NEXUS GAS TRANSMISSION PROJECT

RESOURCE REPORT 2

Water Use and Quality

FERC Docket No. CP16-__-000

November 2015

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Filing Requirement	**Location in Environmental Report**
☒ Identify and describe by milepost perennial waterbodies and municipal water supply or watershed areas, specially designated surface water protection areas and sensitive waterbodies, and wetlands that would be crossed. For each waterbody crossing, identify the approximate width, state water quality classifications, any known potential pollutants present in the water or sediments, and any potable water intake sources within 3 miles downstream. (§380.12(d)(1))	Sections 2.3.1, 2.3.2, 2.3.3, 2.3.4, 2.3.5, 2.3.6, and 2.4.1. Tables 2.3-1, 2.3-2, 2.3-4, 2.3-5 2.3-6, 2.3-7, 2.3-8,- and 2.4-1.
☒ Compare proposed mitigation measures with the staff's current "*Wetland and Waterbody Construction and Mitigation Procedures*," which are available from the Commission Internet home page or the Commission staff, describe what proposed alternative mitigation would provide equivalent or greater protection to the environment, and provide a description of site- specific construction techniques that would be used at each major waterbody crossing. (§380.12(d)(2))	Section 2.3.10, 2.4.4 and Tables 2.3-2 and 2.4-1
☒ Describe typical staging area requirements at waterbody and wetland crossings. Also, identify and describe waterbodies and wetlands where staging areas are likely to be more extensive. (§380.12(d)(3))	Section 1.7.1 in Resource Report 1, Sections 2.3.9 and 2.4.3 and Table 2.3-12.
☒ Include National Wetland Inventory (NWI) maps. If NWI maps are not available, provide the appropriate state wetland maps. Identify for each crossing, the milepost, the wetland classification specified by the U.S. Fish and Wildlife Service, and the length of the crossing. Include two copies of the NWI maps (or the substitutes, if NWI maps are not available) clearly showing the proposed route and mileposts directed to the environmental staff. Describe by milepost, wetland crossings as determined by field delineations using the current Federal methodology. (§380.12(d)(4))	Section 2.4, Table 2.4-1 and Appendix 1A in Resource Report 1
☒ Identify aquifers within excavation depth in the project area, including the depth of the aquifer, current and projected use, water quality and average yield, and known or suspected contamination problems. (§380.12(d)(5))	Section 2.2 and Table 2.2-1
☒ Describe specific locations, the quantity required, and the method and rate of withdrawal and discharge of hydrostatic test water. Describe suspended or dissolved material likely to be present in the water as a result of contact with the pipeline, particularly if an existing pipeline is being retested. Describe chemical or physical treatment of the pipeline or hydrostatic test water. Discuss waste products generated and disposal methods. (§380.12(d)(6))	Section 2.3.8 and Tables 2.3.9, 2.3-10, and 2.3-11
☒ If underground storage of natural gas is proposed: **(i)** Identify how water produced from the storage field will be disposed of, and **(ii)** For salt caverns, identify the source locations, the quantity required, and the method and rate of withdrawal of water for creating salt cavern(s), as well as the means of disposal of brine resulting from cavern leaching. (§380.12(d)(7))	N/A
☒ Discuss proposed mitigation measures to reduce the potential for adverse impacts to surface water, wetlands, or groundwater quality to the extent they are not described in response to paragraph (d)(2) of this section. Discuss the potential for blasting to affect water wells, springs, and wetlands, and measures to be taken to detect and remedy such effects. (§380.12(d)(8))	Sections 2.2.5, 2.3.10, 2.4.4 and Tables 2.3.2, 2.3-3, and 2.4-1
☒ Identify the location of known public and private groundwater supply wells or springs within 150 feet of proposed construction areas. Identify locations of EPA or state-designated sole-source aquifers and wellhead protection areas crossed by the proposed pipeline facilities. (§380.12(d)(9))	Section 2.2.1, 2.2.3 and Table 2.2-2

RESPONSE TO FERC JULY 30, 2015 COMMENTS ON NEXUS RESOURCE REPORT 2 – WATER USE AND QUALITY	
FERC COMMENTS ON DRAFT RESOURCE REPORT 1	**LOCATION OR RESPONSE TO COMMENT**
18[1]. We received a comment letter during scoping that stated that the proposed route "is within feet of three public water wells and a water storage tank associated with the Medina County Chippewa Lake Water Plant." Determine whether this is the case and address it in Section 2.2.3, as appropriate.	NEXUS has been in communications with the Medina County Administrator and determined that the existing water storage tank for the Medina County Chippewa Lake Water Plant, located west of the intersection of Ryan and Chippewa Roads in Lafayette Township, would be located approximately 90 feet southwest of the proposed NEXUS pipeline at approximate MP 68.25. NEXUS plans to install the pipeline in this area using the horizontal bore construction technique that would involve installing the pipeline in the vicinity of the water storage tank starting northwest of Chippewa Road and continuing approximately 6-8 feet below grade past the water tank and below Ryan Road and exiting east of Ryan Road. The three water wells that supply the storage tank are located 0.9 miles west of the water tank. The pipeline also crosses in the vicinity of the wells at Lake Road and the CSX railroad at MP 69.1. The pipeline would be located approximately 380 feet north of the closest well. In addition, there is an existing utility road that NEXUS is proposing to use during construction (TAR-69.1) that is located approximately 2 to 20 feet from two of the wells. The Administrator did not identify any immediate concerns and NEXUS does not anticipate any impact to these facilities during construction of the pipeline.
19. We received a comment letter during scoping that stated that "[c]onstruction of the proposed mainline route (from milepost 59 – 69) and Compressor Station 2 would violate State of Ohio's Balanced Growth Plan for the Upper Chippewa Creek Watershed that protects water quality in the region." Determine whether this is the case and address it in Section 2.2.3, as appropriate.	NEXUS has reviewed Ohio's Balanced Growth Plan for the Upper Chippewa Creek Watershed and determined that construction and operations of NEXUS pipeline and aboveground facilities can be performed consistent with the Plan's objectives. NEXUS sited the Wadsworth Compressor Station (CS 2) in an agricultural field that currently contains existing oil pumps, storage tanks, and pipelines. NEXUS has sited pipeline facilities in open agricultural fields as much as practicable to avoid residential and forested areas. In addition, NEXUS will be using an horizontal directional drill ("HDD") crossing method to avoid impacting the nature preserve associated with the Buckeye Woods Park. Agricultural land temporarily affected by the Project will be restored using techniques outlined in the FERC Plan and Procedures and NEXUS EC&SP Plan provided in Appendix 1B1 of

[1] Numbering of comments is based on letter from the Federal Energy Regulatory Commission to Nexus Gas Transmission, LLC dated July 30, 2015 and posted to Docket Number PF15-10-000 regarding *Comments on Draft Resource Reports 1 through 8 and 10*.

RESPONSE TO FERC JULY 30, 2015 COMMENTS ON NEXUS RESOURCE REPORT 2 – WATER USE AND QUALITY	
FERC COMMENTS ON DRAFT RESOURCE REPORT 1	**LOCATION OR RESPONSE TO COMMENT**
	Resource Report 1. Construction of the NEXUS Project will result in no adverse impacts to groundwater resources and the Project will result in no net loss of wetlands and waterbodies in the Upper Chippewa Creek Watershed area. See Sections 2.2, 2.3, and 2.4 of this resource report for NEXUS avoidance, minimization, and mitigation for groundwater, surface water, and wetland resources that will be temporarily impacted during construction.
20. We received a comment letter during scoping that indicated that the pipeline is "proposed to go through Wise Road Disposal Site (officially identified by the Environmental Protection Agency (EPA) and Government Accountability Office (GAO)), which was historically used for the disposal of industrial wastes. Historical practices on the site have resulted in soil, sediment, and groundwater contamination." Determine whether this is the case. If so, list the site in table 8.4-4 and include it in the discussion of potential sources of groundwater and/or soil contamination.	NEXUS contracted Environmental Data Resources, Inc. ("EDR") to identify the presence of documented contaminated sites within one (1) mile of the Project. The EDR service searches relevant federal and state databases including, but not limited to: the National Priority List ("NPL"); also known as Superfund; proposed NPL; delisted NPL; Comprehensive Environmental Response, Compensation, and Liability Information System no further action planned; Resource Conservation and Recovery Act waste generating facilities; Ohio Environmental Protection Agency ("OEPA") Department of Emergency Response and Remediation; and solid waste/landfill facilities. The "Wise Road Disposal Site" was not listed on any of the databases that were searched by EDR. In addition, the OEPA confirmed the Site is not included in their Department of Emergency Response and Remediation database. On February 23, 2015 the City of Green provided comments to the FERC that indicated the OEPA required that the City conduct soil testing on the Ariss Park Property located off Wise Road based on reports of illegal dumping. The City of Green indicated that tests to date have not identified any level of contamination.
21. We received scoping comments from members of the Fulton County Board of Health concerning potential groundwater impacts to the shallow drinking water wells (25 feet deep or less) in the Oak Openings region, the high water table (less than 8 feet below ground level) requiring dewatering that could affect these shallow wells, and the high vulnerability for pollution to contaminate the shallow sand aquifers. Consult with the Fulton County Board of Health, the Ohio Department of Natural Resources, and the Ohio Environmental Protection Agency (OEPA) regarding these concerns. Provide copies of the correspondence and include any best management practices or site-specific plan that may be developed for the Oak Openings region, such as special construction techniques, refueling restrictions,	NEXUS representatives met with Ohio Department of Natural Resources on September 25, 2015 and discussed typical construction techniques including localized temporary trench dewatering that would occur in the Oak Openings region. On September 30, 2015, a NEXUS representative also contacted OEPA Department of Drinking and Ground Water staff from the Northwest District Office to discuss potential concerns regarding the Oak Openings region groundwater resources. After discussing typical construction measures and other measures outlined in the NEXUS Erosion and Sediment Control Plan ("E&SCP") and Spill Prevention Control and Countermeasure Plan ("SPCC Plan"), no specific concerns or additional measures regarding the construction and operation of the NEXUS Project were recommended with regard to potential groundwater impacts. Also on

RESPONSE TO FERC JULY 30, 2015 COMMENTS ON NEXUS RESOURCE REPORT 2 – WATER USE AND QUALITY	
FERC COMMENTS ON DRAFT RESOURCE REPORT 1	**LOCATION OR RESPONSE TO COMMENT**
well monitoring, and dewatering plans near shallow wells.	September 30, 2015, NEXUS attempted to contact the Fulton County Health Department regarding their concerns with potential groundwater impacts. NEXUS is currently waiting for a response. Agency correspondence and conversation records are provided in Appendix 1C2 of Resource Report 1.
22. Provide updated agency correspondence with the OEPA and Michigan Department of Environmental Quality regarding wellhead protection areas and any best management practices or guidelines suggested by the managing agencies.	NEXUS contacted the OEPA on September 30, 2015 and the Michigan Department of Environmental Quality ("MDEQ") on October 22, 2015 to discuss wellhead protection areas crossed by the proposed Project. After discussing typical construction measures and measures outlined in the E&SCP and SPCC Plan, no specific concerns or additional measures regarding the construction and operation of the NEXUS pipeline Project were recommended with regard to potential groundwater impacts. Agency correspondence and conversation records are provided in Appendix 1C2 of Resource Report 1.
23. Discuss measures NEXUS would implement to reduce potential for horizontal directional drilling mud to be released into karst conduits should there be a loss of returns during drilling.	See updated Section 2.3.9 HDD Monitoring and Contingency Plan located in Appendix 2A of this resource report for the measures taken for loss of circulation of drilling fluid.
24. Include a discussion in section 2.2.5 of how pipeline construction would impact drain tile lines when encountered and the mitigation measures that would be used to ensure continued proper drainage of agricultural lands. Conversely, provide a cross reference to the RR where the main discussion can be found.	See updated Section 2.2.5, Section 8.2.3.2 in Resource Report 8, and the Project Drain Tile Mitigation Plan located in Appendix 1B4 of Resource Report 1.
25. Section 2.2.5.1 discusses springs used as drinking water sources. Confirm that measures would be taken to minimize disruptions to all springs, regardless of the use for a water supply, since disruptions to springs could affect surface flow and flooding.	See updated Section 2.2.5.1.
26. If water wells are required at the Wadsworth and Clyde Compressor Stations, include a discussion of groundwater impacts in section 2.2.5.2.	See updated Section 2.2.5.2.
27. Include a discussion in section 2.3 that addresses how potentially contaminated streambed sediments would be identified and characterized during construction, including which state and federal agencies would be consulted when contaminated sediments are identified.	See updated Section 2.3.6.
28. Add a discussion to section 2.3.7.1 to include Michigan agencies responsible for surface water permits.	See updated Section 2.3.8.1.

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FERC COMMENTS ON DRAFT RESOURCE REPORT 1	**LOCATION OR RESPONSE TO COMMENT**
29. For each waterbody greater than 100 feet wide, provide site-specific construction mitigation and restoration plans in RR 2.	NEXUS is proposing the HDD crossing method for waterbodies greater than 100 feet wide. See Section 2.3 and Table 2.3-2 for waterbody crossings great that 100 feet and Comment 34a regarding HDD site-specific crossing plans.
30. Tables 2.3-12, 2.4-3, 2.4-4, and 8.3-4 identify areas for which NEXUS is requesting modifications to FERC's Upland Erosion Control, Revegetation, and Maintenance Plan (Plan) and Procedures. For each area identified, describe:	Updated Table 2.3-12 identifies site-specific construction workspace areas that require a variance from the FERC Procedures and provides the justification for each construction workspace.
a. site-specific justifications describing how each proposed modification or alternative measure provides equal or better environmental protection, or	Updated Table 2.3-12 provides justifications for each extra work space that requires a variance from the FERC Procedures.
b. why the FERC's Plan and/or Procedures would be infeasible or unworkable based on Project-specific conditions.	Updated Table 2.3-12 provides justifications for each extra work space that require a variance from the FERC Procedures.
31. Correct the Regional Supplement title in section 2.5 to "Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0)."	See updated Section 2.5.
32. Describe all wetland data collection methods in section 2.4, such as the Ohio Rapid Assessment Method for Wetlands.	See Section 2.3.2 for data collection methods for streams which include: Qualitative Habitat Evaluation Index for and Field Evaluation Manual for Ohio's Primary Headwater Habitat Streams. In addition, *see* updated Section 2.4 regarding wetland data collection methods regarding Ohio Rapid Assessment Method for wetlands.
33. In addition to National Wetland Inventory maps, provide all field-delineated wetland crossing data on maps with RR 2.	Field delineated wetland and waterbody resources for the NEXUS Project are depicted on the Project Alignment sheets provided in Resource Report 1, Appendix 1A.
34. For each horizontal directional drill (HDD) location provide:	
a. site-specific construction diagrams that show the location of mud pits, pipe assembly areas, and all areas to be disturbed or cleared for construction, including any disturbances proposed between the entry and exit holes (i.e., travel lanes, access to water withdrawal locations, etc.);	HDD site-specific construction diagrams are provided in the HDD Design Report in Appendix 2A of this resource report.
b. a description of how an inadvertent release of drilling mud would be contained, the procedures that would be used to clean up any inadvertent releases, and how an abandoned drill hole would be sealed, if necessary;	See the HDD Monitoring and Contingency Plan located in Appendix 2A of this resource report for the measures taken for inadvertent release of drilling mud.

RESPONSE TO FERC JULY 30, 2015 COMMENTS ON NEXUS RESOURCE REPORT 2 – WATER USE AND QUALITY	
FERC COMMENTS ON DRAFT RESOURCE REPORT 1	**LOCATION OR RESPONSE TO COMMENT**
c. a contingency plan for crossing the waterbody in the event the HDD is unsuccessful; and	See the HDD Monitoring and Contingency Plan located in Appendix 2A of this resource report in the instance of an unsuccessful HDD.
d. copies of all geotechnical investigations. If geotechnical investigations at the crossing are incomplete, indicate when they would be completed and when the determination whether to use an HDD would be made.	Geotechnical findings are provided in the site specific construction diagrams, *see* the HDD Design Report in Appendix 2A of this resource report.
35. In section 2.4.3, discuss the potential for blasting in wetlands, related impacts on wetlands, and associated mitigation measures.	See updated Section 2.4.3.
36. If revised field-delineated wetland data show that impacts for aboveground facilities may be incurred, describe those impacts in section 2.4.4.1.	NEXUS proposed aboveground facilitates will have no permanent wetland or waterbody impacts. Construction of Meter Station MR4 at MP 255.1 would require 0.13 acre of temporary construction phase (non-forested) wetland impacts. Wetland impacts at MR4 are depicted on the Project alignment sheets in Resource Report 1, Appendix 1A. See Table 2.4-1 for Wetlands Affected by the NEXUS Project.
37. In section 2.4.4.3, describe the wetland mitigation plan for Michigan and provide a more detailed description of the wetland mitigation plan for Ohio (e.g., agency consultations, mitigation ratios for the different wetland types, mitigation banks).	See updated Section 2.4.4.3.
38. NEXUS's proposed SPCC Plan indicates that it would obtain written approval from the Project Chief Inspector or Environmental Inspector for hazardous material storage, and fuel storage, within 100 feet of a wetland or waterbody. However, section VI.A.1.e of FERC's Procedures requires approval to be obtained from an appropriate government authority. Please commit to these requirements.	NEXUS has updated the SPCC Plan to indicate that it would obtain written approval from an appropriate government authority for hazardous material storage, and fuel storage, within 100 feet of a wetland or waterbody per section VI.A.1.e of FERC's Procedures and has committed to these requirements.

ACRONYMS AND ABBREVIATIONS

ATWS	additional temporary workspace
CAZ	critical assessment zone
E&SCP	Erosion and Sediment Control Plan
EDR	Environmental Data Resources, Inc.
EI	Environmental Inspector
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FERC or Commission	Federal Energy Regulatory Commission
FERC Plan	FERC Upland Erosion Control, Revegetation, and Maintenance Plan
FERC Procedures	FERC's Wetland and Waterbody Construction and Mitigation Procedures
GIS	geographic information systems
gpm	gallons per minute
HDD	horizontal directional drill
HDD Plan	HDD Monitoring and Inadvertent Return Contingency Plan
HUC	Hydrologic Unit Code
M&R	metering and regulating
MDNR	Michigan Department of Natural Resources
MDEQ	Michigan Department of Environmental Quality
MP	milepost
NEXUS	NEXUS Gas Transmission, LLC
NEXUS Project or Project	NEXUS Gas Transmission Project
NPL	National Priority List
NRI	National Rivers Inventory
NWI	National Wetlands Inventory
OEPA	Ohio Environmental Protection Agency
ORV	outstandingly remarkable values
PEM	Palustrine Emergent
PFO	Palustrine Forested
PSS	Palustrine Scrub-Shrub
PUB	Palustrine Unconsolidated Bottom
ROW	right-of-way
SDWA	Safe Drinking Water Act of 1974
SPCC Plan	Spill Prevention, Control and Countermeasure Plan
SSA	Sole Source Aquifers
SWAPP	Source Water Assessment Program Plan
TMDL	Total Maximum Daily Load
U.S.	United States
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WHPA	Well Head Protection Area
WHPP	MDEQ Wellhead Protection Program

2.0 RESOURCE REPORT 2 - WATER USE AND QUALITY

2.1 Introduction

NEXUS Gas Transmission, LLC ("NEXUS") is seeking a Certificate of Public Convenience and Necessity from the Federal Energy Regulatory Commission ("FERC or Commission") pursuant to Section 7(c) of the Natural Gas Act authorizing the construction and operation of the NEXUS Gas Transmission Project ("NEXUS Project" or "Project"). NEXUS is owned by affiliates of Spectra Energy Partners, LP and DTE Energy Company. The NEXUS Project will utilize greenfield pipeline construction and capacity of third party pipelines to provide for the seamless transportation of 1.5 million dekatherms per day of Appalachian Basin shale gas, including Utica and Marcellus shale gas production, directly to consuming markets in northern Ohio and southeastern Michigan, and to the Dawn Hub in Ontario, Canada. Through interconnections with existing pipelines, supply from the NEXUS Project will also be able to reach the Chicago Hub in Illinois and other Midwestern markets. The United States portion of the NEXUS Project includes new greenfield pipeline in Ohio and Michigan and capacity leased from others in Pennsylvania, West Virginia, Ohio and Michigan, terminating at the United States ("U.S.")/Canada international boundary between Michigan and Ontario. The Canadian portion of the Project will extend from the U.S./Canada international boundary to the Dawn Hub.

A more detailed description of the Project is set forth in Resource Report 1.

This Resource Report 2 describes the existing water resources and water quality in the Project area, evaluates the potential impacts of construction and operation of the proposed Project on those resources, and identifies proposed mitigation measures to avoid or minimize potential impacts to groundwater, surface waterbodies, and wetland resources. A checklist showing the status of the FERC filing requirements for Resource Report 2 is included following the Table of Contents. A table showing the location of responses to the FERC's July 30, 2015 comments on draft Resource Report 2 follows the FERC filing requirements checklist. Project drawings, maps, and aerial photo based alignment sheets are provided in Appendix 1A in Resource Report 1.

The information presented in this Resource Report was obtained from field surveys, a comprehensive natural resource Geographic Information System ("GIS") database, review of available technical literature, and consultation with various stakeholders including federal, state, and local regulatory agencies.

2.2 Groundwater Resources

This section discusses existing groundwater resources located along the Project route. Descriptions include groundwater uses and quality and federal and state designated aquifers. This section also discusses potential groundwater impacts and methods that NEXUS will use to avoid, minimize, and mitigate impacts.

2.2.1 Sole Source Aquifers

Sole source aquifer ("SSA") designations were defined by the U.S. Environmental Protection Agency ("EPA"), pursuant to Section 1424(e) of the Safe Drinking Water Act ("SDWA") of 1974, for an aquifer that provides a sole or principal source (greater than 50 percent) of drinking water for an area, where contamination of the aquifer could create a significant hazard to public health, and where there are no alternative water sources that could reasonably be expected to replace the water supplied by the aquifer (EPA, 2015a). According to the EPA's designated SSA maps for Region 5, no designated SSAs are crossed by the NEXUS Project (EPA, 2015b).

2.2.2 Regional Aquifers Crossed by the Project

The principal aquifers crossed by the NEXUS Project are unconsolidated surface aquifers (primarily glacial and alluvial deposits) and consolidated and partially consolidated (fragmented bedrock) aquifers that are

confined in siltstone, shale, sandstone, limestone, and dolomite bedrock (U.S. Geological Survey ["USGS"], 1995a; USGS, 1995b).

The surface aquifers are the uppermost aquifer type located along the NEXUS Project. These aquifer systems act as storage reservoirs that are recharged from precipitation and in turn recharge into the underlying confined or partially confined bedrock aquifers. Surface aquifer functions are directly related to the localized surface geologic material that was deposited during advancing and receding continental ice sheets and can range from >100-600 feet and 50-400 feet in thickness in Ohio and Michigan respectively (USGS, 1995a; USGS, 1995b). Glacial till deposits were created by the advancing ice and as a result are typically dense, thin, and unsorted deposits consisting of gravel, fine silt, and clay. Glacial outwash deposits are typically thicker than glacial till deposits and were formed during the receding of the ice sheets where melt water typically sorted deposits based on the energy of water. Coarser materials are primarily deposited where water flows were fastest, and finer materials were deposited in areas with slower moving melt water. Refer to Resource Report 6 for more information regarding surface and bedrock geology.

Sections 2.2.2.1 and 2.2.2.2 below describes the principal regional aquifers crossed by the NEXUS Project. Refer to Figure 2.2-1 for a depiction of each principal aquifer type crossed by the NEXUS Project facilities. Table 2.2-1 provides a summary of milepost ("MP") ranges, thickness, average water depths, and production in gallons per minute ("gpm") of these aquifers.

2.2.2.1 Ohio

Ohio averages approximately 30 to 44 inches of rainfall annually; of the total annual rainfall about 10-33 percent infiltrates into Ohio aquifers (Ohio Environmental Protection Agency ["OEPA"], 2014). According to the USGS, approximately 44 percent of Ohio's population relies on groundwater for its water source (USGS, 1995a). According to the OEPA's 2014 Integrated Water Quality Report, the NEXUS Project traverses three major aquifer types: Sand and Gravel, Sandstone, and Carbonate. Refer to Figure 2.2-1 for a depiction of the principal aquifer types crossed by the Project in Ohio. Table 2.2-1 provides a summary of the aquifer types, milepost ranges crossed, thickness, average water depths, and gpm.

Sand and Gravel Aquifers

The unconsolidated sand and gravel aquifers (surface aquifers) are typically associated with buried valley aquifer systems where the glacial deposits are the thickest, and they are considered the most productive water-bearing formations or aquifers in the State of Ohio. These originated from pre-glacial and glacial watercourses cutting into the bedrock. These valley cuts were then filled by glacial drift and alluvial deposits of sand and gravel as the glaciers advanced and receded. In addition to the unconsolidated sand and gravel aquifers typically associated with buried valley aquifer systems, the Project crosses another sand and gravel aquifer type that is located in the Oak Opening sand deposits formed by the advance and receding of Lake Erie (OEPA, 2014).

These sand and gravel aquifers can range from 500 to 1,000 gpm where deposits are thickest, but lower yielding sand gravel aquifers are more common and are dependent upon the type, distribution, permeability, and thickness as well as construction parameters of a given well (OEPA, 2014). Sand and gravel aquifers recharge rapidly due to the coarser material deposits, which makes these aquifers more vulnerable to potential contamination from surrounding land use activities (OEPA, 2007).

Sandstone Aquifers

Mississippian and Pennsylvanian sandstone units are predominantly bedrock (confined) aquifers located in eastern Ohio. The sandstone aquifers are comprised of numerous layers of siltstone and sandstone that vary in thickness and are typically separated by layers of shale and minor amounts of limestone, clay, and coal. Although some of the thicker sandstone and conglomerate aquifers can yield 50 to 100 gpm, approximately 25 gpm is more common for the higher yielding sandstone aquifers.

Carbonate Aquifers

Carbonate bedrock units are the dominant aquifer type in western Ohio. Carbonate bedrock typically are comprised of limestone and dolomite and can have a total thickness of 300 to 600 feet. Although these aquifers are capable of yielding from 100 to over 500 gpm, the Project crosses carbonate aquifers that yield between 0 to 100 gpm. Higher production units are associated with fractures and dissolution features that can increase the permeability. These carbonates were generally deposited in warm, shallow seas with limited input of sediment from continental sources. Some carbonate aquifers of this type are poor in quality and not used for drinking water.

2.2.2.2 Michigan

The Michigan region averages approximately 20 to 40 inches of precipitation annually, and a small portion of that water infiltrates into Michigan aquifers. According to the USGS, approximately 50 to 55 percent of the Michigan population uses groundwater for their water source (USGS, 1995b). Similar to the western portion of Ohio, the NEXUS Project also crosses carbonate aquifers in Michigan, but the surface aquifers crossed in Michigan are estimated between 50 to 100 feet in depth and can yield approximately 0 to 70 gpm. The majority of the Project crosses confining bedrock units that are impermeable to water and therefore are not considered principal aquifers in Michigan. A smaller portion of the Project is located along the Silurian-Devonian bedrock aquifer that is primarily consolidated. Refer to Figure 2.2-1 for a depiction of the principal aquifer types crossed by the Project in Michigan. Table 2.2-1 provides a summary of the aquifer types, milepost ranges crossed, thickness, average water depths, and gallons per minute.

Unconfined Silurian-Devonian Bedrock Aquifer

In Michigan, the Silurian-Devonian aquifer consists mostly of dolomite and limestone (carbonate bedrock). Silurian-Devonian bedrock is about 300-400 feet thick and typically yields less than 50 gpm. Portions of the aquifer are unconfined and are overlain by surface aquifers and can be susceptible to contamination from the land surface through overlying glacial deposits. Where confined, the Silurian-Devonian aquifers are protected from contamination by overlying confining units (USGS, 1995c).

2.2.3 Wells, Springs, and Groundwater Protection Areas

Under the SDWA, each state is required to develop and implement an aquifer assessment and protection program in order to identify an aquifer's recharge area that contributes to public supply wells and prevent the contamination of drinking water supplies. The SDWA was updated in 1996 with an amendment requiring the development of a broader-based Source Water Assessment Program to analyze existing and potential threats to quality of drinking water. The following section describes the Ohio and Michigan groundwater protection areas and programs.

The SDWA defines public water systems (groundwater and surface water) as having at least 15 service connections or regularly serving at least 25 individuals. There are three types of public water systems in Ohio: 1) community water systems serving at least 15 service connections used by year-round residents or regularly serving at least 25 year-round residents; 2) non-transient non-community systems serving at least 25 of the same persons for over six months per year; and 3) transient non-community systems serving at least 25 different people over 60 days per year. Examples of facilities that use these public water systems include campgrounds, restaurants and gas stations. A private water system is defined as a water system that serves fewer than 25 people per day, 60 days per year. Refer to Section 2.3.4 for surface public water.

NEXUS has reviewed available GIS data and mapping and conducted field surveys where landowner access is available to identify wells, springs and wellhead protection areas located in the vicinity of the Project route to avoid and protect groundwater resources as much as practicable. The following sections describe the groundwater resources located along the NEXUS Project. Section 2.3.3 describes surface water resources located along the NEXUS Project.

Ohio

The OEPA's Division of Drinking and Ground Water assists communities with protecting their sources of drinking water (streams, lakes and aquifers) from contamination through a Source Water Assessment and Protection Program ("SWAPP"). The SWAPP is designed to minimize potential contamination and maintain groundwater quality around water sources, including public water wells. The protection areas for water sources vary in size depending upon a particular water supply's recharge area. A SWAPP or wellhead protection area is developed by delineating the recharge area, identifying and managing potential sources of pollution, groundwater monitoring, and developing a contingency plan.

Based on OEPA GIS data and data collected during field surveys for the Project, NEXUS identified 11 private wells and four public wells located within 150 feet of the Project construction workspace. In addition, three private springs identified within 150 feet of the Project are likely used for livestock drinking water or other agricultural purposes. Based on OEPA GIS data, the NEXUS Project crosses 15 wellhead protection areas. Five of these OEPA wellhead protection areas do not have a well location provided in the GIS data and NEXUS presumes that these wells may not be active. A list of known water supply wells and springs located within 150 feet and wellhead protection areas that are crossed by the Project facilities is provided in Table 2.2-2. In addition, Figure 2.2-2 depicts the location of the OEPA GIS wells and wellhead protection areas along the Project. The wells and springs identified during field surveys are depicted on the Project Alignment Sheets that are provided in Appendix 1A – Volume II-B of Resource Report 1.

Michigan

The Michigan Department of Environmental Quality ("MDEQ") Wellhead Protection Program ("WHPP") is a voluntary program in which communities may choose to develop an approved WHPP according to the guidelines established by the state. As part of the WHPP a Wellhead Protection Area ("WHPA") identifies the overlying surface area that contributes directly to a particular well based on a 10-year groundwater travel timeframe. The WHPA is submitted to the MDEQ for approval; once approved, a higher level of monitoring applies with respect to certain activities located in the WHPA (MDEQ, 2012).

Based on MDEQ GIS Data, and data collected during field surveys, NEXUS identified 20 private wells and three public wells that are located within 150 feet of the Project construction workspace. There are no springs or seeps identified along the Project that are used for drinking water or agricultural purposes. Based on MDEQ GIS data, the NEXUS Project crosses one wellhead protection area for a public well. A list of known public and nonpublic water supply wells located within 150 feet and the WHPA that is crossed by the Project facilities is provided in Table 2.2-2. In addition, Figure 2.2-2 depicts the MDEQ GIS well and wellhead protection areas along the Project. The wells that have been identified by NEXUS in the field are indicated on the Project Alignment Sheets that are provided in Appendix 1A – Volume II-B of Resource Report 1.

2.2.4 Sources of Potentially Contaminated Groundwater [Impaired Groundwater]

NEXUS conducted field and database research to identify, to the extent feasible, properties within one mile of the Project facilities previously impacted with oil and/or hazardous materials. A search completed by Environmental Data Resources, Inc. ("EDR") identified various types of potential and actual sources of contamination to soil and groundwater resources near the proposed Project facilities in Michigan and Ohio. Information from EDR is a compilation of a variety of available federal, state, and local government databases. A list of EDR-identified sites within 0.25-mile of the Project is presented in Table 8.4-3 or Resource Report 8. A discussion of contaminated soils is provided in Sections 7.4.6 and 7.5.7 of Resource Report 7.

Of the 109 reported occurrences along the Project pipeline in the databases queried by EDR, 38 sites are located between 100 and 500 feet from the pipeline and thirteen are less than 100 feet from the pipeline, which suggests that the likelihood of encountering contaminated soils or groundwater along the Project

route is low. Only Willow Run M&R Station (MR04), located in a highly industrialized area, is located within 500 feet of an EDR identified site.

Although not anticipated, if contaminated soil or suspected groundwater contamination is identified during trenching operations, the applicable agencies and the FERC will be notified. NEXUS has developed a Spill Prevention, Control and Countermeasure ("SPCC") Plan, in compliance with EPA regulations 40 C.F.R. Part 112 that will be followed (*see* Appendix 1B2 in Resource Report 1). NEXUS and its contractors will implement the SPCC Plan to manage and minimize the potential effects on groundwater from any existing contaminated sites and potential spills during construction.

Septic systems located in the vicinity of the Project may also be encountered during construction. NEXUS is working with landowners along the proposed route to identify septic systems within the study corridor or in close proximity to the study corridor limits. A list of known septic systems located along the NEXUS routes is provided in Table 8.3-3 in Resource Report 8. NEXUS will continue to work with affected landowners regarding the presence of private septic systems in the Project vicinity. Septic systems located adjacent to the construction workspace will be identified on Site Specific Residential Crossing Plans (*see* Resource Report 8, Appendix 8A) to inform construction crews of the location of existing septic systems and to avoid inadvertent damage to the system that could lead to groundwater contamination. NEXUS will implement its Project Erosion and Sediment Control Plan ("E&SCP") and SPCC Plan (Resource Report 1, Appendices 1B1 and 1B2, respectively) to avoid and minimize potential impacts associated with disturbance of existing contaminated materials encountered during construction. If unanticipated contaminated materials are encountered during construction, they will be managed in consultation with the appropriate agencies and in accordance with federal, state, and local requirements.

2.2.5 Groundwater Impacts and Mitigation

Construction activities associated with the NEXUS Project that have the potential to impact groundwater include shallow excavations, dewatering of excavations, horizontal directional drilling ("HDD"), hydrostatic test water withdrawals and discharges, and potential spills or leaks of hazardous liquids from the refueling of construction vehicles or storage of fuel, oil, and other fluids. As described in Section 2.2.4, the Project has the potential to encounter contaminated groundwater in some locations. NEXUS will implement proper groundwater management procedures in areas where Project-related construction activities encounter contaminated groundwater to avoid or minimize potential impacts. Depending on the volume requiring management, groundwater management procedures would include the use of portable treatment systems and/or transporting contaminated groundwater to a treatment facility. Additionally, clay trench breakers or equivalent will be used if necessary to prevent the potential migration of contaminated groundwater along the trench.

In addition, existing agricultural drain tiles are likely to be encountered during construction through agricultural areas. NEXUS will implement its Drain Tile Mitigation Plan in areas where existing agricultural drain tiles are impacted by construction (*see* Appendix 1B4 to Resource Report 1). NEXUS will implement mitigation measures in consultation with landowners and farmers to maintain needed functionality of these systems during the construction phase of the Project. Permanent repairs, as required, will be implemented following pipeline installation and prior to backfilling. NEXUS' Drain Tile Mitigation Plan is discussed further in Section 8.2.3.2 of Resource Report 8.

Spill Prevention Control and Countermeasures Plan

Potential spills or leaks of hazardous liquids, resulting from the refueling of construction vehicles or storage of fuel, oil, and other fluids during construction, could contaminate groundwater. NEXUS' SPCC Plan for construction addresses preventative measures to be used to minimize the potential impacts of a hazardous material spill on groundwater resources. Spill reporting requirements will be conducted in accordance with applicable federal, state, and local regulations. The SPCC Plan in included in Appendix 1B2 of Resource Report 1.

2.2.5.1 Pipeline Facilities

Short-term and highly localized impacts to groundwater could potentially occur during various construction stages, particularly during clearing and grading, trench excavation, and blasting, if required. During construction, local water table elevations could be affected by trenching and backfilling, thereby temporarily impacting springs and wells in close proximity. In locations where groundwater is near the surface, trench excavation may intersect the water table in low-lying areas. Each of these possible impacts is short-term and temporary; a long-term impact on groundwater resources is not anticipated as a result of this Project.

Dewatering of the pipeline trench may be required in areas with a high water table or after a heavy rain. Removal of water from the trench may result in a temporary fluctuation in local groundwater levels. Trench dewatering activities are usually completed in a few days within a particular location; therefore, impacts are expected to be temporary and localized to the dewatering area. All water removed from the trench will be discharged into well-vegetated upland areas or properly constructed dewatering structures to allow the water to infiltrate back into the ground in the same vicinity where it was removed, thereby minimizing short-term and long-term impacts to the local water table.

The Project is not expected to adversely impact groundwater quality and/or supply. NEXUS proposes to implement construction practices designed to reduce and/or mitigate potential impacts on groundwater during construction as detailed in its Project E&SCP and SPCC Plan, the FERC Upland Erosion Control, Revegetation, and Maintenance Plan ("FERC Plan"), and the FERC's Wetland and Waterbody Construction and Mitigation Procedures ("FERC Procedures") including:

- Installation/maintenance of temporary and/or permanent erosion control structures until soil stabilization is achieved;
- Monitoring of dewatering operations and discharging trench-water to appropriately vegetated upland areas, receiving structures, or filter bags as required;
- Use of secondary containment structures when working in/near sensitive resource areas;
- Enforcing restrictions on refueling locations and storage of hazardous substances;
- Revegetation of disturbed workspace locations following installation of the Project facilities;
- Installation of permanent trench plugs, where needed to maintain existing groundwater flow patterns;
- Limited and controlled use of herbicides on the right-of-way ("ROW") to only appropriate circumstances (where other options are impractical or not available) and consistent with applicable laws, rules, and regulations, as well as enforceable limitations and controls arising from agency consultations; and
- Prohibiting use of herbicides in or within 100 feet of wetlands or waterbodies, except as allowed by applicable agencies.

NEXUS sited the proposed pipeline and associated aboveground facilities based on existing land use, existing utility infrastructure, regional topography, potential adverse effects on the natural and human environment, public health and safety, and construction safety and feasibility considerations.

During the initial landowner contacts to acquire survey access permission, the Project's land representatives requested information on the locations of wells, springs, and septic systems from landowners. In addition survey crews have been identifying wells, springs and septic systems in the field. To date, there have been three springs identified along the Project that have been constructed and are likely used for livestock or other agricultural purposes. NEXUS will work with affected landowners to reconfigure work areas or

modify the pipeline alignment to avoid impacts to springs used as water sources if identified. NEXUS' land representatives will continue to request information on the location of water use wells, springs, and septic systems prior to the commencement of construction to complete an inventory of these structures within 150 feet of the Project.

Other groundwater discharge features that may be considered springs or seeps were observed along sloped areas during the waterbody and wetland surveys and are not provided in the Table 2.2-3. These groundwater discharge areas indicated no evidence of historic or present uses and were identified within and as part of waterbodies or wetlands. NEXUS will protect and minimize potential adverse impacts to these groundwater influenced waterbodies and wetland areas using construction procedures specified within its Project E&SCP. See Section 2.3 and 2.4 regarding waterbodies and wetlands identified along the Project, construction procedures, and minimization and mitigation measures.

NEXUS will offer landowners pre- and post-construction testing of water wells and springs within 150 feet of the construction workspace and will test for yield and turbidity parameters. A Project representative will contact landowners after testing events. If any of the testing demonstrates significant differences in the well yield pre- and post-construction that cannot be attributed to naturally occurring conditions, such as seasonal groundwater level fluctuations, NEXUS will ensure a temporary source of water is provided until the damaged water well is restored to its former capacity and quality, that a replacement source is provided, or that the landowner is fairly compensated for the damages whenever such testing demonstrated abnormalities.

If any blasting is required within 150 feet of any water supply wells, NEXUS will perform pre-blast and post-blast inspections as necessary. All blasting will be performed by registered licensed blasters, in accordance with all appropriate state approvals, and will be monitored by certified blasting inspectors. The contractor will be responsible for supplying explosives and blasting materials that are perchlorate-free in order to eliminate the potential for perchlorate contamination of groundwater. During blasting, NEXUS will monitor ground vibrations at the nearest structure or water well that is within 150 feet of the blast site. In the unlikely event that any water supply well is damaged as a result of blasting, NEXUS will ensure that a temporary source of water is provided until the damaged water well is restored to its former capacity and quality, a replacement source is provided, or the landowner is fairly compensated for the damages. Resource Report 7 identifies areas with mapped shallow bedrock that may require blasting.

Where possible, NEXUS will seek to avoid affecting septic systems and leach fields. Where affecting a septic system, NEXUS will work with the landowner to relocate the system, and appropriately compensate the landowner for any additionally lost usable land and associated costs.

Additional surveys and landowner contacts to identify and re-confirm the location of springs, wells and septic systems are ongoing and will continue prior to construction. If requested by the landowner, wells and springs located within 150 feet of construction workspaces will be reviewed by an expert in the field to make a determination as to whether the normally planned construction activities are expected to have any effect. If any impacts are anticipated to occur, the expert will recommend construction alterations for consideration to avoid impacting these areas.

2.2.5.2 Aboveground Facilities

Construction of new aboveground facilities will require grading, introduction of new impervious surfaces, and in some cases new buildings, concrete pads and gravel surfaces. NEXUS will install necessary temporary stormwater management controls during construction and permanent stormwater management controls for operations of aboveground facilities. NEXUS anticipates that new impervious and graveled surfaces required for aboveground facilities will be small in comparison to the mostly undeveloped areas that will be revegetated surrounding aboveground facility sites. Therefore, it is unlikely that aboveground facility construction and operation will result in meaningful change in groundwater recharge outside of the facility limits.

Hazardous material storage at aboveground facilities will be designed with respect to applicable engineering, safety, and environmental standards. The facilities will include leak detection and spill containment structures commensurate with the quantity of materials stored and will be maintained in compliance with all applicable federal and state regulations and permits.

NEXUS is proposing to install new water wells at the Wadsworth, Hanoverton, and Waterville Compressor Station properties for water uses during the construction and operations of these facilities. Currently, NEXUS is determining the availability of the existing municipal water system in the vicinity of the Clyde Compressor Station. If the municipal system is not readily available, NEXUS will install a new well on the Clyde Compressor Station property for water uses during construction and operation of the facility. The installation of a new water well will require approval by the Ohio board of health for a private water system. In accordance with Ohio Regulations 3701-28-03 and 3701-28-07, permit requirements would ensure environmental effect on groundwater supplies would be minimized by requiring the well(s) to be installed to minimize cross contamination with groundwater or surface waters. Furthermore, a private water system cannot be approved unless a water sample from the private water system meets the standards specified by the Ohio board of health. NEXUS anticipates that minimal use of well water used for the construction and operation of the compressor station will have no adverse drawdown effect to the localized water table at these compressor station locations.

2.3 Surface Water Resources

Surface water resources were initially identified using USGS topographic maps and the Project geographic information systems ("GIS") database and were subsequently verified and surveyed in the field. Surface water resources documented along the NEXUS Project area include major rivers, streams, ponds, and associated tributaries. The following sections describe surface water resources and their associated watersheds along the NEXUS Project.

2.3.1 Watersheds

The United States is divided and subdivided into successively smaller watersheds that were delineated by the USGS and categorized into watersheds using Hydrologic Unit Codes ("HUC"). Each hydrologic unit is identified by a unique HUC consisting of two to twelve digits based on the six levels of classification: 2-digit HUC first-level (region), 4-digit HUC second-level (subregion), 6-digit HUC third-level (accounting unit), 8-digit HUC fourth-level (cataloguing unit), 10-digit HUC fifth-level (watershed), and 12-digit HUC sixth-level (subwatershed) (NRCS, 2007).

Proposed NEXUS Project facilities are located within the Ohio River and Lake Erie drainage basins. Figure 2.3-1 identifies the HUC 12 watersheds crossed by the Project and Table 2.3-1 provides the beginning and end milepost of HUC unit and sub-watershed crossings.

2.3.2 Waterbodies Crossed by the Project

A waterbody, as defined by the FERC, is "any natural or artificial stream, river, or drainage with perceptible flow at the time of crossing, and other permanent waterbodies such as ponds and lakes." The U.S. Army Corps of Engineers ("USACE") has jurisdiction over "waters of the U.S., including wetlands," pursuant to Section 404 of the federal Clean Water Act and identified by ordinary high water mark. The term "waterbody" as it is used in this Resource Report is inclusive of all "waters of the U.S.," other than wetlands, that are jurisdictional to the USACE, and all waterbodies as defined by the FERC. Streams and ponds are the two different types of waterbodies identified along the NEXUS Project route, Section 2.4 discusses wetlands located along the Project. Stream habitat information was gathered for each waterbody identified along the Project and stream habitats located in Ohio were also assessed and scored using either OEPA's Headwater Habitat Evaluation Index or Qualitative Habitat Evaluation Index.

Field surveys for wetlands and waterbodies were conducted during 2014 and 2015 field seasons resulting in approximately 90 percent of the Project area being surveyed to date. Surveys are currently ongoing for

the remaining 10 percent where survey access is pending (*see* Resource Report 1, Section 1.14). For the Project areas not surveyed, NEXUS used publically available USGS topographic quadrangle maps, Project LIDAR topographic mapping with 2-foot contours, and aerial photography to delineate approximate waterbody boundaries using GIS. Approximated waterbodies are depicted as orange on the Project alignment sheets and are listed in Table 2.3-2 as approximated stream "AS" or approximate pond "AP" in the waterbody identifier.

2.3.2.1 Pipeline Facilities

The NEXUS Project including the TGP interconnecting pipeline facilities will cross 385 waterbodies in Ohio and 81 waterbodies in Michigan. These crossings primarily consist of small, intermittent or ephemeral streams as depicted in Table 2.3-2 (*see* Tables Section). Based on the FERC's stream classification system, NEXUS is proposing to cross 8 major waterbodies (waterbodies greater than 100 feet wide – bank to bank), 7 being rivers and 1 being a manmade retention pond. Although the majority of the waterbodies along the NEXUS Project will be crossed using dry or wet cut construction methods, there are 26 waterbodies that will be crossed using the HDD crossing method and 63 crossed using a conventional bore. See Table 2.3-3 for a complete list of waterbodies that are proposed to be crossed using the HDD crossing method and Table 2.3-2 for the list of all waterbody crossings including waterbody widths, FERC classifications, crossing methods, and state designations for each waterbodies crossed by the pipeline facilities.

Temporary and Permanent Access Roads

Wetland and waterbody field surveys were conducted during the 2014 and 2015 field seasons along the majority of the Project access roads. Surveys are currently on going for the remaining access roads where landowner access is pending. To the extent practicable, NEXUS is proposing to use existing roads or open land for temporary access roads ("TAR") and permanent access roads ("PAR") with the intention of avoiding and minimizing waterbody crossings. There are four waterbodies that would be temporarily impacted along Project TARs and two channelized roadside streams that will be crossed by PARs. See Table 2.3-2 for a complete list of waterbodies crossed by the Project access roads. NEXUS proposed access roads are also shown on USGS quadrangle map excerpts and Project alignment sheets located in Appendix 1A – Volume II-B of Resource Report 1.

Aboveground Facilities

Field surveys have been completed at all proposed compressor station sites, metering and regulating ("M&R") station sites, and mainline valve sites. Waterbodies were identified at three of the four compressor station sites (Hanoverton, Wadsworth, and Waterville compressor station sites), however, these stations have been designed to avoid temporary and permanent impacts to waterbodies. The Clyde Compressor Station site had no waterbodies on site. The proposed M&R stations and mainline valve sites have been designed to avoid permanent and temporary waterbody impacts.

Pipe and Contractor Ware Yards

Wetland and waterbody field surveys were conducted during the 2014 and 2015 field seasons for the majority of proposed Project ware yards. Surveys are currently on going for the remaining ware yards where landowner access is pending. At this time one waterbody is located within ware yard 4-2. This waterbody will either be avoided or temporarily bridged during the use of this ware yard. Proposed pipe yards and contractor ware yards are shown on USGS quadrangle map excerpts located in Appendix 1A.

2.3.3 Surface Water Supplies and Surface Water Protection Areas

NEXUS conducted a review of publically available data for public surface water intakes located within three miles downstream of the Project waterbody crossing locations. Three surface water intake locations were identified in Ohio and one was identified in Michigan. See Table 2.3-4 for summary of surface water intakes that are located within three miles downstream of the Project. Table 2.3-5 indicates the surface

water protection areas crossed by the NEXUS Project and Figure 2.3-2 depicts these locations along the Project.

Ohio

Public surface water supplies, as described in Section 2.2.3, are regulated by OEPA's Division of Drinking and Ground Waters. The OEPA mandates public surface water supply systems to establish a SWAPP. Ohio's public watershed areas include municipal watersheds and associated reservoirs as well as state or locally designated surface water protection areas. Based on OEPA GIS data, the Project crosses surface water protection areas located within the greater Ohio River SWAPPs (MPs 0-72.7), Mahoning River SWAPPs (MPs 7.6-8.8 and 14.3-21.2) West Branch Black River SWAPP (MPs 91.2- 94.7), and Swanton Reservoir SWAPP (MPs 193.7-197.8). Although the Project crosses segments of these SWAPPs, NEXUS will avoid direct impacts to these surface waters and intakes by adhering to NEXUS E&SCP along the entire Project and by using the HDD and conventional bore crossing methods for numerous waterbody crossings. Refer to Appendix 1B1 in Resource Report 1 for the Project E&SCP and Section 2.3.10 for waterbody crossing methods.

The surface water intakes associated with the Ohio River SWAPPs are located along the Ohio River which is located approximately 16 miles from the proposed Project at its nearest location. The NEXUS Project is located approximately 20.5 miles from the nearest Ohio River surface water intake (East Liverpool, Columbiana County, Ohio). The Mahoning River SWAPPS are along the Mahoning River which is located approximately 4 miles from the proposed Project at its nearest location. The NEXUS Project is located approximately 7 miles from the nearest Mahoning River surface water intake (Alliance, Stark County, Ohio). Due to the distances from the proposed Project and implementation of the Project-wide E&SCP, it is highly unlikely that NEXUS would affect the Ohio and the Mahoning Rivers or their associated surface water intakes. In addition, NEXUS is proposing use of the HDD crossing method at the West Branch Black River and a conventional bore crossing method for the Swan Creek crossing (intake for Swanton Reservoir) to avoid direct impacts to these public source water streams.

Michigan

Michigan determines surface water protection areas by identifying the watershed upstream from a surface water intake. The surface water protection area for an intake is defined as a critical assessment zone ("CAZ"). A 3,000-foot radius is applied to a CAZ for river intakes and 1,000-3,000-foot radius is applied to shore intake (i.e. lake shore) (USGS and MDEQ, 2002).

Based on the *Michigan's Source-water Assessment Program- Surface-Water Assessments Leading to Protection Initiatives* 2002 report, NEXUS has determined that Blissfield surface water intake along the River Raisin (MP 215.19) is located within three miles of the Project pipeline facilities, but the Project facilities are located outside of the intake's CAZ. In addition, NEXUS is proposing to HDD crossing method for the River Raisin crossing. This crossing method will install the pipeline under the river, therefore, resulting in no direct impacts to the river or the Blissfield surface water intake and water supply. There are no other identified public surface water intakes within 3 miles of the Project.

2.3.4 Sensitive Surface Waters

Sensitive surface waters include all waterbodies that have been designated for intensive water quality management, waters containing federally- or state-listed threatened or endangered species or critical habitats, any waters afforded national or state designated status, and Section 10 (Rivers and Harbors Act) Navigable Waterways. Sensitive surface waters are summarized in Table 2.3-6 by milepost and with applicable surface water designations. See Section 2.3.5 for waters that do not meet state water quality standards and are considered impaired.

Endangered, Threatened, and Special Concern Species and Fisheries of Special Concern

The U. S. Fish and Wildlife Service, Ohio Department of Natural Resources, and Michigan Department of Natural Resources ("MDNR") were consulted to identify state and federally protected species in the Project area. NEXUS Resource Report 3 provides detailed information on state and federally protected species including listed species associated within waterbodies crossed by the Project.

Federal and State Designated Waters

NEXUS reviewed available state regulations and mapping, the National Rivers Inventory ("NRI") (NPS, 2011), and National Wild and Scenic River System maps (National Wild and Scenic River System, 2014) to identify federal or state recognized exceptional quality waters crossed by the Project. The NRI is a listing of more than 3,400 free flowing river segments in the United States that are believed to possess one or more "outstandingly remarkable" natural or cultural values ("ORVs") judged to be of more than local or regional significance. All federal agencies must seek to avoid or mitigate actions that would adversely affect one or more NRI segments (NPS, 2011). The National Wild and Scenic Rivers System was created by Congress in 1968 (Public Law 90-542; 16 U.S.C. 1271 et seq.) to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. The 1968 Wild and Scenic Rivers Act encourages river management that crosses political boundaries and promotes public participation in developing goals for river protection (National Wild and Scenic River System, 2015). Federally and state designated waters are discussed below and are summarized by milepost in Table 2.3-6.

Ohio

The OEPA's Antidegradation rule 3745-1-05 of the Administrative Code identifies stream segments that have exceptional water quality, special ecological significance, or recreational value. NEXUS has identified the Vermillion River (MP 104.37) as an outstanding water based on its ecological value and the Maumee River (MP 181.35) for its outstanding recreational values. NEXUS is proposing to use the HDD crossing method for both of these OEPA designated waterbodies to avoid potential impacts to these resources. See Table 2.3-3 for a list of proposed HDDs.

Review of the NRI identified the following listed river segments crossed by the NEXUS Project in Ohio:

- East Branch Black River (MP 86.72) is listed as having the following ORVs: scenery, recreation, and history.
- West Branch Black River (MP 92.39) is listed as having the following ORVs: scenery, geology, wildlife, and history.
- Tuscarawas River (MP 48.14) is listed as having the following ORVs: scenery, recreation, and history.
- Vermillion River (MP 104.37) is listed as having the following ORVs: scenery, fish, recreation, geology, and wildlife.
- Sandusky River (MP 145.81) is listed as having the following ORVs: recreation and history.

NEXUS is proposing to use the HDD crossing method for all of the NRI designated streams crossed by the Project in order to avoid direct impacts to these resources and also potential indirect impacts along the partially wooded banks. See Table 2.3-3 for a list of proposed HDDs.

NEXUS reviewed the National Wild and Scenic River list and determined that there are no federally designated Wild and Scenic Rivers crossed by the Project in Ohio.

Michigan

Under Part 305 of the Michigan Natural Resource and Environmental Protection Act, Michigan designates state river segments that have unique wild, scenic and recreational values as Natural Rivers. NEXUS

reviewed MDNR's list and map of Michigan's Naturals Rivers and determined that Project route avoids state designated river segments (MDNR, 2015). In addition, NEXUS reviewed the NRI and National Wild and Scenic River listings for Michigan and has determined that the Project does not cross National Wild and Scenic Rivers but does cross one NRI designated river in Michigan:

- Huron River (MP 250.92) is listed as having the following ORVs: recreation, fish, and history.

NEXUS is proposing to use the HDD crossing method for the Huron River in order to avoid direct impacts to this resources and also potential indirect impacts along the wooded banks. See Table 2.3-3 for a list of proposed HDDs.

Navigable Waters

Under Section 10 of the Rivers and Harbors Act of 1899, the USACE has authority to regulate construction in navigable rivers of the United States, which are defined under 33 Code of Federal Regulations § 329 as those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. The NEXUS Project crosses four Section 10 navigable waters including the Tuscarawas River (MP 48.14), Huron River (MP 116.88), Sandusky River (MP 145.81), and the Maumee River (MP 181.35) in Ohio. There are no Section 10 navigable waters crossed in Michigan. NEXUS is proposing to use the HDD crossing method to avoid impacts to Section 10 navigable waters crossed by the Project (*see* Table 2.3-3).

2.3.5 Impaired Surface Waters

Impaired Surface Waters

States are mandated to adopt and review water quality standards under Section 303(c) of the Clean Water Act. Water quality standards define the beneficial designated uses that are protected for each waterbody and the associated water quality criteria that must be met to protect those uses. Water quality classifications are based on the designated uses set under the water quality standards. A waterbody that does not achieve water quality criteria for one or more of its designated uses is considered impaired.

To determine whether any impaired waterbodies will be affected by the Project, NEXUS reviewed the most recent 303(d) lists for Michigan and Ohio. The Total Maximum Daily Load ("TMDL") program, established under Section 303(d) focuses on identifying and restoring polluted rivers, streams, lakes and other surface waterbodies. TMDLs are developed as a step towards achieving water quality standards in waters where the standards are not being met. The purpose of water quality standards is to protect public health and wellbeing and ensure that public water resources can be utilized to their full potential. TMDLs are also used to identify impaired waters.

In Ohio, waterbodies classified in EPA Categories 4 and 5 are considered Impaired Surface Waters. In Ohio Category 4 includes waterbodies where the TMDLs have been exceeded or cannot be met due to the nature of the contamination. Ohio Category 5 includes waterbodies where TMDLs need to be developed by the state.

For Michigan, the MDEQ provides a list of only Category 5 waterbodies that are listed as Impaired. A Category 5 waterbody in Michigan indicates that available data and/or information suggest that at least one designated use is not being supported or is threatened, and a TMDL is required.

NEXUS reviewed both the Ohio and Michigan 2014 Section 303(d) lists of impaired streams. A total of 261 impaired streams along the NEXUS Project mainline pipeline and one along TGP Interconnecting pipeline were identified. Of those 262 impaired streams, 230 are located in Ohio and 32 are located in Michigan. Table 2.3-7 identifies each impaired waterbody by milepost and includes the cause of impairment and state TMDL status for waterbodies in Ohio and Michigan.

The Section 303(d) impaired waterbodies described above provided the basis for determining waterbodies crossed by the Project with existing impaired water quality. See Section 7.4.6 of Resources Report 7 for a discussion of contaminated soils located in the vicinity of the Project area.

NEXUS will perform all proposed waterbody crossings in compliance with the FERC Procedures, the Project E&SCP and SPCC Plan. Construction performed in compliance with these construction standards would not impact the current status of impaired waterbodies in the Project area and mitigate the potential for negative effects resulting from construction in impaired waterbodies.

2.3.6 Contaminated Sediments

As described above in Section 2.2.4, NEXUS conducted a corridor database search to identify various facilities with potential and/or actual existing sources of contamination near the Project. Based on a review of these sites (*see* Table 8.4-4 in Resource Report 8), NEXUS does not anticipated to encounter contaminated sediments during the waterbody construction activities. If contaminated waterbody sediments are identified during trenching operations, the applicable agencies and FERC will be notified immediately to develop the appropriate mitigation.

2.3.7 FEMA Flood Zones

NEXUS reviewed available state and federal digital flood data to identify proposed crossings of areas subject to flooding and high volume flows. Flood zones are geographic areas that the Federal Emergency Management Agency ("FEMA") has defined according to varying levels of flood risk and type of flooding. These zones are depicted on FEMA published Flood Insurance Rate Maps or Flood Hazard Boundary Maps. Special Flood Hazard Areas represent the area subject to inundation by 1-percent-annual chance flood (FEMA, 2015). NEXUS has sited all aboveground facilities outside of FEMA flood zones and the construction of the NEXUS pipeline facilities will not result in changes to the flood storage capacity of the FEMA flood zones crossed by the Project. Figure 2.3-3 depicts mapped FEMA Flood Zones located along the Project and Table 2.3-8 identifies FEMA Flood Zones crossed by the Project.

2.3.8 Construction Permits

NEXUS will apply for applicable federal and state permits, approvals, and licenses related to the construction and operation of the pipeline across regulated waterbodies and wetlands and the withdrawal or discharge of hydrostatic test water. Table 1.13-1 in Resource Report 1 provides a list of the permits, approvals, and authorizations required for construction and operation of the NEXUS Project.

2.3.8.1 Surface Water Permits

NEXUS will acquire applicable construction-related permits at the federal and state level, including: Clean Water Act Sections 404 and 401 authorizations from the USACE, OEPA, and MDEQ for temporary waterbody and wetland impacts; Storm water Discharge from Construction Activities authorization from the MDEQ; National Pollutant Discharge Elimination System general permit for hydrostatic test water discharge from the OEPA and MDEQ; and Water Withdrawal Authorization from the MDEQ. Table 1.13-1 in Resource Report 1 lists required federal and state environmental permits, approvals and authorizations required for the NEXUS Project.

2.3.9 Hydrostatic Test Water

In compliance with U.S. Department of Transportation regulations 49 CFR Part 192, NEXUS will conduct hydrostatic testing of the pipeline facilities prior to placement in service. Potential sources of hydrostatic test water identified to date for the testing of pipeline, aboveground facilities, and the proposed HDD locations are provided in Table 2.3-9, Table 2.3-10, and Table 2.3-11, respectively. The information provided includes the source names by milepost and estimated volumes of water withdrawal based on anticipated test sections. Test sections were selected based on several factors, including pipe parameters,

the elevation changes within the alignment, the target maximum allowable operating design pressure, and the class locations of the pipeline. To the extent practicable, and depending on the ultimate timing and sequence of construction events, NEXUS will transfer hydrostatic test water from one test segment to the next, which may reduce the total volume of test water required.

The source waters were selected based on proximity to the construction area, proximity to the required test sections, and ability to supply a sufficient volume of water for the testing process without compromising normal waterbody dynamics and ecology.

Environmental impacts from withdrawal and discharge of hydrostatic test water will be minimized by using the measures prescribed in the NEXUS Project E&SCP. To minimize impacts NEXUS will:

- Locate hydrostatic test manifolds outside of wetlands and riparian areas, to the extent practicable;
- Comply with all appropriate federal and state permit requirements;
- Not withdraw from or discharge into state-designated special waters, waterbodies that provide habitat for federally listed threatened or endangered species, or waterbodies designated as public water supplies, unless the relevant federal, state, and local permitting agencies grant written permission;
- Screen the intake hose to minimize the potential entrainment and impingement of fish and other aquatic life;
- Maintain ambient, downstream flow rates to protect aquatic life, and provide for all designated water uses, including withdrawals by existing downstream users;
- Discharge test water to a well-vegetated and stabilized area, if practical, and maintain at least a 50-foot vegetated buffer from adjacent waterbody/wetland areas. If an adequate buffer is not available, sediment barriers or similar erosion control measures must be installed;
- Regulate discharge rate, use energy dissipating device(s), and install sediment barriers, as necessary, to prevent sedimentation and streambed scour;
- Reuse hydrostatic test water where practicable; and
- Comply with federal and state discharge requirements once testing is complete.

NEXUS does not anticipate using chemicals for testing or for drying the pipeline following hydrostatic testing. Upon completion of hydrostatic testing, the test water will be discharged into dewatering structures located in upland areas within the construction work area in accordance with the NEXUS Project E&SCP and all applicable permits. Samples of this outflow will be collected and tested in accordance with the federal and state permit requirements.

2.3.10 Waterbody Construction Methods

The waterbodies crossed by proposed pipeline facilities and crossing construction method for those waterbodies are listed in Table 2.3-2. Waterbodies only located within the construction workspace and not crossed by the pipeline trench will either be avoided or temporarily crossed using equipment bridges. The waterbody construction procedures described below and within the Project E&SCP are consistent with those prescribed in the FERC Procedures.

2.3.10.1 General Procedures

Following surveying and staking, it is necessary to mobilize the required equipment at the waterbody crossing. To facilitate this process, temporary bridges may be constructed across the waterbody during clearing and grading activities for construction equipment (*see* the Project E&SCP located in Appendix 1B1 of Resource Report 1). Temporary bridges and associated supports are removed as part of the restoration process.

In general, construction equipment and vehicle refueling and lubricating takes place in upland areas located more than 100 feet from the edge of a waterbody (or wetland). In addition, fuels, lubricating oils, petroleum

products, and other hazardous materials are not stored within 100 feet of an aquatic resource. However, instances may arise where equipment refueling and lubrication near or in a waterbody are necessary. For example, stationary equipment, such as a hydrostatic test water pump, may need to operate continuously on the bank of a waterbody. The Project E&SCP and SPCC Plan address the handling of fuel and other hazardous materials in or within 100 feet of a waterbody, which may be approved with conditions by the Lead Environmental Inspector ("EI").

If trench dewatering is necessary in or near a waterbody, the removed trench water will be discharged into an energy dissipation/sediment filtration device, such as a geotextile filter bag or straw bale/geotextile structure located away from the water's edge to prevent silt-laden water from flowing directly into the waterbody in accordance with the Project E&SCP and applicable permits. Monitoring will be conducted to ensure that all flow from the structure is infiltrating into the underlying soil. Refer to Section 1.7 of Resource Report 1 for additional waterbody construction-related information.

2.3.10.2 Additional Temporary Workspace

In general, additional temporary workspace ("ATWS") is typically required on both sides of a waterbody crossing to store materials and trench spoil. In adherence to the FERC's Procedures, ATWS will be located at least 50 feet away from the waterbody edge, topographic and other site specific conditions permitting and except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. If conditions do not permit a 50-foot setback where required, NEXUS will request a variance from the FERC's Procedures. Table 2.3-12 identifies the locations where deviations from the FERC Procedures ATWS waterbody setback are required for the Project.

2.3.10.3 Clearing

Clearing involves the removal of all trees and brush from the construction workspace. Woody vegetation along the permanent easement is cleared to the edge of the waterbody; however, where available, a 50-foot wide herbaceous strip is left on the approach until immediately before construction to provide a natural sediment filter that helps minimize the potential for erosion immediately adjacent to the waterbody and sedimentation from cleared upland areas. With the exception of stream buffers and forested wetlands, stumps are typically removed over the width of the permanent ROW. Initial grading of the herbaceous strip is limited to what is needed to install the equipment bridge and, where a large grade cut is needed, to the extent necessary to safely implement the construction activity. After clearing and prior to grading activities, temporary erosion control devices (sediment barriers) will be installed and maintained adjacent to the waterbody and within the construction work area, as needed to further minimize the potential for sediment runoff.

2.3.10.4 Crossing Methods

To minimize potential impacts, waterbodies, streams and rivers will be crossed as quickly and safely as possible. Additionally, efforts will be made to plan work during dry conditions for intermittent and ephemeral channels, where practicable. Adherence to the construction procedures will ensure stream flow will be maintained throughout construction. Pending the results of ongoing geotechnical investigations, NEXUS proposes seventeen (17) HDDs along the Project route. The Project HDDs will avoid direct impact to a total of 26 waterbodies. Twenty-three (23) of these waterbodies are located in Ohio, and three (3) are located in Michigan. Proposed waterbody crossing methods for each waterbody crossed by the proposed pipeline are provided in Table 2.3-3.

Wet Crossing (Open Cut)

A wet crossing, often referred to as wet open cut crossings, will be used for waterbodies that are dry at the time of the crossing with no discernible or anticipated flow regardless of the designated waterbody crossing method. This method will use conventional construction techniques with no temporary diversion structures (e.g., flume pipes, cofferdams) required during construction of the crossing. Wet crossings will be

performed by using excavation equipment to trench across the waterbody. Equipment used to dig the trench will work from the waterbody banks, equipment crossings, or by straddling the trenchline where the width of the waterbody prohibits excavations solely from the banks. The depth of the trench will be sufficient to allow a minimum of 5 feet of cover over the pipeline below the streambed, provided rock is not encountered. Consistent with the FERC's Procedures, NEXUS plans to complete construction activities, except for blasting and other rock breaking measures, within 24 hours at minor wet open cut crossings and within 48 hours at intermediate wet open cut crossings. The Lead EI may adjust the final placement of the erosion and sediment control structures in the field to maximize effectiveness.

The following additional stipulations will apply to wet open cut crossings:

- Adherence to measures outlined for open wet cut crossings in the Project E&SCP;
- Use of equipment operating in the waterbody will be limited to that needed to construct the crossing;
- Material excavated from the trench will be kept to a minimum and will be stockpiled in the construction ROW at least 10 feet from the water's edge or in ATWS (located at least 50 feet from the water's edge);
- Material excavated from the trench will be used as backfill, unless federal or state permits specify otherwise;
- Any excess material will be removed from the water body; and
- The waterbody bottom will be returned to its original contour.

Dry Crossing (Dry Cut)

Dry crossing methods involve installation of a flume pipe (s) and/or dam and pump prior to trenching to separate the stream flow from the construction work area and allow trenching of the stream bed in drier conditions. A description of the Flumed crossing method and the Dam and Pump crossing method are included in the Project E&SCP. Spoil removed during the trenching will be stored away from the water's edge and protected by sediment containment structures. Pipe strings will be prefabricated into one continuous section on one bank and either pulled across the trench to the opposite bank, carried into place and lowered into the trench, or floated across the isolated portion of the stream if the trench is inundated. Where these methods are employed, ATWS areas will be required for assembly of the pipe strings and spoil storage.

Consistent with the FERC Procedures, NEXUS plans to complete construction activities within 24 hours at minor dry cut waterbody crossings and within 48 hours at intermediate dry cut crossings. A minimum cover depth of 5 feet will be maintained over the pipeline for all designated waterbodies crossed using a dry crossing method.

NEXUS may choose to use mainline construction procedures across minor waterbodies where the wet cut crossing method is proposed. In these instances, a flume pipe will be installed immediately after trenching is completed. The flume pipe will remain in place until the lowering-in process. The flume pipe will be removed just prior to lowering in the pipeline. The 24-hour restoration timeframe starts as soon as the flume is removed.

Conventional Bore Method (Bore)

In site-specific circumstances, a conventional bore may be used for waterbody crossings. This method is essentially the same as is used for road and railroad crossings, where the pipeline is installed by boring a hole under the waterbody. Specialized boring equipment is used. The soil and or rock are bored by a drill that contains a cutting head which cuts through the soil. Dummy casing which is slightly larger in diameter than the pipeline, is installed immediately behind the cutting head. An auger is placed inside the pipe to remove the cuttings. When completed, the bored hole is slightly larger than the outside diameter of the pipeline to be installed. Once the bore is completed, the pipeline section is welded to the boring pipe and

pulled into place and the boring pipe is removed. Any voids between the pipeline and the subsoil are filled with grout (a sand-cement mix) to prevent settlement. This method requires that bore pits be excavated on both sides of the waterbody so that the boring equipment can install the pipeline below the bottom of the stream channel.

Horizontal Directional Drill

The HDD method is a trenchless installation process by which the pipeline is installed beneath obstacles or sensitive areas using equipment and techniques derived from oil well drilling technology. NEXUS has developed a specific HDD Design Report and HDD Monitoring and Inadvertent Return Contingency Plan ("HDD Plan") for proposed HDD crossings. The HDD Design Report provides a general overview of the HDD construction process, feasibility, considerations, and calculation methods used during the design process as well as site-specific crossing evaluations and diagrams which include:

- General site descriptions
- Subsurface conditions based on geotechnical data
- Design geometry and layout
- Assessment of Feasibility
- Risk identification and assessment
- Installation loading analysis
- Estimated construction duration.

The HDD Plan has been developed in the event that problems develop during the HDD operations in order to complete the crossing successfully while minimizing associated impacts. Both the HDD Design Report and HDD Plan are provided in Appendix 2A of this report.

In principle, HDD construction is the least disturbing method upon the existing environment relative to any other conventional open trench operations. The installation is a multi-stage process consisting of establishing a small diameter pilot hole along the crossing profile, followed by enlargement of the pilot hole to accommodate pull back of the proposed pipeline.

The HDD rig and associated equipment (e.g., control cab, drill string pipe storage, office and tool storage trailers, power generators, bentonite storage, bentonite slurry mixing equipment, slurry pump, cuttings separation equipment, and heavy construction equipment) will be set up on one side of the waterbody crossing. Due to the specialized equipment and area requirements associated with HDD technology, additional temporary workspace will be requested to stage and successfully operate the equipment. Drilling will progress beneath the waterbody towards the other shore. The pilot hole is drilled using a small diameter drill string and a drill bit consisting of an asymmetric jetting head. The hydraulic cutting action of the drill head is remotely operated to control its orientation and direction. The position of the drill string is electronically monitored during the drilling operation. Directional corrections are made as necessary to ensure that the drill string maintains the desired profile and alignment.

Bentonite drilling fluid is delivered to the cutting head through the drill string to provide the hydraulic cutting action, lubricate the drill bit, stabilize the hole, and to remove cutting spoil as the drilling fluid returns to the entry point of the pilot hole to an excavated containment pit. Typically, drilling fluid returns are processed to remove the cuttings and the bentonite is recycled for use as the drilling operation continues. In the event that there is an inadvertent release of drilling fluid, lost circulation materials may be used in an attempt to seal the formation and reestablish drilling fluid returns to the entry and/or exit pits. Many types of lost circulation materials are available for use during HDD operations which are inert and environmentally benign. These can include wood fibers, cotton seed husks, ground walnut shells and other natural materials. Special polymers that swell to several times their original size when introduced to water can also be used. The types of products used are typically left to the discretion of the HDD Superintendent

and the EI. Refer to the NEXUS HDD Design Report located in Appendix 2A for additional information regarding drilling fluid used for the proposed Project HDD crossings.

Because there is the potential for a loss of drilling fluid into karst conduits, additional steps which may be taken by the contractor to either prevent lost circulation or regain circulation include, but are not limited to, the following:

- Size the hole frequently by advancing and retracting the drill string in order to keep the annulus clean and unobstructed.
- When drilling fluid flow has been suspended, establish circulation slowly and before advancing.
- Minimize annular pressures by minimizing density and flow losses. Viscosity should be minimal and consistent with hole cleaning and stabilization requirements.
- Minimize gel strength.
- Control balling of material on bits, reaming tools, and pipe in order to prevent a plunger effect from occurring.
- Control penetration rates and travel speeds in order to prevent a plunger effect from occurring.
- Seal a zone of lost circulation using a high viscosity bentonite plug.
- Use of lost circulation materials.
- Suspend drilling activities for a period of six to eight hours.

NEXUS has developed a HDD Plan, provided in Appendix 2A, for the potential risk of inadvertent release or loss of drilling fluid when certain adverse subsurface conditions are encountered.

Water sources and volumes for HDD locations are discussed above in Section 2.3.8, Hydrostatic Test Water. Drilling mud and cuttings will be recycled or disposed of at an approved upland location or disposal facility. No recovered drilling fluid will be disposed of in waterbodies or wetlands. Recovered materials will be collected in containers for temporary storage prior to removal from the site and all containment structures will be removed from the site.

Enlarging the pilot hole is an incremental process accomplished with one to several reaming passes, depending upon the carrier pipe diameter and the subsurface geology. The rotating reaming/cutting tool is attached to the drill string at the exit point, and drawn back toward the drilling rig situated at the entry point of the pilot hole. Drill pipe is added behind the reaming tool as it progresses toward the drill rig to ensure that a continuous drill string is maintained in the drilled hole. Bentonite drilling fluid is again utilized during the reaming process to remove cutting spoil from the hole and stabilize the enlarged hole.

Additional temporary workspace or false ROW will be required along the other side of the waterbody to prefabricate the pipeline into one continuous section in preparation for the pullback. Once assembled, the pipeline is placed on pipe rollers so that it may be conveyed into the drill hole during the pullback operation. The fabricated pipe will be hydrostatically tested prior to pullback. Once reaming is completed, the prefabricated pipeline is attached to the drill string at the exit point, and drawn back toward the drilling rig at the entry location. Upon completion of pipeline construction, the entire line, including the incorporated HDD segment, will again be hydrostatically tested.

NEXUS has analyzed, evaluated, and determined a risk identification and assessment each of the seventeen proposed HDD crossing locations. At this time, Geotechnical surveys have been conducted at fifteen or the seventeen proposed HDD crossing locations. NEXUS will provide the Commission any additional HDD technical feasibility determination based on the results of the remaining or additional geotechnical surveys that are anticipated in 2016.

2.3.10.5 Drilling and Blasting at Waterbodies

To identify the need for drilling or blasting, the trench crew will drill the stream banks to determine if rock will be encountered during construction. Should these test holes identify the need for blasting, the ditch

crew will prepare the trench line. If in-water blasting is determined to be necessary, NEXUS will follow mitigation measures provided in the Project Blasting Plan. The Blasting Plan is provided in Appendix 1B3 of Resource Report 1. The mainline tie-in crews will then excavate the trench, install the pipeline, and restore the area in accordance with the Project E&SCP.

2.3.10.6 Restoration

Completed stream crossings will be stabilized within 24 hours of backfilling in accordance with the FERC Procedures and the Project E&SCP, weather and soil conditions permitting.

Within the construction ROW, a 25 foot-wide riparian strip adjacent to waterbodies will be allowed to revegetate with native plant species. A 10-foot wide area centered on the pipeline will be maintained to facilitate periodic pipeline corrosion/leak surveys. Any trees within 15 feet of the pipeline that have roots that could compromise the integrity of the pipeline coating may be cut and removed from the permanent ROW during maintenance activities.

2.3.11 Surface Water Effects and Mitigation

Construction activities associated with the Project that have the potential to affect surface waters include clearing activities, crossings of waterbodies for pipeline installation, HDD, hydrostatic test discharges, potential spills or leaks of hazardous liquids from the refueling of construction vehicles or storage of fuel, oil, and other fluids, and temporary access road crossings. Periodic maintenance of the ROW also has the potential to impact bank and riparian areas adjacent to waterbodies.

