figure 5, Environmental Features Map).

2.4 Wetlands

The National Wetland Inventory mapping for the U.S.G.S. Unionville, PA Quadrangle does not show any wetlands within the project area (Figure 5 – Environmental Features Map). The Chester County Countywide Environmental Inventory identifies a large wetland located along Broad Run Road at the intersection with Poorhouse Road. There are also three freshwater ponds located in the study area. Additional wetlands and water features may be present along the first and second order streams in the project area.

2.5 Surface and Groundwater Hydrology

Major hydrogeologic features such as rivers or lakes generally influence regional groundwater flow direction. Surface and/or bedrock topography may also influence regional groundwater flow direction. A review of the Unionville 7.5-minute series topographic quadrangle map suggests that shallow groundwater flow mimics surface topography and is generally to the south, southwest towards Broad Run. Broad Run is a tributary of West Branch Brandywine Creek and is classified as Exceptional Value (EV), Migratory Fishes (MF) in PA 25 Chapter 93. The protective use is for fish, shellfish, and wildlife protection and propagation.

The flood insurance rate map for West Bradford Township, Pennsylvania, Chester County, (Map 42029C0200F, panel 200 of 380, last revised September 29, 2006) was reviewed on the FEMA website (www.fema.gov). The entire property was rated as zone x, or those areas outside the 500-year floodplain. There are two tributaries (Tributary 21 and Tributary 22) of Broad Run located within the Site.

2.6 Wildlife Habitat

The Natural Lands Trust has rated the value of habitats for wildlife throughout the county. High value habitat for birds and reptiles and amphibians is located along the Broad Run Road corridor and near the intersection of Poorhouse Road and Federal Drive within the study area (Figure 6, Potential High Quality Bird Habitat Areas and Figure 7, Potential High Quality Reptile and Amphibian Habitat Areas).

AES Proposed Pipeline at Bradford Glen Environmental Features Map

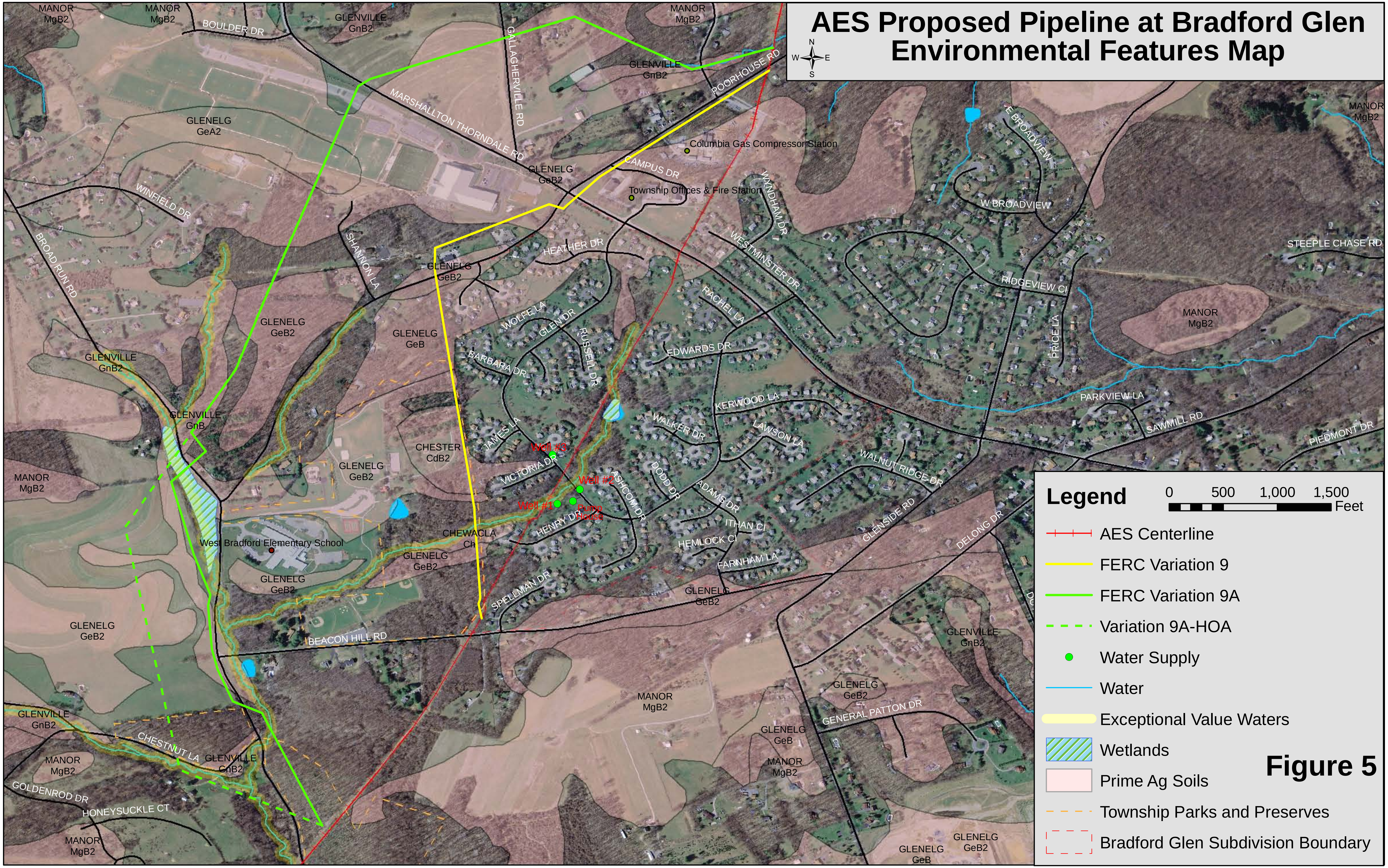
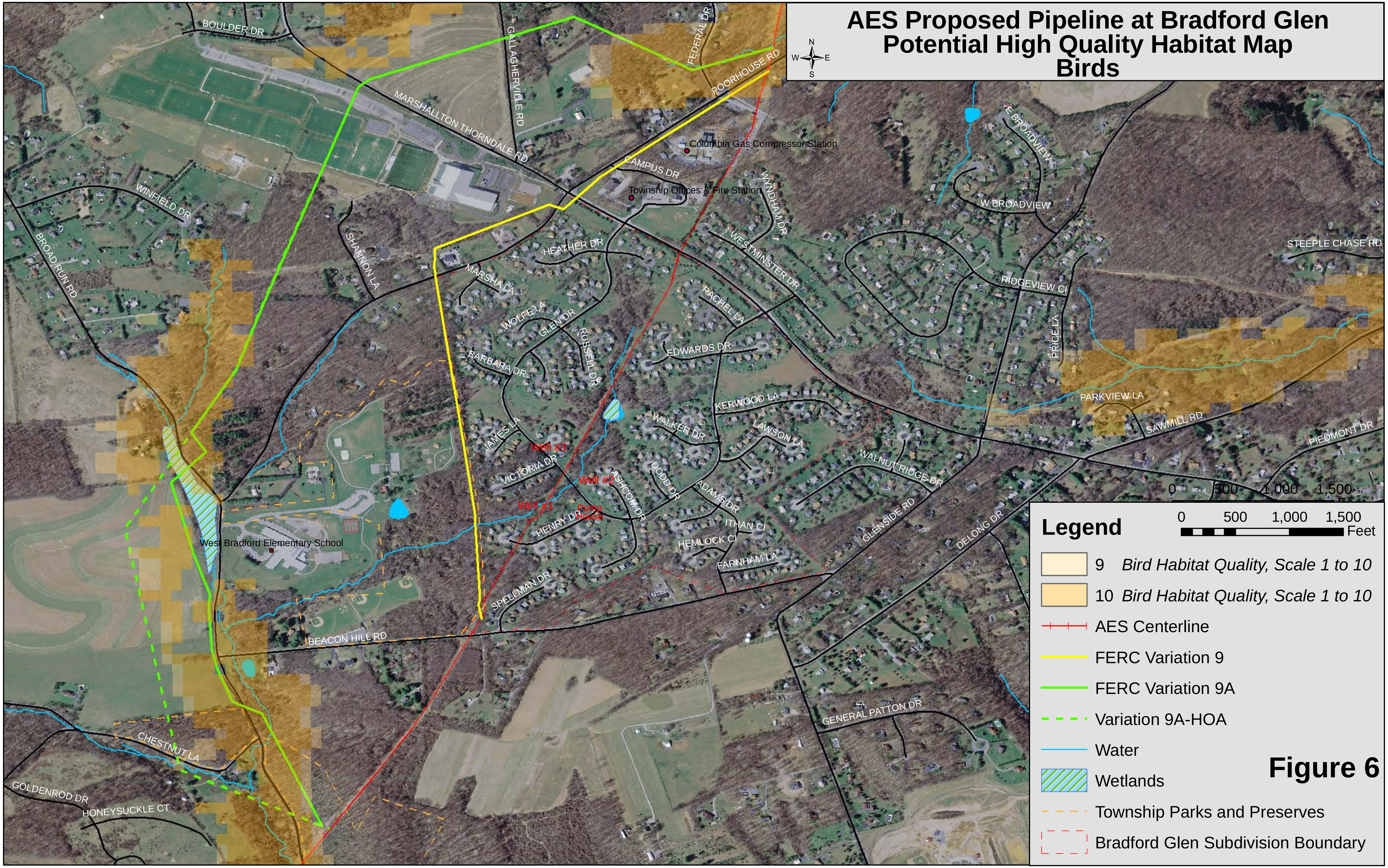


Figure 5



AES Proposed Pipeline at Bradford Glen
Potential High Quality Habitat Map
Birds
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Legend
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500
1,000
1,500
Feet
9 Bird Habitat Quality, Scale 1 to 10
10 Bird Habitat Quality, Scale 1 to 10
AES Centerline
FERC Variation 9
FERC Variation 9A
Variation 9A-HOA
Water
Wetlands
Township Parks and Preserves
Bradford Glen Subdivision Boundary
Figure 6
BOULDER DR
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MARSHALLTON THORNDALE RD
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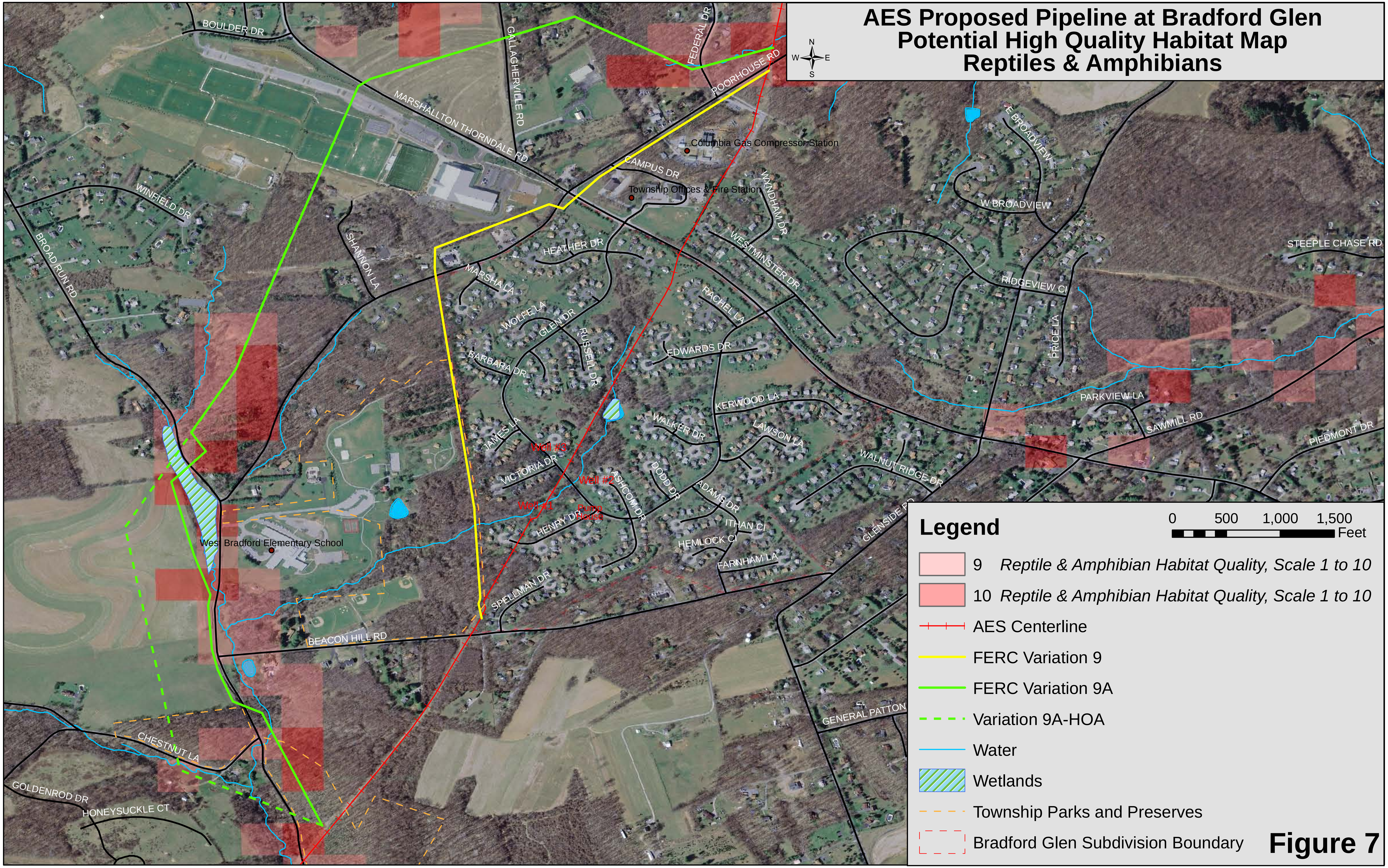
CAMPUS DR
Township Offices & Fire Station
VANDHAM DR
E BROADVIEW
W BROADVIEW
WINFIELD DR
BROAD RUN RD
SHANNON LA
HEATHER DR
WESTMINSTER DR
STEEPLE CHASE RD
MARSHALA
RIDGEVIEW CI
RACHEL LA
WOLFE LA
GLEN DR
RUSSELL DR
EDWARDS DR
PRICE LA
BARBARA DR
PARKVIEW LA
KERWOOD LA
SAWMILL RD
WALKER DR
LAWSON LA
JAMES LA
PIEDMONT DR
VICTORIA DR
WALNUT RIDGE DR
Well #3
Well #2
Well #1
Pump House
ASHCOM DR
DODD DR
ADAMS DR
HENRY DR
ITHAN CI
GLENSIDE RD
DELONG DR
HEMLOCK CI
West Bradford Elementary School
FARNHAM LA
SPELLMAN DR
BEACON HILL RD
GENERAL PATTON DR
CHESTNUT LA
GOLDENROD DR
HONEYSUCKLE CT


AES Proposed Pipeline at Bradford Glen
Potential High Quality Habitat Map
Reptiles & Amphibians
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BOULDER DR
GALLAGHERVILLE RD
FEDERAL DR
POORHOUSE RD
MARSHALLTON THORNDALE RD
Columbia Gas Compressor Station
CAMPUS DR
Township Offices & Fire Station
WINDHAM DR
E BROADVIEW
W BROADVIEW
WINFIELD DR
BROAD RUN RD
SHANNON LA
HEATHER DR
WESTMINSTER DR
STEEPLE CHASE RD
MARSHA LA
RACHEL LA
RIDGEVIEW CI
WOLFE LA
GLEN DR
RUSSELL DR
EDWARDS DR
PRICE LA
BARBARA DR
KERWOOD LA
PARKVIEW LA
WALKER DR
SAWMILL RD
JAMES LA
LAWSON LA
PIEDMONT DR
Well #3
VICTORIA DR
Well #2
ASHCOM DR
DODD DR
ADAMS DR
WALNUT RIDGE DR
Well #1
Pump House
HENRY DR
ITHAN CI
GLENSIDE RD
West Bradford Elementary School
HEMLOCK CI
FARNHAM LA
SPELLMAN DR
BEACON HILL RD
GENERAL PATTON
CHESTNUT LA
GOLDENROD DR
HONEYSUCKLE CT
Legend
0
500
1,000
1,500
Feet
9 Reptile & Amphibian Habitat Quality, Scale 1 to 10
10 Reptile & Amphibian Habitat Quality, Scale 1 to 10
AES Centerline
FERC Variation 9
FERC Variation 9A
Variation 9A-HOA
Water
Wetlands
Township Parks and Preserves
Bradford Glen Subdivision Boundary
Figure 7

2.7 Historical Use Land Use and Land Cover

GTS reviewed available aerial photographs of the site and surrounding areas for the years 1937, 1958/1964, 1971, 1992, 1999, and 2010 to identify historical land use. The aerial photographs were obtained from the Pennsylvania Geological Survey's website (www.pennpilot.psu.edu) and the Google Earth website (www.google.com\maps). The current aerial was obtained from Bing's website (www.bing.com\maps). Copies of the above-referenced aerial photographs are included in Appendix B.

In 1937 the project area was predominantly agricultural with scattered woodlots. Between 1937 and 1958/1964 the land use of the area changed very little and remained agricultural in nature. During this period, an airstrip was developed northwest of the present day Bradford Glen Subdivision.

By 1971, single family homes began to be built along Broad Run Road, Poorhouse Road, and Beacon Hill Road. The West Bradford Elementary School site was also developed and the airstrip expanded.

By 1992 the Bradford Glen Subdivision and several other housing developments had been constructed. The West Bradford Township Park was being developed. The land use remained relatively unchanged through 1999. The main exceptions are that the West Bradford Township Park has been further developed and the conversion of the airstrip to a recreational facility.

2.8 Pipeline and Existing Utility Infrastructure

Numerous utilities service Bradford Glen and other subdivisions (Figure 8, Existing Bradford Glen Utility Infrastructure). The Interstate Fiber Optic line runs through the Bradford Glen site following the right-of-way of a Columbia Gas gas pipeline. In addition, water lines, sewer lines, storm sewers and electrical and telephone service lines service the homes in the subdivision. Detailed depictions of the existing utility infrastructure in the Bradford Glen Subdivision in relation to the proposed AES pipeline are provided on Figures 9, 10, and 11.


AES Proposed Pipeline at Bradford Glen
Existing Utility Infrastructure
NOTICE: Locations of all utilities are approximate.
Legend
Water Supply
PECO Overhead Transmission
Storm Sewer
Sanitary Sewer
Water Main
Interstate Fiber Optic Line
AES Centerline
Bradford Glen Subdivision Boundary
N
S
E
W
Well #1
Well #2
Well #3
Pump House
MARSHALLTON THORNDALE RD
POORHOUSE RD
HEATHER DR
DONNA LA
JULIE DR
RHONDA CI
WOLFE LA
GLEN DR
LORETTA LA
RUSSELL DR
BARBARA DR
PINE CI
EDWARDS DR
CHRISTOPHER CT
RACHEL LA
BUCKINGHAM DR
WESTMINSTER DR
RIDGEVIEW CI
KERWOOD LA
BLAIR CT
WALKER DR
LAWSON LA
DECATUR CT
VALLEY WOOD DR
WALNUT RIDGE DR
JAMES LA
DIANNE CI
VICTORIA DR
ASHCOM DR
DODD DR
ADAMS DR
CARLISLE LA
ITHAN CI
HENRY DR
HEMLOCK CI
WITHERSPOON DR
FARNHAM LA
GLENSIDE RD
SPELLMAN DR
BEACON HILL RD
0
500
1,000
Feet
Figure 8