Pipeline construction across rivers and streams or adjacent to surface waters can result in temporary and long-term adverse environmental impacts if not properly completed. However, proper construction techniques and timing will ensure that any such effects are both temporary and minor. The primary effect associated with in-stream trenching is a temporary increase in turbidity and the resulting sedimentation that may occur downstream. Surface runoff and erosion from the cleared ROW can also increase in-stream sedimentation during construction. Other potentially deleterious effects include accidental hazardous material spills resulting from refueling/maintaining construction equipment, fuel storage, or equipment failure in or near a waterbody, and could have immediate effects on aquatic resources and contaminate the waterbody downstream of the release point.

Long-term effects on water quality can result from alteration of stream banks and removal of riparian vegetation. If not stabilized and revegetated properly, soil erosion associated with surface runoff and stream bank sloughing can result in the deposition of sediment into the waterbody. Increased turbidity from soil erosion and increased water temperature from vegetation removal can reduce the suitability of habitat for fisheries.

Minor long-term effects associated with pipeline operations and maintenance will largely be restricted to periodic clearing of vegetation within the permanent ROW at waterbody crossings as described earlier in this section. These maintenance activities will be performed in compliance with the FERC Procedures, which have been fully integrated into the Project E&SCP.

2.3.11.1 Mitigation and Restoration Measures

To minimize effects at waterbody crossings during construction, operation, and maintenance, NEXUS will construct the Project in accordance with the Project E&SCP and with all federal and state regulations and permit requirements. NEXUS has sited the proposed ROW adjacent to existing maintained utility ROWs and agricultural fields at waterbody crossings to the extent practicable to minimize potential impacts on riparian buffers along stream corridors. Additionally, major waterbody crossings and crossings of federal and state-designated waterbodies are proposed to be crossed using the HDD crossing method to avoid in-stream disturbance and to minimize tree clearing at stream banks along these sensitive waters.

To minimize the potential for sedimentation in waterbodies and within public drinking water watershed areas caused by erosion from the adjacent landscape, trench spoil that is excavated from streambeds and banks will be placed at least 10 feet from the top of the waterbody bank or within ATWS located 50 feet from the water's edge, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. Erosion control devices, such as silt fences and other best management practices, will be placed at the downslope edges of the spoil piles to prevent sediment from entering the waterbody.

Once the pipeline is placed in the trench, the temporarily-stored spoil material will be placed back in the trench and the stream banks and streambed will be restored as close to their pre-construction contours as feasible. Stream banks and riparian areas will then be revegetated in accordance with the Project E&SCP and any applicable agency requirements. During construction, the open trench may, on occasion, accumulate water from either groundwater intrusion or precipitation. In such cases, the trench will be dewatered periodically to allow for proper and safe construction. Additionally, major waterbody crossings and crossings of federal and state-designated waterbodies are proposed to be crossed using the HDD crossing method to avoid in-stream disturbance and to minimize tree clearing at stream banks along these sensitive waters.

Any hazardous materials, chemicals, lubricating oils, solvents, or fuels used during construction will be stored in upland areas at least 100 feet from wetlands and waterbodies, and if spilled inadvertently during construction will be handled in accordance with NEXUS' SPCC Plan. Except where absolutely necessary, or required to otherwise minimize overall effects to the environment, there will be no refueling or lubricating of vehicles or equipment within 100 feet of a waterbody. Under no circumstances will refuse be discarded in waterbodies, trenches, or along the construction corridor. In accordance with the SPCC Plan, NEXUS will conduct routine inspections of tanks and storage areas to help reduce the potential for spills of hazardous materials (*see* Appendix 1B2 of Resource Report 1). NEXUS will consult with federal and state agencies regarding the potential to encounter contaminated sediments along the Project. In the event that contaminated sediment areas are confirmed, NEXUS will work with federal and state agencies to develop appropriate mitigation.

2.3.11.2 Hydrostatic Test Water

The piping associated with all Project facilities will be hydrostatically tested for structural integrity prior to being placed in service. Testing will be completed by capping installed pipe facilities with test manifolds, filling these segments with water, and maintaining a test pressure in excess of normal operating pressures for a specified period of time (typically 8 hours). Hydrostatic testing will be conducted on this Project in a manner that meets or exceeds the U.S. Department of Transportation "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards" (49 CFR Part 192).

NEXUS will employ measures designed to reduce the likelihood of entrainment or impingement of juvenile and adult fishes during hydrostatic test water withdrawal operations. NEXUS will attempt to avoid low-flow conditions to limit any potential effect on downstream aquatic resources. Hydrostatic test water intake structures will be floated so they are not laying on the streambed and screened with wire to prevent larger fish from entering the intake structure. The screen around the intake will be fabricated to provide an adequate surface area of fine meshed screen designed to reduce the approach velocity to prevent impingement or entrainment of small fish and/or macroinvertebrates. NEXUS will obtain necessary permits for water withdrawal as required to be implemented during surface water withdrawals to maintain adequate stream flow rates and to ensure adequate volumes are available downstream for withdrawals by existing users.

Upon completion of the hydrostatic test, environmental effects from the discharge of hydrostatic test water will be minimized by using the measures described in the Project E&SCP as previously described in Section 2.3.8.

2.4 Wetlands

Wetlands are defined as areas inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted to saturated and anaerobic soil conditions. Typical wetlands include swamps, marshes, wet meadows, and similar areas.

NEXUS identified, located, classified, and delineated wetland resources within the Project area through field surveys conducted during 2014 and 2015 field seasons. Surveys have been completed where landowner access was available and will continue as needed when survey access is granted. Jurisdictional wetlands crossed by the Project were field delineated in accordance with the USACE's Wetlands Delineation Manual (Environmental Laboratory, 1987), Regional Supplement to the Corps of Engineers Wetland Delineation Manual: North Central and Northeast Region (Version 2.0) (USACE, 2012); and Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest (Version 2.0) (USACE, 2010). Wetlands were also assessed and scored in accordance with OEPA's Ohio Rapid Assessment Method for Wetlands V.5.0.

Wetland field surveys were conducted during the 2014 and 2015 field seasons and approximately 90 percent of the Project route has been surveyed to date. Surveys are currently ongoing for the remaining 10 percent where survey access is pending (*see* Resource Report 1, Section 1.14). Field surveys have been completed at all aboveground facilities and are being conducted along the Project access roads, staging areas and ware yards. In areas where survey access was not available, NEXUS approximated wetland boundaries using publically available National Wetlands Inventory ("NWI") mapping, USGS topographic quadrangle maps, Project LIDAR topographic mapping with 2-foot contour interval, aerial photography and the Project GIS including Natural Resource Conservation Service medium intensity soil mapping. These approximated wetland boundaries are depicted on the Project alignment sheets using an orange color to easily distinguish them from field delineated wetlands.

2.4.1 Existing Conditions

Wetland types were assigned based on the NWI classifications as described in Cowardin et al., 1979. NWI maps for the Project area are provided in Appendix 1A, Volume II-B of Resource Report 1. The U. S. Fish and Wildlife Service wetland classification system described by Cowardin et al. was used to classify wetlands crossed or affected by the Project. The wetlands in the Project area were classified as Palustrine Forested ("PFO"), Palustrine Scrub-Shrub ("PSS"), Palustrine Emergent ("PEM"), Palustrine Unconsolidated Bottom ("PUB"), or a combination of these four wetland types. Palustrine systems include non-tidal wetlands that are dominated by trees, shrubs, persistent emergent, and emergent mosses or lichens and wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 percent. The palustrine system was developed to group vegetated wetlands, commonly referred to as marshes, swamps, bogs, and prairies. This system includes ponds and may be situated shoreward of lakes, river channels, estuaries, and river floodplains or in isolated catchments or on slopes (Cowardin et al., 1979). All of the wetlands identified along the Project route are classified as palustrine, or freshwater systems (*see* sections below).

A brief description of the wetland cover types and associated vegetative communities crossed by the Project are described below. Wetlands in the Project area are listed in Table 2.4-1 by identification numbers, MPs, and cover type(s). The table also provides calculated temporary and permanent wetland effects associated with the construction and operation of the Project, which are further discussed in Section 2.4.4. Table 2.4-2 provides a summary of wetland effects by wetland type for the Project.

Palustrine Forested Wetlands

Palustrine forested wetlands are characterized by woody vegetation that is 6 meters (approximately 20 feet) tall or taller and normally include an overstory of trees, an understory of young trees or shrubs, and an

herbaceous layer (Cowardin et al., 1979). Among the many types of forested wetlands in the U.S. are maple swamps, floodplain or bottomland hardwood swamps, forested bogs, cypress-gum (tupelo) swamps, bay swamps, wet flatwoods, and pine swamps and lowlands (Tiner, 1999). The majority of forested wetlands along the Project are classified as palustrine forested broad-leaved deciduous. The forested wetlands along the route were typically found along floodplains and poorly drained basins (depressions). Generally, these wetlands have seasonally flooded inorganic, poorly drained mineral soils. Plants often associated with forested wetland communities in Ohio and Michigan are: red maple (*Acer rubrum*), slippery elm (*Ulmus rubra*), American elm (*Ulmus americana*) green ash (*Fraxinus pennsylvanica*), black willow (*Salix nigra*), eastern cottonwood (*Populus deltoides*), pin oak (*Quercus palustris*), shagbark hickory (*Carya ovata*), silver maple (*Acer sacharinum*), and box elder (*Acer negundo*). Shrub species observed in PFO wetlands can consist of spice bush (*Lindera benzoin*), multiflora rose (*Rosa multiflora*) and redoiser dogwood (*Cornus sericea*). Depending on canopy cover, hydrology and soil characteristics, the following species can be observed as an herb layer in PFO wetlands: skunk cabbage (*Symplocarpus foetidus*), fowl mannagrass (*Glyceria striata*), stout wood reed (*Cinna arundinacea*), garlic mustard (Allaria petiolata), white avens (*Geum canadense*), sensitive fern (*Onoclea sensibilis*), poison ivy (*Toxidendron redicans*), jewel weed (*Impatiens capensis*) and various *Carex* species.

Palustrine Scrub-Shrub Wetlands

Scrub-shrub wetlands are dominated by woody vegetation less than 20 feet in height (Cowardin et al., 1979). The species found in PSS wetlands include true shrubs, saplings, young trees, and trees or shrubs that are small or stunted because of environmental conditions. Scrub-shrub wetlands may include habitats where the climax community consists of shrub species such as a buttonbush swamp, or where secondary-growth habitat composed of shrub or sapling species is present due to recent disturbance. In cases of disturbance or where individuals do not reach 20 feet due to other environmental conditions, sapling species composition for scrub-shrub wetlands may overlap with species described above for forested wetlands. These shrub dominated wetlands are commonly called bogs, pocosins, shrub-carrs, or simply shrub swamps (Tiner, 1999). Vegetation communities for PSS wetlands in Ohio and Michigan consisted of the following species: steeple bush (*Spiraea latifolia*), buttonbush (*Cephalanthus occidentalis*), redoiser dogwood, gray dogwood (*Cornus racemosa*), silky dogwood (*Cornus amomum*), green ash, red maple, black raspberry (*Rubus occidentalis*), red raspberry (*Rubus idaeus*), multiflora rose and various species of willow (*Salix* sp).

Palustrine Emergent Wetlands

PEM wetlands are non-tidal wetlands characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. PEM wetlands usually are dominated by perennial plants (Cowardin et al., 1979). These wetlands are commonly referred to by a host of terms, including marsh, wet meadow, sloped seeps, fen, and vernal pool. Marshes represent emergent wetlands that are flooded for all or most of the year. These wetlands are often associated with utility ROWs, currently active or fallow agricultural areas, abandoned or reclaimed mined areas, slopes, depressions, and the edges of open waterbodies. The PEM wetland cover type exists on its own as well as in conjunction with other wetland types, creating a more heterogeneous wetland system within the Project area.

In the Project area, emergent wetlands were the most common wetland designation, often occurring in conjunction with other wetland types (PSS, PFO) and also along open water or streams/rivers. Many emergent wetlands throughout the Project occur within active agricultural fields and therefore have altered hydrology, soils, and vegetation. These emergent wetlands that exist within active agricultural fields are classified as AG-PEM wetlands. The characteristics of an AG-PEM wetland consist of the following; presence of soils that are disturbed on a regular basis due to plowing and field maintenance, evidence that the hydrology that has been altered by tile drains and ditches, and there is evidence of stressed or failed row crops.

Emergent wetlands were also located within existing utility corridors throughout the Project area. This specific wetland type has a variety of species that occupy it, and the following list of species are the most common species observed in PEM wetlands throughout Ohio and Michigan: jewel weed, deer tongue grass (*Dichanthelium clandestinum*), tearthumb (*Polygonum sp.*), Joe pye weed (*Eupatorium purpureum*), reed canary grass (*Phalaris arundinacae*), rice cut grass (*Leersia oryzoides*), white cutgrass (*leersia oryzoides*), common rush (*Juncus effusus*), fowl mannagrass, woolgrass (*Scirpus cyperinus*), Canada goldenrod (*Solidago canadensis*), gray goldenrod (*S.nemoralis*),sensitive fern, narrowleaf cattail (*Typha angustifolia*), bluejoint grass (*Calamagrostis canadensis*), gray's sedge (*Carex grayii*), fox sedge (*Carex vulpinoidea*), poison ivy (*Toxidendron radicans*), Frank's sedge (*Carex frankii*), green bulrush (*Scirpus atrovirens*) and common reed (*Phragmites australis*). Common species observed in AG-PEM wetlands throughout Ohio and Michigan include: barnyard grass (*Echinochloa spp*), yellow foxtail grass (*Setaria pumila*), fall panicgrass (*Panicum dichotomiflorum*), cattails, reed canary grass, as well as stressed corn (*Zea mays*) and soybean (*Glycine max*) row crops.

Palustrine Unconsolidated Bottom Wetland Associations

The palustrine unconsolidated bottom cover type includes wetlands with at least 25 percent cover of particles smaller than stones, and a vegetative cover less than 30 percent (Cowardin et al., 1979). A small number of PUBs were identified along the route and include small, shallow depression areas which are seasonally to permanently flooded. These PUB areas are generally anthropogenic in origin and are the result of mining activity, railroad or road construction excavations, and agricultural activities. PUB areas are dominated by mineral soils with a small percentage of the soil surface covered by vegetation. Generally the edges of the PUB components are vegetated with either emergent or shrub species.

Forested/Scrub-Shrub/Emergent Wetlands

Some wetlands are best characterized as having co-dominance between vegetation types, such as a mixed forest and scrub-shrub communities. On NWI maps, these can appear as PFO/PSS, PFO/PEM, and PSS/PEM and may occur as adjacent communities within a single wetland, or a single co-dominant community. Communities with mixed dominance are composed of vegetation similar to that described above for separate forested, emergent, and scrub-shrub wetlands.

2.4.2 Wetlands Crossed by the Project Facilities

Wetlands identified in the vicinity of proposed NEXUS Project facilities are listed in Table 2.4-1. As described in Section 2.4.1, currently 90 percent of the Project was surveyed in the field for the presence of wetlands; areas where surveys have not been conducted were evaluated using best available data sources and are represented as approximated wetlands on Project alignment sheets in impact summary tables.

NEXUS has designed the Project route to avoid and minimize effects on wetlands to the extent practicable and there are no permanent wetland impacts associated with construction or operation of the proposed facilities. In additional, NEXUS is proposing to use the HDD crossing method to avoid approximately 4.57 acres of temporary wetland impacts and to avoid 2.53 acres of forested wetland conversion.

NEXUS proposes to implement its E&SCP and SPCC Plan to minimize effects on wetlands, and proposes mitigation where temporary effects are unavoidable, as described in Section 2.4.4. A summary of temporary effects on wetlands is included in Table 2.4-2.

Pipeline Facilities

The wetland crossings along the pipeline will result in a total of 129.32 acres of temporary impact to wetlands, which includes 75.90 acres of temporary impact to PEM, PSS, and PUB wetland types and 53.42 acres of PFO wetland types. Since hydrologic conditions during operation of the pipeline will be returned to pre-construction conditions, there will be no permanent loss of wetlands. There will, however, be a

permanent conversion of 32.57 acres of forested wetlands into emergent or scrub-shrub wetlands as a result of vegetation maintenance of the permanent maintained ROW.

Temporary and Permanent Access Roads

The NEXUS Project will use existing roads or existing open land as TARs and PARs to the extent practicable, and will avoid temporary wetland crossings to the extent practicable. A total of 0.10 acres of wetlands are potentially affected by Project access roads. See Table 2.3-2 for a complete list of wetland areas crossed by the Project access roads. Proposed access roads are shown on USGS Quadrangle mapping and Project alignment sheets located in Appendix 1A – Volume II-B of Resource Report 1.

Aboveground Facilities

Wetland field surveys were completed for all proposed aboveground facilities. Wetland resources were identified at three of the four proposed compressor station sites (Hanoverton, Wadsworth, and Waterville sites), however, these stations were designed to avoid temporary and permanent wetland impacts. The Clyde Compressor Station has no wetlands on site. The proposed Mainline Valve sites have been designed to avoid permanent wetland impacts. Four of the five M&R stations were designed for avoid temporary and permanent wetland impacts. M&R Station MR04 will require approximately 0.17 acres of temporary wetland impacts to pre-disturbed PEM wetlands. These wetlands will be restored to pre-construction conditions following construction.

Contractor Ware Yards

The NEXUS Project has identified potential pipe and contractor ware yards along the Project. The majority of the proposed ware yards were surveyed during 2014 and 2015 field seasons where access was granted. NEXUS has selected locations that avoid wetland impacts for the use of pipe and contractor yards and no wetlands are located at the ware yards that have been surveyed to date. Proposed pipe yards and contractor ware yards are shown on USGS Quadrangle mapping located in Appendix 1A.

2.4.3 Wetland Construction Methods

NEXUS will avoid and minimize potential adverse impacts on wetlands to the extent practicable using construction procedures specified within its Project E&SCP.

For wetlands that have firm substrates, are unsaturated, and not frozen at the time of construction, the top 12 inches of wetland soil over the trenchline will be segregated and stockpiled separate from subsoil. Wetland vegetation will be cut to ground level. Stump removal and grading will be limited to the area over the trench except where safety conditions dictate additional site preparation on the working side of the ROW. Trench spoils will be temporarily piled in a ridge along the pipeline trench. Gaps in the spoil pile(s) will be left at appropriate intervals to provide for natural circulation or drainage of water.

Temporary trench plugs will be installed in the trench at the edges of the wetland if the possibility exists for sediment-laden water to flow from uplands down the trench and into the wetland. Silt fence and/or straw bales will be installed at the edges of the construction work area if the possibility exists for spoil to flow into undisturbed areas of the wetland. Original topographic conditions and contours will be restored as close to pre-construction conditions as possible after completion of construction. See Section 1.7.1.3 of Resource Report 1 for more details on proposed Wetland Construction Methods. If dry conditions exist pipe fabrication will occur in wetlands.

Construction methods will minimize the extent and time that construction equipment operates in wetland areas. The pipeline trench will be excavated across the wetland by equipment supported on timber mats to minimize the disturbance to wetland soils. If wetlands are saturated at the time of construction the pipe strings will be fabricated on one bank and either pulled across the excavated trench in the wetland, floated across the wetland, or carried into place and submerged into the trench. This method will minimize the amount of equipment and travel in wetland areas.

As described in the FERC Procedures Section VI.A.1, NEXUS is proposing standard upland construction methods for crossing wetlands located in actively cultivated croplands. Wetlands located in active agricultural land are identified as AG-PEM in Table 2.4-1 and were described in Section 2.4.1. NEXUS is in communications with the USACE, the OEPA, and the MDEQ and has requested concurrence from these agencies for use of the construction methods described in the FERC Procedures for AG-PEM wetlands. NEXUS will perform these crossing based on regulatory permit conditions issued by applicable regulatory agencies.

A review of available geological information indicates that blasting may be required in some wetland areas where shallow rock is present and has too high shear strength to be removed from the trench effectively by other methods. However, if required at all, the total combined length is anticipated to be less than 1 mile.

If blasting is required in these segments, it will be designed and controlled to focus the energy of the blasting to the rock within the trench and to limit ground accelerations outside the trench. This narrow and controlled blasting design will minimize fracturing of the rock outside of the trench. However, even if new fractures do develop in the rock outside of the trench, the ground accelerations outside of the targeted trench area are not expected to be high enough to produce ground displacement along these fractures that would be high enough to open these fractures and significantly increase the permeability of the rock outside of the trench. Therefore, where blasting is required for trenching, no greater impacts are expected in wetland than in non-wetland areas.

2.4.3.1 Construction Workspace Greater than 75 Feet within Wetlands

NEXUS has designed each wetland crossing using a 75-foot nominal construction workspace width. See Section 2.4.3.2 for a summary of ATWS located within 50 feet from a wetland boundary along the Project facilities.

2.4.3.2 Additional Temporary Workspace

In general, ATWS is typically required on both sides of a wetland crossing to store materials and trench spoil. These work areas will be located at least 50 feet away from the wetland edge, topographic and other site specific conditions permitting and except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. Where conditions do not permit a 50-foot setback as required, NEXUS is requesting a variance from the FERC's Procedures unless the ATWS is located in an adjacent upland consisting of cultivated or rotated cropland or other disturbed land. Table 2.3-12 identifies the locations where the ATWS wetland setbacks are less than 50 feet from the wetland boundary and site-specific justifications for that workspace.

2.4.4 Wetland Effects and Mitigation

2.4.4.1 Construction Effects

Construction of proposed NEXUS facilities and access roads will result in a total of 129.42 acres of temporary wetland impacts, which includes 75.94 acres of temporary effects on PEM, PSS and PUB wetlands and 53.42 acres of temporary effects on PFO wetlands. Approximately 32.57 acres of forested wetlands will be permanently converted from forested wetlands to emergent and/or scrub-shrub wetlands as a result of vegetation maintenance within the permanent ROW. The remaining temporarily impacted forested wetlands will be allowed to revert to forest following construction and restoration of the ROW. As described above, the portion of the Project area where access is not available, the wetland data is defined by using photo interpretation methods and use of existing data sources. It should be noted that NEXUS used a conservative approach for defining wetland areas where access is not available. NEXUS expects a slight reduction in the total number of wetlands and wetland impact area once wetland delineations have been completed along the entire Project prior to construction activities.

There is no proposed permanent wetland loss associated with the NEXUS Project. The Project aboveground facilities have been sited to avoid impacts to wetland areas, and only M&R Station MR04 will require 0.17 acres of non-forested temporary wetland impact. Table 2.4-1 lists each wetland crossed by the NEXUS Project pipeline facilities. The total Project temporary wetland impacts are summarized in Table 2.4-2.

2.4.4.2 Minimization of Effects

NEXUS will minimize potential adverse effects on wetlands by complying with the applicable permit conditions issued by applicable federal and state regulatory agencies and through implementation of the wetland construction procedures described in the Project E&SCP. In addition, NEXUS is proposing to use the HDD crossing method to avoid approximately 4.57 acres of temporary wetland impacts and to avoid 2.53 acres of forested wetland conversion along the pipeline facilities. These wetland construction procedures are summarized below:

Expediting Construction In and Around Wetlands

Expediting construction in and around wetlands will reduce the amount of time wetland soils are exposed, minimizing the opportunity for soil loss and reducing the amount of time during which wetland functions and values are affected.

Minimizing Vegetation Clearing within Wetlands

NEXUS has reduced workspace in and around wetlands during construction in accordance with the Commission's requirements. With the exception of areas identified in Table 2.4-3, workspace within wetlands will be reduced to a width of 75 feet. Table 2.4-3 provides a list by milepost of any areas where greater than 75 feet of construction workspace will be needed in wetlands and provides site-specific justification for these proposed variances from the FERC Procedures. In forested wetlands, NEXUS will minimize tree clearing to the extent practicable while maintaining safe construction conditions.

During operation of the Project, wetlands within the permanent ROW will be maintained in accordance with the FERC Procedures.

Use of Equipment Mats

Equipment mats will be used to cross most wetlands to minimize the potential for rutting. Soil decompaction would be performed if necessary following removal of mats.

Segregation of Topsoil

Effects on wetlands will be minimized by segregating up to the top 12 inches of top soil in non-saturated wetland areas disturbed by trenching activities. The topsoil will be restored to its original location immediately after backfilling to preserve the existing seedbank and promote revegetation of the disturbed wetlands.

Installation of Erosion Controls

Erosion controls, including but not limited to silt fence and/or staked hay bales, will be installed to protect wetlands from sediment from disturbed soils in adjacent uplands during construction. The Project E&SCP describes the erosion and sediment controls that will be used to minimize wetland impacts.

Stabilization and Restoration of Wetlands

Restoring wetlands to their original configurations and contours, post-construction, will assist in maintaining preconstruction hydrology, minimizing impacts on wetlands. Prompt stabilization of disturbed upland areas adjacent to wetlands will minimize sediment transport into wetlands, protecting wetlands from filling with sediment and maintaining functions and values long-term. Wetlands will be seeded with annual rye to provide soil stabilization while allowing the natural seedbank to revegetate the wetland area. After construction, disturbed wetlands and adjacent uplands will be monitored to ensure long-term stabilization.

Regular inspections and maintenance of erosion control measures will expedite successful restoration of impacted wetlands.

Invasive Species Monitoring and Control

NEXUS will conduct post-construction maintenance and monitoring of the ROW in affected wetlands to assess the success of restoration and revegetation. Monitoring efforts will include documenting occurrences of exotic invasive species in wetlands compared to adjacent off-ROW wetland areas. Monitoring will continue for a minimum of 3 years after construction or until revegetation is successful. If after 3 years of monitoring the densities of invasive species are documented as being below or consistent with off ROW densities, then NEXUS will cease monitoring activities upon approval from the applicable regulatory agencies (i.e., USACE, MDEQ, and OEPA). The use of herbicides or pesticides for targeted invasive species control may be implemented if necessary and only in accordance with approval from the applicable regulatory agency. Without such direct approval, herbicides and pesticides will not be used within 100 feet of wetlands or waterbodies. Refer to Resource Report 3 and the Invasive Species Management Plan located in Appendix 1B7 of Resource Report 1 for more information regarding invasive species.

2.4.4.3 Mitigation of Effects

To minimize effects on wetlands, NEXUS will implement the construction procedures described in the Project E&SCP. In wetlands, vegetation maintenance over the full width of the permanent ROW is prohibited pursuant to the FERC Procedures. During operation of the Project, to facilitate periodic pipeline corrosion/leak surveys, 10 feet of the permanent ROW, centered over the pipeline, will be maintained within wetlands at an early successional stage in accordance with Commission requirements. In forested wetlands, NEXUS will minimize tree clearing to the maximum extent practicable while maintaining safe construction conditions. During operations, tree clearing within wetlands will be limited to selectively clearing trees within 15 feet of the pipeline with roots that could compromise the integrity of the pipeline coating. Trees and shrubs that become reestablished beyond 15 feet on either side of the pipeline will not be disturbed.

Within wetlands, the nominal construction corridor will be reduced to a width of 75 feet or less. Access within the ROW across wetlands will only be permitted where the soils are non-saturated and able to support construction equipment at the time of crossing or with the use of equipment mats to avoid rutting of the wetland soil. Effects on wetlands will be minimized by segregating the top 12 inches of soil from the area disturbed by trenching activities, except in areas where standing water is present or soils are saturated. The topsoil will be restored to its original location immediately after backfilling is complete, to preserve the existing seedbank and promote revegetation of the affected area. Seed mixes spread on the restored topsoil for temporary stabilization will include annual rye grass at a rate of 40 pounds per acre (unless standing water is present) or appropriate mixes recommended by the local conservation districts. The use of fertilizers will not be permitted. Erosion controls including silt fence and/or staked best management practices will also be put in place to protect wetlands from sediment disturbed in adjacent uplands during construction. Post-construction, the disturbed area will be monitored to ensure long-term stabilization of the site. The Project E&SCP provides additional details on construction practices within wetlands.

NEXUS will protect and minimize potential adverse effects on wetlands by expediting construction in and around wetlands, by restoring wetlands to their original configurations and contours, by segregating topsoil during excavation where applicable, by permanently stabilizing upland areas near wetlands as soon as possible after backfilling, by inspecting the ROW periodically during and after construction and by repairing any erosion control or restoration features until permanent revegetation is successful. NEXUS will comply with the applicable permit conditions issued by federal, state, and local permitting agencies.

Between the fall of 2014 and the fall of 2015, NEXUS consulted with the MDEQ, the OEPA, and the USACE Districts crossed by the Project specifically to discuss the federal and state regulatory permitting process and framework relative to wetland protection and mitigation. The agencies indicated mitigation

ratios vary depending on the type of impacts associated with construction of the Project. There is no permanent loss of wetland that would result from construction for the NEXUS Project. Following construction, temporarily impacted wetlands will be restored and the conversion of forested to emergent or scrub/shrub wetland habitats will require further mitigation as described below.

Based on discussions with the OEPA and the USACE, restoration will be required on a 1 to 1 ratio for temporary wetland impacts. As part of the USACE permitting process, additional wetland mitigation will be required for the conversion of forested to emergent or scrub/shrub wetland habitats. In Ohio, for any mitigation required by the USACE, NEXUS proposes to use USACE approved in-lieu-fee programs to address potential wetland mitigation requirements.

As part of the MDEQ/USACE Joint Permit Application process, MDEQ has requested that a conceptual mitigation plan be prepared as part of the application process and that the plan would be developed through consultation with the MDEQ during their review process. Based on discussions with the MDEQ, restoration will be required on a 1 to 1 ratio for temporary wetland impacts. The mitigation plan will include proposed mitigation based on mitigation ratios for forested wetland conversion provided by the MDEQ.

NEXUS will continue to consult with the applicable federal and state regulatory agencies for guidance during development of the proposed mitigation measures and plans. As additional mitigation measures are developed and submitted as part of the federal and state permit applications, supplemental information will be provided to the Commission.

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TABLES

TABLE 2.2-1

Aquifers Crossed by the NEXUS Project

State and Facility	From Milepost	To Milepost	Crossing Length (mi) a/	Thickness b/	Yield c/	Average Water Depth d/	Aquifer Name	Aquifer Type
Ohio								
TGP Interconnecting Pipeline	0.00	0.89	0.886381	> 100	0 - 5	> 95	Pennsylvanian	Sandstone
Mainline Pipeline	0.00	4.81	4.811629	~ 100	0 - 5	> 95	Pennsylvanian	Sandstone
	4.81	5.02	0.212321	25 - 100	< 5	< 95	Sandy Creek Buried Valley	Sand and Gravel
	5.02	9.83	4.80238	~ 100	0 - 5	95	Pennsylvanian	Sandstone
	9.83	10.98	1.149943	> 100	5 - 25	< 95	Mahoning Buried Valley	Sand and Gravel
	10.98	11.31	0.336143	> 100	5 - 25	< 95	Sandy Creek Buried Valley	Sand and Gravel
	11.31	11.59	0.279411	> 100	5 - 25	< 95	Sandy Creek Buried Valley	Sand and Gravel
	11.59	15.71	4.116403	~ 100	0 - 25	95	Pennsylvanian	Sandstone
	15.71	17.35	1.637733	> 100	5 - 25	< 95	Mahoning Buried Valley	Sand and Gravel
	17.35	18.02	0.669631	> 100	5 - 25	95	Pennsylvanian	Sandstone
	18.02	21.20	3.18462	> 100	5 - 25	< 95	Mahoning Buried Valley	Sand and Gravel
	21.20	26.65	5.445428	~ 100	5 - 25	95	Pennsylvanian	Sandstone
	26.65	26.96	0.309831	> 100	25 - 100	< 95	Sandy Creek Buried Valley	Sand and Gravel
	26.96	27.42	0.469425	> 100	25 - 100	95	Pennsylvanian	Sandstone
	27.42	27.95	0.5247	> 100	25 - 100	< 95	Kent-Hartville Buried Valley	Sand and Gravel
	27.95	28.88	0.935169	~ 100	5 - 100	95	Pennsylvanian	Sandstone
	28.88	29.91	1.020952	> 100	25 - 100	< 95	Kent-Hartville Buried Valley	Sand and Gravel
	29.91	30.71	0.80887	~ 100	5 - 100	95	Pennsylvanian	Sandstone
	30.71	30.88	0.161143	25 - 100	5 - 25	< 95	Kent-Hartville Buried Valley	Sand and Gravel
	30.88	31.25	0.372477	> 100	25 - 100	95	Pennsylvanian	Sandstone
	31.25	33.52	2.270524	25 - > 100	25 - 100	< 95	Kent-Hartville Buried Valley and Outwash/Kame	Sand and Gravel
	33.52	35.35	1.829667	25 - > 100	25 - 100	< 95	Portage Lakes Buried Valley and Outwash/Kame	Sand and Gravel
	35.35	36.20	0.851247	~ 100	5 - 100	95	Pennsylvanian	Sandstone

TABLE 2.2-1

Aquifers Crossed by the NEXUS Project

State and Facility	From Milepost	To Milepost	Crossing Length (mi) a/	Thickness b/	Yield c/	Average Water Depth d/	Aquifer Name	Aquifer Type
	36.20	42.05	5.848012	25 - > 100	5 - > 100	< 95	Portage Lakes Buried Valley and Outwash/Kame	Sand and Gravel
	42.05	42.41	0.357412	> 100	25 - 100	95	Pennsylvanian	Sandstone
	42.41	42.56	0.158607	> 100	25 - 100	< 95	Tuscarawas Buried Valley	Sand and Gravel
	42.56	43.93	1.365505	> 100	25 - 100	95	Pennsylvanian	Sandstone
	43.93	44.29	0.365497	> 100	25 - 100	< 95	Tuscarawas Buried Valley	Sand and Gravel
	44.29	45.25	0.957142	~ 100	5 - 100	95	Pennsylvanian	Sandstone
	45.25	45.54	0.291956	> 100	25 - 100	< 95	Tuscarawas Buried Valley	Sand and Gravel
	45.54	47.91	2.363095	~ 100	5 - 100	95	Pennsylvanian	Sandstone
	47.91	49.19	1.285936	> 100	5 - 100	< 95	Tuscarawas Buried Valley	Sand and Gravel
	49.19	51.24	2.050259	~ 100	5 - 100	95	Pennsylvanian	Sandstone
	51.24	52.55	1.304667	> 100	5 - 25	< 95	Chippewa Buried Valley	Sand and Gravel
	52.55	54.88	2.33259	~ 100	5 - 100	95	Pennsylvanian	Sandstone
	54.88	55.63	0.754389	~ 100	5 - 100	95	Mississippian	Sandstone
	55.63	55.92	0.287347	< 100	5 - 25	95	Pennsylvanian	Sandstone
	55.92	56.01	0.087047	> 100	25 - 100	95	Mississippian	Sandstone
	56.01	56.49	0.476581	< 100	5 - 25	95	Pennsylvanian	Sandstone
	56.49	57.08	0.598109	> 100	25 - 100	95	Mississippian	Sandstone
	57.08	58.63	1.550054	> 100	100 - 500	< 95	Chippewa Buried Valley	Sand and Gravel
	58.63	59.40	0.763321	> 100	25 - 100	95	Mississippian	Sandstone
	59.40	59.76	0.364739	< 100	5 - 25	95	Pennsylvanian	Sandstone
	59.76	60.04	0.281998	> 100	25 - 100	95	Mississippian	Sandstone
	60.04	60.47	0.422425	< 100	5 - 25	95	Pennsylvanian	Sandstone
	60.47	60.71	0.239598	> 100	25 - 100	95	Mississippian	Sandstone
	60.71	61.00	0.296873	> 100	5 - 25	< 95	Chippewa Buried Valley	Sand and Gravel
	61.00	61.76	0.755944	> 100	25 - 100	95	Mississippian	Sandstone

TABLE 2.2-1

Aquifers Crossed by the NEXUS Project

State and Facility	From Milepost	To Milepost	Crossing Length (mi) a/	Thickness b/	Yield c/	Average Water Depth d/	Aquifer Name	Aquifer Type
	61.76	64.56	2.804732	< 100	5 - 25	95	Pennsylvanian	Sandstone
	64.56	64.83	0.262121	> 100	25 - 100	95	Mississippian	Sandstone
	64.83	65.04	0.219307	> 100	5 - 25	< 95	Chippewa Buried Valley	Sand and Gravel
	65.04	65.20	0.155664	> 100	25 - 100	95	Mississippian	Sandstone
	65.20	65.63	0.430424	> 100	5 - 25	< 95	Chippewa Buried Valley	Sand and Gravel
	65.63	67.23	1.597088	> 100	25 - 100	95	Mississippian	Sandstone
	67.23	68.11	0.886827	> 100	5 - 25	< 95	Chippewa Buried Valley	Sand and Gravel
	68.11	70.50	2.380631	> 100	25 - 100	95	Mississippian	Sandstone
	70.50	71.73	1.233077	> 100	25 - 100	< 95	Chippewa Buried Valley	Sand and Gravel
	71.73	92.27	20.545412	~ 100	0 - 100	95	Mississippian	Sandstone
	92.27	92.72	0.443024	25 - > 100	5 - 25	< 95	Black River Buried Valley	Sand and Gravel
	92.72	100.25	7.533152	~ 100	0 - 25	95	Mississippian	Sandstone
	100.25	100.71	0.461517	> 100	0 - 5	95	Devonian	Carbonate
	100.71	109.78	9.073141	~ 100	0 - 25	95	Mississippian	Sandstone
	109.78	109.99	0.202918	25 - 100	5 - 25	< 95	Galion Thin Upland	Sand and Gravel
	109.99	112.11	2.127165	~ 100	0 - 5	95	Mississippian	Sandstone
	112.11	114.16	2.049827	> 100	0 - 5	95	Devonian	Carbonate
	114.16	116.71	2.545609	25 - > 100	5 - 100	< 95	Norwalk Buried Valley	Sand and Gravel
	116.71	124.25	7.541101	> 100	0 - 5	95	Devonian	Carbonate
	124.25	126.50	2.248142	~ 100	0 - > 100	95	Devonian	Carbonate
	126.50	141.52	15.021854	~ 100	0 - > 100	95	Silurian	Carbonate
	141.52	143.01	1.484521	> 100	5 - 25	< 95	Green Creek Buried Valley	Sand and Gravel
	143.01	186.62	43.618926	~100	0 - > 100	95	Silurian	Carbonate
	186.62	196.29	9.666138	25 - 100	5 - 100	< 95	Oak Openings Beach Ridge	Sand and Gravel
	196.29	203.12	6.832302	~ 100	0 - 25	< 95	Devonian	Carbonate

TABLE 2.2-1

Aquifers Crossed by the NEXUS Project

State and Facility	From Milepost	To Milepost	Crossing Length (mi) a/	Thickness b/	Yield c/	Average Water Depth d/	Aquifer Name	Aquifer Type
	203.12	208.32	5.195145	< 100	0 - 5	95	Mississippian	Sandstone
Michigan								
	208.32	231.648943	23.33	N/A	N/A	N/A	Confining Unit	N/A
	231.648943	240.674725	9.03	< 25	< 5	95	Silurian-Devonian	Carbonate
	240.674725	243.687869	3.01	N/A	N/A	N/A	Confining Unit	N/A
	243.687869	251.376125	7.69	< 25	< 5	95	Silurian-Devonian	Carbonate
	251.376125	255.1	3.72	N/A	N/A	N/A	Confining Unit	N/A

a/ Minor discrepancies in totals are due to rounding.
b/ Overlapping aquifer type thicknesses were averaged and indicated as " ~ ".
c/ Overlapping aquifer type yields were grouped into broader range (i.e. 0-100).
d/ Due to varying conditions, aquifer water depths were approximated.

TABLE 2.2-2

Wells and Springs Located within 150 Feet and Wellhead Protection Areas Crossed by the NEXUS Project

State, Facility, and MP	County	Approximate Distance from Construction Workspace (feet) a/	Workspace Crossing Wellhead Protected Area (Yes/No)	Approximate Workspace Crossing Length on Wellhead (feet)	Type	Active or Inactive
Ohio						
Mainline						
3.5	Columbiana	93	No	N/A	Private Spring	Active
11.4	Columbiana	17	No	N/A	Private Well	Active
36.7	Summit	Unknown location	Yes	72	Private Well	Inactive
36.8	Summit	0	No	N/A	Private Well	Active
37.2	Summit	Unknown location	Yes	1,076	Public Well	Inactive
37.4	Summit	Unknown location	Yes	1,450	Public Well	Inactive
48.0	Summit	145	No	N/A	Private Well	Active
52.9	Wayne	0	No	N/A	Private Well	Inactive
53.1	Wayne	1	No	N/A	Private Spring	Active
57.5	Wayne/Medina	>150	Yes	8,634	Public Wells	Active
68.7	Medina	>150	Yes	3,368	Public Wells	Active
84.4	Lorain	38	No	N/A	Private Well	Inactive
84.4	Lorain	34	No	N/A	Private Well	Inactive
84.4	Lorain	49	No	N/A	Private Well	Inactive
92.6	Lorain	35	No	N/A	Private Well	Inactive
99.3	Lorain	0	No	N/A	Private Well	Inactive
99.3	Lorain	0	No	N/A	Private Spring	Unknown
116.7	Erie	Unknown location	Yes	2,978	Public Well	Inactive
125.5	Erie	>150	Yes	41,904	Public Wells	Inactive and Active
125.9	Erie	92	No	N/A	Private Well	Inactive
134.1	Sandusky	0	No	N/A	Private Well	Active
145.9	Sandusky	75 and 95	Yes	2,971	Public Wells	Active
146.1	Sandusky	Unknown location	Yes	562	Private Well	Inactive
153.4	Sandusky	>150	Yes	9,649	Public Wells	Active
157	Sandusky	>150	Yes	29,569	Public Well	Active
162	Sandusky	>150	Yes	17,161	Public Wells	Active
164.8	Wood	>150	Yes	1,538	Public Well	Active
173.2	Wood	>150	Yes	2,596	Private Well	Active
Michigan						
Mainline						
227.6	Lenawee	0	No	N/A	Private Well	Unknown
228.1	Lenawee	0	No	N/A	Private Well	Unknown
231.3	Monroe	31	No	N/A	Private Well	Unknown

TABLE 2.2-2

Wells and Springs Located within 150 Feet and Wellhead Protection Areas Crossed by the NEXUS Project

State, Facility, and MP	County	Approximate Distance from Construction Workspace (feet) a/	Workspace Crossing Wellhead Protected Area (Yes/No)	Approximate Workspace Crossing Length on Wellhead (feet)	Type	Active or Inactive
232.5	Monroe	38	No	N/A	Private Well	Unknown
233.1	Monroe	21	No	N/A	Private Well	Unknown
234.6	Monroe	3	No	N/A	Private Well	Unknown
236.2	Monroe	30	No	N/A	Private Well	Unknown
237	Monroe	>150	Yes	13,200	Public Well	Unknown
237.6	Washtenaw	30	No	N/A	Private Well	Unknown
239.3	Washtenaw	42	No	N/A	Private Well	Unknown
245.2	Washtenaw	0	No	N/A	Private Well	Unknown
245.2	Washtenaw	0	No	N/A	Private Well	Unknown
245.2	Washtenaw	0	No	N/A	Private Well	Unknown
247.4	Washtenaw	72	No	N/A	Private Well	Active
250.5	Washtenaw	0, 0, and 0	No	N/A	Public Wells	Unknown
Michigan						
Aboveground Facilities						
MP 255.1 - MR04 (DTE/Willow Run)	Washtenaw	0	No	N/A	Private Well	Unknown
Contractor Wareyards						
MP 228.6 - Wareyard 4-1	Lenawee	0	No	N/A	Private Well	Unknown
MP 228.7 - Wareyard 4-1	Monroe	26.8	No	N/A	Private Well	Unknown
MP 228.8 - Wareyard 4-1	Monroe	25.2	No	N/A	Private Well	Unknown
Access Roads						
TAR 69.1	Medina	1.5 and 25	Yes	1,300	Public Wells	Unknown
TAR 237.2	Washtenaw	32.5 and 44.3	No	N/A	Private Wells	Unknown

a/ Distance measured from edge of NEXUS Project workspace to water well or spring. Based on available GIS information, some wellhead protection areas do not have well location information and are indicated as *unknown location*.

TABLE 2.3-1

Watersheds Crossed by the NEXUS Project

State, Facility	From MP	To MP	Crossing Length (mi)	HUC 12 Identifier	HUC12 Name	HUC 8 Identifier	HUC08 Name
Ohio							
TGP Interconnect Mainline Pipeline	0.00	0.89	0.89	050301010503	Brush Creek	05030101	Upper Ohio
	0.00	0.33	0.33	050301010503	Brush Creek	05030101	Upper Ohio
	0.33	4.35	4.02	050400010406	Headwaters Sandy Creek	05040001	Tuscarawas
	4.35	6.99	2.65	050400010401	Conser Run	05040001	Tuscarawas
	6.99	7.13	0.13	050301030101	Beaver Run-Mahoning River	05030103	Mahoning
	7.13	7.64	0.51	050400010401	Conser Run	05040001	Tuscarawas
	7.64	8.63	0.99	050301030101	Beaver Run-Mahoning River	05030103	Mahoning
	8.63	8.69	0.07	050400010402	Middle Branch Sandy Creek	05040001	Tuscarawas
	8.69	8.83	0.13	050301030101	Beaver Run-Mahoning River	05030103	Mahoning
	8.83	14.26	5.43	050400010402	Middle Branch Sandy Creek	05040001	Tuscarawas
	14.26	14.32	0.06	050301030102	Beech Creek	05030103	Mahoning
	14.32	14.34	0.02	050400010402	Middle Branch Sandy Creek	05040001	Tuscarawas
	14.34	14.79	0.45	050301030102	Beech Creek	05030103	Mahoning
	14.79	14.83	0.04	050301030103	Fish Creek-Mahoning River	05030103	Mahoning
	14.83	21.22	6.39	050301030102	Beech Creek	05030103	Mahoning
	21.22	26.78	5.56	050400010501	Swartz Ditch-Middle Branch Nimishillen Creek	05040001	Tuscarawas
	26.78	26.95	0.17	050400010504	City of Canton-Middle Branch Nimishillen Creek	05040001	Tuscarawas
	26.95	28.44	1.49	050400010501	Swartz Ditch-Middle Branch Nimishillen Creek	05040001	Tuscarawas
	28.44	33.27	4.84	050400010503	West Branch Nimishillen Creek	05040001	Tuscarawas
	33.27	35.46	2.19	050400010101	Headwaters Tuscarawas River	05040001	Tuscarawas
	35.46	35.66	0.20	050400010503	West Branch Nimishillen Creek	05040001	Tuscarawas
	35.66	36.40	0.74	050400010101	Headwaters Tuscarawas River	05040001	Tuscarawas
	36.40	36.44	0.04	050400010302	Nimisila Reservoir-Nimisila Creek	05040001	Tuscarawas
	36.44	36.51	0.07	050400010101	Headwaters Tuscarawas River	05040001	Tuscarawas
	36.51	41.36	4.85	050400010302	Nimisila Reservoir-Nimisila Creek	05040001	Tuscarawas
	41.36	45.83	4.47	050400010303	Lake Lucern-Nimisila Creek	05040001	Tuscarawas
	45.83	50.95	5.12	050400010301	Pancake Creek-Tuscarawas River	05040001	Tuscarawas
	50.95	56.31	5.36	050400010207	Silver Creek-Chippewa Creek	05040001	Tuscarawas
	56.31	60.45	4.14	050400010204	River Styx	05040001	Tuscarawas
	60.45	63.03	2.58	050400010205	Tommy Run-Chippewa Creek	05040001	Tuscarawas
	63.03	63.84	0.81	050400010202	Hubbard Creek-Chippewa Creek	05040001	Tuscarawas
	63.84	64.14	0.30	050400010205	Tommy Run-Chippewa Creek	05040001	Tuscarawas
	64.14	68.27	4.13	050400010202	Hubbard Creek-Chippewa Creek	05040001	Tuscarawas
	68.27	72.66	4.39	050400010201	Headwaters Chippewa Creek	05040001	Tuscarawas
	72.66	77.92	5.26	041100010104	Mallet Creek	04110001	Black-Rocky
	77.92	79.82	1.89	041100010106	Cossett Creek-West Branch Rocky River	04110001	Black-Rocky

TABLE 2.3-1

Watersheds Crossed by the NEXUS Project

State, Facility	From MP	To MP	Crossing Length (mi)	HUC 12 Identifier	HUC12 Name	HUC 8 Identifier	HUC08 Name
	79.82	84.70	4.88	041100010402	Salt Creek-East Branch Black River	04110001	Black-Rocky
	84.70	87.09	2.38	041100010404	Jackson Ditch-East Branch Black River	04110001	Black-Rocky
	87.09	91.55	4.47	041100010506	Lower West Branch Black River	04110001	Black-Rocky
	91.55	91.91	0.35	041100010503	Wellington Creek	04110001	Black-Rocky
	91.91	94.78	2.87	041100010504	Middle West Branch Black River	04110001	Black-Rocky
	94.78	97.71	2.93	041100010505	Plum Creek	04110001	Black-Rocky
	97.71	103.63	5.93	041000120202	East Fork Vermilion River	04100012	Huron-Vermilion
	103.63	105.11	1.47	041000120203	Town of Wakeman-Vermilion River	04100012	Huron-Vermilion
	105.11	106.88	1.78	041000120302	Chappel Creek	04100012	Huron-Vermilion
	106.88	108.66	1.78	041000120304	Old Woman Creek	04100012	Huron-Vermilion
	108.66	109.17	0.51	041000120302	Chappel Creek	04100012	Huron-Vermilion
	109.17	109.38	0.21	041000120304	Old Woman Creek	04100012	Huron-Vermilion
	109.38	110.96	1.58	041000120302	Chappel Creek	04100012	Huron-Vermilion
	110.96	114.90	3.94	041000120304	Old Woman Creek	04100012	Huron-Vermilion
	114.90	119.78	4.88	041000120606	Huron River-Frontal Lake Erie	04100012	Huron-Vermilion
	119.78	123.83	4.05	041000110101	Sawmill Creek	04100011	Sandusky
	123.83	127.68	3.86	041000110102	Pipe Creek-Frontal Sandusky Bay	04100011	Sandusky
	127.68	131.29	3.61	041000110103	Mills Creek	04100011	Sandusky
	131.29	135.62	4.33	041000110202	Strong Creek	04100011	Sandusky
	135.62	138.29	2.66	041000110203	Pickerel Creek	04100011	Sandusky
	138.29	140.11	1.82	041000110204	Raccoon Creek	04100011	Sandusky
	140.11	141.41	1.30	041000110205	South Creek	04100011	Sandusky
	141.41	142.40	0.99	041000111203	Green Creek	04100011	Sandusky
	142.40	146.57	4.16	041000111303	Mouth Sandusky River	04100011	Sandusky
	146.57	147.46	0.90	041000111403	Little Muddy Creek	04100011	Sandusky
	147.46	148.36	0.89	041000111301	Muskellunge Creek	04100011	Sandusky
	148.36	151.25	2.89	041000111403	Little Muddy Creek	04100011	Sandusky
	151.25	151.73	0.48	041000111404	Town of Lindsey-Muddy Creek	04100011	Sandusky
	151.73	152.03	0.30	041000111403	Little Muddy Creek	04100011	Sandusky
	152.03	154.81	2.78	041000111404	Town of Lindsey-Muddy Creek	04100011	Sandusky
	154.81	156.40	1.60	041000100501	Little Portage River	04100010	Cedar-Portage
	156.40	158.17	1.76	041000100502	Portage River	04100010	Cedar-Portage
	158.17	160.27	2.10	041000100401	Sugar Creek	04100010	Cedar-Portage
	160.27	163.49	3.22	041000100402	Larcarpe Creek Outlet #4-Portage River	04100010	Cedar-Portage
	163.49	169.04	5.55	041000100601	Upper Tousant Creek	04100010	Cedar-Portage
	169.04	169.35	0.31	041000100602	Packer Creek	04100010	Cedar-Portage
	169.35	169.40	0.05	041000100601	Upper Tousant Creek	04100010	Cedar-Portage

TABLE 2.3-1

Watersheds Crossed by the NEXUS Project

State, Facility	From MP	To MP	Crossing Length (mi)	HUC 12 Identifier	HUC12 Name	HUC 8 Identifier	HUC08 Name
	169.40	173.68	4.28	041000100602	Packer Creek	04100010	Cedar-Portage
	173.68	176.56	2.88	041000100703	Cedar Creek-Frontal Lake Erie	04100010	Cedar-Portage
	176.56	178.63	2.07	041000090901	Grassy Creek Diversion	04100009	Lower Maumee
	178.63	182.11	3.48	041000090603	Haskins Road Ditch-Maumee River	04100009	Lower Maumee
	182.11	183.14	1.04	041000090804	Heilman Ditch-Swan Creek	04100009	Lower Maumee
	183.14	187.15	4.00	041000090802	Lower Blue Creek	04100009	Lower Maumee
	187.15	189.81	2.66	041000090801	Upper Blue Creek	04100009	Lower Maumee
	189.81	189.89	0.08	041000090802	Lower Blue Creek	04100009	Lower Maumee
	189.89	193.66	3.77	041000090801	Upper Blue Creek	04100009	Lower Maumee
	193.66	197.73	4.07	041000090702	Fewless Creek-Swan Creek	04100009	Lower Maumee
	197.73	203.47	5.74	041000090701	Ai Creek	04100009	Lower Maumee
	203.47	205.98	2.51	041000010303	Prairie Ditch	04100001	Ottawa-Stony
	205.98	208.31	2.33	041000010304	Headwaters Tenmile Creek	04100001	Ottawa-Stony
Michigan							
	208.31	209.44	1.13	041000010304	Headwaters Tenmile Creek	04100001	Ottawa-Stony
	209.44	219.07	9.64	041000020307	Floodwood Creek-River Raisin	04100002	Raisin
	219.07	220.08	1.00	041000020308	Camp Drain-River Raisin	04100002	Raisin
	220.08	224.41	4.34	041000020309	Little River Raisin	04100002	Raisin
	224.41	227.00	2.59	041000020405	South Branch Macon Creek	04100002	Raisin
	227.00	229.04	2.04	041000020408	Macon Creek	04100002	Raisin
	229.04	229.67	0.63	041000020404	Headwaters Macon Creek	04100002	Raisin
	229.67	231.73	2.06	041000020408	Macon Creek	04100002	Raisin
	231.73	234.66	2.92	041000020406	Bear Swamp Creek	04100002	Raisin
	234.66	236.82	2.17	041000020407	North Branch Macon Creek	04100002	Raisin
	236.82	237.86	1.04	041000020409	Saline River	04100002	Raisin
	237.86	242.85	4.99	041000010106	Sugar Creek-Stony Creek	04100001	Ottawa-Stony
	242.85	246.68	3.83	041000010105	Paint Creek	04100001	Ottawa-Stony
	246.68	247.12	0.44	041000010107	Stony Creek	04100001	Ottawa-Stony
	247.12	247.98	0.86	041000010103	Middle Creek-Swan Creek	04100001	Ottawa-Stony
	247.98	249.16	1.18	041000010102	North Branch Swan Creek	04100001	Ottawa-Stony
	249.16	249.56	0.40	040900050405	Griggs Drain-Huron River	04090005	Huron
	249.56	251.08	1.52	040900050404	Belleville Lake-Huron River	04090005	Huron
	251.08	251.42	0.34	040900050403	Ford Lake-Huron River	04090005	Huron
	251.42	252.41	0.99	040900050404	Belleville Lake-Huron River	04090005	Huron
	252.41	253.19	0.78	040900050403	Ford Lake-Huron River	04090005	Huron
	253.19	253.45	0.26	040900050404	Belleville Lake-Huron River	04090005	Huron
	253.45	255.18	1.73	040900040302	Molt Drain-Lower River Rouge	04090004	Detroit

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
Ohio									
Ohio River Basin									
Columbiana County									
TGP interconnect									
B15-17-S2	Tributary to Brush Creek	0.69	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	Dry Cut
B15-17-S2	Tributary to Brush Creek	0.74	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	Dry Cut
Nexus Mainline									
B15-17-S4	Tributary to Brush Creek	0.07	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	N/A
B15-17-S3	Tributary to Brush Creek	0.07	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	N/A
B15-17-S2	Tributary to Brush Creek	0.07	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	Wet Cut
B15-28-S1	Tributary to Sandy Creek	0.66	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	2	Wet Cut
B15-29-S1	Tributary to Sandy Creek	0.96	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
A14-5-S4	Tributary to Sandy Creek	2.03	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Bore
A14-5-S3	Tributary to Sandy Creek	2.19	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	N/A
A14-5-S3	Tributary to Sandy Creek	2.2	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	Dry Cut
A14-8-S1	Tributary to Sandy Creek	3.9	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	9	Dry Cut
A14-10-S1	Conser Run	4.87	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	20	Bore
A14-10-S2	Tributary Conser Run	4.96	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2	N/A
A14-11-S1	Tributary to Conser Run	5.25	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
A14-127-S1	Tributary to Conser Run	5.66	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	Wet Cut
AS-CO-214	Tributary to Conser Run	6.45	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Dry Cut
A15-44-S1	Tributary to Conser Run	7.44	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	3.5	N/A
B15-33-S1	Tributary to Lake Placentia	7.75	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
A14-196-S1	Tributary to Middle Branch Sandy Creek	9.77	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
A14-13-S1	Tributary to Middle Branch Sandy Creek	10.08	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2	N/A
A14-15-S1	Tributary to Middle Branch Sandy Creek	10.58	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	Dry Cut
C15-65-S1	Tributary to Middle Branch Sandy Creek	10.97	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	8	Dry Cut
A15-34-S1/AS-CO-201A	Tributary to Middle Branch Sandy Creek	11.2	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	Bore
AS-CO-201	Sandy Creek	11.21	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	7	Bore

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
A14-17-S4	Tributary to Middle Branch Sandy Creek	11.67	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	3	Dry Cut
A14-17-S4	Tributary to Middle Branch Sandy Creek	11.82	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	3	Dry Cut
A14-165-S2	Tributary to Woodland Lake	12.26	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	6	N/A
A14-165-S1	Tributary to Woodland Lake	12.31	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Dry Cut
Stark County									
AS-ST-213	Tributary to Middle Branch Sandy Creek	13.38	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	2	Dry Cut
AS-ST-2	Tributary to Middle Branch Sandy Creek	13.68	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Dry Cut
A15-47-S1	Tributary to Middle Branch Sandy Creek	13.85	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	Dry Cut
B15-54-S2	Tributary to Middle Branch Sandy Creek	14.04	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	1.3	Wet Cut
C15-92-S1	Tributary to Beech Creek	15.3	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3	N/A
C15-92-S1	Tributary to Beech Creek	15.32	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3	N/A
AS-ST-7	Beech Creek	17.17	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	13	Dry Cut
AS-ST-7A	Tributary to Beech Creek	17.28	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	8	Wet Cut
A14-105-S1	Tributary to Beech Creek	17.79	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3	Bore
A14-103-S1	Tributary to Beech Creek	18.2	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
AS-ST-202	Tributary to Beech Creek	19.36	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	8	Dry Cut
A15-36-S1	Tributary to Red Pine Lake	20.49	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
A15-36-S2	Tributary to Red Pine Lake	20.52	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	4	N/A
A14-25-S1	Middle Branch Nimishillen Creek	21.78	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
B15-41-S1	Tributary to Middle Branch Nimishillen Creek	22.04	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3.5	Bore
B15-40-S1	Tributary to Middle Branch Nimishillen Creek	22.25	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	4	Bore
A14-175-S1	Tributary to Middle Branch Nimishillen Creek	22.75	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
A14-174-S1	Tributary to Middle Branch Nimishillen Creek	23	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	4	Wet Cut
A14-27-S1	Tributary to Middle Branch Nimishillen River	24.12	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3	Wet Cut
A14-161-S1	Tributary to Middle Branch Nimishillen Creek	24.6	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	28	Dry Cut

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
A14-161-S2	Tributary to Middle Branch Nimishillen River	24.61	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Dry Cut
A14-28-WB1	Tributary to Middle Branch Nimishillen Creek	25.16	Pond	Intermediate	WWH	AWS and IWS	Primary Contact B	100	N/A
A14-31-S1	Tributary to Middle Branch Nimishillen Creek	25.75	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
A14-100-S1	Tributary to Nimishillen Creek	26.72	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3	Wet Cut
AS-ST-209	Nimishillen Creek	26.83	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	20	Dry Cut
AS-ST-210	Tributary To Nimishillen	26.94	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	4	Wet Cut
B15-45-S1/AS-ST-200	Tributary to Swartz Ditch	27.71	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Wet Cut
A14-168-S1/AS-ST-27	Tributary to West Branch Nimishillen Creek	28.92	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	8	Wet Cut
AS-ST-14	Tributary to Nimishillen Creek	29.27	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	4	Dry Cut
AS-ST-15	Tributary to Nimishillen Creek	29.33	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	18	Dry Cut
AS-ST-17	Tributary to Nimishillen Creek	29.63	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	27	Wet Cut
A14-157-S1	Tributary to West Branch Nimishillen Creek	30.25	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Wet Cut
A14-159-S1	Tributary to West Branch Nimishillen Creek	30.72	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
A14-158-S1	Tributary to West Branch Nimishillen Creek	30.92	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Dry Cut
A14-162-S1	Tributary to West Branch Nimishillen Creek	31.45	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
A14-163-S1	Tributary to West Branch Nimishillen Creek	31.59	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	Dry Cut
A14-164-S2	West Branch Nimishillen Creek	31.98	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	16	Dry Cut
A14-164-S1	Tributary to West Branch Nimishillen Creek	32.21	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	22	Dry Cut
AS-ST-205	Tributary to Tuscarawas River	33.66	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Dry Cut
AS-ST-205	Tributary to Tuscarawas River	33.79	Perennial	Intermediate	WWH	AWS and IWS	Secondary Contact	12	Dry Cut
AS-ST-205	Tributary to Tuscarawas River	33.87	Perennial	Intermediate	WWH	AWS and IWS	Secondary Contact	12	Dry Cut
Summit County									
AS-SU-211	Tributary to Tuscarawas River	34.72	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
AS-SU-210	Tributary to Tuscarawas River	34.93	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
AS-SU-209	Tributary to Tuscarawas River	35.13	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
AS-SU-208A	Tributary to Tuscarawas River	36.23	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	10	Wet Cut

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
AS-SU-208	Tributary to Tuscarawas River	36.31	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
AS-SU-206	Tributary to Willow Lake	36.74	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3	Wet Cut
AS-SU-205	Tributary to Willow Lake	37.44	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Dry Cut
AS-SU-201	Tributary to Nimisilla Reservoir	39.35	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	6	Dry Cut
A14-112-S1	Tributary to Nimisila Reservoir	39.49	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Dry Cut
A14-112-S1-A	Tributary to Nimisila Reservoir	39.88	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Wet Cut
A14-112-S1-B	Tributary to Nimisila Reservoir	40.07	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Wet Cut
A14-112-S2	Tributary to Nimisila Reservoir	40.08	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2	Wet Cut
AS-SU-13	Tributary to Nimisila Reservoir	40.33	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	N/A
AS-SU-13A	Tributary to Nimishillen Reservoir	40.37	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	8	Wet Cut
AS-SU-200	Nimisila Reservoir	40.94	Reservoir	Major	WWH	AWS and IWS	Primary Contact B	650	HDD
A14-122-S4	Tributary to Nimisila Creek	41.71	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	N/A
A14-122-S2	Nimisila Creek	41.71	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	80	Dry Cut
A14-122-S3	Tributary to Nimisila Creek	41.72	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	30	N/A
A14-122-S5	Tributary to Nimisila Creek	41.86	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Dry Cut
A14-122-S1	Tributary to Nimisila Creek	41.97	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	Wet Cut
AS-SU-18	Tributary to Nimisila Creek	42.47	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	11	Wet Cut
A14-117-S1	Tributary to Nimisila Creek	43.26	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Wet Cut
A15-16-S1	Tributary to Nimisila Creek	43.66	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3	N/A
A15-16-S2	Tributary to Nimisila Creek	43.69	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	3	N/A
A15-16-S1	Tributary to Nimisila Creek	43.69	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3	N/A
A15-16-S3	Tributary to Nimisila Creek	43.72	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3	Wet Cut
A15-16-S4	Tributary to Nimisila Creek	43.74	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2	Wet Cut
AS-SU-22	Tributary to Nimisila Creek	43.93	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	9	Wet Cut
AS-SU-23	Tributary to Nimisila Creek	44.14	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	17	Dry Cut
AS-SU-29	Tributary to Tuscarawas River	45.94	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
AS-SU-30	Tributary to Tuscarawas River	46.17	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	Bore
A14-119-S1	Tributary to Tuscarawas River	46.42	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	2.5	Wet Cut
C15-25-S1	Tributary to Tuscarawas River	46.78	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	6	Dry Cut
A15-13-S1	Tributary to Tuscarawas River	46.84	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	4	N/A
AS-SU-35A	Tributary to Tuscarawas River	47.01	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
A15-14-S1	Tributary to Tuscarawas River	47.01	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	8	Wet Cut
C15-28-S1	Tuscarawas River	48.14	Perennial	Intermediate	MWH	AWS and IWS	Primary Contact A	83	HDD

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
A15-18-WB1	Tributary to Pancake Creek	48.88	Pond	Intermediate	WWH	AWS and IWS	Primary Contact B	50	N/A
AS-SU-40	Pancake Creek	48.9	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	24	Dry Cut
AS-SU-43	Tributary to Willowdale Lake	49.24	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	16	Wet Cut
AS-SU-43A	Tributary to Willowdale Lake	49.6	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
AS-SU-43	Tributary to Willowdale Lake	49.63	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	16	Wet Cut
A14-41-S2	Tributary to Pancake Creek	49.79	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	Wet Cut
A14-41-S2	Tributary to Pancake Creek	49.82	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	N/A
A14-41-S1	Tributary to Pancake Creek	49.87	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	Bore
A14-41-S1	Tributary to Pancake Creek	49.94	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	N/A
A14-42-S2	Tributary to Pancake Creek	50.11	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	2	Wet Cut
A14-42-S1	Tributary to Pancake Creek	50.12	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	Wet Cut
A14-42-S1	Tributary to Pancake Creek	50.15	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	N/A
A15-20-S1	Tributary to Pancake Creek	50.46	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
A15-21-S2	Tributary to Silver Creek	51.52	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	N/A
A15-21-S1	Tributary to Silver Creek	51.57	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2	Wet Cut
C15-34-S1	Tributary to Silver Creek	52.2	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	8	Wet Cut
A14-124-S2	Tributary to Silver Creek	52.57	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	7	Dry Cut
A14-124-S1	Silver Creek	52.64	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Dry Cut
AS-WE-201A	Tributary to Silver Creek	52.75	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	N/A
AS-WE-201	Tributary to Silver Creek	52.75	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Dry Cut
AS-WE-201A	Tributary to Silver Creek	52.81	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	4	Dry Cut
A15-52-S1	Tributary to Silver Creek	52.94	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	1.5	Dry Cut
A15-53-S1	Tributary to Silver Creek	52.96	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Dry Cut
A15-54-S1	Tributary to Silver Creek	52.98	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	7	N/A
C15-96-S1	Tributary to Silver Creek	53.1	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	N/A
B15-47-S1	Tributary to Mill Creek	54.92	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	17	Dry Cut
A15-41-S1	Mill Creek	55.3	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
AS-ME-1	Tributary to Styx River	56.77	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	8	Bore
B15-50-S1	Tributary to Styx River	57.29	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	8	N/A
B15-51-S1	Styx River	57.64	Perennial	Intermediate	MWH	AWS and IWS	Primary Contact B	28	Dry Cut

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
Medina County									
B15-53-S1	Tributary to Styx River	57.69	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	7	Bore
B14-7-S1	Tributary to Styx River	58.4	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
A14-44-S1	Tributary to Styx River	59.27	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	N/A
B15-02-S1	Tributary to Styx River	59.85	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Dry Cut
A14-39-S1	Tommy Run	60.73	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
A14-40-S1	Tributary to Tommy Run	60.89	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	8	Dry Cut
A14-40-S2	Tributary to Tommy Run	60.9	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	2	Wet Cut
AS-ME-19	Tributary to Chippewa Creek	61.85	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	8	Wet Cut
AS-ME-91A	Tributary to Chippewa Creek	62.85	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	7	Wet Cut
A14-116-S2	Tributary to Hubbard Creek	65.29	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Wet Cut
A14-116-S5	Tributary to Hubbard Creek	65.35	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	4	Wet Cut
AS-ME-24	Tributary to Hubbard Creek	66.02	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	8	Bore
B14-4-S1	Tributary to Hubbard Creek	66.2	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
AS-ME-27	Tributary to Chippewa Creek	67.38	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	17	Wet Cut
AS-ME-30	Tributary to Chippewa Creek	67.58	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Wet Cut
AS-ME-31	Tributary to Chippewa Creek	67.64	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
AS-ME-31A	Tributary to Chippewa Creek	67.7	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
AS-ME-31B	Tributary to Chippewa Creek	67.78	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	4	Wet Cut
AS-ME-32	Tributary to Chippewa Creek	67.85	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
AS-ME-34	Tributary to Chippewa Creek	68.12	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	21	Dry Cut
AS-ME-35	Tributary to McCabe Creek	68.47	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
A15-3-S1/AS-ME-37	McCabe Creek	68.78	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Dry Cut
C15-40-S1	Tributary to The Inlet	69.4	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	4.5	Wet Cut
C15-41-S1	Tributary to The Inlet	69.66	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Dry Cut
C15-6-S2	Tributary to The Inlet	69.86	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	17	Wet Cut
C15-6-S1	Tributary to The Inlet	69.95	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	23	Wet Cut
C15-42-S1/AS-ME-46	The Inlet	70.78	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	21	Bore
AS-ME-47	Tributary to The Inlet	70.92	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	13	Bore
C15-44-S1	Tributary to The Inlet	71.14	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	13	HDD
A14-46-S2	Tributary to The Inlet	71.34	Ephemeral	Intermediate	WWH	AWS and IWS	Primary Contact B	13	HDD
A14-46-S1/AS-ME-50	Tributary to The Inlet	71.36	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	13	HDD
AS-ME-211	Tributary to Mallet Creek	71.64	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	N/A

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
Lake Erie Basin									
C15-24-S1/AS-ME-209	Tributary to Mallet Creek	72.91	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	20	Dry Cut
AS-ME-53A	Tributary to Mallet Creek	73.08	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
C15-24-S7	Tributary to Mallet Creek	73.32	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	1.5	Wet Cut
C15-24-S8	Tributary to Mallet Creek	73.35	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	4	Wet Cut
C15-24-S1-3	Mallet Creek	73.38	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Dry Cut
C15-24-S1-3	Mallet Creek	73.49	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	N/A
AS-ME-56	Tributary to Mallet Creek	73.69	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Bore
AS-ME-58A	Tributary to Mallet Creek	73.86	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	14	Dry Cut
AS-ME-58	Tributary to Mallet Creek	73.98	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Dry Cut
B14-9-S1	Tributary to Mallet Creek	74.29	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	4	N/A
AS-ME-62A	Tributary to Mallet Creek	74.86	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	N/A
AS-ME-62	Tributary to Mallet Creek	74.87	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
B14-10-S1	Tributary to Mallet Creek	75.1	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2	Wet Cut
AS-ME-206B	Tributary to Mallet Creek	75.81	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	8	Wet Cut
AS-ME-206	Mallet Creek	76	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	25	Dry Cut
AS-ME-204	Tributary to Mallet Creek	76.3	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	8	Wet Cut
AS-ER-202B	Tributary to Mallet Creek	76.93	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Dry Cut
AS-ME-202A	Tributary to Mallet Creek	76.98	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Dry Cut
AS-ME-201	Tributary to Mallet Creek	77.44	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	N/A
AS-ME-77	Tributary to Mallet Creek	77.81	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	16	Dry Cut
AS-ME-200	Tributary to Mallet Creek	77.97	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	6	Bore
AS-ME-96	Tributary to West Branch Rocky River	78.9	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	14	Dry Cut
AS-ME-97	Tributary to West Branch Rocky River	79.06	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Bore
AS-ME-98	Tributary to West Branch Rocky River	79.35	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
AS-ME-99	Tributary to West Branch Rocky River	79.51	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
AS-LO-1	Tributary to East Branch Black River	80.34	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	19	Dry Cut
B15-15-S1	Tributary to East Branch Black River	80.45	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	2	Dry Cut

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
Lorain County									
A15-28-S1	Tributary to East Branch Black River	81.37	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
A14-59-S1	Tributary to East Branch Black River	82.03	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	2	N/A
A14-69-S4	Salt Creek	84.35	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	25	Dry Cut
AS-LO-10	Tributary to East Branch Black River	85.83	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Dry Cut
AS-LO-10	Tributary to East Branch Black River	85.96	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Bore
A14-50-S1	East Branch Black River	86.72	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact A	65	HDD
AS-LO-11	Tributary to East Branch Black River	87.07	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	10	Bore
A14-55-S1	Tributary to Dent Ditch	87.31	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
AS-LO-45	Tributary to East Branch Black River	88.01	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	8	Wet Cut
A14-73-S1	King Ditch	88.63	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	7	Dry Cut
A14-128-S1	Tributary to King Ditch	89.24	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3	Bore
A14-75-S1	Tributary to King Ditch	89.25	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	Bore
A14-75-S2	Tributary to King Ditch	89.31	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	8	Wet Cut
A14-76-S1	Kelner Ditch	90.22	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Dry Cut
A14-130-S1	Tributary to Kelner Ditch	90.48	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	Wet Cut
A14-131-S1	Tributary to Elk Creek	90.95	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2.5	Wet Cut
A14-131-S2	Tributary to Elk Creek	90.96	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2	N/A
A14-131-S1	Tributary to Elk Creek	91.11	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2.5	Wet Cut
C15-37-S1	Elk Creek	91.34	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	20	Dry Cut
C15-35-S1	Wellington Creek	91.8	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	50	Dry Cut
C15-8-S2	Tributary to West Branch Black River	92.25	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	9	HDD
C15-8-S3	Tributary to West Branch Black River	92.26	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	55	HDD
C15-8-S4	West Branch Black River	92.39	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact A	45	HDD
C15-9-S1	Tributary to West Branch Black River	92.6	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	25	Dry Cut
A14-140-S1	Tributary to West Branch Black River	93.44	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2	Bore
A14-141-S1	Plum Creek	96.09	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut

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C15-57-S1	Tributary to Plum Creek	97.32	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	2	Wet Cut
C15-61-S1	Tributary to East Fork Vermilion River	98.29	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Wet Cut
C15-66-S2	Tributary to East Fork Vermilion River	99.31	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	15	N/A
C15-66-S1	East Fork Vermilion River	99.31	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	40	Dry Cut
C15-67-S1	Frankenburg Creek	101.29	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Bore
Huron County									
AS-HU-200	Tributary to Frankenburg Creek	101.65	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
AS-HU-201	Tributary to Frankenburg Creek	101.89	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
AS-HU-202	Tributary to Frankenburg Creek	102.33	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	8	Dry Cut
C15-88-S1	Tributary to Frankenburg Creek	102.97	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Dry Cut
C15-56-S1	Tributary to Vermilion River	104.18	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	8	HDD
C15-56-S4	Vermilion River	104.37	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact A	66	HDD
C15-56-S4b	Vermilion River	104.42	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact A	60	HDD
C15-56-S4A	Tributary to Vermilion River	104.46	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	40	HDD
Erie County									
C15-69-S1	Chappel Creek	105.9	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	34	Dry Cut
AS-ER-35	Tributary to Old Woman Creek	112.99	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3	Wet Cut
A14-187-S1	Old Woman Creek	113.14	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	28	Dry Cut
A14-188-S2	Tributary to Old Woman Creek	113.32	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	N/A
A14-188-S1	Tributary to Old Woman Creek	113.32	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
AS-ER-12	Tributary to Old Woman Creek	113.84	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	33	Dry Cut
B15-07-S1	Tributary to Old Woman Creek	114.25	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
C15-14-S1	Tributary to Huron River	115.39	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	4	Wet Cut
C15-15-S1	Tributary to Huron River	115.73	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	30	Dry Cut
B15-09-S1	Tributary to Huron River	115.97	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Wet Cut
C15-17-S1	Tributary to Huron River	116.07	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2	Wet Cut
C15-16-S1	Tributary to Huron River	116.17	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
A14-156-S2	Tributary to Huron River	116.47	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	N/A
A14-155-S1	Tributary to Huron River	116.51	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Bore
A14-186-S1/AS-ER-19	Huron River	116.88	Perennial	Major	WWH	AWS and IWS	Primary Contact A	195	HDD
A14-186-S1/AS-ER-19	Huron River	116.89	Perennial	Major	WWH	AWS and IWS	Primary Contact A	195	N/A

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AS-ER-20A	Tributary to Huron River	117.03	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	3	HDD
AS-ER-20	Tributary to Huron River	117.11	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	HDD
C15-20-S1	Tributary to Mud Brook	117.42	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	18	N/A
C15-20-S1	Tributary to Mud Brook	117.62	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	18	Dry Cut
C15-18-S1	Tributary to Mud Brook	118.42	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	18	Wet Cut
B15-11-S1	Tributary to Mud Brook	118.8	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Dry Cut
B15-11-S1	Tributary to Mud Brook	118.81	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Dry Cut
E14-97-S1	Mud Creek	118.96	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	19	Dry Cut
AS-ER-206	Zorn Beutal Ditch	120	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	18	Dry Cut
C15-22-S1	Sheerer Ditch	120.36	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	28	Dry Cut
C15-74-S1	Tributary to Sheerer Ditch	120.48	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	4	Wet Cut
B15-12-S1	Sherer Ditch	120.86	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	2	Bore
B15-13-S1	Sherer Ditch	122.04	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Bore
B15-13-S1	Sherer Ditch	122.06	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	N/A
AS-ER-205	Tributary to Sawmill Creek	122.13	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	5	Dry Cut
E14-96-S1	Tributary to Sherer Ditch	123.06	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
AS-ER-28	Tributary to Pipe Creek	124.03	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	20	Dry Cut
C15-23-S1	Tributary to Pipe Creek	125.71	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	6.5	Wet Cut
E14-95-S1	Pipe Creek	125.86	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
E14-49-S1/AS-ER-202	Tributary to Pipe Creek	127.4	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
E14-50-S1/AS-ER-30	Tributary to Mills Creek	127.94	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	10	Wet Cut
E14-51-S1/AS-ER-201	Tributary to Mills Creek	128.12	Perennial	Intermediate	WWH	AWS and IWS	Secondary Contact	15	Dry Cut
E14-94-S1/AS-ER-200	Mills Creek	129.25	Perennial	Intermediate	WWH	AWS and IWS	Secondary Contact	30	Dry Cut
Sandusky County									
D15-74-S1	Scherz Ditch	134.28	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	14	Dry Cut
D14-4-S1	Strong Creek	135.34	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Dry Cut
D14-6-S1	Fuller Creek	135.96	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	13	Dry Cut
D14-6-S1	Fuller Creek	135.98	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	13	N/A
D14-7-S1	Tributary to Fuller Creek	136.41	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	6	Bore
D15-49-S1/AS-SA-202	Tributary to Fuller Creek	136.91	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Wet Cut
E14-105-S1	Pickerel Creek	138.01	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	18	Dry Cut

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D14-9-S1	Little Raccoon Creek	138.65	Perennial	Minor	WWH	AWS and IWS	Secondary Contact	10	Dry Cut
D14-10-S1	Tributary to Little Racoon Creek	139.08	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
D14-8-S2	Tributary to Raccoon Creek	139.89	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2	N/A
D14-8-S1	Raccoon Creek	139.89	Perennial	Intermediate	WWH	AWS and IWS	Secondary Contact	30	Dry Cut
E14-103-S1	South Creek	140.53	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	22	Dry Cut
D15-31-S1	Tributary to South Creek	141.17	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	18	Dry Cut
D14-11-S1	Green Creek	141.69	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	35	Dry Cut
AS-SA-100	Tributary to Buehler Ditch	142.7	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	7	Bore
E14-36-S1	Tributary to Buehler Ditch	142.99	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	10	Wet Cut
D15-47-S1	Buehler Ditch	143.34	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	20	Dry Cut
D14-40-S1	Bark Creek	143.72	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	20	Dry Cut
AS-SA-204	Sandusky River	145.81	Perennial	Major	WWH	AWS and IWS	Primary Contact A	515	HDD
D15-104-WB	Tributary to Sandusky River	146.28	Pond	Minor	WWH	AWS and IWS	Primary Contact B	200	Dry Cut
D15-104-S1	Tributary to Sandusky River	146.29	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	7	Dry Cut
AS-SA-206	Tributary to Greesman Ditch	146.71	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
D14-33-S1	Tributary to Muskellunge Creek	147.48	Ephemeral	Intermediate	WWH	AWS and IWS	Primary Contact B	14	Bore
E14-98-S1	Tributary to Little Muddy Creek	147.62	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Bore
E14-121-S1	Tributary to Muskellunge Creek	147.73	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	9	Wet Cut
D15-34-S1	Tributary to Little Muddy Creek	148.76	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
D15-52-S1	Little Muddy Creek	149.37	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	30	Dry Cut
D15-87-S1	Tributary to Muddy Creek	152.74	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	Bore
E14-43-S1	Muddy Creek	153.35	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	24	Dry Cut
E14-181-S1	Tributary to Muddy Creek	153.76	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Bore
D15-35-S1	Tributary to Muddy Creek	154.44	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	20	Dry Cut
E14-109-S1	Tributary to Muddy Creek	154.74	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	4	Bore
E14-42-S1	Ninemile Creek	155.19	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	18	Dry Cut
E14-3-S1	Tributary to Ninemile Creek	155.92	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	4	Bore
D15-51-S1	Tributary to Wolf Creek	156.56	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	7	Wet Cut
D15-50-S1	Tributary to Wolf Creek	156.87	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	8	Wet Cut
C15-79-S1	Wolf Creek	157.81	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	11	Dry Cut
D14-25-S1	Sugar Creek	158.61	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact A	35	Dry Cut
E14-107-S1	Tributary to Victoria Creek	160.78	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	9	Wet Cut
E14-108-S1	Victoria Creek	161.29	Ephemeral	Intermediate	WWH	AWS and IWS	Primary Contact B	13	Wet Cut

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D15-26-S1	Portage River	162.49	Perennial	Major	WWH	AWS and IWS	Primary Contact A	200	HDD
Wood County									
E14-111-S1	Martin Ditch	163.81	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	17	Dry Cut
D14-31-S1	Tributary to Martin Ditch	164.75	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
E14-85-S1	Tributary to Toussaint Creek	165.62	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	13	Dry Cut
E14-153-S1	Tributary to Toussaint Creek	166.49	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
D14-34-S1	Tributary to Toussaint Creek	166.8	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	6	Bore
E14-175-S1	Toussaint Creek	167.34	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	24	Dry Cut
E15-22-S1	Tributary to Toussaint Creek	167.83	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Bore
E14-48-S3	Tributary to Toussaint Creek	168.24	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
E14-48-S4	Tributary to Toussaint Creek	168.26	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
E14-79-S1	Tributary to Packer Creek	170.44	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	7	Wet Cut
E14-80-S1	Tributary to Packer Creek	170.82	Ephemeral	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Dry Cut
E14-40-S1	Packer Creek	171.13	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	25	Dry Cut
D15-62-S1	Tributary to Cedar Creek	173.96	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Bore
E14-35-S1	Tributary to Cedar Creek	174.48	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Bore
E15-32-S1	Tributary to Henry Creek	175.44	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
E15-33-S1	Tributary to Henry Creek	175.59	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
E15-34-S1	Tributary to Henry Creek	176.16	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	4	Wet Cut
E15-7-S1	Tributary to Maumee River	177.32	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	11	Dry Cut
D14-45A-S1	Tributary to Maumee River	178.07	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	8	Bore
E15-8-S1	Tributary to Maumee River	179.91	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	4	HDD
D15-101-S1	Tributary to Maumee River	179.95	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	40	HDD
D15-99-S1	Tributary to Maumee River	180.05	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	HDD
E14-46-S1	Tributary to Maumee River	180.68	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	5	Wet Cut
E14-44-S1	Tributary to Maumee River	180.78	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Wet Cut
E14-47-S1	Tributary to Maumee River	180.99	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	2.5	Wet Cut
E14-55-S1	Maumee River	181.35	Perennial	Major	WWH	AWS and IWS	Primary Contact A	857	HDD
Lucas County									
E14-55-S1	Maumee River	181.68	Perennial	Major	WWH	AWS and IWS	Primary Contact A	710	HDD
D15-48-S1	Tributary to Maumee River	181.87	Intermittent	Minor				3	HDD
E14-116-S1	Blystome Ditch	182.73	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
E14-29-S1	Suter Ditch	183.28	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	9	Wet Cut

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
AS-LU-2	Tributary to Whitemeir Ditch	183.37	Ephemeral	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Bore
E14-1-S1	Whitemeir Ditch	183.56	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
E14-37-S1	Estworthy Ditch	183.71	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
E14-38-S1	Disher Ditch	184.11	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Dry Cut
E14-39-S1	Harris Ditch	185.28	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	18	Bore
E14-22-S1	Tributary to Ruhm Ditch	186.61	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Wet Cut
E15-21-S1	Doran Ditch	187.32	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
D15-1-S1	Yawberg Ditch	187.46	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Dry Cut
D15-91-S1	Jeffers Ditch	187.7	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Wet Cut
E15-9-S1	Laver Ditch	188.12	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
Henry County									
E15-29-S1	Tributary to Harris Ditch	189.48	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
D15-56-S1	Tributary to Aumend Ditch	189.69	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
D15-7-S2	Tributary to Blue Creek	190.16	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	9	Dry Cut
D15-7-S1	Tributary to Blue Creek	190.22	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	6	Bore
Fulton County									
E15-14-S1	Blue Creek	190.93	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	23	Dry Cut
E15-14-S2	Tributary to Blue Creek	191.06	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	4	Wet Cut
D15-110-S1	Tributary to Blue Creek	192.28	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	9	Dry Cut
D15-111-S1	Tributary to Blue Creek	193.22	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Dry Cut
D15-60-S1	Tributary to Fewless Creek	193.87	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
E15-37-S1	Tributary to Fewless Creek	194.98	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	35	Dry Cut
E15-36-S1	Fewless Creek	195.24	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	37	Dry Cut
D15-61-S1	Tributary to Fewless Creek	195.86	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	15	Wet Cut
D15-17-S1	Swan Creek	196.36	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	20	Bore
D15-9-S1	Tributary to Swan Creek	197.25	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Wet Cut
D15-98-S1	Tributary to Swan Creek	197.51	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Dry Cut
D15-60A-S1	Tributary to Fewless Creek	197.85	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Bore
D15-10-S1	Tributary to Swan Creek	198.64	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Dry Cut
D15-13-S1	Tributary to Swan Creek	199.09	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Bore
E14-4-S1	Ai Creek	200.78	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	25	Dry Cut
E15-19-S1	Frankfort Ditch	202.13	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	6	Wet Cut
D14-24-S1	Tributary to McNett Ditch	202.69	Ephemeral	Minor	WWH	AWS and IWS	Primary Contact B	5	Bore

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
E14-112-S1	McNett Ditch	203.43	Ephemeral	Intermediate	WWH	AWS and IWS	Primary Contact B	11	Wet Cut
D14-44-S1	Tributary to Langenderfer Ditch	203.76	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Bore
D14-44-S1	Tributary to Langenderfer Ditch	203.88	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Dry Cut
D14-44-S1	Tributary to Langenderfer Ditch	203.93	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	15	Dry Cut
E14-53-S1	Tributary to Langenderfer Ditch	205.19	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	12	Dry Cut
D15-82-S1	Tributary to Langenderfer Ditch	205.6	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Dry Cut
D15-83-S1	Tributary to Langenderfer Ditch	205.97	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	10	Bore
E14-11-S1	Tributary to Schmitz Ditch	206.22	Intermittent	Intermediate	WWH	AWS and IWS	Primary Contact B	20	Dry Cut
E14-12-S1	Tributary to Tenmile Creek	206.98	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	8	Bore
D14-45-S1	Tenmile Creek	207.87	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	20	Dry Cut
Michigan									
Lenawee County									
E14-113-S1	Tributary to Tenmile Creek	208.73	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	14	Dry Cut
E14-113-S1	Tributary to Tenmile Creek	208.73	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	14	Dry Cut
E14-114-S1	Tributary to Tenmile Creek	208.97	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	11	Bore
AS-LE-1	Tributary to Tenmile Creek	209.99	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	5	Bore
E14-78-S1	Tributary to Tenmile Creek	211	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	4	Wet Cut
E14-56-S1	Tributary to Clement Drain	212.03	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	8	Wet Cut
E14-137-S1	Tributary to Clement Drain	212.99	Intermittent	Minor	WWH	AWS and IWS	Partial/Total	8	Dry Cut
E14-138-S1	Tributary to Clement Drain	213.5	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	11	Wet Cut
E14-139-S1	Tributary to Clement Drain	214.02	Perennial	Minor	WWH	AWS and IWS	Partial/Total	8	Dry Cut
E14-140-S1	River Raisin	215.19	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	80	HDD
D15-28-S1	Tributary to River Raisin	215.79	Intermittent	Minor	WWH	AWS and IWS	Partial/Total	7	Dry Cut
AS-LE-5	Tributary to River Raisin	216.29	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	7	Dry Cut
E14-58-S1	Goodrich Drain	216.77	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	15	Dry Cut
AS-LE-7	Tributary to Goodrich Drain	217.11	Intermittent	Minor	WWH	AWS and IWS	Partial/Total	7	Bore
E14-59-S1	Tributary to Goodrich Drain	217.49	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	16	Dry Cut
AS-LE-8	Hill Drain	218.12	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	13	Dry Cut
E14-141-S1	Pease Drain	218.51	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	12	Dry Cut
E14-142-S1	Colvin Drain	218.81	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	11	Dry Cut
AS-LE-9	Tributary to Little River Raisin	219.63	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	5	Bore
AS-LE-10	Tributary to Little River Raisin	220.07	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	5	Bore
E14-143-S1	Little River Raisin	220.47	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	18	Dry Cut

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
E14-64-S1	Fry Drain	220.7	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	13	Dry Cut
E14-69-S1	Isley Drain	222.05	Ephemeral	Intermediate	WWH	AWS and IWS	Partial/Total	15	Dry Cut
E14-76-S1	Swamp Raisin Creek	222.48	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	23	Dry Cut
E14-77-S1	Tributary to Swamp Raisin Creek	222.66	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	11	Dry Cut
E14-145-S1	Spring Brook	223.24	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	20	Dry Cut
E14-171-S1	Schwab Drain	223.83	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	12	Dry Cut
E14-70-S1	Kelly Drain	224.42	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	15	Bore
AS-LE-200	Wilson Drain	225.05	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	20	Dry Cut
AS-LE-202	Tributary to South Branch Macon Creek	225.59	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	22	Dry Cut
AS-LE-203	Dibble Drain	225.81	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	16	Dry Cut
AS-LE-204	South Branch Macon Creek	226.43	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	22	Dry Cut
E14-126-S1/AS-LE-205	Tributary to South Branch Macon Creek	226.65	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	22	Dry Cut
E14-74-S1	Schreeder Brook	226.84	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	10	Dry Cut
E14-75-S1	Tributary to Wahoo Prairie Drain	227.01	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	10	Dry Cut
E14-60-S1	Wahoo Prairie Drain	228.15	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	18	Dry Cut
E14-149-S1/AS-LE-12	Tributary to Middle Branch Macon Creek	228.8	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	13	Dry Cut
E14-150-S1	Tributary to Macon Creek	229.38	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	14	Dry Cut
E14-87-S2	Tributary to Macon Creek	229.53	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	3	N/A
E14-87-S1	Macon Creek	229.53	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	28	Dry Cut
E14-61-S1	Tributary to Richardson Drain	229.82	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	20	Dry Cut
E14-62-S1	Tributary to Richardson Drain	230.36	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	5	N/A
Monroe County									
E14-63-S1	Tributary to Richardson Drain	230.71	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	16	Dry Cut
AS-MO-1	Richardson Drain	231.42	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	15	Dry Cut
E14-65-S1	Bear Swamp Creek	231.9	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	12	Dry Cut
E14-66-S1	Tributary to Bear Swamp Creek	232.39	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	8	Dry Cut
E14-67-S1	Tributary to Bear Swamp Creek	232.48	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	6	Bore
D15-40-S1	Cone Drain	233.28	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	25	Dry Cut
AS-MO-2	Tributary to Center Creek	233.69	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	15	Dry Cut
AS-MO-10A	Tributary to Center Creek	234.26	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	5	Bore

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
AS-MO-10	Center Creek	234.39	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	15	Dry Cut
AS-MO-3	Tributary to North Branch Macon Creek	235.35	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	9	Dry Cut
AS-MO-4	North Branch Macon Creek	235.99	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	15	Dry Cut
Washtenaw County									
E14-157-S1	Saline River	237.55	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	60	HDD
E14-159-S1	Tributary to McIntyre Drain	238.21	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	8	Bore
AS-WA-200	McIntyre Drain	239.08	Intermittent	Minor	WWH	AWS and IWS	Partial/Total	7	Dry Cut
E14-89-S1	Tributary to McIntyre Drain	239.22	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	12	Dry Cut
AS-WA-202	Tributary to McIntyre Drain	239.31	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	6	Bore
E14-165-S1	Tributary to McIntyre Drain	239.33	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	8	Bore
E14-91-S1	Tributary to Sugar Creek	239.73	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	15	Dry Cut
E14-92-S1	Sugar Creek	239.84	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	11	Dry Cut
E14-93-S1	Tributary to Buck Creek	240.64	Intermittent	Minor	WWH	AWS and IWS	Partial/Total	10	Dry Cut
E14-128-S3	Tributary to Buck Creek	240.81	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	4	N/A
E14-128-S1	Buck Creek	240.83	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	13	Dry Cut
E14-160-S1	Tributary to Stony Creek	241.49	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	12	Dry Cut
E14-131-S1	Tributary to Stony Creek	242.27	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	6	Wet Cut
E14-132-S1	Stony Creek	242.35	Perennial	Minor	WWH	AWS and IWS	Partial/Total	8	Dry Cut
E14-161-S1	Tributary to North Branch	243.79	Intermittent	Minor	WWH	AWS and IWS	Partial/Total	10	Dry Cut
E14-135-S1	McCarthy Drain	244.18	Perennial	Minor	WWH	AWS and IWS	Partial/Total	9.5	Dry Cut
E14-162-S1	West Branch Paint Creek	244.72	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	14	Dry Cut
E15-13-S1	Tributary to West Branch Paint Creek	244.96	Intermittent	Minor	WWH	AWS and IWS	Partial/Total	6	Bore
E14-99-S1	Tributary to Bird Drain	245.02	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	5	Wet Cut
E14-164-S1/AS-WA-6	Paint Creek	246.29	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	25	Dry Cut
E14-176-S1	Tributary to Paint Creek	246.58	Intermittent	Minor	WWH	AWS and IWS	Partial/Total	7	Dry Cut
D15-30-S1	Tributary to Bradshaw Drain	247.19	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	15	Dry Cut
D15-29-S1	Tributary to North Branch Swan Creek	248.15	Ephemeral	Minor	WWH	AWS and IWS	Partial/Total	5	Bore
AS-WA-46	Tributary to North Branch Swan Creek	248.44	Intermittent	Minor	WWH	AWS and IWS	Partial/Total	9	Dry Cut
E14-102-S1	Tributary to North Branch Swan Creek	248.89	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	14	N/A

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/
D15-21-S1	Huron River	250.92	Perennial	Major	WWH	AWS and IWS	Partial/Total	200	HDD
D15-24-S1/D15-25-S1	Tributary to Willow Run	251.83	Intermittent	Minor	WWH	AWS and IWS	Partial/Total	15	Dry Cut
E15-25-S1	Tributary to Willow Run	253.4	Perennial	Intermediate	WWH	AWS and IWS	Partial/Total	18	Dry Cut
Access Roads									
Ohio									
Ohio River Basin									
(TAR-8.2) B15-31-S1	Tributary to Mahoning River	8.12	Perennial	Minor	WWH	AWS and IWS	Primary Contact B	2.5	Bridge
Lake Erie Basin									
(TAR-73.1) C15-24-S1-2	Mallet Creek	73.18	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	14	Bridge
(PAR-89.2) A14-75-S1	Tributary to King Ditch	89.25	Intermittent	Minor	WWH	AWS and IWS	Primary Contact B	3	Bridge
(TAR-128.3) E14-51-S1	Tributary to Mills Creek	128.35	Perennial	Intermediate	WWH	AWS and IWS	Secondary Contact	15	Bridge
(TAR-200.7) E15-23-S1	Tributary to Ai Creek	200.81	Perennial	Intermediate	WWH	AWS and IWS	Primary Contact B	11	Bridge
Michigan									
(PAR-208.9) E14-114-S1	Tributary to Tenmile Creek	208.97	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	11	Bridge
Ward yards/Staging Areas									
(Ware yard 4-2) D15-24-S1/D15-25-S1	Tributary to Willow Run	251.83	Intermittent	Intermediate	WWH	AWS and IWS	Partial/Total	15	N/A

a/ Identifies State and County where the stream is located, Drainage Area where stream is located, Project I.D.
b/ Waterbody crossing reference by nearest NEXUS pipeline milepost.
c/ Flow types were identified in the field based on flow relative to time/duration terminology from USGS Hydrologic Definitions.
Perennial – streams that flow continuously.
Intermittent – streams which flow only at certain times of the year when they receive water from springs or from some surface source such as melting snow in mountainous areas.
Ephemeral – streams that flow only in direct response to precipitation and whose channel is at all times above the water table.
d/ FERC stream classification is based on FERC's "Procedures" definition of minor, intermediate and major waterbodies. Minor = waterbodies less than or equal to 10 feet wide; Intermediate = waterbodies greater than 10 feet wide but less than or equal to 100 feet wide; Major = greater than 100 feet wide.

TABLE 2.3-2

Waterbodies Crossed by NEXUS Project

Pipeline/Station/ Drainage/Basin/ Waterbody ID a/	Waterbody Name	Milepost b/	Flow TYPE c/	FERC Classification d/	State Water Quality Classification e/	State Water Supply Classification f/	State Recreation Classification g/	Waterbody Width (feet) h/	Proposed Construction Method i/

e/ Aquatic Life Habitat designation types that area crossed by the NEXUS Project are defined below:

State Of Ohio - Water Use Quality Designations for Aquatic Life Habitat.

WWH (Warmwater Habitat) - these are waters capable of supporting and maintaining a balanced, integrated, adaptive community of warmwater aquatic organisms having a species composition, diversity, and functional organization comparable to the twenty-fifth percentile of the identified reference sites within each of the following ecoregions: the interior plateau ecoregion, the Erie/Ontario lake plains ecoregion, the western Allegheny plateau ecoregion, and the eastern corn belt plains ecoregion. For the Huron/Erie lake plains ecoregion, the comparable species composition, diversity and functional organization are based upon the ninetieth percentile of all sites within the region. For all ecoregions, the attributes of species composition, diversity and functional organization will be measured using the index of biotic integrity, the modified index of well-being and the invertebrate community index as defined in "Biological Criteria for the Protection of Aquatic Life: Volume II, User's Manual for Biological Field Assessment of Ohio Surface Waters," as cited in paragraph (B) of rule 3745-1-03 of the Administrative Code. In addition to those water body segments designated in rules 3745-1-08 to 3745-1-32 of the Administrative Code, all upground storage reservoirs are designated warmwater habitats. Attainment of this use designation (except for upground storage reservoirs) is based on the criteria in table 7-15 of this rule.

MWH **(**Modified Warmwater Habitat) – applies to extensively modified habitats that are capable of supporting the semblance of a warmwater biological community, but fall short of attaining WWH because of functional and structural deficiencies due primarily to altered macrohabitats.

State of Michigan - Water Use Quality Designations for Aquatic Life Habitat:

WWH **–** All surface waters of the state are designated and protected for warm water fishery. Specific rivers and inland lakes are designated and protected for cold water fishery. There are no specified cold water fisheries crossed by the NEXUS Project.

f/ The states of Michigan and Ohio assume that all streams support agricultural and industrial uses. Only water supply designation types that are crossed by the NEXUS Project are defined below:

AWS **(**Agricultural) - these are waters suitable for irrigation and livestock watering without treatment.

IWS (Industrial) - these are waters suitable for commercial and industrial uses, with or without treatment. Criteria for the support of the industrial water supply use designation will vary with the type of industry involved.

g/ **Ohio** - These Ohio use designations are in effect only during the recreation season, which is the period from May 1 to October 31. Primary Contact Classes A, B, and secondary contact recreational uses are crossed by the NEXUS Project. Primary Contact are waters that, during the recreation season, are suitable for one or more full-body contact recreation activities such as, but not limited to, wading, swimming, boating, water skiing, canoeing, kayaking, and scuba diving. Three classes of Primary Contact Recreation use are defined to reflect differences in the observed and potential frequency and intensity of usage. State recreation classifications are identified in rules 3745-1-08 to 3745-1-30 of the Administrative Code and defined below:

*Primary Contact A***.** These are waters that support, or potentially support, frequent primary contact recreation activities. The following water bodies are designated as class A Primary Contact Recreation waters. The streams and rivers listed in table 7-16 of this rule 3745-1-07 are popular paddling streams with public access points developed, maintained, and publicized by governmental entities.

Primary Contact B. These are waters that support, or potentially support, occasional Primary Contact Recreation activities. All surface waters of the state are designated as class B Primary Contact Recreation unless otherwise designated as bathing waters, Class A Primary Contact Recreation, Class C Primary Contact Recreation or Secondary Contact Recreation.

Secondary Contact. These are waters that result in minimal exposure potential to water borne pathogens because the waters are: rarely used for water based recreation such as, but not limited to, wading; situated in remote, sparsely populated areas; have restricted access points; and have insufficient depth to provide full body immersion, thereby greatly limiting the potential for water based recreation activities.

Michigan - At a minimum, all surface waters in Michigan are designated and protected by MIDEQ for the partial body contact recreation and total body contact recreation designations. Partial body contact recreation is designated throughout the year and total body recreation is designated from May 1 through October 1. Most designations have two or more types of assessment that may be used to determine support. These types of assessment include biological, physical/chemical, toxicological, pathogen indicators, other public health indicators and other aquatic health indicators.

Partial Body Contact - These are waters that support, or potentially support, occasional Partial Body Contact Recreation activities. Partial body recreation activities include paddling, canoeing, kayaking, etc. and are protected in all surface waters year round in Michigan.

Total Body Contact **-** These are waters that support, or potentially support, occasional Total Body Contact Recreation activities. Total body contact recreation activities include activities such as swimming, and all surface waters in Michigan are protected from May 1 through October 1 for such activities.

h/ Waterbody widths were estimated based on the average width located within NEXUS Project study corridor.

i/ NEXUS is proposing to utilize wet cut, dry cut, conventional bore, and HDD crossing methods. See section 2.3.9 of Resource Report 2 for descriptions of each crossing method type. Waterbodies that are located within the construction workspace but will not be crossed by the pipeline are listed as N/A (not applicable).

TABLE 2.3-3

Summary of Waterbodies Crossed by NEXUS Project HDDs

State, Facility, Waterbody ID	Milepost	Waterbody Name a/
Ohio		
Mainline		
AS-SU-200	40.91	Nimisila Reservoir
C15-28-S1	48.13	Tuscarawas River
C15-44-S1	71.14	Tributary to The Inlet
A14-46-S2	71.34	Tributary to The Inlet
A14-46-S1/AS-ME-50	71.35	Tributary to The Inlet
A14-50-S1	86.71	East Branch Black River
C15-8-S2	92.25	Tributary to West Branch Black River
C15-8-S3	92.25	Tributary to West Branch Black River
C15-8-S4	92.38	West Branch Black River
C15-56-S1	104.16	Tributary to Vermilion River
C15-56-S4	104.37	Vermilion River
C15-56-S4B	104.41	Vermilion River
C15-56-S4A	104.45	Tributary to Vermilion River
A14-186-S1/AS-ER-19	116.86	Huron River
AS-ER-20A	117.03	Tributary to Huron River
AS-ER-20	117.11	Tributary to Huron River
AS-SA-204	145.76	Sandusky River
D15-26-S1	162.47	Portage River
E15-8-S1	179.91	Tributary to Maumee River
D15-101-S1	179.95	Tributary to Maumee River
D15-99-S1	180.05	Tributary to Maumee River
E14-55-S1	181.34	Maumee River
E14-55-S1	181.61	Maumee River
Michigan		
Mainline		
E14-140-S1	215.2	River Raisin
E14-157-S1	237.5	Saline River
D15-21-S1	250.9	Huron River

a/ Name of surveyed waterbody.

TABLE 2.3-4

Surface Water Intakes Located Within 3 Miles of the NEXUS Project a/

State, Facility County	Nearest MP	Municipality	Waterbody Intake
Ohio			
TGP Interconnecting Pipeline			
None			
Mainline			
Lorain	91.38 and 92.50	Oberlin Water Department	West Branch Black River
Lucas	197.21	Swanton Village	Swan Creek
Michigan			
Mainline			
Lenawee	215.86	Blissfield	River Raisin

a/ Only intakes located with 3-miles and downstream of the Project are listed.

TABLE 2.3-5

Surface Public Water Protection Areas Crossed by the NEXUS Project

Facility	State	County	Milepost Begin	Milepost End	Source	Municipality, County (Original)	System Name
TGP Interconnect							
	OH	Columbiana	0	0.9	Ohio River	Wellsville, Columbiana	Buckeye Water District - Ohio River
						Cincinnati, Hamilton	Cincinnati Public Water System
						East Liverpool, Columbiana	East Liverpool City
						Ironton, Lawrence	Ironton Pws
						Portsmouth, Scioto	Portsmouth Public Water System
						Steubenville, Jefferson	Steubenville, City Of
						Toronto, Jefferson	Toronto Pws
Mainline							
	OH	Columbiana	0	7.6	Ohio River	Cincinnati, Hamilton	Cincinnati Public Water System
						Ironton, Lawrence	Ironton Pws
						Portsmouth, Scioto	Portsmouth Public Water System
					Mahoning River	Alliance, Stark	Alliance City Pws
						Sebring, Mahoning	Sebring Village Pws
						Newton Falls, Trumbull	Newton Falls City
		Columbiana	7.6	8.8	Ohio River	Wellsville, Columbiana	Buckeye Water District - Ohio River
						Cincinnati, Hamilton	Cincinnati Public Water System
						East Liverpool, Columbiana	East Liverpool City
						Ironton, Lawrence	Ironton Pws
						Portsmouth, Scioto	Portsmouth Public Water System
						Stuebenville, Jefferson	Steubenville, City Of
						Toronto, Jefferson	Toronto Pws
	OH	Columbiana-Stark	8.8	14.3	Ohio River	Cincinnati, Hamilton	Cincinnati Public Water System
						Ironton, Lawrence	Ironton Pws
						Portsmouth, Scioto	Portsmouth Public Water System
	OH	Stark	14.3	21.2	Mahoning River	Newton Falls, Trumbull	Newton Falls City
					Ohio River	Wellsville, Columbiana	Buckeye Water District - Ohio River

TABLE 2.3-5

Surface Public Water Protection Areas Crossed by the NEXUS Project

Facility	State	County	Milepost Begin	Milepost End	Source	Municipality, County (Original)	System Name
						Cincinnati, Hamilton	Cincinnati Public Water System
						East Liverpool, Columbiana	East Liverpool City
						Ironton, Lawrence	Ironton Pws
						Portsmouth, Scioto	Portsmouth Public Water System
						Stuebenville, Jefferson	Steubenville, City Of
						Toronto, Jefferson	Toronto Pws
						Cincinnati, Hamilton	Cincinnati Public Water System
	OH	Stark-Medina	21.2	72.7	Ohio River	Ironton, Lawrence	Ironton Pws
						Portsmouth, Scioto	Portsmouth Public Water System
	OH	Lorain	91.2	94.7	West Branch of Black River Reservoir	Oberlin, Lorain	Oberlin Water Department
	OH	Fulton	193.7	197.8	Swanton Reservoir	Swanton, Fulton	Swanton Village
Aboveground							
						Wellsville, Columbiana	Buckeye Water District - Ohio River
						Cincinnati, Hamilton	Cincinnati Public Water System
						East Liverpool, Columbiana	East Liverpool City
TGP M&R Station	OH	Columbiana	0	0.1	Ohio River	Ironton, Lawrence	Ironton Pws
						Portsmouth, Scioto	Portsmouth Public Water System
						Steubenville, Jefferson	Steubenville, City Of
						Toronto, Jefferson	Toronto Pws
						Wellsville, Columbiana	Buckeye Water District - Ohio River
						Cincinnati, Hamilton	Cincinnati Public Water System
						East Liverpool, Columbiana	East Liverpool City
MR02 (Kensington)	OH	Columbiana	0	0.1	Ohio River	Ironton, Lawrence	Ironton Pws
						Portsmouth, Scioto	Portsmouth Public Water System
						Steubenville, Jefferson	Steubenville, City Of
						Toronto, Jefferson	Toronto Pws
MR03 (Texas Eastern)	OH	Columbiana	0.8	0.9	Ohio River	Cincinnati, Hamilton	Cincinnati Public Water System

TABLE 2.3-5

Surface Public Water Protection Areas Crossed by the NEXUS Project

Facility	State	County	Milepost Begin	Milepost End	Source	Municipality, County (Original)	System Name
Hanoverton Compressor Station (CS1)	OH	Columbiana	1.3	1.5	Ohio River	East Liverpool, Columbiana	East Liverpool City
						Ironton, Lawrence	Ironton Pws
						Portsmouth, Scioto	Portsmouth Public Water System
						Steubenville, Jefferson	Steubenville, City Of
						Toronto, Jefferson	Toronto Pws
						Cincinnati, Hamilton	Cincinnati Public Water System
						Ironton, Lawrence	Ironton Pws
						Portsmouth, Scioto	Portsmouth Public Water System
Wadsworth Compressor Station (CS2)	OH	Medina	63.3	63.6	Ohio River	Cincinnati, Hamilton	Cincinnati Public Water System
						Ironton, Lawrence	Ironton Pws
						Portsmouth, Scioto	Portsmouth Public Water System
WareYards							-
Wareyard 1-1	OH	Stark	21	21.2	Mahoning River	Newton Falls, Trumbull	Newton Falls City
						Wellsville, Columbiana	Buckeye Water District - Ohio River
					Ohio River	East Liverpool, Columbiana	East Liverpool City
						Steubenville, Jefferson	Steubenville, City Of
						Toronto, Jefferson	Toronto Pws
						Cincinnati, Hamilton	Cincinnati Public Water System
			21.2	21.6	Ohio River	Ironton, Lawrence	Ironton Pws
						Portsmouth, Scioto	Portsmouth Public Water System

TABLE 2.3-6

Sensitive Waters Crossed by the NEXUS Project

State, Facility	County	MP	Waterbody ID a/	Waterbody Name	NRI ORV b/	State Designation c/
Ohio						
Mainline						
	Summit	48.14	C15-28-S1*	Tuscarawas River	N/A	N/A
	Lorain	86.72	A14-50-S1	East Branch Black River	S, R, H	N/A
	Lorain	92.39	C15-8-S4	West Branch Black River	S, R, G, W, H	N/A
	Erie	100.40	AS-ER-100-S1	Vermillion River	S, F, R	OSW-E
	Erie	116.88	A14-186-S1/AS-ER-19*	Huron River	N/A	N/A
	Sandusky	141.28	E14-31-S1*	Sandusky River	R, H	N/A
	Wood/Lucas	176.12	E14-55-S1*	Maumee River	N/A	OSW-R
TGP Interconnecting Pipeline						
	Washtenaw	250.92	D15-21-S1	Huron River	R, F, H	N/A

a/ *: Indicates the waterbodies that are under USACE Section 10 of the Rivers and Harbors Act and designated as Navigable waters.

b/ NRI ORV Definitions

Scenery (S): The landscape elements of landform, vegetation, water, color, and related factors result in notable or exemplary visual features and/or attractions. When analyzing scenic values, additional factors -- such as seasonal variations in vegetation, scale of cultural modifications, and the length of time negative intrusions are viewed -- may be considered. Scenery and visual attractions may be highly diverse over the majority of the river or river segment.

Recreation (R): Recreational opportunities are, or have the potential to be, popular enough to attract visitors from throughout or beyond the region of comparison or are unique or rare within the region. Visitors are willing to travel long distances to use the river resources for recreational purposes. River-related opportunities could include, but are not limited to, sightseeing, wildlife observation, camping, photography, hiking, fishing and boating.

Geology (G): The river, or the area within the river corridor, contains one or more example of a geologic feature, process or phenomenon that is unique or rare within the region of comparison. The feature(s) may be in an unusually active stage of development, represent a "textbook" example, and/or represent a unique or rare combination of geologic features (erosional, volcanic, glacial, or other geologic structures).

Fish (F): Fish values may be judged on the relative merits of either fish populations, habitat, or a combination of these river-related conditions.

Wildlife (W): Wildlife values may be judged on the relative merits of either terrestrial or aquatic wildlife populations or habitat or a combination of these conditions.

History (H): The river or area within the river corridor contains a site(s) or feature(s) associated with a significant event, an important person, or a cultural activity of the past that was rare or one-of-a-kind in the region. Many such sites are listed on the National Register of Historic Places. A historic site(s) and/or features(s) is 50 years old or older in most cases.

c/ State Designations are based on the OEPA Antidegradation Rule definitions.

OSW-E: Waters that have special significance for the state because of their exceptional ecological values.

OSW-R: Waters that have special significance for the state because of their exceptional recreational values.

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
Ohio			
Mainline			
Ohio River Drainage Basin			
Columbiana			
B15-17-S2	Tributary to Brush Creek	0.07	Aquatic Health Human Health Recreation
B15-28-S1	Tributary to Sandy Creek	0.66	Aquatic Health
B15-17-S2	Tributary to Brush Creek	0.69	Aquatic Health
B15-17-S2	Tributary to Brush Creek	0.74	Aquatic Health Human Health Recreation
B15-29-S1	Tributary to Sandy Creek	0.96	Aquatic Health Human Health Recreation
A14-5-S4	Tributary to Sandy Creek	2.03	Aquatic Health Human Health Recreation
A14-5-S3	Tributary to Sandy Creek	2.19	Aquatic Health Human Health Recreation
A14-5-S3	Tributary to Sandy Creek	2.2	Aquatic Health Human Health Recreation
A14-8-S1	Tributary to Sandy Creek	3.9	Aquatic Health Human Health Recreation
A14-10-S1	Conser Run	4.87	Aquatic Health Human Health Recreation
A14-11-S1	Tributary to Conser Run	5.25	Aquatic Health Human Health Recreation
A14-127-S1	Tributary to Conser Run	5.66	Aquatic Health Human Health Recreation
AS-CO-214	Tributary to Conser Run	6.45	Aquatic Health Human Health Recreation Aquatic Health

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
A14-196-S1	Tributary to Middle Branch Sandy Creek	9.77	Human Health Recreation
C15-65-S1	Tributary to Middle Branch Sandy Creek	10.97	Human Health Recreation
A15-34-S1/AS-CO-201A	Tributary to Middle Branch Sandy Creek	11.2	Human Health Recreation
AS-CO-201	Sandy Creek	11.21	Human Health Recreation
A14-165-S2	Tributary to Woodland Lake	12.26	Human Health Recreation
Stark			
AS-ST-213	Tributary to Middle Branch Sandy Creek	13.38	Human Health Recreation
AS-ST-7	Beech Creek	17.17	Recreation Aquatic Health
A14-103-S1	Tributary to Beech Creek	18.2	Recreation Aquatic Health
AS-ST-202	Tributary to Beech Creek	19.36	Recreation Aquatic Health
A15-36-S1	Tributary to Red Pine Lake	20.49	Recreation Aquatic Health
A14-25-S1	Middle Branch Nimishillen Creek	21.78	Human Health Recreation Aquatic Health
A14-175-S1	Tributary to Middle Branch Nimishillen Creek	22.75	Human Health Recreation Aquatic Health
A14-161-S1	Tributary to Middle Branch Nimishillen Creek	24.6	Human Health Recreation Aquatic Health
AS-ST-209	Nimishillen Creek	26.83	Human Health Recreation Aquatic Health
B15-45-S1/AS-ST-200	Tributary to Swartz Ditch	27.71	Human Health Recreation Aquatic Health

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
			Human Health
AS-ST-15	Tributary to Nimishillen Creek	29.33	Recreation
			Aquatic Health
			Human Health
AS-ST-17	Tributary to Nimishillen Creek	29.63	Recreation
			Aquatic Health
			Human Health
A14-158-S1	Tributary to West Branch Nimishillen Creek	30.92	Recreation
			Aquatic Health
			Human Health
A14-163-S1	Tributary to West Branch Nimishillen Creek	31.59	Recreation
			Aquatic Health
			Human Health
A14-164-S2	West Branch Nimishillen Creek	31.98	Recreation
			Aquatic Health
			Human Health
A14-164-S1	Tributary to West Branch Nimishillen Creek	32.21	Recreation
			Aquatic Health
			Human Health
AS-ST-205	Tributary to Tuscarawas	33.79	Recreation
			Aquatic Health
			Human Health
AS-ST-205	Tributary to Tuscarawas	33.87	Recreation
			Aquatic Health
Summit			
			Human Health
AS-SU-211	Tributary to Tuscarawas River	34.72	Recreation
			Aquatic Health
			Human Health
AS-SU-208A	Tributary to Tuscarawas River	36.23	Recreation
			Aquatic Health
AS-SU-205	Tributary to Willow Lake	37.44	Recreation
			Aquatic Health
AS-SU-201	Tributary to Nimisilla Reservoir	39.35	Recreation
			Aquatic Health
A14-112-S1	Tributary to Nimisila Reservoir	39.49	Recreation
			Aquatic Health

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
A14-112-S1-A	Tributary to Nimisila Reservoir	39.88	Recreation Aquatic Health
A14-112-S1-B	Tributary to Nimisila Reservoir	40.07	Recreation Aquatic Health
AS-SU-13A	Tributary to Nimishillen Reservoir	40.37	Recreation Aquatic Health
AS-SU-200	Nimisila Reservoir	40.94	Recreation Aquatic Health
A14-122-S2	Nimisila Creek	41.71	Human Health Recreation
A14-122-S3	Tributary to Nimisila Creek	41.72	Human Health Recreation
AS-SU-18	Tributary to Nimisila Creek	42.47	Human Health Recreation
AS-SU-23	Tributary to Nimisila Creek	44.14	Human Health Recreation
C15-25-S1	Tributary to Tuscarawas River	46.78	Human Health Recreation Aquatic Health
C15-28-S1	Tuscarawas River	48.14	Human Health Recreation Aquatic Health
AS-SU-40	Pancake Creek	48.9	Human Health Recreation Aquatic Health
AS-SU-43	Tributary to Willowdale Lake	49.24	Recreation Aquatic Health
AS-SU-43	Tributary to Willowdale Lake	49.63	Recreation Aquatic Health
Wayne			
A15-20-S1	Tributary to Pancake Creek	50.46	Human Health Recreation Aquatic Health
A14-124-S2	Tributary to Silver Creek	52.57	Human Health Recreation Aquatic Health
A14-124-S1	Silver Creek	52.64	Human Health

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
			Recreation
			Aquatic Health
			Human Health
B15-47-S1	Tributary to Mill Creek	54.92	Recreation
			Aquatic Health
			Human Health
A15-41-S1	Mill Creek	55.3	Recreation
			Aquatic Health
			Human Health
B15-51-S1	Styx River	57.64	Recreation
			Aquatic Health
Medina			
			Human Health
B15-02-S1	Tributary to Styx River	59.85	Recreation
			Aquatic Health
			Human Health
A14-39-S1	Tommy Run	60.73	Recreation
			Aquatic Health
			Human Health
AS-ME-19	Tributary to Chippewa Creek	61.85	Recreation
			Aquatic Health
			Human Health
A14-116-S2	Tributary to Hubbard Creek	65.29	Recreation
			Aquatic Health
			Human Health
B14-4-S1	Tributary to Hubbard Creek	66.2	Recreation
			Aquatic Health
			Human Health
AS-ME-27	Tributary to Chippewa Creek	67.38	Recreation
			Aquatic Health
			Human Health
AS-ME-30	Tributary to Chippewa Creek	67.58	Recreation
			Aquatic Health
			Human Health
AS-ME-34	Tributary to Chippewa Creek	68.12	Recreation
			Aquatic Health
A15-3-S1/AS-ME-37	McCabe Creek	68.78	Human Health

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
			Recreation
			Aquatic Health
			Human Health
C15-41-S1	Tributary to The Inlet	69.66	Recreation
			Aquatic Health
			Human Health
C15-6-S2	Tributary to The Inlet	69.86	Recreation
			Aquatic Health
			Human Health
C15-6-S1	Tributary to The Inlet	69.95	Recreation
			Aquatic Health
			Human Health
C15-42-S1/AS-ME-46	The Inlet	70.78	Recreation
			Aquatic Health
			Human Health
C15-44-S1	Tributary to The Inlet	71.14	Recreation
			Aquatic Health
			Human Health
A14-46-S1/AS-ME-50	Tributary to The Inlet	71.36	Recreation
			Aquatic Health
Lake Erie Drainage Basin			
			Human Health
C15-24-S1/AS-ME-209	Tributary to Mallet Creek	72.91	Aquatic Health
			Human Health
C15-24-S8	Tributary to Mallet Creek	73.35	Aquatic Health
			Human Health
C15-24-S1-3	Mallet Creek	73.38	Aquatic Health
			Human Health
C15-24-S1-3	Mallet Creek	73.49	Aquatic Health
			Human Health
AS-ME-58A	Tributary to Mallet Creek	73.86	Aquatic Health
			Human Health
AS-ME-58	Tributary to Mallet Creek	73.98	Aquatic Health
			Human Health
AS-ME-62	Tributary to Mallet Creek	74.87	Aquatic Health
			Human Health
B14-10-S1	Tributary to Mallet Creek	75.1	Aquatic Health

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
AS-ME-206B	Tributary to Mallet Creek	75.81	Human Health Aquatic Health
AS-ME-206	Mallet Creek	76	Human Health Aquatic Health
AS-ME-204	Tributary to Mallet Creek	76.3	Human Health Aquatic Health
AS-ER-202B	Tributary to Mallet Creek	76.93	Human Health Aquatic Health
AS-ME-202A	Tributary to Mallet Creek	76.98	Human Health Aquatic Health
AS-ME-201	Tributary to Mallet Creek	77.44	Human Health Aquatic Health
AS-ME-77	Tributary to Mallet Creek	77.81	Human Health Aquatic Health
AS-ME-96	Tributary to West Branch Rocky River	78.9	Recreation Aquatic Health
AS-LO-1	Tributary to East Branch Black River	80.34	Human Health Recreation Aquatic Health
B15-15-S1	Tributary to East Branch Black River	80.45	Human Health Recreation Aquatic Health
Lorain			
A15-28-S1	Tributary to East Branch Black River	81.37	Human Health Recreation Aquatic Health
A14-69-S4	Salt Creek	84.35	Human Health Recreation Aquatic Health
AS-LO-10	Tributary to East Branch Black River	85.83	Human Health Recreation Aquatic Health
AS-LO-10	Tributary to East Branch Black River	85.96	Human Health Recreation Aquatic Health
A14-50-S1	East Branch Black River	86.72	Human Health Recreation

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
A14-55-S1	Tributary to Dent Ditch	87.31	Aquatic Health Human Health Recreation
AS-LO-45	Tributary to East Branch Black River	88.01	Aquatic Health Human Health Recreation
A14-73-S1	King Ditch	88.63	Aquatic Health Human Health Recreation
A14-75-S2	Tributary to King Ditch	89.31	Aquatic Health Human Health Recreation
A14-76-S1	Kelner Ditch	90.22	Aquatic Health Human Health Recreation
C15-37-S1	Elk Creek	91.34	Aquatic Health Human Health Recreation
C15-35-S1	Wellington Creek	91.8	Aquatic Health Recreation
C15-8-S3	Tributary to West Branch Black River	92.26	Aquatic Health Human Health Recreation
C15-8-S4	West Branch Black River	92.39	Aquatic Health Human Health Recreation
C15-9-S1	Tributary to West Branch Black River	92.6	Aquatic Health Human Health Recreation
A14-141-S1	Plum Creek	96.09	Aquatic Health Human Health Recreation
C15-61-S1	Tributary to East Fork Vermilion River	98.29	Aquatic Health Human Health
C15-66-S1	Tributary to East Fork Vermilion River	99.31	Aquatic Health Human Health Aquatic Health

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
C15-66-S2	East Fork Vermilion River	99.31	Human Health Aquatic Health
C15-67-S1	Frankenburg Creek	101.29	Human Health Aquatic Health
Huron			
AS-HU-200	Tributary to Frankenburg Creek	101.65	Human Health Aquatic Health
AS-HU-202	Tributary to Frankenburg Creek	102.33	Human Health Aquatic Health
C15-88-S1	Tributary to Frankenburg Creek	102.97	Human Health Aquatic Health
C15-56-S4	Vermilion River	104.37	Human Health Aquatic Health
C15-56-S4b	Vermilion River	104.42	Human Health Aquatic Health
C15-56-S4A	Tributary to Vermilion River	104.46	Human Health Aquatic Health
Erie			
C15-69-S1	Chappel Creek	105.9	Aquatic Health
A14-187-S1	Old Woman Creek	113.14	Recreation Aquatic Health
A14-188-S1	Tributary to Old Woman Creek	113.32	Recreation Aquatic Health
AS-ER-12	Tributary to Old Woman Creek	113.84	Recreation Aquatic Health
B15-07-S1	Tributary to Old Woman Creek	114.25	Recreation Aquatic Health
C15-14-S1	Tributary to Huron River	115.39	Recreation Aquatic Health
C15-15-S1	Tributary to Huron River	115.73	Recreation Aquatic Health
A14-155-S1	Tributary to Huron River	116.51	Recreation Aquatic Health
A14-186-S1/AS-ER-19	Huron River	116.88	Recreation Aquatic Health
C15-20-S1	Tributary to Mud Brook	117.62	Recreation Aquatic Health

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
C15-18-S1	Tributary to Mud Brook	118.42	Recreation Aquatic Health
B15-11-S1	Tributary to Mud Brook	118.8	Recreation Aquatic Health
E14-97-S1	Mud Creek	118.96	Recreation Aquatic Health
AS-ER-206	Zorn Beutal Ditch	120	Recreation
C15-22-S1	Sheerer Ditch	120.36	Recreation
B15-12-S1	Sherer Ditch	120.86	Recreation
B15-13-S1	Sherer Ditch	122.04	Recreation
B15-13-S1	Sherer Ditch	122.06	Recreation
AS-ER-205	Tributary to Sawmill Creek	122.13	Recreation
AS-ER-28	Tributary to Pipe Creek	124.03	Recreation Aquatic Health
C15-23-S1	Tributary to Pipe Creek	125.71	Recreation Aquatic Health
E14-95-S1	Pipe Creek	125.86	Recreation Aquatic Health
E14-51-S1/AS-ER-201	Tributary to Mills Creek	128.12	Recreation Aquatic Health
E14-51-S1	Tributary to Mills Creek	128.35	Recreation Aquatic Health
E14-94-S1/AS-ER-200	Mills Creek	129.25	Recreation Aquatic Health
Sandusky			
D15-74-S1	Scherz Ditch	134.28	Recreation
D14-4-S1	Strong Creek	135.34	Recreation
D14-6-S1	Fuller Creek	135.96	Recreation Aquatic Health
D14-6-S1	Fuller Creek	135.98	Recreation Aquatic Health
D14-7-S1	Tributary to Fuller Creek	136.41	Recreation Aquatic Health
D15-49-S1/AS-SA-202	Tributary to Fuller Creek	136.91	Recreation Aquatic Health
E14-105-S1	Pickerel Creek	138.01	Recreation Aquatic Health

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
D14-9-S1	Little Raccoon Creek	138.65	Recreation Aquatic Health
D14-10-S1	Tributary to Little Raccoon Creek	139.08	Recreation Aquatic Health
D14-8-S1	Raccoon Creek	139.89	Recreation Aquatic Health
E14-103-S1	South Creek	140.53	Recreation Aquatic Health
D15-31-S1	Tributary to South Creek	141.17	Recreation Aquatic Health
D14-11-S1	Green Creek	141.69	Recreation Aquatic Health
AS-SA-100	Tributary to Buehler Ditch	142.7	Aquatic Health
E14-36-S1	Tributary to Buehler Ditch	142.99	Aquatic Health
D15-47-S1	Buehler Ditch	143.34	Aquatic Health
D14-40-S1	Bark Creek	143.72	Aquatic Health
AS-SA-204	Sandusky River	145.81	Aquatic Health
D15-104-S1	Tributary to Sandusky River	146.29	Aquatic Health
AS-SA-206	Tributary to Greesman Ditch	146.71	Recreation Aquatic Health
D14-33-S1	Tributary to Muskellunge Creek	147.48	Recreation Aquatic Health
E14-121-S1	Tributary to Muskellunge Creek	147.73	Recreation Aquatic Health
D15-52-S1	Little Muddy Creek	149.37	Recreation Aquatic Health
E14-43-S1	Muddy Creek	153.35	Human Health Recreation Aquatic Health
D15-35-S1	Tributary to Muddy Creek	154.44	Human Health Recreation Aquatic Health
E14-109-S1	Tributary to Muddy Creek	154.74	Human Health Recreation Aquatic Health
E14-42-S1	Ninemile Creek	155.19	Human Health Recreation

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
Wood			
E14-3-S1	Tributary to Ninemile Creek	155.92	Aquatic Health Human Health Recreation
D15-50-S1	Tributary to Wolf Creek	156.87	Aquatic Health Human Health Recreation
C15-79-S1	Wolf Creek	157.81	Aquatic Health Human Health Recreation
D14-25-S1	Sugar Creek	158.61	Aquatic Health Human Health Recreation
E14-107-S1	Tributary to Victoria Creek	160.78	Aquatic Health Human Health Recreation
E14-108-S1	Victoria Creek	161.29	Aquatic Health Human Health Recreation
D15-26-S1	Portage River	162.49	Aquatic Health Human Health Recreation
E14-111-S1	Martin Ditch	163.81	Aquatic Health Human Health Recreation
D14-31-S1	Tributary to Martin Ditch	164.75	Aquatic Health Human Health Recreation
E14-85-S1	Tributary to Toussaint Creek	165.62	Aquatic Health Human Health Recreation
D14-34-S1	Tributary to Toussaint Creek	166.8	Aquatic Health Human Health Recreation
E14-175-S1	Toussaint Creek	167.34	Aquatic Health Human Health Recreation

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
			Aquatic Health
			Human Health
E15-22-S1	Tributary to Toussaint Creek	167.83	Recreation
			Aquatic Health
E14-79-S1	Tributary to Packer Creek	170.44	Human Health
			Aquatic Health
E14-80-S1	Tributary to Packer Creek	170.82	Human Health
			Aquatic Health
E14-40-S1	Packer Creek	171.13	Human Health
			Aquatic Health
D15-62-S1	Tributary to Cedar Creek	173.96	Recreation
			Aquatic Health
E14-35-S1	Tributary to Cedar Creek	174.48	Recreation
			Aquatic Health
E15-32-S1	Tributary to Henry Creek	175.44	Recreation
			Aquatic Health
E15-33-S1	Tributary to Henry Creek	175.59	Recreation
			Aquatic Health
E15-7-S1	Tributary to Maumee River	177.32	Recreation
D14-45A-S1	Tributary to Maumee River	178.07	Recreation
D15-101-S1	Tributary to Maumee River	179.95	Recreation
E14-46-S1	Tributary to Maumee River	180.68	Recreation
E14-44-S1	Tributary to Maumee River	180.78	Recreation
Lucas			
			Recreation
E14-116-S1	Blystome Ditch	182.73	Aquatic Health
			Recreation
E14-29-S1	Suter Ditch	183.28	Aquatic Health
			Recreation
E14-1-S1	Whitemeir Ditch	183.56	Aquatic Health
			Recreation
E14-37-S1	Estworthy Ditch	183.71	Aquatic Health
			Recreation
E14-38-S1	Disher Ditch	184.11	Aquatic Health
			Recreation
E14-39-S1	Harris Ditch	185.28	Aquatic Health
E14-22-S1	Tributary to Ruhm Ditch	186.61	Recreation

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
			Aquatic Health
E15-21-S1	Doran Ditch	187.32	Recreation
D15-1-S1	Yawberg Ditch	187.46	Recreation
D15-91-S1	Jeffers Ditch	187.7	Recreation
E15-9-S1	Laver Ditch	188.12	Recreation
Fulton			
E15-14-S1	Blue Creek	190.93	Recreation
E15-14-S2	Tributary to Blue Creek	191.06	Recreation
D15-110-S1	Tributary to Blue Creek	192.28	Recreation
D15-111-S1	Tributary to Blue Creek	193.22	Recreation
D15-60-S1	Tributary to Fewless Creek	193.87	Recreation
			Aquatic Health
E15-37-S1	Tributary to Fewless Creek	194.98	Recreation
			Aquatic Health
E15-36-S1	Fewless Creek	195.24	Recreation
			Aquatic Health
D15-17-S1	Swan Creek	196.36	Recreation
			Aquatic Health
D15-9-S1	Tributary to Swan Creek	197.25	Recreation
			Aquatic Health
D15-98-S1	Tributary to Swan Creek	197.51	Recreation
			Aquatic Health
D15-60A-S1	Tributary to Fewless Creek	197.85	Recreation
			Aquatic Health
D15-10-S1	Tributary to Swan Creek	198.64	Recreation
			Aquatic Health
D15-13-S1	Tributary to Swan Creek	199.09	Recreation
			Aquatic Health
E14-4-S1	Ai Creek	200.78	Recreation
			Aquatic Health
E15-19-S1	Frankfort Ditch	202.13	Recreation
			Aquatic Health
D14-24-S1	Tributary to McNett Ditch	202.69	Recreation
			Aquatic Health
E14-112-S1	McNett Ditch	203.43	Recreation
			Aquatic Health
D14-44-S1	Tributary to Langenderfer Ditch	203.76	Human Health

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
D14-44-S1	Tributary to Langenderfer Ditch	203.88	Recreation Human Health
D14-44-S1	Tributary to Langenderfer Ditch	203.93	Recreation Human Health
E14-11-S1	Tributary to Schmitz Ditch	206.22	Recreation Human Health
D14-45-S1	Tenmile Creek	207.87	Aquatic Health Recreation Human Health Aquatic Health
Michigan			
Lenawee			
E14-140-S1	River Raisin	215.19	Fish Consumption
D15-28-S1	Tributary to River Raisin	215.79	Fish Consumption
AS-LE-5	Tributary to River Raisin	216.29	Fish Consumption
E14-143-S1	Little River Raisin	220.47	Fish Consumption
E14-64-S1	Fry Drain	220.7	Fish Consumption
E14-69-S1	Isley Drain	222.05	Fish Consumption
E14-76-S1	Swamp Raisin Creek	222.48	Fish Consumption
E14-77-S1	Tributary to Swamp Raisin Creek	222.66	Fish Consumption
AS-LE-203	Dibble Drain	225.81	Fish Consumption
AS-LE-202	Tributary to South Branch Macon Creek	225.59	Fish Consumption
AS-LE-204	South Branch Macon Creek	226.43	Fish Consumption
E14-126-S1/AS-LE-205	Tributary to South Branch Macon Creek	226.65	Fish Consumption
E14-74-S1	Schreeder Brook	226.84	Fish Consumption
E14-149-S1/AS-LE-12	Tributary to Middle Branch Macon Creek	228.8	Fish Consumption
E14-87-S1	Macon Creek	229.53	Fish Consumption Aquatic Life and Wildlife
E14-61-S1	Tributary to Richardson Drain	229.82	Fish Consumption
Monroe			
E14-63-S1	Tributary to Richardson Drain	230.71	Fish Consumption
AS-MO-1	Richardson Drain	231.42	Fish Consumption
E14-65-S1	Bear Swamp Creek	231.9	Fish Consumption
E14-66-S1	Tributary to Bear Swamp Creek	232.39	Fish Consumption
D15-40-S1	Cone Drain	233.28	Fish Consumption
AS-MO-2	Tributary to Center Creek	233.69	Fish Consumption

TABLE 2.3-7

Impaired Surface Waters Crossed by NEXUS Project

State, Drainage Basin, County, Waterbody I.D. a/	Waterbody Name	Milepost b/	Beneficial Use Impaired c/
AS-MO-10A	Tributary to Center Creek	234.26	Fish Consumption
AS-MO-10	Center Creek	234.39	Fish Consumption
AS-MO-4	North Branch Macon Creek	235.99	Fish Consumption
Washtenaw			
E14-157-S1	Saline River	237.55	Fish Consumption
E14-135-S1	McCarthy Drain	244.18	Aquatic Life and Wildlife
E14-162-S1	West Branch Paint Creek	244.72	Aquatic Life and Wildlife
E15-13-S1	Tributary to West Branch Paint Creek	244.96	Aquatic Life and Wildlife
E14-99-S1	Tributary to Bird Drain	245.02	Aquatic Life and Wildlife
E14-164-S1/AS-WA-6	Paint Creek	246.29	Aquatic Life and Wildlife
E14-176-S1	Tributary to Paint Creek	246.58	Aquatic Life and Wildlife
TGP Interconneting Pipeline			
Ohio River Drainage Basin			
Columbiana			
B15-17-S2	Tributary to Brush Creek	0.07	Aquatic Life

a/ Identifies State and County where the stream is located, Drainage Area where stream is located, Project I.D.
b/ Stream crossing referenced by nearest NEXUS Project pipeline facility milepost.
c/ Beneficial use impairment was identified by the 2014 Ohio Integrated Water Quality Monitoring Report and OEPA GIS data and the 2014 Michigan Integrated Water Quality Monitoring Report.
Human Health - Ohio -waterbodies with a weighted average fish tissue concentration of PCBs, mercury, DDT, chlordane, or hexachlorobenzene above the WQS-based fish tissue concentration is then assigned a corresponding score.
Recreation -Ohio - waterbodies with a seasonal geometric mean E.coli content based on samples from the recreation season within a calendar year exceeds the predetermined levels of acceptance.
Aquatic Life- Ohio - A biological community at an EWH, WWH, or MWH sampling site must achieve the relevant criteria for all three indices, or those available and/or applicable, in order to be in full attainment of the designated aquatic life use criteria. Partial attainment is determined if one criterion is not achieved while nonattainment results when all biological scores are less than the criteria or if poor or very poor index scores are measured in either fish or macroinvertebrate communities.
Aquatic Life/Wildlife and Fish Consumption -Michigan surface waters impacted by polychlorinated biphenyls (PCBs) and mercury do not support the other indigenous aquatic life and wildlife designated use and/or the fish consumption designated use.

TABLE 2.3-8

FEMA Flood Zones Crossed by the NEXUS Project

State, Facility, County	Milepost Enter a/	Milepost Exit a/	FEMA Flood Zone b/
Ohio			
Mainline			
Columbiana	1.99	2.04	A
Columbiana	2.05	2.23	A
Columbiana	4.99	5.05	A
Columbiana	10.97	11.00	A
Columbiana	11.15	11.21	A
Stark	25.74	25.75	A
Stark	25.85	25.88	A
Stark	26.46	26.49	A
Stark	26.69	26.85	A
Stark	31.97	32.00	AE
Stark	32.06	32.10	AE
Stark	32.10	32.16	AE
Stark	32.21	32.22	AE
Stark	33.66	33.67	AE
Stark	33.75	33.84	AE
Stark	33.85	34.01	AE
Stark	34.02	34.19	AE
Summit	41.72	42.10	A
Summit	48.88	48.95	A
Wayne	52.64	52.65	A
Wayne/Medina	57.41	57.96	AE
Medina	60.70	60.74	AE
Medina	68.78	68.80	A
Medina	70.77	70.78	AE
Medina	70.95	70.96	AE
Medina	70.98	71.00	AE
Medina	71.03	71.16	AE
Medina	75.91	76.09	A
Lorain	84.32	84.46	A
Lorain	86.44	86.74	A
Lorain	88.59	88.82	A
Lorain	90.21	90.26	A
Lorain	91.33	91.36	A
Lorain	91.78	91.85	A
Lorain	91.82	91.90	A
Lorain	92.22	92.77	A
Lorain	96.06	96.10	AE
Lorain	99.27	99.34	A
Huron	104.34	104.46	AE
Huron	104.49	104.51	AE
Erie	105.83	105.91	A
Erie	113.13	113.23	A
Erie	113.31	113.32	A
Erie	113.83	113.89	A
Erie	114.25	114.27	A
Erie	115.38	115.39	A
Erie	115.73	115.74	A
Erie	116.49	116.53	AE

TABLE 2.3-8

FEMA Flood Zones Crossed by the NEXUS Project

State, Facility, County	Milepost Enter a/	Milepost Exit a/	FEMA Flood Zone b/
Erie	116.72	116.98	AE
Erie	117.40	117.41	A
Erie	117.59	117.63	A
Erie	118.40	118.44	A
Erie	118.80	118.82	A
Erie	118.90	118.91	A
Erie	118.92	119.01	A
Erie	125.70	125.72	A
Erie	125.83	125.89	A
Erie	129.02	129.45	A
Sandusky	131.52	131.70	A
Sandusky	135.33	135.35	A
Sandusky	135.94	136.02	A
Sandusky	137.93	138.06	A
Sandusky	139.84	139.95	A
Sandusky	140.52	140.55	A
Sandusky	141.10	141.19	A
Sandusky	141.52	141.73	A
Sandusky	143.68	143.83	A
Sandusky	145.32	145.37	AE
Sandusky	145.40	145.41	AE
Sandusky	145.43	145.44	AE
Sandusky	145.54	145.86	AE
Sandusky	145.96	144.06	AE
Sandusky	149.37	149.47	A
Sandusky	153.34	153.50	A
Sandusky	153.86	153.88	A
Sandusky	153.91	153.92	A
Sandusky	155.13	155.19	A
Sandusky	158.57	158.75	A
Sandusky	162.46	162.65	A
Wood	165.61	165.62	A
Wood	167.26	167.40	A
Wood	171.12	171.14	A
Wood/Lucas	181.35	181.75	AE
Lucas	182.65	182.78	AE
Lucas	185.25	185.29	AE
Lucas	185.30	185.32	A
Fulton	190.75	190.96	AE
Fulton	191.05	191.06	AE
Fulton	191.13	191.14	AE
Fulton	194.97	194.98	AE
Fulton	195.14	195.30	AE
Fulton	195.84	195.97	AE
Fulton	196.30	196.39	AE
Fulton	200.77	200.87	AE
Fulton	207.86	207.92	AE

TABLE 2.3-8

FEMA Flood Zones Crossed by the NEXUS Project

State, Facility, County	Milepost Enter a/	Milepost Exit a/	FEMA Flood Zone b/
Michigan			
Mainline			
Monroe	230.70	230.71	A
Monroe	231.41	231.42	A
Monroe	231.90	231.91	A
Monroe	232.39	232.41	A
Monroe	233.22	233.38	A
Monroe	234.08	234.10	A
Monroe	234.17	234.18	A
Monroe	234.36	234.41	A
Monroe	235.34	235.35	A
Monroe	235.97	236.03	A
Washtenaw	237.36	237.56	A
Washtenaw	244.65	244.91	AE
Washtenaw	246.24	246.35	AE
Washtenaw	250.84	250.94	AE
Washtenaw	253.36	253.42	A
Ohio			
Aboveground Facilities			
Erie - WareYard 2-1 - 2.61 acres	110.40	110.41	A

a/ Approximate enter and exit MP along the proposed pipeline centerline rounded to the nearest hundredth.
b/ Flood hazard areas identified on the Flood Insurance Rate Map are identified as a Special Flood Hazard Area ("SFHA"). SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year.
FEMA Flood Zone A: Areas subject to inundation by the 1-percent-annual-chance (100 year) flood event generally determined using approximate methodologies.
FEMA Flood Zone AE: Areas subject to inundation by the 1-percent-annual-chance (100 year). Flood event determined by detailed methods.

TABLE 2.3-9

Potential Hydrostatic Testing Water Sources for the NEXUS Project Pipeline Segments

Approximate Withdrawal Milepost	Potential Source(s) a/, b/	Estimated Volume Uptake (gallons) c/
Ohio		
Mainline		
Spread 1		
25.17	Unknown Lake	13,841,520
Spread 2		
92.26	Tributary to West Branch Black River	10,846,130
116.86	Huron River	9,644,494
86.71	East Branch of Black River	Alternative Source
123.35	Unknown Lake	Alternative Source
Spread 3		
145.76	Sandusky River	8,421,233
181.34	Maumee River	11,137,999
162.47	Portage River	Alternative Source
Interconnect Pipeline to TGP		
N/A	Water Truck	232,848
Ohio Subtotal		***54,124,224***
Michigan		
Mainline		
Spread 4		
237.53	Saline River	9,280,849
251.1	Ford Lake	2,830,950
215.17	River Raisin	Alternative Source
Michigan Subtotal		***12,111,799***
PROJECT TOTAL		***66,236,023***

a/ The NEXUS Project may use additional waterbodies to those included in the above table depending on conditions encountered during construction. All waterbodies used as sources will be registered and permitted as required for withdrawal of hydrostatic test water. Known alternative water sources have been identified for project use and are included in this table.
b/ Water will be trucked in from a municipal or other approved project source.
c/ Volumes of potential water sources may vary from this table depending on project use of alternative water sources and conditions encountered during construction.

TABLE 2.3-10

Potential Sources of Hydrostatic Test Water for the NEXUS Project Aboveground Facilities

Facility	Estimated Volume (gallons) a/, b/	Potential Source(s) c/
Compressor Stations		
Compressor Station 1 - Hanoverton	154,211	Water Truck
Compressor Station 2 - Wadsworth	85,545	Water Truck
Compressor Station 3 - Clyde	129,552	Water Truck
Compressor Station 4 - Waterville	104,407	Water Truck
Meter Stations		
MR01	27,056	Water Truck
MR02	31,497	Water Truck
MR03	32,257	Water Truck
MR04	44,669	Water Truck
MR05	27,056	Water Truck
Aboveground Facilities Total	**636,250**	

a/ Volumes for Meter Stations do not include skid piping. This piping is tested during initial fabrication prior to arriving at the Project site. Testing as part of the Project installation is not anticipated.
b/ Assume 30% water re-use for CS 1, 2, 3, and 4.
c/ Water will be trucked in from a municipal or other approved project source.

TABLE 2.3-11

Potential Hydrostatic Test Water for the NEXUS Project HDDs

HDD	Milepost of the HDD Exit	Maximum Estimated Volume (gallons) Hydrostatic Test Water	Water Source a/
Ohio			
Mainline			
MP 7.7 Category III Wetland	8.4	149,341	Water Truck
Nimisila Reservoir	41.1	77,875	Water Truck
RR and Tuscarawas River	48.4	166,753	Water Truck
MP 70.4 Category III Wetland	71.4	82,266	Water Truck
East Branch of Black River	86.9	94,985	East Branch of Black River
West Branch of Black River	92.5	84,840	West Branch of Black River
Vermillion River	104.7	153,580	Water Truck
Interstate 80	110.3	72,626	Water Truck
Huron River	117.3	122,995	Huron River
Sandusky River	146.1	109,621	Sandusky River
Portage River	162.7	91,149	Portage River
Findley Road/State Hwy 64	180.1	77,219	Maumee River
Maumee River	181.9	202,788	Maumee River
	Ohio Sub Total	1,486,039	
Michigan			
Mainline			
River Raisin	215.3	74,948	River Raisin
Saline River	237.7	66,620	Saline River
Hydro Park	251.1	115,627	Ford Lake
I-94	251.7	72,475	Water Truck
	Michigan Sub Total	329,670	
	HDD Project Total	1,815,709	

Notes:

a/ Water will be trucked in from a municipal or other approved project source.