AES Proposed Pipeline at Glen Drive Existing Utilities

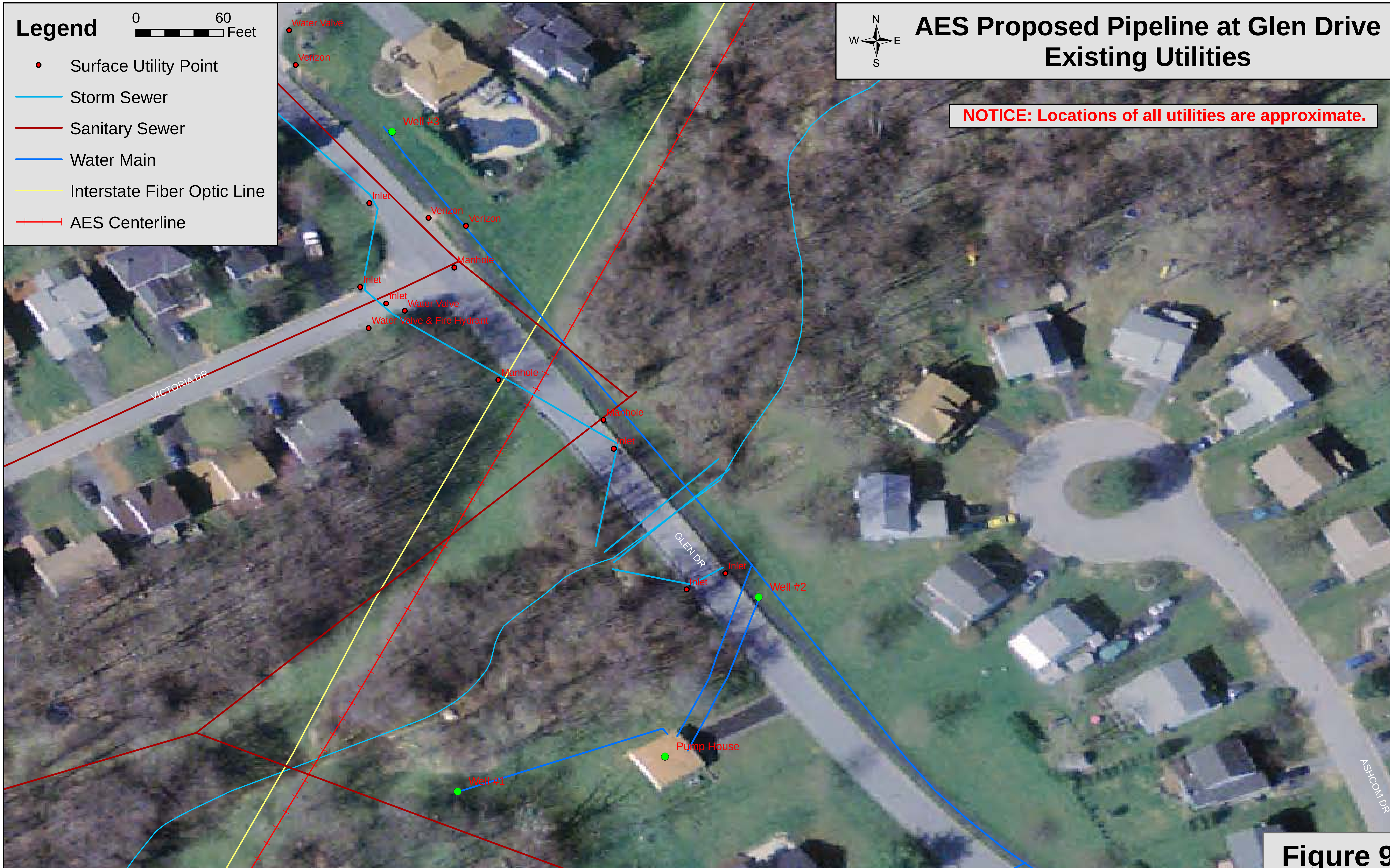
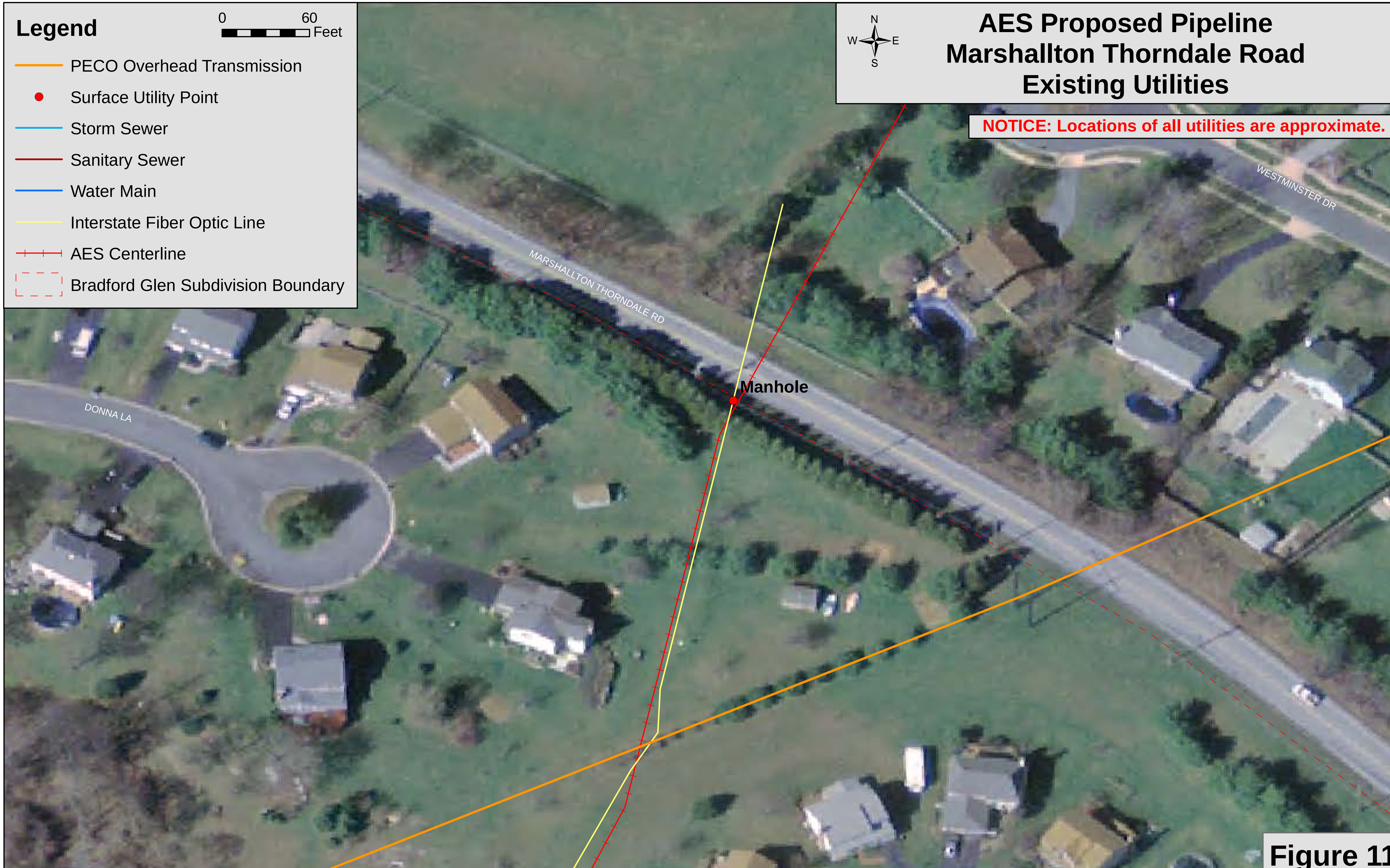


Figure 9


Legend
0
60
Feet
Storm Sewer
Sanitary Sewer
Water Main
Interstate Fiber Optic Line
AES Centerline
N
W
E
S
AES Proposed Pipeline at Henry Drive
Existing Utilities
NOTICE: Locations of all utilities are approximate.
HENRY DR

Figure 10



AES Proposed Pipeline
Marshallton Thorndale Road
Existing Utilities
NOTICE: Locations of all utilities are approximate.
Legend
0
60
Feet
PECO Overhead Transmission
Surface Utility Point
Storm Sewer
Sanitary Sewer
Water Main
Interstate Fiber Optic Line
AES Centerline
Bradford Glen Subdivision Boundary
N
S
E
W
Manhole
MARSHALLTON THORNDALE RD
WESTMINSTER DR
DONNA LA

Figure 11

3.0 PIPELINE SAFETY CONCERNS

The Federal gas transmission pipeline safety regulations, especially with additional recent requirements, are intended to assure the safety of people and structures adjacent to the proposed Pipeline. The design of a proposed pipeline is determined by the Class of the immediate surrounding area to the pipeline. Class locations are defined in Code (§192.5) in accordance with the number of dwelling units within 220 yards on either side of the centerline of the pipeline. If a class location changes over time, the maximum allowable operating pressure (MAOP) must be reduced accordingly within 24 months. If reduction in the MAOP results in an inadequate pipeline capacity, an additional pipeline will be constructed adjacent to the existing pipeline, a process which is called looping.

According to the EIS, the pipeline will be 30-inch diameter with a maximum operating pressure of 2080 psig and deliver up to 1.5 Bcfd (billion cubic feet per day). Mainline valves are currently proposed at MP 69.27 and MP 78.11.

Areas within the pipeline's potential impact radius (PIR) are determined by a calculation taking into consideration the MAOP. The PIR formula requires that the MAOP of that segment of the Pipeline (in this case, the entire Pipeline) be used in the formula. The PIR for the AES Pipeline is 944 feet or a radius that extends 944 feet on either side of the pipeline from the point of a catastrophic failure. Knowing this radius is important in order to assure the safety of persons within that area by imposing Pipeline Integrity Management Plans (IMP) regulations.

Typically gas pressure declines as it travels down the pipeline until it reaches a compressor station where the gas is re-pressured and sent onto the next compressor station. As stated previously, the PIR for the entire pipeline is 944 feet. However, because no intermediate compressor stations are currently proposed, the anticipated pressure at MP 78, in the Bradford Glen Subdivision, will be about 1100 psig or about half of the 2080 psig MAOP. This would reduce the catastrophic PIR distance to 472 feet or about half the MOAP PIR of 944 feet.

It is impossible to know if and when a catastrophic failure will occur on a pipeline due to the numerous variables. Data on previous catastrophic failures cannot and should not be used as a reliable source as construction methods and standards continue to change and advance.

The Federal Energy Regulation Commission (FERC) is the Federal agency with responsibility for approving the Certificate of Public Convenience and Necessity for interstate gas transmission pipelines, which includes approving the tariffs that the pipeline operator can charge for transporting the gas. Although FERC has already issued the order granting authority for the AES Pipeline on January 15, 2009, and Mid-Atlantic Express accepted the certificate on January 15, 2010, some additional proposed features are listed on Page 7 in the *Analysis of the Potential Impact Radius Should Current and/or Proposed Pipeline Have a Catastrophic Failure in the Bradford Glen Subdivision* Report in Appendix C.

Because of safety concerns within the Bradford Glen Subdivision a number of variations or alternative alignments were developed to reduce potential catastrophic impacts in the event of a pipeline rupture and explosion. Each of these alternatives has an associated PIR (Figures 12 through 15, Pipeline Potential Impact Radius).

The original pipeline alignment proposed by AES follows the existing Columbia Gas right-of-way through the middle of the Bradford Glen Subdivision. There are 348 homes that lie within the 944 foot PIR of the alignment in the vicinity of Bradford Glen. To reduce the number of homes within the PIR, FERC Variation 9 was developed by AES. This variation generally follows the western boundary of the Bradford Glenn Subdivision. However, due to its close proximity to the subdivision, there are still 268 homes in the PIR of this alignment. FERC Variation 9A moves the proposed pipeline alignment further west to avoid Bradford Glen altogether. The PIR for FERC Variation 9A includes 74 homes and the West Bradford Elementary School. To avoid the school, Variation 9A-HOA was suggested. While keeping the school out of the PIR, this variation still includes 76 homes in the PIR.

A catastrophic pipeline failure has the potential to disrupt emergency services with each of the proposed alignments. In the case of failure, a disruption of emergency services could hamper response time as well as evacuation and rescue efforts. The pipeline operator, West Bradford Township, and the Bradford Glen HOA should develop an Emergency Response Plan to inform emergency responders and the general public of what to do in the event of a failure. Contingent procedures should be identified if the primary emergency services are disrupted as a result of the failure incident.

The Emergency Response Plan should include:

- Designated emergency personnel names and phone numbers.
- Emergency services phone numbers and alternatives.
- Identification of appropriate medical facilities.
- Utility company contacts.
- Identification of evacuation routes and alternatives.
- Identification of critical operations.
- Training requirements and an up to date log of those trained

A sample template for an emergency response plan can be found at: www.readygallatin.com/docs/erguidelines-11.pdf.

In the event of a pipeline failure, it would likely take from one to two hours to shut off the flow of gas with the manual shut-off valve proposed at MP 69.27. It is not possible to determine the amount of time required to burn-off the gas in the pipeline in case of a failure/explosion because that period would vary greatly based on size of failure, location of failure, location of emergency pipeline personnel, time to travel to the valve and time to shut off the valve.

Reviewing National Transportation Safety Board (NTSB) gas transmission (not gas distribution) pipeline failures reports that are available online back to 1985, there have

AES Proposed Pipeline at Bradford Glen
Potential Impact Radius
AES Alignment

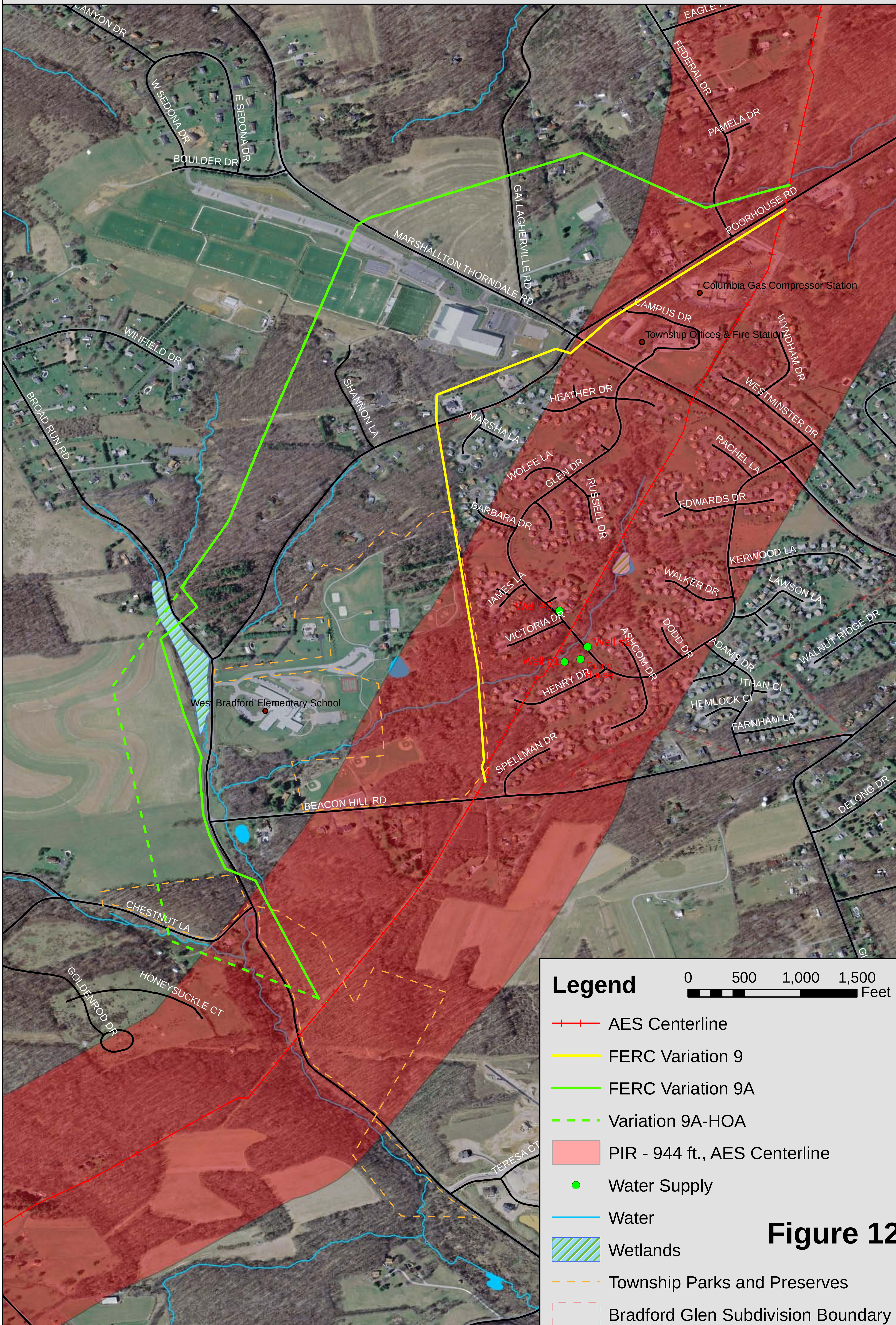
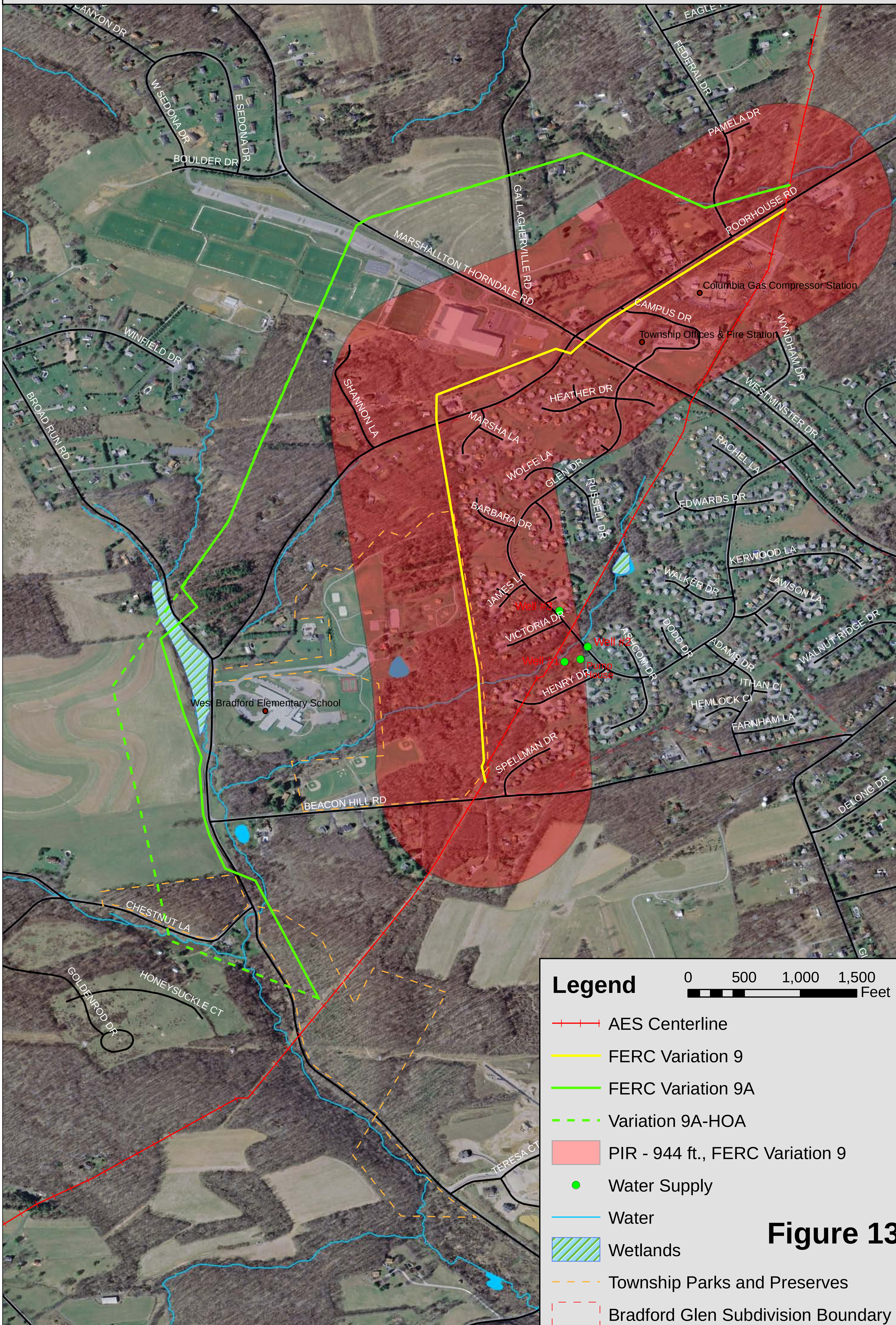