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Ohio								
Mainline								
Columbiana	ATWS-2340	0.9	X		B15-29	12.5	Topsoil segregation (outside wetland) and extra workspace for wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2341	1.0	X		B15-29	12.8	Topsoil segregation (outside wetland), Road crossing and extra workspace for wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2342	1.9		X	A14-5-S4	48.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2570	2.0	X	X	A14-5/A14-5-S4	0/20.1	Road, waterbody and wetland crossing. HWY 30 and waterbody bored crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2618	2.0	X		A14-5/AWB-CO-200	46.3	Road, waterbody and wetland crossing. HWY 30 and waterbody bored crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-3047	2.1	X		A14-5/AWB-CO-200	25.7/0	Road and wetland crossing. HWY 30 and waterbody bored crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-1096	2.2	X	X	A14-5/AWB-CO-200/A14-5-S3/A14-5-S3	0/0/0/29.5	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-3048	2.2	X		A14-5	0	Bend installation and pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-1105	2.3	X		A14-5	13.8	Topsoil segregation (outside the wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Columbiana	ATWS-15	4.8	X		A14-9	0	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-3050	4.9	X	X	A14-10/A14-10-S1/A14-10-S2/A14-10-S2	0/0/14/14.1	Road, waterbody and wetland crossing. Kettering Road and waterbody bored crossing. Also proposed open cut of Weaver Road. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-3049	4.9	X		A14-10	0	Road and wetland crossing. Kettering Road and waterbody bored crossing. Also proposed open cut of Weaver Road. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-4201	5.0	X	X	A14-10/A14-10-S2/A14-10-S2	0/19/12.9	Road and wetland crossing. Kettering Road and waterbody bored crossing. Also proposed open cut of Weaver Road. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-633	5.0	X		A14-10	36.2	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2302	5.5	X		A14-126	15.8	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2554	7.1	X		A15-46	11.5	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2560	7.3	X		A15-46	23.3	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2559	7.3	X		A15-45	13.6	Bend installation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2561	7.5	X		A15-43	35.1	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2557	9.7		X	A14-196-S1	12.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Columbiana	ATWS-652	9.7		X	A14-196-S1	11.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-653	9.8		X	A14-196-S1	11.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2556	9.8		X	A14-196-S1	11.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-604	10.3	X		A14-14/AWB-CO-205	15.1/29.6	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-3707	10.3	X		A14-14	26.0	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-640	10.6	X		A14-15/AWB-207	44.7	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2288	10.9	X	X	C15-65/C15-65-S1	11.8/36.4	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2289	10.9	X	X	C15-65/C15-65-S1	10.8/41.9	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2287	11.0	X		A15-33	10.5	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-3061	11.0	X		A15-33	14.4	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2493	11.1	X	X	A15-34/AS-CO-201/AS-CO-201A/A15-34-S1	0/13/23.6/33.5	Bend installation, waterbody, rail and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2635	11.1	X	X	A15-34/A15-34-S1	0/21.5	Waterbody, rail and wetland bored crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2492	11.2	X		A15-31	0	Waterbody, rail and wetland bored crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Columbiana	ATWS-2279	11.2	X		A15-31	0	Waterbody, rail and wetland bored crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2285	11.3	X		A15-31	0	Road and wetland crossing. Homeworth Rd bored crossing. Homeworth Rd bored crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2278	11.3	X		A15-31	10.1	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-4209	11.3	X		A15-31	37.3	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-2276	11.4	X		A15-32	48.8	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-3712	11.7		X	A14-17-S4	15.7	Bend installation and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-3291	12.3		X	A15-165-S2/A14-165-S1	14.7/18.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-3713	12.4		X	A14-165-S1	29.2	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Columbiana	ATWS-33	12.4		X	A14-165-S1	29.3	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-1124	12.6		X	AS-ST-211A	36.3	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-4003	13.0		X	AS-ST-211	46.6	Drag section for wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3714	13.0	X		A14-108/AWB-ST-211	44.6	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Stark	ATWS-3290	13.1	X		AWB-ST-212	26.8	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-80	13.1	X		AWB-ST-212	26.2	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3293	13.3	X	X	AWB-ST-212/AS-ST-213	24.4/24.6	Bend installation and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3294	13.4		X	AS-ST-213	17.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3295	13.4		X	AS-ST-213	24.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3292	13.4		X	AS-ST-213	27.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-1126	13.4	X		AWB-ST-213	11.3	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3717	13.5	X		AWB-ST-213	14.7	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-35	14.0	X	X	B15-54/B15-54-S1/B15-54-S2	42.1/15.2/12.4	Road, waterbody and wetland crossing. ATWS in Non-disturbed area.	Y
Stark	ATWS-3726	14.0		X	B15-54-S2	12.7	Road and waterbody crossing. ATWS in Non-disturbed area.	Y
Stark	ATWS-666	14.0	X	X	B15-54/B15-54-S1	10.8/31.9	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-642	14.1		X	B15-54-S4	34.7	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-4214	14.8	X		A14-20	0	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Stark	ATWS-1132	14.8	X		A14-20	33.9	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-4005	15.0	X		A14-21	12.1	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-1879	15.7	X		A15-27/AWB-ST-215	11.3	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-1136	16.3	X		AWB-ST-5	13.2	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3723	16.7	X		AWB-ST-5	11.8	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3725	16.7	X		AWB-ST-5	11.2	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-40	16.8	X		AWB-ST-5	33.3	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-42	17.0	X		AWB-ST-7	3.7	Trail / rail and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-1137	17.3	X		A14-107	13.0	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-1138	17.6	X		A14-106	40.8	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-44	17.7		X	A14-105-S1	12.0	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-43	17.8		X	A14-105-S1	48.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-4217	17.8		X	A14-105-S1	11.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Stark	ATWS-1141	18.0		X	A14-103-S1	17.3	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-1881	18.2		X	A14-103-S1	15.1	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2238	18.9	X		C15-85	37.8	Bend installation and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3052	19.0	X		C15-85	13.7	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3125	19.0	X		C15-85	11.3	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2241	19.2	X		C15-86	48.2	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2924	19.3	X		C15-86	24.3	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3068	19.7	X		A15-35	17.7	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2573	20.4	X		B15-42	44.3	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2575	20.4		X	A15-36-S1	40.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3128	21.7		X	A14-25-S1	22.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2585	21.8		X	A14-25-S1	29.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3129	21.8		X	A14-25-S1	12.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Stark	ATWS-2584	21.8		X	A14-25-S1	11.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2283	22.0		X	B15-41-S1	14.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2282	22.0		X	B15-41-S1	27.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2471	22.1		X	B15-41-S1	28.0	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2303	22.2		X	B15-40-S1	27.9	Bend installation, Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2601	22.2	X	X	B15-40/B15-40-S1	26.7/26.7	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2602	22.3	X	X	B15-40/B15-40-S1	0/17.6	Road, waterbody and wetland crossing. Marlboro Rd crossing bore.	Y
Stark	ATWS-3202	22.7		X	A14-175-S1	15.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-689	22.7		X	A14-175-S1	31.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-688	22.8		X	A14-175-S1	12	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3203	22.8		X	A14-175-S1	16.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3207	23.0		X	A14-174-S1	22.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3204	23.0		X	A14-174-S1	23.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Stark	ATWS-3205	23.0		X	A14-174-S1	22.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3206	23.0		X	A14-174-S1	33.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-733	23.9		X	A15-37-S1	18	Extra room for bend/fitting. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-10	24.1		X	A14-27-S1	20.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2	24.1		X	A14-27-S1	17.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-4436	25.2		X	A14-28-WB1	0	Access to hydrotest water. Spoil will be stored at least 10FT from water's edge. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land.	Y
Stark	ATWS-550	25.2		X	A14-28-WB1	40	Extra room for bend/fitting. ATWS in non-disturbed area.	Y
Stark	ATWS-1165	25.4	X		A14-167	12.3	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-1166	25.5	X		A14-167	13.0	Bend installation and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3135	25.7		X	A14-31-S1	20.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-646	25.7		X	A14-31-S1	25.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3136	25.7		X	A14-31-S1	14.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-645	25.8		X	A14-31-S1	17	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Stark	ATWS-1170	26.4	X		B15-44	47.2	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2490	26.7	X	X	A14-100/A14-100-S1	13.0/18.8	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3139	26.8	X		B15-43	13.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3138	26.8		X	AS-ST-209	26.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2488	26.8	X	X	AWB-ST-210/AS-ST-209	13.4/21.1	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2487	26.9	X	X	AWB-ST-210/AS-ST-210	13.7/19.2	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2301	27.4	X		B15-46	11.4	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2300	27.4	X		B15-46	13.2	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2298	27.4	X		B15-46	27.2	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2299	27.5	X		B15-46	12.2	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-4223	27.6		X	B15-45-S1	12.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2296	27.7		X	AS-ST-200/B15-45-S1	12.9/48.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2293	27.7	X	X	AWB-ST-201/B15-45-S1	14.7/16	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Stark	ATWS-2295	27.7		X	AS-ST-200	13.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2294	27.8	X		AWB-ST-201	11.1	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-4015	27.8	X		A14-34/AWB-ST-201	0	Topsoil segregation. Rail road bored crossing.	Y
Stark	ATWS-4017	27.9	X	X	A14-34/A14-34-S2	0/18.9	Bend installation.	Y
Stark	ATWS-735	28.0	X		A14-34	11.9	Rail and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-500	28.0	X		A14-34/AWB-ST-13	0	Rail and wetland crossing. Rail road bored crossing.	Y
Stark	ATWS-3143	28.7	X		A14-168	16.4	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-1176	28.8	X		A14-170/AWB-ST-29	27.0/39.1	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-4349	28.8	X		A14-168	13.9	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3234	29.2	X		AWB-ST-14	28.7	Wetland crossing. ATWS in non-disturbed area.	Y
Stark	ATWS-1179	29.3	X	X	AWB-ST-14/AS-ST-15	27.7/10.7	Bend installation, waterbody, road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-737	29.3		X	AS-ST-15	16.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3235	29.6	X	X	AWB-ST-17/AS-ST-17	34.7/30.5	Bend installation, waterbody and road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-1181	29.6		X	AS-ST-17	16.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Stark	ATWS-739	29.6	X	X	AWB-ST-18/AS-ST-17	32.3/14.6	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2501	29.7	X		AWB-ST-18	9.8	Bend installation and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-1183	30.0	X		AWB-ST-26	36.4	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-4359	30.1		X	AP-ST-25	17.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3144	30.1		X	A14-157-S1	15.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3236	30.6		X	A14-159-S1	17.1	Waterbody crossing, Bend installation and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-6	30.7		X	A14-159-S1	12.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3237	30.7		X	A14-159-S1	19.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3238	30.7		X	A14-159-S1	15.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-612	30.8		X	A14-158-S1	30.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3147	30.8		X	A14-158-S1	22	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-613	30.9		X	A14-158-S1	18.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3240	30.9		X	A14-158-S1	17	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Stark	ATWS-4225	31.4		X	A14-162-S1	30.0	Bend installation and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3148	31.6		X	A14-163-S1	26.0	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3149	31.6		X	A14-163-S1	33.9/30.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2254	31.6		X	A14-163-S1	20.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3150	31.6		X	A14-163-S1	45.8/49.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2250	31.9		X	A14-164-S2	17.8	Road, bend/fitting and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-691	32.0		X	A14-164-S2	13.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2249	32.0		X	A14-164-S2	15.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3244	32.0		X	A14-164-S2	11.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-90	32.1		X	A14-164-S1	12.8	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3245	32.1	X		A14-164	45.9	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3246	32.1	X		A14-164	0	Road and wetland crossing. Wagner Ave bored crossing. ATWS located in cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-1384	32.2		X	A14-164-S1	20.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Stark	ATWS-740	32.2	X		A14-164	12.5	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3248	32.7	X		AWB-ST-206	0	Bend installation, waterbody and Road crossing. ATWS in non-disturbed area. Dotwood Rd bored crossing and bend/installation.	Y
Stark	ATWS-4020	32.7	X		AWB-ST-206	44.0	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-3250	32.7	X		AWB-ST-206	0	Road and wetland crossing.ATWS in non-disturbed area. Dotwood Rd bored crossing and bend/fitting installation.	Y
Stark	ATWS-647	32.8	X		AWB-ST-208	0	Road and wetland crossing. ATWS in non-disturbed area. Dotwood Rd bored crossing.	Y
Stark	ATWS-3249	32.8	X		AWB-ST-208		Road and wetland crossing. ATWS in non-disturbed area. Dotwood Rd bored crossing.	Y
Stark	ATWS-2258	33.1	X		AWB-ST-204	0	Cleveland Rd bored crossing and wetland crossing. ATWS in non-disturbed area	Y
Stark	ATWS-4226	33.3	X		AWB-ST-205	0	Wetland crossing and equipment movement. ATWS in non-disturbed area. Long wetland crossing with waterbodies in wetland. Extra width required to move crews/equipment down row.	Y
Stark	ATWS-4021	33.6	X		AWB-ST-205	0	Waterbody and wetland crossing. ATWS in non-disturbed area. Long wetland crossing with waterbodies in wetland. Extra width required to move crews/equipment down row.	Y
Stark	ATWS-4022	33.7	X		AWB-ST-205	0	Waterbody and wetland crossing. ATWS in non-disturbed area. Long wetland crossing with waterbodies in wetland. Extra width required to move crews/equipment down row.	Y
Stark	ATWS-4227	33.7	X		AWB-ST-205	0	Topsoil segregation. ATWS in non-disturbed area. Long wetland crossing with waterbodies in wetland. Extra width required to move crews/equipment down row.	Y
Stark	ATWS-2628	33.8	X		AWB-ST-205	0	Waterbody and wetland crossing. ATWS in non-disturbed area. Long wetland crossing with waterbodies in wetland. Extra width required to move crews/equipment down row.	Y

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Stark	ATWS-2629	33.8	X		AWB-ST-205	0	Waterbody and wetland crossing. ATWS in non-disturbed area. Long wetland crossing with waterbodies in wetland. Extra width required to move crews/equipment down row.	Y
Stark	ATWS-2630	33.8	X		AWB-ST-205	0	Waterbody and wetland crossing. ATWS in non-disturbed area. Long wetland crossing with waterbodies in wetland. Extra width required to move crews/equipment down row.	Y
Stark	ATWS-2235	33.8	X	X	AWB-ST-205/AS-ST-205	0/37.3	Bend installation, waterbody and wetland crossing. ATWS in non-disturbed area. Long wetland crossing with waterbodies in wetland. Extra width required to move crews/equipment down row.	Y
Stark	ATWS-3152	33.8	X	X	AWB-ST-205/AS-ST-205	0/17.2	Waterbody and wetland crossing. ATWS PRIMARILY located in upland consisting of cultivated or rotated cropland or disturbed land. Variance needed.	Y
Stark	ATWS-2378	33.9		X	AS-ST-205	34.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Stark	ATWS-2381	33.9		X	AS-ST-205	38.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-4228	34.1	X		AWB-SU-213	49.9	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2385	34.3	X		AWB-SU-213	0	Rail Road bored crossing.	Y
Summit	ATWS-2384	34.3	X		AWB-SU-213	0	Rail Road bored crossing.	Y
Summit	ATWS-2386	34.3	X		AWB-SU-213	0	Rail Road bored crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-2382	34.3	X		AWB-SU-213	0	Bend installation and rail Road bored crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-3265	34.4	X		AWB-SU-213	0	Pipeline crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-4229	34.4	X		AWB-SU-213	0	Road and wetland crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-3264	34.4	X		AWB-SU-213	0	Pipeline crossing. ATWS in non-disturbed area.	Y

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Summit	ATWS-2359	34.6	X		AWB-SU-213	11.2	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2357	34.7	X	X	AWB-SU-211/AP-SU-212/AS-SU-211	18.0/18/18.7	Topsoil segregation, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-4230	34.8		X	AS-SU-210	24.6	Waterbody crossing, bend installation and topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-3155	34.9		X	AS-SU-210	35.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2363	34.9		X	AS-SU-210	36.8	Waterbody and road crossing and topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2364	35.0		X	AS-SU-210	32.4	Bend installation and waterbody and road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2356	35.2	X		AWB-SU-3	10.4	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2337	35.4	X		AWB-SU-3	13.8	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-94	35.5	X		AWB-SU-4	16.9	Road and wetland crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-4231	35.6	X		AWB-SU-4	0	Wetland crossing. Interstate 77 bored crossing ATWS in non-disturbed area.	Y
Summit	ATWS-2335	35.6	X		AWB-SU-4	18.1	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-3160	36.0	X		AWB-SU-208	17.1	Bend installation and wetland crossing.ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-4232	36.1	X		AWB-SU-208	14.8	Wetland crossing drag section. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Summit	ATWS-4233	36.7	X		AWB-SU-206	17.4	Waterbody and wetland crossing.	Y
Summit	ATWS-4025	36.7		X	AS-SU-206	12.6	Waterbody crossing.	Y
Summit	ATWS-4026	36.8		X	AS-SU-206	12.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2350	36.8	X		AWB-SU-217	45.0	Bend installation, road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2352	36.8	X		AWB-SU-217	35.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-4027	37.2	X		AWB-SU-214	11.5	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-3212	37.4	X		AWB-SU-205	46.7	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2325	37.4	X		AWB-SU-205	0	Massillon Rd bored crossing. Waterbody and wetland crossing.	Y
Summit	ATWS-2324	37.4	X		AWB-SU-205	0	Massillon Rd bored crossing. Waterbody and wetland crossing.	Y
Summit	ATWS-2327	37.6	X		AWB-SU-205	23.5	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2313	38.9	X		AWB-SU-218	35.3	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2318	39.3	X	X	AWB-SU-201/AS-SU-201	2.1/35.4	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed. .	N
Summit	ATWS-2311	39.4	X	X	AWB-SU-201/AS-SU-201	0/24.7	Waterbody and wetland crossing. ATWS located in cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2319	39.4	X	X	AWB-SU-201/AS-SU-201	12.1/44.3	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Summit	ATWS-2274	39.4	X		AWB-SU-201	0	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2320	39.5		X	A14-112-S1	35.6	Waterbody crossing and topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2321	39.5		X	A14-112-S1	24.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-1401	39.5		X	A14-112-S1	40.2	Bend installation and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2275	39.5		X	A14-112-S1	21.7	Waterbody crossing, bend installation and topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-99	39.8	X		A14-112	0	Arlington Rd crossing and wetland crossing.	Y
Summit	ATWS-3274	39.8	X		A14-112	0	Arlington Rd crossing and wetland crossing.	Y
Summit	ATWS-743	39.8	X		A14-112	23.8	Road and wetland crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-3172	40.1	X		AWB-SU-13	0	Bend installation and wetland crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-2089	40.3	X		AWB-SU-13	0	Killinger Rd crossing and wetland crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-3275	40.3	X	X	AWB-SU-13/AS-SU-13	0/0	Road, waterbody and wetland crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-3276	40.3	X	X	AWB-SU-13/AS-SU-13	0/0	Road, waterbody and wetland crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-101	40.3	X		AWB-SU-13	0	Killinger Rd crossing and wetland crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-102	40.6	X		A14-121	48.1	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Summit	ATWS-1991	40.6	X		AWB-SU-13	19.1	Pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2927	40.8		X	A14-120-S2	40.9	Extending width of road turn radius for vehicle/material movement. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-4415	41.0	X		A15-49	0	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-3278	42.0	X		A14-122/AWB-SU-220	0/13.4	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-744	42.0	X		A14-122/AWB-SU-220	21.8/29.0	Bend installation, road, and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-104	42.3	X		A14-123	4.8	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-1408	43.9	X		AWB-SU-21	39.1	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-1986	45.3	X	X	B14-1/B14-1-S1	0/44.3	Bend installation, pipeline and wetland crossing.	Y
Summit	ATWS-2479	45.4	X		B14-1	0	Bend/fitting installation and 6 foreign pipeline crossings. Wetland crossing.	Y
Summit	ATWS-1985	45.4	X		B14-1	0	Bend/fitting installation and 6 foreign pipeline crossing. Road and wetland crossing.	Y
Summit	ATWS-3288	45.4	X		B14-1	0	Road, pipeline and wetland crossing.	Y
Summit	ATWS-3182	45.5	X		B14-1	35.4	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-3289	45.5	X		B14-1	17.5	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-1410	45.8		X	AS-SU-29	19.4	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Summit	ATWS-580	46.3		X	A14-119-S1/C15-27/AWB-SU-219	12.4	Bend installation, waterbody and wetland crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-1370	46.7	X		C15-26	10.1	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-747	46.7	X	X	C15-25/AS-SU-32/C15-25-S1	13.5/36.4/18.0	Pipeline, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-4402	46.7	X	X	C15-25/C15-25-S1	12.8/45.8	Road, pipeline, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-3183	46.8	X	X	C15-25/AP-SU-32	10.7/13.1	Road, pipeline, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-121	46.8		X	A15-13-S1	11.9	Road and waterbody crossing.	Y
Summit	ATWS-581	48.6	X		AWB-SU-39	13.4	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-3326	48.8		X	AS-SU-40	20.9	Waterbody crossing and bend/fitting. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-125	48.8		X	A15-18-WB1	48.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-4378	48.9		X	A15-18-WB1	0	Access to hydrotest water. Spoil will be stored at least 10FT from water's edge (if applicable).ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-2504	48.9		X	AS-SU-40/A15-18-S1	23.4/33.7	Waterbody crossing and bend/fitting. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-3325	49.0	X		AWB-SU-41	12.3	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	NN
Summit	ATWS-2505	49.0	X		AWB-SU-41	12.8	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Summit	ATWS-4033	49.2		X	AS-SU-43	31.7	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Summit	ATWS-3233	49.3	X		AWB-SU-43	0	Cleveland Massillon Rd bored crossing and bend/fitting installation. Bore pull back string.	Y
Summit	ATWS-3232	49.3	X		AWB-SU-43	0	Bend installation. ATWS in non-disturbed area.	Y
Summit	ATWS-4237	49.3	X		AWB-SU-43	0	Road and wetland crossing. ATWS in non-disturbed area.	Y
Summit	ATWS-128	49.9		X	A14-41-S1	14.2	Road and waterbody crossing. ATWS in non-disturbed area	Y
Wayne	ATWS-130	50.4		X	A15-20-S1	32.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-2942	50.4		X	A15-20-S1	30.0	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-3335	50.5		X	A15-20-S1	19.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-3336	50.5		X	A15-20-S1	21.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-1979	50.7	X		B14-2	28.1	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-1375	51.2	X		A15-23	24.2	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-1978	51.3	X		A15-23	13.9	Bend installation.ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-3339	51.4	X	X	A15-21	12.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-3340	51.5	X		A15-21	11.5	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Wayne	ATWS-585	52.5		X	A14-124-S2	21.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-3753	52.6	X	X	A14-124/AWB-WE-200/AS-WE-200/A14-124-S1	35.5/40.4/46	Bend installation, waterbody and wetland crossing.	Y
Wayne	ATWS-2513	52.7	X		AWB-WE-200/AWB-WE-201	7.1/22.2	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-2599	52.8	X	X	AWB-WE-201/AS-WE-201A	0/11.5	Road, waterbody and wetland crossing. ATWS in non-disturbed area.	Y
Wayne	ATWS-2841	52.9	X	X	AWB-WE-201/AS-WE-201A	30.9/11.7	Existing pipeline and road crossing. ATWS in non-disturbed area.	Y
Wayne	ATWS-141	55.2	X		A15-41	26.6	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-2945	55.2	X		A15-41	25.2	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-608	55.3		X	A15-41-S1	13.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-2946	55.3	X	X	A15-41/A15-41-S1	23.4/49.9	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-1348	55.3	X		C15-89	12.1	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-2022	55.5	X		C15-89	11.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-3351	55.6	X		C15-89	9.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Wayne	ATWS-2948	55.6	X	X	B15-48/C15-89-S1	12.5/42	Road crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-2949	55.7	X		B15-48	0	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-4036	55.8	X		B15-48	41.3	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-144	56.7		X	AS-ME-1	19.2	Rail, road and waterbody crossing. ATWS partially located in upland.	Y
Medina	ATWS-754	56.7		X	AS-ME-1	21.3	Rail, road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4038	57.2	X		B15-49	20.9	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-271	57.2	X		B15-49	12.1	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2237	57.2	X		B15-49	11.7	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-3356	57.4	X		B15-50	25.3	ATWS for bore pull back. ATWS located in upland.	Y
Wayne	ATWS-2536	57.6		X	B15-51-S1	15.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-2537	57.6		X	B15-51-S1	31.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-2306	57.6	X	X	B15-52/B15-51-S1	0/28.6	Eastern Rd and waterbody bored crossing and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-2305	57.7	X	X	B15-52/B15-51-S1	0/27.1	Eastern Rd and waterbody bored crossing and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Medina	ATWS-2304	57.7		X	B15-53-S1	20.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-649	57.7		X	B15-53-S1	19.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-614	58.2	X		C15-90	18.3	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2057	58.3	X	X	C15-90/B14-7/B14-7-WB1/B14-7-S1	8.7/9.8/34.9/38.4	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-756	58.4	X		B14-7	21.5	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4041	58.8	X		C15-91	12.9	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4241	59.0	X		C15-91	14.2	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-1431	59.9	X		AWB-ME-15	44.0	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3363	60.8		X	A14-39-S1	35.5	Waterbody crossing. ATWS located in upland.	Y
Medina	ATWS-4043	60.9		X	A14-40-S2	25.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-1433	60.9		X	A14-40-S1	31.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-1353	61.5		X	A14-37-S1	14.8	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2195	61.8		X	AS-ME-19	11.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Medina	ATWS-2439	61.8		X	AS-ME-19	11.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2440	61.8		X	AS-ME-19	30.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2441	61.9		X	AS-ME-19	20.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2422	61.9	X		AWB-ME-20	24.6	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3365	62.0	X		AWB-ME-20	15.9	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3366	62.0	X		AWB-ME-20	37.9	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4244	62.1	X		B15-01/AWB-ME-20	19.5	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4242	62.1	X		B15-01/AWB-ME-20	21.3/34.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-155	62.6	X		AWB-ME-91	0	Greenwich Rd bored crossing and wetland crossing.	Y
Medina	ATWS-590	64.5	X		A14-114	14.0	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-760	64.6	X		A14-114	24.9	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-160	65.9	X		AWB-ME-23	45.6	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2019	65.9	X		AWB-ME-23	47.9	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Medina	ATWS-3384	66.6	X		A14-129	45.6	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2868	67.1	X	X	AWB-ME-26/AP-ME-27	22.3/43.2	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3383	67.1	X	X	AWB-ME-26/AP-ME-27	21.3/15	Road crossing and ACCESS. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2163	67.2		X	AP-ME-27	16.8	Driveway crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-280	67.5		X	AS-ME-30A	13.3	Bend installation, Topsoil segregation and wetland crossing drag section. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2366	67.5	X		AWB-ME-29	33.6	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4247	67.6	X		AWB-ME-31	0	Waterbody and wetland crossing. Side slope and steep terrain construction. ATWS in non-disturbed area.	Y
Medina	ATWS-4248	67.7	X		AWB-ME-31	12.1	Waterbody and wetland crossing. ATWS in non-disturbed area.	Y
Medina	ATWS-172	67.9	X	X	AWB-ME-33/AP-ME-33	14.3/40	Bend installation. ATWS located in upland.	Y
Medina	ATWS-173	68.4		X	AS-ME-35	25.7	Road crossing (long bore) and topsoil segregation and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-1358	68.5	X		AWB-ME-35	14.0	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4050	68.8		X	AS-ME-37/A15-3-S1	12.3/28.4	Waterbody crossing. ATWS in non-disturbed area	Y
Medina	ATWS-4052	68.8		X	AS-ME-37/A15-3-S1	11.6/37.3	Chippewa Rail Trail and waterbody crossing. ATWS in non-disturbed area	Y
Medina	ATWS-4054	68.8		X	A15-3-S1/A15-3-S3	13.6/21.3	Chippewa Rail Trail and waterbody crossing. ATWS in non-disturbed area	Y
Medina	ATWS-175	69.0	X		B15-16	42.8	Bend installation and road crossing. ATWS in non-disturbed area.	Y

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Medina	ATWS-281	69.1	X		B15-16	0	Rail and wetland crossing. ATWS in non-disturbed area.	Y
Medina	ATWS-3372	69.1	X		C15-39	0	ATWS for bore pull back.	Y
Medina	ATWS-3374	69.2	X		C15-39	0	Bend installation.	Y
Medina	ATWS-1451	69.4	X		C15-39	13.0	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-1452	69.4	X	X	C15-40/C15-41-S1	13.0/16.1	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-176	69.7	X	X	C15-06-W2/C15-41-S1	15.1/17.9	Bend installation, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-1455	70.0	X		C15-6	10.6	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3376	70.2	X		C15-7	3.4	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3380	70.5	X		B15-27	19.7	Bend installation and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3381	70.5	X		B15-27	13.3	Pipeline and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3379	70.6	X		C15-42	0	Two existing pipeline crossing. and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3378	70.6	X		C15-42	0	Two existing pipeline crossing. and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2845	70.7	X	X	C15-42/AS-ME-46/C15-42-S1	0/31.4/26.6	Chippewa Rail Trail and waterbody crossing and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Medina	ATWS-2373	70.7	X	X	C15-42/AS-ME-46/C15-42-S1	0/37.4/23	Chippewa Rail Trail and waterbody crossing and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2846	70.8		X	AS-ME-46/C15-42-S1	24.2/36.4	Chippewa Rail Trail and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2374	70.8		X	AS-ME-46/C15-42-S1	35.5/45.2	Chippewa Rail Trail, waterbody and road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3095	70.9		X	AS-ME-47	40.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2375	70.9		X	AS-ME-47	14.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3382	70.9		X	AS-ME-47	13.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3686	71.6		X	AS-ME-211	13.5	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3685	71.6		X	AS-ME-211	29.9	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3729	72.5	X		A14-48	0	Carlton Rd bored crossing and bend/fitting installation. Wetland crossing. ATWS in non-disturbed area.	Y
Medina	ATWS-3393	72.5	X		A14-48	0	Carlton Rd bored crossing and bend/fitting installation. ATWS in non-disturbed area.	Y
Medina	ATWS-181	72.5	X		A14-48	0	Carlton Rd bored crossing and bend/fitting installation and wetland crossing.	Y
Medina	ATWS-3392	72.5	X		A14-48	0	Carlton Rd bored crossing and bend/fitting installation and wetland crossing.	Y
Medina	ATWS-283	72.7		X	AP-ME-210	12.8	Rail and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4059	72.7		X	AP-ME-210	11.5	Rail and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Medina	ATWS-182	72.8	X		AWB-ME-52	19.7	Rail and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2218	73.2	X		AWB-ME-209	32.1	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2219	73.2	X		C15-24-W8	0	Bend installation, waterbody and wetland crossing.	Y
Medina	ATWS-3735	73.2	X		C15-24-W9	0	Bend installation, waterbody and wetland crossing.	Y
Medina	ATWS-3734	73.3	X	X	C15-24-W8/C15-24-S1-2	0/24.8	Wetland crossing. ATWS in non-disturbed area.	Y
Medina	ATWS-3733	73.3	X	X	C15-24-W7/C15-24-S7	0/0	Wetland crossing and equipment movement. Extra width required to move crews/equipment down row. ATWS in non-disturbed area	Y
Medina	ATWS-3737	73.4	X	X	C15-24-W10/C15-24-S1-3	12.0/11.4	Bend installation and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-284	73.5		X	C15-24-S1-3	45.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-285	73.7		X	AS-ME-56	25.4	Road and waterbody crossing. ATWS in non-disturbed area	Y
Medina	ATWS-1461	73.7		X	AP-ME-57	17.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-1463	73.9	X		C15-54/AWB-ME-58	18.8/11.9	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3099	74.9		X	AS-ME-62	19.9	Bend installation and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3100	75.1		X	B14-10-S1	21.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3394	75.1		X	B14-10-S1	19.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Medina	ATWS-2731	75.1		X	B14-10-S1	34.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3101	75.1		X	B14-10-S1	33.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3741	75.4	X		AWB-ME-208	21.6	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2732	75.4	X		AWB-ME-208	14.5	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2396	75.4	X		AWB-ME-208	7.3	Wail, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2397	75.5	X		AWB-ME-208	10.4	Rail, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2400	75.6	X		AWB-ME-206	12.6	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2632	75.7	X		AWB-ME-206	25.6	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3742	75.9		X	AS-ME-206	23.2	Waterbody and wetland crossing and bend. ATWS in non-disturbed area.	Y
Medina	ATWS-3743	75.9	X		AWB-ME-206	11.3	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2633	76.0	X	X	AWB-ME-206/AS-ME-206	48.7/16.6	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2401	76.0	X	X	AWB-ME-204	32.9/45.5	Waterbody crossing, topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4061	76.3	X		AWB-ME-204	27.6	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Medina	ATWS-2592	76.3	X	X	AWB-ME-204/AS-ME-204	0/15.5	Beck Rd bored crossing, waterbody and wetland crossing.	Y
Medina	ATWS-2591	76.3	X	X	AWB-ME-204/AS-ME-204	0/16.8	Beck Rd bored crossing, waterbody and wetland crossing.	Y
Medina	ATWS-2593	76.3	X		AWB-ME-204	43.4	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4062	76.6	X		AWB-ME-203	38.2	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2413	76.9	X	X	AWB-ME-202/AS-ER-202B	9.2/28.0	Bend installation and waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4065	76.9	X	X	AWB-ME-202/AS-ER-202B	13.1/43.1	Bend installation and waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3398	77.0	X	X	AWB-ME-202/AS-ER-202B/AS-ME-202A	0/12.4/11.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3397	77.0	X	X	AWB-ME-202/AS-ME-202A	0/10.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2417	77.0	X	X	AWB-ME-202/AS-ME-202A	10.3/27.1	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3396	77.0	X	X	AWB-ME-202/AS-ME-202A	12.3/12.2	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2419	77.4	X		AWB-ME-201	22.9	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3747	77.5	X	X	AWB-ME-201/AS-ME-201	25.9/44.3	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2390	77.8	X	X	AWB-ME-77/AS-ME-77	12.3/37.3	Wetland and waterbody crossing. Bend fitting ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Medina	ATWS-3401	77.8		X	AS-ME-77	11.8	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2597	77.8		X	AS-ME-77	16.6	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3170	77.8		X	AS-ME-77	13.9	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2964	77.9		X	AS-ME-200	12.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2932	77.9		X	AS-ME-200	10.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2931	78.0		X	AS-ME-200	25.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2963	78.0		X	AS-ME-200	28.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4067	78.0	X		AWB-ME-90	10.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2596	78.0	X		AWB-ME-90	12.5	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2598	78.2	X		AWB-ME-95	17.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-1481	78.3	X		AWB-ME-95	11.8	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-4068	78.3	X		AWB-ME-95	13.7	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3405	78.9		X	AS-ME-96	23.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Medina	ATWS-3403	78.9		X	AS-ME-96	13.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3404	78.9		X	AS-ME-96	18.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3406	78.9		X	AS-ME-96	15.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3103	79.0		X	AS-ME-97	21.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-195	79.0		X	AS-ME-97	16.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3407	79.1		X	AS-ME-97	11.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-196	79.1		X	AS-ME-97	13.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2058	79.2		X	AS-ME-98	16.8	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3751	79.3		X	AS-ME-98	14.8	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-2013	79.3	X	X	AWB-ME-99/AS-ME-98/AS-ME-99	11.0/15.3/24.1	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-1487	79.5	X	X	AWB-ME-99/AS-ME-99	12.1/49.5	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Medina	ATWS-3752	80.4	X		AWB-LO-1	12.2	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2542	81.3		X	A15-28-S1	22.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lorain	ATWS-2541	81.4		X	A15-28-S1	17.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2424	81.4		X	A15-28-S1	21.5	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3107	81.6	X		A15-29	18.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3760	82.0	X		A14-59	15.9	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2243	82.5	X		C15-83	37.3	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2242	82.6	X		C15-83	36.5	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-201	82.6	X	X	C15-83/A14-61-S1	16.6/20.2	Road waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-768	82.6	X		C15-83	11.5	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-593	82.7	X		A14-63	0	Law Rd bored crossing and wetland crossing. ATWS in non-disturbed area.	Y
Lorain	ATWS-595	82.9	X		A14-63	11.3	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-288	83.0	X		A14-63	10.9	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3764	83.5	X		A14-68	0	Wetland crossing, Bend installation and equipment movement. ATWS in non-disturbed area.	Y
Lorain	ATWS-771	83.6	X		A14-67	0	Bend installation.	Y
Lorain	ATWS-3408	83.9		X	B15-24-WB1	11	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lorain	ATWS-1492	84.2		X	A14-69-S2/A14-69-S3	25.0/22.3	Waterbody and wetland crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3768	84.4	X		A15-30	19.0	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-4074	84.9	X		A15-51	11.7	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-4075	85.0	X	X	A14-71	12.9/13.3	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3770	85.1	X		A14-71	13.1	Bend installation. ATWS located in upland.	Y
Lorain	ATWS-1496	85.9	X	X	AWB-LO-10/AS-LO-10/AS-LO-10A	28.6/15.6/24.8	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3409	85.9	X	X	AWB-LO-10/AS-LO-10	25.2/13.6	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-1498	86.0	X		AWB-LO-10	14.5	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-1342	86.0	X		AWB-LO-10	14.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-911	86.4	X		A14-51	25.7	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2025	86.9	X		A14-52	13.4	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3773	87.0	X	X	A14-52/AS-LO-11	0/11.4	Rail, road, waterbody and wetland crossing. ATWS in non-disturbed area.	Y
Lorain	ATWS-3410	87.3		X	A14-55-S1	23.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lorain	ATWS-3411	88.0		X	AS-LO-45	10	Waterbody crossing. Spoil will be stored at least 10FT from water's edge. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3413	88.0		X	AS-LO-45	12.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3776	88.5	X		A14-73	15.1	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-290	88.8	X		A14-73	11.3	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3431	89.2		X	A14-128-S1	10.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-701	89.3		X	A14-75-S2/A14-75-S1	14.2/13.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-700	89.3		X	A14-75-S2	15	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3779	90.1		X	A14-76-S1	30.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-702	90.2	X	X	A14-76/A14-76-S1	42.8/9.8	Waterbody and wetland crossing.	Y
Lorain	ATWS-209	90.2	X	X	A14-76/A14-76-S1	0/11.2	Waterbody crossing and Whitehead Rd bored crossing and wetland crossing.	Y
Lorain	ATWS-210	90.3	X		A14-76	25.3	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2734	90.5		X	A14-130-S1	13.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3428	90.5		X	A14-130-S1	22.8	Waterbody and wetland crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lorain	ATWS-774	90.9		X	A14-131-S1	33.8	Waterbody and wetland crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3418	91.0		X	A14-131-S1	11.9	Waterbody and wetland crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-1297	91.1		X	A14-131-S1	15.3	Waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-1298	91.8		X	C15-35-S1	21.6	Waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-776	91.8		X	C15-35-S1	21.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-4354	91.8		X	C15-8-S1/C15-8-S2	45/20.7	HDD pull back string. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-779	92.5	X		C15-9	15.9	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-4385	92.5	X		C15-9	12.4	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-4077	93.4		X	A14-140-S1	16.1	Road and waterbody crossing. ATWS in non-disturbed area	Y
Lorain	ATWS-213	93.4		X	A14-140-S1	12.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-4078	93.7	X		A14-77	27.4	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-1893	94.3	X		A14-178	12.3	Pipeline. ATWS in non-disturbed area	Y
Lorain	ATWS-217	94.7	X		B15-57	18.4	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lorain	ATWS-1304	94.8	X		A14-179	14.9	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-1515	95.1	X		A14-179	12.1	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2178	95.5	X		A14-181	11.4	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2176	95.6	X		A14-182	14.1	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-4404	96.0	X		A14-141	5.9	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-4406	96.3	X	X	C15-58/C15-58-WB1	0/19.7	Abandoned rail, waterbody and wetland crossing. ATWS in non-disturbed.	Y
Lorain	ATWS-4405	96.3	X		C15-58	0	Abandoned rail bored crossing and wetland crossing. ATWS in non-disturbed.	Y
Lorain	ATWS-2870	96.7	X		A15-38	24.4	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2871	96.7	X		A15-38	0	Quarry Rd bored crossing.	Y
Lorain	ATWS-3787	96.8	X		A15-38	20.8	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2746	97.3	X	X	C15-57/C15-57-S1	15.3/31.1	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3112	97.3	X	X	C15-57/C15-57-S1	16.0/43.9	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2697	98.0	X		C15-62	14.9	Road and pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lorain	ATWS-2694	98.3		X	C15-61-S1	14.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2709	98.3		X	C15-61-S1	13	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3434	98.3		X	C15-61-S1	12.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2710	98.5	X		C15-59	18.2	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3791	99.3		X	C15-66-S1	14.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3792	99.3		X	C15-66-S1	15.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-3794	100.1	X		C15-63	16.5	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2435	100.2	X		C15-63	25.1	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2430	100.6	X		AWB-LO-201	16.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-4089	101.0	X		AWB-LO-201	15.9	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-4087	101.0	X		AWB-LO-201/AWB-LO-202	11.4/11.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2446	101.0	X		AWB-LO-202	12.8	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-4088	101.1	X		AWB-LO-202	13.9	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lorain	ATWS-2465	101.3		X	C15-67-S1	15	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lorain	ATWS-2428	101.3		X	C15-67-S1	12.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-2464	101.3		X	C15-67-S1	23.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-2451	101.3		X	C15-67-S1	24	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-2427	101.7		X	AS-HU-200	26.8	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-2447	101.8	X	X	AWB-HU-201/AS-HU-201	19.0/40.5	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-2425	101.9	X		AWB-HU-201	49.5	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-2784	101.9	X	X	AWB-HU-201/AS-HU-201	15.1/46.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-4092	102.2	X		AWB-ER-202	18.2	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-2785	102.3	X		AWB-HU-202	26.2	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-2781	102.3	X	X	AWB-HU-202/AS-HU-202	24.6/14.7	Road, waterbody and wetland crossing. ATWS located in upland.	Y
Huron	ATWS-2820	102.4	X	X	AWB-HU-202/AS-HU-202	24.7/15	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-3444	102.9		X	C15-88-S1	18.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Huron	ATWS-2802	102.9		X	C15-88-S1	16.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-2801	103.0		X	C15-88-S1	27.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-3445	103.0		X	C15-88-S1	19.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-2800	103.0	X		AWB-HU-203	11.8	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Huron	ATWS-4380	104.2		X	C15-56-S1	3.3	Access to hydrotest water. Spoil will be stored at least 10FT from water's edge (if applicable). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2793	105.2	X		C15-71	16.0	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2792	105.7	X		C15-70	21.0	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2819	105.8	X		C15-70	0	Road and wetland crossing.	Y
Erie	ATWS-2791	105.8	X		C15-70	0	Waterbody and Florence Wakemen Rd crossing and wetland crossing.	Y
Erie	ATWS-3119	107.4		X	C15-11-S1	47.5	Bend/fitting. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3798	107.5		X	C15-11-S1	24.7	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3448	107.6		X	C15-11-S1	15.5	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-1539	109.2	X		AWB-ER-43	43.9	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-1540	109.4	X		AWB-ER-43	42.0	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Erie	ATWS-3200	109.7	X		B15-05	11.9	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2082	109.8	X		B15-05	21.4	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3122	110.5	X		C15-13	10.9	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-1542	110.6	X		C15-12	15.5	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3123	110.7	X		C15-13	11.0	Bend installation and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-1543	111.0	X		C15-12	14.1	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-804	111.3	X		A14-111	15.2	Bend installation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-547	111.3	X		A14-111	24.9	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-4099	111.6	X		B15-38	24.4	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-1321	112.2	X		A14-154	10.4	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3802	112.8	X		A14-154	10.8	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3804	113.1		X	A14-187-S1	13.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-246	115.9		X	B15-09-S1	34.9	Rail and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Erie	ATWS-248	116.3		X	A14-156-S1	17.5	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3809	116.5	X	X	C15-78/AWB-ER-18/A14-156-S2	0/0	Rail / trail and wetland crossing. ATWS in non-disturbed area.	Y
Erie	ATWS-3810	116.5	X	X	A14-156/A14-155-S1	0/49.1	Rail / trail, waterbody and wetland crossing.	Y
Erie	ATWS-4382	116.9		X	AS-ER-19/A14-186-S1	0	Access to hydrotest water. Spoil will be stored at least 10FT from water's edge.	Y
Erie	ATWS-1554	117.4		X	C15-20-S1	0	HDD pull back string for Huron River crossing. Spoil will be stored at least 10FT from water's edge.	Y
Erie	ATWS-2765	117.6		X	C15-20-S1	12.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2766	117.6		X	C15-20-S1	15.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3817	119.0		X	E14-97-S1	42.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2848	119.9		X	AS-ER-206	13.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3819	120.0		X	AS-ER-206	18.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2849	120.0		X	AS-ER-206	41.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-1561	120.1		X	AS-ER-51/C15-22-S1	19.8/17.5	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3820	120.3		X	C15-22-S1	16	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2064	120.4	X		C15-22/AWB-ER-204	25.6/42.2	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Erie	ATWS-3821	120.4	X	X	C15-22-W2/AS-ER-51/C15-22-S1	46.3/11.4/13.1	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-821	120.4	X		C15-22-W2	0	Road and wetland crossing.	Y
Erie	ATWS-3824	120.5	X	X	C15-75/C15-74-S1	11.9/14.6	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3457	120.5	X	X	C15-75/C15-74-S1	13.2/13.9	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3822	120.5	X		C15-75	29.7	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-1562	120.7	X		C15-77	22.0	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-822	120.8	X		B15-12	42.1	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2979	120.8	X	X	B15-12/B15-12-S1	40.4/48.3	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2980	120.9	X	X	B15-12/B15-12-S1	24.2/30.4	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-823	120.9	X	X	B15-12/B15-12-S1	24.0/28.3	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3458	122.0		X	B15-13-S1	15.8	Waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-256	122.0		X	B15-13-S1	14.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-257	122.1		X	AS-ER-205	22.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Erie	ATWS-825	122.1		X	AS-ER-205	18.3	Waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3459	123.0		X	E14-96-S1	10.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3825	123.0		X	E14-96-S1	13.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3826	123.1		X	E14-96-S1	14.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3460	123.1		X	E14-96-S1	14.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3827	123.5	X		C15-80	28.2	Abandoned rail and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3828	123.6	X		C15-80	21.8	Abandoned rail and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-302	123.6	X		C15-80	30.4	Abandoned rail and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-545	124.0		X	AS-ER-28	25.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3829	124.0		X	AS-ER-28	38.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3830	124.0		X	AS-ER-28	11.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-546	124.0		X	AS-ER-28	12.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3833	125.8		X	E14-95-S1	14.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Erie	ATWS-829	125.9		X	E14-95-S1	47.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2837	125.9		X	E14-95-S1	31	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-265	127.4		X	AS-ER-202/E14-49-S1	17.4/15.4	Waterbody and DRIVEWAY crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3462	127.4		X	AS-ER-202	15.8	Waterbody and DRIVEWAY crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3463	127.4		X	AS-ER-202	26.2	Waterbody and DRIVEWAY crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-266	127.4		X	AS-ER-202/E14-49-S1	28.5/28.1	Waterbody and DRIVEWAY crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3464	127.9		X	E14-50-S1	26.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-835	127.9		X	AS-ER-30	32.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3837	127.9		X	AS-ER-30/E14-50-S1	34.7/16.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-834	127.9		X	AS-ER-30	18.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-1332	128.0		X	AS-ER-201	11.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3838	128.1		X	E14-51-S1	11.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2830	128.1		X	AS-ER-201/E14-51-S1	21.6/22.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Erie	ATWS-837	128.2		X	E14-51-S1	24	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-2992	128.3		X	E14-51-S1	12.6	Rail and road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3465	129.2		X	AS-ER-200/E14-94-S1	14.2/47.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Erie	ATWS-3466	129.3		X	AS-ER-200/E14-94-S1	16.6/15.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-1581	132.8	X		B15-14	38.0	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3847	133.3	X		B15-14	12.6	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-543	133.4	X		B15-14	35.0	Road and wetland crossing.ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-1580	133.4	X		B15-14	14.0	Topsoil segregation and Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-503	134.3		X	D15-74-S1	42.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2994	134.3		X	D15-74-S1	20.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2995	134.3		X	D15-74-S1	26.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3510	134.3		X	D15-74-S1/D15-92-S1	16.6/18	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2861	135.3		X	D14-4-S1	13	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Sandusky	ATWS-843	135.3		X	D14-4-S1	15	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2862	135.3		X	D14-4-S1	13.4/12.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-845	135.3		X	D14-4-S1	18.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-847	136.0		X	D14-6-S1/D14-6-S2A	19.7/45.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3849	136.0		X	D14-6-S1	17.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-848	136.4		X	D14-7-S1	16.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2923	136.4		X	D14-7-S1	14.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-849	136.4		X	D14-7-S1	25.0	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2922	136.4		X	D14-7-S1	26.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3850	136.9		X	AS-SA-202/D15-49-S1	18.5/18.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-1962	136.9		X	AS-SA-202/D15-49-S1	12/14.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2603	136.9		X	AS-SA-202/D15-49-S1	22/12.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3852	136.9		X	AS-SA-202/D15-49-S1	31.7/15.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Sandusky	ATWS-2998	137.4	X		D15-109	42.5	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2999	137.4	X		D15-109	0	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-852	138.0		X	E14-105-S1	33.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-853	138.0		X	E14-105-S1	32.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-855	138.6	X		D14-9	48.3	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3521	138.6	X		D14-9	0	N STATE ROUTE 510 bored crossing and wetland crossing. ATWS in non-disturbed area.	Y
Sandusky	ATWS-3522	138.6	X	X	D14-9/D14-9-S1	0/15.5	Road, waterbody and wetland crossing. ATWS in non-disturbed area.	Y
Sandusky	ATWS-856	138.7	X	X	D14-9/D14-9-S1	29.3/11.4	Wetland and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3856	139.0	X		D14-10	14.8	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3525	139.0	X		D14-10	17.4	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3855	139.1		X	D14-10-S1	21.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-857	139.1		X	D14-10-S1	25.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-553	139.2	X		D15-71	10.9	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Sandusky	ATWS-2838	139.2	X		D15-71	0	Road and wetland crossing.	Y
Sandusky	ATWS-2839	139.3	X		D15-71	20.2	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-313	139.3	X		D15-71	21.2	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-1592	139.9		X	D14-8-S1	26.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3529	140.5		X	E14-103-S1	39.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3531	140.5		X	E14-103-S1	38.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3535	141.1		X	D15-31-S1	25.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-864	141.1		X	D15-31-S1	17.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2507	141.2		X	D15-31-S1	20.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-865	141.2		X	D15-31-S1	19.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-1246	141.3	X		D15-32	24.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3859	141.6	X		D15-32	0	County RD 239 bored crossing and wetland crossing.	Y
Sandusky	ATWS-2509	141.6	X		D15-32	0	County RD 239 bored crossing and wetland crossing.	Y
Sandusky	ATWS-866	141.6	X		D15-32/D14-11-S1	36.0/41.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Sandusky	ATWS-2510	141.6	X	X	D15-32/D14-11-S1	36.5/44.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3537	141.7		X	D14-11-S1	34.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-868	141.7		X	D14-11-S1	27.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-323	142.6		X	AS-SA-100	11.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2519	142.7		X	AS-SA-100	11.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-324	142.7		X	AS-SA-100	27.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2520	142.7		X	AS-SA-100	28.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3539	143.0		X	E14-36-S1	11.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-872	143.0		X	E14-36-S1	10.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3540	143.0		X	E14-36-S1	10.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-873	143.0		X	E14-36-S1	11.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2477	143.3		X	D15-47-S1	11.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-326	143.3		X	D15-47-S1	10.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Sandusky	ATWS-3542	143.3		X	D15-47-S1	11.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3541	143.3		X	D15-47-S1	12.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3545	143.7		X	D14-40-S1	15.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3546	143.7		X	D14-40-S1	16.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3544	143.7		X	D14-40-S1	19.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-599	143.7		X	D14-40-S1	16.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3038	144.8		X	D15-106-S1	14.1	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2531	145.4	X		AWB-SA-203	26.2	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2474	146.1	X		D15-102	0	Wetland crossing.	Y
Sandusky	ATWS-4353	146.1	X		D15-102	14.6	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3863	146.1	X		D15-102	0	Road and wetland crossing.	Y
Sandusky	ATWS-3862	146.1	X		D15-102	0	N State Route 53 bored crossing and wetland crossing.	Y
Sandusky	ATWS-3861	146.1	X		D15-102	0	N State Route 53 bored crossing and wetland crossing.	Y
Sandusky	ATWS-2475	146.2	X		D15-104	11.8	Road, waterbody and wetland crossing. ATWS located in upland.	Y

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Sandusky	ATWS-3864	146.2	X		D15-104/AWB-SA-207	30.7/14.1	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed. .	N
Sandusky	ATWS-2882	146.4	X		D15-104	12.9	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-4117	146.7		X	AS-SA-206	23.5	Topsoil segregation and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-4116	146.7		X	AS-SA-206	18.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-4119	146.7		X	AS-SA-206	15.7	Topsoil segregation and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3559	147.2	X		AWB-SA-210	11.5	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3558	147.2	X		AWB-SA-210	10.5	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2890	147.5		X	D14-33-S1	11.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-504	147.5		X	D14-33-S1	10.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3562	147.6		X	E14-98-S1	12.2	Rail and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-393	147.6		X	E14-98-S1	11.5	Rail and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3564	147.7		X	E14-121-S1	14.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3563	147.7		X	E14-121-S1	18.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Sandusky	ATWS-3566	147.7		X	E14-121-S1	16.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3565	147.7		X	E14-121-S1	16.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3570	148.7		X	D15-34-S1	15.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3571	148.7		X	D15-34-S1	16.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3572	148.8		X	D15-34-S1	16.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3573	148.8		X	D15-34-S1	17.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-882	149.3		X	D15-52-S1	34	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2569	149.3		X	D15-52-S1	26.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-881	149.4		X	D15-52-S1	27.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3574	149.4		X	D15-52-S1	39.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-506	151.1	X		D14-37	16.8	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2987	151.1	X		D14-37	10.7	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-527	151.2	X		D15-59	26.2	Rails to Trails and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Sandusky	ATWS-528	151.3	X		D15-58	40.6	Rails to Trails and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-1253	152.3	X		E14-73	43.2	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-337	152.7		X	D15-87	11.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-1661	153.4	X	X	E14-43/E14-43-S1	21.6/36.7	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-338	153.7		X	E14-181-S1	30.0	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-339	153.8		X	E14-181-S1	0.0	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-4363	154.4		X	D15-35-S1	17.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-342	154.4		X	D15-35-S1	15.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-3580	154.4		X	D15-35-S1	18.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-671	154.5		X	D15-35-S1	15.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-1953	154.7		X	E14-109-S1	22.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-617	154.7		X	E14-109-S1	24.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-343	154.7		X	E14-109-S1	0.0	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

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NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Sandusky	ATWS-3001	154.7		X	E14-109-S1	0.0	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-601	155.1		X	E14-42-S1	15.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2894	155.1		X	E14-42-S1	16.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2893	155.2		X	E14-42-S1	15.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-529	155.2		X	E14-42-S1	16.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-1617	155.3	X		D15-89	12.9	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-885	155.6	X		D15-89	10.9	Bend installation and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed. .	N
Sandusky	ATWS-1618	155.7		X	E14-3-S1	28.9	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-886	155.8		X	E14-3-S1	22.2	Bend installation and Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2896	155.9		X	E14-3-S1	14.5	Bend installation and Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-669	155.9		X	E14-3-S1	15.3	Bend installation and Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-887	156.2	X		D15-70	37.1	Bend installation and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-888	156.5		X	D15-51-S1	14.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Sandusky	ATWS-1255	156.5		X	D15-51-S1	14.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-4364	156.6		X	D15-51-S1	22.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-4365	156.6		X	D15-51-S1	23.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-4366	156.8		X	D15-50-S1	22.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-889	156.8		X	D15-50-S1	36	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-890	156.9		X	D15-50-S1	15.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-4367	156.9		X	D15-50-S1	16.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2996	157.1	X		D14-41	32.4	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-895	157.1	X		D14-41	36.4	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-2997	157.1	X		D14-41	13.2	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-4125	157.6	X		D14-41	0	Road and wetland crossing. ATWS in non-disturbed area.	Y
Sandusky	ATWS-2877	157.6	X		D14-41	29.8	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-554	157.8		X	C15-79-S1	17.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Sandusky	ATWS-555	157.8	X	X	E14-122/C15-79-S1	31.5/15.4	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-4127	158.1	X		E14-123/E14-124/D14-42	0/47.3/39.8	N STATE ROUTE 300 bored crossing and wetland crossing. ATWS in non-disturbed area.	Y
Sandusky	ATWS-1948	158.1	X		E14-123/D14-42	0/40.1	N STATE ROUTE 300 bored crossing and wetland crossing. ATWS in non-disturbed area.	Y
Sandusky	ATWS-347	158.2	X		D14-42	0	Road and wetland crossing. ATWS in non-disturbed area.	Y
Sandusky	ATWS-4128	158.2	X		D14-42	0	N STATE ROUTE 300 bored crossing and wetland crossing.	Y
Sandusky	ATWS-1259	158.2	X		D14-42	36.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-348	158.5	X		D14-25	12.2	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-4129	158.6	X	X	D14-25/D14-25-S1	0/29.3	Waterbody and wetland crossing.	Y
Sandusky	ATWS-899	158.6		X	D14-25-S1	17.9	Waterbody crossing. ATWS located in upland.	Y
Sandusky	ATWS-3671	160.8		X	E14-107-S1	16.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-530	161.2		X	E14-108-S1	16.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-531	161.3		X	E14-108-S1	16.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-1934	162.7	X		E14-33	13.0	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-354	163.0	X		E14-33	28.0	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed. .	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Sandusky	ATWS-4136	163.1	X		D15-75	11.6	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-1267	163.5	X		E14-34	12.7	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Sandusky	ATWS-920	163.6	X		D14-38/AWB-SA-211	10.5/34.3	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-921	163.7	X	X	D14-38/E14-111-S1	40.1/16.3	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-4137	163.7		X	E14-111-S1	12	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-1273	164.7		X	D14-31-S1	18.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-1932	165.5	X		D15-73	10.8	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-3604	165.5	X		D15-73	12.8	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-933	165.5	X		D15-73	35.7	Wetland and existing pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-3584	165.5	X		D15-73	37.1	Wetland and existing pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-2897	165.6		X	E14-85-S1	17.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-928	165.6		X	E14-85-S1	16.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-2898	165.6		X	E14-85-S1	15.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Wood	ATWS-929	165.6		X	E14-85-S1	17.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-1270	165.6	X		E14-84	11.3	Topsoil segregation and bend/fitting. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-934	166.3	X	X	E14-154/E14-153-S1	45.9/28.8	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-1275	166.5	X	X	E14-152/E14-153-S1	16.6/21.1	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-2903	166.7	X		E14-152/D15-62A	0/34.2	Rail and wetland crossing. ATWS partially in disturbed area and partially in non-disturbed area.	Y
Wood	ATWS-4142	166.8		X	D14-34-S1	14.7	Rail, waterbody and wetland crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-941	167.3		X	E14-175-S1	39.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-4368	167.3		X	E14-175-S1	11.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-942	167.3		X	E14-175-S1	35.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-3588	167.4		X	E14-175-S1	23.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-943	167.7		X	E15-22-S1	21.7	Bend installation and road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-360	167.8		X	E15-22-S1	21.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-944	167.8		X	E15-22-S1	12.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Wood	ATWS-532	168.2		X	E14-48-S3	20.1	Waterbody crossing and topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-361	168.3		X	E14-48-S4	13.9	Bend installation and road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-1280	170.2	X		E14-52	13.4	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-366	170.4		X	E14-79-S1	23.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-367	170.4		X	E14-79-S1	13.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-368	170.8		X	E14-80-S1	17.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-369	170.8		X	E14-80-S1	21.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-1922	170.9	X		E14-41	13.3	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-1920	171.0	X		E14-41	10.2	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-533	171.1		X	E14-40-S1	16.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-534	171.1		X	E14-40-S1	16.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-1919	171.2		X	D15-90-WB1	6	Topsoil segregation. Trench spoil will be stored at least 10FT from water's edge. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-370	172.5	X		D15-72	27.9	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Wood	ATWS-371	172.6	X		D15-72	10.3	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-372	173.9	X		E15-6	22.4	Rail crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-373	174.0		X	D15-62-S1	16.2	Rail and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-374	174.4		X	E14-35-S1	26.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-1916	174.5	X		E14-115	31.5	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-4370	175.2		X	E15-32-S1	20.1	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-1915	175.4		X	E15-32-S1	15.2	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-1913	175.5		X	E15-33-S1	27.4	Bend installation and road, waterbody and existing pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-378	175.6		X	E15-33-S1	28.5	Road, waterbody and existing pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-379	175.6		X	E15-33-S1	13.5	Road, waterbody and existing pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-3598	175.6		X	E15-33-S1	14.2	Road, waterbody and existing pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-4374	176.0		X	E15-34-S1	16.5	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-1914	176.2		X	E15-34-S1	23.7	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Wood	ATWS-382	177.3		X	E15-7-S1	30.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-383	177.3		X	E15-7-S1	15.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-384	178.0		X	D14-45A-S1	35.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-385	178.1		X	D14-45A-S1	16.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-963	180.9		X	E14-47-S1	13.8	Road, waterbody and existing pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-3002	180.9		X	E14-47-S1	14.8	Road, waterbody and existing pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-3007	181.0		X	E14-47-S1	31.1	Road, waterbody and existing pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-964	181.0		X	E14-47-S1	31.7	Road, waterbody and existing pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wood	ATWS-4435	181.3	X	X	D15-107/E14-55-S1	0	Access to hydrotest water at Maumee River. Spoil will be stored at least 10FT from water's edge (if applicable). ATWS partially located in upland consisting of cultivated or rotated cropland or disturbed land and partially located in non-disturbed area.	Y
Lucas	ATWS-2640	182.7		X	E14-116-S1	23	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-3676	182.7		X	E14-116-S1	21	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-3677	182.7		X	E14-116-S1	22.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lucas	ATWS-2639	182.7		X	E14-116-S1	19.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4285	183.2		X	E14-29-S1	16.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-3678	183.2		X	E14-29-S1	16.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-675	183.3	X	X	AWB-LU-14/E14-29-S1	29.1/15.1	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-676	183.3	X	X	AWB-LU-14/E14-29-S1	28.2/15.2	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-3680	183.4		X	AS-LU-2	36.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-3679	183.4		X	AS-LU-2	45.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-3681	183.6		X	E14-1-S1	16.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-2202	183.6		X	E14-1-S1	12.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4153	183.7		X	E14-37-S1	14.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-2203	183.7		X	E14-37-S1	15.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4154	183.7		X	E14-37-S1	13.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-2204	183.7		X	E14-37-S1	11.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lucas	ATWS-4155	184.1		X	E14-38-S1	13.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-1063	184.1		X	E14-38-S1	16	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-2201	184.1		X	E14-38-S1	17.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4156	184.1		X	E14-38-S1	16.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-2029	185.2		X	E14-39-S1	17.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-2205	185.2		X	E14-39-S1	14.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-3683	185.3		X	E14-39-S1	16.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4408	186.5		X	E14-22-S1	16.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4159	186.6		X	E14-22-S1	12.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-1066	186.6		X	E14-22-S1	12.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-1195	186.7		X	E14-22-S1	12.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-1068	187.3		X	E15-21-S1	17.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-3004	187.3		X	E15-21-S1	15	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lucas	ATWS-1018	187.3		X	E15-21-S1	24.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-3005	187.3		X	E15-21-S1	16.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4163	187.4		X	D15-1-S1	13.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4162	187.4		X	D15-1-S1	15.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4161	187.5		X	D15-1-S1	14.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4160	187.5		X	D15-1-S1	14.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-2103	187.5		X	D15-91-S1	14.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4287	187.7		X	D15-91-S1	16.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4288	187.7		X	D15-91-S1	14.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-4261	187.9	X		E15-10	12.3	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-1189	187.9	X		E15-10	11.7	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-1070	188.1		X	E15-9-S1	35.7	Waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-2657	188.1		X	E15-9-S1	31.6	Waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lucas	ATWS-4164	188.1		X	E15-9-S1	24.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-976	188.9	X		D15-3	11.6	Wetland crossing and Bend. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-2907	189.1	X		D15-4	4.2	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lucas	ATWS-1190	189.2	X		D15-5	24.1	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Henry	ATWS-4169	189.3	X		E15-28/AWB-HE-1	0	COUNTY RD 1 bored crossing and wetland crossing and Bend.	Y
Henry	ATWS-1188	189.4	X	X	E15-28/E15-29-S1	27.5/11.9	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Henry	ATWS-4289	189.4		X	E15-29-S1	16.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Henry	ATWS-4290	189.5		X	E15-29-S1	30.5	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Henry	ATWS-2106	189.5	X		E15-30	11.5	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Henry	ATWS-2032	189.8	X		D15-54	11.4	Wetland and existing pipeline crossing. ATWS located in upland.	Y
Henry	ATWS-2034	189.8	X		D15-53	20.8	Wetland and existing pipeline crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Henry	ATWS-2648	190.1	X	X	D15-7/D15-7-S2	0/13.6	Wetland and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Henry	ATWS-4175	190.1	X	X	D15-7/D15-7-S2	0/12.6	Wetland and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Henry	ATWS-2650	190.2	X	X	D15-7/D15-7-S2/D15-7-S1	0/11.2/10.6	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Henry	ATWS-2649	190.2	X	X	D15-7/D15-7-S1	0/15.3	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-981	190.2	X	X	D15-7/D15-7-S2/D15-7-S1	23.3/27.3/31.2	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-3013	190.2	X	X	D15-7/D15-7-S1	28.1/31.5	Road crossing.ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1073	190.9		X	E15-14-S1	11.7	waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1072	190.9		X	E15-14-S1	11.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2579	191.0		X	E15-14-S2	18.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1074	191.0		X	E15-14-S2	17.9	Waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2578	191.1		X	E15-14-S2	15.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1199	191.1		X	E15-14-S2	21.3	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4264	191.5	X		D15-14	13.5	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2110	191.5	X		D15-14	26.0	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4178	191.5	X		D15-14	13.7	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Fulton	ATWS-4265	191.6	X		D15-15	13.9	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1019	192.2		X	D15-110-S1	15.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4179	192.3		X	D15-110-S1	13.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1022	192.3		X	D15-110-S1	24.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-3017	192.3		X	D15-110-S1	17.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1024	193.1		X	D15-111-S1	13	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1023	193.2		X	D15-111-S1	14.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2646	193.8	X	X	D15-97/D15-60-S1	11.2/35.9	Road crossing and bend/fitting. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1025	193.8	X		D15-97	11.9	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4293	193.8		X	D15-60-S1	19.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1076	193.8		X	D15-60-S1	28.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4294	193.9		X	D15-60-S1	12	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1215	193.9		X	D15-60-S1	14.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Fulton	ATWS-4419	194.8	X		E15-38	14.8	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2100	194.8	X		E15-38	6.4	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2660	194.9		X	E15-37-S1	36	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1028	194.9		X	E15-37-S1	27.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4182	195.0		X	E15-37-S1	36.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1029	195.0		X	E15-37-S1	19.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1079	195.2		X	E15-36-S1	16.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1080	195.2		X	E15-36-S1	12.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1081	195.3		X	E15-36-S1	12.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4297	195.8		X	D15-61-S1	27.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1033	195.8		X	D15-61-S1	18.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-999	196.3		X	D15-17-S1	18.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4186	196.3		X	D15-17-S1/D15-84-S1	11.5/46.0	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Fulton	ATWS-998	196.4		X	D15-17-S1	14.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4187	196.4		X	D15-17-S1	19.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1208	196.4	X		D15-18	10.7	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1211	196.6	X		D15-18	11.0	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1000	197.2		X	D15-9-S1	15.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2119	197.3		X	D15-9-S1	15.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-3019	197.3		X	D15-9-S1	14.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4189	197.5		X	D15-98-S1	13.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2653	197.5		X	D15-98-S1	21.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2118	197.5		X	D15-98-S1	13.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4190	197.5		X	D15-98-S1	15.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1007	197.8	X		D15-85	14.9	Rail and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2037	197.8	X		D15-85	11.9	Rail and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Fulton	ATWS-1005	197.9		X	D15-60A-S1	12.3	Rail and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2038	197.9		X	D15-60A-S1	11	Rail and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1010	198.6		X	D15-10-S1	16.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4194	198.6		X	D15-10-S1	13.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1011	198.6		X	D15-10-S1	14.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4195	198.7		X	D15-10-S1	23.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4301	198.8	X		D15-11	16.2	Wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2655	198.9	X		D15-11	15.0	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1082	199.0	X		D15-12	10.8	Road crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1035	199.1		X	D15-13-S1	20	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1083	199.1		X	D15-13-S1	25.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-539	200.7		X	E14-4-S1	47.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-444	200.8		X	E14-4-S1	29.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Fulton	ATWS-1084	201.7	X		E15-20/E15-16	1.5/2.8	Topsoil SEGRATION and bend/fitting. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1222	201.9	X		E15-16	15.7	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1040	202.1	X	X	E15-17/E15-19-S1	0/20.5	Wetland and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-516	202.6		X	D14-24-S1	33.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1041	202.7		X	D14-24-S1	11.8	Bend installation and Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1043	203.4		X	E14-112-S1	13.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1042	203.4		X	E14-112-S1	11.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-446	203.7		X	D14-44-S1	37.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-447	203.8		X	D14-44-S1	14.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1045	203.9		X	D14-44-S1	10.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1044	203.9		X	D14-44-S1	12.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4309	205.2		X	E14-53-S1	15.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1049	205.2		X	E14-53-S1	13.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Fulton	ATWS-1048	205.2		X	E14-53-S1	14	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-4302	205.2		X	E14-53-S1	13.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1050	205.6		X	D15-82-S1	19.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2209	205.6		X	D15-82-S1	14.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-2039	205.9		X	D15-83-S1	13.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1087	206.0		X	D15-83-S1	40.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1088	206.2		X	E14-11-S1	17	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1089	206.2		X	E14-11-S1	13.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
	ATWS-1052	206.9		X	E14-12-S1	44.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1053	207.8		X	D14-45-S1	15.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Fulton	ATWS-1055	207.9		X	D14-45-S1	20	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Michigan								
Lenawee	ATWS-1057	208.7		X	E14-113-S1	16.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-4313	208.7		X	E14-113-S1	19.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1056	208.7		X	E14-113-S1	13.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-4314	208.7		X	E14-113-S1	11.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3026	208.9		X	E14-114-S1	13.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1671	208.9		X	E14-114-S1	14.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1670	209.0		X	E14-114-S1	30	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3025	209.0		X	E14-114-S1	27.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-452	209.9		X	AS-LE-1	4.0	Rail, road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2662	210.0		X	AS-LE-1	23.1	Bend installation and rail, Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3028	211.0		X	E14-78-S1	15.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-454	211.0		X	E14-78-S1	11.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lenawee	ATWS-3027	211.0		X	E14-78-S1	24.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-455	211.0		X	E14-78-S1	26.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3030	212.0		X	AS-LE-206/E14-56-S1	30.8/14.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-456	212.0		X	E14-56-S1	12.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-457	212.0		X	E14-56-S1	25.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3029	212.0		X	AS-LE-206/E14-56-S1	34.8/26.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-458	213.0		X	E14-137-S1	14.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3032	213.0		X	E14-137-S1	16	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-459	213.0		X	E14-137-S1	15.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3031	213.0		X	E14-137-S1	23.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-679	213.5		X	E14-138-S1	13.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-4318	213.5		X	E14-138-S1	16.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-4319	213.5		X	E14-138-S1	17.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lenawee	ATWS-680	213.5		X	E14-138-S1	13.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3034	214.0		X	E14-139-S1	14.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-460	214.0		X	E14-139-S1	14.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3033	214.0		X	E14-139-S1	26.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-461	214.0		X	E14-139-S1	29.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1674	215.7		X	D15-28-S1	28.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2097	215.7		X	D15-28-S1	28.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1059	215.8		X	D15-28-S1	12.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2757	215.8		X	D15-28-S1	14.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-4322	216.3		X	AS-LE-5	15.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2616	216.3		X	AS-LE-5	15.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2617	216.3		X	AS-LE-5	14.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-4323	216.3		X	AS-LE-5	16	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lenawee	ATWS-2042	216.7		X	E14-58-S1	13	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-465	216.7		X	E14-58-S1	15.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-4325	216.8		X	E14-58-S1	14.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-4329	216.8		X	E14-58-S1	21.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1683	217.1		X	AS-LE-7	15	Rail, road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1682	217.1		X	AS-LE-7	10.4	Rail, road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-541	217.4		X	E14-59-S1	12.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-4331	217.5		X	E14-59-S1	18	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-542	217.5		X	E14-59-S1	17.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1688	218.1		X	AS-LE-8	18.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-4332	218.1		X	AS-LE-8	20	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1689	218.1		X	AS-LE-8	23	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-682	218.5		X	E14-141-S1	25.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lenawee	ATWS-4337	218.5		X	E14-141-S1	14.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-4338	218.5		X	E14-141-S1	15.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-681	218.5		X	E14-141-S1	20.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-683	218.8		X	E14-142-S1	24.3	ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-684	218.8		X	E14-142-S1	21.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3987	218.8		X	E14-142-S1	13	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1694	219.6		X	AS-LE-9	25.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1693	219.7		X	AS-LE-9	12.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1696	220.0		X	AS-LE-10	11.0	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1695	220.1		X	AS-LE-10	34.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1698	220.4		X	E14-143-S1	11.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1699	220.5		X	E14-143-S1	15	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1700	220.6		X	E14-64-S1	9.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lenawee	ATWS-1701	220.7		X	E14-64-S1	47.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1712	222.0		X	AS-LE-207/E14-69-S1	16.9/12	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1713	222.0		X	E14-69-S1	30.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1716	222.4		X	E14-76-S1	11.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1715	222.5		X	E14-76-S1	11.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1718	222.6		X	E14-77-S1	12.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1719	222.6		X	E14-77-S1	18.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1723	223.2		X	AS-LE-208/E14-145-S1	10.2/11.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1722	223.2		X	E14-145-S1	21.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1724	223.3	X		E14-170	10.4	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1725	223.5	X		E14-170	10.4	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3981	223.8		X	E14-171-S1	22.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3980	223.8		X	E14-171-S1	12.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lenawee	ATWS-1727	224.3		X	E14-70-S1	39.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1728	224.4		X	E14-70-S1	17.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-4395	225.0		X	AS-LE-200	18.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2624	225.1		X	AS-LE-200	19.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2623	225.5		X	AS-LE-202	22.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3975	225.5		X	AS-LE-202	17.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2622	225.6		X	AS-LE-202	12.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3976	225.6		X	AS-LE-202	13.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3974	225.8		X	AS-LE-203	5.9	Waterbody crossing. Spoil will be stored at least 10FT from water's edge. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2620	225.8		X	AS-LE-203	12.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2619	225.8		X	AS-LE-203	12.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3973	225.8		X	AS-LE-203	12.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2914	226.4		X	AS-LE-204	20.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lenawee	ATWS-4339	226.4		X	AS-LE-204	32.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1744	226.6		X	E14-126-S1	12.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2917	226.6		X	AS-LE-205/E14-126-S1	9.9/12.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1745	226.6		X	AS-LE-205/E14-126-S1	43.8/29.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2918	226.7		X	AS-LE-205	29.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-2044	226.8		X	AS-LE-210/E14-74-S1	20.9/20.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1747	226.8		X	E14-74-S1	26.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1748	227.0		X	E14-75-S1	16.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3969	227.0		X	E14-75-S1	13.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3968	228.1		X	AS-LE-211/E14-60-S1	17.5/13.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1755	228.1		X	AS-LE-211/E14-60-S1	21.6/18.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3967	228.7		X	AS-LE-12/E14-149-S1	28.3/17.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3966	228.8		X	AS-LE-12/E14-149-S1	18/20.7	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Lenawee	ATWS-2808	229.3		X	E14-150-S1	16	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1759	229.3		X	E14-150-S1	12.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1760	229.4		X	E14-150-S1	15.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1762	229.5		X	E14-87-S1	25.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-3963	229.5		X	E14-87-S2	29.9	Waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1766	229.8		X	E14-61-S1	11.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1765	229.8		X	E14-61-S1	12.6	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Lenawee	ATWS-1771	230.3		X	E14-62-S1	0.0	Bend installation and Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-1772	230.4		X	E14-62-S1	29.7	Bend installation and Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-1773	230.4	X		E14-62	13.3	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-1774	230.5	X		E14-62	12.6	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-1776	230.7		X	E14-63-S1	13.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3960	230.7		X	E14-63-S1	21.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Monroe	ATWS-3959	230.7		X	E14-63-S1	15.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-1783	231.3		X	AS-MO-1	11.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-1784	231.4		X	AS-MO-1	12.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-1786	231.9		X	E14-65-S1	15.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-1787	231.9		X	E14-65-S1	25.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3955	232.4		X	E14-66-S1	16	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-2806	232.4		X	E14-66-S1	16.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-2098	232.4		X	E14-67-S1	23.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-1793	232.5		X	E14-67-S1	13.6	Bend installation and Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-2071	233.0		X	E14-86-S2	12.4	Equipment ACCESS AROUND Road and rail crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3948	233.2		X	AS-MO-11/D15-40-S1	15.6/17.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3949	233.2		X	D15-40-S1	13.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3947	233.3		X	D15-40-S1	15.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Monroe	ATWS-3946	233.3		X	D15-40-S1	13.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3942	233.6		X	AS-MO-2	14.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3943	233.6		X	AS-MO-2	14.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3941	233.7		X	AS-MO-2	14.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3940	233.7		X	AS-MO-2	12.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3939	234.2		X	AS-MO-10A	22.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-1803	234.2		X	AS-MO-10A	25.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-1806	234.3		X	AS-MO-10/AS-MO-10A	35.4/24.4	Bend installation and Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-1802	234.3		X	AS-MO-10A	37.7	Bend installation and Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3938	234.4		X	AS-MO-10	12.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3937	234.4		X	AS-MO-10	12.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3930	235.3		X	AS-MO-3	22.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-3929	235.3		X	AS-MO-3	24.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Monroe	ATWS-2610	236.1	X		AWB-MO-6	13.7	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Monroe	ATWS-2611	236.2	X		AWB-MO-8	12.5	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3925	237.0		X	E14-157-S1	42.3	Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-4375	237.4		X	E14-157-S1	0	Access to hydrotest water. Spoil will be stored at least 10FT from water's edge.	Y
Washtenaw	ATWS-1657	237.7		X	AS-WA-204/E14-159-S1	34.1/11.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3921	238.2		X	E14-159-S1	30.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-1820	238.2		X	AS-WA-204/E14-159-S1	26.9/27.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2215	239.1		X	AS-WA-200	12.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3512	239.1		X	AS-WA-200	18.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2214	239.1		X	AS-WA-200	23.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3918	239.1		X	AS-WA-200/E14-88-S1	22.4/46.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3917	239.2		X	E14-89-S1	12.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2210	239.2		X	E14-89-S1	13.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Washtenaw	ATWS-3507	239.2	X	X	E14-89/E14-89-S1	30.0/15.3	Waterbody and bend/fitting. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3506	239.3		X	AS-WA-202/E14-90-S1	12.6/15	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2753	239.3		X	AS-WA-202	13.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2752	239.3		X	E14-165-S1	13.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3505	239.3		X	E14-165-S1	12.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2748	239.5	X		AWB-WA-205	37.3	Road and wetland crossing and bend/fitting. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2750	239.5	X		AWB-WA-205	35.9	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2749	239.6		X	AS-WA-202A/E14-91-S1	27.7/27.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-1831	239.7		X	E14-91-S1	25.5	Waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-1833	239.8		X	E14-92-S1	19.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-1832	239.8		X	E14-92-S1	28.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-1837	240.1		X	E14-93-S1	18.3	Waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-1838	240.6		X	E14-93-S1	12.8	Waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Washtenaw	ATWS-3504	240.8		X	AS-WA-206/E14-128-S1	11.2/13	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3503	241.4		X	AS-WA-207/E14-160-S1	16.5/17.9	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3502	241.5		X	E14-160-S1/E14-160-S2	15/25.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2669	242.2		X	E14-131-S1	26.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-1848	242.2		X	E14-131-S1	26.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2668	242.3		X	E14-131-S1	15.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-1850	242.3		X	E14-131-S1	15.4	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2670	242.4		X	E14-132-S1	49	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2679	243.7		X	E14-161-S1	13.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2678	243.7		X	E14-161-S1	12.1	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2681	243.8		X	E14-161-S1	20.9	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2680	243.8		X	E14-161-S1	19.3	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3499	243.9		X	E14-135-S1	39.4	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Washtenaw	ATWS-3498	244.1		X	E14-135-S1	18.6	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3908	244.6	X		E15-11	0	Waterbody and bend/fitting. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3909	244.6	X		E15-11	0	Waterbody and bend/fitting. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3497	244.7		X	E14-162-S1	32.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2687	244.9		X	E15-13-S1	14.2	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2685	244.9		X	E15-13-S1	15.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3907	244.9	X	X	E15-12/E15-13-S1	0/30.3	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2688	245.0		X	E15-13-S1/E14-99-S1	31.9/14.0	Road, waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2689	245.0		X	E14-99-S1	14.6	waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-481	245.0		X	E14-99-S1	35.3	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3906	245.0		X	E14-99-S1	19.8	waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3905	245.2	X		E14-167/AWB-WA-4	15.5	Road and wetland crossing.	Y
Washtenaw	ATWS-480	245.2	X		E14-167/AWB-WA-4	12.0	Road and wetland crossing.	Y
Washtenaw	ATWS-4390	245.2	X		E14-167/AWB-WA-4	25.8/0	Road and wetland crossing.	Y

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Washtenaw	ATWS-1652	245.2	X		E14-167	11.8	Road and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-1651	245.3		X	E14-166-S1	27.2	Waterbody crossing and Topsoil segregation. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2674	246.2	X		E14-164	46.0	Topsoil segregation and bend/fitting. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-1647	246.3		X	AS-WA-6	28.1	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3901	246.3		X	AS-WA-6	36.7	Waterbody and wetland crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3492	246.5		X	E14-176-S1	22.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-479	246.5		X	E14-176-S1	20.7	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-478	246.6		X	E14-176-S1	12.6	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3491	246.6		X	E14-176-S1	13	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-1645	246.6		X	D15-30-S1	6.5	Waterbody crossing. Trench spoil will be stored at least 10FT from water's edge. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3490	247.2		X	D15-30-S1	6.9	Waterbody crossing. Trench spoil will be stored at least 10FT from water's edge. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3488	247.2		X	D15-30-S1	15.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3489	247.2		X	D15-30-S1	26.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Washtenaw	ATWS-1637	248.1		X	D15-29-S1	27.8	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-2676	248.1		X	D15-29-S1	17.6	Road and waterbody crossing. ATWS in non-disturbed area.	Y
Washtenaw	ATWS-2677	248.2		X	D15-29-S1	16.5	Road and waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3495	248.4		X	AS-WA-46	16.8	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3496	248.4		X	AS-WA-46	15.1	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3494	248.4		X	AS-WA-46	13.2	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3493	248.6		X	D15-36-WB1	36.6	Bend installation . ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-3481	248.8		X	E14-102-S1	33.5	Waterbody crossing. ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Washtenaw	ATWS-1619	250.6	X		D15-79	15.0	Hydro Park HDD entry workspace. ATWS in non-disturbed area	Y
Washtenaw	ATWS-1621	251.1			D15-58A-WB1	0	Access to hydrotest water. Spoil will be stored at least 10FT from water's edge. ATWS in non-disturbed area	Y
Washtenaw	ATWS-3884	251.2	X		D15-23	14.4	Topsoil segregation (outside wetland). ATWS located in upland consisting of cultivated or rotated cropland or disturbed land. No variance needed.	N
Wayne	ATWS-2721	254.4	X		AWB-WY-201	0	Road and wetland crossing and bend/fitting. ATWS in non-disturbed area.	Y
Wayne	ATWS-3475	254.5	X		AWB-WY-202	47.4	Road crossing. ATWS in non-disturbed area.	Y
Wayne	ATWS-2723	254.6	X		AWB-WY-203	0	Road crossing and truck turnaround area. ATWS is partially in disturbed area and partially in non-disturbed area.	Y
Wayne	ATWS-2725	254.8	X		AWB-WY-204	2.3	Rail and wetland crossing. ATWS in non-disturbed area.	Y

TABLE 2.3-12

NEXUS Project ATWS Within 50 feet of Wetlands and Waterbodies

State, Facility, County	ATWS ID	Milepost a/	Within 50ft f a Wetland	Within 50ft of a Waterbody	Feature ID	Distance from Resource Area (feet) b/	Justification c/	Variance Required (Y/N) d/
Wayne	ATWS-2744	254.9	X		E15-26	15.9	Road and wetland crossing. ATWS in non-disturbed area outside 10-FT buffer of wetland.	Y
Washtenaw	ATWS-4413	255.2	X	X	D15-42/D15-41-WB1	0/0/5.2	Willow Run M&R workspace. Trench spoil will be stored at least 10FT from water's edge.	Y

a/ Approximate milepost along the pipeline rounded to the nearest tenth.
b / Nearest distance from the ATWS to a wetland and/or waterbody.
c/ Justification provided is for the portion of the ATWS within 50 feet of the wetland and/or waterbody.
d/ Variance Required Yes/No (Y/N) are based on 2013 FERC Wetland and Waterbody Construction and Mitigation Procedures. Jurisdictions include: Y = ATWS that is located in upland undisturbed land or within a wetland/waterbody and does require a variance, N = ATWS that is located in previously disturbed, cultivated, or cropland and doesn't require a variance.

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
Ohio							
Columbiana							
TGP Interconnect							
B15-17	PEM	0.74	31.00	0.03	0.00	0.02	0.00
Mainline							
B15-17	PFO	0.07	65.00	0.08	0.08	0.05	0.05
B15-28	PEM/PSS	0.64	177.00	0.25	0.00	0.21	0.00
B15-29	PEM	0.94	219.00	0.37	0.00	0.24	0.00
C15-84	PEM/PFO/PSS	1.17	178.00	0.21	0.00	0.19	0.00
AWB-CO-06	PEM/PSS	1.2	0.00	0.06	0.00	0.00	0.00
A14-5	PEM	2.03	26.00	0.04	0.00	0.03	0.00
A14-5	AG-PEM/PEM	2.08	584.00	1.85	0.00	0.67	0.00
AWB-CO-200	PEM	2.18	10.00	0.00	0.00	0.00	0.00
A14-5	AG-PEM	2.2	130.00	0.20	0.00	0.01	0.00
A14-5	AG-PEM	2.23	102.00	0.16	0.00	0.11	0.00
A14-9	AG-PEM	4.82	23.00	0.02	0.00	0.00	0.00
A14-10	PEM	4.87	19.00	0.00	0.00	0.00	0.00
A14-10	PSS	4.88	161.00	0.21	0.00	0.16	0.00
A14-10	PFO	4.9	17.00	0.01	0.01	0.00	0.00
A14-10	PEM/PSS	4.92	490.00	1.40	0.00	0.52	0.00
A14-11	PEM/PFO	5.25	94.00	0.13	0.03	0.08	0.03
A15-25	PEM	5.29	6.00	0.00	0.00	0.00	0.00
A14-126	PEM	5.58	17.00	0.03	0.00	0.02	0.00
AWB-CO-204	PEM/PSS	5.62	88.00	0.14	0.00	0.09	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
A14-127	PEM	5.66	50.00	0.04	0.00	0.02	0.00
AWB-SU-214	PEM	6.45	58.00	0.06	0.00	0.05	0.00
A15-46	PEM	7.32	67.00	0.03	0.00	0.00	0.00
A15-45	PEM	7.39	21.00	0.00	0.00	0.00	0.00
A15-45	PEM	7.41	128.00	0.14	0.00	0.07	0.00
A15-43	PEM/PSS	7.44	93.00	0.08	0.00	0.04	0.00
B15-33	PEM	7.75	30.00	0.01	0.00	0.00	0.00
B15-31[HDD]	PEM	8.02	4.00	0.00	0.00	0.00	0.00
B15-31[HDD]	PUB	8.09	495.00	0.00	0.00	0.00	0.00
A14-14	PEM	10.32	173.00	0.27	0.00	0.19	0.00
A14-15	PEM	10.58	28.00	0.04	0.00	0.03	0.00
C15-65	PSS	10.97	32.00	0.05	0.00	0.03	0.00
A15-33	PSS/PEM/AG-PEM	10.98	139.00	0.20	0.00	0.14	0.00
A15-34	PEM	11.16	399.00	1.28	0.00	0.30	0.00
A15-31	PEM	11.26	417.00	1.19	0.00	0.45	0.00
A15-32	PEM	11.41	132.00	0.09	0.00	0.03	0.00
A14-17	PEM	11.67	62.00	0.08	0.00	0.05	0.00
A14-17	PEM	11.82	25.00	0.03	0.00	0.02	0.00
AWB-CO-211	PEM	11.82	25.00	0.03	0.00	0.02	0.00
Stark							
AWB-ST-211	PEM	12.98	75.00	0.09	0.00	0.05	0.00
A14-108	PEM	12.99	0.00	0.03	0.00	0.03	0.00
AWB-ST-212	PEM	13.07	339.00	0.56	0.00	0.37	0.00
AWB-ST-213	PEM/PSS	13.48	60.00	0.06	0.00	0.06	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
AWB-ST-2	PFO	13.68	28.00	0.05	0.05	0.03	0.03
A15-47	PFO	13.84	13.00	0.00	0.00	0.00	0.00
A15-47	PFO	13.85	2.00	0.00	0.00	0.00	0.00
B15-55	PEM	13.95	38.00	0.02	0.00	0.00	0.00
A14-20	AG-PEM	14.78	82.00	0.15	0.00	0.00	0.00
A14-21	AG-PEM/PEM	15.04	355.00	0.60	0.00	0.40	0.00
C15-92	PEM/PSS	15.32	586.00	0.93	0.00	0.64	0.00
AWB-ST-215	PEM	15.76	20.00	0.02	0.00	0.01	0.00
AWB-ST-6	PEM/PSS	17.03	65.00	0.05	0.00	0.02	0.00
AWB-ST-7	PFO	17.16	129.00	0.14	0.14	0.11	0.11
AWB-ST-7	PFO	17.18	621.00	0.99	0.99	0.64	0.64
AWB-ST-7	PFO	17.28	15.00	0.03	0.03	0.02	0.02
A14-107	AG-PEM	17.31	24.00	0.03	0.00	0.02	0.00
A14-106	PSS	17.64	85.00	0.13	0.00	0.10	0.00
A14-104	PEM	18	21.00	0.01	0.00	0.01	0.00
C15-85	AG-PEM	18.97	71.00	0.03	0.00	0.01	0.00
C15-85	AG-PEM	19.02	75.00	0.07	0.00	0.05	0.00
C15-87	PSS	19.34	52.00	0.08	0.00	0.05	0.00
AWB-ST-202	PEM/PSS	19.35	56.00	0.14	0.00	0.08	0.00
AWB-ST-202	PEM/PSS	19.35	6.00	0.00	0.00	0.00	0.00
AWB-ST-202	PEM/PSS	19.37	346.00	0.60	0.00	0.41	0.00
B15-42[HDD]	PEM	20.42	1.00	0.00	0.00	0.00	0.00
B15-40	PEM	22.26	148.00	0.46	0.00	0.13	0.00
A14-161	PFO	24.58	181.00	0.10	0.10	0.10	0.10

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
A14-161	PFO	24.6	65.00	0.04	0.04	0.01	0.01
A14-167	PSS	25.45	40.00	0.06	0.00	0.03	0.00
A14-100	PEM	26.7	136.00	0.11	0.00	0.05	0.00
A14-100	PEM	26.7	1.00	0.00	0.00	0.00	0.00
AWB-ST-210	PEM/PSS	26.93	174.00	0.16	0.00	0.11	0.00
AWB-ST-210	PEM/PSS	26.94	4.00	0.01	0.00	0.00	0.00
B15-46	PEM	27.45	26.00	0.05	0.00	0.03	0.00
AWB-ST-201	PSS	27.83	162.00	0.21	0.00	0.10	0.00
A14-34	PEM	27.84	930.00	2.59	0.00	1.06	0.00
A14-34	PEM	28.05	41.00	0.05	0.00	0.00	0.00
AWB-ST-201	PSS	28.05	7.00	0.03	0.00	0.00	0.00
A14-168	PFO	28.89	99.00	0.23	0.23	0.16	0.16
A14-168	PFO	28.9	1.00	0.00	0.00	0.00	0.00
AWB-ST-27	PFO	28.92	21.00	0.00	0.00	0.00	0.00
AWB-ST-14	PFO	29.27	180.00	0.29	0.29	0.20	0.20
AWB-ST-18	PFO	29.87	144.00	0.13	0.13	0.06	0.06
AWB-ST-203	PFO	29.98	93.00	0.09	0.09	0.05	0.05
AWB-ST-26	PFO	30.02	92.00	0.11	0.11	0.09	0.09
A15-2	PFO	31.35	70.00	0.09	0.09	0.06	0.06
A14-164	PEM/AG-PEM	32.11	207.00	0.65	0.00	0.22	0.00
A14-164	PEM/AG-PEM	32.23	509.00	0.55	0.00	0.27	0.00
AWB-ST-206	PSS	32.74	144.00	0.47	0.00	0.15	0.00
AWB-ST-208	PEM/PSS	32.79	507.00	1.17	0.00	0.44	0.00
AWB-ST-204	PFO	33.14	225.00	0.40	0.40	0.00	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
AWB-ST-205	PFO	33.33	1851.00	3.51	3.51	1.92	1.92
AWB-ST-205	PFO	33.67	695.00	1.67	1.67	0.77	0.77
AWB-ST-205	PFO	33.8	410.00	1.07	1.07	0.49	0.49
Summit							
AWB-SU-213	PEM/PSS	34.2	701.00	2.09	0.00	0.81	0.00
AWB-SU-213	PFO	34.34	1393.00	4.09	4.09	1.60	1.60
AWB-SU-213	PEM/PSS	34.62	125.00	0.08	0.00	0.02	0.00
AWB-SU-211	PSS	34.72	114.00	0.12	0.00	0.10	0.00
AWB-SU-211	PSS	34.76	50.00	0.02	0.00	0.00	0.00
AWB-SU-209	PEM/PSS	35.12	105.00	0.14	0.00	0.10	0.00
AWB-SU-3	PEM	35.26	167.00	0.28	0.00	0.19	0.00
AWB-SU-3	PFO	35.33	266.00	0.36	0.36	0.23	0.23
AWB-SU-4	PEM/PSS/PFO	35.6	539.00	0.70	0.57	0.26	0.26
AWB-SU-208	PFO	36.2	486.00	0.77	0.77	0.50	0.50
AWB-SU-208	PFO	36.33	111.00	0.05	0.05	0.00	0.00
AWB-SU-207	PFO	36.45	44.00	0.01	0.01	0.00	0.00
AWB-SU-207	PEM	36.52	59.00	0.03	0.00	0.00	0.00
AWB-SU-207	PEM/PFO	36.55	223.00	0.11	0.05	0.02	0.02
AWB-SU-207	PEM	36.64	112.00	0.18	0.00	0.11	0.00
AWB-SU-217	PFO	36.96	241.00	0.37	0.37	0.23	0.23
AWB-SU-214	PFO	37.09	470.00	0.70	0.70	0.44	0.44
AWB-SU-205	PEM	37.4	221.00	0.78	0.00	0.25	0.00
AWB-SU-205	PEM	37.44	218.00	0.40	0.00	0.27	0.00
AWB-SU-205	PFO	37.71	84.00	0.10	0.10	0.08	0.08

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
AWB-SU-205	PFO	37.75	270.00	0.28	0.28	0.14	0.14
AWB-SU-204	PFO	37.94	316.00	0.44	0.44	0.27	0.27
AWB-SU-204	PFO	38.09	422.00	0.66	0.66	0.43	0.43
AWB-SU-203	PFO	38.33	54.00	0.05	0.05	0.03	0.03
AWB-SU-222	PSS	38.47	1.00	0.00	0.00	0.00	0.00
AWB-SU-221	PFO	38.59	209.00	0.26	0.26	0.19	0.19
AWB-SU-202	PFO	38.7	102.00	0.17	0.17	0.11	0.11
AWB-SU-201	PEM/PFO	39.34	190.00	0.63	0.19	0.20	0.00
A14-112	PEM/PSS	39.7	601.00	1.40	0.00	0.67	0.00
A14-112	PSS	39.82	69.00	0.01	0.00	0.00	0.00
A14-112	PSS	39.85	144.00	0.22	0.00	0.15	0.00
A14-112	PSS	39.88	105.00	0.09	0.00	0.03	0.00
A14-112	PSS	40.02	285.00	0.48	0.00	0.32	0.00
A14-112	AG-PEM/PEM/PSS	40.09	315.00	0.42	0.00	0.31	0.00
AWB-SU-13	PEM/PSS	40.3	242.00	0.57	0.00	0.25	0.00
AWB-SU-13	PEM/PSS	40.35	146.00	0.48	0.00	0.18	0.00
AWB-SU-13	PEM/PSS	40.38	933.00	1.50	0.00	0.97	0.00
AWB-SU-13	PEM/PSS	40.59	217.00	0.32	0.00	0.22	0.00
A14-121	PEM	40.79	21.00	0.00	0.00	0.00	0.00
AWB-SU-200	PEM/PSS	40.91	32.00	0.04	0.00	0.04	0.00
AWB-SU-200^{HDD}	PEM/PSS	40.98	186.00	0.00	0.00	0.00	0.00
A15-49	AG-PEM	41.04	17.00	0.03	0.00	0.02	0.00
A14-122	PSS	41.71	85.00	0.10	0.00	0.07	0.00
A14-122	PEM	41.73	58.00	0.01	0.00	0.00	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
A14-122	PSS	41.77	1.00	0.00	0.00	0.00	0.00
A14-122	PEM/PSS	41.79	1036.00	1.94	0.00	1.32	0.00
AWB-SU-220	PEM	42	304.00	0.58	0.00	0.15	0.00
A14-123	PEM	42.29	115.00	0.11	0.00	0.04	0.00
A15-16	PEM	43.7	47.00	0.03	0.00	0.00	0.00
A15-17	PSS	43.89	30.00	0.02	0.00	0.00	0.00
AWB-SU-22	PEM/PSS/PFO	43.9	182.00	0.28	0.22	0.19	0.14
AWB-SU-22	PEM/PSS	43.93	13.00	0.04	0.00	0.03	0.00
AWB-SU-21	PEM/PSS	43.99	85.00	0.13	0.00	0.09	0.00
AWB-SU-44	PEM/PSS	44.07	25.00	0.00	0.00	0.00	0.00
AWB-SU-23	PEM	44.13	67.00	0.09	0.00	0.05	0.00
AWB-SU-24	PEM/PFO	45.13	396.00	0.63	0.59	0.45	0.45
B14-1	PFO	45.26	423.00	0.70	0.70	0.48	0.48
B14-1	PEM	45.36	131.00	0.17	0.00	0.04	0.00
B14-1	PEM	45.39	415.00	1.10	0.00	0.40	0.00
A15-15	PEM	45.64	173.00	0.14	0.00	0.05	0.00
AWB-SU-27	PEM/PSS/PFO	45.67	236.00	0.20	0.04	0.19	0.04
AWB-SU-28	PEM/PSS/PFO	45.78	29.00	0.05	0.05	0.04	0.03
AWB-SU-29	PFO	45.93	54.00	0.03	0.03	0.01	0.01
AWB-SU-219	PFO	46.43	22.00	0.05	0.05	0.04	0.04
C15-27	PFO	46.44	40.00	0.02	0.02	0.02	0.02
C15-25	PEM	46.78	78.00	0.05	0.00	0.01	0.00
C15-25	PEM	46.79	56.00	0.08	0.00	0.04	0.00
C15-30[HDD]	PEM	47.8	37.00	0.00	0.00	0.00	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
C15-28[HDD]	AG-PEM	48.1	64.00	0.00	0.00	0.00	0.00
B15-56[HDD]	PEM	48.17	15.00	0.00	0.00	0.00	0.00
AWB-SU-43	PEM/PSS	49.26	599.00	1.18	0.00	0.56	0.00
AWB-SU-43	PEM/PSS	49.56	204.00	0.33	0.00	0.24	0.00
A14-41	PFO/PSS	49.77	91.00	0.03	0.01	0.00	0.00
A14-41	PEM/PSS	49.81	119.00	0.10	0.00	0.09	0.00
A14-42	PEM	50.12	124.00	0.07	0.00	0.02	0.00
A14-42	PEM	50.15	44.00	0.01	0.00	0.00	0.00
A14-42	PEM	50.21	1.00	0.00	0.00	0.00	0.00
Wayne							
A15-23	AG-PEM	51.25	53.00	0.09	0.00	0.06	0.00
A15-21	PEM	51.51	118.00	0.16	0.00	0.12	0.00
A15-21	PEM	51.57	55.00	0.08	0.00	0.04	0.00
A15-21	PEM	51.64	17.00	0.00	0.00	0.00	0.00
A15-21	PEM	51.7	498.00	0.16	0.00	0.00	0.00
C15-34	PSS	52.2	39.00	0.02	0.00	0.02	0.00
C15-34	AG-PEM/PEM	52.21	51.00	0.03	0.00	0.00	0.00
A14-124	PEM/PSS	52.58	327.00	0.61	0.00	0.34	0.00
A14-124	PEM	52.65	7.00	0.03	0.00	0.03	0.00
AWB-WE-200	PEM/PSS	52.65	29.00	0.03	0.00	0.02	0.00
AWB-WE-201	PFO	52.74	37.00	0.06	0.06	0.03	0.03
AWB-WE-201	PFO	52.76	46.00	0.07	0.07	0.05	0.05
AWB-WE-201	PFO	52.81	147.00	0.22	0.22	0.15	0.15
AWB-WE-201	PFO	52.86	129.00	0.12	0.12	0.00	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
A15-53	PSS	52.96	32.00	0.01	0.00	0.00	0.00
A15-41	PEM	55.29	1.00	0.00	0.00	0.00	0.00
A15-42	PEM	55.29	19.00	0.03	0.00	0.02	0.00
A15-41	PEM	55.3	11.00	0.00	0.00	0.00	0.00
C15-89	PEM	55.46	14.00	0.02	0.00	0.01	0.00
C15-89	PEM	55.58	16.00	0.02	0.00	0.01	0.00
C15-89	AG-PEM	55.62	42.00	0.02	0.00	0.00	0.00
B15-48	PEM	55.68	1.00	0.00	0.00	0.00	0.00
B15-48	PEM	55.72	122.00	0.34	0.00	0.13	0.00
Medina							
B15-49	PEM	57.18	13.00	0.02	0.00	0.02	0.00
B15-49	PEM	57.21	7.00	0.00	0.00	0.00	0.00
B15-49	PEM	57.27	27.00	0.04	0.00	0.03	0.00
Wayne							
B15-50	PEM	57.35	28.00	0.02	0.00	0.00	0.00
B15-52	AG-PEM	57.68	112.00	0.22	0.00	0.04	0.00
Medina							
C15-90	PEM	58.26	309.00	0.24	0.00	0.23	0.00
B14-7	AG-PEM/PEM	58.4	319.00	0.51	0.00	0.33	0.00
C15-91	PEM	58.93	256.00	0.34	0.00	0.25	0.00
B15-02	PEM/PSS	59.85	120.00	0.21	0.00	0.13	0.00
A14-39	PEM	60.73	10.00	0.00	0.00	0.00	0.00
A14-39	PEM	60.73	7.00	0.00	0.00	0.00	0.00
A14-39	PEM	60.73	1.00	0.01	0.00	0.00	0.00

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Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
AWB-ME-20	PEM	62.04	22.00	0.04	0.00	0.03	0.00
AWB-ME-91	PEM	62.64	691.00	1.31	0.00	0.73	0.00
AWB-ME-91	PEM	62.8	88.00	0.08	0.00	0.07	0.00
AWB-ME-91	PFO	62.83	127.00	0.23	0.23	0.15	0.15
AWB-ME-91	PEM	62.88	10.00	0.03	0.00	0.02	0.00
B15-23	PEM	62.88	88.00	0.14	0.00	0.10	0.00
B15-23	PEM	62.93	314.00	0.43	0.00	0.26	0.00
A14-114	PEM	64.6	41.00	0.07	0.00	0.05	0.00
B15-22	PEM	64.86	50.00	0.02	0.00	0.00	0.00
B15-22	PEM	64.87	1.00	0.00	0.00	0.00	0.00
AWB-ME-23[HDD]	PEM	65.98	14.00	0.00	0.00	0.00	0.00
B14-4	PFO/PSS	66.19	80.00	0.07	0.07	0.03	0.03
B14-4	PFO	66.2	54.00	0.09	0.09	0.06	0.06
A14-129	AG-PEM	66.58	104.00	0.08	0.00	0.03	0.00
AWB-ME-26	PFO	67.13	157.00	0.22	0.22	0.13	0.13
AWB-ME-26	PFO	67.19	68.00	0.03	0.03	0.00	0.00
AWB-ME-27	PFO	67.38	18.00	0.01	0.01	0.00	0.00
AWB-ME-27	PFO	67.39	65.00	0.09	0.09	0.05	0.05
AWB-ME-29	PFO	67.48	57.00	0.02	0.02	0.00	0.00
AWB-ME-30	PFO	67.56	110.00	0.14	0.14	0.08	0.08
AWB-ME-31	PEM/PSS/PFO	67.69	200.00	0.46	0.27	0.22	0.21
AWB-ME-31	PFO	67.78	41.00	0.06	0.06	0.03	0.03
AWB-ME-32	PFO	67.85	64.00	0.12	0.12	0.08	0.08
AWB-ME-33	PFO	68.11	10.00	0.00	0.00	0.00	0.00

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Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
AWB-ME-33	PFO	68.12	53.00	0.08	0.08	0.06	0.06
AWB-ME-35	PFO	68.47	55.00	0.08	0.08	0.06	0.06
AWB-ME-35	PEM/PSS/PFO	68.53	201.00	0.28	0.00	0.19	0.00
AWB-ME-35	PEM/PFO	68.62	124.00	0.19	0.18	0.12	0.11
B15-16	PEM	69.06	20.00	0.00	0.00	0.00	0.00
C15-43	PEM	69.09	84.00	0.03	0.00	0.00	0.00
C15-39	PEM	69.11	73.00	0.07	0.00	0.01	0.00
C15-43	PSS	69.11	111.00	0.05	0.00	0.00	0.00
C15-39	PEM	69.13	31.00	0.08	0.00	0.00	0.00
C15-39	PEM	69.14	54.00	0.01	0.00	0.00	0.00
C15-39	PEM	69.18	18.00	0.00	0.00	0.00	0.00
C15-39	PEM	69.23	826.00	1.14	0.00	0.65	0.00
C15-40	PEM	69.4	147.00	0.25	0.00	0.17	0.00
C15-06-W2	PEM	69.82	88.00	0.10	0.00	0.06	0.00
C15-06-W2	PEM	69.86	17.00	0.01	0.00	0.01	0.00
C15-06-W2	PEM	69.86	1.00	0.00	0.00	0.00	0.00
C15-06-W2	PEM	69.87	28.00	0.00	0.00	0.00	0.00
C15-06-W2	PEM	69.87	13.00	0.00	0.00	0.00	0.00
C15-06-W3	PFO	69.93	181.00	0.06	0.06	0.06	0.06
C15-06-W4	PFO	69.95	26.00	0.01	0.01	0.00	0.00
C15-6	PFO	69.98	122.00	0.16	0.16	0.09	0.09
C15-7	PEM	70.16	139.00	0.24	0.00	0.16	0.00
B15-27	PEM	70.38	610.00	0.96	0.00	0.62	0.00
C15-42	AG-PEM	70.55	1066.00	1.98	0.00	1.15	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
C15-42	AG-PEM	70.75	67.00	0.02	0.00	0.00	0.00
C15-44[HDD]	PFO	71.13	11.00	0.00	0.00	0.00	0.00
C15-44[HDD]	PFO	71.14	398.00	0.00	0.00	0.00	0.00
AWB-ME-48[HDD]	PFO	71.33	656.00	0.00	0.00	0.00	0.00
C15-50	PFO	72.26	524.00	0.82	0.82	0.56	0.56
A14-48	PEM/PFO	72.46	355.00	1.03	1.00	0.40	0.40
AWB-ME-52	PEM/PSS	72.79	25.00	0.03	0.00	0.02	0.00
AWB-ME-53	PFO	73.01	36.00	0.01	0.01	0.00	0.00
C15-24-W8	PFO/PSS	73.23	292.00	0.65	0.05	0.35	0.04
C15-24-W9	PEM	73.23	12.00	0.00	0.00	0.00	0.00
C15-24-W7	PFO/PSS	73.31	156.00	0.21	0.13	0.10	0.08
C15-24-W10	PEM	73.42	5.00	0.00	0.00	0.00	0.00
C15-24-W10	PEM	73.43	72.00	0.06	0.00	0.06	0.00
AWB-ME-58	PEM/PSS	73.85	35.00	0.04	0.00	0.02	0.00
AWB-ME-58	PEM/PSS	73.86	25.00	0.04	0.00	0.02	0.00
AWB-ME-58	PEM/PSS	73.91	11.00	0.02	0.00	0.01	0.00
AWB-ME-58	PEM/PSS	73.91	1.00	0.00	0.00	0.00	0.00
C15-54	PFO	73.91	30.00	0.05	0.05	0.03	0.03
AWB-ME-58	PFO	73.97	60.00	0.10	0.10	0.07	0.07
AWB-ME-58	PFO	73.98	1.00	0.00	0.00	0.00	0.00
AWB-ME-58	PFO	73.98	39.00	0.02	0.02	0.00	0.00
B14-8	AG-PEM	74.03	37.00	0.02	0.00	0.00	0.00
AWB-ME-208	PEM	75.43	52.00	0.09	0.00	0.06	0.00
AWB-ME-206	PFO	75.68	62.00	0.09	0.09	0.07	0.07

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
AWB-ME-206	PEM	75.81	48.00	0.05	0.00	0.04	0.00
AWB-ME-206	PEM	75.82	10.00	0.05	0.00	0.03	0.00
AWB-ME-207	PEM	75.88	108.00	0.03	0.00	0.00	0.00
AWB-ME-206	PEM/PSS	75.98	145.00	0.16	0.00	0.12	0.00
AWB-ME-204	PEM	76.29	61.00	0.11	0.00	0.08	0.00
AWB-ME-204	PEM	76.3	120.00	0.36	0.00	0.09	0.00
AWB-ME-202	PEM	76.93	315.00	0.83	0.00	0.34	0.00
AWB-ME-201	PEM/PSS	77.42	240.00	0.42	0.00	0.29	0.00
AWB-ME-90	PEM	78.04	25.00	0.04	0.00	0.03	0.00
AWB-ME-95	PEM	78.31	23.00	0.04	0.00	0.03	0.00
AWB-ME-95	PEM	78.39	22.00	0.01	0.00	0.00	0.00
AWB-ME-99	PEM/PSS	79.51	42.00	0.02	0.00	0.00	0.00
AWB-LO-1	PFO	80.35	88.00	0.08	0.08	0.03	0.03
B15-15	PEM/PFO/PSS	80.42	614.00	1.05	0.31	0.69	0.31
Lorain							
C15-82	PEM	81.04	55.00	0.06	0.00	0.05	0.00
A15-29	PEM	81.57	37.00	0.03	0.00	0.01	0.00
A14-59	AG-PEM/PEM/PFO	82.02	118.00	0.09	0.02	0.03	0.00
C15-83	PEM	82.58	14.00	0.02	0.00	0.01	0.00
A14-62	AG-PEM/PEM	82.64	164.00	0.24	0.00	0.18	0.00
A14-63	PFO	82.78	181.00	0.35	0.35	0.09	0.09
A14-63	AG-PEM/PFO	82.83	456.00	0.71	0.63	0.50	0.50
A14-63	AG-PEM/PFO	82.99	126.00	0.18	0.15	0.12	0.12
C15-3	PEM	83.37	68.00	0.10	0.00	0.06	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
C15-2	PFO	83.43	65.00	0.07	0.07	0.07	0.07
C15-1	PFO	83.46	30.00	0.02	0.02	0.00	0.00
A14-68	PFO	83.51	38.00	0.06	0.06	0.03	0.03
A14-68	PEM/PFO	83.52	193.00	0.44	0.42	0.23	0.23
A14-67	PFO	83.63	20.00	0.04	0.04	0.04	0.04
A14-67	PEM/PFO	83.66	163.00	0.21	0.00	0.14	0.00
A14-67	PFO	83.7	729.00	1.21	1.21	0.80	0.80
A14-69	PFO	84.32	47.00	0.06	0.06	0.03	0.03
A14-69	PFO	84.33	1.00	0.00	0.00	0.00	0.00
A14-69	PFO	84.34	1.00	0.00	0.00	0.00	0.00
A14-69	PFO	84.35	15.00	0.03	0.03	0.01	0.01
A14-69	PFO	84.35	16.00	0.01	0.01	0.01	0.01
A14-69	PFO	84.36	40.00	0.03	0.03	0.00	0.00
A14-69	PFO	84.37	58.00	0.10	0.10	0.07	0.07
A15-30	PEM	84.45	20.00	0.02	0.00	0.02	0.00
A15-51	AG-PEM	84.95	59.00	0.10	0.00	0.06	0.00
A14-71	AG-PEM/PEM/PFO	85.02	21.00	0.13	0.08	0.08	0.07
A14-71	PEM/PFO	85.11	501.00	0.63	0.52	0.51	0.51
A15-50	PEM	85.79	90.00	0.09	0.00	0.08	0.00
AWB-LO-10	PFO	85.82	54.00	0.09	0.09	0.05	0.05
AWB-LO-10	PFO	85.84	120.00	0.15	0.15	0.09	0.09
AWB-LO-10	PEM/PSS	85.96	96.00	0.15	0.00	0.10	0.00
C15-94	AG-PEM	86.52	30.00	0.00	0.00	0.00	0.00
A14-51[HDD]	AG-PEM/PEM/PFO/PSS	86.6	300.00	0.00	0.00	0.00	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
A14-51[HDD]	PFO	86.67	24.00	0.00	0.00	0.00	0.00
A14-52[HDD]	AG-PEM/PEM	86.79	341.00	0.00	0.00	0.00	0.00
A14-52	PFO	87.04	12.00	0.08	0.08	0.00	0.00
A14-73	PFO	88.5	145.00	0.15	0.15	0.07	0.07
A14-73	PFO	88.64	181.00	0.22	0.22	0.19	0.19
A14-73	PFO	88.7	327.00	0.33	0.33	0.27	0.27
A14-76	PEM/PFO	90.21	55.00	0.03	0.02	0.01	0.00
A14-76	PEM	90.22	7.00	0.01	0.00	0.00	0.00
A14-76	PEM	90.24	52.00	0.17	0.00	0.04	0.00
A14-131	PEM/PFO	90.76	1126.00	1.63	1.12	1.13	1.09
AWB-LO-15	PFO	90.76	0.00	0.06	0.06	0.02	0.02
A14-131	PEM	90.96	39.00	0.01	0.00	0.00	0.00
C15-37	PEM	91.34	1.00	0.00	0.00	0.00	0.00
C15-37	PEM/PSS	91.35	50.00	0.07	0.00	0.04	0.00
C15-36	PEM	91.72	24.00	0.00	0.00	0.00	0.00
C15-9	AG-PEM/PEM/PFO	92.58	139.00	0.22	0.03	0.14	0.02
C15-9	PFO	92.61	18.00	0.04	0.04	0.03	0.03
A14-78	AG-PEM	93.92	199.00	0.16	0.00	0.05	0.00
A14-178	PEM	94.15	19.00	0.01	0.00	0.00	0.00
A14-178	PSS	94.21	234.00	0.30	0.00	0.23	0.00
A14-178	PSS	94.27	82.00	0.08	0.00	0.04	0.00
A14-178	PSS	94.39	39.00	0.01	0.00	0.00	0.00
B15-57	AG-PEM/PEM	94.69	723.00	0.46	0.00	0.19	0.00
A14-179	PEM/PSS	95.1	65.00	0.06	0.00	0.02	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
A14-181	AG-PEM/PEM	95.39	124.00	0.18	0.00	0.11	0.00
A14-181	AG-PEM	95.45	273.00	0.13	0.00	0.01	0.00
A14-182	PEM	95.64	287.00	0.45	0.00	0.31	0.00
A14-182	PEM	95.72	325.00	0.34	0.00	0.31	0.00
A14-141	AG-PEM/PEM/PFO	96.06	236.00	0.35	0.06	0.24	0.01
A14-141	PEM/PFO	96.09	1.00	0.00	0.00	0.00	0.00
C15-58	PEM/PFO	96.12	1113.00	1.35	1.04	0.60	0.59
C15-58	PFO	96.18	14.00	0.01	0.01	0.01	0.01
C15-58	PFO	96.2	30.00	0.02	0.02	0.02	0.02
A15-38	AG-PEM/PEM/PSS	96.76	162.00	0.47	0.00	0.09	0.00
A15-39	AG-PEM	96.89	100.00	0.05	0.00	0.01	0.00
C15-57	PSS	97.32	19.00	0.04	0.00	0.02	0.00
C15-59	PEM	98.56	18.00	0.01	0.00	0.00	0.00
C15-59	AG-PEM	98.63	111.00	0.10	0.00	0.05	0.00
C15-63	AG-PEM	100.16	102.00	0.20	0.00	0.14	0.00
AWB-LO-200	PFO	100.46	93.00	0.10	0.10	0.06	0.06
AWB-LO-200	PFO	100.51	79.00	0.06	0.06	0.02	0.02
AWB-LO-201	PEM/PSS	100.78	1033.00	1.77	0.00	1.18	0.00
AWB-LO-202	PEM	101.02	1.00	0.00	0.00	0.00	0.00
Huron							
AWB-HU-201	PFO	101.89	148.00	0.26	0.26	0.17	0.17
AWB-ER-202/AWB-HU-202	PFO	102.31	180.00	0.28	0.28	0.18	0.18
AWB-HU-203	PEM	103.09	80.00	0.12	0.00	0.07	0.00
C15-56^{HDD}	PFO	104.25	519.00	0.00	0.00	0.00	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
C15-56-W2[HDD]	PEM	104.45	11.00	0.00	0.00	0.00	0.00
C15-56-W2[HDD]	PEM/PFO	104.48	438.00	0.00	0.00	0.00	0.00
Erie							
C15-70	PEM	105.84	238.00	0.99	0.00	0.25	0.00
C15-69	PSS	105.9	9.00	0.00	0.00	0.00	0.00
C15-10	PEM	106.39	5.00	0.00	0.00	0.00	0.00
C15-10	PEM/PFO	106.43	728.00	0.98	0.98	0.70	0.69
C15-10	PFO	106.56	400.00	0.61	0.61	0.39	0.39
AWB-ER-210	PFO	106.62	113.00	0.20	0.20	0.14	0.14
C15-10	PFO	106.75	36.00	0.02	0.02	0.00	0.00
C15-10	PEM/PFO	106.78	267.00	0.40	0.28	0.28	0.16
AWB-ER-43	PFO	109.41	161.00	0.29	0.29	0.19	0.19
B15-05	PEM/PFO	109.77	35.00	0.06	0.02	0.04	0.02
AWB-ER-42[HDD]	PEM/PSS	110.25	47.00	0.00	0.00	0.00	0.00
C15-12	AG-PEM	110.97	29.00	0.01	0.00	0.00	0.00
A14-111	PEM	111.39	93.00	0.08	0.00	0.03	0.00
B15-38	PFO	111.69	26.00	0.04	0.04	0.03	0.03
B15-39	PEM	111.71	10.00	0.00	0.00	0.00	0.00
B15-39	PEM	111.73	52.00	0.04	0.00	0.02	0.00
A14-154	AG-PEM/PEM	112.79	167.00	0.09	0.00	0.06	0.00
AWB-ER-35	PFO	112.99	22.00	0.01	0.01	0.01	0.01
A14-187	PEM	113.19	63.00	0.04	0.00	0.02	0.00
A14-188	PFO	113.22	161.00	0.27	0.27	0.18	0.18
A14-188	PEM/PSS	113.28	223.00	0.31	0.00	0.22	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

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AWB-ER-12	PFO	113.83	37.00	0.05	0.05	0.04	0.04
AWB-ER-12	PFO	113.85	231.00	0.36	0.36	0.25	0.25
B15-07	PSS	114.25	46.00	0.04	0.00	0.01	0.00
B15-07	PEM/PSS	114.26	77.00	0.10	0.00	0.08	0.00
B15-08	PEM	114.5	45.00	0.13	0.00	0.09	0.00
C15-14	PEM/PFO	115.39	72.00	0.12	0.05	0.08	0.05
B15-10	PEM	116.07	1.00	0.00	0.00	0.00	0.00
C15-16	PEM	116.17	35.00	0.03	0.00	0.00	0.00
A14-156	PEM/PFO	116.45	150.00	0.29	0.17	0.13	0.09
AWB-ER-18	PFO	116.48	0.00	0.00	0.00	0.00	0.00
AWB-ER-18	PFO	116.48	0.00	0.00	0.00	0.00	0.00
C15-19	PEM	118.21	408.00	0.67	0.00	0.44	0.00
C15-22	PEM	120.37	15.00	0.01	0.00	0.00	0.00
C15-22-W2	PEM	120.42	12.00	0.03	0.00	0.01	0.00
C15-22-W2	PEM	120.43	16.00	0.01	0.00	0.00	0.00
C15-73	PEM/PSS	120.45	18.00	0.02	0.00	0.01	0.00
C15-75	PEM/PSS	120.51	10.00	0.02	0.00	0.01	0.00
C15-76	PEM	120.52	10.00	0.01	0.00	0.01	0.00
B15-12	PEM	120.86	12.00	0.02	0.00	0.02	0.00
C15-80	PEM	123.58	43.00	0.07	0.00	0.04	0.00
Sandusky							
B15-14	PEM	133.35	6.00	0.01	0.00	0.01	0.00
D15-105	AG-PEM	137.31	18.00	0.02	0.00	0.01	0.00
D15-109	AG-PEM	137.45	46.00	0.03	0.00	0.00	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
E14-163	PFO	138.34	80.00	0.07	0.07	0.07	0.07
E14-163	PFO	138.38	253.00	0.38	0.38	0.29	0.29
D14-9	PSS	138.6	280.00	0.73	0.00	0.28	0.00
D14-10	PEM	139.07	31.00	0.04	0.00	0.03	0.00
D15-71	PEM	139.28	10.00	0.01	0.00	0.00	0.00
D15-71	PEM	139.3	11.00	0.02	0.00	0.01	0.00
D15-69	PSS	139.81	56.00	0.10	0.00	0.07	0.00
D14-8	PEM/PFO	139.86	115.00	0.08	0.07	0.05	0.05
D15-32	PEM	141.55	195.00	0.42	0.00	0.22	0.00
AWB-SA-209[HDD]	PSS	145.89	45.00	0.00	0.00	0.00	0.00
AWB-SA-205[HDD]	PEM/PSS	145.99	357.00	0.00	0.00	0.00	0.00
D15-103[HDD]	PEM/PSS	146.05	15.00	0.00	0.00	0.00	0.00
D15-102	PEM	146.11	56.00	0.04	0.00	0.00	0.00
D15-102	PEM	146.13	136.00	0.33	0.00	0.08	0.00
D15-104	PEM/PSS	146.2	0.00	0.06	0.00	0.04	0.00
AWB-SA-207	PEM	146.21	73.00	0.02	0.00	0.02	0.00
D15-104	PSS	146.29	10.00	0.02	0.00	0.01	0.00
D15-104	PEM/PSS	146.3	16.00	0.03	0.00	0.02	0.00
D15-104	PEM	146.31	129.00	0.16	0.00	0.11	0.00
D15-104	PEM	146.34	69.00	0.08	0.00	0.07	0.00
D15-104	PEM	146.36	95.00	0.05	0.00	0.05	0.00
AWB-SA-210[HDD]	PEM	147.21	13.00	0.00	0.00	0.00	0.00
D14-37	PEM	151.12	7.00	0.01	0.00	0.01	0.00
D15-59	PSS	151.25	59.00	0.07	0.00	0.04	0.00

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Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
D15-58	PSS	151.27	27.00	0.04	0.00	0.02	0.00
E14-73	PEM/PFO	152.25	169.00	0.21	0.21	0.18	0.18
E14-43	PFO	153.36	32.00	0.05	0.05	0.04	0.04
E14-110	PSS	154.88	43.00	0.06	0.00	0.03	0.00
D15-89	PSS	155.61	67.00	0.06	0.00	0.03	0.00
D15-70	PFO	156.33	235.00	0.29	0.29	0.16	0.16
D14-41	PFO	157.3	762.00	1.30	1.30	0.86	0.86
D14-41	PFO	157.45	139.00	0.18	0.18	0.14	0.14
D14-41	PFO	157.63	57.00	0.08	0.08	0.01	0.01
E14-122	PEM/PFO	157.92	240.00	0.45	0.44	0.29	0.29
E14-123	PFO	158.11	37.00	0.01	0.01	0.00	0.00
E14-123	PEM/PFO	158.12	171.00	0.63	0.59	0.22	0.22
D14-42	PEM/PSS	158.17	219.00	0.83	0.00	0.24	0.00
D14-25	PEM/PFO	158.58	169.00	0.26	0.13	0.11	0.09
D14-49	PFO	159.87	402.00	0.49	0.49	0.27	0.27
D14-48	PEM	160.15	332.00	0.27	0.00	0.08	0.00
E14-33	PEM/PFO	162.89	802.00	1.25	1.22	0.80	0.78
D15-75	PEM	163.07	6.00	0.01	0.00	0.00	0.00
E14-33	PEM	163.07	18.00	0.01	0.00	0.00	0.00
E14-34	PFO	163.34	532.00	0.91	0.91	0.61	0.61
E14-34	PFO	163.52	222.00	0.16	0.16	0.15	0.15
D14-38	PEM	163.72	5.00	0.01	0.00	0.01	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
Wood							
D14-31	PFO	164.76	334.00	0.58	0.58	0.38	0.38
D15-88	PEM	165.06	41.00	0.00	0.00	0.00	0.00
D15-73	PEM	165.5	7.00	0.01	0.00	0.01	0.00
E14-84	AG-PEM/PEM/PFO	165.7	462.00	0.63	0.57	0.38	0.32
E14-154	PFO	166.19	662.00	1.13	1.13	0.74	0.74
E14-152	AG-PEM/PEM/PFO	166.55	1146.00	2.27	1.62	1.30	1.02
D15-62A	PEM	166.78	12.00	0.03	0.00	0.02	0.00
D14-39	AG-PEM	168.66	39.00	0.03	0.00	0.01	0.00
E14-52	PEM/PFO	170.05	636.00	0.91	0.62	0.55	0.55
E14-41	AG-PEM	170.91	1.00	0.00	0.00	0.00	0.00
E14-41	AG-PEM	170.94	159.00	0.05	0.00	0.00	0.00
D15-72	PEM	172.58	6.00	0.01	0.00	0.01	0.00
E15-6	PFO	173.8	43.00	0.00	0.00	0.00	0.00
E15-6	PEM/PFO	173.82	393.00	0.51	0.22	0.39	0.20
E14-46	PFO	180.68	125.00	0.20	0.20	0.13	0.13
D15-107	AG-PEM	181.25	134.00	0.15	0.00	0.15	0.00
D15-107	AG-PEM	181.33	23.00	0.03	0.00	0.03	0.00
Lucas							
D15-48[HDD]	AG-PEM	181.82	27.00	0.00	0.00	0.00	0.00
AWB-LU-14[HDD]	PEM	183.33	11.00	0.00	0.00	0.00	0.00
D15-2	AG-PEM	188.53	59.00	0.06	0.00	0.04	0.00
D15-3	AG-PEM	188.97	44.00	0.01	0.00	0.00	0.00
D15-4	AG-PEM/PFO	189.06	410.00	0.42	0.40	0.40	0.37

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
D15-5	PEM	189.15	389.00	0.59	0.00	0.38	0.00
Henry							
AWB-HE-1	PEM	189.34	138.00	0.27	0.00	0.15	0.00
E15-27	AG-PEM/PEM	189.36	180.00	0.32	0.00	0.18	0.00
E15-28	AG-PEM	189.41	83.00	0.10	0.00	0.09	0.00
E15-30	AG-PEM	189.49	42.00	0.04	0.00	0.01	0.00
D15-57	PFO	189.59	109.00	0.01	0.01	0.00	0.00
D15-7	PFO	190	204.00	0.32	0.32	0.22	0.22
D15-7	PFO	190.04	64.00	0.06	0.06	0.06	0.06
D15-7	AG-PEM	190.08	496.00	1.67	0.00	0.56	0.00
D15-7	AG-PEM/PEM	190.17	360.00	1.04	0.00	0.29	0.00
Fulton							
D15-8	AG-PEM	190.44	62.00	0.01	0.00	0.00	0.00
D15-14	AG-PEM	191.53	83.00	0.13	0.00	0.09	0.00
D15-15	AG-PEM	191.59	129.00	0.16	0.00	0.13	0.00
D15-94	PEM/PFO	193.32	147.00	0.23	0.22	0.15	0.14
D15-95	PFO	193.43	145.00	0.17	0.17	0.09	0.09
D15-96	PFO	193.7	24.00	0.01	0.01	0.00	0.00
D15-97	PEM	193.74	99.00	0.10	0.00	0.05	0.00
D15-97	PEM	193.74	57.00	0.03	0.00	0.01	0.00
D15-97	PEM	193.77	93.00	0.10	0.00	0.05	0.00
E15-38	AG-PEM	194.84	38.00	0.02	0.00	0.00	0.00
D15-18	AG-PEM	196.58	132.00	0.22	0.00	0.15	0.00
D15-19	AG-PEM/PFO	196.68	127.00	0.04	0.00	0.00	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
D15-19	AG-PEM	196.73	50.00	0.06	0.00	0.03	0.00
D15-19	AG-PEM	196.78	34.00	0.02	0.00	0.00	0.00
D15-85	PEM/PFO	197.84	9.00	0.01	0.01	0.01	0.01
D15-11	AG-PEM	198.85	254.00	0.27	0.00	0.14	0.00
D15-12	AG-PEM	198.97	198.00	0.22	0.00	0.11	0.00
E15-16	AG-PEM	201.87	88.00	0.10	0.00	0.05	0.00
E15-18	AG-PEM	202.03	130.00	0.05	0.00	0.00	0.00
E15-17	AG-PEM	202.12	88.00	0.24	0.00	0.08	0.00
E14-13	AG-PEM	207.37	66.00	0.06	0.00	0.02	0.00
Michigan							
Lenawee							
D15-100[HDD]	PFO	215.23	162.00	0.00	0.00	0.00	0.00
E14-170	PFO	223.44	141.00	0.09	0.09	0.02	0.02
E14-170	PFO	223.46	23.00	0.00	0.00	0.00	0.00
Monroe							
E14-62	PSS	230.47	25.00	0.04	0.00	0.03	0.00
AWB-ME-4	PFO	235.97	97.00	0.15	0.15	0.09	0.09
AWB-MO-4	PFO	236	15.00	0.11	0.11	0.09	0.09
AWB-MO-6	PEM	236.21	1.00	0.00	0.00	0.00	0.00
AWB-MO-8	PEM	236.24	10.00	0.01	0.00	0.00	0.00
Washtenaw							
E14-158	PFO	238.01	1.00	0.00	0.00	0.00	0.00
AWB-WA-205[HDD]	PEM	239.6	11.00	0.00	0.00	0.00	0.00
E14-135	PFO	244.19	733.00	1.06	1.06	0.69	0.69

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
E15-11	PFO	244.43	22.00	0.00	0.00	0.00	0.00
E15-11	PFO	244.46	42.00	0.03	0.03	0.01	0.01
E15-11	PFO	244.48	51.00	0.04	0.04	0.01	0.01
E15-11	AG-PEM/PFO	244.53	705.00	1.18	0.96	0.68	0.67
E15-12	AG-PEM	244.98	164.00	0.19	0.00	0.00	0.00
AWB-WA-4	PEM	245.21	13.00	0.02	0.00	0.02	0.00
E14-167	PEM	245.22	172.00	0.13	0.00	0.04	0.00
E14-164	PEM	246.25	102.00	0.16	0.00	0.11	0.00
E14-180	PFO	248.94	70.00	0.05	0.05	0.01	0.01
D15-39	PEM	249.11	126.00	0.14	0.00	0.07	0.00
E14-155	PFO	249.23	686.00	1.09	1.09	0.74	0.74
E14-156	PEM	249.39	239.00	0.39	0.00	0.25	0.00
E14-168	PEM	249.74	495.00	0.79	0.00	0.55	0.00
E14-168	PEM	249.87	309.00	0.41	0.00	0.29	0.00
D15-78	PFO	250.43	223.00	0.34	0.34	0.24	0.24
D15-79	PFO	250.63	43.00	0.04	0.04	0.01	0.01
D15-80^{HDD}	PSS	250.87	20.00	0.00	0.00	0.00	0.00
D15-80^{HDD}	PSS	250.87	35.00	0.00	0.00	0.00	0.00
D15-80^{HDD}	PSS	250.89	33.00	0.00	0.00	0.00	0.00
D15-20^{HDD}	PEM	250.96	116.00	0.00	0.00	0.00	0.00
D15-22^{HDD}	PEM	251.01	198.00	0.00	0.00	0.00	0.00
D15-23	PFO	251.18	160.00	0.27	0.27	0.18	0.18
E15-25	PSS	253.37	13.00	0.00	0.00	0.00	0.00
E15-25	PFO	253.4	35.00	0.01	0.01	0.00	0.00

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
E15-25	PSS	253.4	6.00	0.00	0.00	0.00	0.00
Wayne County							
AWB-WY-201	PFO	254.46	152.00	0.20	0.20	0.00	0.00
AWB-WY-200	PFO	254.49	77.00	0.07	0.07	0.02	0.02
AWB-WY-202[HDD]	PSS	254.54	58.00	0.00	0.00	0.00	0.00
AWB-WY-203	PSS	254.57	43.00	0.07	0.00	0.05	0.00
AWB-WY-204	PEM	254.72	447.00	0.56	0.00	0.33	0.00
E15-26	PSS	254.94	31.00	0.01	0.00	0.00	0.00
	Pipeline Facility Subtotal		***84,865***	***129.32***	***53.42***	***70.27***	***32.57***
Access Roads							
(TAR-8.2)B15-31	PEM	8.09	45.00	0.00	0.00	0.00	0.00
(TAR-8.2)B15-31	PEM	8.12	125.00	0.00	0.00	0.00	0.00
(TAR-8.2)B15-31	PEM	8.12	10.00	0.00	0.00	0.00	0.00
(TAR-10.6)C15-33	PEM	10.62	71.00	0.00	0.00	0.00	0.00
(TAR-18.6)B15-36	AG-PEM	18.64	70.00	0.04	0.00	0.00	0.00
(TAR-18.6)B15-36	AG-PEM	18.71	34.00	0.01	0.00	0.00	0.00
(TAR-33.5)AWB-ST-205	PFO	33.55	36.00	0.01	0.01	0.00	0.00
(TAR-95.7)A14-182	PEM	95.69	120.00	0.01	0.00	0.00	0.00
(TAR-95.7)A14-182	PEM	95.7	124.00	0.02	0.00	0.00	0.00
(TAR-95.7)A14-109	PEM	95.74	319.00	0.00	0.00	0.00	0.00
	Access Road Subtotal		***954***	***0.10***	***0.01***	***0.00***	***0.00***

TABLE 2.4-1

Wetlands Crossed by the NEXUS Project a/

Facility, State, County, Wetland ID b/	Classification c/	Milepost	Crossing Length d/	Total Wetland Acreage Affected During Construction e/	Total Forested Wetland Affected During Construction e/	Total Wetland Acreage Affected by O&M f/	Total Forested Wetland Affected by O&M f/
Michigan							
Washtenaw							
Aboveground Facilities							
M&R Station MR4							
D15-42	PEM	255.16	84.00	0.04	0.00	0.00	0.00
D15-41	PEM	255.18	142.00	0.13	0.00	0.00	0.00
		Aboveground Subtotal	***226***	***0.17***	***0.00***	***0.00***	***0.00***
Ware yards							
--	--	--	--	--	--	--	--
		Project Total	***8,6045***	***129.59***	***52.43***	***70.27***	***32.57***

a/ Minor discrepancies in totals are due to rounding.
b/ Facility indicates where a particular wetland is located along Project mainline or aboveground facility. County indicates which county the wetland is located. Wetland ID indicates the project identifier of each wetland crossing. HDD indicates wetland areas that will be crossed using a HDD method and no impacts are proposed at these wetland crossings. Interpreted wetlands where surveys have not been completed at this time are indicated with "AWB" for approximate wetland boundary.
c/ Classifications are based on Cowardin classification system:
AG-PEM - Palustrine emergent wetland in active row crop agricultural land
PEM - Palustrine emergent wetland
PSS - Palustrine scrub-shrub wetland
PFO - Palustrine forested wetland
PUB - Palustrine unconsolidated bottom
d/ Crossing length is the distance between the enter MP and exit MP.
e/ Total wetland/forested wetland acreage affected includes impacts associated with all areas within the construction workspace limits, temporary and permanent.
f/ Total wetland/forested wetland acreage affected by Operation and Maintenance (O&M) includes impacts associated with vegetation maintenance.

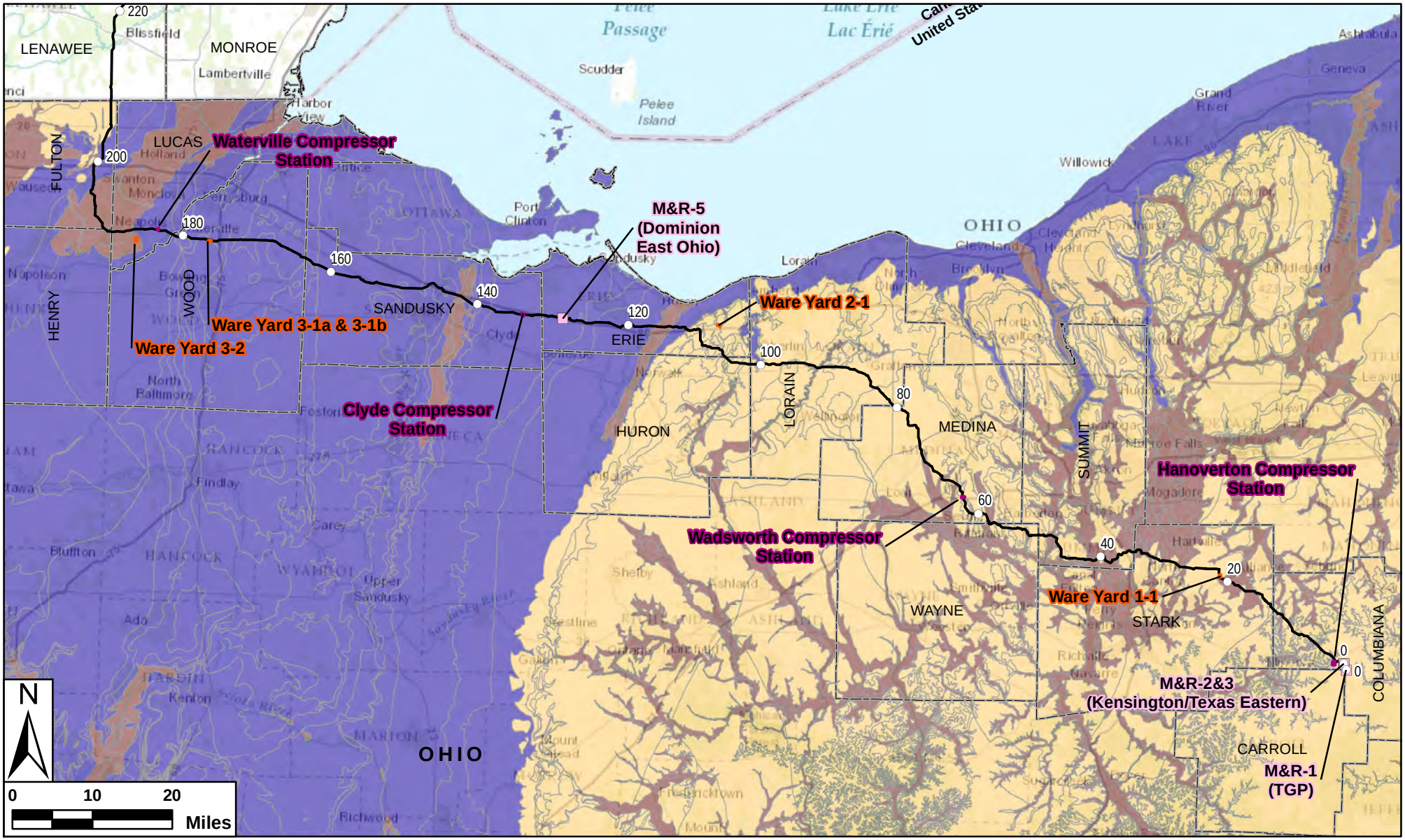
TABLE 2.4-2

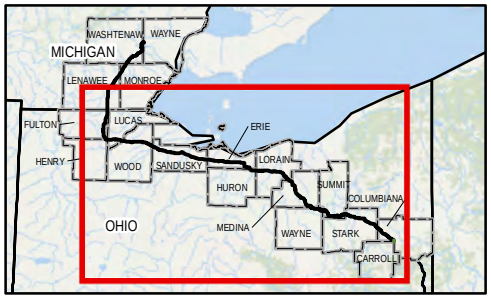
Summary of Wetlands Affected by Construction and Operation of the NEXUS Project a/

Facility, County	Total Crossing Length (feet)	Total Wetland Area Affected (acres)	Total Forested Wetland Area Affected (acres)	Wetland Area Affected by Periodic O&M (acres)	Total Forested Wetland Area Affected (acres)
Pipeline Facilities					
Pipeline Subtotal	85,091	129.32	53.42	70.27	32.57
Aboveground Facilities					
Aboveground Facilities Subtotal	226	0.17	0	0	0
Temporary Access Road					
Access Road Subtotal	874	0.10	0.01	0.00	0.00
PROJECT TOTAL	**86,045**	**129.59**	**53.43**	**70.27**	**32.57**

a/ Minor discrepancies in totals are due to rounding.

FIGURES





Legend

- Milepost (20 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Carbonate
- Sand and Gravel
- Sandstone

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Sources: ESRI, TRC, Ohio EPA and SPECTRA.

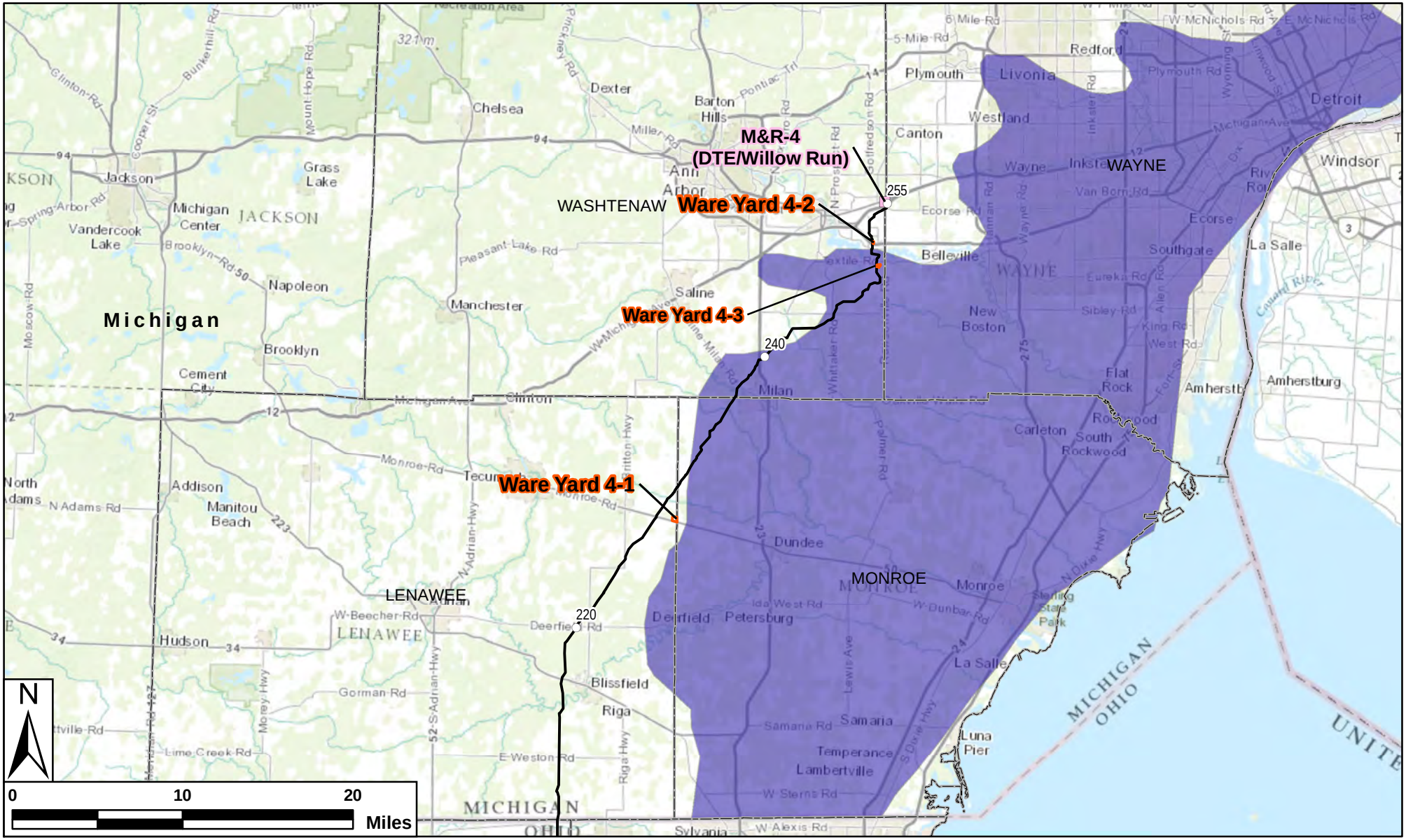
Figure 2.2-1

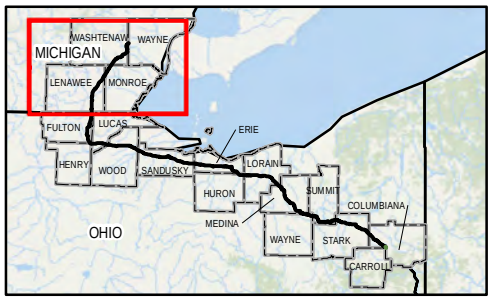
State Aquifers Crossed by the NEXUS Project

Ohio

NEXUS GAS TRANSMISSION

11/12/2015





Legend

- Milepost (20 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed Ware Yards
- Project Counties
- Carbonate

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Sources: ESRI, TRC, MI DEQ and SPECTRA.

Figure 2.2-1

State Aquifers Crossed by the NEXUS Project

Michigan

NEXUS GAS TRANSMISSION

11/11/2015

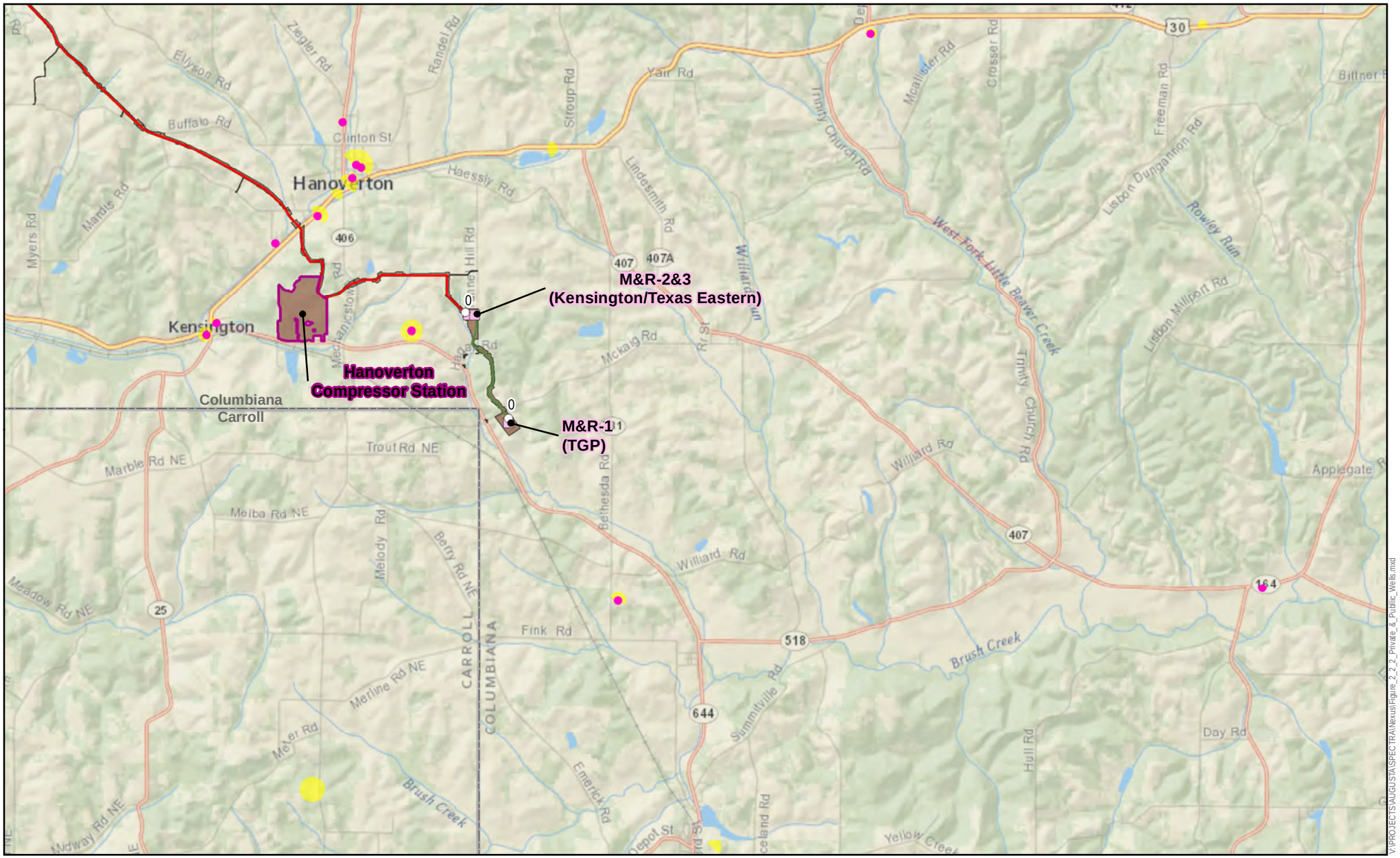


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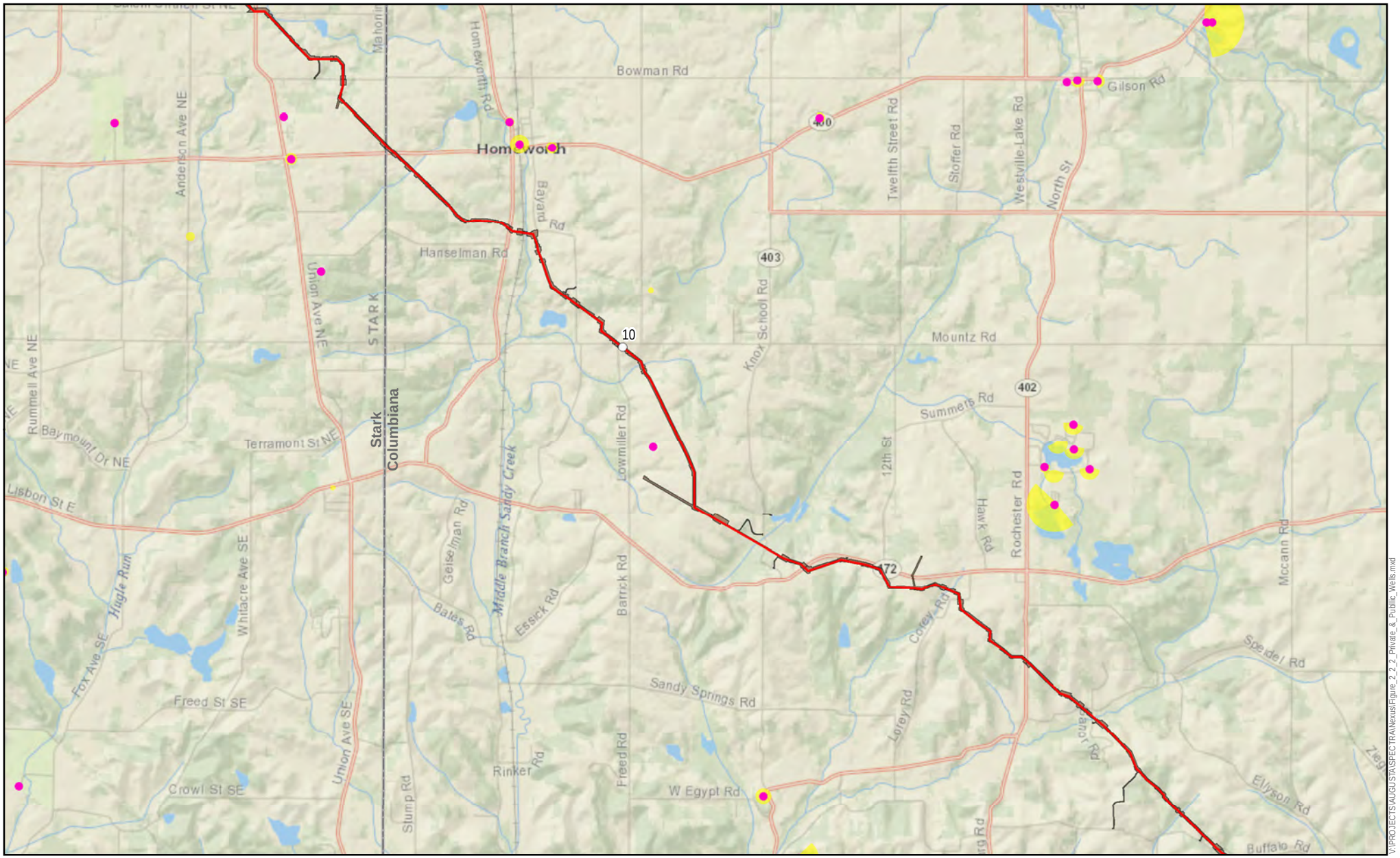
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Columbiana and Carroll Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

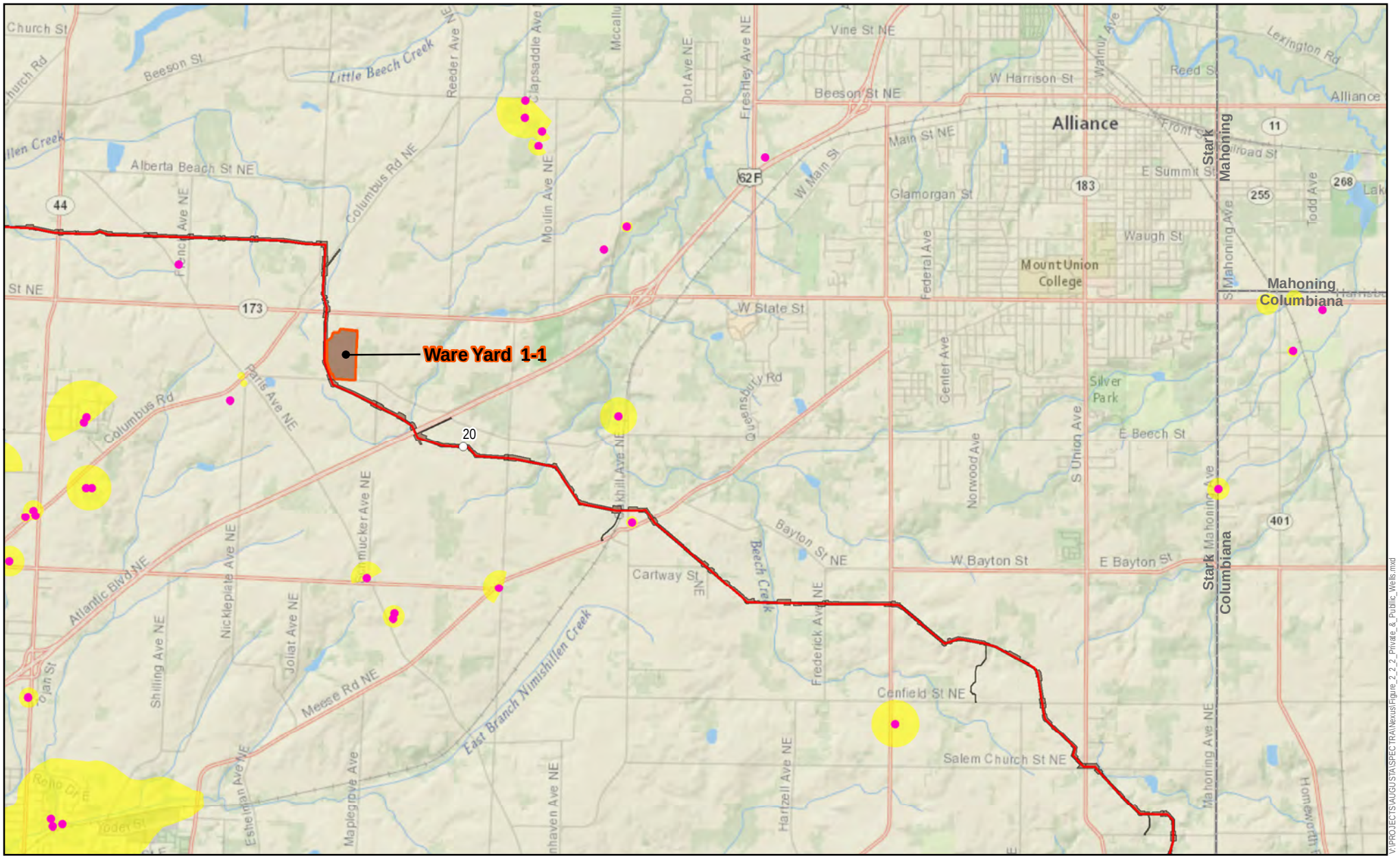
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Columbiana and Stark Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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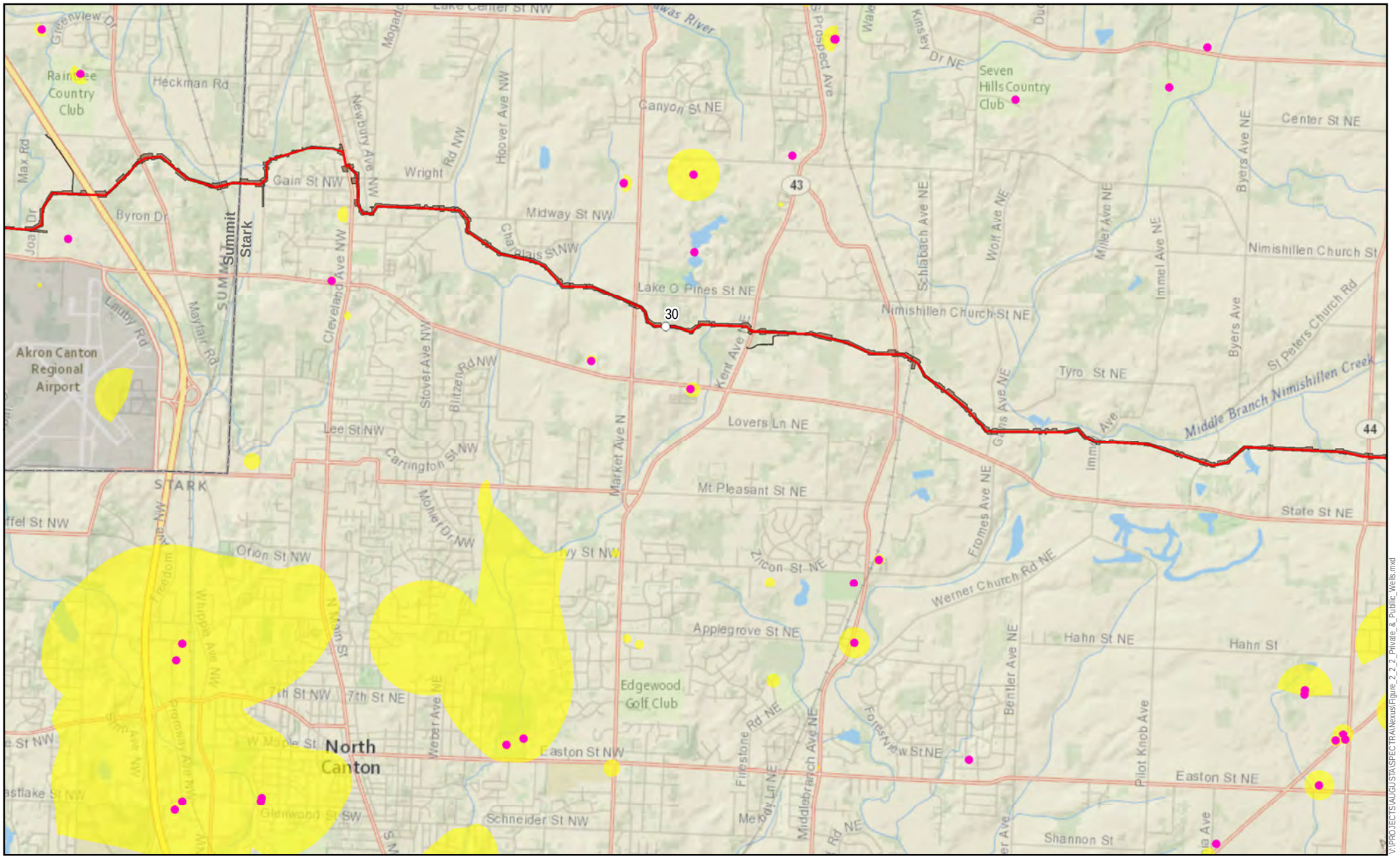
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Stark and Columbiana Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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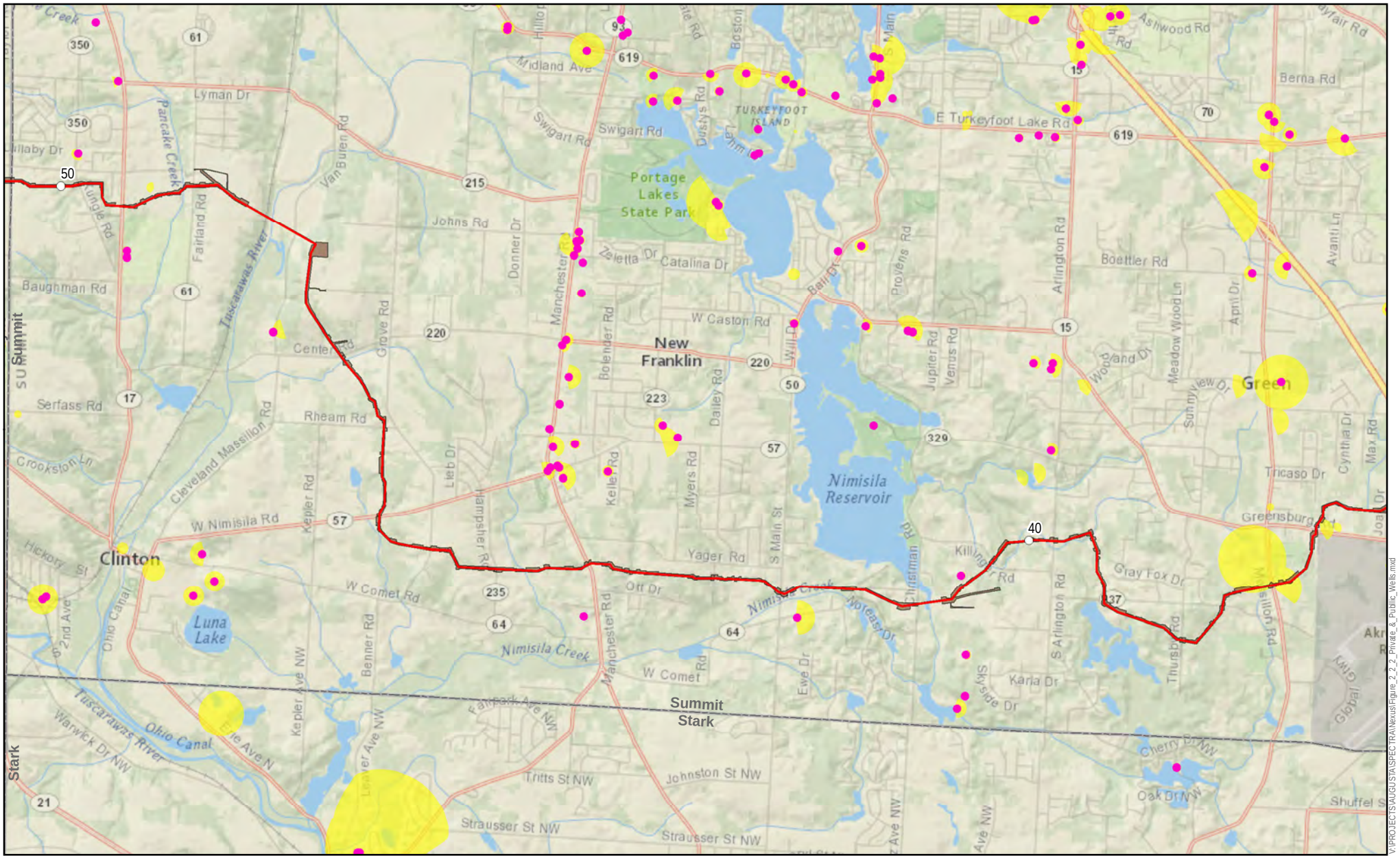
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Stark and Summit Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Summit and Stark Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015