Figure 12

AES Proposed Pipeline at Bradford Glen
Potential Impact Radius
FERC Variation 9



AES Proposed Pipeline at Bradford Glen
Potential Impact Radius
FERC Variation 9A

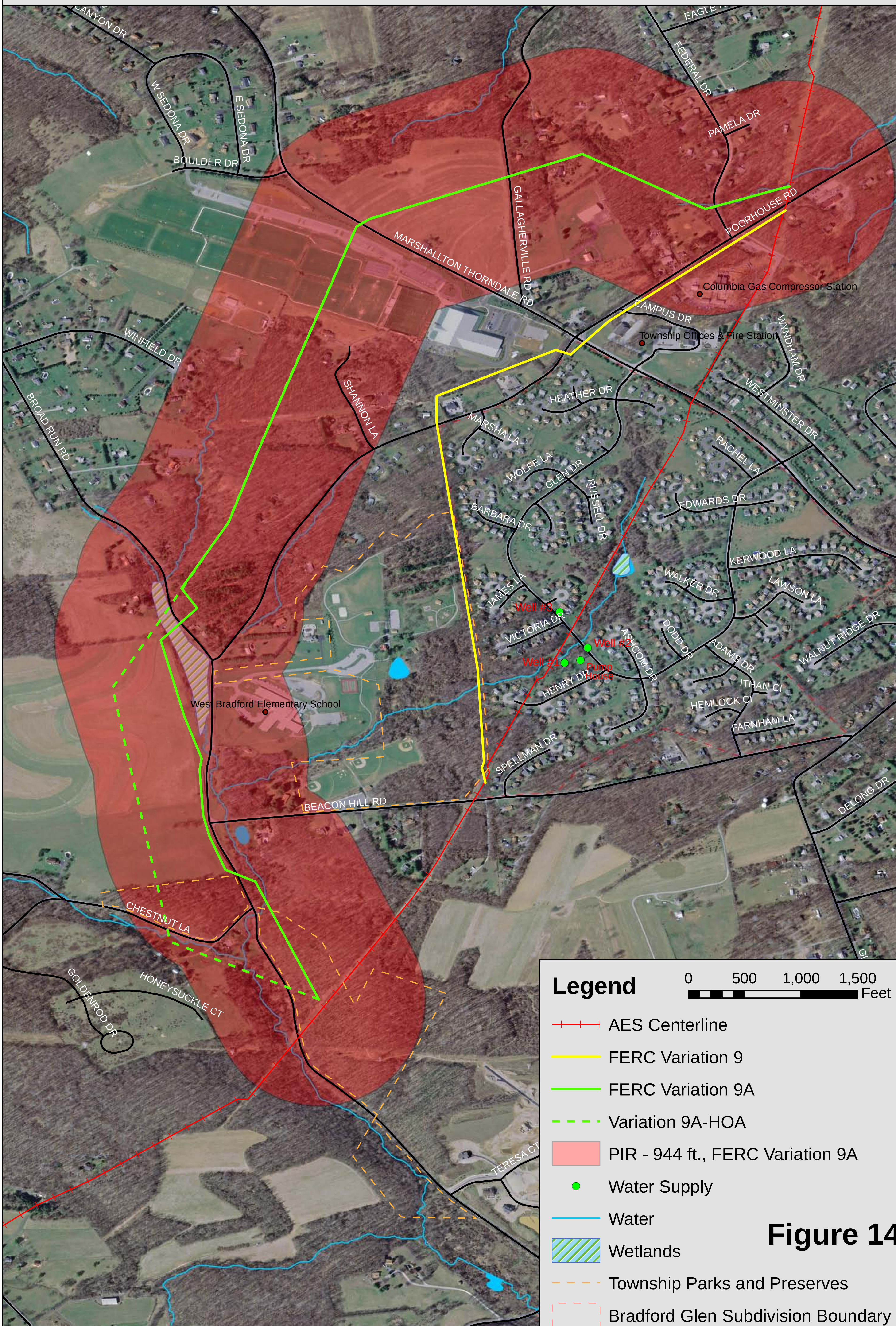
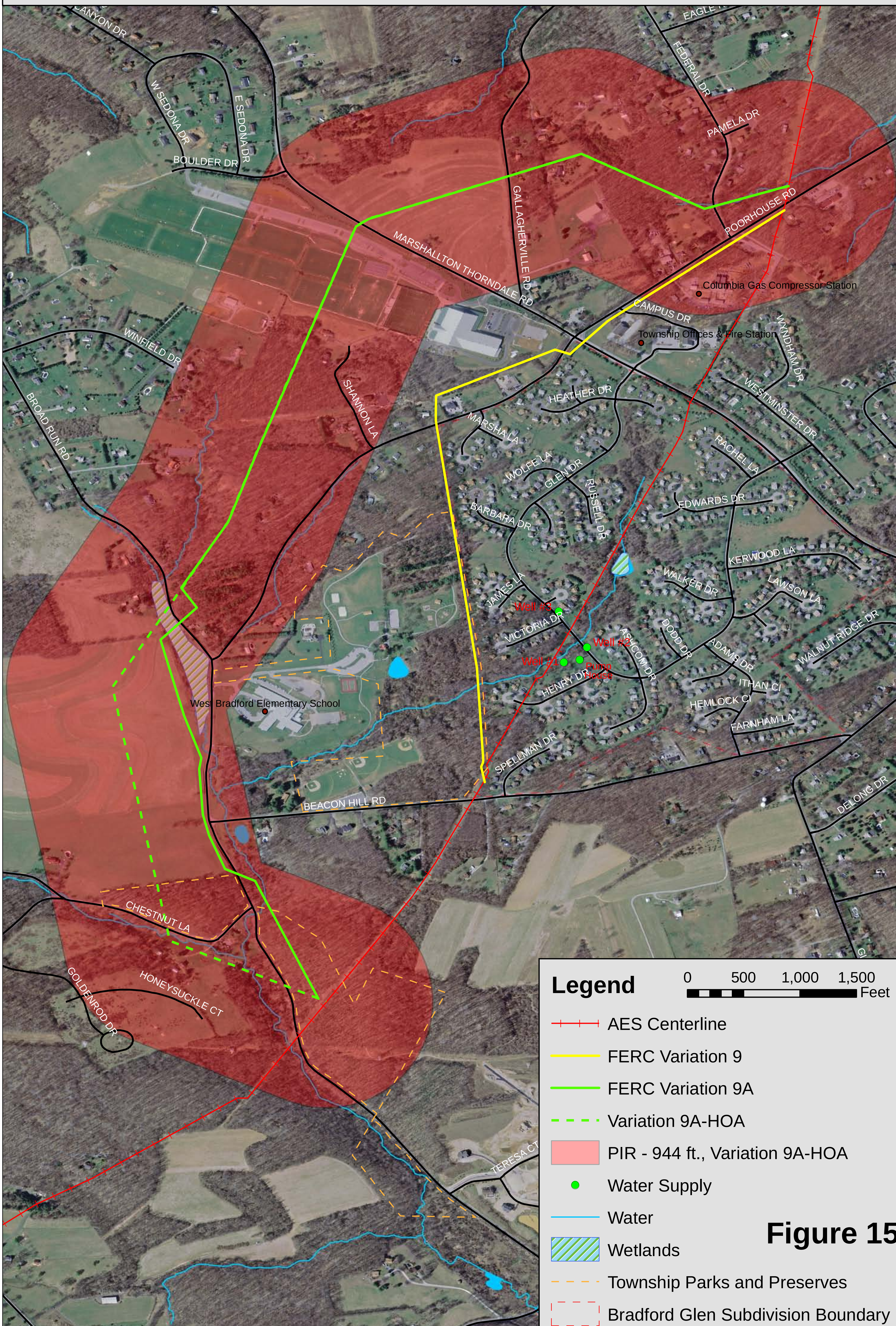


Figure 14

AES Proposed Pipeline at Bradford Glen
Potential Impact Radius
Variation 9A-HOA



been 3 failures that took 2½ hours to shut-down the gas and extinguish the fire. One failure was in 1994, one offshore failure in 1996, and one failure in 1985. Those 3 failures were the longest times to shut-down the fire on gas transmission pipeline failures/fires. The least time period was 1 hour - which is about the shortest period that one can expect without automatic valves.

An Interstate Natural Gas Association of America (INGAA) study in July 1995 includes in Appendix B "Assessment of Injury/Fatality Reduction Through the use of Rapid or Automatic Valves Based on a Survey of Pipeline Incidents." That study identified 159 incidents from 1970 to 1992 for inclusions in the study. It included some pipelines with automatic valves and most with manual valves. The study concluded that "only one incident in which the application of a quick closing valve could have prevented the injury that occurred. In the remainder of the incidents, immediate burns or impact from the gas released caused the injury or fatality, and quick valves would not have mitigated the consequences of the incidents to people." The report also adds: "Because about half of the outside force incidents cause the gas to be released at the time the damage is introduced on the pipe, this cause is more likely to result in immediate injuries/fatalities than corrosion or construction/material defects because operators of excavation and construction equipment are working in close proximity to the pipeline."

The result of the automatic valves study has been the basis of pipeline industry arguments that automatic valves will not mitigate injuries or fatalities. In other words, the injuries or fatalities occur in the first few minutes of a pipeline explosion/fire, and the longer period required to shut-off the gas through the use of manual valves does not result in further injuries or fatalities.

The potential impacts and benefits of each of these proposed alignments are discussed further in the next section of this report.

4.0 ANTICIPATED IMPACTS

Given the developed nature of the proposed pipeline corridor between Baltimore, Maryland and Chester County, Pennsylvania, there is no good or easy way to develop a project such as this. There is always a necessary tradeoff between the public need for the project and the affects it creates. There is also typically a tradeoff between impacting the built environment (such as homes, roads, and other man-made facilities) and the natural environment by the development of the project. The following assessment will examine the potential impacts of the proposed pipeline alternatives on the built and natural environments. Table 1 summarizes the comparison of the four alternative routes as presented in the Environmental Impact Statement prepared by AES for the proposed pipeline.

4.1 AES Alignment

The proposed AES pipeline alignment is located adjacent to the existing Columbia Gas pipeline. It will have minimal impact on prime farmland soils and agricultural lands. The site is underlain by the Octoraro Formation which is a member of the Wissahickon Formation. This formation is composed of albite-chlorite schist Albite-Chlorite Schist is typically a phyllite. The estimated thickness of the formation is 8,000 to 10,000 feet. The pipeline currently follows along an exceptional value (EV) tributary to Broad Run which is a tributary to the West Branch of the Brandywine Creek. This proposed alignment will also impact the potential wetlands located along the tributary to Brandywine Creek. Due to the rating of the tributary as EV, the wetlands would also be classified as EV wetlands.

There are areas of botanical disturbance associated with the proposed AES alignment. The first is a small area of forest located along Beacon Hill Road (right of the proposed pipeline). This forest contains a tulip poplar, scattered silver maple, red maple, and red oak. Another area of botanical disturbance is a larger forested area located between Victoria Drive and the tributary to Broad Run. This forested area contains tulip poplar, silver maple, red oak, black cherry and white ash. The third area is located between Pine Circle and Walker Drive. This area includes a mixture of silver maple, red maple, tulip poplar, with a few black cherry and tree-of-heaven trees.

The AES proposed alignment will have the most impact to existing utilities and during construction there may be temporary disruptions in service. In addition, it also includes the most homes within the alignments potential impact radius (PIR). The West Bradford Township Office, West Bradford Fire Station and Columbia Gas Compressor station are all located within the PIR.

It is recommended that the Chester County Conservation District review and comment on the proposed activities of this option. AES should follow the workspace areas as opposed to the proposed workspace to avoid maximum disturbance to the highest quality forest. All tree removals are to be identified by AES in the field for review and approval by the property owner. Proper erosion controls must be implemented for right-of-way approximately 150-feet from the edge of roadways within the Bradford Glen development in order to control sediment run-off into the exceptional value (EV) stream. Woodland areas that were removed within the temporary easement areas are to be replanted during restoration by AES with native trees at the rate of 2.5-3 inch caliper specimen for every 400 square feet of woodland removal. Species mixture is to be approved by the property owner.

4.2 FERC Variation 9

FERC Variation 9 diverts the proposed route at MP 77.0 where it then heads west crossing Beacon Hill Road. It then heads north and follows a mostly forested area that separates the Bradford Glen development from the adjacent Beacon Hill and Broad Run Parks. This variation is located outside the limits of the subdivision but will affect the forested area behind approximately 10 residences. The variation then crosses Poorhouse Road and continues east north of Poorhouse Rood.

The FERC variation 9 would impact all environmental features along the alignment, as it is not currently impacted by the Columbia Gas line. FERC variation 9 has similar geology to that of the proposed AES alignment. The variation would directly impact existing soil throughout the alignment. Some of these soils being impacted will be prime farmland soil. This variation will not impact agricultural farmland and will reduce the direct impact to homes within the Bradford Glen subdivision. Although this variation reduces the impacts to residences, it impacts the forested buffer of Beacon Hill and broad run parks and would impact a different group of residences. This variation will avoid any impact to the EV tributary of broad run and any potential wetlands or high-quality bird, reptile, or amphibian habitat associated with this wetland.

There are some potential impacts on utilities, primarily sanitary and storm sewer, which may lead to temporary disruptions during construction. In addition, this variation has the second highest number of homes located within the potential impact radius. The West Bradford Township Office, West Bradford Fire Station and Columbia Gas Compressor station are all located within the PIR.

4.3 FERC Variation 9A

FERC Variation 9A diverts from the proposed route at MP 76.6 and heads northwest along the eastern side of Broad Run Road. The variation then crosses Broad Run Road and travels along the western side of the road for about 0.25-mile until it turns northeast, crosses an emergent wetland area and Broad Run Road. The variation then heads northeast through a forested area before it crosses soccer fields of United Sports Training Center and then crosses Marshallton Thorndale Road. Next, the variation turns east-northeast and crosses Gallagherville Road where it continues through a mixed forested and residential area. It then crosses Federal Drive and rejoins the proposed route at MP 78.1.

FERC Variation 9A would impact all environmental features along its alignment, as it is not currently impacted by the Columbia Gas line. The variation would directly impact existing soil throughout the alignment. FERC Variation 9A has similar geology to that of the proposed AES Alignment. Some of these soils being impacted will be prime farmland soils. There are minimal impacts to agricultural farmland as the variation closely follows Broad Run Road. As this variation travels north along the western side of Broad Run Road, it will have a long, longitudinal impact to the EV tributary of Broad Run and any associated wetlands. This also may impact any high quality bird and reptile or amphibian habitats location along the EV tributary of Broad Run. FERC Variation 9A will also impact a large area of forested land that is currently undisturbed located between Broad Run Road and Poorhouse Road. The pipeline would also cut directly into the soccer fields associated with United Sports Training Center located south of Marshallton Thorndale Road.

The FERC Variation 9A would have little impact on utilities. The primary utilities that would be impacted are sanitary and storm sewer. This variation will have a lower number of homes in the PIR, however, the elementary school would be located within the PIR. The Columbia Gas Compressor station is located within the PIR but the West Bradford Township Office and West Bradford Fire Station are outside the PIR.

4.4 Variation 9A-HOA

Variation 9A-HOA is similar to FERC Variation 9A. Variation 9A-HOA diverts from the proposed route at MP 76.6 and heads northwest across Broad Run Road and along a tributary of Broad Run and then heads north across Chestnut Lane. The variation then heads north through agricultural fields and then turns east-northeast, crossing an emergent wetland and Broad Run Road. The variation then heads northeast through a forested area before it crosses soccer fields of United Sports Training Center and then crosses Marshallton Thorndale Road. Next, the variation turns east-northeast and crosses Gallagherville Road where it continues through a mixed forested and residential area. It then crosses Federal Drive and rejoins the proposed route at MP 78.1.

Variation 9A-HOA would impact all environmental features along its alignment, as it is not currently impacted by the Columbia Gas line. Variation 9A-HOA has similar geology to that of the proposed AES Alignment. The variation would directly impact existing soil throughout the alignment. Some of these soils being impacted will be prime farmland soils. There are also direct impacts to farm fields using this alignment. By pulling the variation west out into the farm fields, it does reduce the long, longitudinal impacts to the EV tributary of Broad Run, the associated wetlands, and the associated potential high-quality bird and reptile/amphibian habitats. The impacts to the undisturbed forested land located between Broad Run and Poorhouse Road and the soccer fields owned by United Sports Training Center remain the same in Variation 9A-HOA as they were in FERC Variation 9A.

The Variation 9A-HOA would have little impact on utilities. The primary utilities that would be impacted are sanitary and storm sewer. This variation will have a lower number of homes in the PIR. This variation also keeps the West Bradford Elementary School out of the PIR. The Columbia Gas Compressor station is located within the PIR but the West Bradford Township Office and West Bradford Fire Station are outside the PIR.

5.0 PERMITS REQUIRED

A project such as this undertaking requires a number of federal, state and local approvals and permits. FERC has already approved the certificate of public convenience and necessity and approved the Final Environmental Impact Statement (FEIS) for this proposed project. The public comment period for these approvals is closed.

AES has initiated the process of securing state and local permits and approvals but these have not been secured. This project will require a waterways encroachment permit from the US Army Corps of Engineers (USACE) and the Pennsylvania Department of Environmental Protection (PADEP) for impacts to wetlands, streams, and floodplains. This joint permit application was submitted by AES but found to be “Administratively Incomplete”. AES must submit additional information to the USACE and PADEP to continue the technical review of the application. A public comment period will be required before this permit can be issued.

TABLE 1 – COMPARISON OF ALTERNATIVE ROUTES[1]

Characteristics or Resource	Units	AES Alignment	FERC Variation 9	FERC Variation 9A	Variation 9A-HOA
Total Length	Miles	1.53	1.21	2.05	2.27
Length Adjacent to Existing Right-of-Way	Miles	1.53	0.56	0.0	0.0
Length of Forested Wetlands	Feet	0.0	0.0	0.0	0.0
Length in Herbaceous Wetlands	Mile	0.0	0.0	0.07	0.07
Number of Waterbody Crossings	Each	3	1	3	3
Number of Major Waterbody Crossings (>100 feet)	Each	0	0	0	0
Length in Forested Areas	Miles	0.57	0.52	0.99	1.00
Length in Agricultural Areas	Miles	0.06	0	0.63	0.84
Length in Residential Areas	Miles	0.73	0.37[2]	0.27	0.27
Length in Commercial/Industrial Areas	Miles	0.17	0.30	0.16	0.16
Residences within Potential Impact Radius	Each	348	268	74	76

[1]Comparison data summarized from the EIS prepared by AES for the proposed pipeline.
[2]Based on aerial photography, trees may be masking additional residences.

The project will also require erosion and sedimentation control approval and a National Pollution Discharge Elimination System (NPDES) permit from the PADEP and Chester County Conservation District (CCCD). This application has also been submitted but found to be "Administratively Incomplete". AES must submit additional information to the PADEP and CCCD to continue the technical review of the application. A public comment period will be required before this permit can be issued.

6.0 CONCLUSIONS AND RECOMMENDATIONS

As stated previously, a project such as this can not be developed with out impacts. It is up to federal and state regulatory agencies to determine if the benefits of the project outweigh the anticipated impacts. If the project does move forward, it is up to these agencies to ensure that all practicable steps have been taken to reduce and minimize the adverse impacts to the built and natural environment.

The proposed AES pipeline will have numerous impacts to the Bradford Glen Subdivision and its surrounding vicinity. The potential impacts of each of the alternative alignments are discussed above. Given the trade off between the built and natural environments, FERC Variation 9 or Variation 9A-HOA would reduce the number of homes located in the PIR will still minimizing the impacts to the natural environment to the extent possible.

If the project is to be built, there are several things that AES can do to increase the safety of the facility including the following:

- The pipeline could be buried deeper to reduce the effects of a catastrophic failure. The PIR is based on a standard burial of three feet. Additional soil cover would help to dampen the effects of an explosion. However, deeper burial may require additional excavation into rock which will increase construction costs and increase temporary impacts during construction. If the blasting of rock is required, a blasting safety plan would be required including a pre- and post-blast conditions survey to document the effects of the blasting on surrounding structures identify the need for repairs.
- An additional shut off valve can be added just south of the Bradford Glen Subdivision. This shut off valve should be an "automatic valve" either operated remotely from a control center or automatically when the gas pressure strays from an acceptable limit. Although the automatic valve would do little to reduce the initial damage of a failure/explosion, the shut off valve would reduce the amount of product burn-off in the event of a catastrophic failure of the pipeline, potentially reducing the emergency response time and duration of evacuation.
- An Emergency Response Plan should be developed. The plan should identify emergency responders, evacuation routes, and medical facilities. Contingent plans should be developed in the event that primary emergency services are disrupted by the failure event.
- Regular inspection of the pipeline facility will be vital to ensure that the facility is maintained and deterioration is identified and repaired before catastrophic failure occurs.

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United States Department of the Interior Geological Survey, 1953, Photo revised 1992. Unionville, Pennsylvania - 7.5-minute series (Topographic), United States Department of the Interior, Geologic Survey, Reston, Virginia.