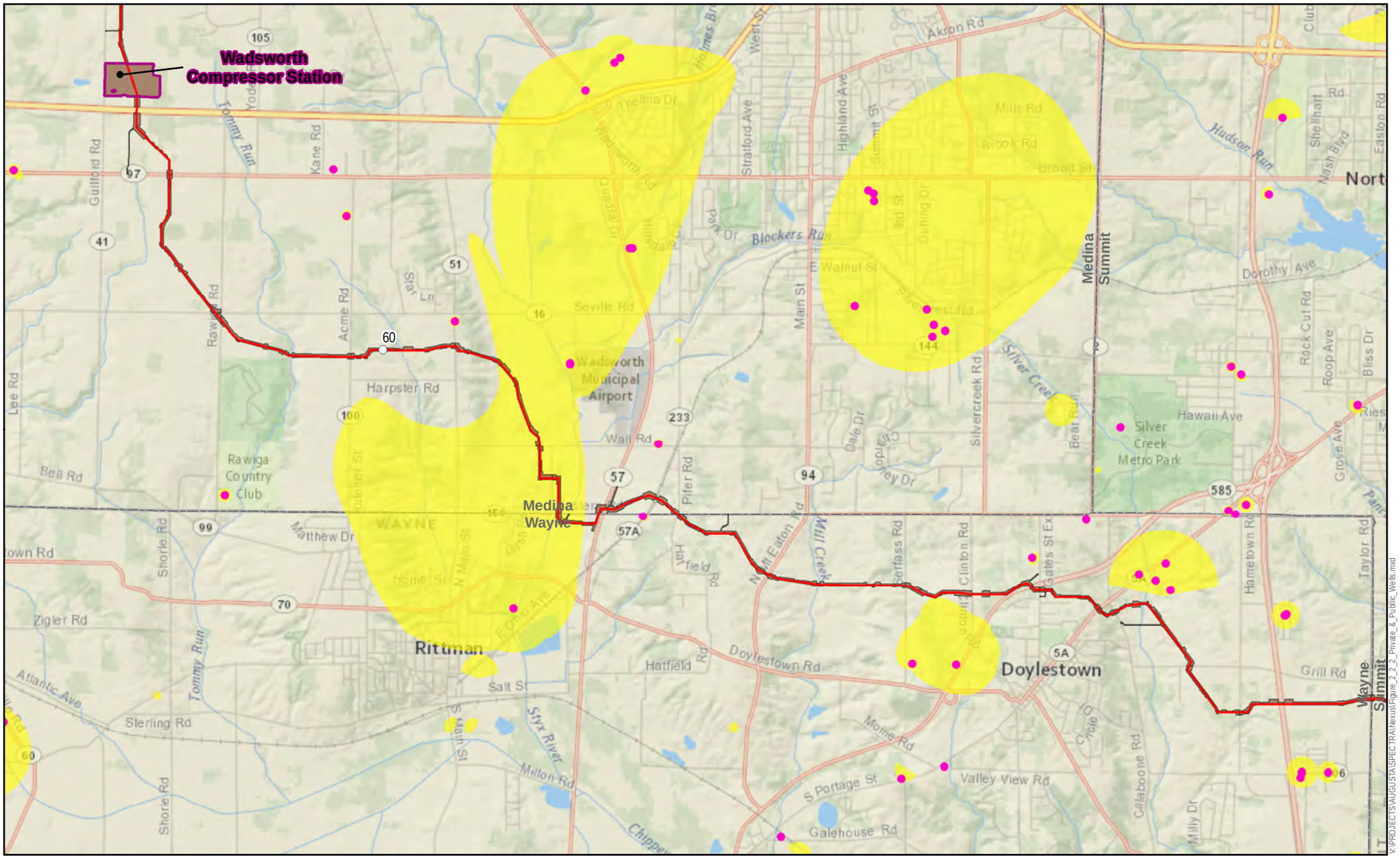


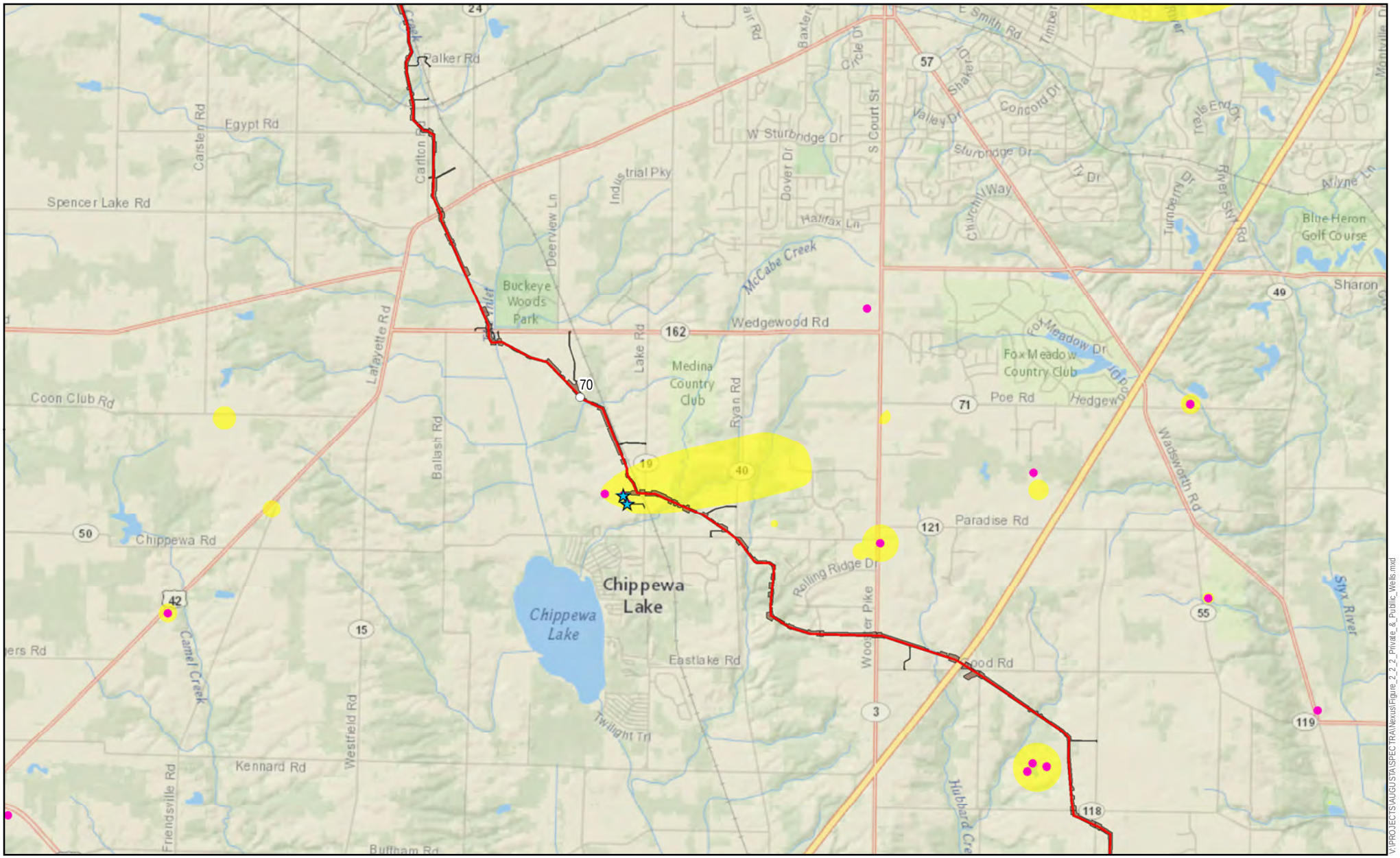
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Wayne, Summit and Medina Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

V:\PROJECTS\AUGUSTA\SPECTRA\Nexus\Figure_2_2_2_Private_&_Public_Wells.mxd

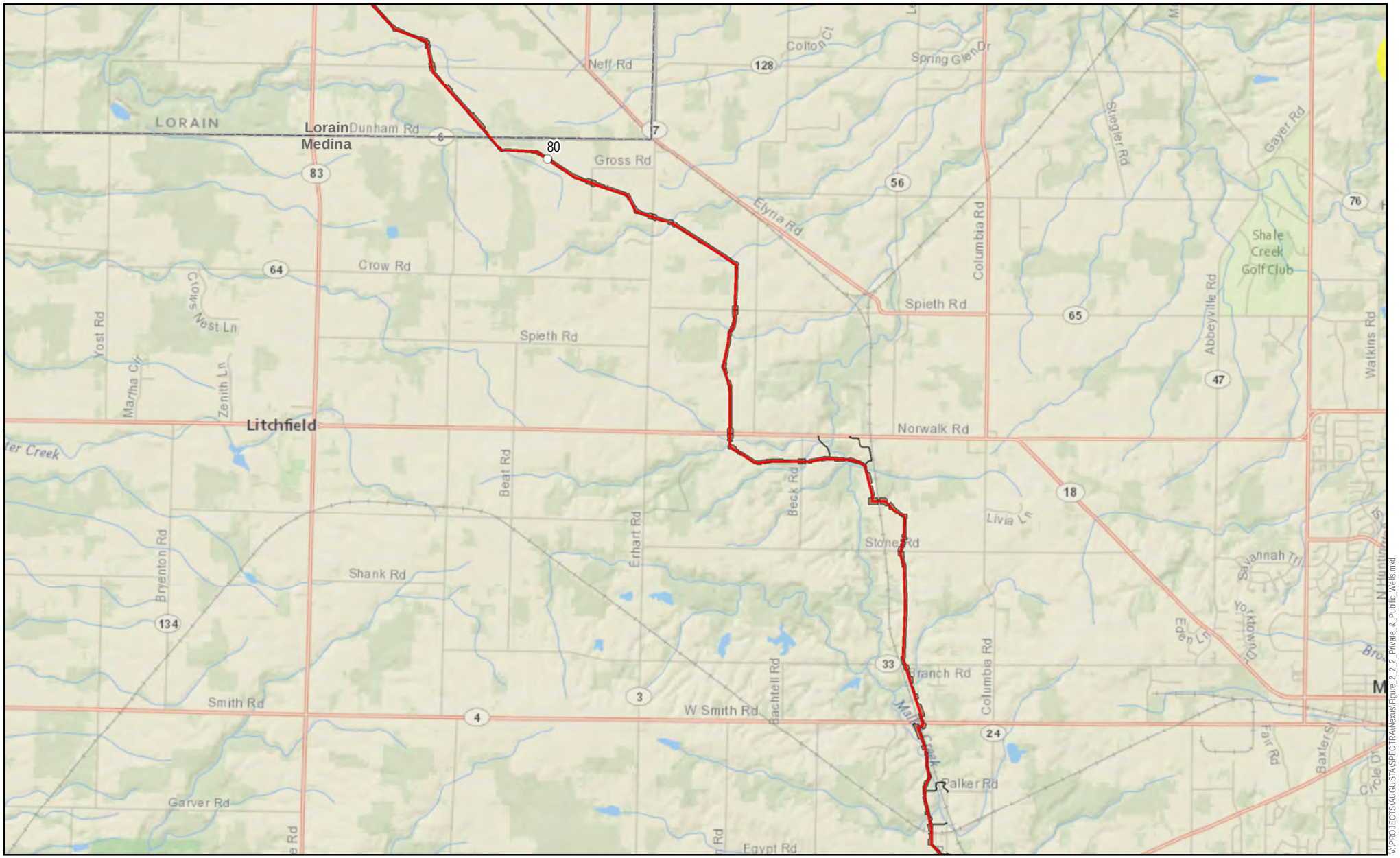
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Medina County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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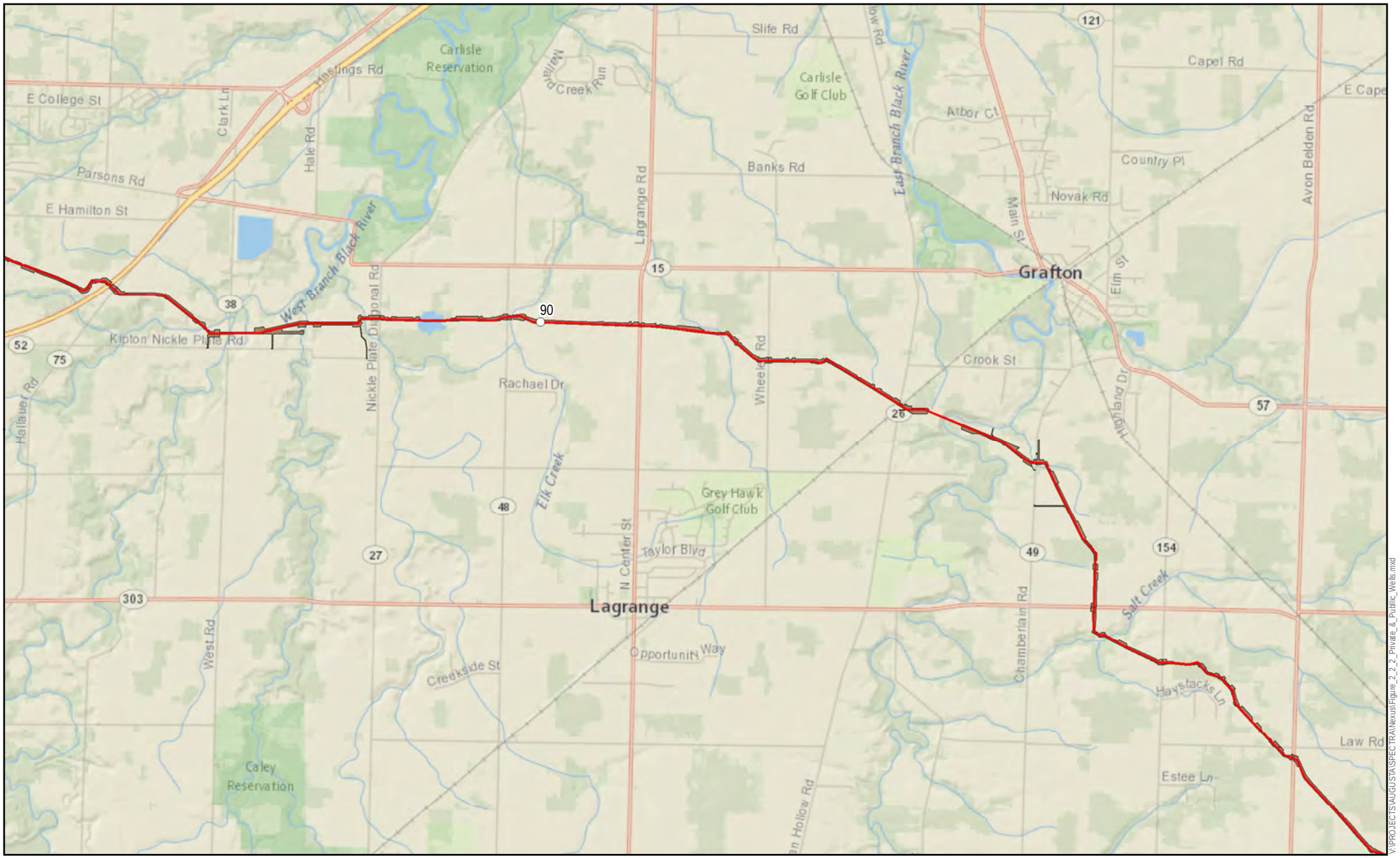
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Medina and Lorain Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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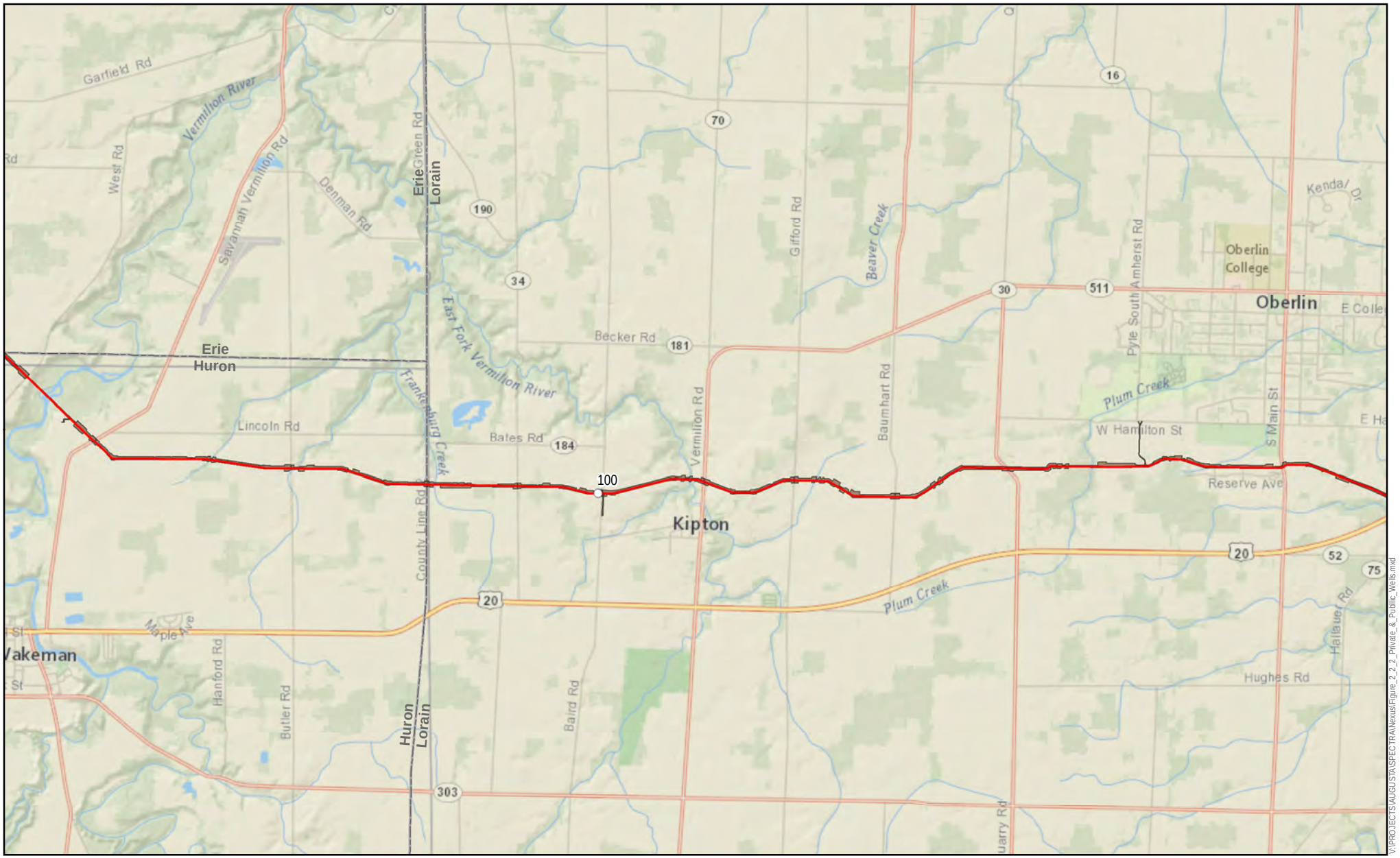
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Lorain County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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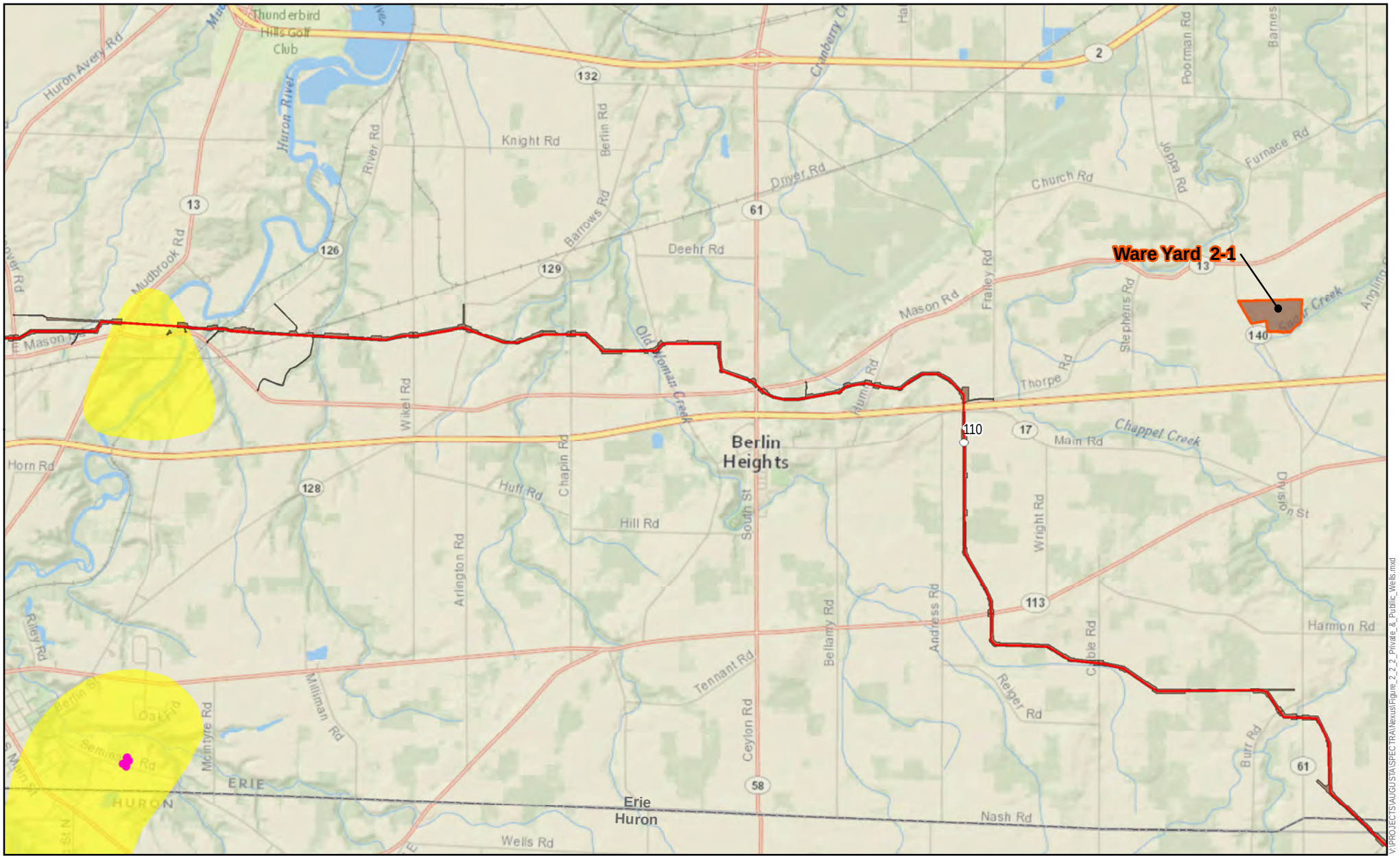
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Lorain, Erie and Huron Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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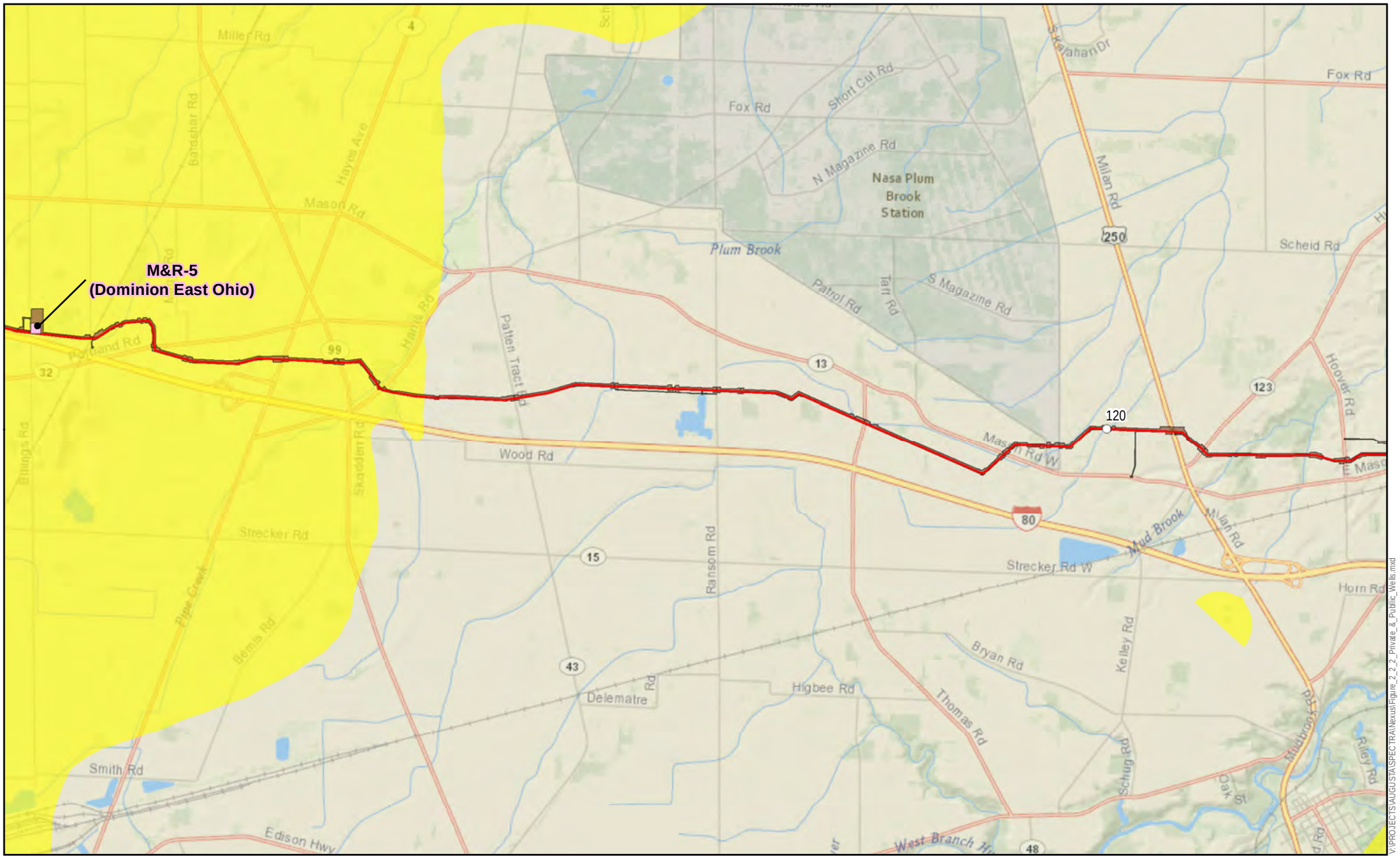
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Huron and Erie Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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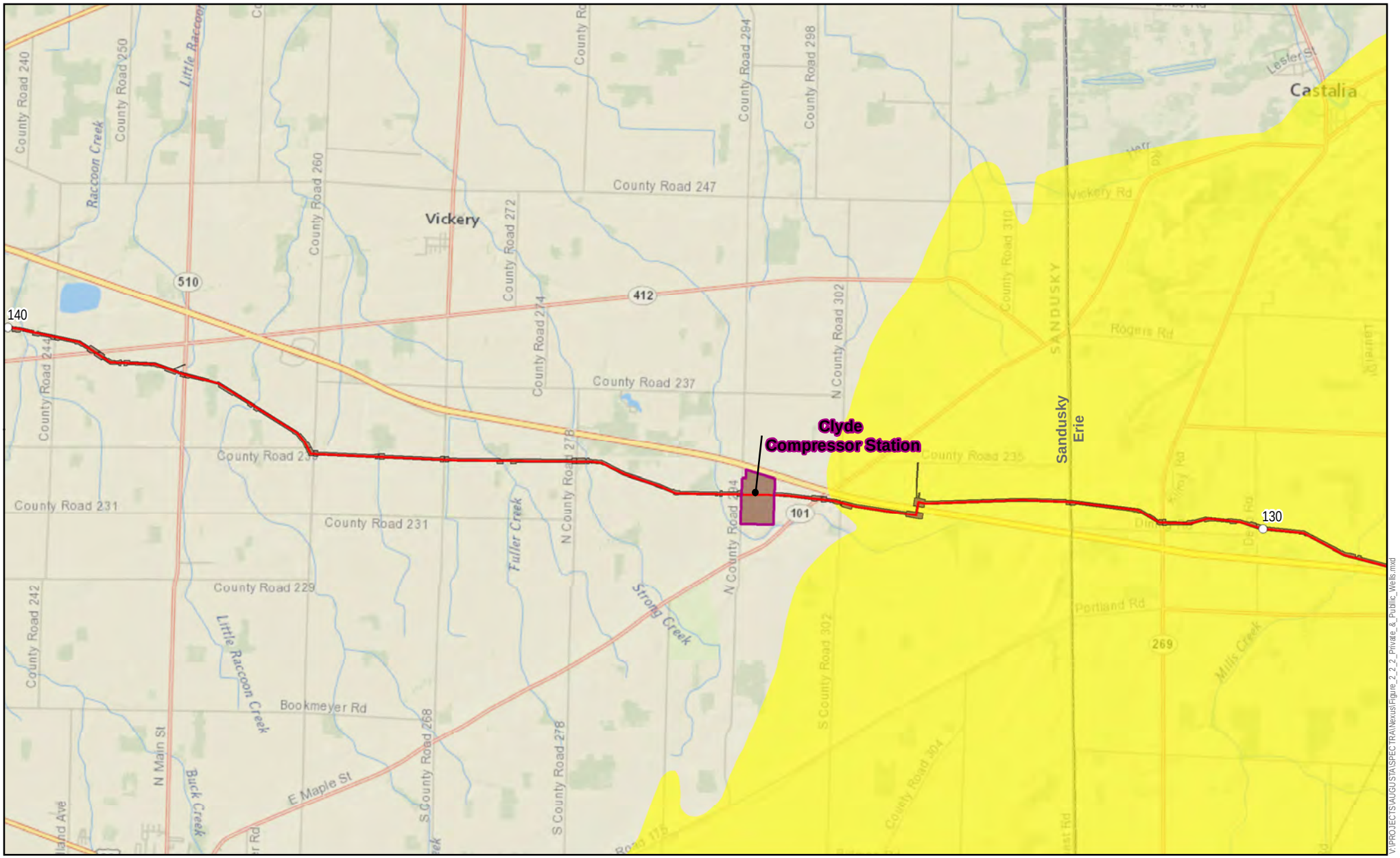
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Erie County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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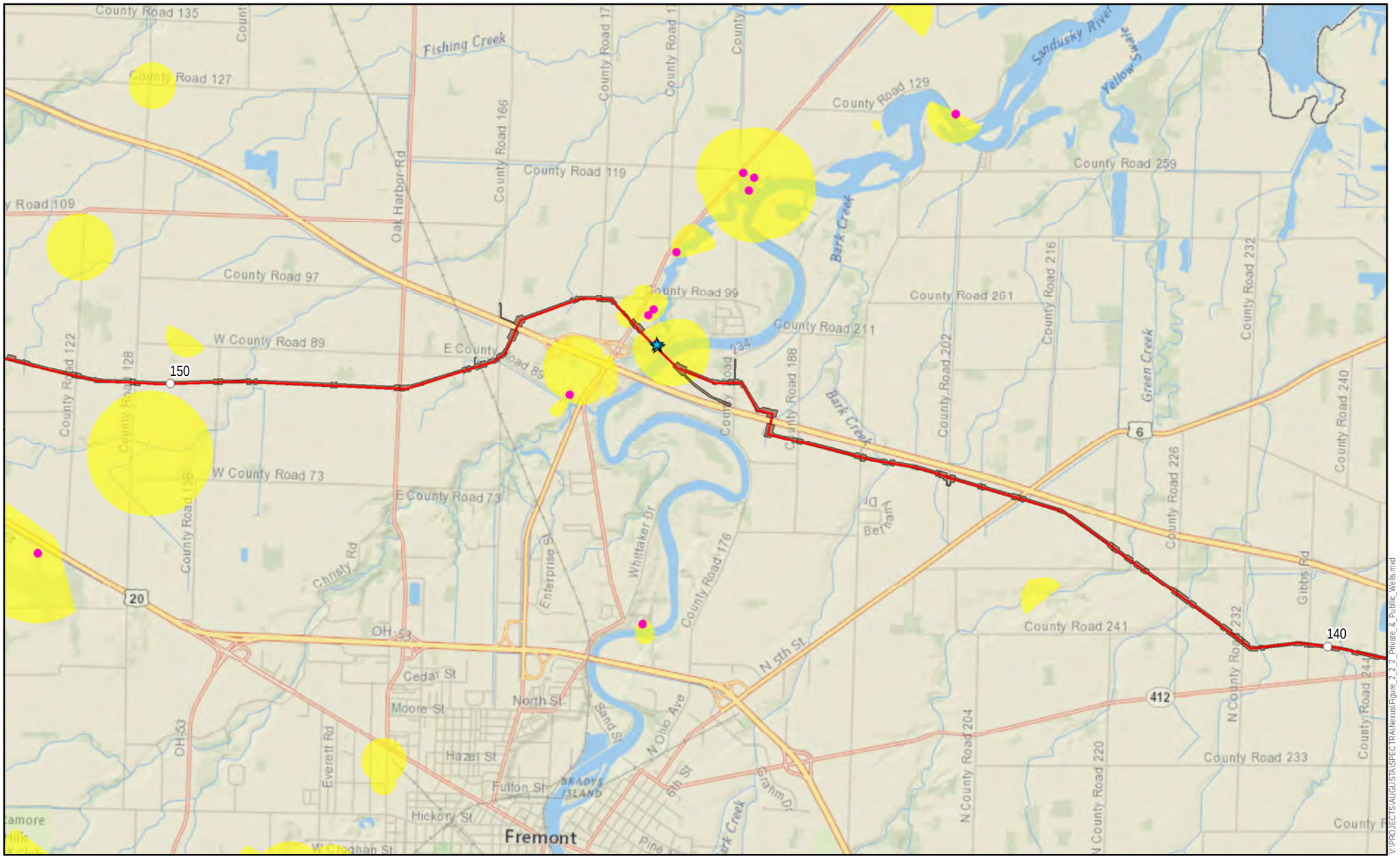
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Erie and Sandusky Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

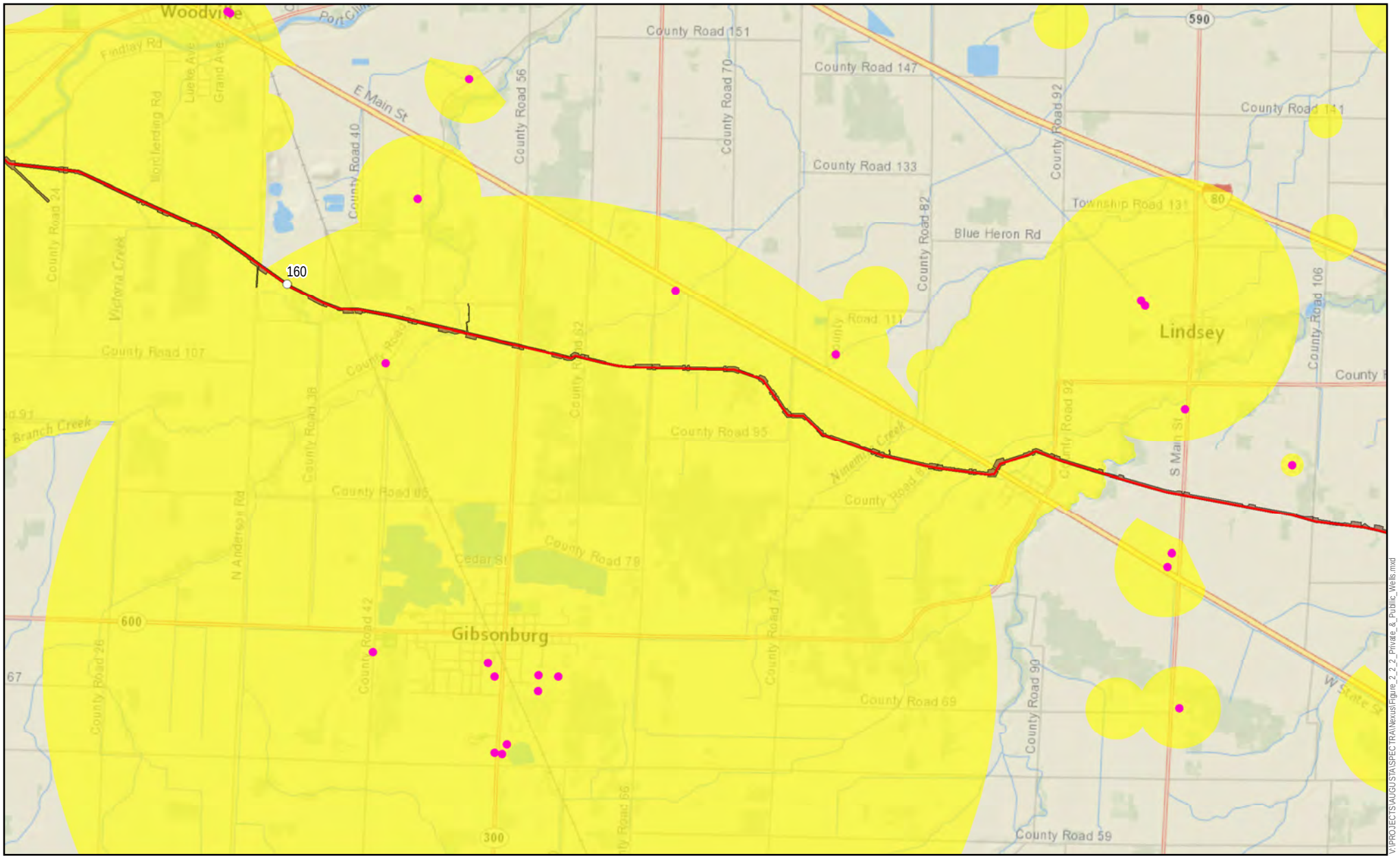
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Sandusky County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

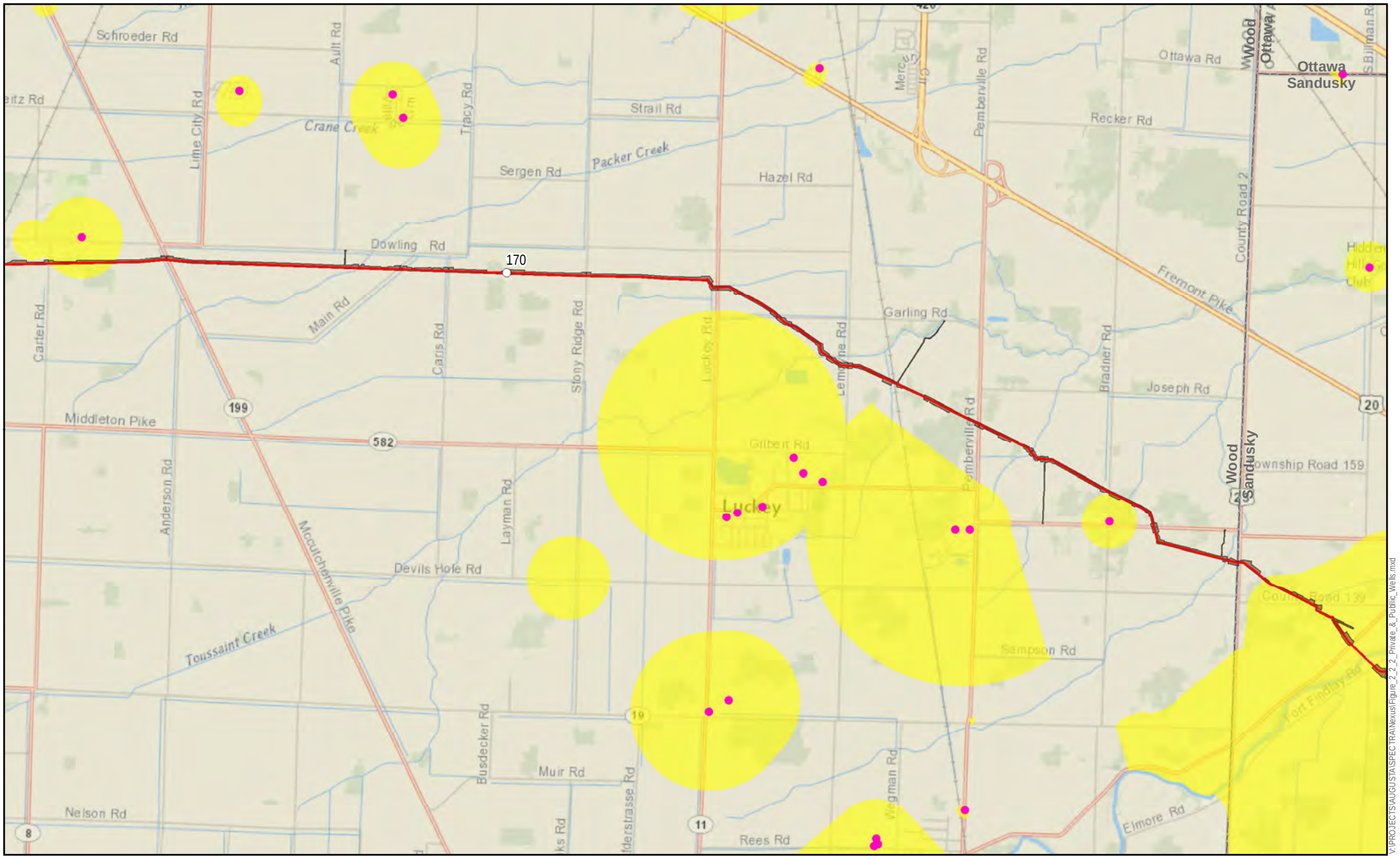
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Sandusky County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Sandusky and Wood Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015

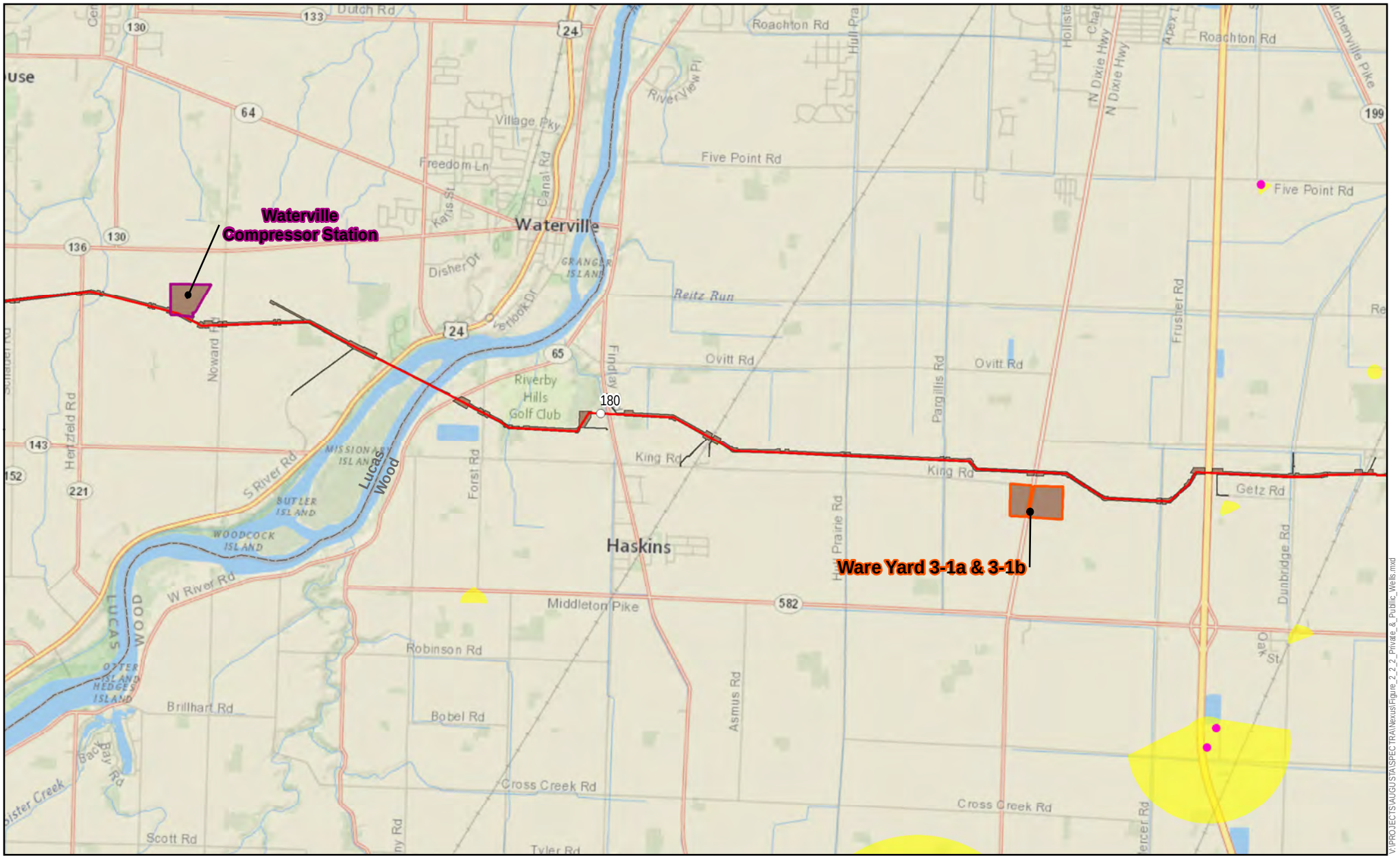

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Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Wood and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015

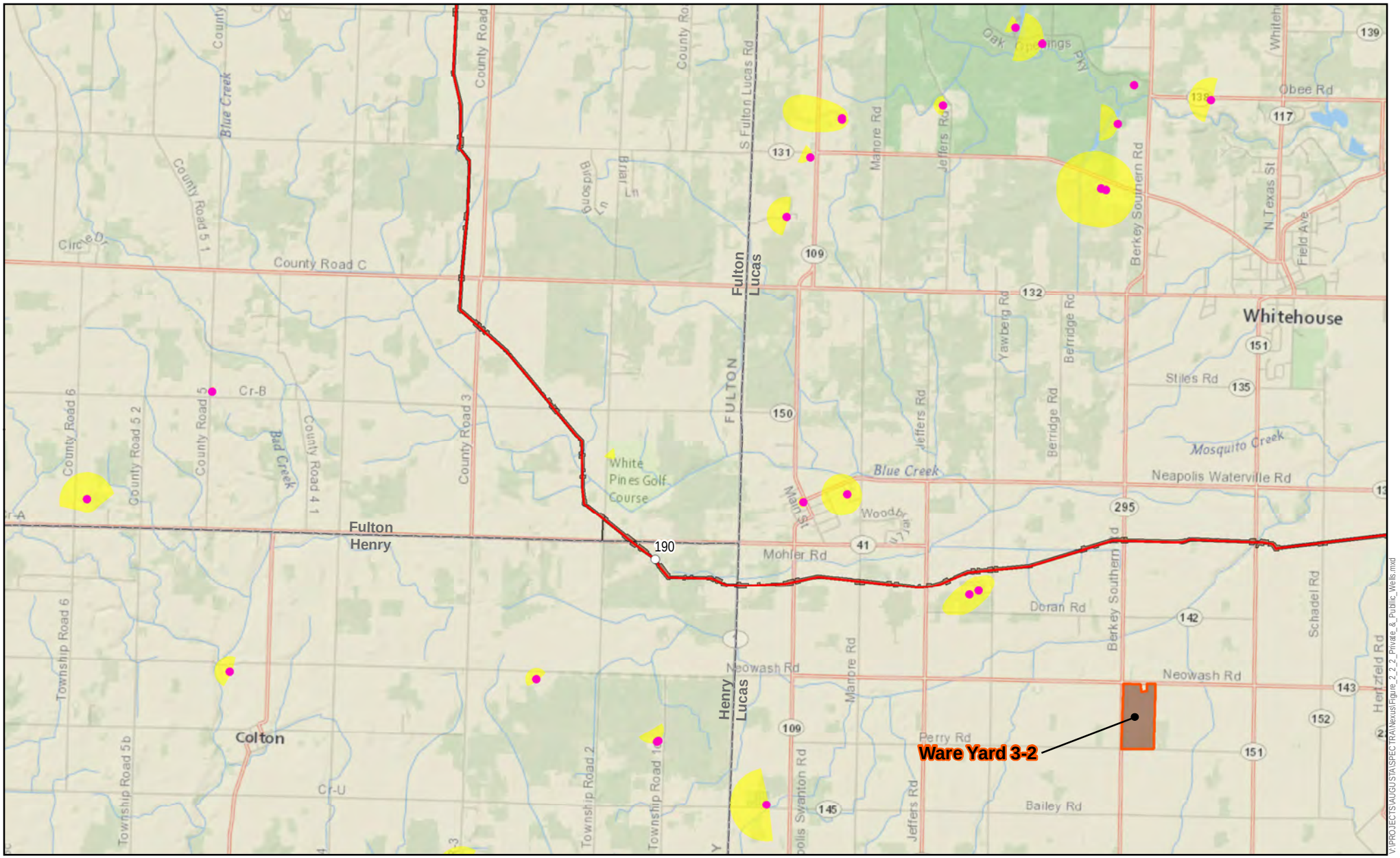


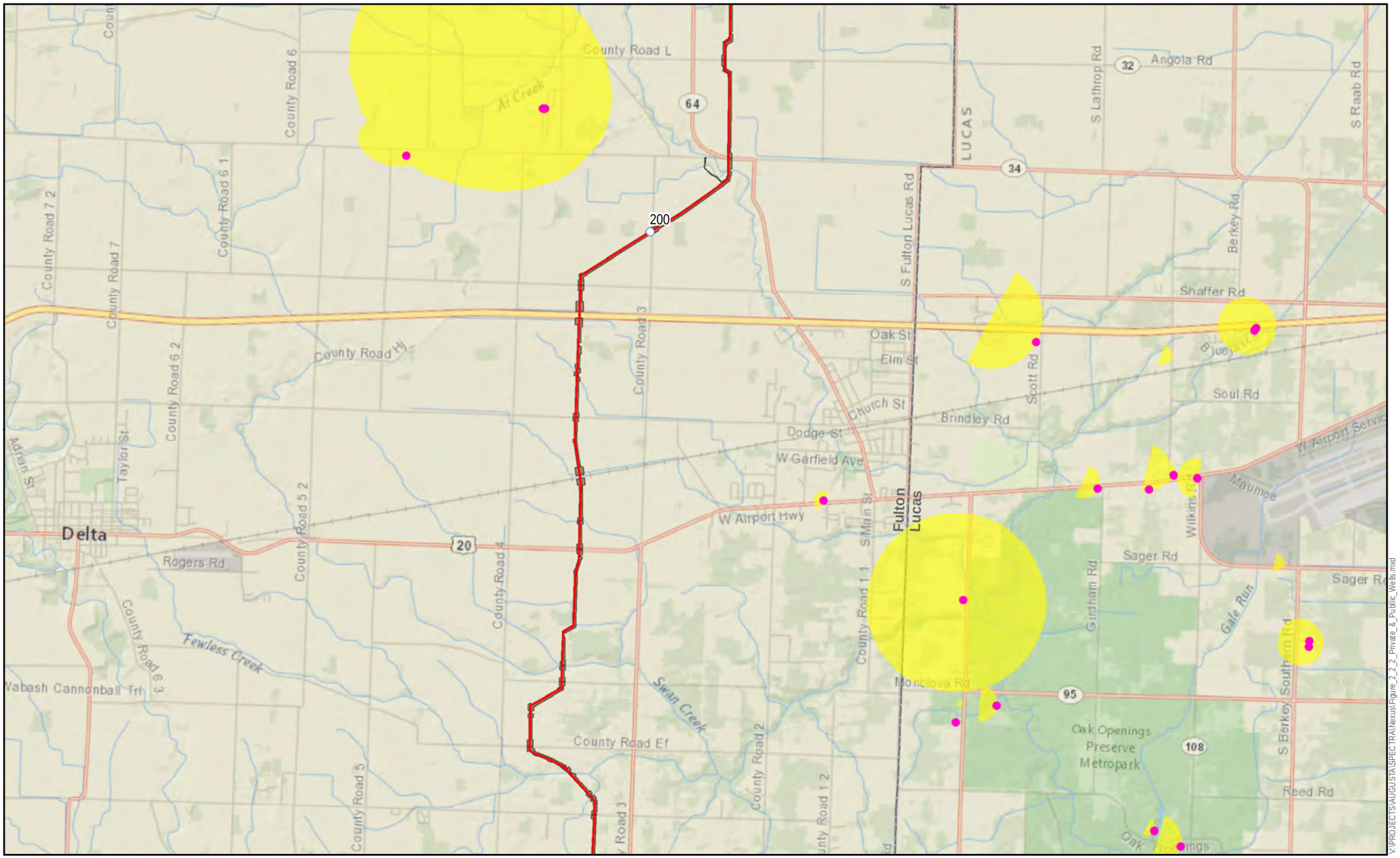
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Henry, Fulton and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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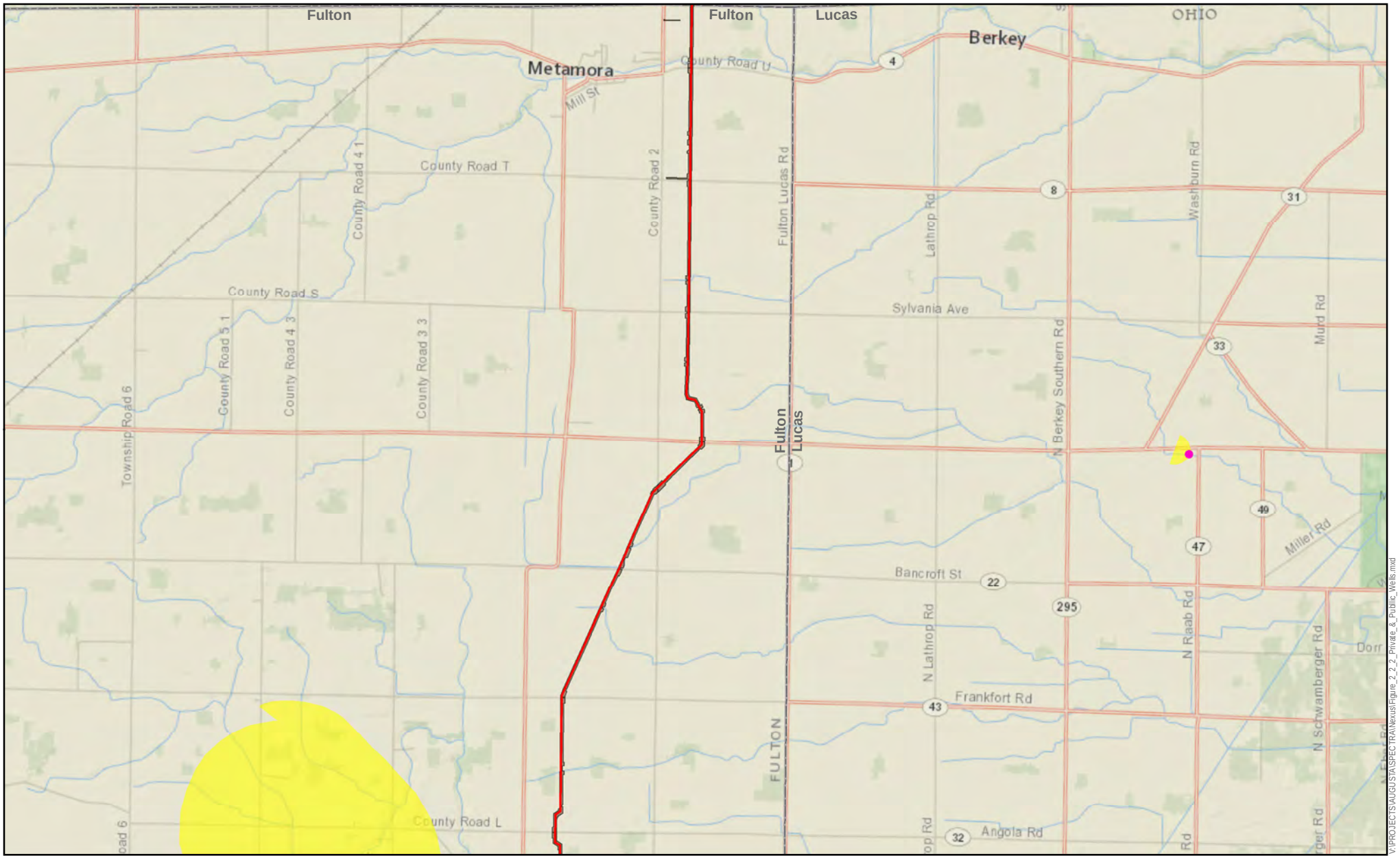
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Fulton and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

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0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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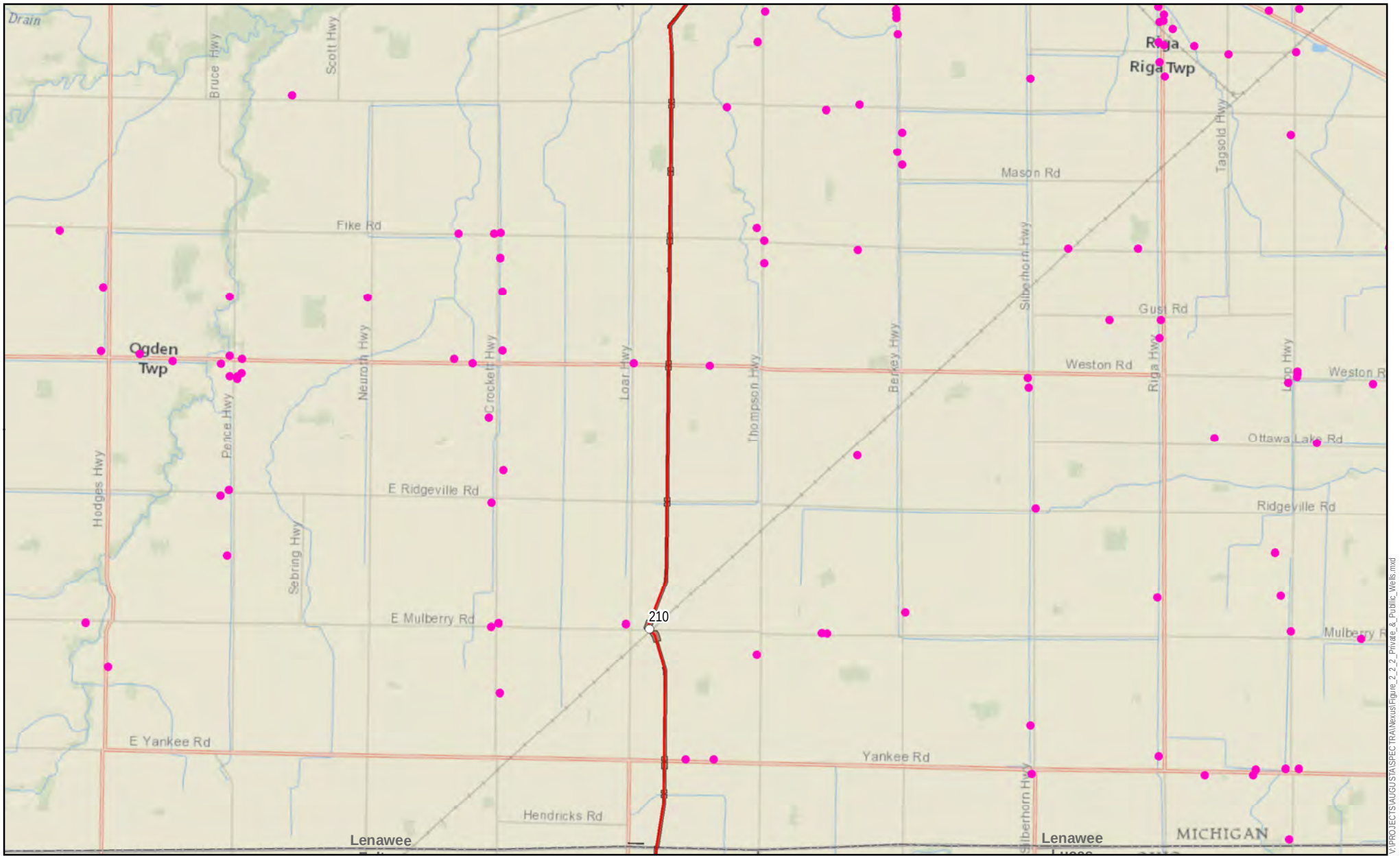
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Fulton and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

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0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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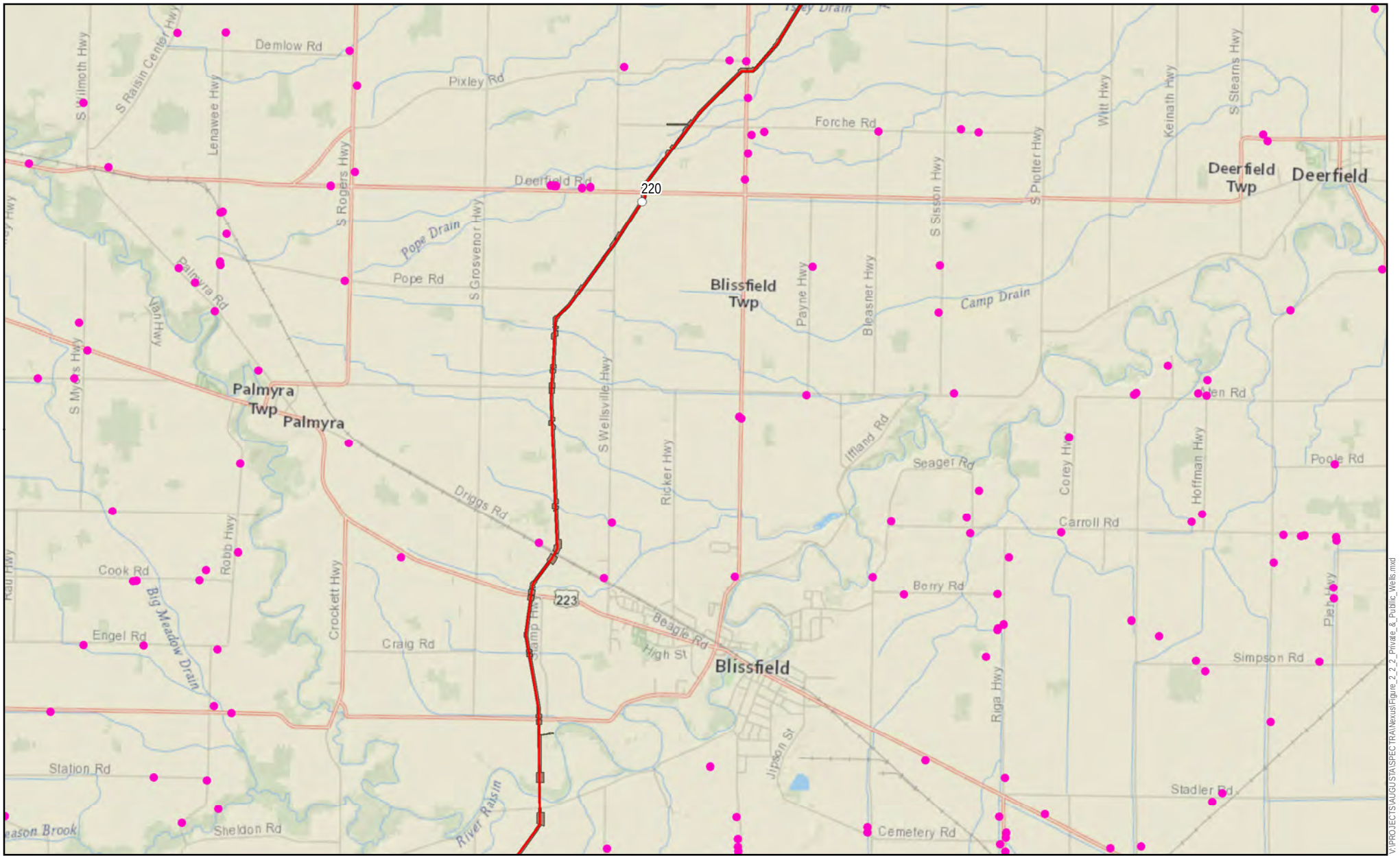
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Lenawee County, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

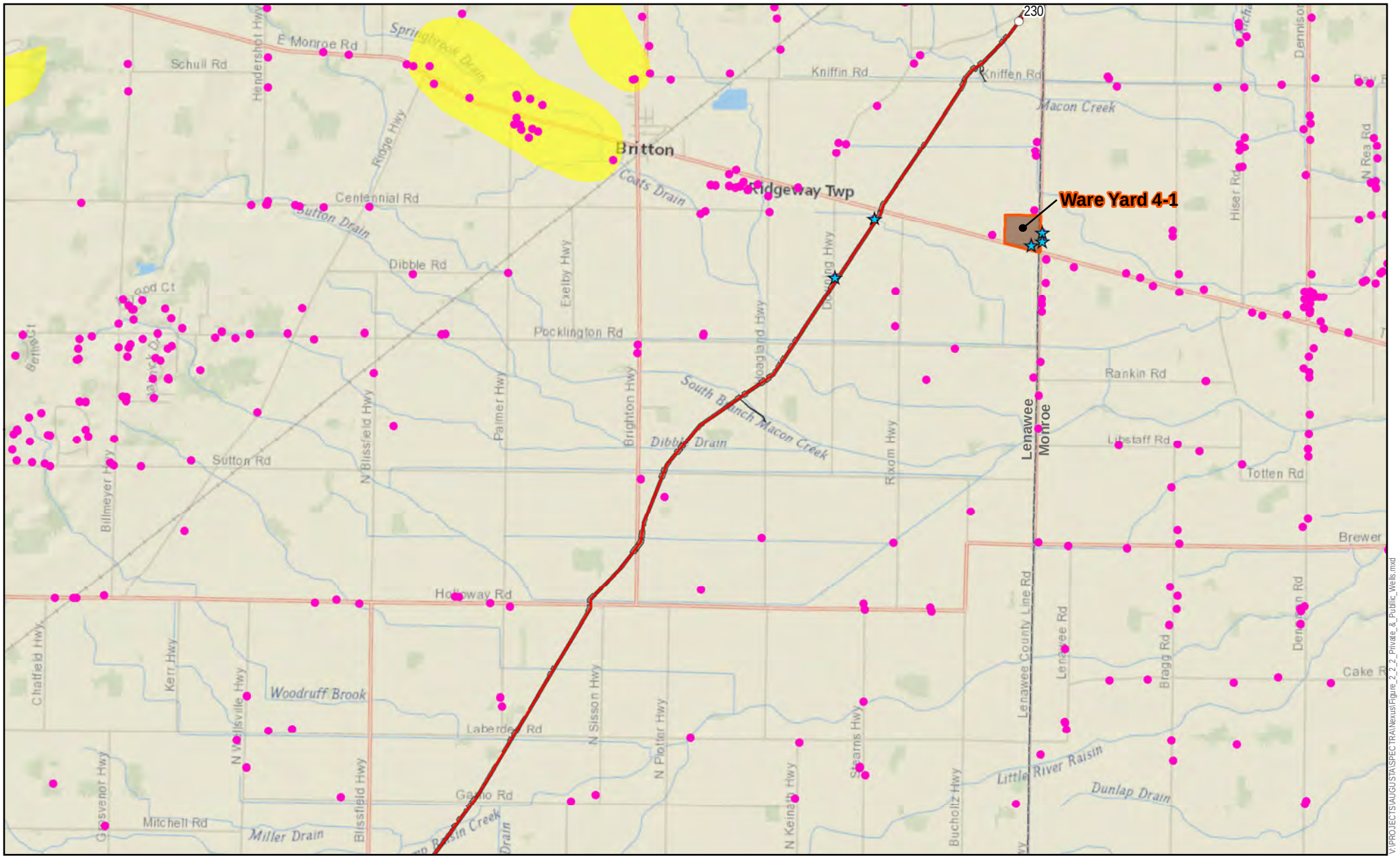
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Lenawee County, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

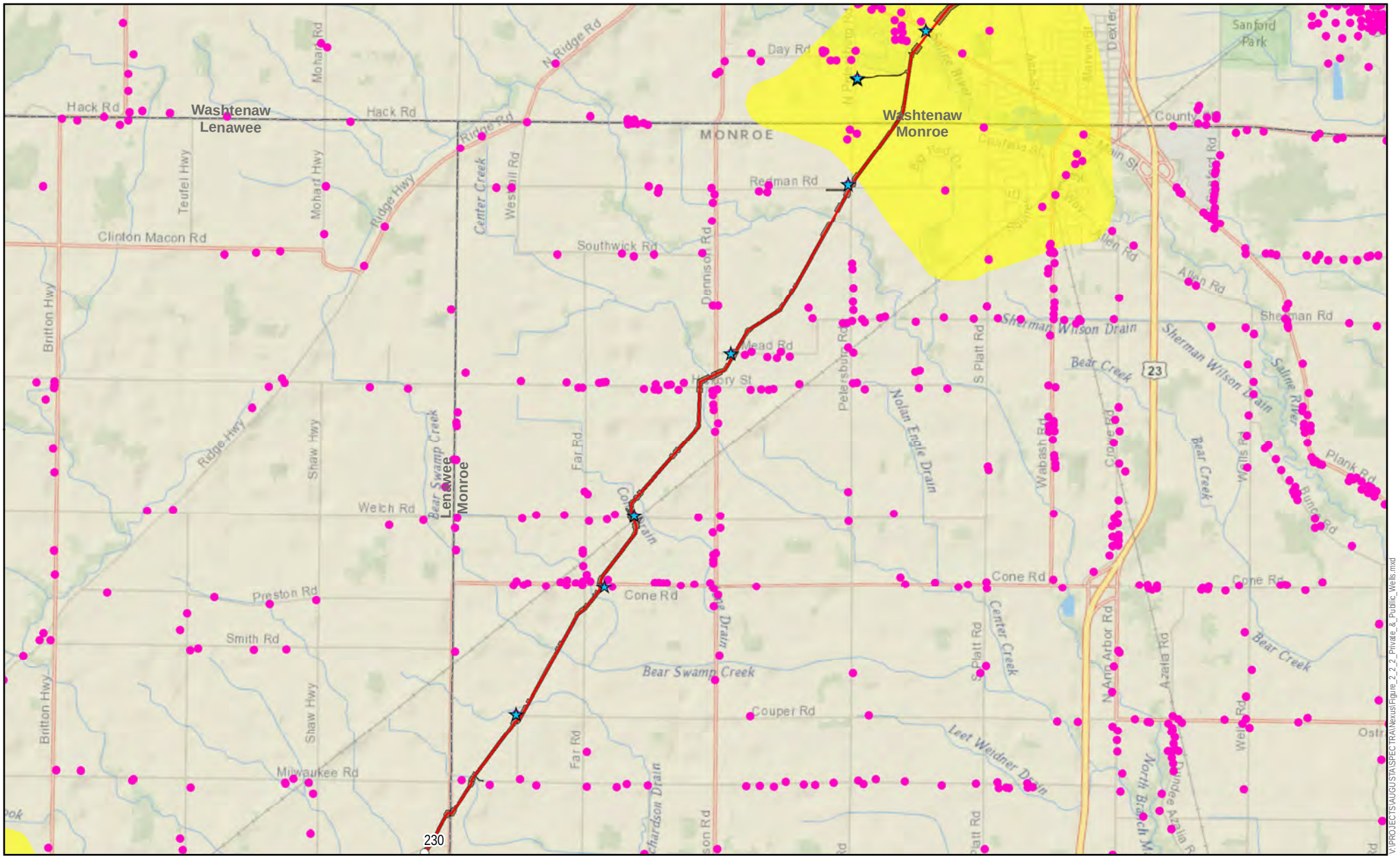
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Lenawee and Monroe Counties, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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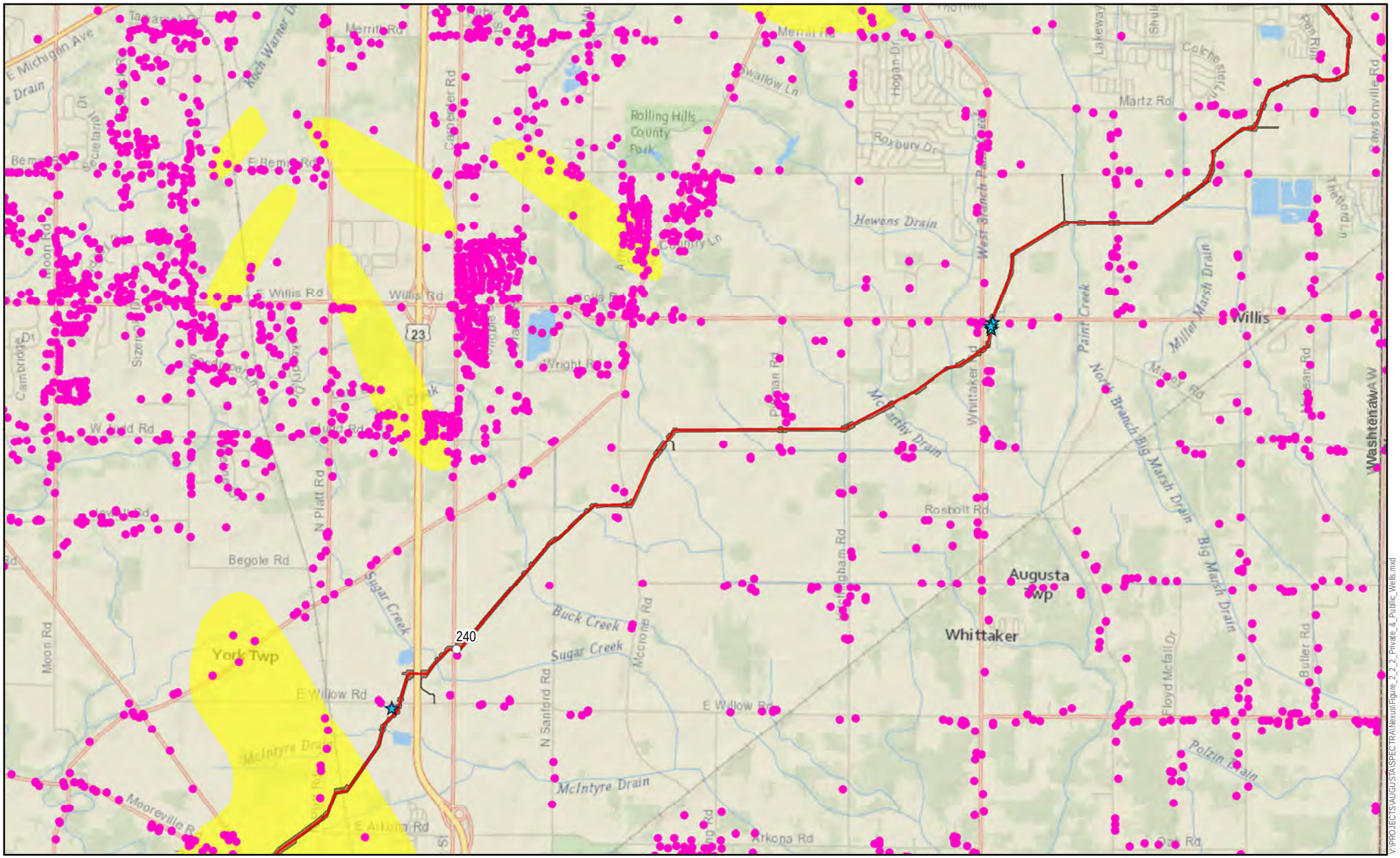
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Lenawee, Monroe and Washtenaw Counties, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
- Wells Within 150' of NEXUS Project
- Wells
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Construction Workspace
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Wellhead Protection Areas

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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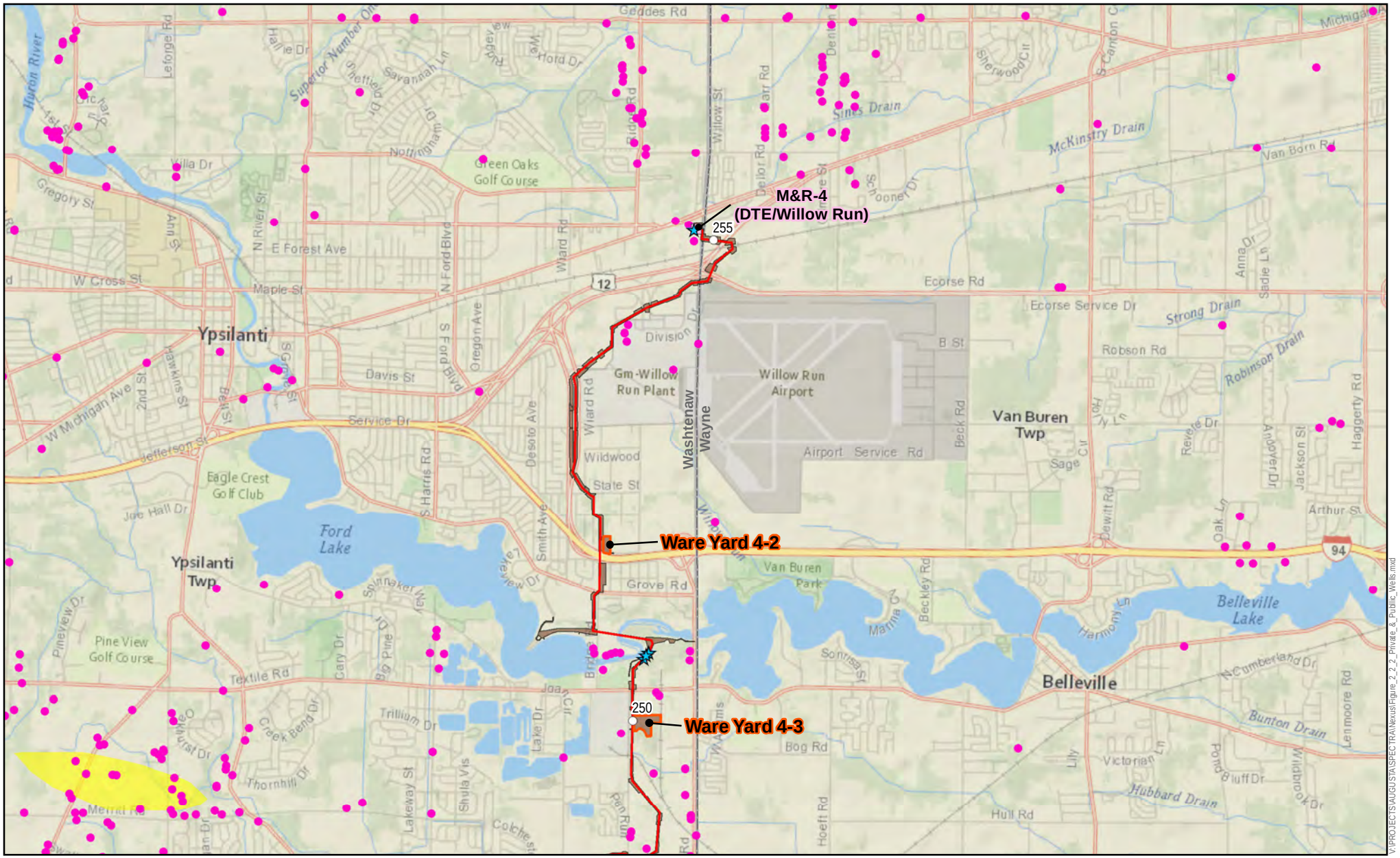
Figure 2.2-2

Private and Public Ground Water Supplies Located Along the NEXUS Project

Washtenaw County, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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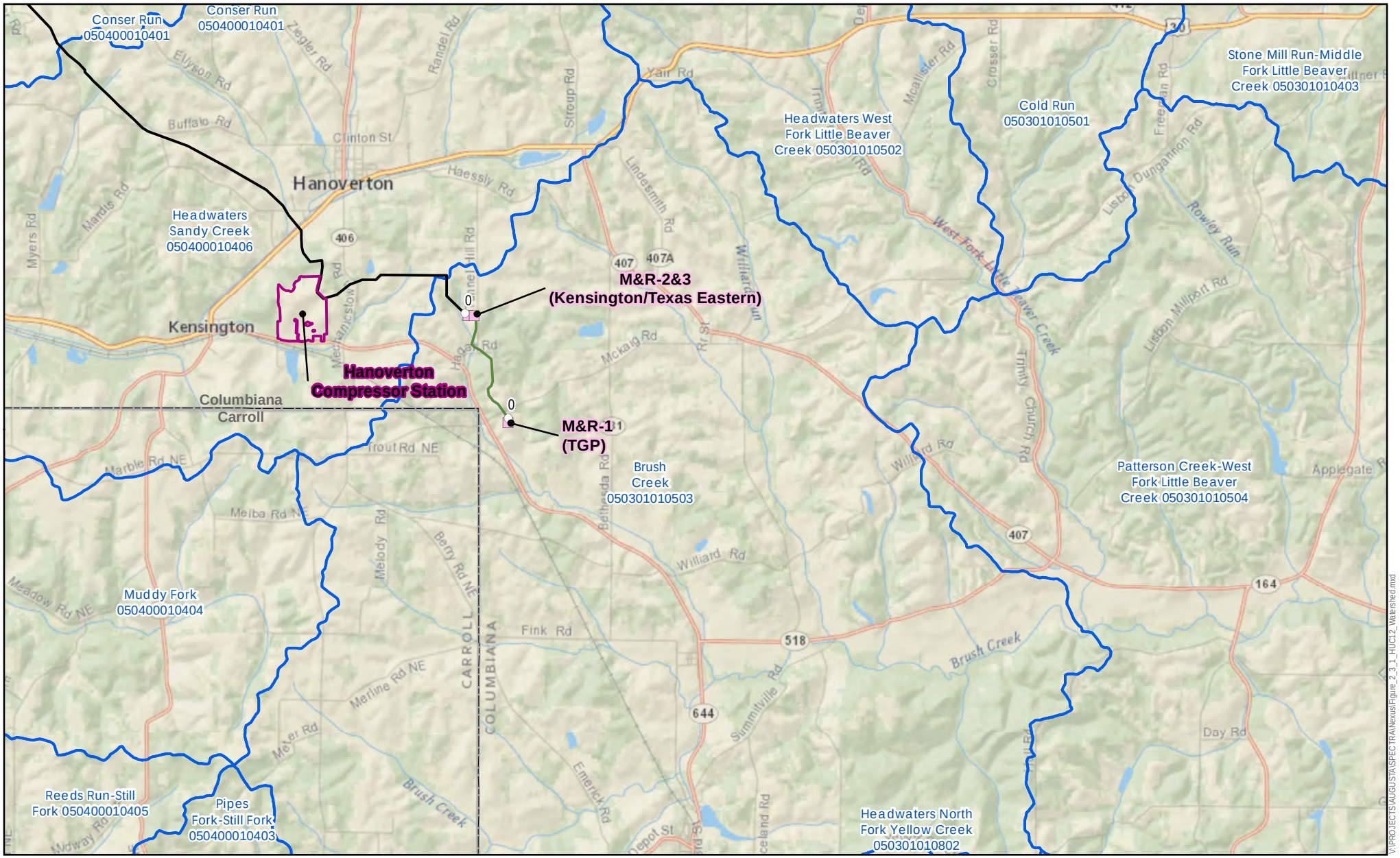
Figure 2.2-2

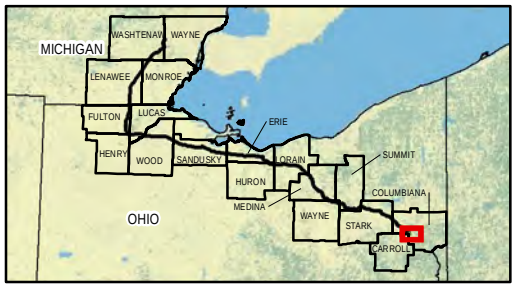
Private and Public Ground Water Supplies Located Along the NEXUS Project

Washtenaw and Wayne Counties, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

Figure 2.3-1

Watersheds Crossed by the NEXUS Project

Columbiana and Carroll Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015

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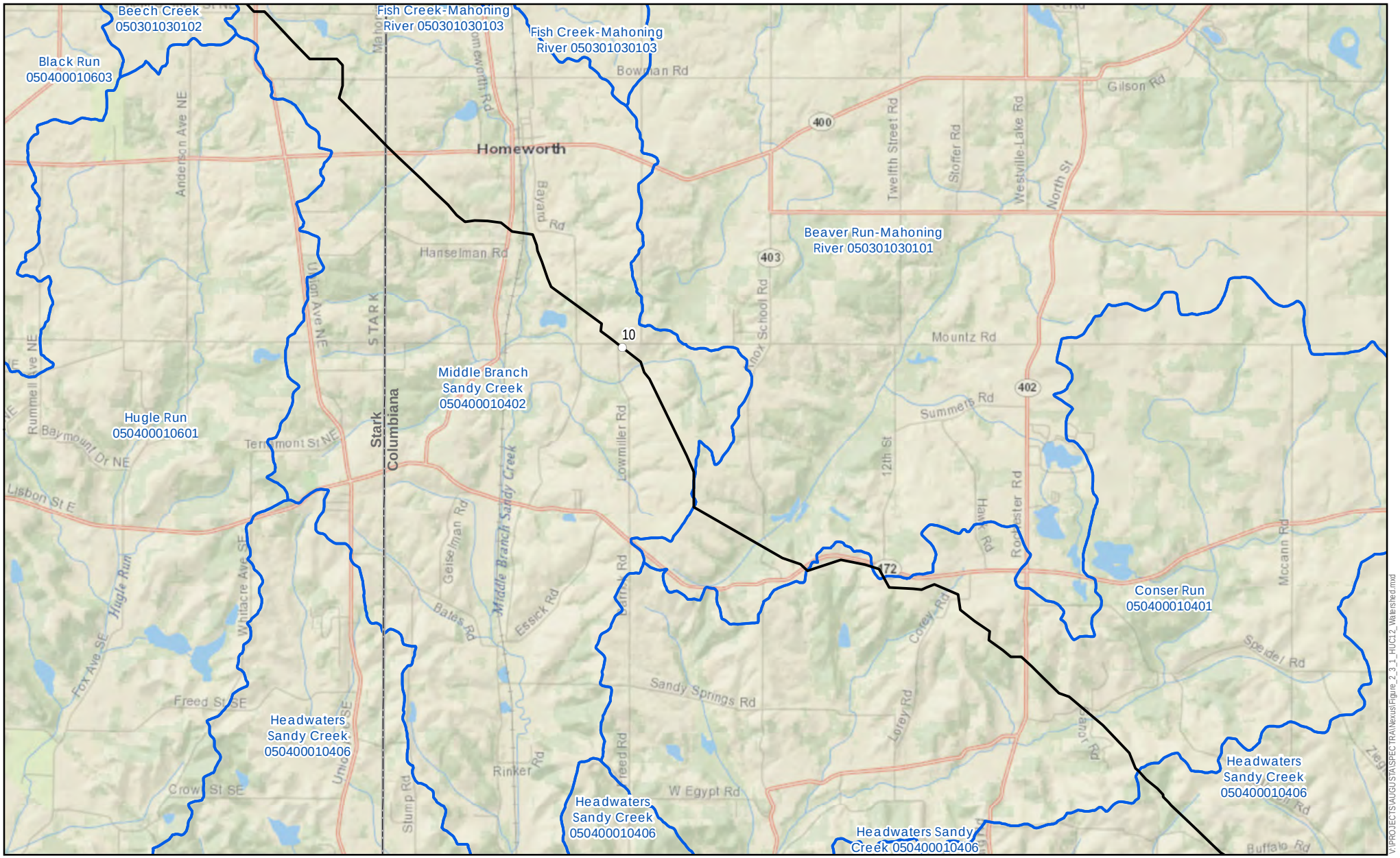
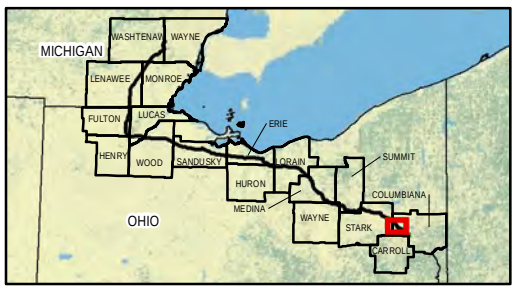




- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

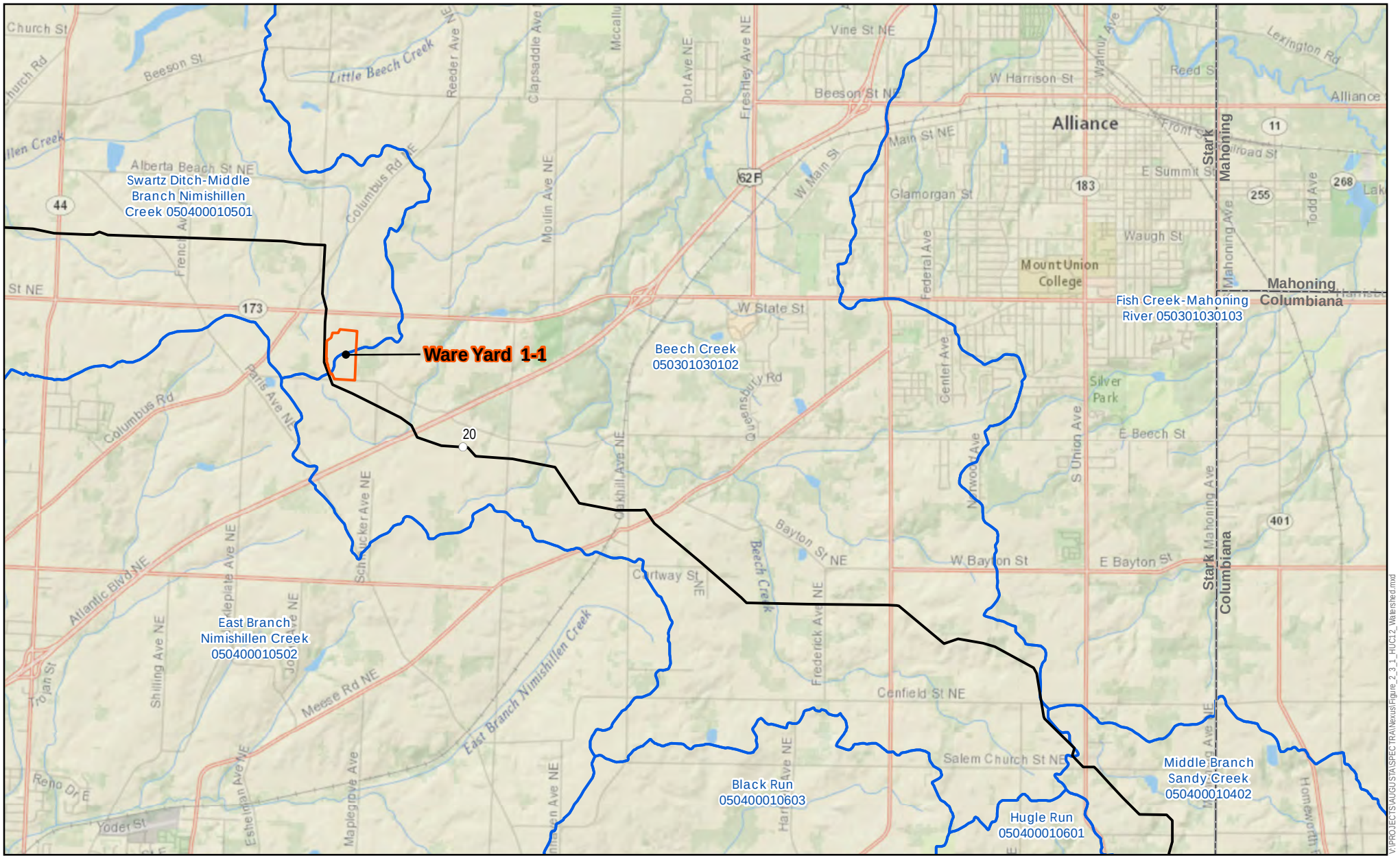
Figure 2.3-1

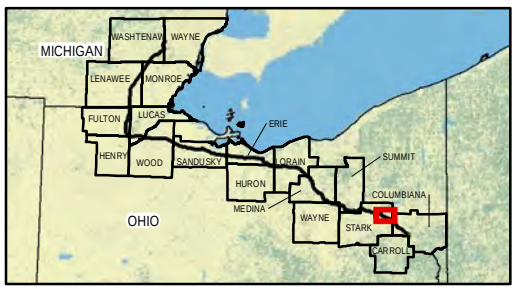
Watersheds Crossed by the NEXUS Project

Columbiana and Stark Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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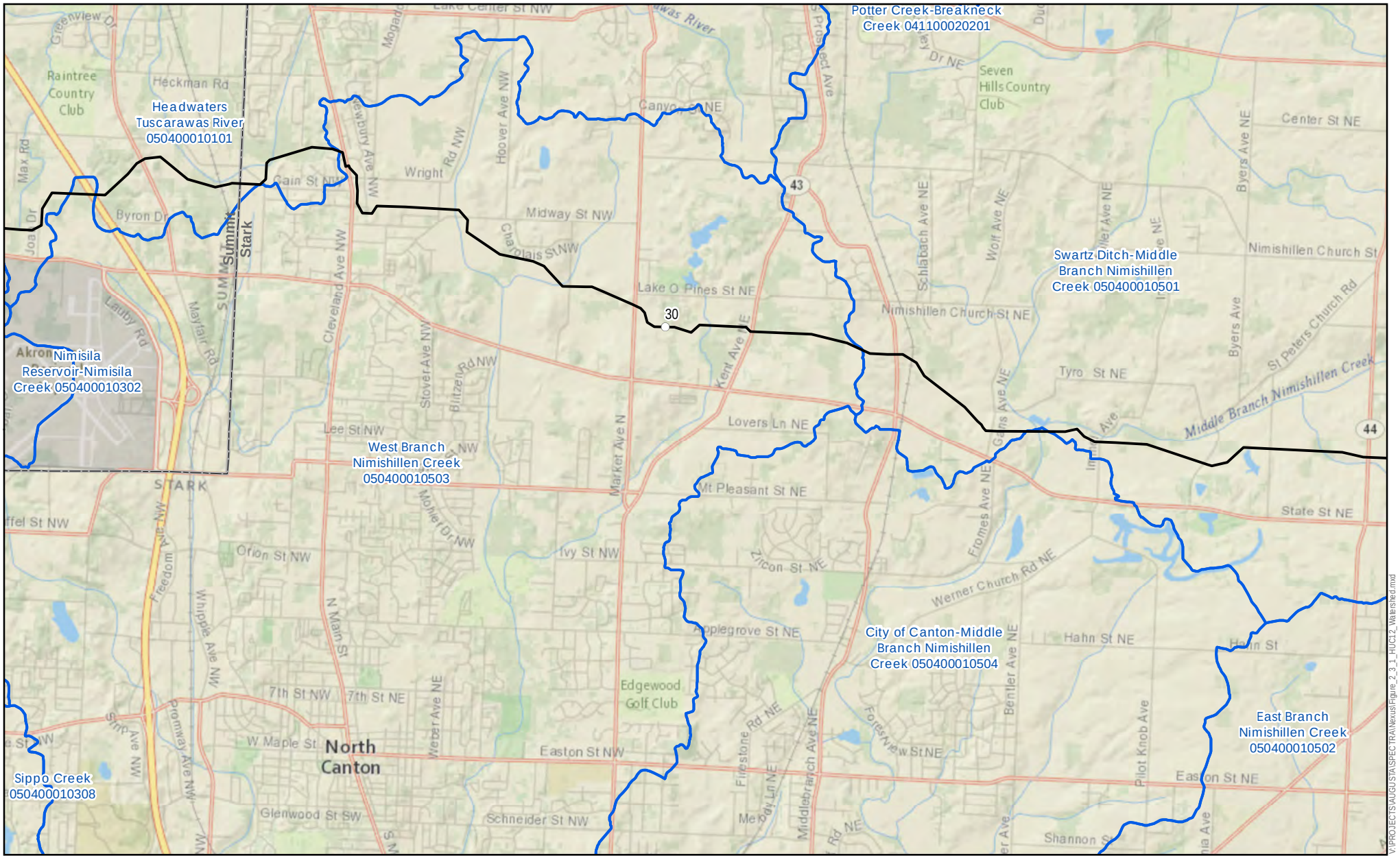
Figure 2.3-1

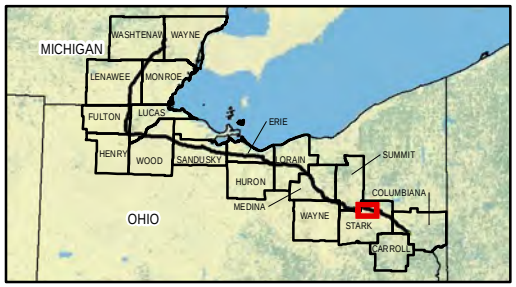
Watersheds Crossed by the NEXUS Project

Stark and Columbiana Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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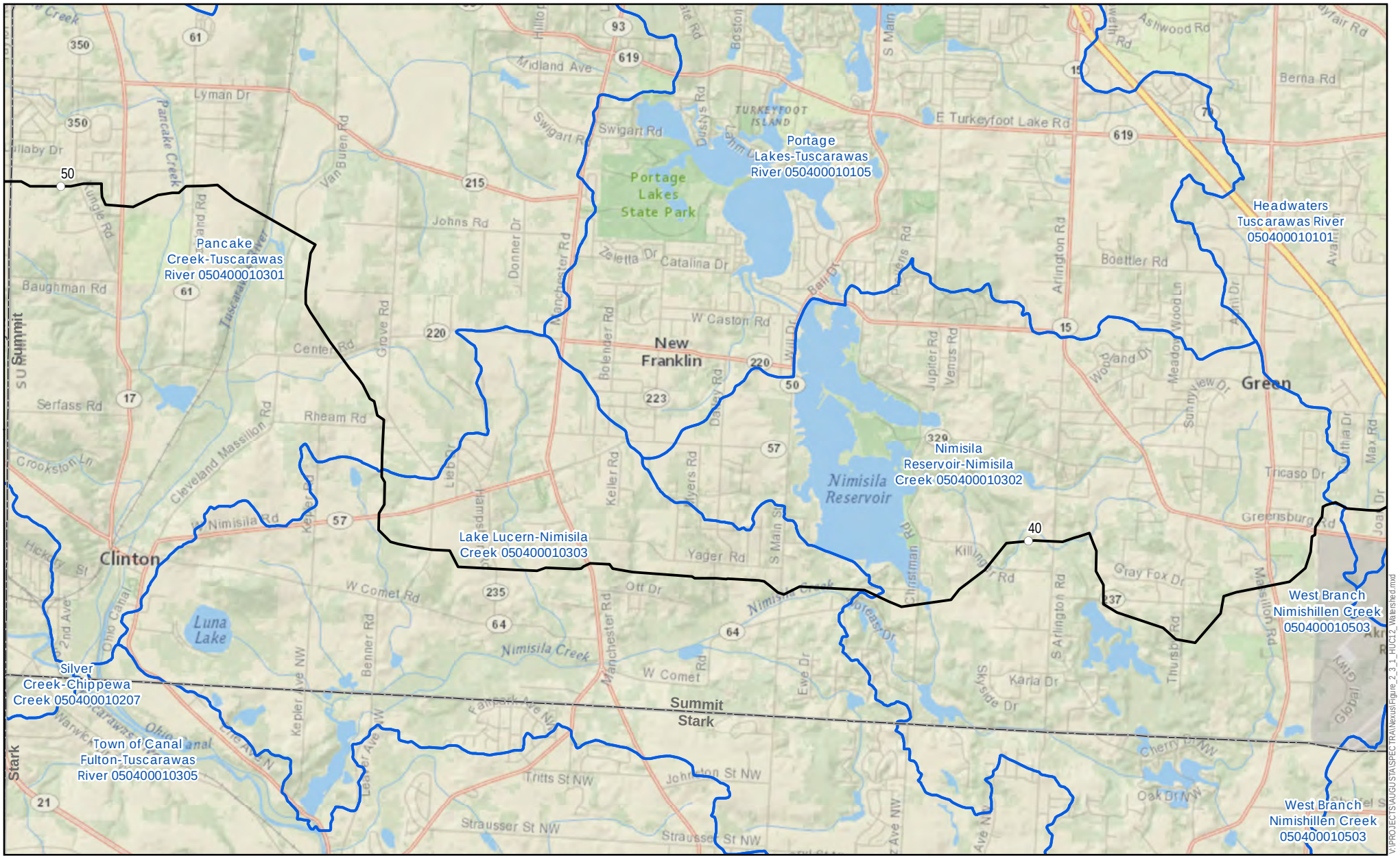
Figure 2.3-1

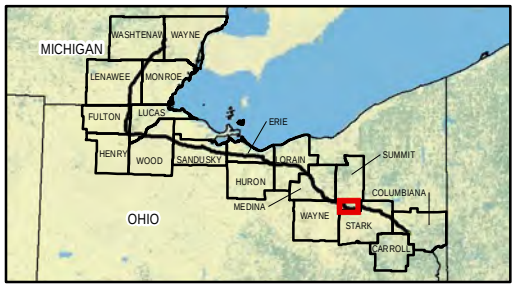
Watersheds Crossed by the NEXUS Project

Stark and Summit Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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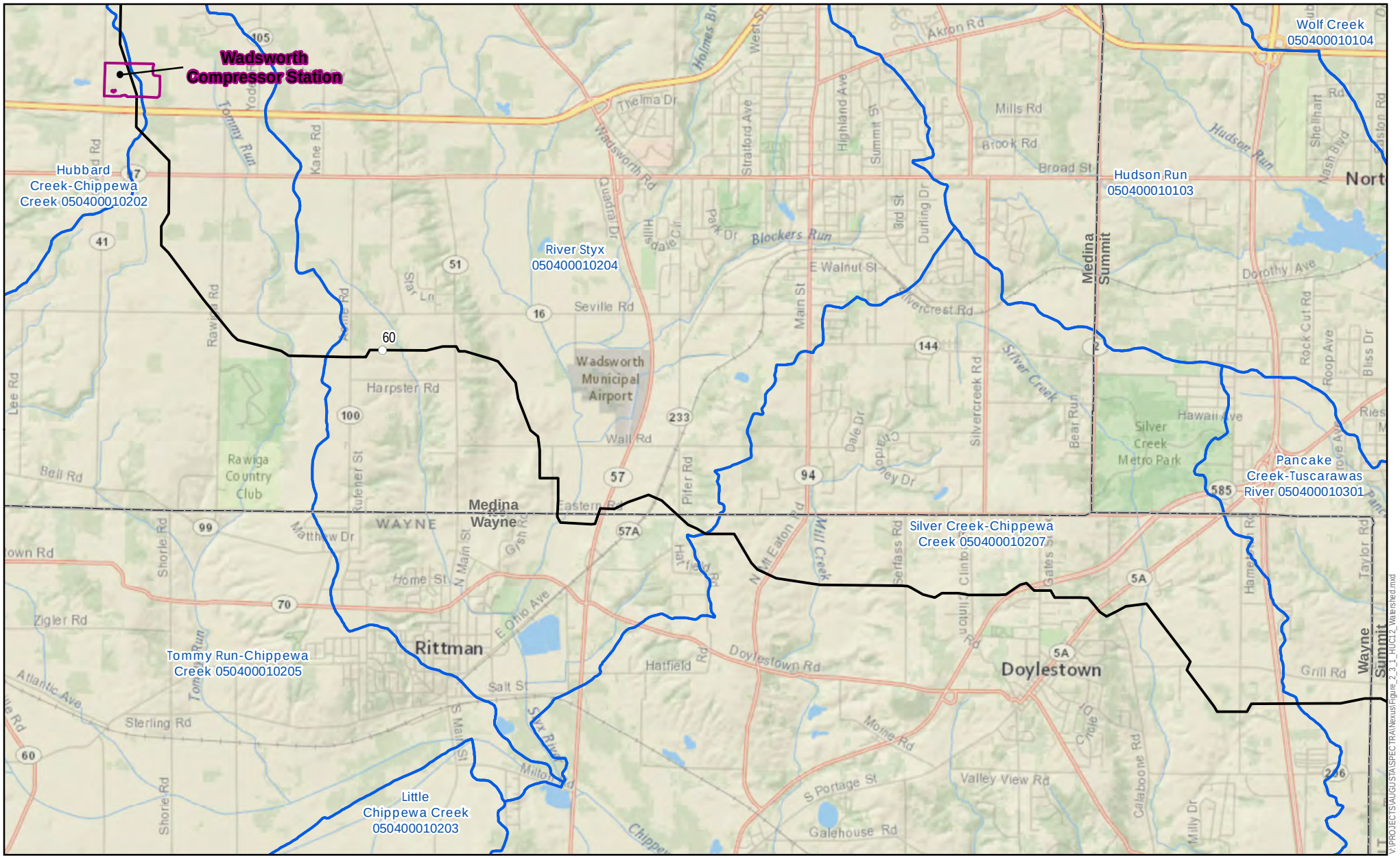
Figure 2.3-1

Watersheds Crossed by the NEXUS Project

Summit and Stark Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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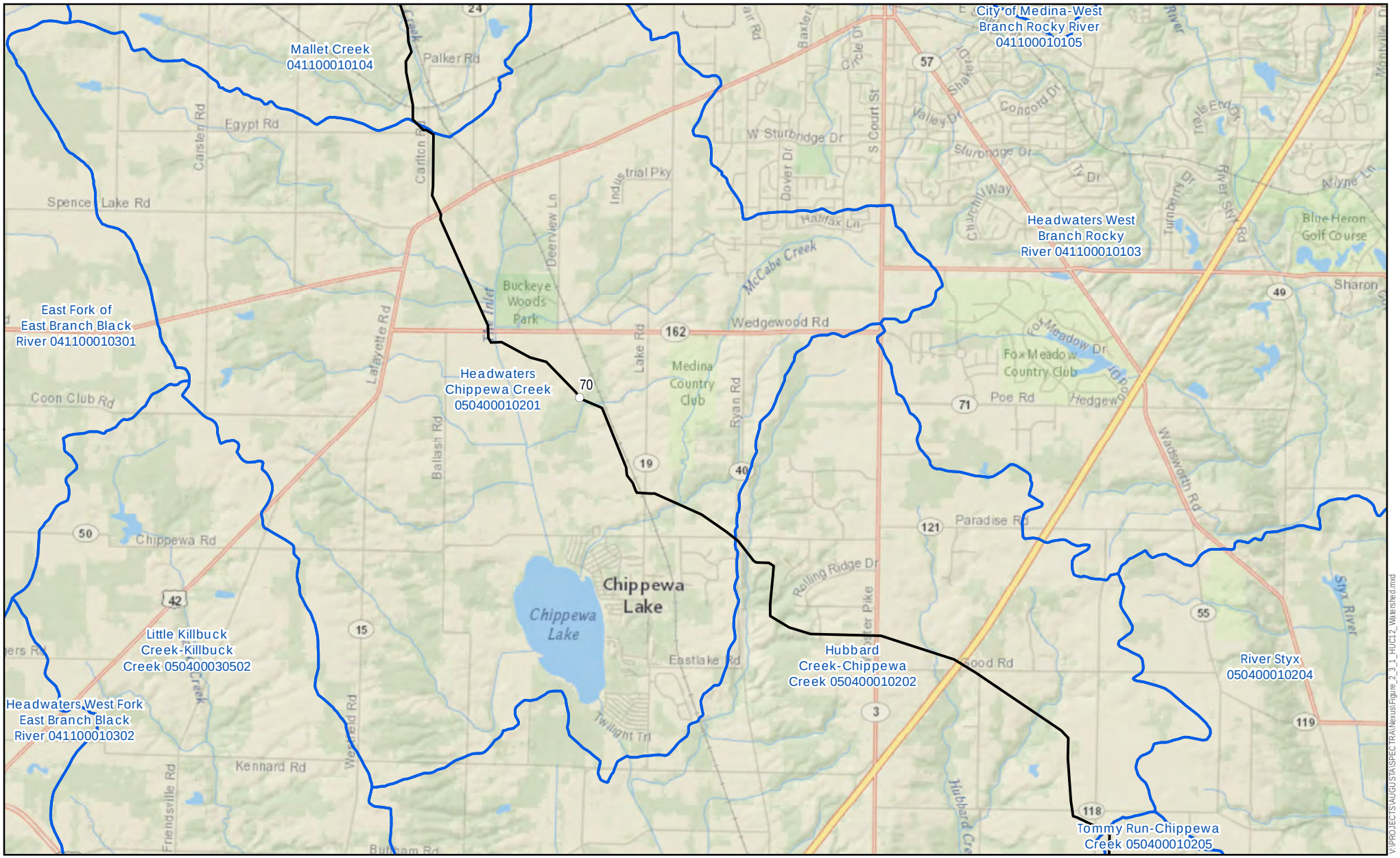
Figure 2.3-1

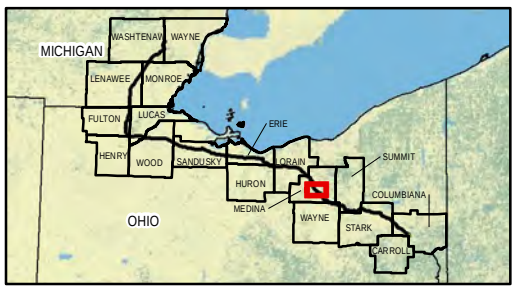
Watersheds Crossed by the NEXUS Project

Wayne, Summit and Medina Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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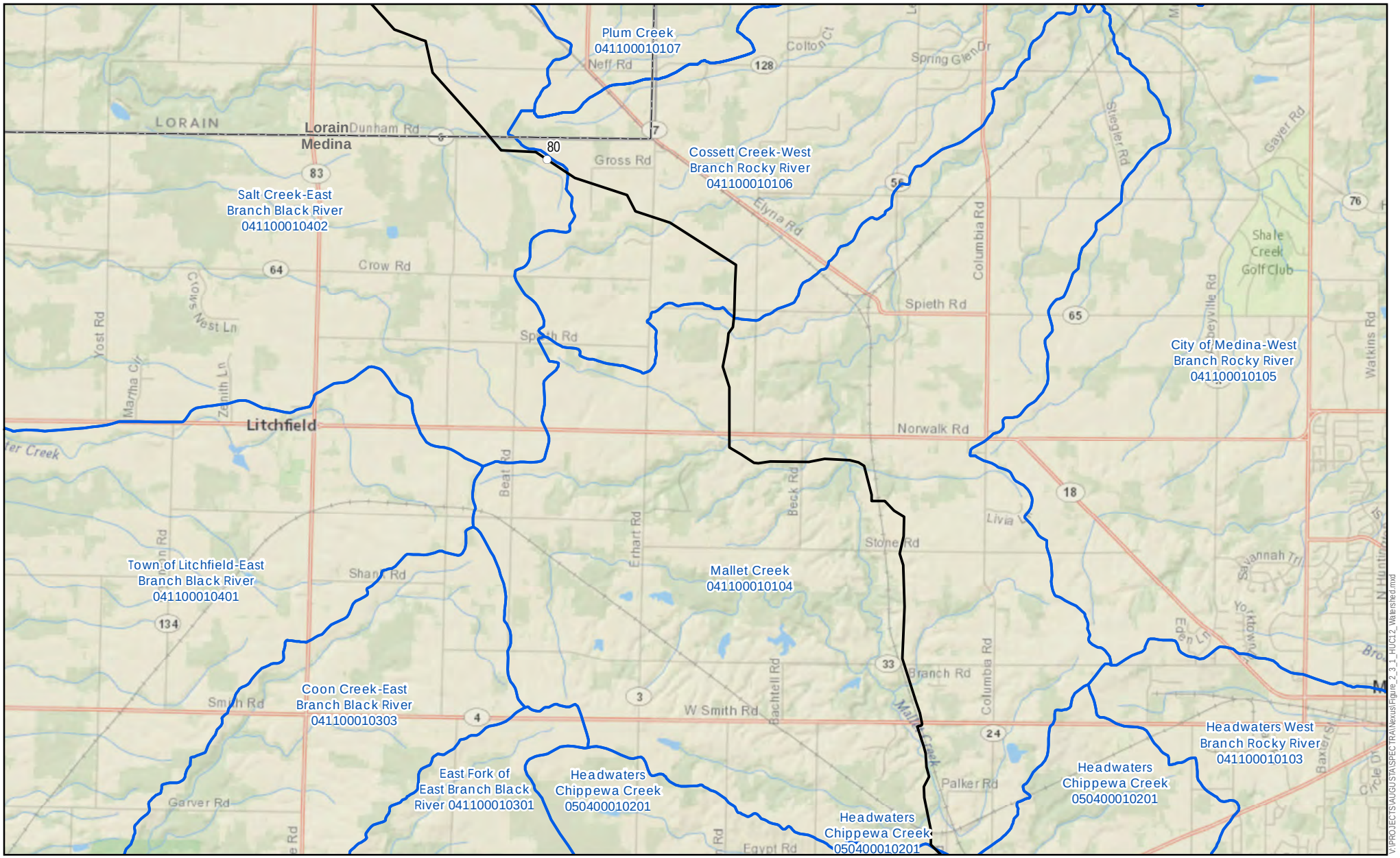
Figure 2.3-1

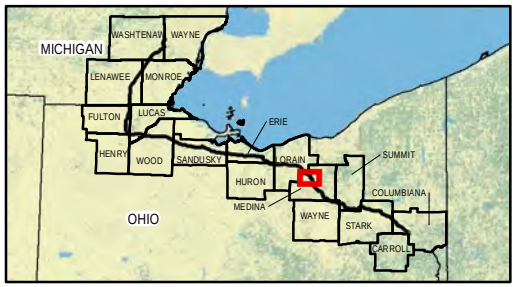
Watersheds Crossed by the NEXUS Project

Medina County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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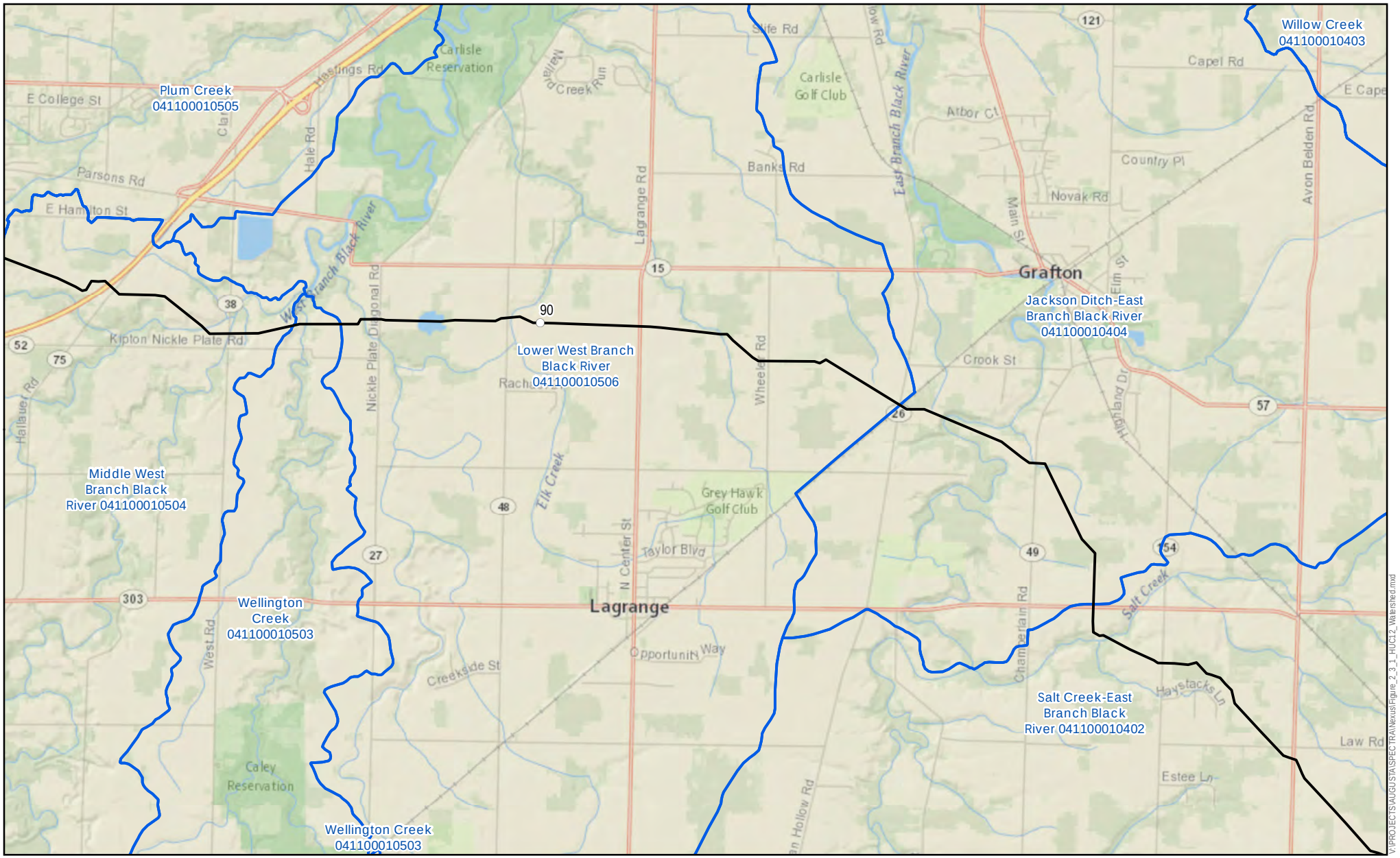
Figure 2.3-1

Watersheds Crossed
by the NEXUS Project

Medina and Lorain Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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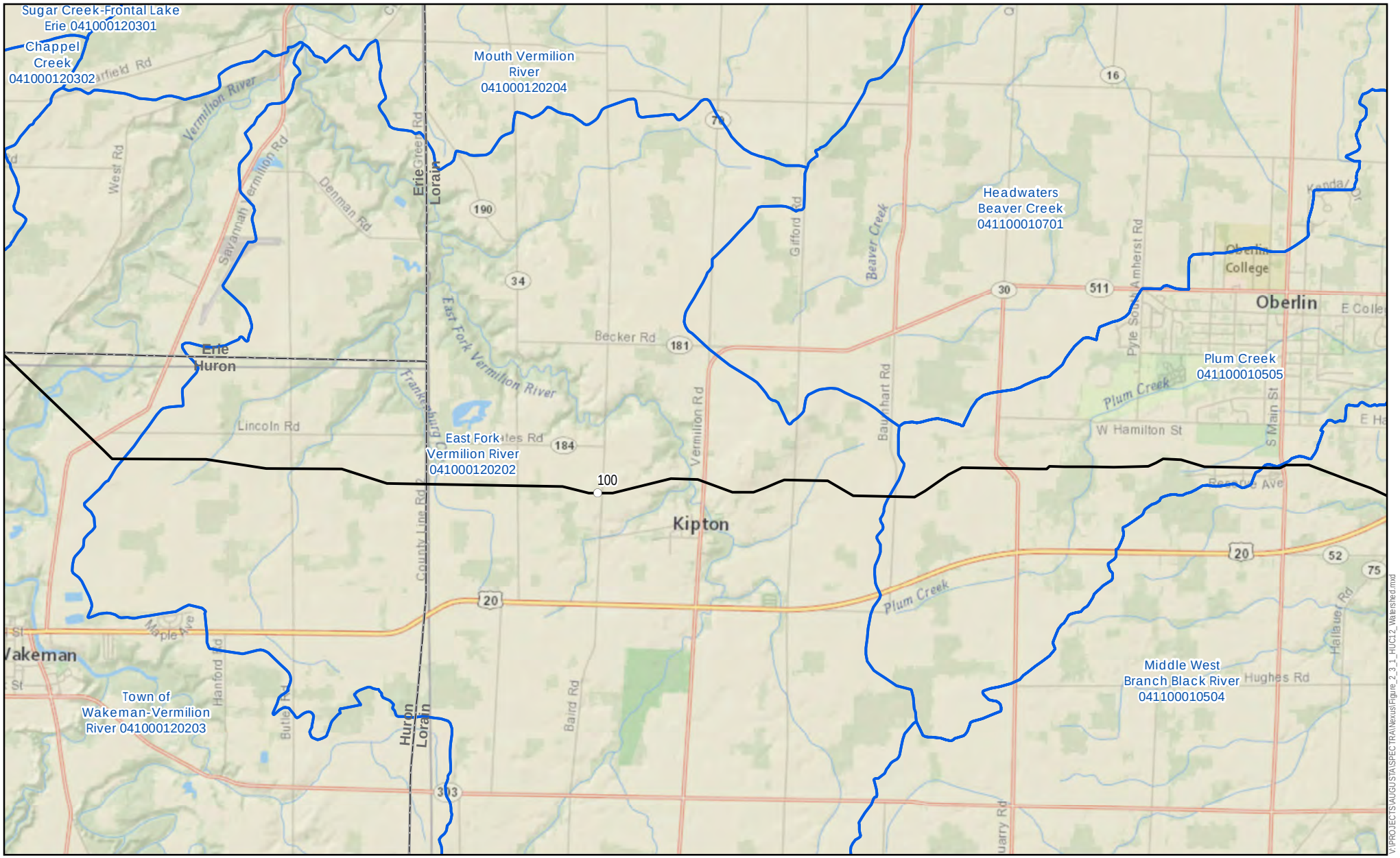
Figure 2.3-1

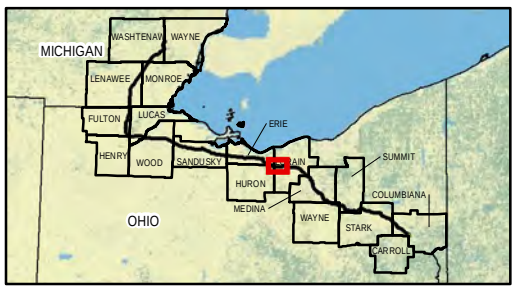
Watersheds Crossed by the NEXUS Project

Lorain County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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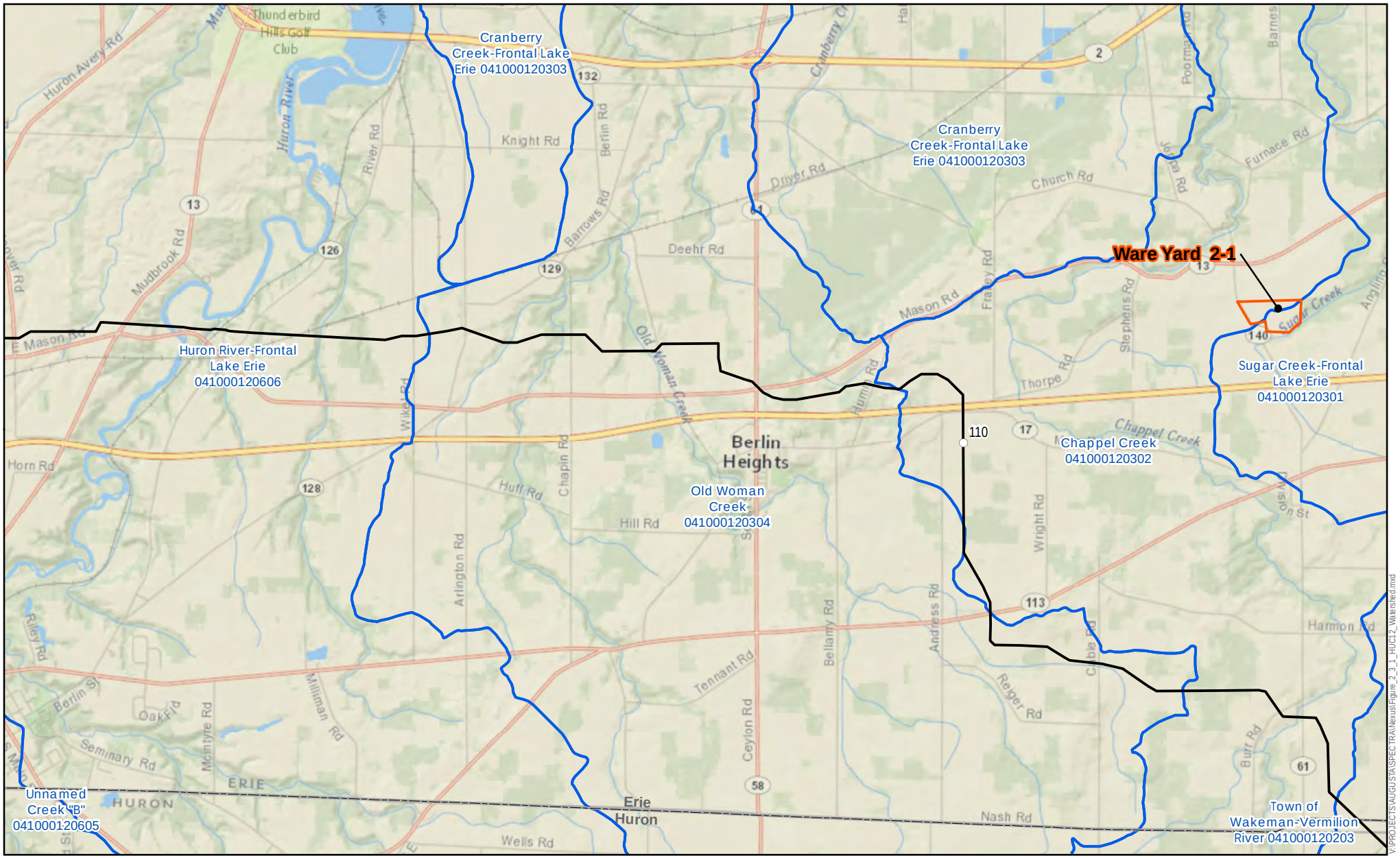
Figure 2.3-1

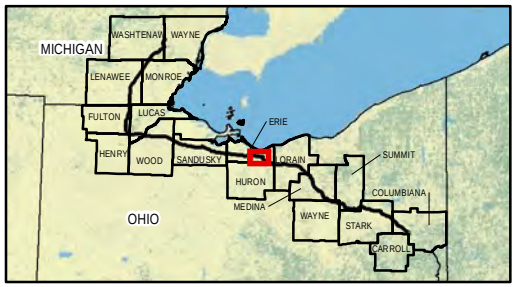
Watersheds Crossed by the NEXUS Project

Lorain, Erie and Huron Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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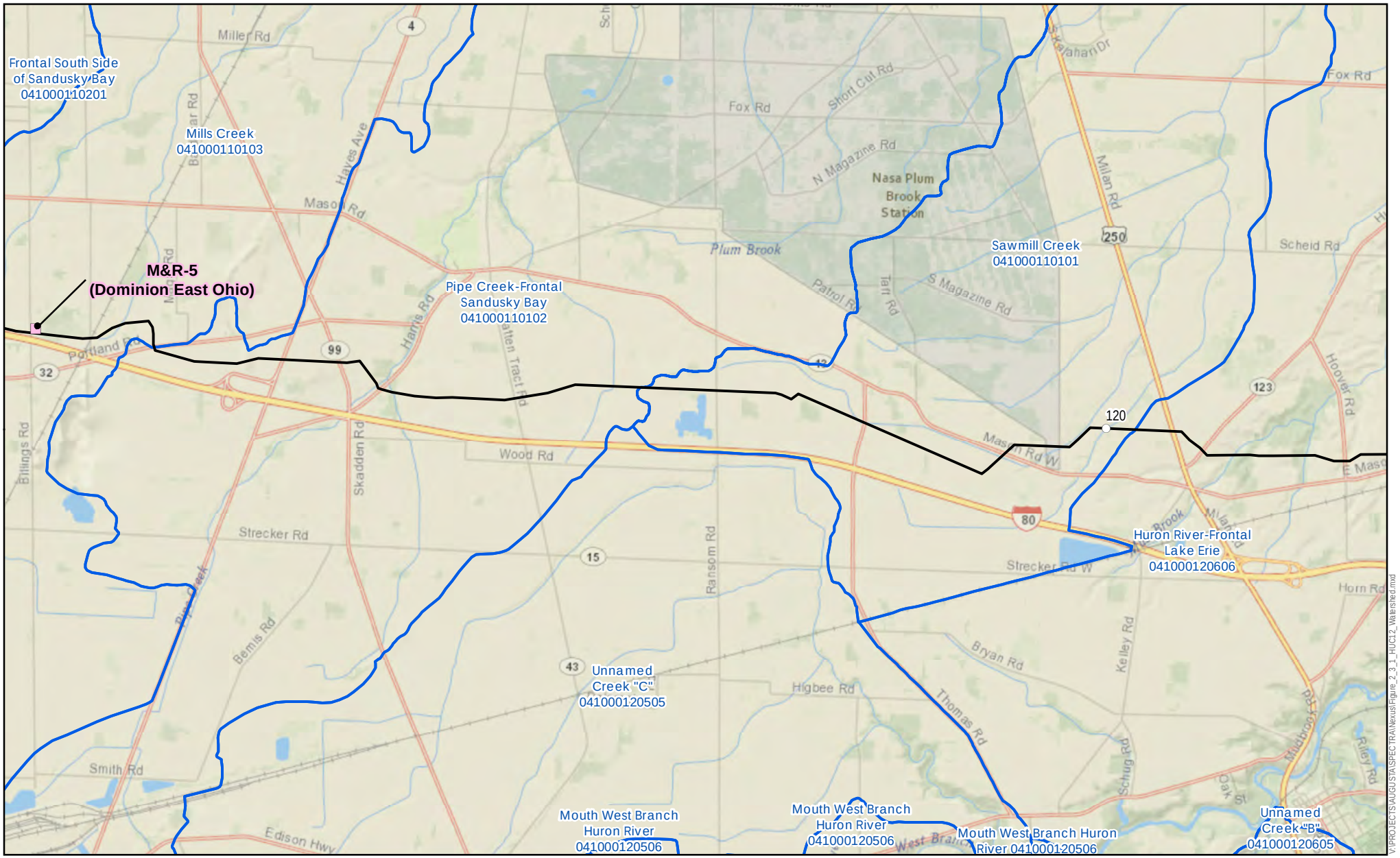
Figure 2.3-1

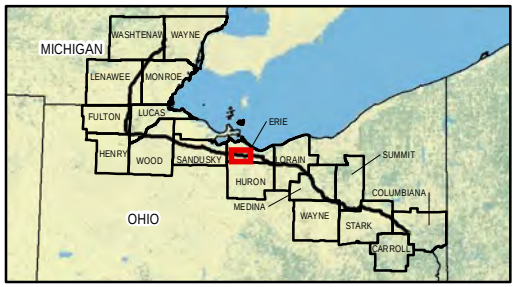
Watersheds Crossed by the NEXUS Project

Huron and Erie Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
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- Proposed TGP Interconnect
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- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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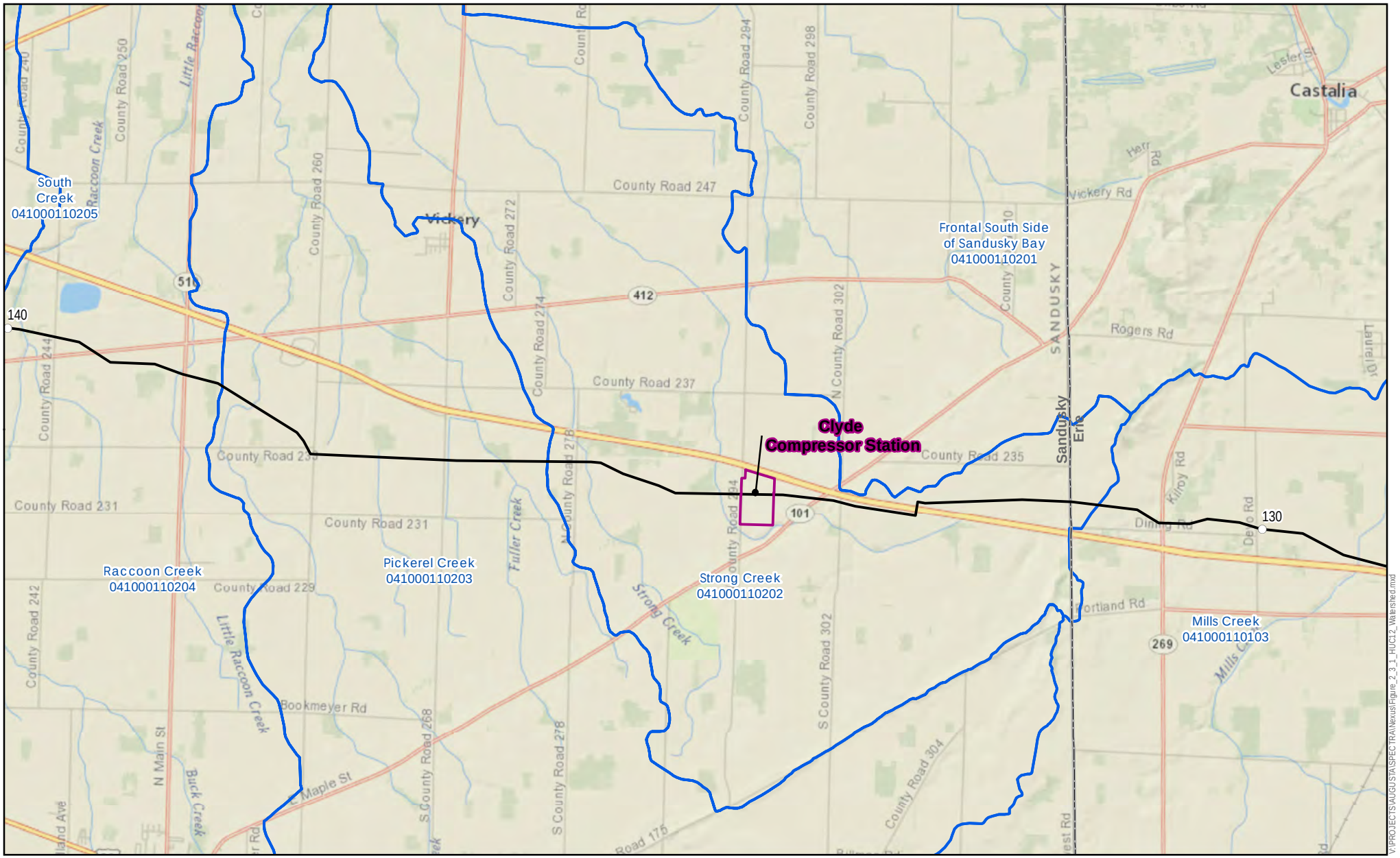
Figure 2.3-1

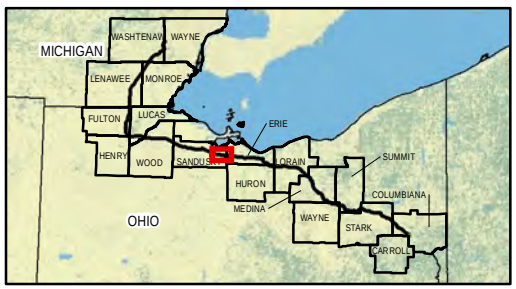
Watersheds Crossed by the NEXUS Project

Erie County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
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- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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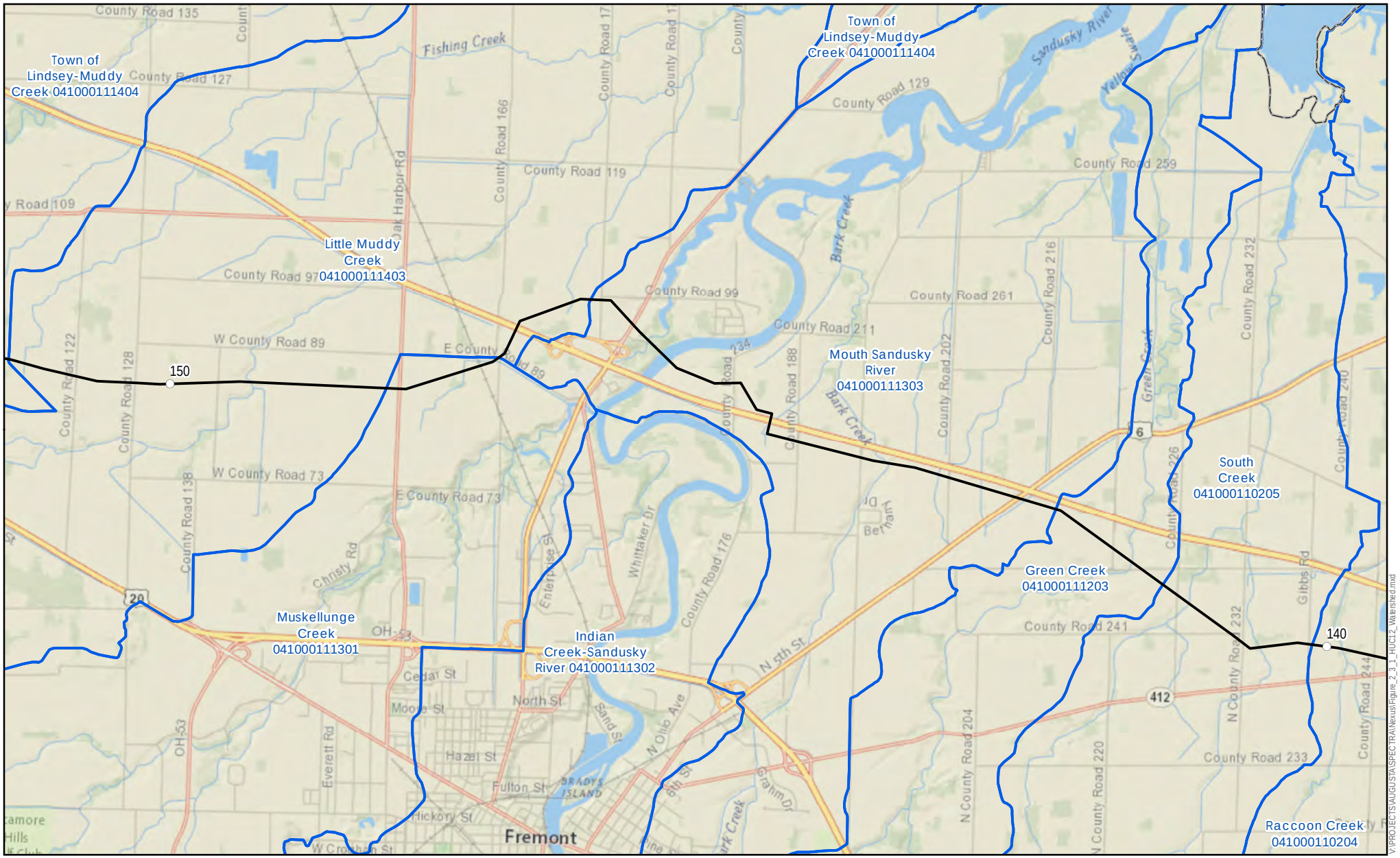
Figure 2.3-1

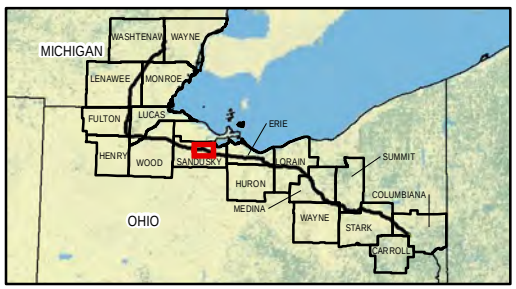
Watersheds Crossed by the NEXUS Project

Erie and Sandusky Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
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- Proposed TGP Interconnect
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- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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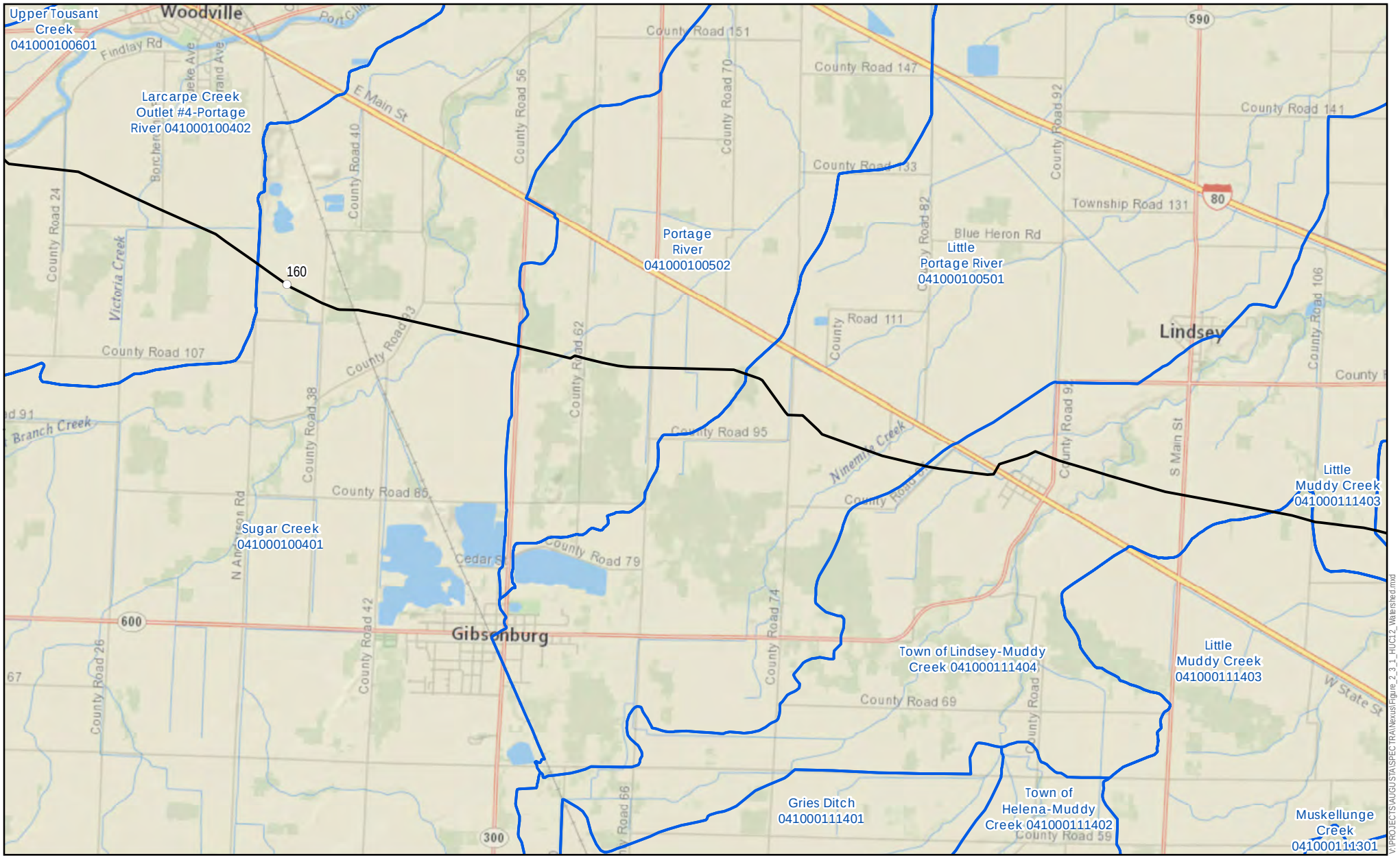
Figure 2.3-1

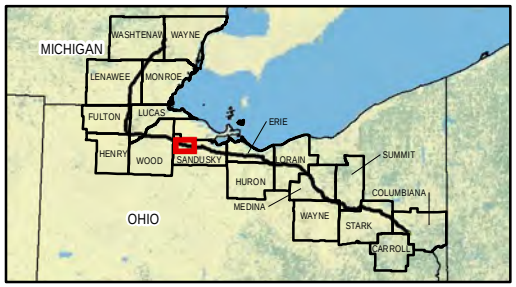
Watersheds Crossed by the NEXUS Project

Sandusky County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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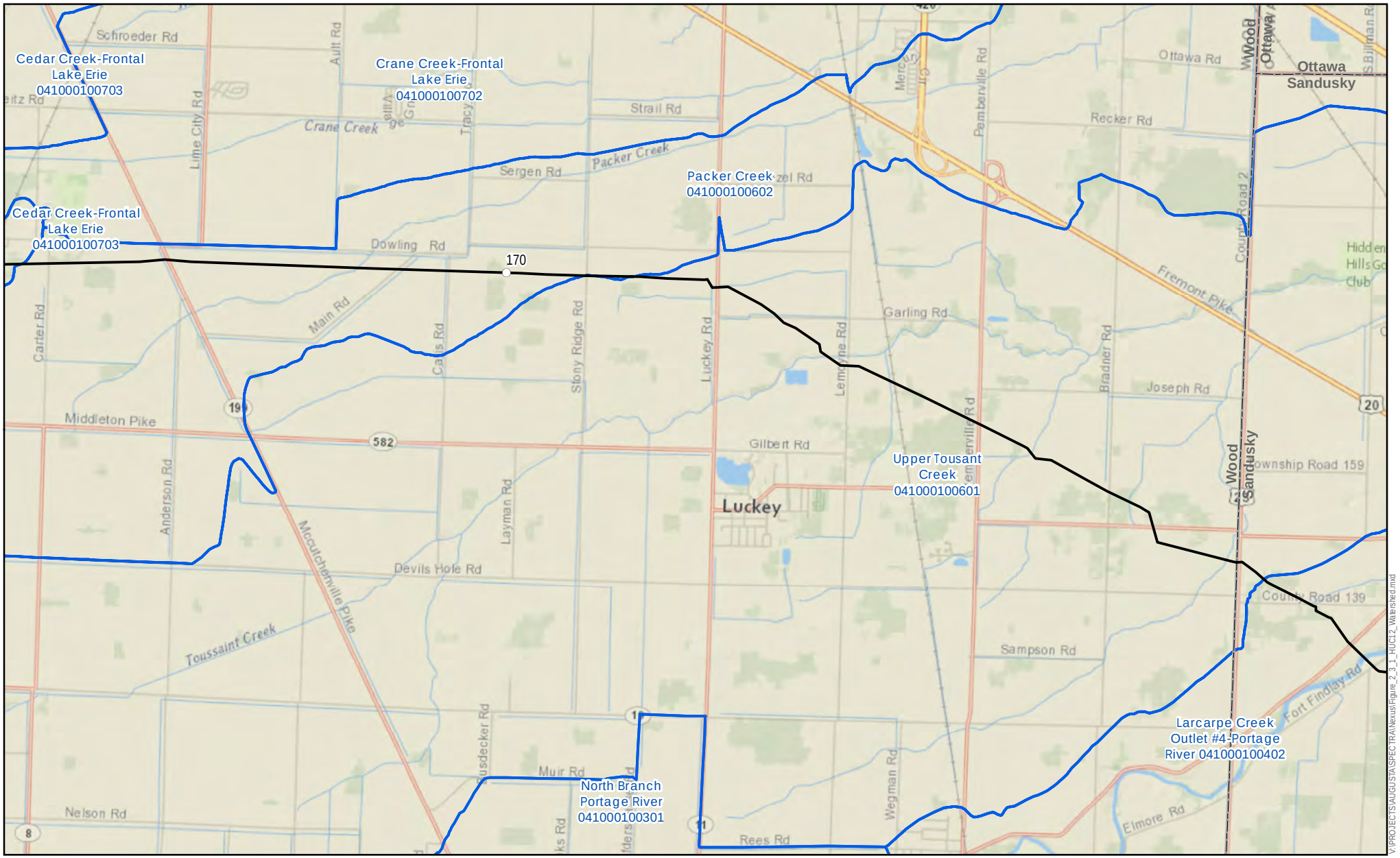
Figure 2.3-1

Watersheds Crossed by the NEXUS Project

Sandusky County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (10 miles)
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- HUC-12 Watersheds

N

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Miles

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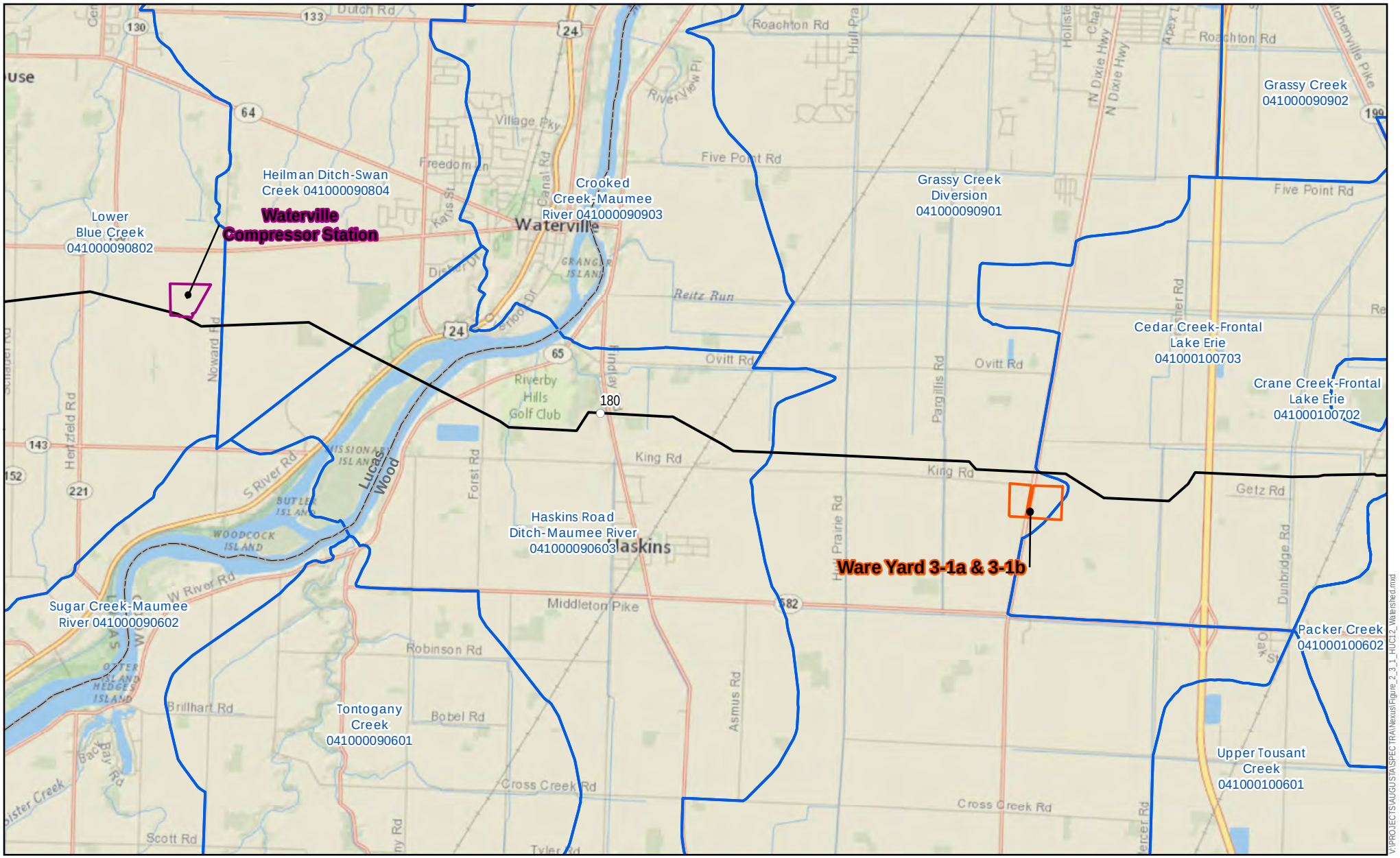
Figure 2.3-1