APPENDIX A

PROFESSIONAL PROFILES

Andrew C. Parker

Professional Experience:	23 years
Education:	M.S. Biology/Ecology Shippensburg University, 2003 B.S. Land Reclamation and Earth Science Major, Biology Minor Frostburg State College, 1987
Responsibility:	Project Management, Document Review

Arthur E. Clark

Professional Experience:	6 years
Education:	B.S. Geoenvironmental Studies Shippensburg University, 1995
Responsibility:	Field Visit, Data Collecting

Elizabeth A. Willey

Professional Experience:	5 years
Education:	B.S. Geoenvironmental Studies Shippensburg University, 2005
Responsibility:	Field Visit, Document Preparation

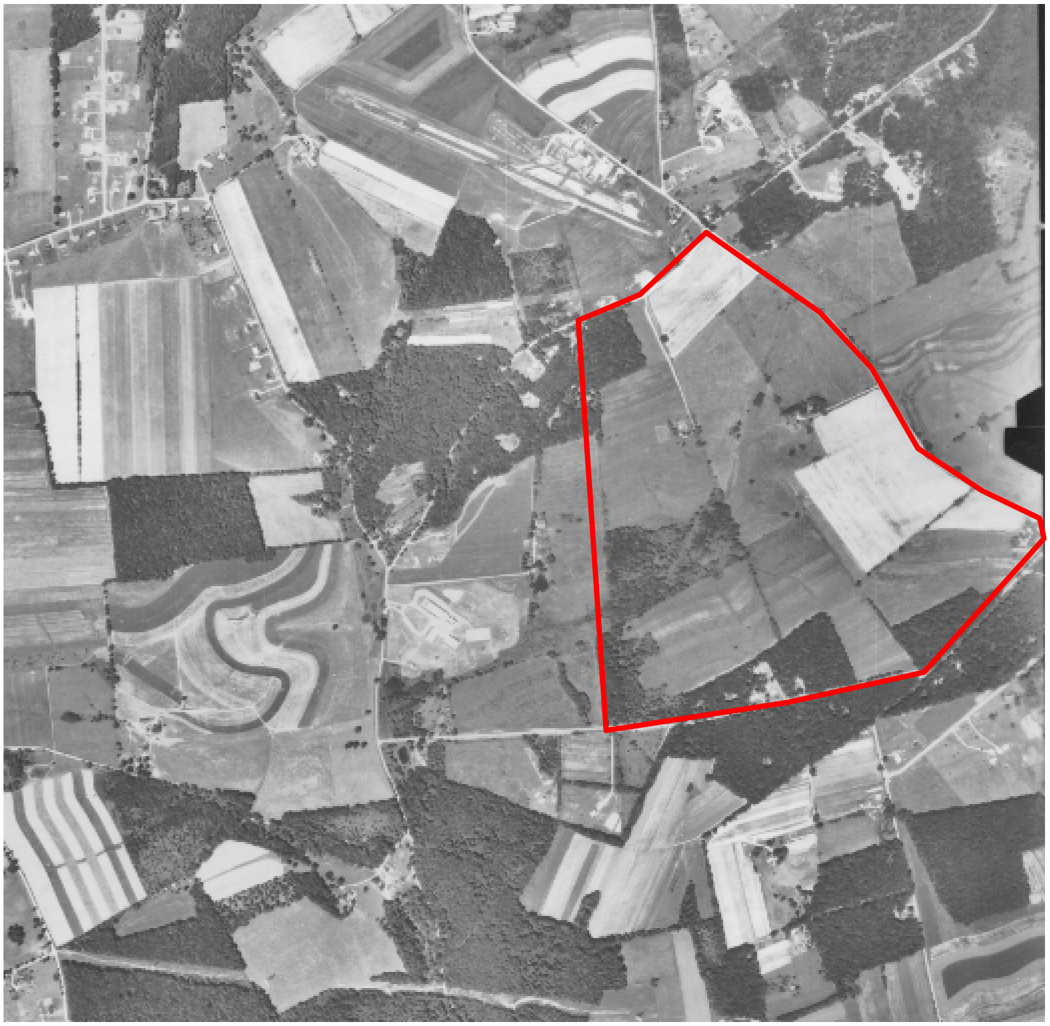
APPENDIX B

HISTORIC AERIAL PHOTOGRAPHS

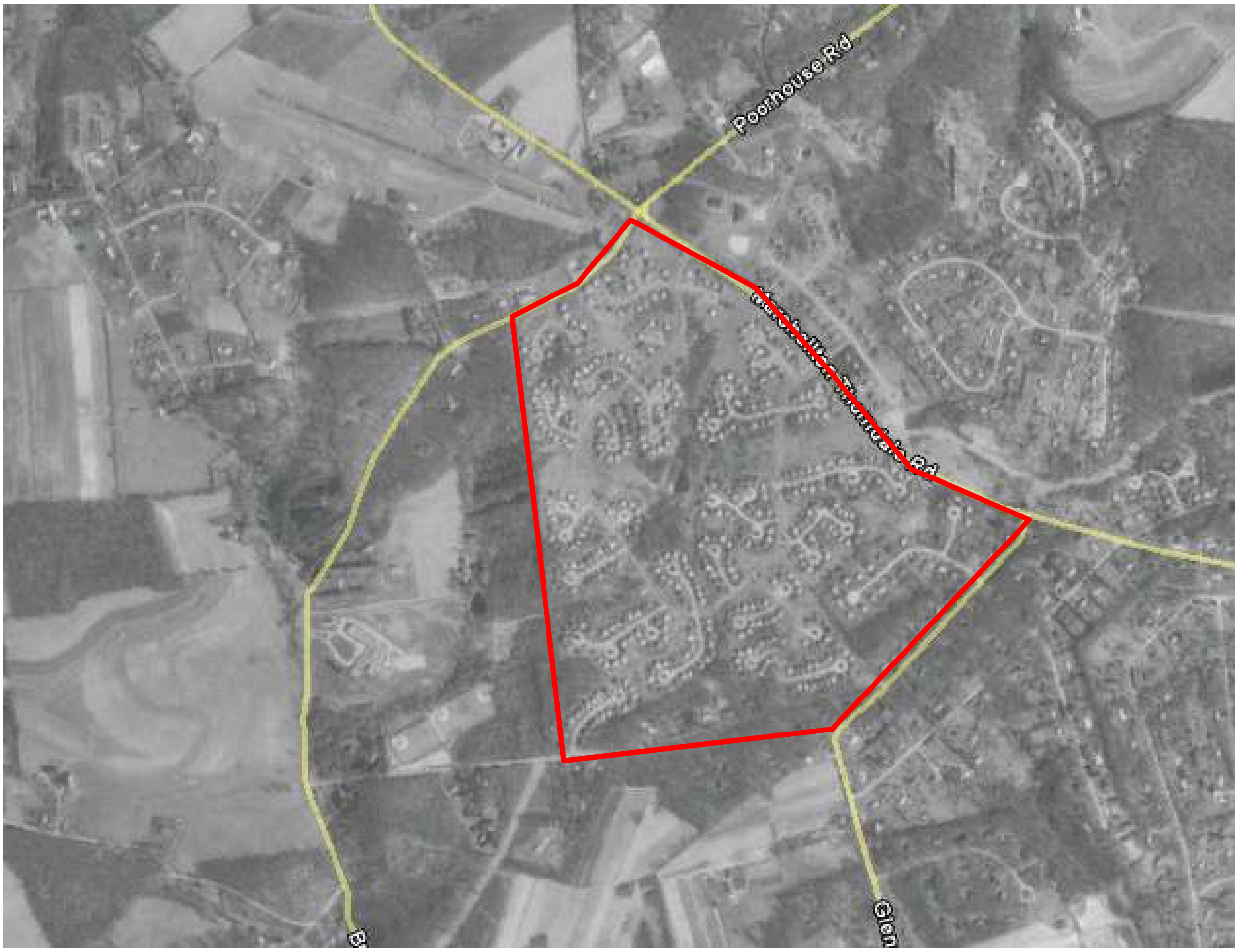
Historic Aerial Photographs

1937 Aerial Photograph

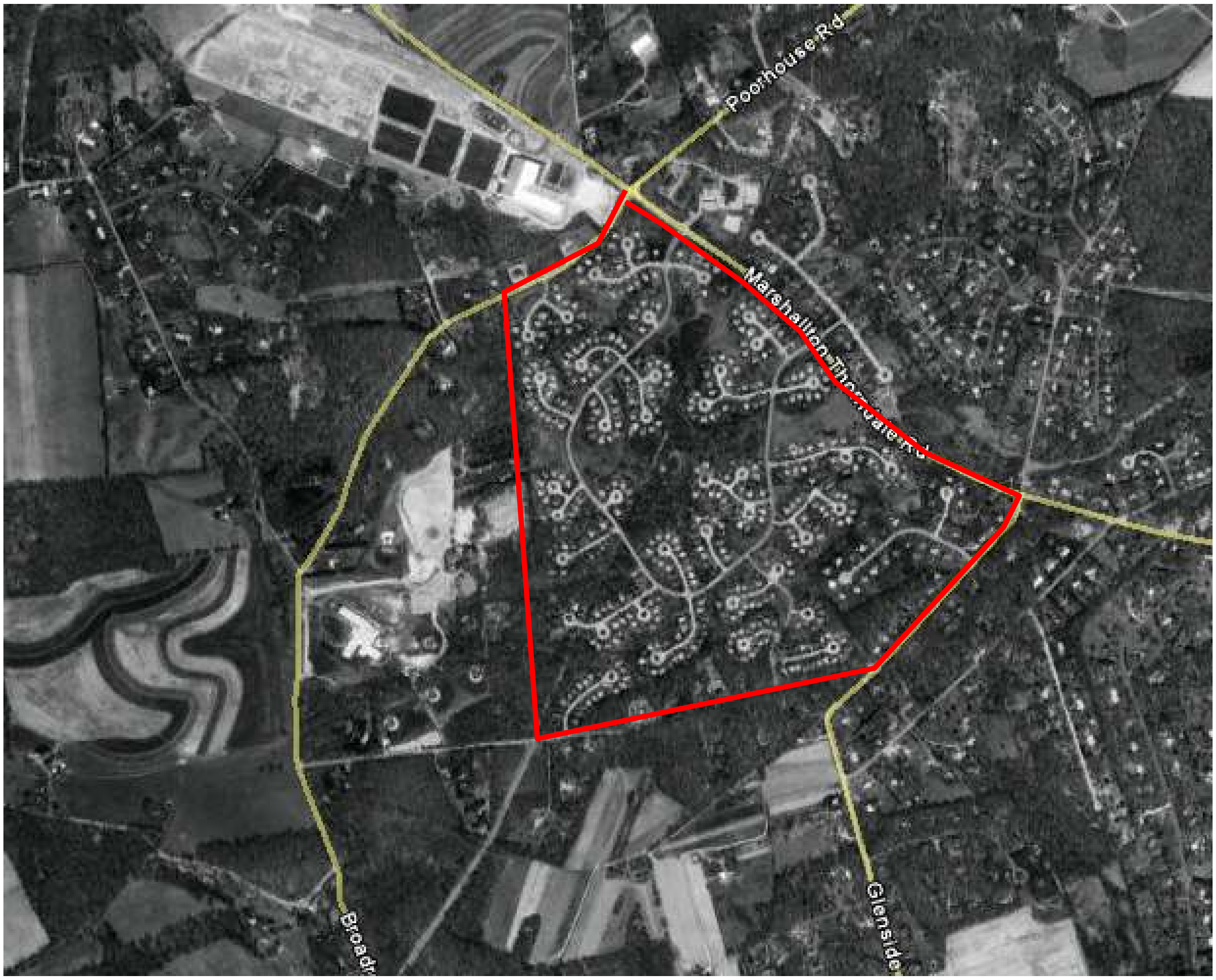
1958 (eastern photo) & 1964 (western photo) Aerial Photograph



1971 Aerial Photograph



1992 Aerial taken from Google Earth



1999 Aerial taken from Google Earth

2010 Aerial Photograph taken from Bing.com

APPENDIX C

ANALYSIS OF THE POTENTIAL IMPACT RADIUS SHOULD CURRENT AND/OR PROPOSED PIPELINE HAVE A CATASTROPHIC FAILURE IN THE BRADFORD GLEN SUBDIVISION

Final

Analysis of the Potential Impact Radius Should Current and/or Proposed Pipeline Have a Catastrophic Failure in the Bradford Glen Subdivision

by Cesar de Leon, P.E.
Date: 08/04/10

I. INTRODUCTION

Cesar de Leon, P.E. of PanAm Pipeline Technology, Inc. was retained by Mr. Andrew Parker, Director of Environmental Services of GTS Technologies, Inc. of Harrisburg, Pennsylvania. Mr. de Leon was to analyze the potential impact radius should current or proposed pipeline have a catastrophic failure in the Bradford Glen Subdivision.

Cesar de Leon, a pipeline safety engineering consultant, was with the Office of Pipeline Safety (now PHMSA) for over 23 years, including Director of the Office for over 5 years and Deputy Director for an additional 5 years. In those positions, he was responsible for directing or co-directing the U.S. national program for issuing and enforcing Federal design, construction, operation, and maintenance regulations for all gas and petroleum pipelines in the country. In the oil/gas industry, he was Vice-President of GeoCondor, Inc. and Engineering Manager of the Western Company, both companies in the oilfield well servicing business. He holds a B.S. in Petroleum Engineering from University of Texas/Austin and an M.S. in Civil Engineering from Texas A&M University/College Station; and is a registered professional engineer in Texas and Colorado.

Basis for Analysis. In preparing this analysis, Mr. de Leon reviewed the following documents, associated exhibits, and information:

1. Title 49 of the Code of Federal Regulations, Part 192 (49 CFR Part 192).
2. "Pipeline Risk Management Manual", by W. Kent Muhlbauer; 3rd Edition, Gulf Professional Publishing.
3. Attachment 1 – Gas pipeline incidents, injuries, and fatalities – 1970 to 2008.
4. GRI-00/0189 "A Model for Sizing High Consequence Areas Associated with Natural Gas Pipelines" by Mark J. Stephens, C-FER Technologies, dated October 2000.
5. Briefing Paper on Utility Corridors regarding Presidential Executive Order 13212.
6. 126 FERC ¶61,019 Order Granting Authority Under Section 3 of the Natural Gas Act and Issuing Certificates Under Section 7 of the Natural Gas Act; issued January 15, 2009.
7. Maps:(1) Bradford Glen Overview; (2) Variation 9; (3) Variation 9A; (4) Variation 9A_HOA; (5) AES_Proposed
8. Letter from Baker Botts LLP to FERC, dated January 15, 2010.

The pipeline. AES Sparrows Point LNG, LLC and Mid-Atlantic Express, LLC (collectively referred to as AES) propose to build an 88-mile gas transmission pipeline (Pipeline) connecting an LNG terminal at Sparrows Point in Baltimore, Maryland with three existing interstate pipelines. The Final Environmental Impact Statement (FEIS) for the LNG terminal and pipeline project, dated December 2008, is titled "Sparrows Point LNG Terminal and Pipeline Project – FERC/EIS 0222F." The Bradford Glen Subdivision is located approximately between Mile Post (MP) 76.4 and MP 78.1 along the proposed Pipeline. According to the EIS, the pipeline will be 30-inch diameter with a maximum operating pressure of 2080 psig and deliver up to 1.5 Bcfd (billion cubic feet per day). Mainline valves are currently proposed at MP 69.27 and MP 78.11.

II. DISCUSSION

The Federal gas transmission pipeline safety regulations, especially with additional recent requirements, assure the safety of people and structures adjacent to the proposed Pipeline. Pipelines have an excellent safety record and the safety record is getting better. According to the statistics of the National Transportation Safety Board, pipelines are by far the safest and most economical method of transporting gas and petroleum products.

In 2009, there are over 2 million miles of gas transmission, gas distribution, and petroleum pipelines in the United States. There are currently about 310,000 miles of gas transmission pipelines in the country. Since Title 49, Part 192 of the Code of Federal Regulations (Code) was issued in 1968, there has been a steady decline in injuries and fatalities on gas transmission pipelines as illustrated in Attachment 1.

Over the past 10 years, there has been an average of 8 injuries and 3 fatalities per year for the 310,000 miles of gas transmission lines; and only an average of 6 injuries and 1 fatality per year over the past 8 years. This decline should improve even further because of additional Federal requirements adopted over the past 7 years that require improving and continuing assurance of the integrity of gas transmission pipelines. These additional Federal requirements are discussed below.

Federal regulations for residences and buildings proximate to the Pipeline. The proposed gas transmission Pipeline will have to be built in accordance with the Code. These Federal regulations require that the Pipeline be designed, constructed, operated, and maintained in accordance with comprehensive continually updated requirements.

A significant factor in the design formula is related to the class location of the immediate surroundings of the Pipeline. Class locations are defined in the Code (§192.5) in accordance with the number of dwelling units (buildings intended for human occupancy) within an area 220 yards (660 feet) either side of the centerline of the Pipeline along any continuous 1 mile length of the Pipeline. There are 4 class locations. Each separate unit in a multiple unit building, such as an apartment building or condominium, is counted in the above totals. Transmission pipeline operators are required by the Code to monitor the population along the pipeline, usually done annually. When a class location change occurs due to higher population density, the pipeline operator must confirm or reduce the maximum allowable operating pressure (MAOP) of the line within 24 months, to conform to the new class location. A required reduction in the MAOP will result in a loss of capacity in the pipeline.

A common industry practice, called *looping,* is to construct an additional pipeline adjacent to the old pipeline in order to provide additional gas supply if a reduction in the MAOP results in an inadequate pipeline capacity. In October 2008, three additional sections (§§ 192.112, 192.328, and 192.620) were added to the Code that includes a procedure that permits continuation of the same MAOP (thereby permitting the same pipeline capacity) when a pipeline changes class location due to a higher population density proximate to a pipeline. Compliance with these new regulations places additional very stringent requirements on a pipeline.

The Code assures more stringent and adequate safety practices when encroachment of dwelling units results in a higher population density proximate to the pipeline. The Code assures more stringent safety practices when additional dwelling units result in a higher population density proximate to the pipeline, thereby changing the class location. For instance, more frequent pipeline patrols (§192.705); closer sectionalizing valve spacing (§192.179); more frequent leak surveys (§192.706); and, as discussed above, pressure levels are reduced in the pipeline (§192.611). In addition, thorough comprehensive pipeline marker requirements (§192.707) require that a line marker be placed and maintained over each buried transmission pipeline in order that the public is aware of the location of a pipeline.

In 2005, more comprehensive Public Awareness regulations (§192.616) were issued requiring provisions to educate the public, appropriate government organizations, and persons engaged in excavation related activities on the use of one-call notification systems, hazards associated with pipelines, steps that should be taken in the event of a failure, and other aspects to assure maximum safety to nearby public. These Public Awareness regulations have resulted in extensively updated programs to make the public, appropriate government organizations, and persons engaged in excavation activities aware of the location and appropriate protection from such pipelines.

What is the maximum extent of injurious heat in case of a catastrophic failure? As discussed above, the area of adjacent to a pipeline that establishes the area subject to Federal regulatory requirements is 220 yards on either side of the pipeline as defined in §192.5. This class location concept has been in the industry pipeline safety standards since the Federal pipeline safety regulations were initially issued in 1968.

In 2003, comprehensive gas transmission Pipeline Integrity Management Plan (IMP) regulations (as defined in Part 192, Subpart O) were issued that extended Federal regulatory requirements beyond 220 yards on either side of the pipeline as discussed below. The IMP regulations provided for extensive requirements for pipelines near populations living or congregating within *high consequence areas* (HCA) (as defined in §192.903 in Subpart O) from a gas transmission pipelines. These IMP rules impose inspection, operation, repair, and other requirements that are additional to the requirements for other parts of pipelines in the pipeline operator's system. These IMP regulations require a detailed and comprehensive program that an operator must develop and continually improve.

An HCA includes a Class 3 and 4 location, the class locations having the highest population density, within the area 220 yards either side of the centerline of the Pipeline along any continuous 1 mile length of the Pipeline. However, the HCA extended this area adjacent to the pipeline for larger pipelines operating at higher pressures, based on a *potential impact radius (PIR).* The PIR is based on fire modeling by C-FER Technologies (C-FER Report) that developed the maximum lateral extent of injurious heat in case of a catastrophic failure. A PIR is based on formula $r = 0.69 * (\text{square root of } (p*d^2))$, where 'r' is the radius of a circular area in feet surrounding the point of failure, 'p' is the maximum allowable operating pressure (MAOP) in the pipeline segment in pounds per square inch, and 'd' is the nominal diameter of the pipeline in inches. The C-FER Report is Attachment 2 to this report.

Any *identified sites* that are within the PIR will also designate that segment of the pipeline an HCA. Some examples of *identified sites* are: (1) an outside area or open structure, such as beaches, playgrounds, recreational facilities, camping grounds, outdoor theaters, stadiums, or areas outside a rural building, that is occupied by twenty or more persons on at least 50 days in any twelve month period. (2) A building, such as religious facilities, office buildings, community centers, general store, or roller skating rinks, that is occupied by twenty or more persons on at least five days a week for ten weeks in any twelve month period. (3) A facility, such as hospitals, prisons, schools, day-care facilities, retirement facilities or assisted-living facilities, occupied by persons who are confined, are of impaired mobility, or would be difficult to evacuate.

The C-FER Report discusses the limited type of catastrophic failures, such as a guillotine-type failure, that will result in injurious heat extending to the PIR distance. Guillotine-type failures are extremely rare. In validating the PIR formula, Page 12 of the C-FER Report (Figure 2) compares twelve catastrophic failures, nine in the U.S. going back to 1970 and three in Canada going back to 1994, in comparing between the distances resulting in injurious heat and the calculated PIR distances. Only four of the twelve failures in the C-FER report extended beyond the 220 yards established by the class location, because the other eight failures were for pipelines with a PIR less than 220 yards; i.e., with a smaller diameter and/or operating at a lower MAOP.

The PIR for the AES Pipeline is 944 feet or a radius that extends 944 feet on one side of the Pipeline and 944 feet on the other side of the Pipeline from the point of a catastrophic failure. The issuance of the HCA regulations and establishment of the PIR was not meant to discourage residences, businesses, outside recreational areas, or buildings within that area; but, to assure the safety of persons within that area by imposing IMP requirements. The probability of large failures will further decrease in *high consequence areas*, because of the IMP requirements that continually assess and improve the integrity of pipelines in those areas.

And as discussed below in **What is the anticipated Pipeline gas pressure through the Bradford Glen Subdivision?,** the maximum pressure expected at MP 78 in the Bradford Glen Subdivision, will be about half of the 2080 psig MAOP of the Pipeline, so that the consequences of a catastrophic failure at the Bradford Glen Subdivision when the pressure is half of the MAOP would only extend to about half of 944 feet. But, as noted above, the PIR formula requires that the MAOP of that segment of the Pipeline (in this case, the entire Pipeline) be used in the formula. So the PIR for the entire pipeline is 944 feet.

What is the probability of a catastrophic failure? While the HCA in the Code established the maximum extent of injurious heat in case of a catastrophic failure, it did not establish the likelihood or probability of such an occurrence. Neither does the C-FER Report. It is important to note that basing future failure probability estimates on the new proposed Pipeline based on the failure data of the entire U.S. gas transmission pipeline system is not valid. There are too many variables in the approximately 310,000 miles of gas transmission pipelines in the U.S. that vary substantially from the AES Pipeline, such as: age of pipe, pipe wall thickness, size of pipe, coating, pressure, corrosion, soil corrosivity, cathodic protection, terrain, flow rate, potential natural forces in the area, pipe manufacturer, steel specifications, welding technology, ILI internal inspections, pressure testing, and other variables.

W. Kent Muhlbauer, author of "Pipeline Risk Management Manual," makes some important observations in his book regarding relying on past failure data on U.S. pipelines to predict future failures. Page 4 states: "...there are no systems beyond very simple, fixed outcome-type systems that can be fully understood solely on the basis of past observations – the core of statistics." On page 6, Muhlbauer states: "The point is that observed past occurrences are rarely sufficient information on which to base probability estimates." Page 8 states: "A pipeline with its infinite combinations of historical, environmental, structural, operational, and maintenance parameters, can be expected to behave as a so-called dynamic system – perhaps, establishing patterns over time, but never repetition."

Therefore, failure data on the 310,000 miles of U.S gas transmission pipelines cannot reliably be used to determine if there will ever be a catastrophic failure on the Pipeline on the Bradford Glen Subdivision. It is illogical to use historical failure data on pipelines that vary from recently constructed pipelines to pipelines over 100 years old to predict the future failure probability on a pipeline constructed in 2010. The historically decreasing occurrence of catastrophic failures and the more stringent IMP regulatory requirements will further decrease the likelihood of future catastrophic failures.

The FEIS disregards the significant dissimilarity between the characteristics of the Pipeline and characteristics of the 310,000 miles of U.S. gas transmission lines, and includes the anticipated future failure of the Pipeline. Page 4-337 of the FEIS reports that "...the Mid-Atlantic Express Pipeline might result in a public fatality every 1,136 plus years. This would represent a slight increase in risk to the nearby public."

In summation, the Pipeline will be a new pipeline incorporating new design and construction technology and subject to increasingly stringent operation and maintenance regulations that it is **improbable** that a catastrophic failure will ever occur within the Bradford Glen Subdivision.

What is the role of the Federal Energy Regulatory Commission? The Federal Energy Regulatory Commission (FERC) is the Federal agency with responsibility for approving the certificate of public convenience and necessity for interstate gas transmission pipelines, which includes approving the tariffs that the pipeline operator can charge for transporting the gas. The FERC approval process includes approval of the pipeline route. The FERC will always consider alternate routes in determining the best route for such a pipeline. In most cases, FERC will tend to want a new pipeline to be constructed adjacent to an existing pipeline in order to lessen the environmental impact. And in all cases, the FERC will require that a new pipeline be constructed, maintained, and operated in accordance with DOT safety protocols to assure the safety of the public.

126 FERC ¶61,019 Order Granting Authority under Section 3 of the Natural Gas Act and Issuing Certificates under Section 7 of the Natural Gas Act, issued on January 15, 2009, finalized the Order for Granting Authority for the AES Pipeline. That FERC Order determined the costs of the Pipeline, determined the necessity of the Pipeline, determined the proposed tariffs, established the Pipeline route after reviewing 4 major alternative routes and 30 route variations, held public meetings where 98 individuals presented comments, considered and responded to protests from other pipeline operators, and

considered and found acceptable the impacts to the environment in a Final Environmental Impact Statement. On January 15, 2010, a letter to FERC from the attorney representing Mid-Atlantic Express accepted the certificate for the Pipeline granted to Mid-Atlantic Express.

What is the anticipated Pipeline gas pressure through the Bradford Glen Subdivision? The maximum allowable operating pressure (MAOP) in the Pipeline at the initiation point at Sparrows Point will be 2,080 psig. This will be one of the highest MAOP for gas transmission pipelines in the country. A typical pipeline gas pressure declines as gas travels down the pipeline until the gas reaches a compressor station where the gas is re-pressured and sent on to the next compressor station. The Pipeline does not have any intermediate compressor stations before being delivered at MP 87. So, the gas pressure in the Pipeline will be approximately 1100 psig when the gas passes through MP 78 in the Bradford Glen Subdivision.

What are Utility Corridors? For many years, there has been a national effort to develop utility corridors to construct new energy transmission facilities in a cost effective and timely manner. This also includes ability to interconnect existing facilities so that energy is transported and utilized as efficiently and reliably as possible. The latest Presidential response to this effort was the Executive Order 13212 issued by President George W. Bush on May 18, 2001, where he created the White House Task Force on Energy Project Streamlining. For the Western U.S., the Bureau of Land Management and the USDA – Forest Service, as well as the Western Governors Association and various utility groups initiated efforts to address this issue. Many current pipeline routes that include several adjacent pipelines as well as utilities serve as de-facto utility corridors. A Briefing Paper on Utility Corridors is Attachment 3 to this report that explains the need for establishing utility corridors.

III. Conclusion

What are possible additional design and construction features? Additional design and construction features that can be added to the Pipeline would have to be approved by AES, as well as FERC, since the additional costs could affect the construction cost of the pipeline and the tariffs for the gas being transported. FERC considers that complying with the DOT regulations in Part 192 will provide adequate safety to the public. Importantly, FERC has already issued the Order for Granting Authority for this Pipeline on January 15, 2009, and Mid-Atlantic Express accepted the certificate on January 15, 2010. Nonetheless, such additional features might be:

1. An additional mainline valve at MP 76.4 so that there is a valve at each side of the Bradford Glen Subdivision. Such an additional valve would assure that a failure anywhere in the Bradford Glen Subdivision would have shut-off valves on each side of the Subdivision and thereby quickly isolate such a failure in the Bradford Glen Subdivision.

2. Provide remote controls on each of the two valves on either side of the Subdivision, if remote controlled valves are not planned.

3. Bury the pipeline with five foot of cover through the Subdivision instead of the customary three feet of cover as required by §192.327 for pipelines in

Class 2, 3 and 4. Such additional burial may considerably increase the excavation costs in that area if the excavation is in rock.

4. If the pipeline is buried with five foot of cover, provide an underground marking tape one foot above the top of the pipeline. The objective of the marking tape is to have an uninformed excavator discover the tape rather than hit the pipeline. This underground marking tape can also be used, even if the pipeline is buried with the customary three feet of cover.

GRI-00/0189

A MODEL FOR SIZING HIGH CONSEQUENCE AREAS ASSOCIATED WITH NATURAL GAS PIPELINES

TOPICAL REPORT

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C-FER Report 99068

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GAS RESEARCH INSTITUTE
Contract No. 8174

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13. ABSTRACT (*Maximum 200 words*)
This report developed a simple and defendable approach to sizing the ground area potentially affected by a worst-case ignited rupture of a high-pressure natural gas pipeline. Based on this model, a simple equation has been developed that relates the diameter and operating pressure of a pipeline to the size of the area likely to experience high consequences in the event of an ignited rupture failure. Pipeline incident reports, located in the public domain, were reviewed and provide the basis for evaluating the validity of the proposed affected area equation. The correlation suggests that the simple equation provides a credible estimate of affected area.

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RESEARCH SUMMARY

Title	A Model for Sizing High Consequence Areas Associated with Natural Gas Pipelines
Contractor(s)	C-FER Technologies
GRI-Contract Number	8174
Principal Investigator(s)	Mark J. Stephens
Report Type	Topical Report
Objective State	To develop a simple and defendable approach to sizing the ground area potentially affected by the failure of a high-pressure natural gas pipeline.
Technical Perspective	The rupture of a high-pressure natural gas pipeline can lead to outcomes that can pose a significant threat to people and property in the immediate vicinity of the failure location. The dominant hazard is thermal radiation from a sustained fire and an estimate of the ground area affected by a credible worst-case event can be obtained from a model that characterizes the heat intensity associated with rupture failure of the pipe where the escaping gas is assumed to feed a fire that ignites very soon after line failure.
Technical Approach	An equation has been developed that relates the diameter and operating pressure of a pipeline to the size of the affected area in the event of a credible worst-case failure event. The model upon which the hazard area equation is based consists of three parts: 1) a fire model that relates the rate of gas release to the heat intensity of the fire; 2) an effective release rate model that provides a representative steady-state approximation to the actual transient release rate; and 3) a heat intensity threshold that establishes the sustained heat intensity level above which the effects on people and property are consistent with the adopted definition of a High Consequence Area (HCA).
Results	For methane with an HCA threshold heat intensity of 5,000 Btu/hr ft^2, the hazard area equation is given by: $r = 0.685\sqrt{p\,d^2}$ where r is the hazard area radius (ft), d is the line diameter (in), and p is the maximum operating pressure (psi).
Project Implications	Natural gas transmission line operators will provide periodic assurances that their pipelines are safe. The Federal code 49CFR192 mandates increased wall thickness thereby reducing the corrosion and mechanical damage risks as the population density increases. The definition of High Consequence Areas is expected to require additional protection for people with limited mobility such as day care centers, old age homes, and prisons. This report suggests the definition for the HCA area of increased protection be set by two parameters, the pipe diameter and it's operating pressure.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Scope and Objective

This report summarizes the findings of a study conducted by C-FER Technologies (C-FER), under contract to the Gas Research Institute (GRI), to develop a simple and defendable approach to sizing the ground area potentially affected by the failure of a high-pressure natural gas pipeline. This work was carried out at the request of the Integrity Management and Systems Operations Technical Advisory Group (IM&SO TAG), a committee of GRI.

1.2 Technical Background

The failure of a high-pressure natural gas pipeline can lead to various outcomes, some of which can pose a significant threat to people and property in the immediate vicinity of the failure location. For a given pipeline, the type of hazard that develops, and the damage or injury potential associated with the hazard, will depend on the mode of line failure (*i.e.*, leak vs. rupture), the nature of gas discharge (*i.e.*, vertical vs. inclined jet, obstructed vs. unobstructed jet) and the time to ignition (*i.e.*, immediate vs. delayed). The various possible outcomes are summarized in Figure 1.1.

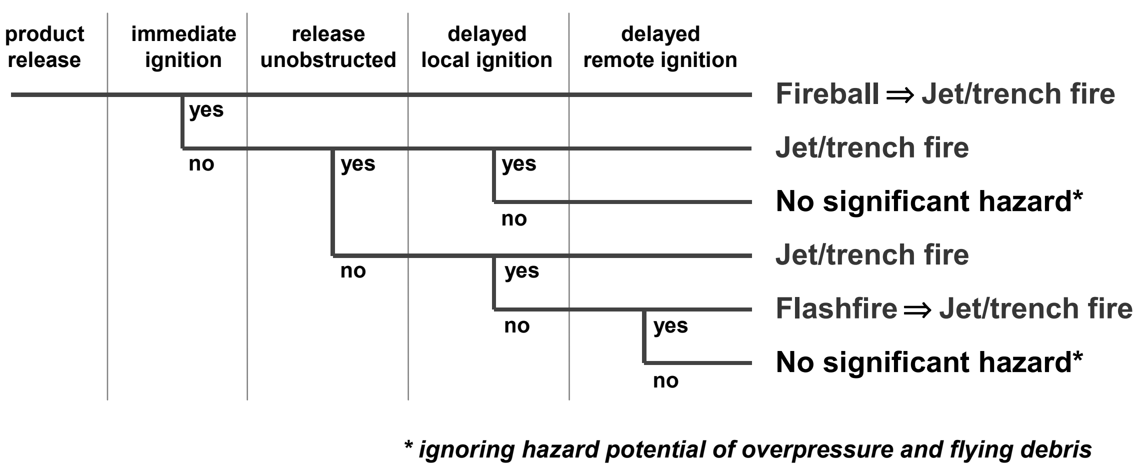

Figure 1.1 Event tree for high pressure gas pipeline failure (adapted from Bilo and Kinsman 1997).

For gas pipelines, the possibility of a significant flash fire resulting from delayed remote ignition is extremely low due to the buoyant nature of the vapor, which generally precludes the formation of a persistent flammable vapor cloud at ground level. The dominant hazard is, therefore, thermal radiation from a sustained jet or trench fire, which may be preceded by a short-lived fireball.

In the event of line rupture, a mushroom-shaped gas cloud will form and then grow in size and rise due to discharge momentum and buoyancy. This cloud will, however, disperse rapidly and a quasi-steady gas jet or plume will establish itself. If ignition occurs before the initial cloud disperses, the flammable vapor will burn as a rising and expanding fireball before it decays into a sustained jet or trench fire. If ignition is slightly delayed, only a jet or trench fire will develop. Note that the added effect on people and property of an initial transient fireball can be accounted for by overestimating the intensity of the sustained jet or trench fire that remains following the dissipation of the fireball.

A trench fire is essentially a jet fire in which the discharging gas jet impinges upon an opposing jet and/or the side of the crater formed in the ground. Impingement dissipates some of the momentum in the escaping gas and redirects the jet upward, thereby producing a fire with a horizontal profile that is generally wider, shorter and more vertical in orientation, than would be the case for a randomly directed and unobstructed jet. The total ground area affected can, therefore, be greater for a trench fire than an unobstructed jet fire because more of the heat-radiating flame surface will typically be concentrated near the ground surface.

An estimate of the ground area affected by a credible worst-case failure event can, therefore, be obtained from a model that characterizes the heat intensity associated with rupture failure of the pipe, where the escaping gas is assumed to feed a sustained trench fire that ignites very soon after line failure.

Because the size of the fire will depend on the rate at which fuel is fed to the fire, it follows that the fire intensity and the corresponding size of the affected area will depend on the effective rate of gas release. The release rate can be shown to depend on the pressure differential and the hole size. For guillotine-type failures, where the effective hole size is equal to the line diameter, the governing parameters are, therefore, the line diameter and the pressure at the time of failure. Given the wide range of actual pipeline sizes and operating pressures, a meaningful fire hazard model should explicitly acknowledge the impact of these parameters on the area affected.

1.3 Report Organization

The hazard model developed to relate the area potentially affected by a failure to the diameter and pressure of the pipeline is described in Section 2.0. Validation of the proposed hazard area model, based on historical data from high-pressure gas pipeline failure incidents in the United States and Canada, is presented in Section 3.0.

2. HAZARD MODEL

2.1 Overview

An equation has been developed that relates the diameter and operating pressure of a pipeline to the size of the area likely to experience high consequences in the event of a credible worst-case failure event. The hazardous event considered is a guillotine-type line rupture resulting in double-ended gas release feeding a trench fire that is assumed to ignite soon after failure.

The hazard model upon which the hazard area equation is based consists of three parts: 1) a fire model that relates the rate of gas release to the heat intensity of the fire as a function of distance from the fire source; 2) an effective release rate model that provides a representative steady-state approximation to the actual transient release rate; and 3) a heat intensity threshold that establishes the sustained heat intensity level above which the effects on people and property are consistent with the definition of a high consequence area. Note that in the context of this study, an HCA is defined as the area within which the extent of property damage and the chance of serious or fatal injury would be expected to be significant in the event of a rupture failure.

The basis for each model, and any underlying assumptions, are described in Sections 2.2 through 2.4. The hazard area equation obtained by combining the model components is described in Section 2.5.

2.2 Fire Model

A jet flame can be idealized as a series of point source heat emitters spread along the length of the flame (see Figure 2.1). Each point source can be is assumed to radiate an equal fraction of the total heat with the heat flux I_i at a given location resulting from point source *i* being given by (Technica 1988):

$$I_i = \frac{\eta X_g Q_{eff} H_c}{4 n_p \pi x_i^2} \qquad [2.1]$$

where H_c = heat of combustion (constant for given product) ≅ 50,000 kJ/kg for methane;
η = combustion efficiency factor = 0.35;
X_g = emissivity factor = 0.2;
n_p = number of point sources;
Q_{eff} = effective gas release rate; and
x_i = radial distance from heat source *i* to the location of interest.

The total heat flux reaching a given point is obtained by summing the radiation received from each point source emitter.

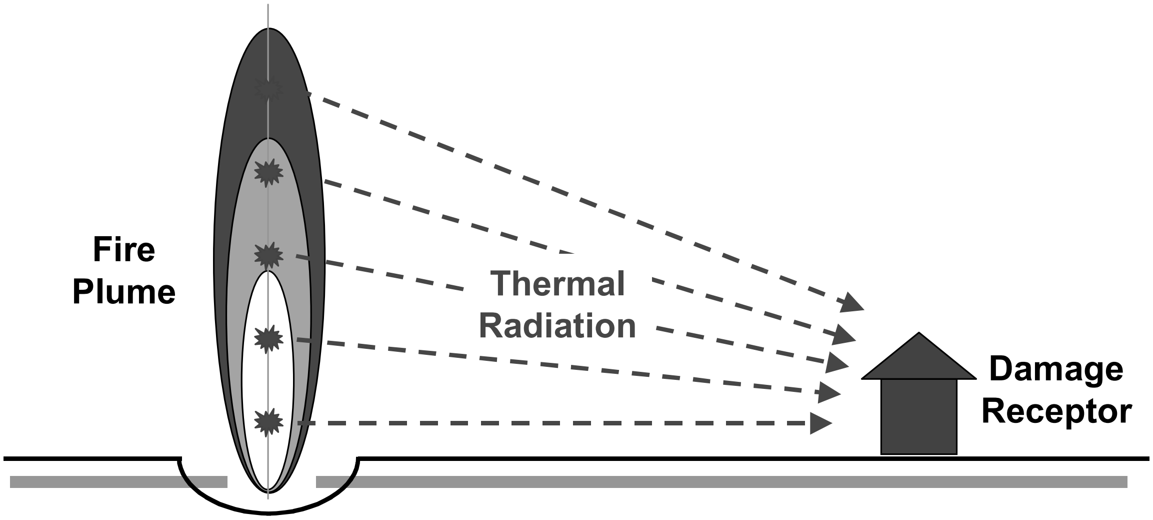

Figure 2.1 Conceptual fire hazard model.

A simplifying assumption, that generally yields a conservative estimate of the total heat flux received by ground level damage receptors, involves collapsing the set of heat emitters into a single point source emitter located at ground level (see Figure 2.2).

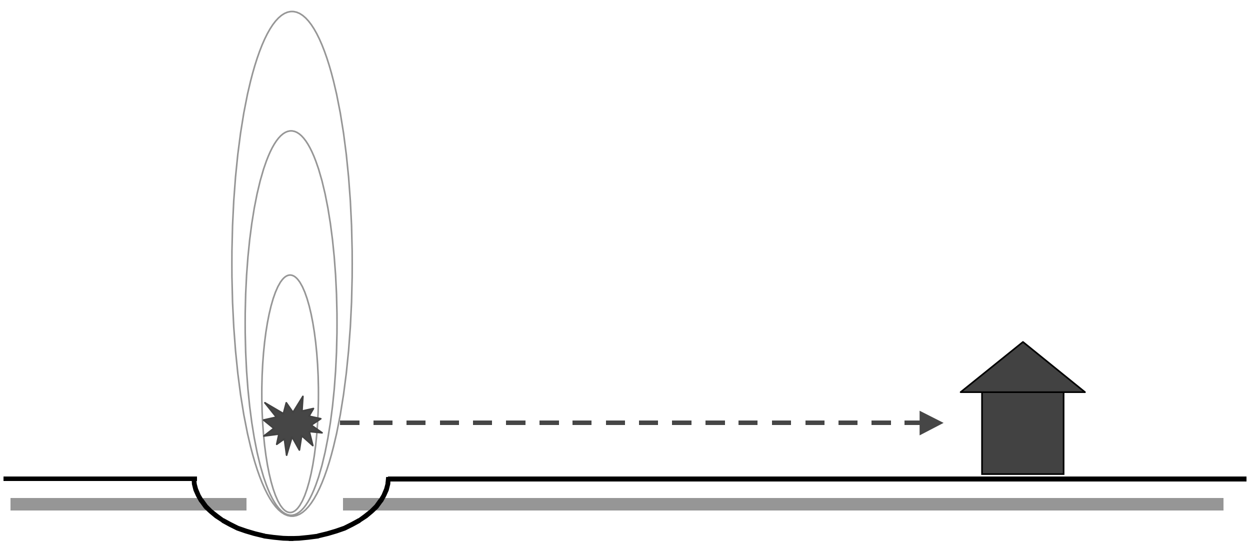

Figure 2.2 Simplified fire hazard model.

The resulting equation for the total heat flux I at a horizontal distance of r from the fire center is given by:

$$I = \frac{\eta X_g Q_{eff} H_c}{4\pi r^2} \qquad [2.2]$$

This simplification is, in some respects, more consistent with the geometry of a trench fire which, due to the jet momentum dissipation (see Section 1.2), concentrates more of the heat-radiating flame surface near ground level. Note, however, that while a ground-level point source model represents a conservative approximation to a vertically-oriented jet flame or trench fire, this conservatism is partially offset by the fact that the model does not explicitly account for the possibility of laterally-oriented jets and/or the effects of wind on the actual position of the fire center relative to the center of the pipeline.

Note, also, that for a single point source emitter located at ground level directly above the pipeline, the locus of points receiving a heat flux of I defines a circular area of radius r centered on the pipeline. Thermal radiation hazard zones of increasing impact severity are, therefore, described by concentric circles centered on the pipeline having radii that correspond to progressively higher heat fluxes.

The adopted heat flux versus distance relationship given by Equation [2.2] represents an extension of the widely recognized flare radiation model given in API RP 521 (API 1990). It can be shown to be less conservative than the API flare model (*i.e.*, it gives lower heat intensity estimates at a given distance) but this should not be considered surprising since the API model is widely recognized to be conservative (Lees 1996).

The adopted model is also preferred over some of the more generic, multi-purpose models available for industrial fire hazard analysis because it acknowledges factors, ignored by other models, that play a significant role in mitigating the intensity of real-world jet fire events. In particular, it accounts for the incomplete combustion of the escaping gas stream (through the combustion efficiency factor η), and it acknowledges (through the emissivity factor X_g) that a significant portion of the radiant heat energy will be absorbed by the atmosphere before it can reach targets at any significant distance from the flame surface.

2.3 Effective Release Rate Model

The rate of gas release from a full-bore line rupture varies with time. Within seconds of failure, the rate of release will have dropped to a fraction of the peak initial value and over time the release rate will decay even further. This tendency for rapid release rate decay is illustrated in Figure 2.3, which shows how the rate would be expected to vary with time for two representative line diameter and operating pressure combinations. The relative release rate estimates shown in the figure were calculated using a non-dimensional rate decay model presented in a study by the Netherlands Organization of Applied Scientific Research, Division of Technology for Society (TNO 1982) which is based on realistic gas flow and decompression characteristics and which acknowledges both the compressibility of the gas and the effects of pipe wall friction.

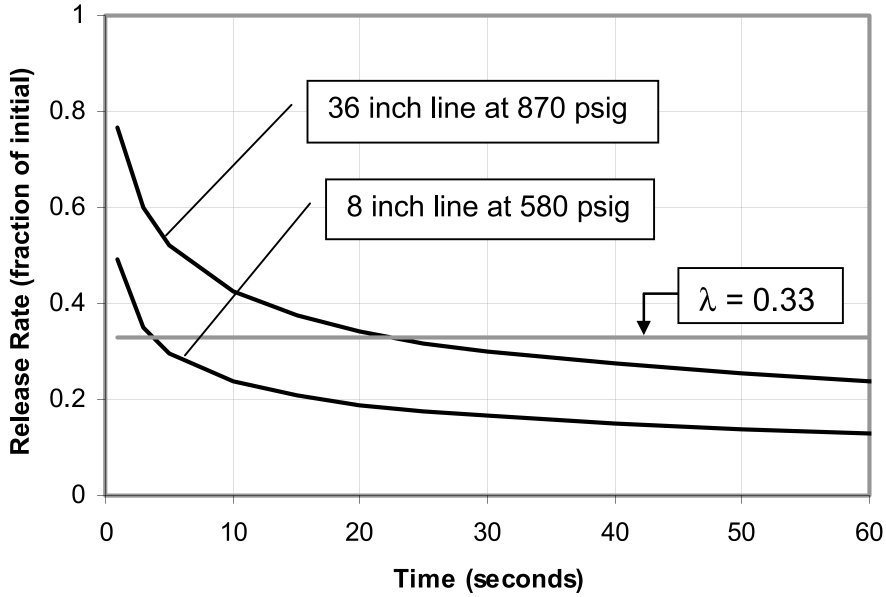

Figure 2.3 Release rate decay.

The peak initial release rate from the single end of a full-bore line rupture can be estimated using the widely recognized gas discharge equation given by the Crane Co. (1981) for sonic or choked flow through an orifice:

$$Q_{in} = C_d \frac{\pi d^2}{4} p \frac{\varphi}{a_0} \qquad [2.3a]$$

where φ = flow factor = $\gamma\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma+1}{2(\gamma-1)}}$; [2.3b]

a_0 = sonic velocity of gas = $\sqrt{\frac{\gamma R T}{m}}$; [2.3c]

C_d = discharge coefficient ≅ 0.62;
γ = specific heat ratio of gas ≅ 1.306 for methane;
R = gas constant = 8,310 J/(kg mol)/K;
T = gas temperature ≅ 288 K or 15 C;
m = gas molecular weight ≅ 16 kg/mol for methane;
d = effective hole diameter ≅ line diameter; and
p = pressure differential ≅ line pressure.

Given that the release rate is highly variable, it follows that the size and intensity of the associated fire will also vary with time and the peak intensity of the fire will depend on exactly when ignition occurs. The hazard model developed herein accounts for the above by approximating the transient jet or trench fire as a steady state fire that is fed by an *effective* release rate. The effective release rate is a fractional multiple of the peak initial release rate that can be used to obtain estimates of sustained heat flux that are comparable to those obtained from a more realistic transient fire model that assumes a slight delay in ignition time.

For a guillotine-type failure of a pipeline resulting in double-ended release, the effective release rate that is assumed to feed a steady-state fire is given by:

$$Q_{eff} = 2\lambda Q_{in} = 2\lambda C_d \frac{\pi d^2}{4} p \frac{\varphi}{a_0} \qquad [2.4]$$

where λ is the release rate decay factor and the factor of 2 acknowledges that gas will be escaping from both failed ends of the pipeline.

In general, the most appropriate value for the release rate decay factor will depend on the size of pipeline being considered, the pressure in the line at the time of failure, the assumed time to ignition, and the time period required to do damage to property or cause harm to people. Given that even immediate ignition will require several seconds for the establishment of the assumed radiation conditions and given further that a fatal dose of thermal radiation can be received from a pipeline fire in well under 1 minute (see Section 2.4), it follows from Figure 2.3 that a rate decay factor in the range of 0.2 to 0.5 will likely yield a representative steady state approximation to the release rate for typical pipelines.

In a study of the risks from hazardous pipelines in the United Kingdom conducted by A. D. Little Ltd. (Hill and Catmur 1995), the authors report using a release rate decay factor of 0.25. A slightly more conservative value for λ of 0.33 has been adopted herein to ensure that the sustained fire intensity associated with nearly immediate ignition of fires associated with large diameter pipelines will not be underestimated (see Figure 2.3). Given that anecdotal information on natural gas pipeline failures suggests that the time to ignition may typically be in the range of 1 to 2 minutes (as in the Edison, New Jersey incident of 1994), the adopted release rate decay factor will likely yield an effective release rate estimate that overestimates the actual rate for the full duration of a typical gas pipeline rupture fire.

2.4 Heat Intensity Threshold

For people, the degree of harm caused by thermal radiation is usually estimated using a model that relates the chance of burn injury or fatality to the thermal load received where the thermal load L_p is given by an equation of the form (Lees 1996):

$$L_p = t\, I^n \qquad [2.5]$$

where t is the exposure duration, I is the heat flux and n is an index.

Various recognized thermal load vs. effect models based on Equation [2.5] are summarized in Table 2.1 together with calculated estimates of the exposure times required to reach various conditions of injury and mortality for persons exposed to specified heat intensity levels. If it is assumed that within a 30 second time period an exposed person would remain in their original position for between 1 and 5 seconds (to evaluate the situation) and then run at 5 mph (2.5 m/s) in the direction of shelter, it is estimated that within this period of time they would travel a distance of about 200 ft (60 m). On the further assumption that, under typical conditions, a person can reasonably be expected to find a sheltered location within 200 ft of their initial position, a 30 second exposure time is considered credible and is, therefore, adopted as the reference exposure time for people outdoors at the time of failure.

Radiation Intensity or Heat Flux (Btu/hr ft^2)	Radiation Intensity or Heat Flux (kW/m^2)	Time to Burn Threshold (Eisenberg et al. 1975) $t*I^{1.15}$ = 195	Time to Blister Threshold - lower[1] (Hymes 1983)[2] $t*I^{1.33}$ = 210	Time to Blister Threshold - upper[1] (Hymes 1983)[2] $t*I^{1.33}$ = 700	Time to 1% Mortality (Hymes 1983)[2] $t*I^{1.33}$ = 1060	Time to 50% Mortality (Hymes 1983)[2] $t*I^{1.33}$ = 2300	Time to 100% Mortality[3] (Bilo & Kinsman 1997) $t*I^{1.33}$ = 3500
1600	5.05	30.3	24.4	81.3	123.1	267.1	406.4
2000	6.31	23.5	18.1	60.4	91.5	198.5	302.1
3000	9.46	14.7	10.6	35.2	53.4	115.8	176.2
4000	12.62	10.6	7.2	24.0	36.4	79.0	120.2
5000	15.77	8.2	5.4	17.9	27.0	58.7	89.3
8000	25.24	4.8	2.9	9.6	14.5	31.4	47.8
10000	31.55	3.7	2.1	7.1	10.8	23.3	35.5
12000	37.85	3.0	1.7	5.6	8.4	18.3	27.9

Note:
1) Hymes gives a thermal load range (210 to 700) rather than a single value for blister formation
2) the thermal load values given by Hymes are based on a revised interpretation of the results obtained by Eisenberg et al.
3) Bilo and Kinsman assume that 100% mortality corresponds to a lower bound estimate of the thermal load associated with the spontaneous ignition of clothing

Table 2.1 Effects of thermal radiation on people.

The exposure time estimates closest to this reference time are highlighted in Table 2.1 for each different thermal load effect. Note that the onset of burn injury within the reference exposure time is associated with a heat flux in the range of 1,600 to 2,000 Btu/hr ft^2 (5 to 6.3 kW/m^2), depending on the burn injury criterion. The chance of fatal injury within the reference exposure time becomes significant at a heat flux of about 5,000 Btu/hr ft^2 (15.8 kW/m^2), if the significance threshold is taken to be a 1% chance of mortality (*i.e.,* 1 in 100 people directly exposed to this thermal load would not be expected to survive).

For property, as represented by a wooden structure, the time to both piloted ignition (*i.e.,* with a flame source present) and spontaneous ignition (*i.e.,* without a flame source present) can also be estimated as a function of the thermal load received. For buildings, the thermal load L_b is given by an equation of the form (Lees 1996):

$$L_b = (I - I_x)t^n \quad [2.6]$$

where I_x is the heat flux threshold below which ignition will not occur.

Models based on Equation [2.6], developed from widely cited tests as re-interpreted by the UK Health and Safety Executive (Bilo and Kinsman 1997), are summarized in Table 2.2 together with calculated estimates of the exposure times required for both piloted and spontaneous ignition at selected heat intensity levels.

Radiation Intensity or Heat Flux (Btu/hr ft^2)	Radiation Intensity or Heat Flux (kW/m^2)	Time to Piloted Ignition[1] (Bilo & Kinsman 1997) $(I-14.7)*t^{0.667}=118.6$	Time to Spontaneous Ign.[1] (Bilo & Kinsman 1997) $(I-25.6)*t^{0.8}=167.6$
4000	12.62	no ignition	no ignition
5000	15.77	1162.3	no ignition
8000	25.24	37.8	no ignition
10000	31.55	18.7	65.0
12000	37.85	11.6	26.3
Note: 1) based on experiments on American whitewood			

Table 2.2 Effects of thermal radiation on wooden structures.

From Table 2.2 it can be seen that 5,000 Btu/hr ft^2 (15.8 kW/m^2), corresponds to piloted ignition after about 20 minutes (1,200 seconds) of sustained exposure. The table further shows that spontaneous ignition is not possible at this heat intensity level. It is therefore assumed that this heat intensity represents a reasonable estimate of the heat flux below which wooden structures would not be destroyed, and below which wooden structures should afford indefinite protection to occupants.

Note that the model employed for estimating the effects of thermal radiation on property explicitly considers the duration of exposure required to cause ignition. Some earlier wood ignition models, which appear to be the basis for the often cited 4,000 Btu/hr ft^2 (12.6 kW/m^2) threshold for piloted wood ignition, are in fact associated with an almost indefinite time to ignition and are, therefore, considered to be overly conservative given the transient (decaying) nature of real pipeline rupture fires.

In light of the above, if a high consequence area is defined as the area within which both the extent of property damage and the chance of serious or fatal injury would be expected to be significant, it follows that this area can reasonably be defined by a heat intensity contour corresponding to a threshold value below which:

- property, as represented by a typical wooden structure, would not be expected to ignite and burn;
- people located indoors at the time of failure would likely be afforded indefinite protection; and
- people located outdoors at the time of failure would be exposed to a finite but low chance of fatality.

The information presented on thermal load effects suggests that below 5,000 Btu/hr ft^2, a wooden structure would not be expected to burn and it, thereby, affords indefinite protection to sheltered persons. Also, this heat intensity level corresponds to approximately a 1 percent chance of fatality for persons exposed for a credible period of time before reaching shelter. A heat flux of 5,000 Btu/hr ft^2 has, therefore, been adopted as the threshold heat intensity for the purpose of sizing a high consequence area.

2.5 Hazard Area Equation

Substituting the expression developed for the effective release rate (Equation [2.4]) into the heat intensity versus distance formula (Equation [2.2]), replacing all constants and rearranging gives the following expression for the radial distance to locations where the heat flux is equal to the threshold value:

$$r = \sqrt{\frac{2348\, p\, d^2}{I_{th}}} \quad \text{(ft)} \qquad [2.7]$$

where I_{th} = threshold heat intensity (Btu/hr/ft^2);
p = line pressure (psi); and
d = line diameter (in).

For a threshold heat intensity of 5,000 Btu/hr ft^2, the above expression reduces to:

$$r = 0.685\sqrt{p\, d^2} \qquad [2.8]$$

Equation [2.8] can, therefore, be used to estimate the radius of a circular area surrounding the assumed point of line failure within which the impact on people and property would be expected to be consistent with the adopted definition of a high consequence area.

Hazard area radii, as calculated using Equation [2.8] are plotted in Figure 2.4 as a function of line diameter and operating pressure. The figure shows that, for pipelines operating at pressure levels in the range of 600 to 1,200 psi, the calculated hazard area radius ranges from under 100 ft for small diameter lines to over 1,100 ft for large diameter lines.

Note that the concept of relating the potential hazard area to the line diameter and operating pressure is not new. An approach similar to that described herein has been an integral part of the high pressure gas transmission pipeline code in the United Kingdom since 1977 (Knowles *et al*. 1978 and IGE 1993). The standard as developed in the United Kingdom incorporates the concept of a Building Proximity Distance (BPD), multiples of which serve to define development exclusion zones and establish the pipeline corridor width for the purpose of determining Location Class. The BPD is calculated directly from the line diameter and the maximum operating pressure.

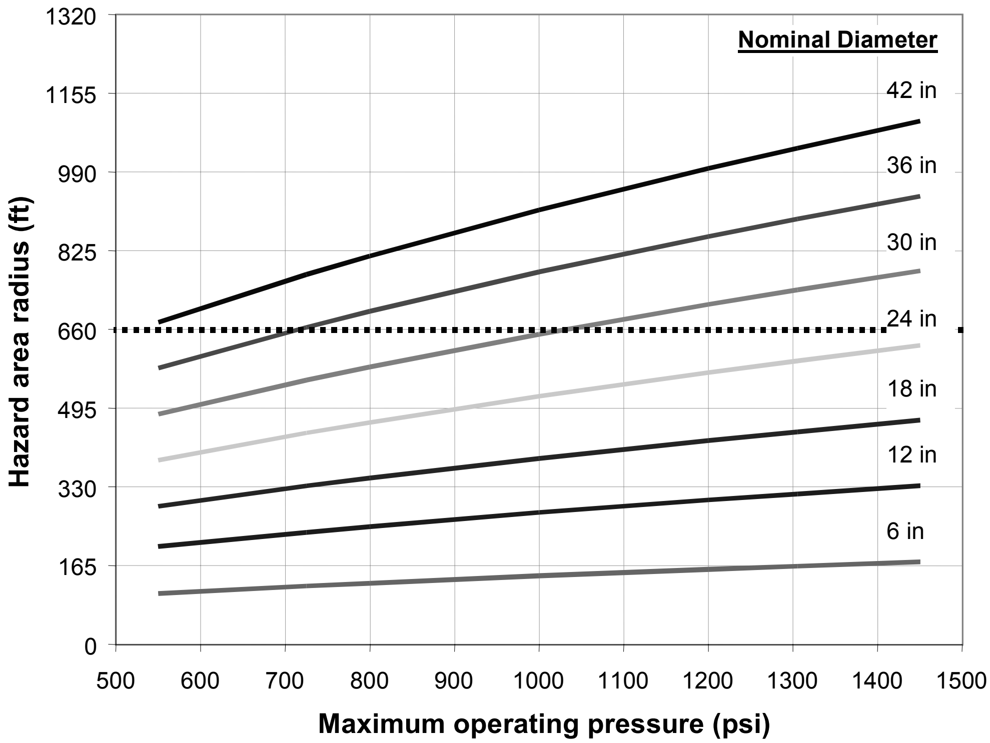

Figure 2.4 Proposed hazard area radius as a function of line diameter and pressure.

3. MODEL VALIDATION

Pipeline incident reports, located in the public domain, were reviewed to provide a basis for evaluating the validity the proposed hazard area model given by Equation [2.8]. The data sources reviewed included reports on pipeline incidents in the United States prepared by the National Transportation Safety Board (NTSB) going back to 1970, and similar reports on incidents in Canada prepared by the Transportation Safety Board (TSB) going back to 1994. Note that the information extracted from these reports required some interpretation due to differences in the way the information was reported. The processed data together with hazard area estimates obtained using Equation [2.8] are summarized in Figure 3.1. A summary of the information that forms the basis for Figure 3.1 is given in Table 3.1.

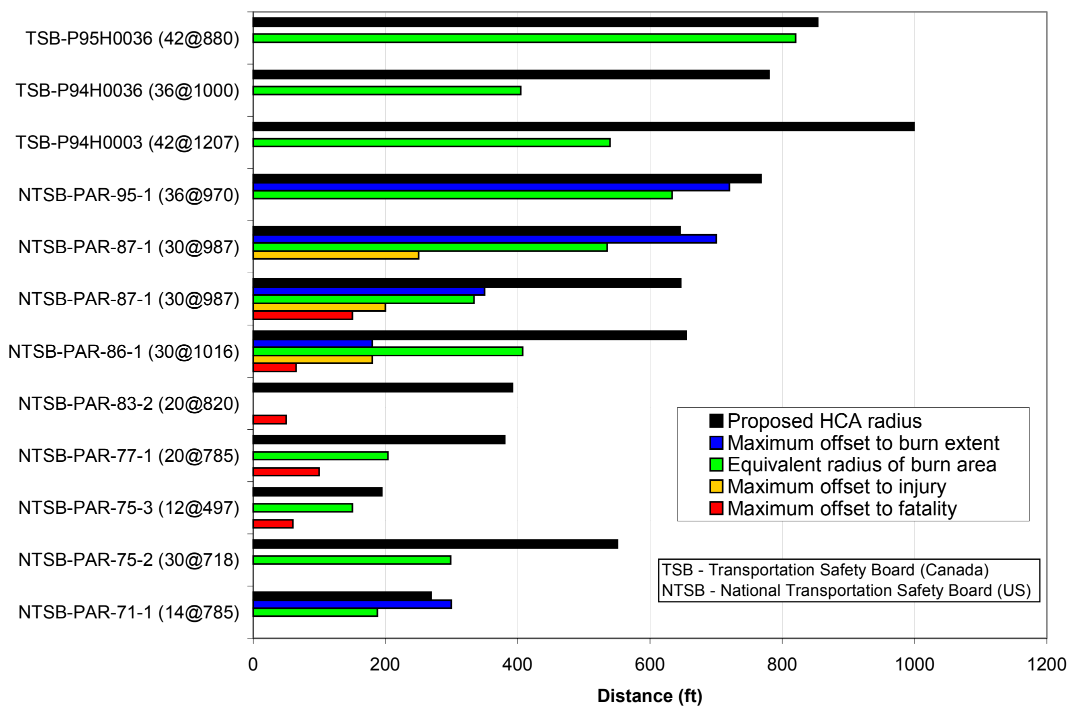

Figure 3.1 Comparison between actual incident outcomes and the proposed hazard area model.

In interpreting the incident outcomes summarized in Figure 3.1 note the following:

- the *equivalent radius of burn area* is the radius of a circle having an area equal to the reported area of burnt ground;
- the *maximum offset to burn extent* is the maximum reported of inferred lateral extent of burnt ground measured perpendicular to a line tracing the alignment of the pipeline prior to failure; and
- the *maximum offset to injury/fatality* is the maximum reported or inferred distance to an injury/fatality again measured perpendicular to a line tracing the alignment of the pipeline prior to failure.

Figure 3.1 shows that in every case the hazard area calculated using the proposed equation is greater than the actual reported area of burnt ground. In addition, with the sole exception of one of the incidents reported in NTSB-PAR-87-1, the radius obtained from the hazard area equation conservatively approximates the maximum lateral extent of the burn zone. Finally, in all cases the calculated hazard zone radius significantly exceeds the maximum reported offset distance to injury or fatality.

Note, however, that whereas the interpretation of reported burn areas and burn distances is obvious, caution should be exercised in interpreting maximum offset distances to injury and fatality. Given that most of the incidents occurred in sparsely populated areas, the reported injury and fatality offsets are more indicative of where people happened to be at the time of failure rather than being representative of the maximum possible distances to injury or fatality for the incident in question.

Acknowledging the uncertainty associated with interpreting reported offsets to injury and fatality, the balance of information still overwhelmingly indicates that the proposed hazard area radius equation provides a reasonable, if somewhat conservative, estimate of the zone of high consequence.

It is thought that one of the main reasons for the apparent conservatism in the proposed hazard area model is that it is based on an effective sustained release rate that is consistent with the assumption of almost immediate ignition. The actual time to ignition for many of the reported incidents is probably longer (see incident notes in Table 3.1) making the effective release rate approximation conservative.

Date	Report	Location	Incident	Damage	Maximum Burn Distance	Diameter (in)	Pressure (psi)
1969	NTSB-PAR-71-1	near Houston, Texas	Rupture at 3:40 p.m. on September 9th, explosive ignition 8 to 10 minutes after failure.	Burned area 370 ft long by 300 ft wide (all to one side). Houses destroyed by blast to 250 ft, heat damage to 300 ft, 106 homes damaged, 9 injuries, and 0 fatalities.	300 ft	14	789
1974	NTSB-PAR-75-2	near Bealeton, Virginia		Burned area 700 ft by 400 ft.		30	718
1974	NTSB-PAR-75-3	near Farmington, New Mexico	Rupture at 3:45 a.m. on March 15th, ignition soon after failure.	Earth charred within a 300 ft diameter circle, 3 fatal injuries (within 60 ft offset)		12.75	497
1976	NTSB-PAR-77-1	Cartwright, Louisiana	Rupture at 1:05 p.m. on August 9th, ignited within seconds	Burn area 3 acres (implies a 200 ft radius circle), 6 fatalities (within about 100 ft offset) and 1 injury.		20	770
1982	NTSB-PAR-83-2	Hudson, Iowa		5 fatalities (within 150 ft, less than 50 ft offset).		20	820
1984	NTSB-PAR-86-1	near Jackson, Louisiana	Rupture at 1:00 p.m. on November 25th, ignition soon after failure.	Burned area 1450 ft long by 360 ft wide (furthest fire extent 950 ft), 5 fatalities (within 65 ft, 0 ft offset), and 23 injuries (within 800 ft,180 ft offset).	Offset 180 ft. Distance 950 ft.	30	1016
1985	NTSB-PAR-87-1	near Beaumont, Kentucky	Rupture at 9:10 p.m. on April 27th, ignition soon after failure.	Burned area 500 ft wide by 700 ft long. 2 houses, 3 house trailers and numerous other structures and equipment destroyed. 5 fatalities due to smoke inhalation in house 318 ft from rupture (150 ft offset), 3 people burned running from house 320 ft from rupture (200 ft offset) one hospitalized with 2nd degree burns.	Offset 350 ft. Distance 500 ft.	30	990
1986	NTSB-PAR-87-1	near Lancaster Kentucky	Rupture at 2:05 a.m. on February 21st, ignition soon after failure.	Burned area 900 ft by 1000 ft. 2 houses, 1 house trailer and numerous other structures and equipment destroyed. 3 people burned running from house 280 ft from rupture (requiring hospitalization), 5 others received minor burn injuries running from dwellings between 200 and 525 ft from rupture (250 ft offset).	Offset 700 ft. Distance 800 ft.	30	987
1994	NTSB-PAR-95-1	Edison, New Jersey	Rupture at night on March 23rd, ignition within 1 to 2 minutes after failure.	Burned area 1400 ft long by 900 ft wide. Fire damage to dwelling units up to 900 ft from rupture, dwelling units at 500 ft and beyond caught fire between 7 to 10 minutes after failure, no fatalities but 58 injuries.	Offset 720 ft. Distance 960 ft.	36	970
1994	TSB Report No. P94H0003	Maple Creek, Saskatchewan	Rupture at 7:40 p.m. on February 14th, ignition soon after failure.	Fire burn area 21.0 acres (8.5 hectares).		42	1207
1994	TSB Report No. P94H0036	Latchford, Ontario	Rupture at 7:13 a.m. on July 23rd, ignition soon after failure.	Fire burn area 11.8 acres (4.77 hectares), heat-affected area 18.6 acres (7.52 hectares).		36	1000
1995	TSB Report No. P95H0036	Rapid City, Manitoba	Rupture of 42 inch line at 5:42 a.m. on July 29th, ignition soon after failure leading to rupture and fire on adjacent 36 inch line at 6:34 a.m.	Fire burn area 48.5 acres (19.6 hectares), heat-affected area 198 acres (80 hectares).		42	880

Table 3.1 Summary of relevant North American pipeline failure incident reports.

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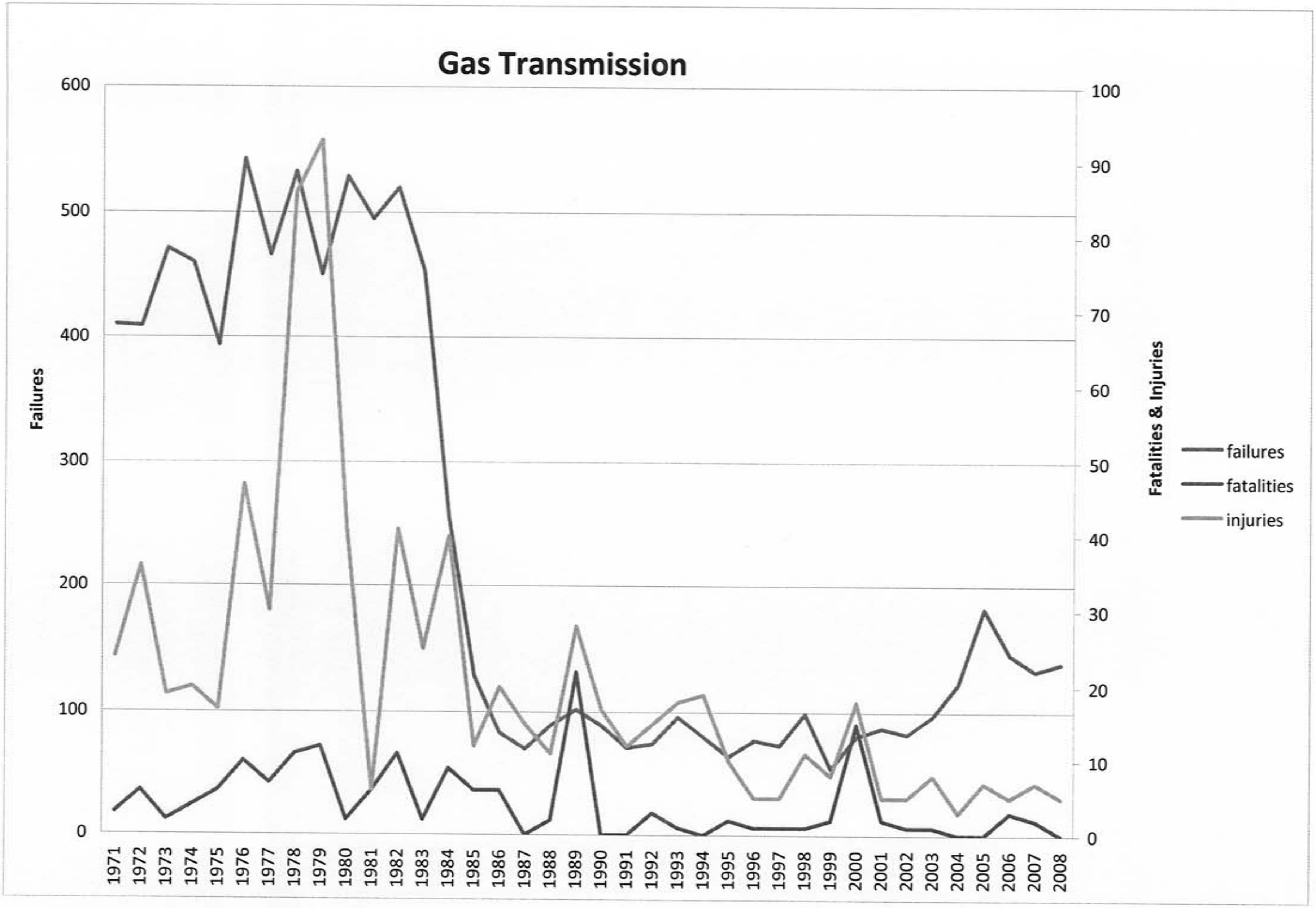

Gas Transmission
Failures
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BRIEFING PAPER ON UTILITY CORRIDORS

Introduction

On May 18, 2001 President George W. Bush issued Executive Order Number 13212. This Executive Order was in response to a mounting energy crisis that threatened the adequate production and supply of energy to the citizens of the United States of America. Item 1 of Executive Order 13212 stated that…

> "In general it is the policy of this administration that executive departments and agencies (agencies) shall take appropriate actions, to the extent with applicable law, to expedite projects that will increase the production, transmission, or conservation of energy."

In response to Executive Order 13212, President Bush created the White House Task force on Energy Project Streamlining. In addition, the Bureau of Land Management and the USDA – Forest Service have also initiated efforts to address this issue as well as the Western Governor's Association and various utility industry groups. Congress is also looking at legislative answers for this dilemma.

Following is a summary of one such ongoing effort to streamline the process and help provide the nation with the ability to permit, construct, operate and maintain energy transmission facilities in a cost effective and timely manner.

Background

A key element concerns the nation's ability to construct linear energy transmission facilities in a cost effective and timely manner. This also includes the ability to interconnect existing facilities so that energy is transported and utilized as efficiently and reliably as possible. Presently it often takes years and millions of dollars to successfully permit and construct a major energy transmission facility. This includes electric transmission lines, natural gas pipelines and oil pipelines.

One major inhibitor to the timely review and approval of permits needed for construction of a major energy facility is the effort involved in selecting a suitable route for the facility while minimizing the environmental impacts created by its construction, operation and continued maintenance. This includes the requirement that suitable alternative routes be identified and reviewed at the same level of scrutiny as the preferred route.

One way to help alleviate this inhibitor and help streamline the permitting process is to identify and designate right-of-way corridors in federal and state land management plans. If the corridor is designated as such in the plan, then it has already been determined to be the "preferred route" and other alternative routes need not be addressed. If the project proponent uses the designated corridor as his route, then the proponent would only be required to do on the ground environmental studies to determine if the route is suitable for the construction of the project. This simplifies the permitting process and can save considerable time as well as up to 2/3 of the permitting costs.

The designation of right-of-way corridors in the federal land planning process is not a new concept. Congress addressed the issue in Section 503 of the Federal Land Management Policy Act of 1976 (FLPMA). Since 1979, the Western Utility Group[1] and others have worked with the Bureau of Land Management and Forest Service to have corridors identified and designated in their land management plans. This has met with limited success. There are still federal planning areas where the designation of right-of-way corridors has not been addressed. Unfortunately this has limited the continuity of right-of-way corridors as well as resulted in the loss of potential energy facility routing options on a vast scale. Fortunately there has been a lot of work done in the Western United States that details out existing and potential routes for the construction of energy transmission facilities. The culmination of this effort resides within the Western Utility Group's – *Western Regional Corridor Study* (*WRCS*) that was published in 1993.

Although it is starting to become dated, the study still provides the best information on right-of-way corridors available for the eleven western continental United States. The Bureau of Land Management has taken the document and digitized the information contained therein and placed it into their GIS database. This includes the information on the right-of-way corridors as well as the constraint information that was available at the time the document was published. However, to evolve into a useful planning tool the study needs some updates and work done to it. This work includes:

1. **Making the corridors more accurate**: The corridors on the 1993 *WRCS* were mapped by hand at a scale of 750,000 to 1. Consequently the lines may not accurately indicate where the right-of-way corridors are actually located.
2. **Updating new and revised constraint areas**: There have been new national Monuments that have been dedicated since 1993 as well as changes in land planning criteria with resulting losses of available right-of-way corridor routes.
3. **Updating new and revised utility facilities and corridors**: Although there have not been many new facilities constructed in the last few years, there are a few that need to be reviewed and added to the study (if appropriate).
4. **Security issues need to be addressed**: How much information should be collected? How much of it should be available to the public? Where is the information kept? Who is responsible for its upkeep?
5. **Review of existing corridors to determine if they should be designated or removed from consideration**: The federal agencies' present definition of a utility corridor is:

> "Designated right-of-way corridor means a parcel of land either linear or aerial in character that has been identified by law, Secretarial Order, the land-use planning process, or by other management decision, as being a preferred location for existing and future rights-of-way grants and suitable

[1] See attached Western Utility Group - Corridor Western Regional Corridor Study

to accommodate ore than 1 type of right-of-way or 1 or more rights-ofway which are similar, identical or compatible.

Transportation and utility corridor means a parcel of land, without fixed limits or boundaries, that is used as the location for one or more transportation or utility rights-of-way;

Full WUG (industry), Federal and State Agencies, WECC, Western Governor's Association & White House Task Force on Energy Streamlining will need to agree upon the definitions of a "corridor" prior to the corridors being designated.

Due to the increases in technology, the advent of computer Geographical Information Systems (GIS) and Geographical Positioning Systems (GPS), the agreed upon definition of a designated right-of- way corridor needs to include specific widths and locations. In addition, compatible uses can now be determined fairly easily. The *WRCS* can evolve from a good reference guide to an accurate, easily updated planning tool that can be used as an effective and efficient tool to assist in the routing of linear energy transmission facilities.

Action

The Western Utility Group, Department of Interior (BLM), Department of Agriculture (US Forest Service), White House Task Force on Energy Project Streamlining, The Western Governor's Association and The Western Electricity Coordinating Council have agreed that an effort to address and designate priority corridors is necessary to help streamline the process for the permitting and construction of energy transmission facilities. This action will help insure the efficient and cost effective transmission of energy resources being generated in the western United States while minimizing environmental impacts. To achieve this goal, the entities mentioned above have identified a two-prong approach:

<u>Approach No. 1: Identifying Priority Corridors</u>

A priority corridor has been defined to be a strategic interstate or intrastate right-of-way corridor that been identified to the most likely route to be utilized for the construction of a new energy transmission facility during the next one to ten year period. The industry will identify approximately 15 corridors that it considers being the most strategic and which need to be reviewed and designated as such in federal land management plans. The corridors will be categorized into three levels.

- Level 1 corridors will be those corridors that industry planners have identified as potential routes to be utilized in the near future (the next one to two years)
- Level 2 corridors are those that have the potential to be used in the next 3 to 5 years

- Level 3 corridors are those that have the potential for use in the next 5 to 10 year period

The industry will then justify its selection to the agencies. The federal agencies, with industries' and state assistance, will review those selected corridors and perform the following tasks:

- Determine the compatibility of the corridor for other uses (i.e., what other facilities can be placed within the corridor)
- Determine if there are any obvious environmental issues or other constraints that would eliminate the route as a designated right-of-way corridor
- Determine the actual width and location of the corridor
- Either provide review and designation within the plan if it is being revised or amend the plan to address that specific corridor and others if appropriate.
- Insure that adjoining agency jurisdictions participate in the corridor review process
- Recognize the designated corridor as the highest and best use for the property and provide the appropriate protection necessary to insure that any use of the property is not incompatible with its use as the location for an energy transmission facility
- Regular progress and status reports will be provided to the White House Committee on Energy Project Streamlining as well to the participating federal agencies, The Western Governor's Association, and participating industry associations

Once that effort is completed then the industry will identify the next 15 most strategic corridors that need to be reviewed and designated as such in federal land management plans. This process will continue to be repeated until the most strategic routes have been reviewed for designation as right-of-way corridors.

<u>Approach No. 2: Participation in the Federal Planning Process</u>

Both the USDA – Forest Service and the Bureau of Land Management are in the process of revising their outdated land management plans. As these plans come due, it will be a requirement that the agencies, with the assistance of the utility industry, review the potential designation of right-of-way corridors in their planning area. The industry will be expected to participate in this planning process and will help define which corridors should be reviewed for designation. The Western Utility Group will appoint and maintain representatives for each state that will be the main contact point for the agencies in this process. The Western Governor's Association will appoint a representative to coordinate various state agency input to this process. The WECC will also appoint a task force to determine the corridors appropriateness in the western grid system. Specific Action items include the following

- The Western Utility Group representative will coordinate the various utilities response to the agencies and insure the participation of the industry in the planning process.
- At a minimum, the corridors as shown in the *WRCS* will be reviewed and determined for designation.
- Corridors that are determined suitable for designation will be located accurately, constraints will be identified, and compatible uses will be determined (i.e., what energy transmission facilities could be located within the corridor).
- The WRCS will be updated as appropriate.

Both approaches will be interconnected so that all potential corridors are reviewed in a systematic and timely fashion.

APPENDIX D

FINDINGS OF THE BRANDYWINE CONSERVANCY

Bradford Glen Subdivision
West Bradford Township, Chester County
0 200 400 800 Feet
Brandywine Conservancy
Environmental Management Center
Data Source: Base data from Chester County GIS Department, 2007. Aerial photography from DVRPC, 2005. Pipeline data from Haley & Aldrich, 9/23/2008.
**Disclaimer - Pipeline data is subject to change.
Date created: October 14, 2008
50-5A-191
50-2N-83
50-5A-326
50-5A-191
50-5A-164
50-5A-326
50-5A-326.1
50-5A-327
50-5A-263-U
50-5E-27
50-5A-262
1
2
3
4
5
6
7
8
9
CAMPUS DR
W BROADVIEW
RIDGEVIEW CT
CHRISTOPHER CT
EDWARDS DR
BEACON HILL RD
POORHOUSE RD
BROAD RUN RD
ADAMS DR
ITHAN CT
GLENSIDE RD
Legend
1-9 Study areas
Roads
Proposed AES pipeline
Victoria Crossing Variation
Proposed variation
Streams
Bodies of water
Proposed workspace
Workspace
Tax parcels

Mid-Atlantic Express Pipeline Brief / Natural Features Analysis
Bradford Glen Homeowners Association

Property Data

Municipality	West Bradford Township
Tax Parcel ID	50-5A-327 & 50-5E-27 / Map #: 1 of 4

Proposed Activities
Refer to table on map.

Proposed Impacts
<u>Stream Crossing</u>
None

<u>Wetland Crossings</u>
None

<u>Floodplain Crossings</u>
None

<u>Woodland Disturbance/Tree Removal</u>
Workspace and Proposed Workspace easement impact woodland area just north of Beacon Hill Road.

<u>Prime Agricultural Soils Disturbance</u>
None

<u>Steep Slopes Disturbance</u>
None

<u>Botanical Disturbance</u>
Area #1: A small stand of forest fronting Beacon Hill Road and located to the right of the proposed AES pipeline. This forest contains a tulip poplar, scattered silver maples and one red oak (12-16" diameter)
Area #2: This section of forest is the most mature and represents the most ecological value of all the forests possibly affected by the proposed AES pipeline. This area was possibly logged at one point removing most but not all oaks. A number of red oaks (+/- 6) ranging from 20"-36" can be found in areas closer to Beacon Hill Road. This area is also scattered with medium sized silver maples, red maples and tulip poplars. 3 larger tulip poplars can be found close to or on the Fenimore's property.

Recommendations
1. Conservation District to review and comment on proposed activities

2. Recommend AES to follow the workspace areas as opposed to the proposed workspace to avoid maximum disturbance to the highest quality forest.
3. All tree removals are to be identified by AES in the field for review and approval by the property owner
4. Proper erosion controls must be implemented for right of way ~150' from the edge of Henry Drive in Area #2 to control sediment run-off into the exceptional value stream.
5. Woodland areas that were removed within the temporary easement areas are to be replanted during restoration by AES with native trees at the rate of one 2 ½ - 3 inch caliper specimen for every 400 square feet of woodland removal. Species mixture is to be approved by the property owner.

Mid-Atlantic Express Pipeline Brief / Natural Features Analysis
Bradford Glen Homeowners Association

Property Data

Municipality	West Bradford Township
Tax Parcel ID	50-5A-262, 50-5A-263-U & 50-5A-327 / Map #: 2 of 4

Proposed Activities
Refer to table on map.

Proposed Impacts
Stream Crossing
On property adjacent to both subject properties and owned by Bradford Glen Water Company.

Wetland Crossings
None

Floodplain Crossings
None

Woodland Disturbance/Tree Removal
Workspace and Proposed Workspace easement impact woodland following the existing pipeline easement behind Dianne Circle and Ashcom Drive. Two other sections of woodland are located between Victoria Drive and Henry Drive.

Prime Agricultural Soils Disturbance
None

Steep Slopes Disturbance
None

Botanical Disturbance
Area #3: Part of a larger forest located in between Victoria drive and stream (on map 2 of 4). This forest contains a tulip poplar, scattered silver maples and one red oak (12-16” diameter).
Area #4: A few scattered wooded areas following a stream and extending into the Homeowners Association property. These wooded areas are comprised mainly of Silver and Red Maples. Also located here are a Black Cherry, White Ash and Tulip Poplar.
Area #5: This woodland area is an extension of Area #3 and comprised mainly of Silver and Red Maples and most notably a number of large 30”-36” Tulip Poplars.

Recommendations
1. Conservation District to review and comment on proposed activities

2. Recommend AES to follow the proposed workspace areas as opposed to the workspace areas to avoid maximum disturbance of natural resources.
3. All tree removals are to be identified by AES in the field for review and approval by the property owner.
4. Woodland areas that were removed within the temporary easement areas are to be replanted during restoration by AES with native trees at the rate of one 2 ½ - 3 inch caliper specimen for every 400 square feet of woodland removal. Species mixture is to be approved by the property owner.

Mid-Atlantic Express Pipeline Brief / Natural Features Analysis
Bradford Glen Homeowners Association

Property Data

Municipality West Bradford Township
Tax Parcel ID 50-5A-164 / Map #: 3 of 4

Proposed Activities

Refer to table on map.

Proposed Impacts

Stream Crossing

Stream with exceptional value status.

Wetland Crossings

Workspace comes within 10’ of wetland on property.

Floodplain Crossings

None

Woodland Disturbance/Tree Removal

Workspace and Proposed Workspace easement impact woodland following the existing pipeline easement behind Pine Circle and running southwest to Dianne Circle.

Prime Agricultural Soils Disturbance

None

Steep Slopes Disturbance

None

Botanical Disturbance

Area #6: Sparsely wooded area comprised of Silver and Red maple, Sassaphras, Tulip Poplar, Tree ofc Heaven, White Ash and Black Cherry trees. Trees to note are a 36” White Ash and a 32” Black Cherry at the edge of the easement clearing.
Area #7: This is one of the largest affected woodland areas. Area #2 is mainly comprised of Silver Maple, Red Maple and smaller Tulip Poplar. A few Black Cherries and Tree of Heaven were also found here.
Area #8: A small stand of trees located behind the property owned by Mr. Bruce Abele and Mrs. Laurie Wyche. This stand of trees is comprised mostly of White Ash. Also located here are Tree of Heaven, Oriental Honeysuckle and Eastern Dogwood. A few Azalea bushes have also been planted here.

Recommendations

1. Conservation District to review and comment on proposed activities
2. Recommend AES to follow the proposed workspace areas as opposed to the workspace to keep further from wetland and reduce possible damage.

3. All tree removals are to be identified by AES in the field for review and approval by the property owner.
4. Monitor for wetland disturbance.
5. Woodland areas that were removed within the temporary easement areas are to be replanted during restoration by AES with native trees at the rate of one 2 ½ - 3 inch caliper specimen for every 400 square feet of woodland removal. Species mixture is to be approved by the property owner.

Mid-Atlantic Express Pipeline Brief / Natural Features Analysis
Bradford Glen Homeowners Association

Property Data

Municipality	West Bradford Township
Tax Parcel ID	50-5A-191 & 50-5A / Map #: 4 of 4

Proposed Activities
Refer to table on map.

Proposed Impacts
<u>Stream Crossing</u>
None

<u>Wetland Crossings</u>
Workspace comes within 10’ of wetland on property.

<u>Floodplain Crossings</u>
None

<u>Woodland Disturbance/Tree Removal</u>
Possibly a small number of trees located behind the lot owned by Mr. Wen Hsin-Gee.

<u>Prime Agricultural Soils Disturbance</u>
None

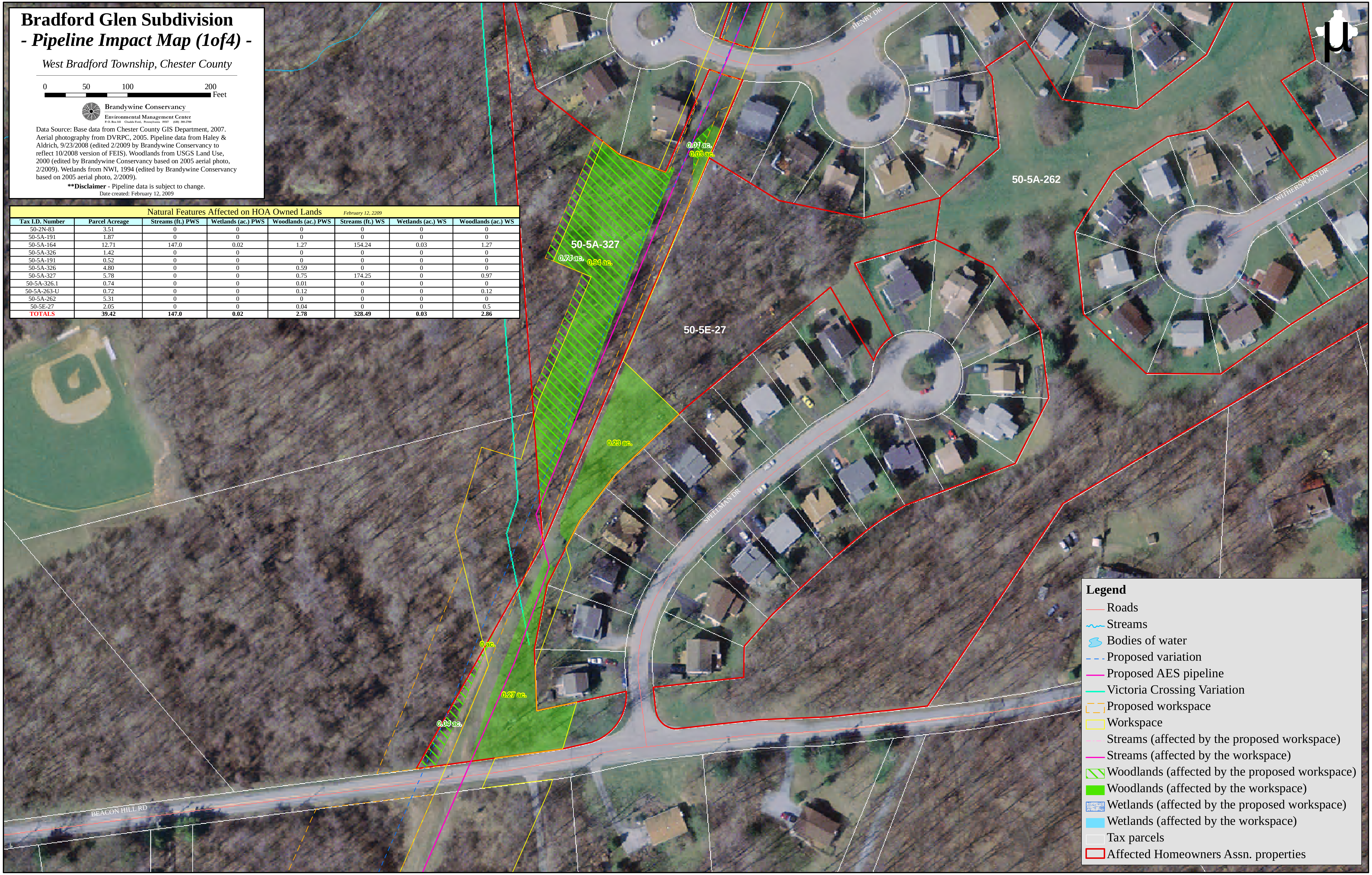
<u>Steep Slopes Disturbance</u>
None

<u>Botanical Disturbance</u>
Possibly a number of Silver Maple trees.

Recommendations
1. Conservation District to review and comment on proposed activities
2. Recommend AES to follow the workspace areas as opposed to the proposed workspace to reduce impact to runoff into EV stream.
3. Proper erosion controls must be implemented for right of way ~150’ from the edge of Henry Drive in Area #2.
4. All tree removals are to be identified by AES in the field for review and approval by the property owner.
5. Woodland areas that were removed within the temporary easement areas are to be replanted during restoration by AES with native trees at the rate of one 2 ½ - 3 inch caliper specimen for every 400 square feet of woodland removal. Species mixture is to be approved by the property owner.

Bradford Glen Subdivision
- Pipeline Impact Map (1of4) -

West Bradford Township, Chester County



Data Source: Base data from Chester County GIS Department, 2007. Aerial photography from DVRPC, 2005. Pipeline data from Haley & Aldrich, 9/23/2008 (edited 2/2009 by Brandywine Conservancy to reflect 10/2008 version of FEIS). Woodlands from USGS Land Use, 2000 (edited by Brandywine Conservancy based on 2005 aerial photo, 2/2009). Wetlands from NWI, 1994 (edited by Brandywine Conservancy based on 2005 aerial photo, 2/2009).

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Date created: February 12, 2009

Natural Features Affected on HOA Owned Lands *February 12, 2209*

Tax I.D. Number	Parcel Acreage	Streams (ft.) PWS	Wetlands (ac.) PWS	Woodlands (ac.) PWS	Streams (ft.) WS	Wetlands (ac.) WS	Woodlands (ac.) WS
50-2N-83	3.51	0	0	0	0	0	0
50-5A-191	1.87	0	0	0	0	0	0
50-5A-164	12.71	147.0	0.02	1.27	154.24	0.03	1.27
50-5A-326	1.42	0	0	0	0	0	0
50-5A-191	0.52	0	0	0	0	0	0
50-5A-326	4.80	0	0	0.59	0	0	0
50-5A-327	5.78	0	0	0.75	174.25	0	0.97
50-5A-326.1	0.74	0	0	0.01	0	0	0
50-5A-263-U	0.72	0	0	0.12	0	0	0.12
50-5A-262	5.31	0	0	0	0	0	0
50-5E-27	2.05	0	0	0.04	0	0	0.5
TOTALS	**39.42**	**147.0**	**0.02**	**2.78**	**328.49**	**0.03**	**2.86**

Bradford Glen Subdivision
- Pipeline Impact Map (2of4) -

West Bradford Township, Chester County

0 50 100 200 Feet

Brandywine Conservancy
Environmental Management Center
P. O. Box 141 Chadds Ford, Pennsylvania 19317 (610) 388-2700

Data Source: Base data from Chester County GIS Department, 2007. Aerial photography from DVRPC, 2005. Pipeline data from Haley & Aldrich, 9/23/2008 (edited 2/2009 by Brandywine Conservancy to reflect 10/2008 version of FEIS). Woodlands from USGS Land Use, 2000 (edited by Brandywine Conservancy based on 2005 aerial photo, 2/2009). Wetlands from NWI, 1994 (edited by Brandywine Conservancy based on 2005 aerial photo, 2/2009).

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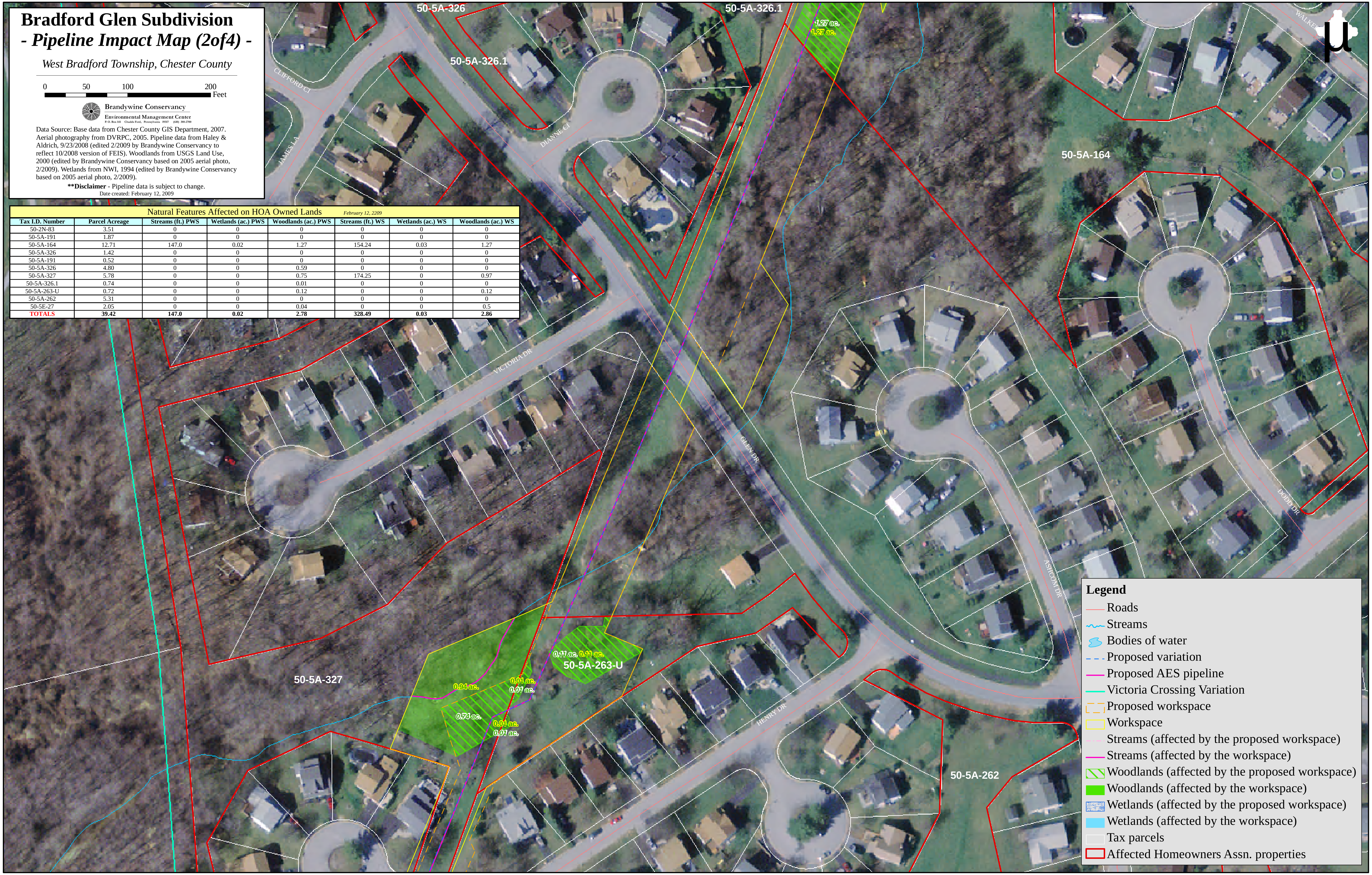
50-5A-326	1.42	0	0	0	0	0	0
50-5A-191	0.52	0	0	0	0	0	0
50-5A-326	4.80	0	0	0.59	0	0	0
50-5A-327	5.78	0	0	0.75	174.25	0	0.97
50-5A-326.1	0.74	0	0	0.01	0	0	0
50-5A-263-U	0.72	0	0	0.12	0	0	0.12
50-5A-262	5.31	0	0	0	0	0	0
50-5E-27	2.05	0	0	0.04	0	0	0.5
TOTALS	**39.42**	**147.0**	**0.02**	**2.78**	**328.49**	**0.03**	**2.86**



Bradford Glen Subdivision
- *Pipeline Impact Map (3of4)* -

West Bradford Township, Chester County

0 50 100 200 Feet

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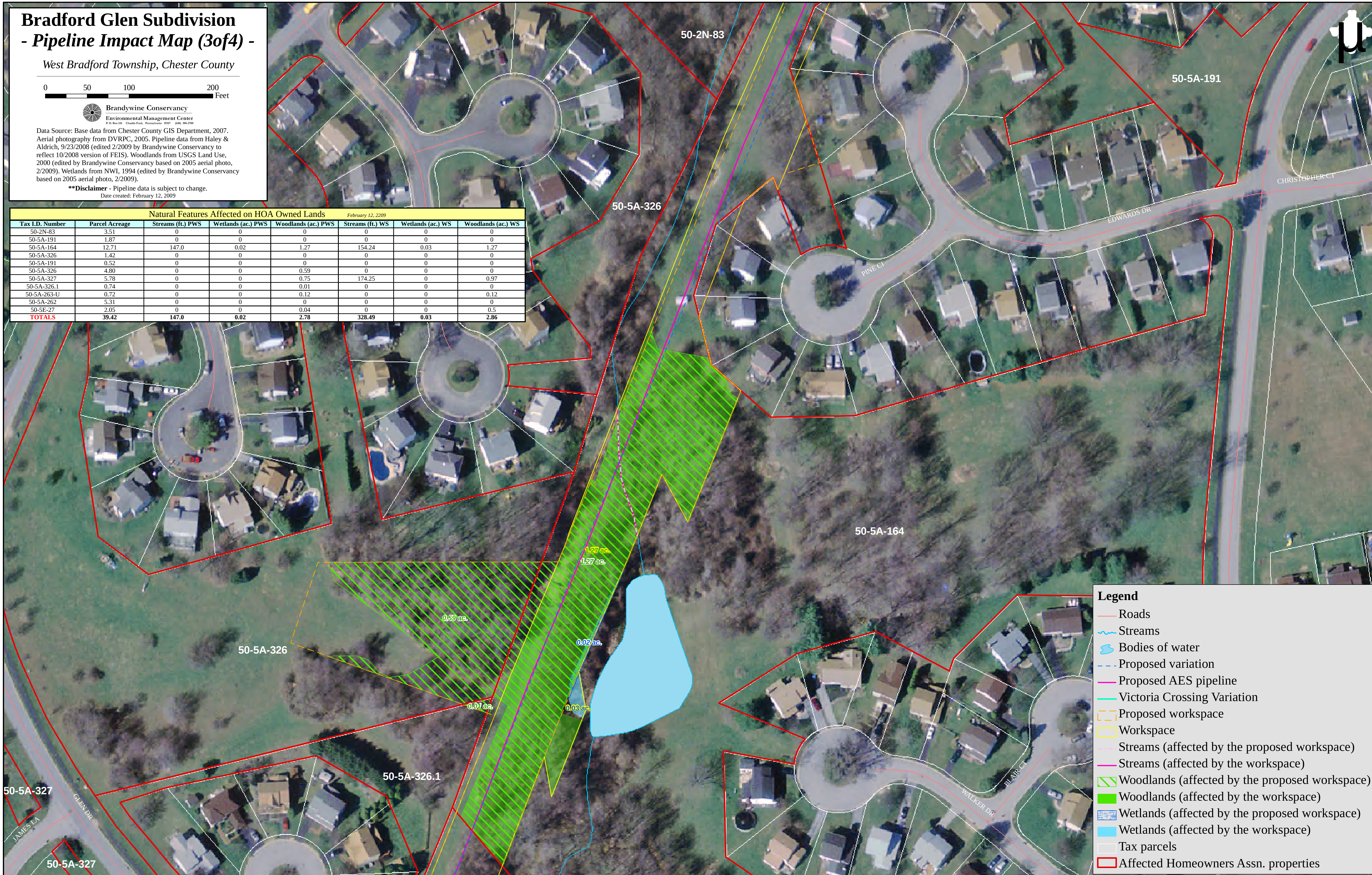
50-5A-326	4.80	0	0	0.59	0	0	0
50-5A-327	5.78	0	0	0.75	174.25	0	0.97
50-5A-326.1	0.74	0	0	0.01	0	0	0
50-5A-263-U	0.72	0	0	0.12	0	0	0.12
50-5A-262	5.31	0	0	0	0	0	0
50-5E-27	2.05	0	0	0.04	0	0	0.5
TOTALS	**39.42**	**147.0**	**0.02**	**2.78**	**328.49**	**0.03**	**2.86**



Bradford Glen Subdivision
- *Pipeline Impact Map (4of4)* -

West Bradford Township, Chester County

0 50 100 200 Feet

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50-5A-191	0.52	0	0	0	0	0	0
50-5A-326	4.80	0	0	0.59	0	0	0
50-5A-327	5.78	0	0	0.75	174.25	0	0.97
50-5A-326.1	0.74	0	0	0.01	0	0	0
50-5A-263-U	0.72	0	0	0.12	0	0	0.12
50-5A-262	5.31	0	0	0	0	0	0
50-5E-27	2.05	0	0	0.04	0	0	0.5
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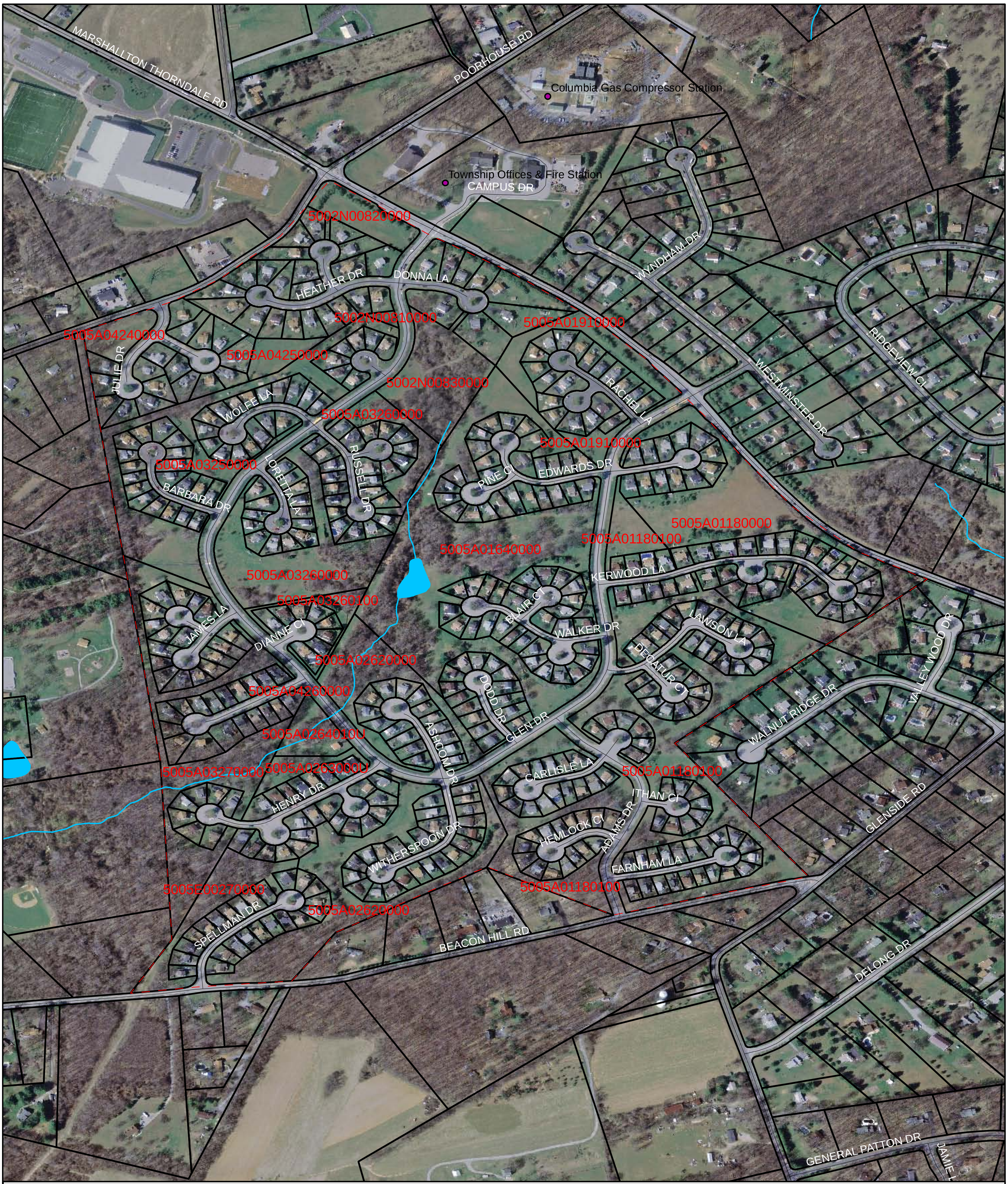

Bradford Glen Subdivision

Bradford Glen Subdivision Boundary

W Bradford Twp Tax Parcels 2007

N W E S

0 250 500 1,000 1,500 Feet

Bradford Glen HOA Common Areas	
Parcel ID	Lot Size (acres)
5002N00810000	0.12
5002N00820000	1.51
5002N00830000	3.51
5005A01180000	6.66
5005A01180100	1.03
5005A01180100	8.05
5005A01180100	3.19
5005A01640000	12.71
5005A01910000	1.87
5005A01910000	0.52
5005A02620000	2.88
5005A02620000	5.31
5005A0263000U	0.72
5005A0264010U	1.19
5005A03250000	4.85
5005A03260000	1.42
5005A03260000	4.80
5005A03260100	0.74
5005A03270000	5.78
5005A04240000	0.97
5005A04250000	0.81
5005A04260000	0.03
5005E00270000	2.05