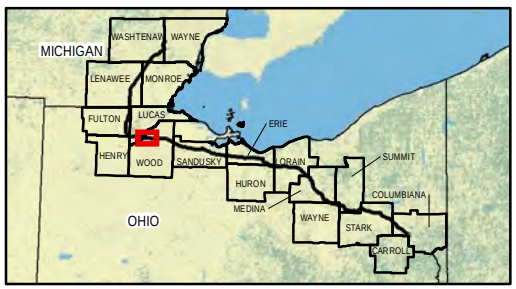
Watersheds Crossed by the NEXUS Project

Sandusky and Wood Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

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0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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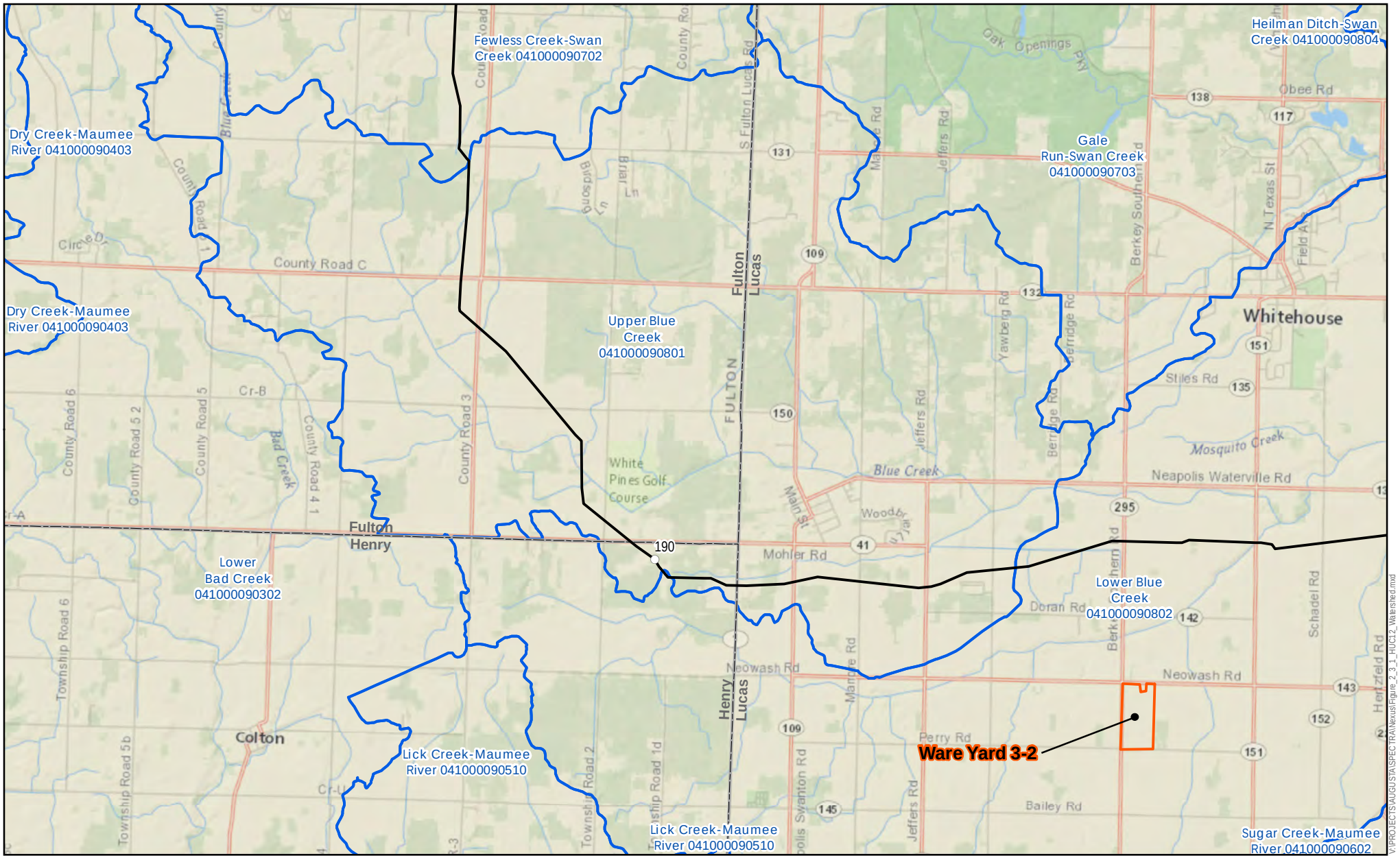
Figure 2.3-1

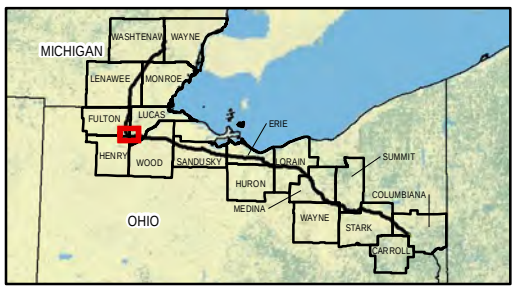
Watersheds Crossed by the NEXUS Project

Wood and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

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0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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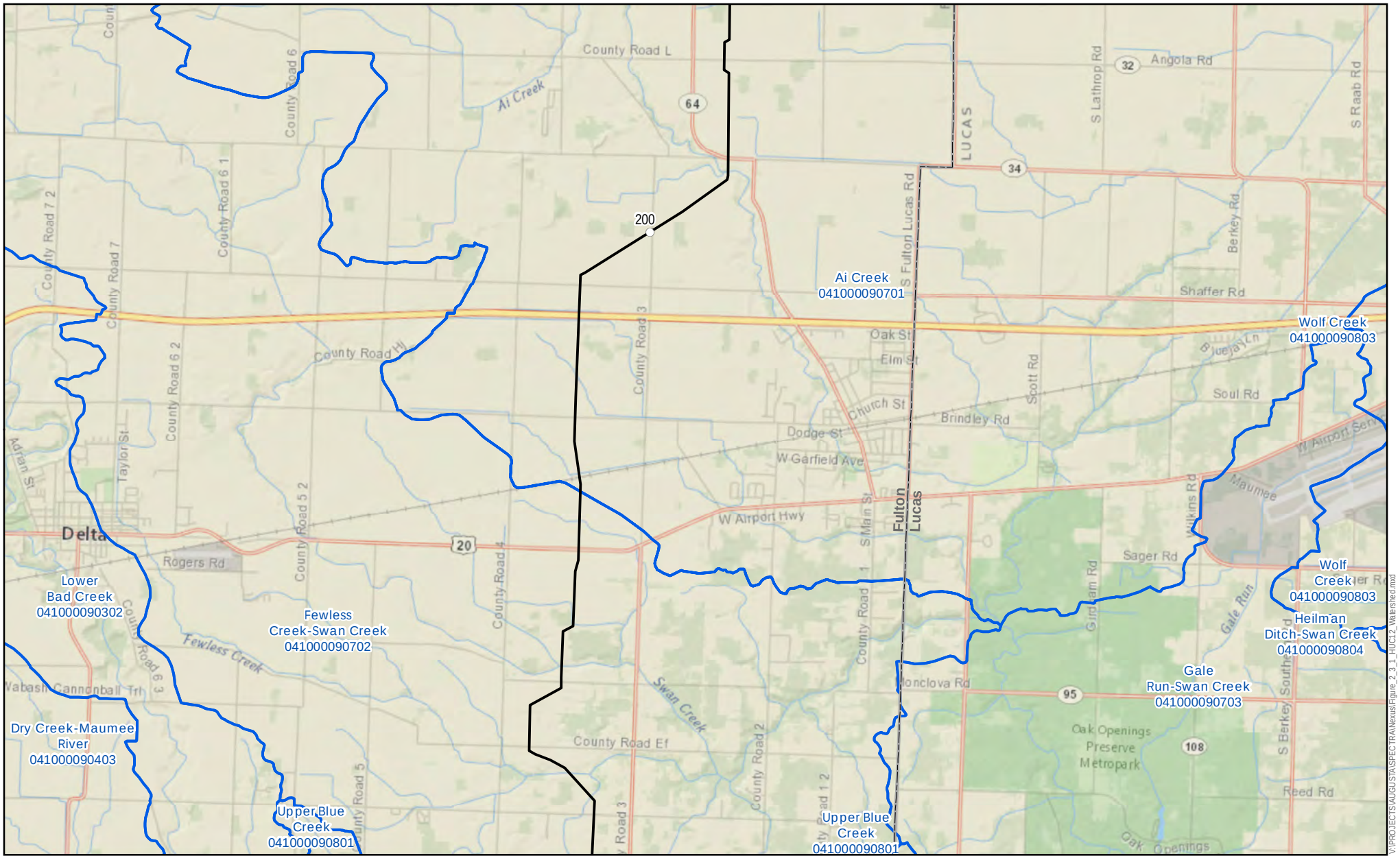
Figure 2.3-1

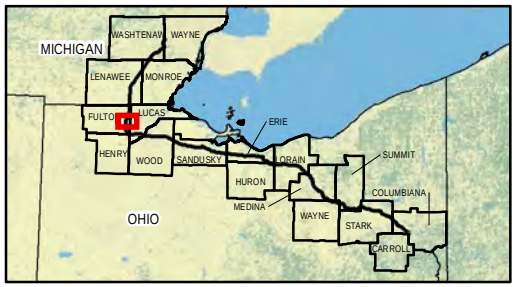
Watersheds Crossed by the NEXUS Project

Henry, Fulton and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

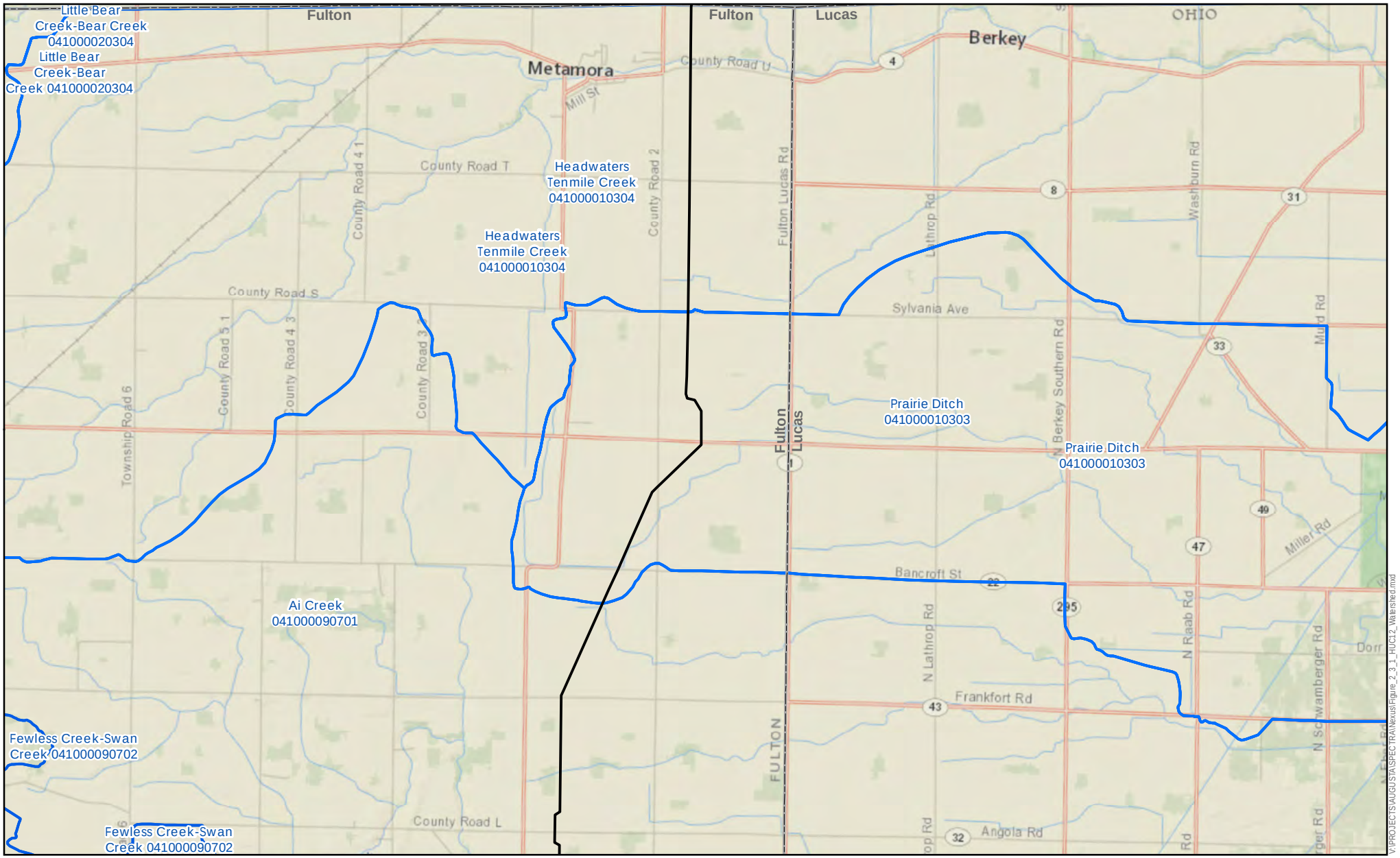
Figure 2.3-1

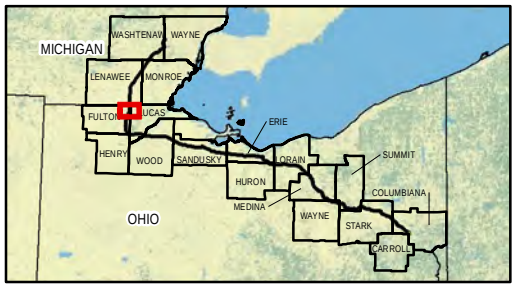
Watersheds Crossed
by the NEXUS Project

Fulton and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

V:\PROJECTS\AUGUSTA\SPECTRA\Nexus\Figure_2_3_1_HUC12_Watershed.mxd

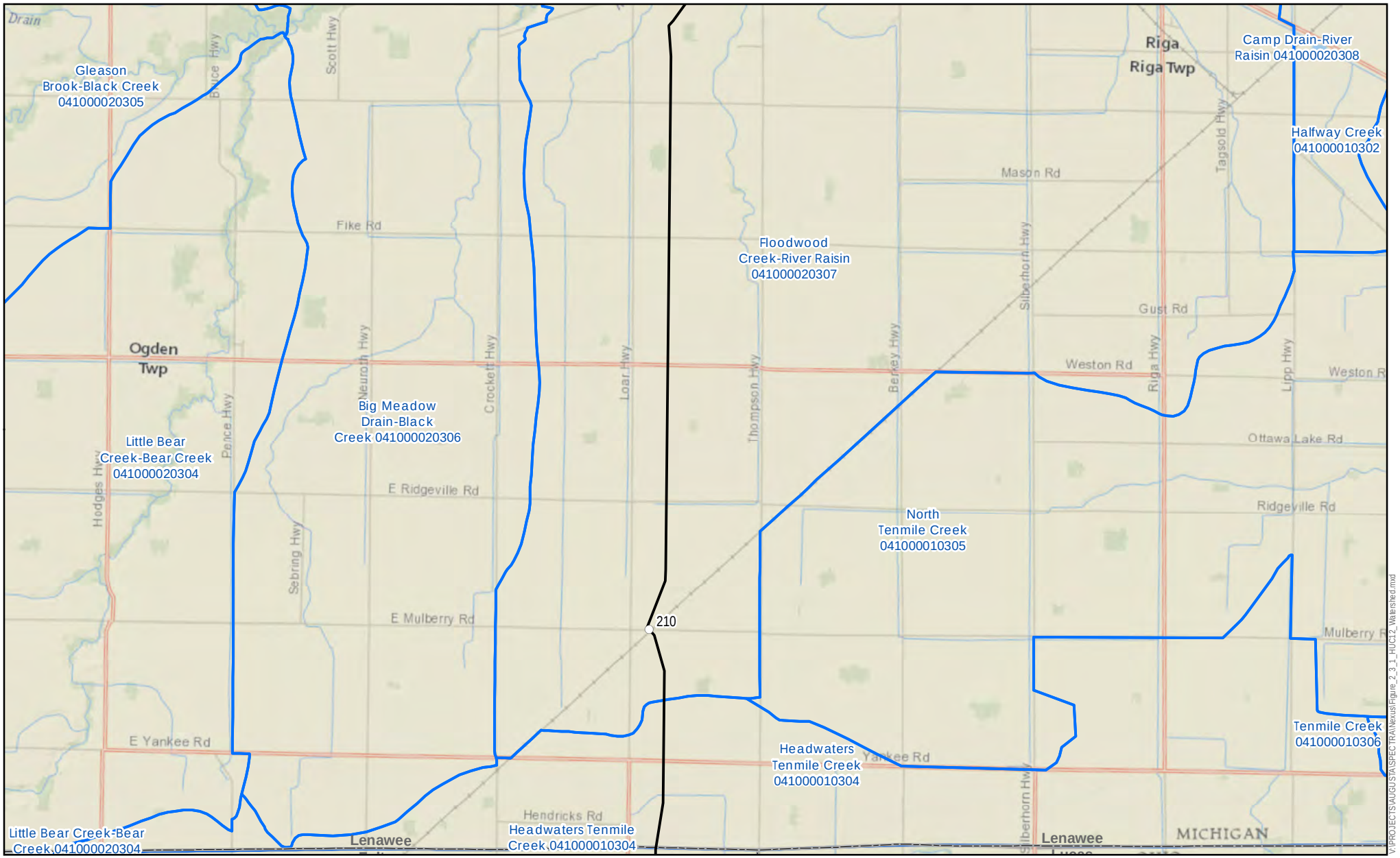
Figure 2.3-1

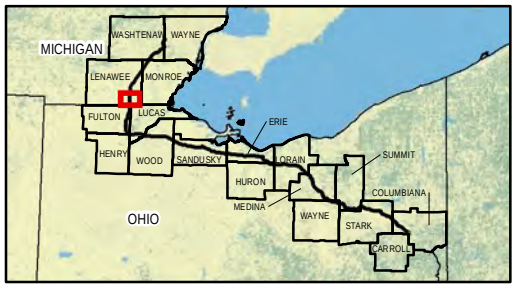
Watersheds Crossed by the NEXUS Project

Fulton and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

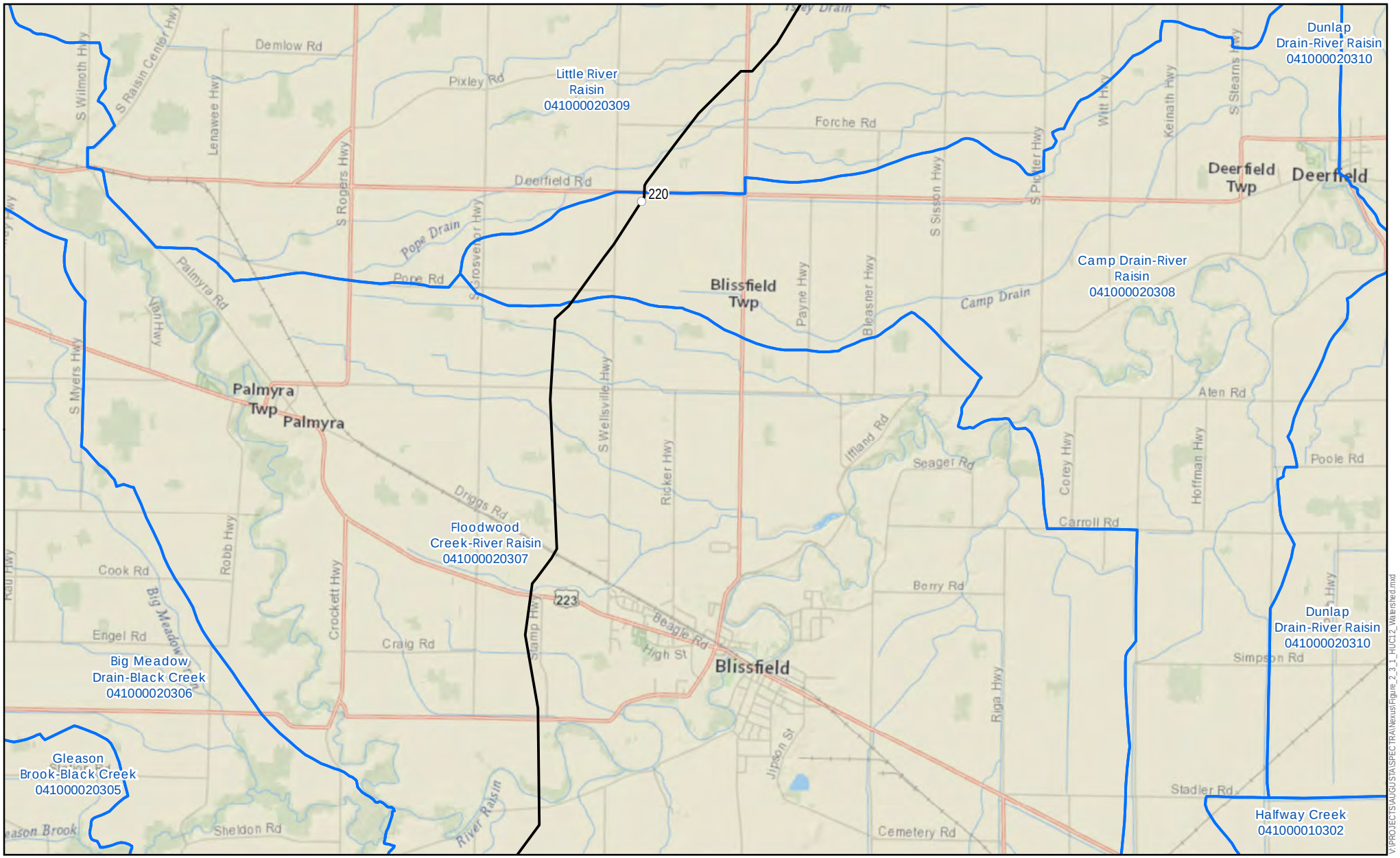
Figure 2.3-1

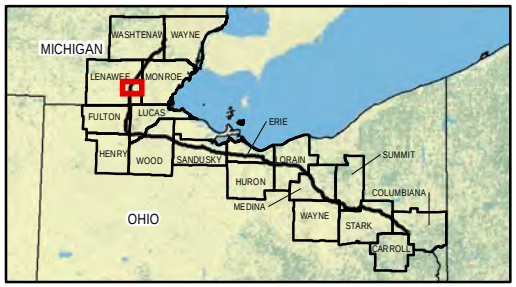
Watersheds Crossed by the NEXUS Project

Lenawee County, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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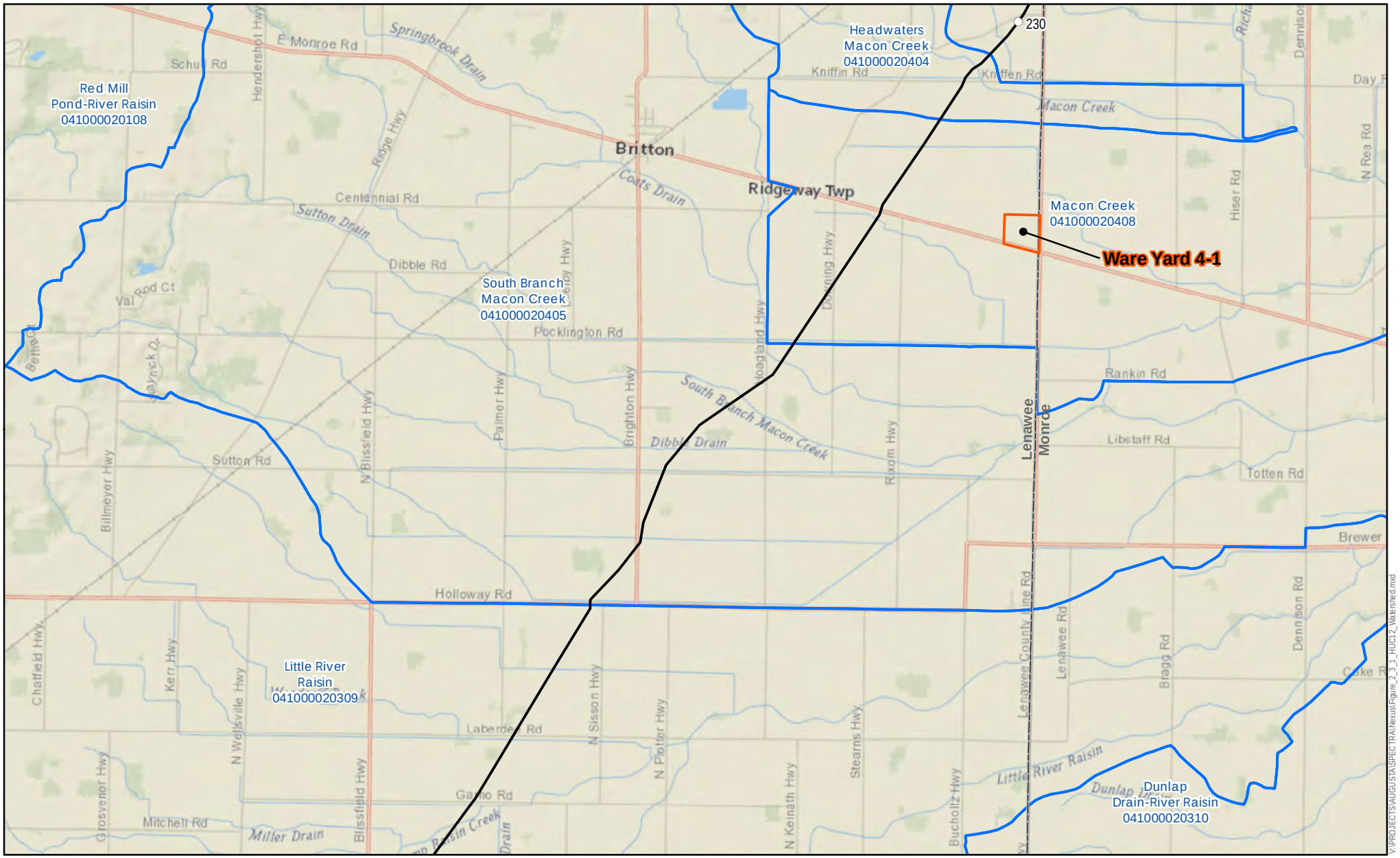
Figure 2.3-1

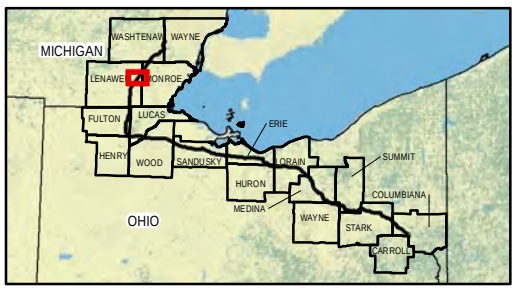
Watersheds Crossed by the NEXUS Project

Lenawee County, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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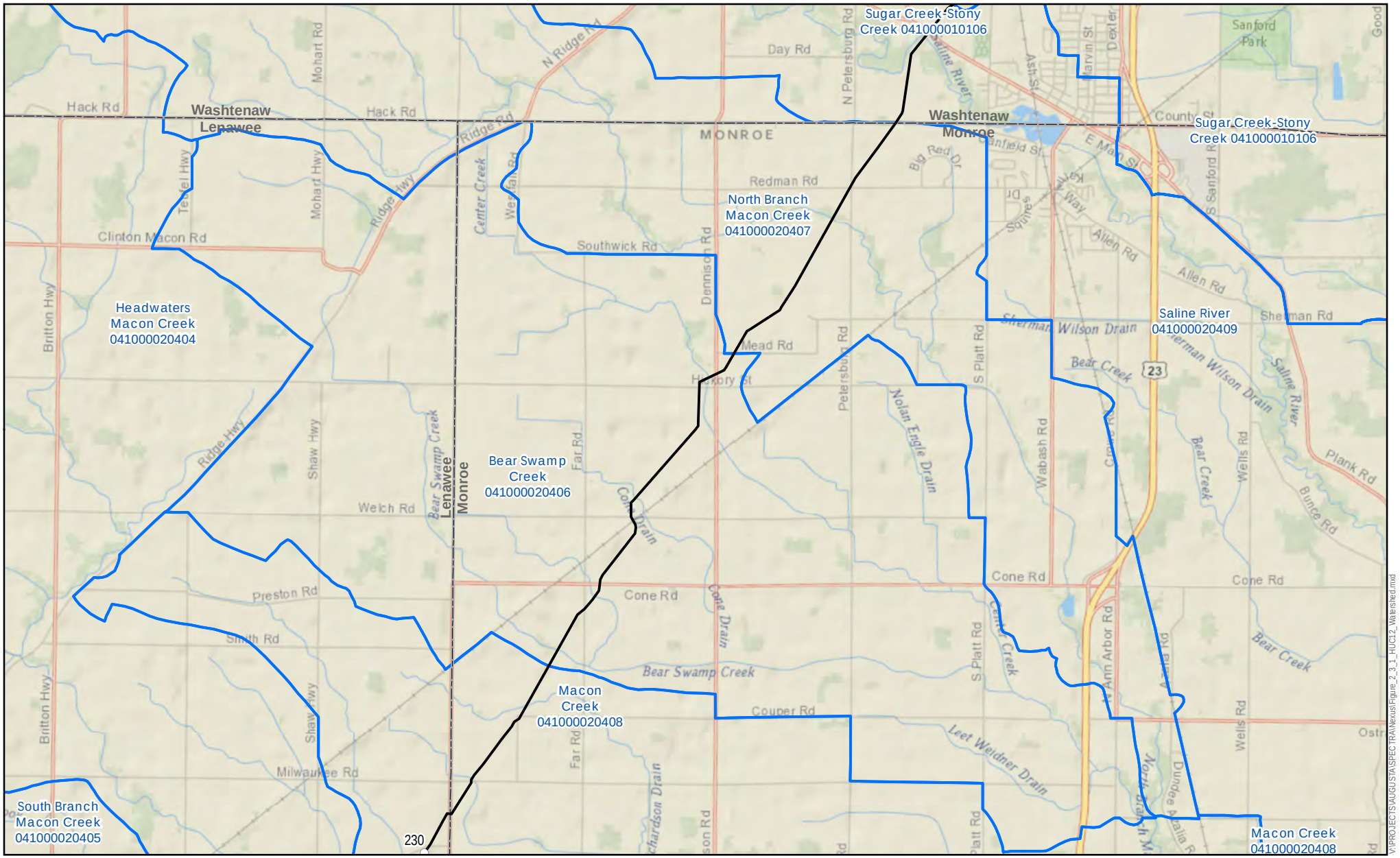
Figure 2.3-1

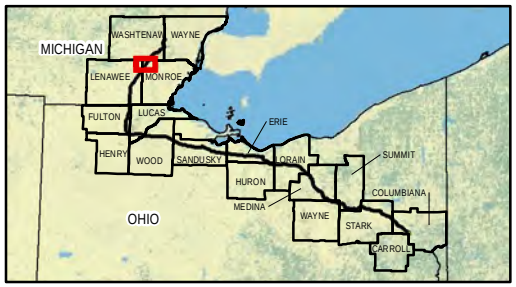
Watersheds Crossed
by the NEXUS Project

Lenawee and Monroe Counties, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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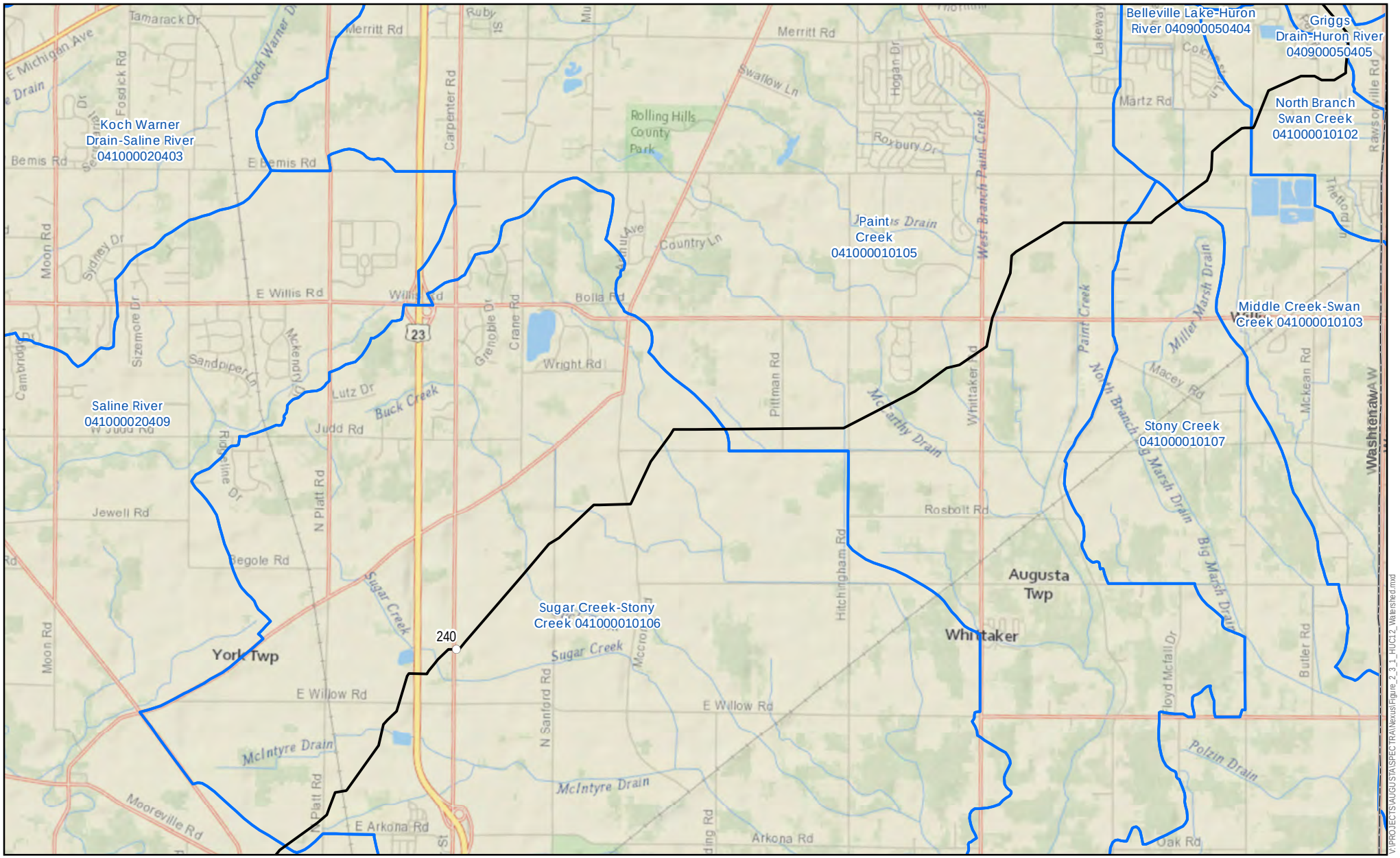
Figure 2.3-1

Watersheds Crossed by the NEXUS Project

Lenawee, Monroe and Washtenaw Counties, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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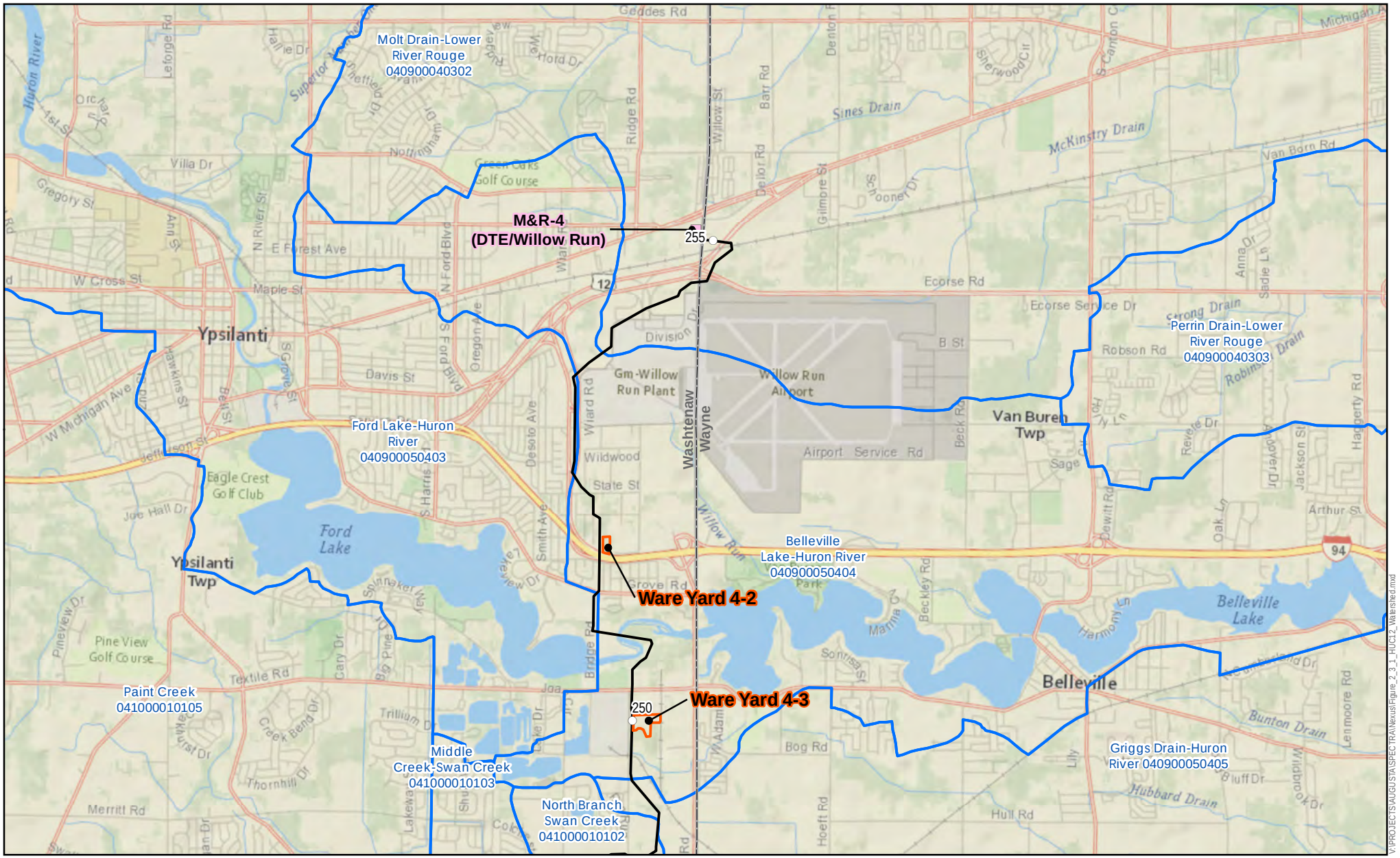
Figure 2.3-1

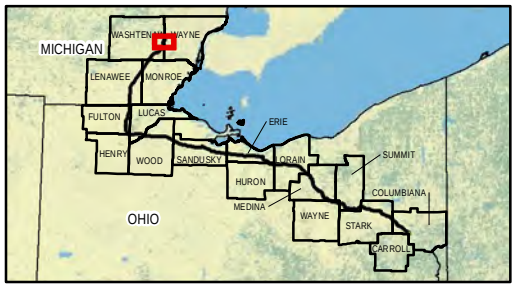
Watersheds Crossed by the NEXUS Project

Washtenaw County, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015





- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- HUC-12 Watersheds

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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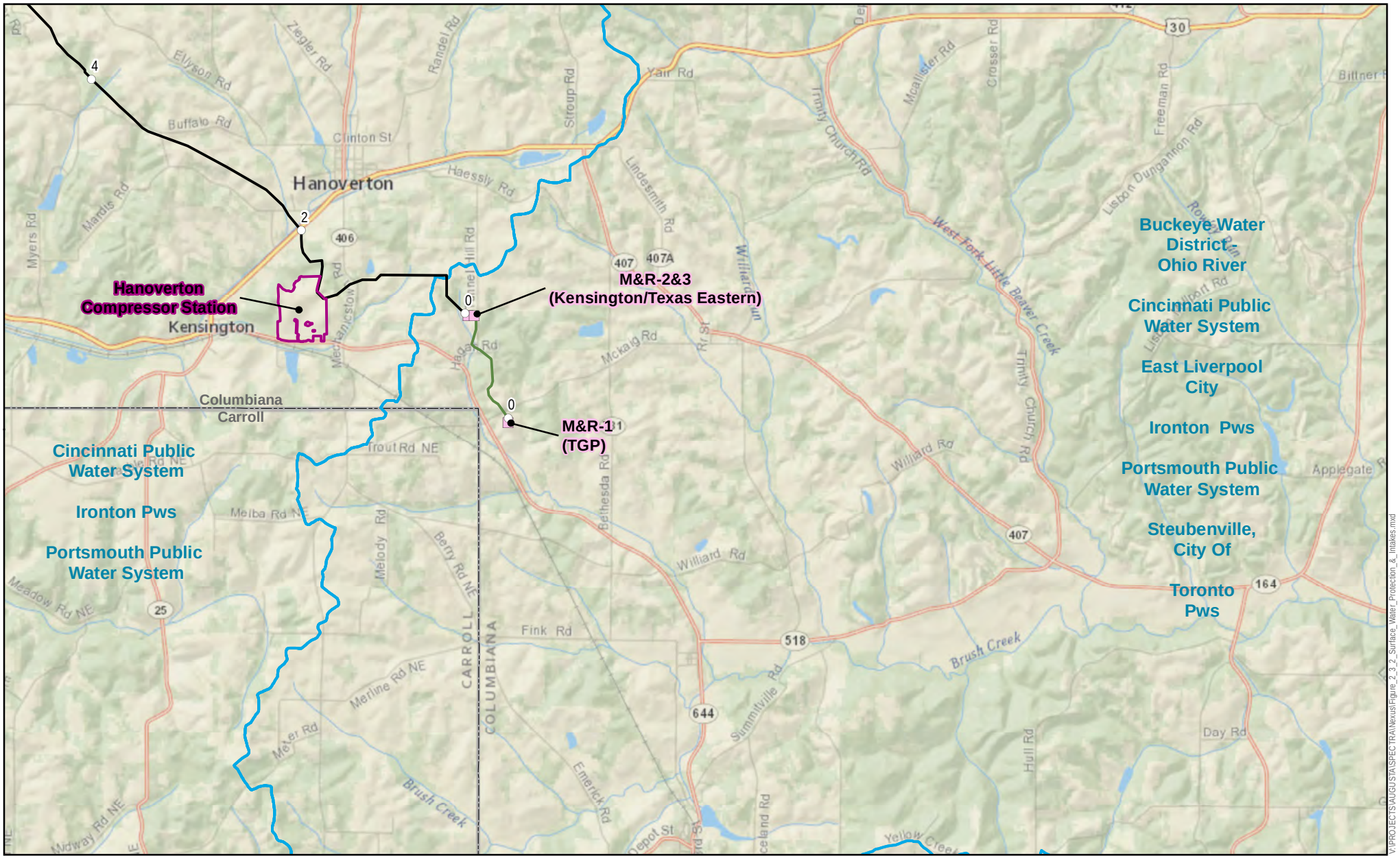
Figure 2.3-1

Watersheds Crossed by the NEXUS Project

Washtenaw and Wayne Counties, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015



- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

Figure 2.3-2

Public Surface Water Supplies Located Along the NEXUS Project

Columbiana and Carroll Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015

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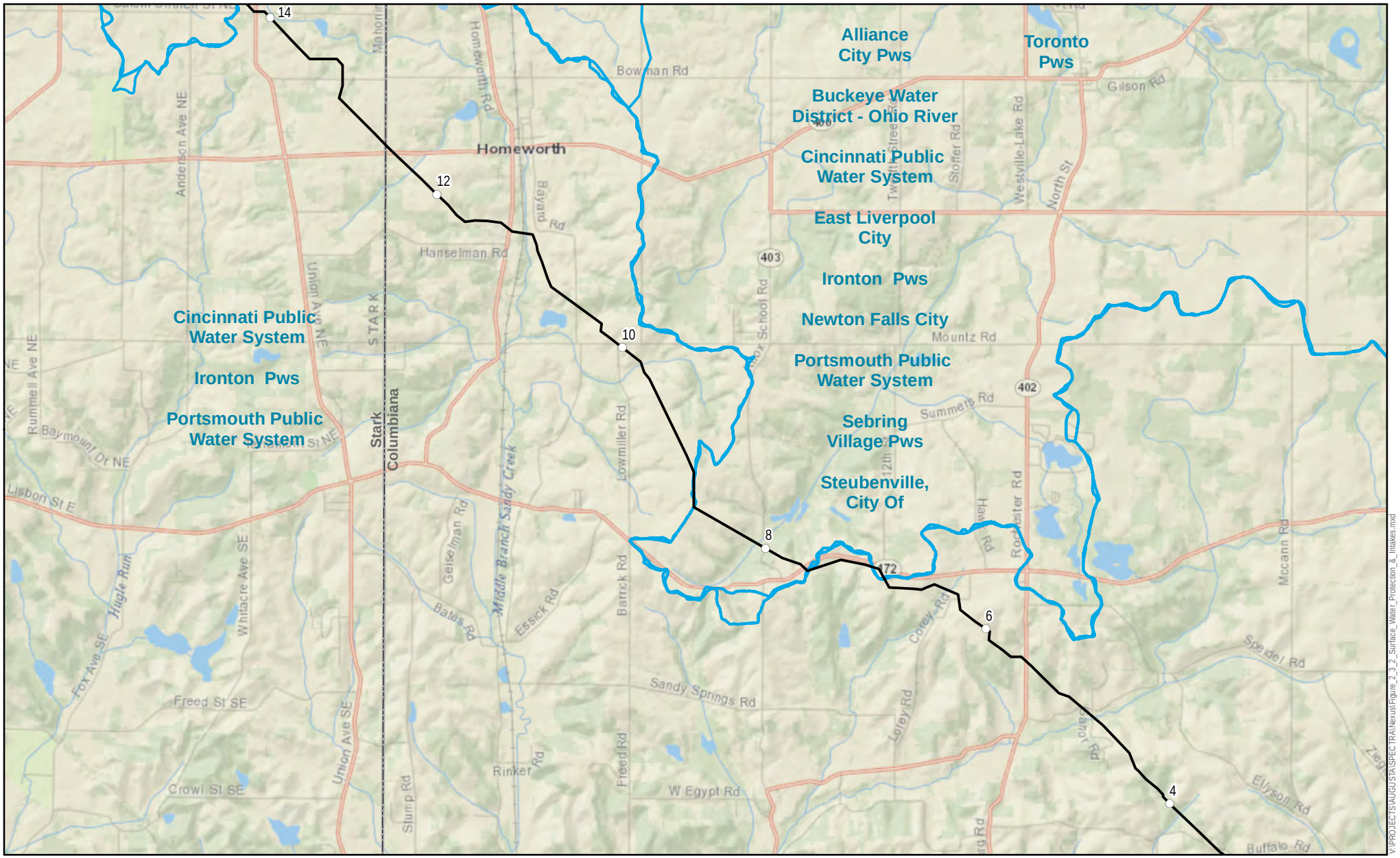

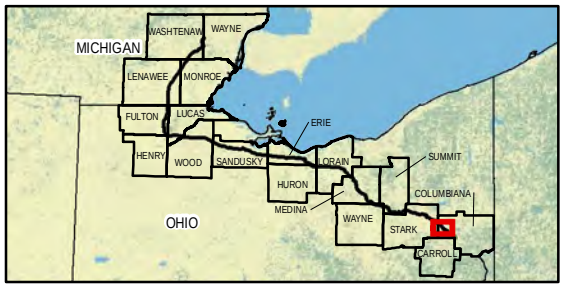

- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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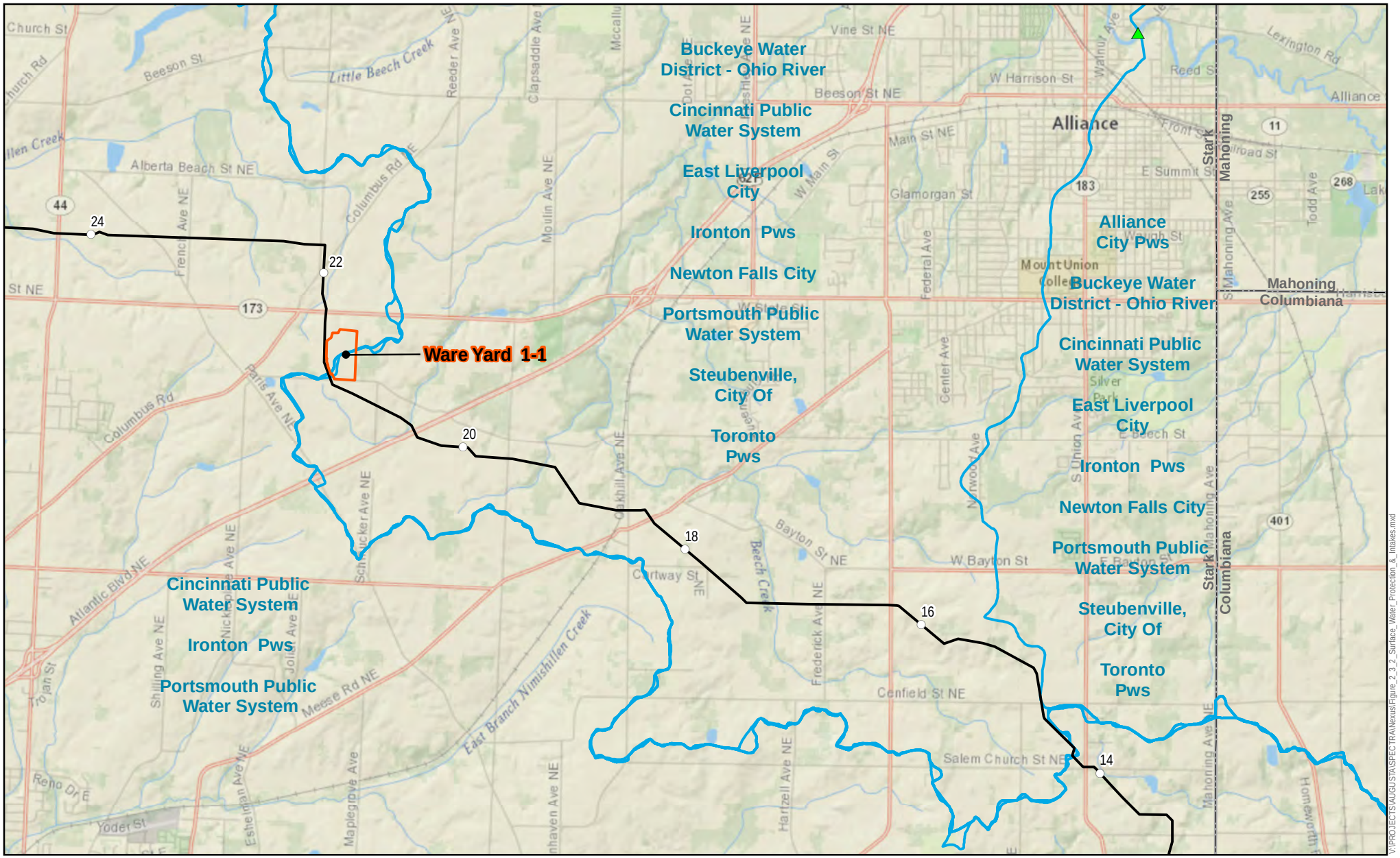
Figure 2.3-2

Public Surface Water Supplies
Located Along the NEXUS Project

Columbiana and Stark Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015



- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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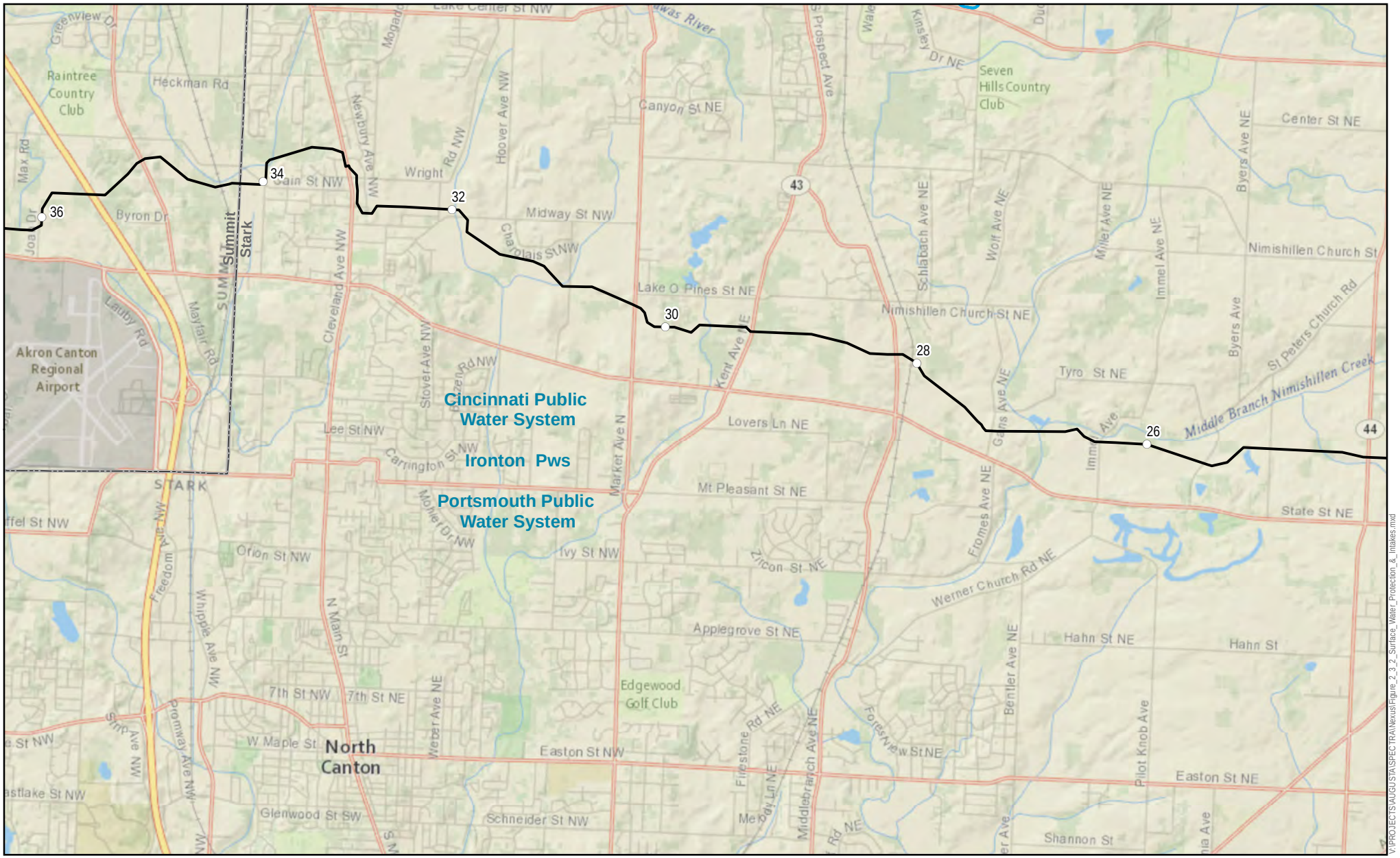
Figure 2.3-2

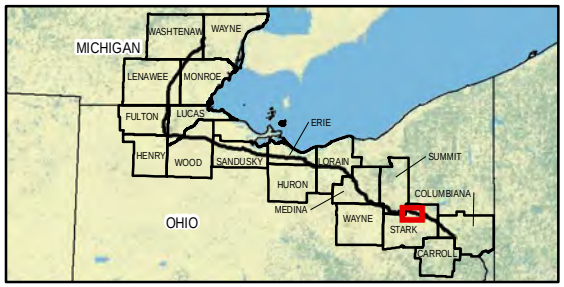
Public Surface Water Supplies
Located Along the NEXUS Project

Stark and Columbiana Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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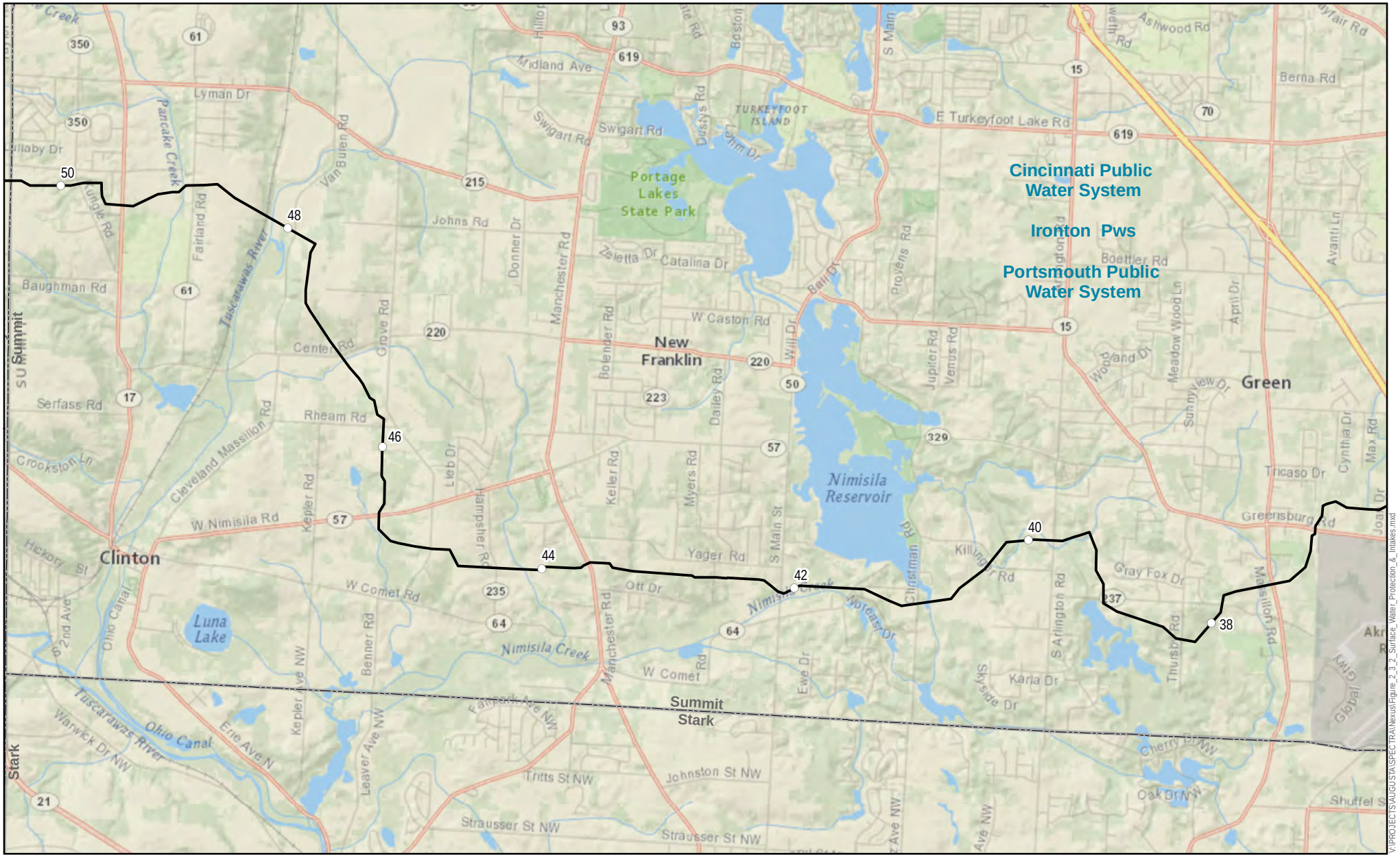
Figure 2.3-2

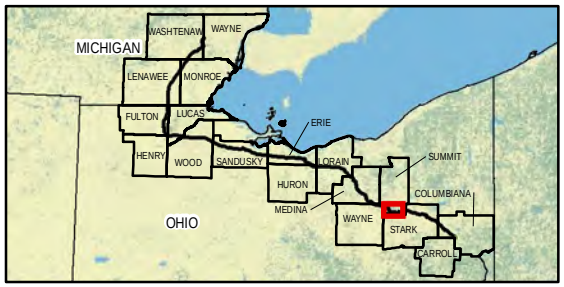
Public Surface Water Supplies
Located Along the NEXUS Project

Stark and Summit Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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Figure 2.3-2

Public Surface Water Supplies
Located Along the NEXUS Project

Summit and Stark Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015

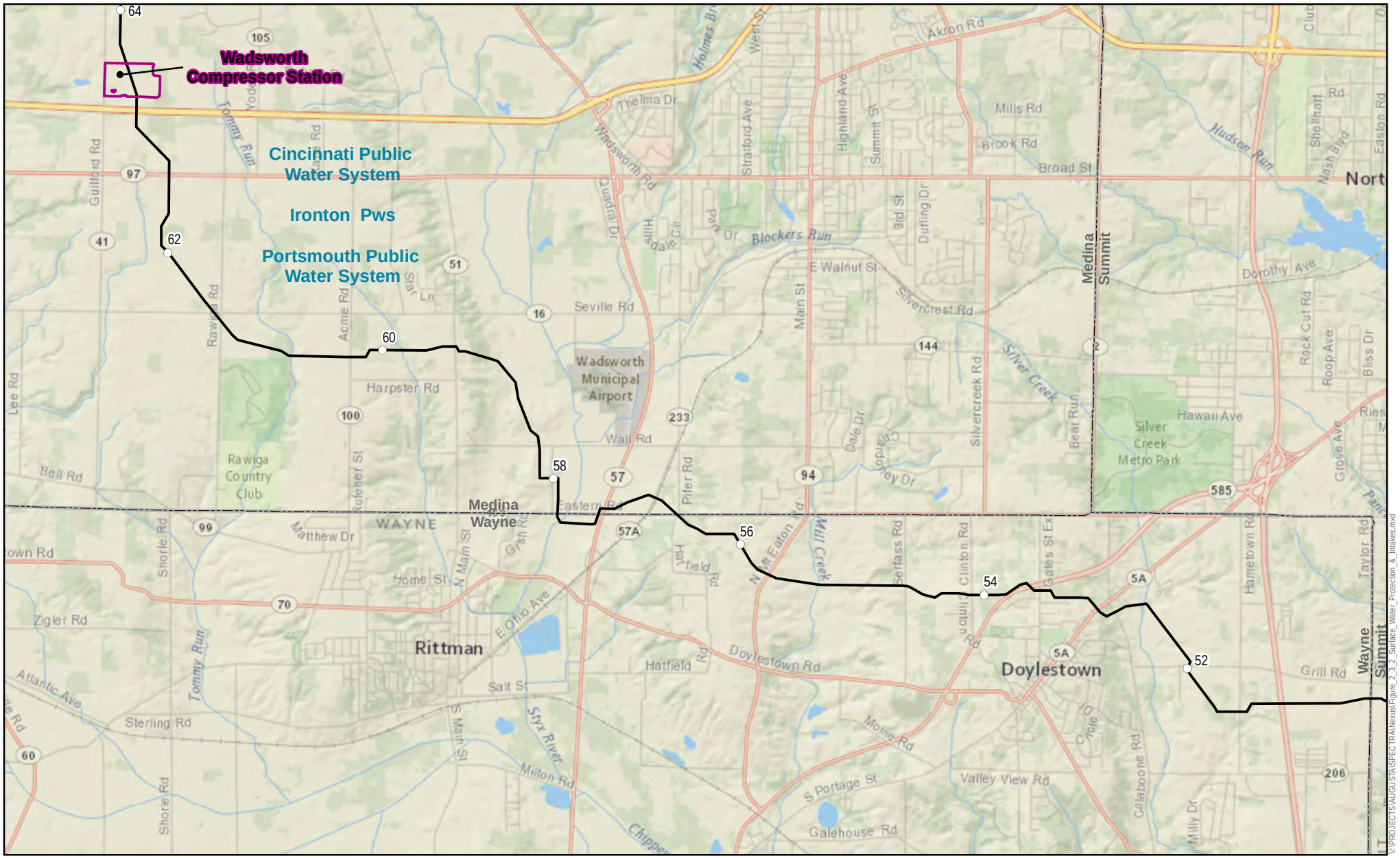


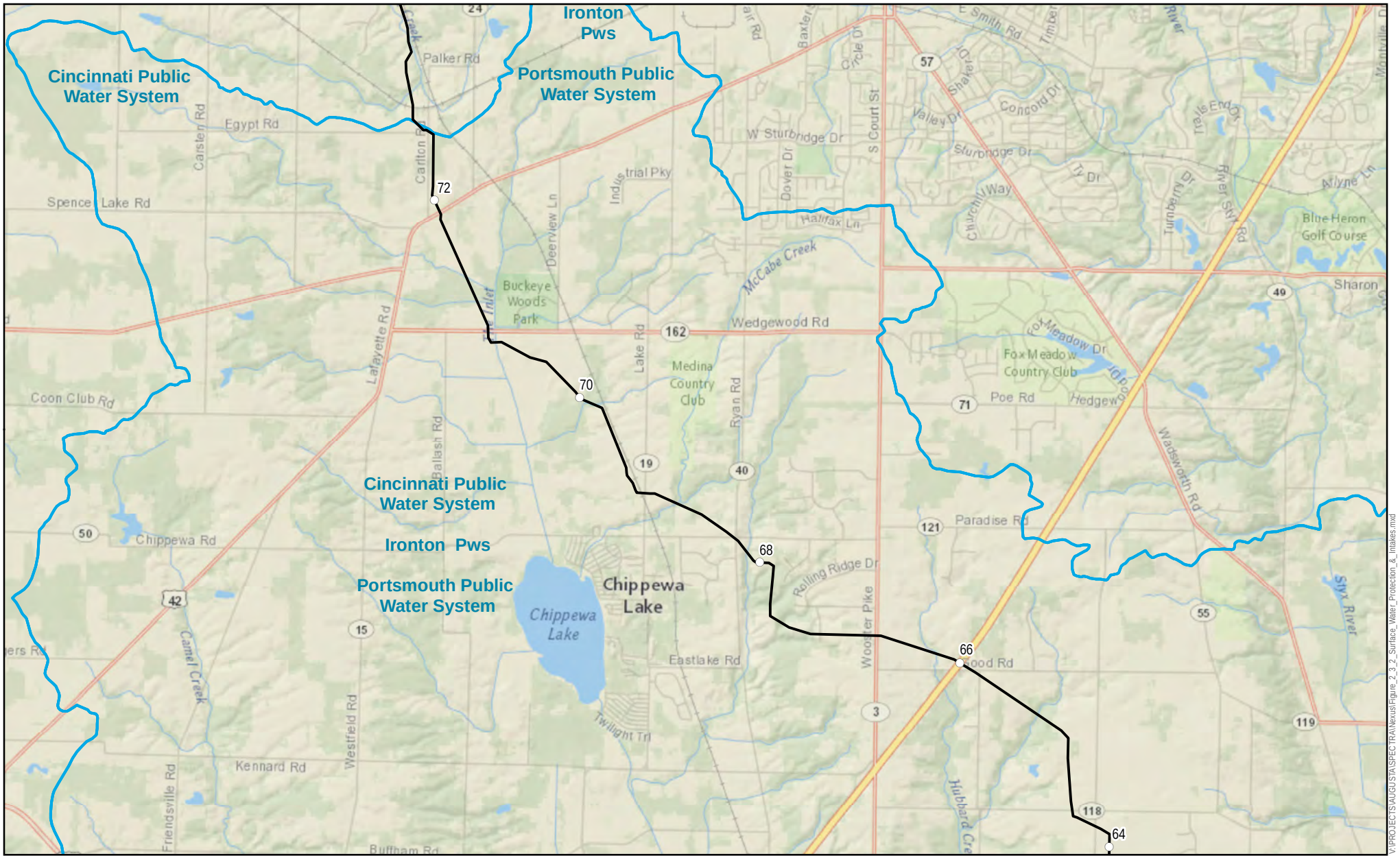
Figure 2.3-2

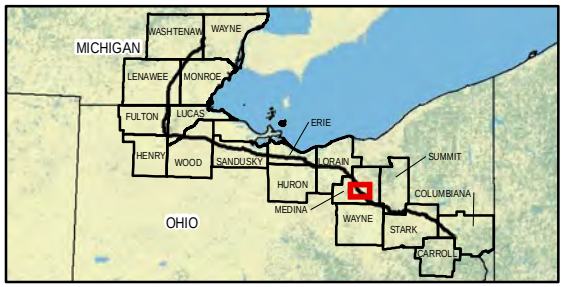
Public Surface Water Supplies
Located Along the NEXUS Project

Wayne, Summit and Medina Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

Figure 2.3-2

Public Surface Water Supplies Located Along the NEXUS Project

Medina County, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015

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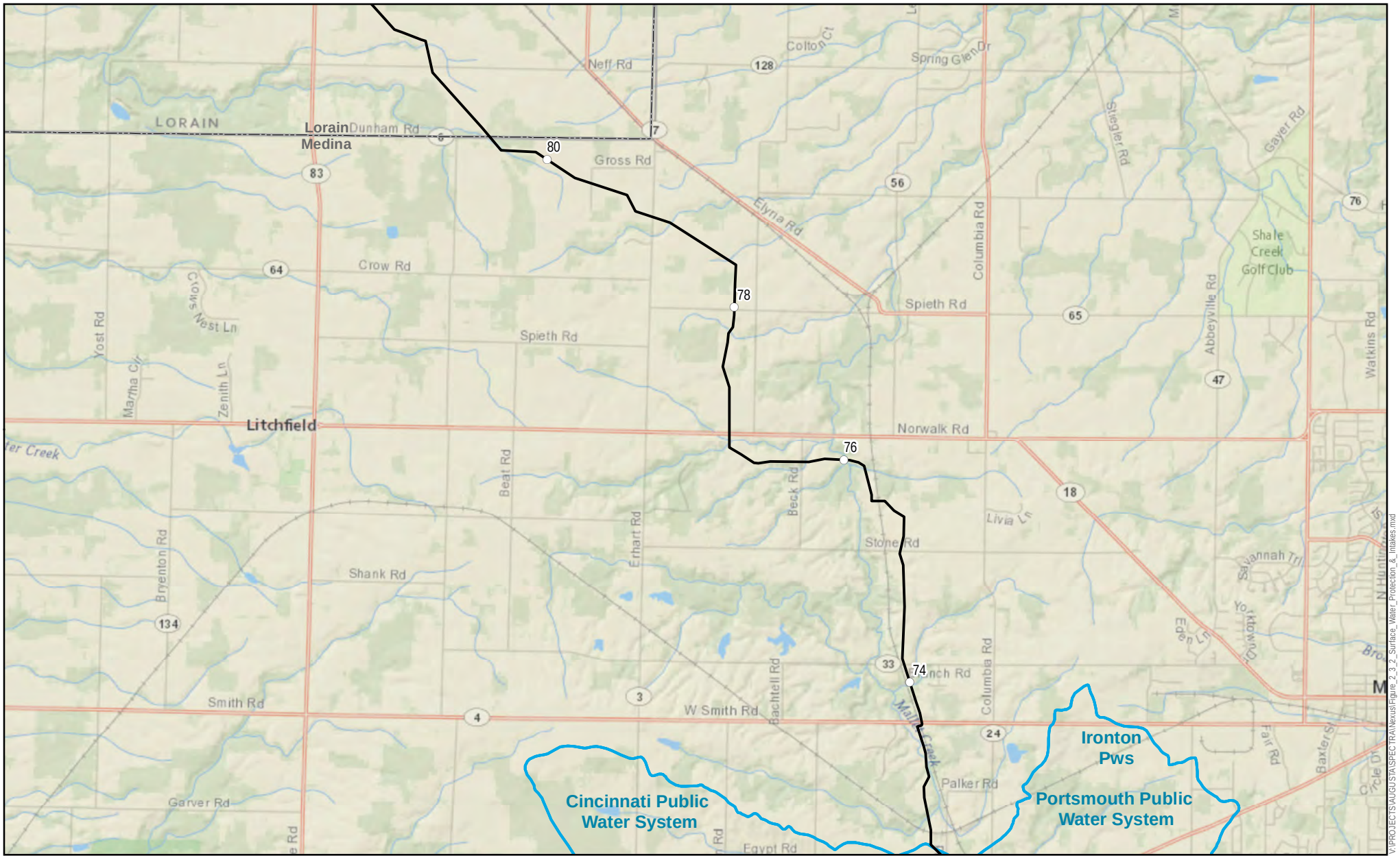

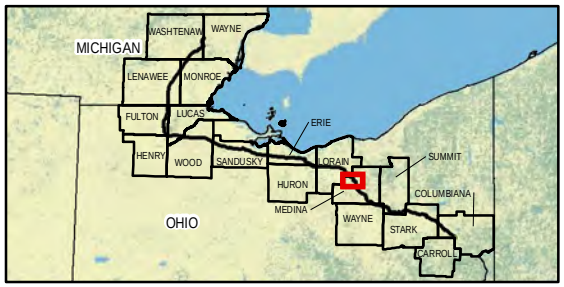

- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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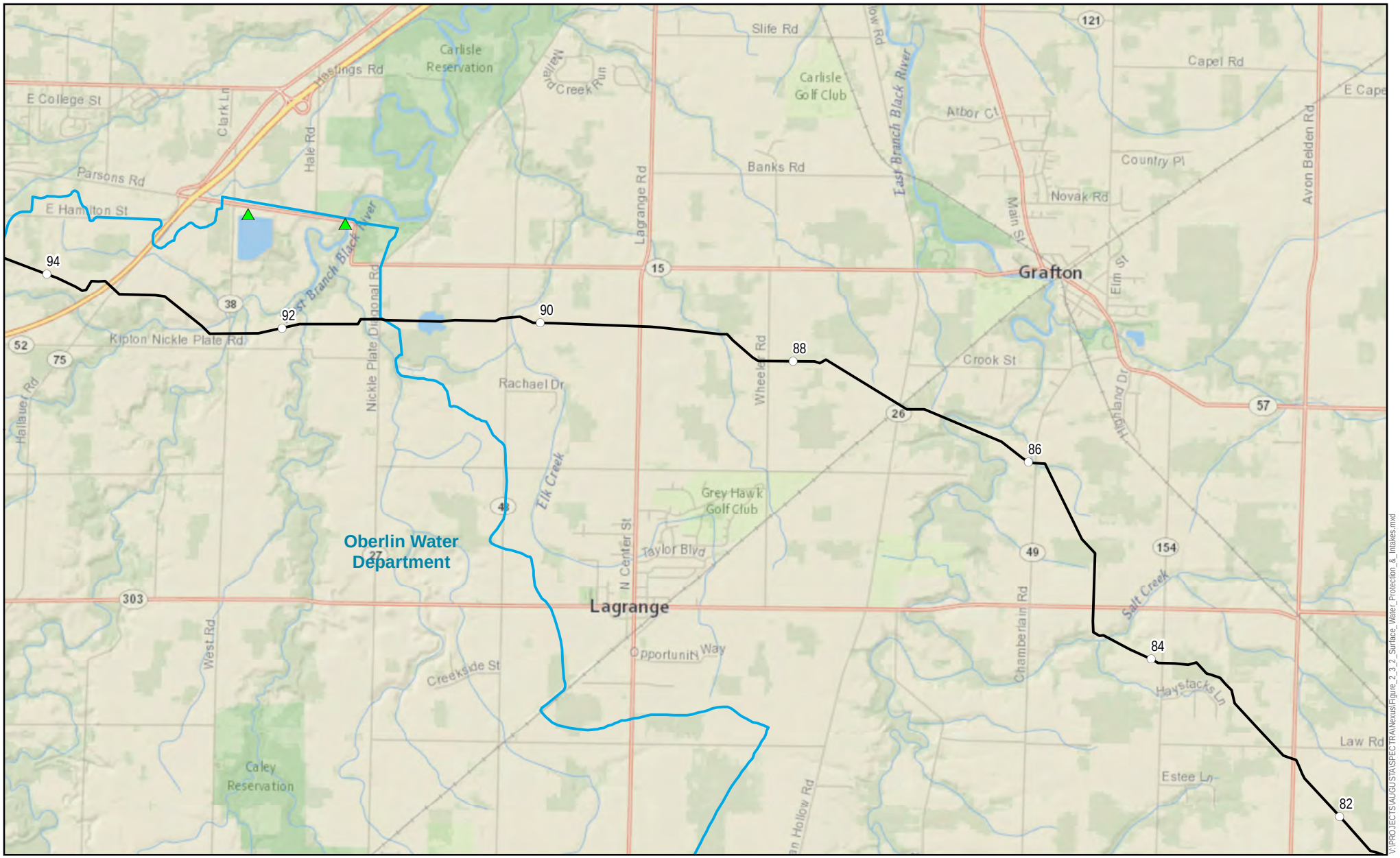
Figure 2.3-2

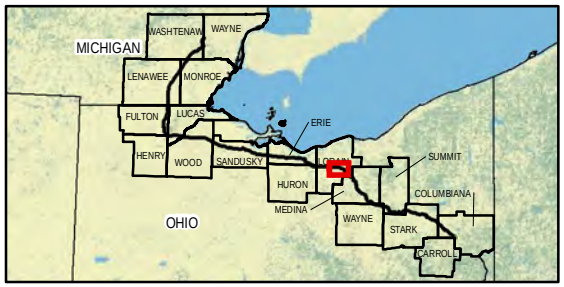
Public Surface Water Supplies
Located Along the NEXUS Project

Medina and Lorain Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

Figure 2.3-2

Public Surface Water Supplies
Located Along the NEXUS Project

Lorain County, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015

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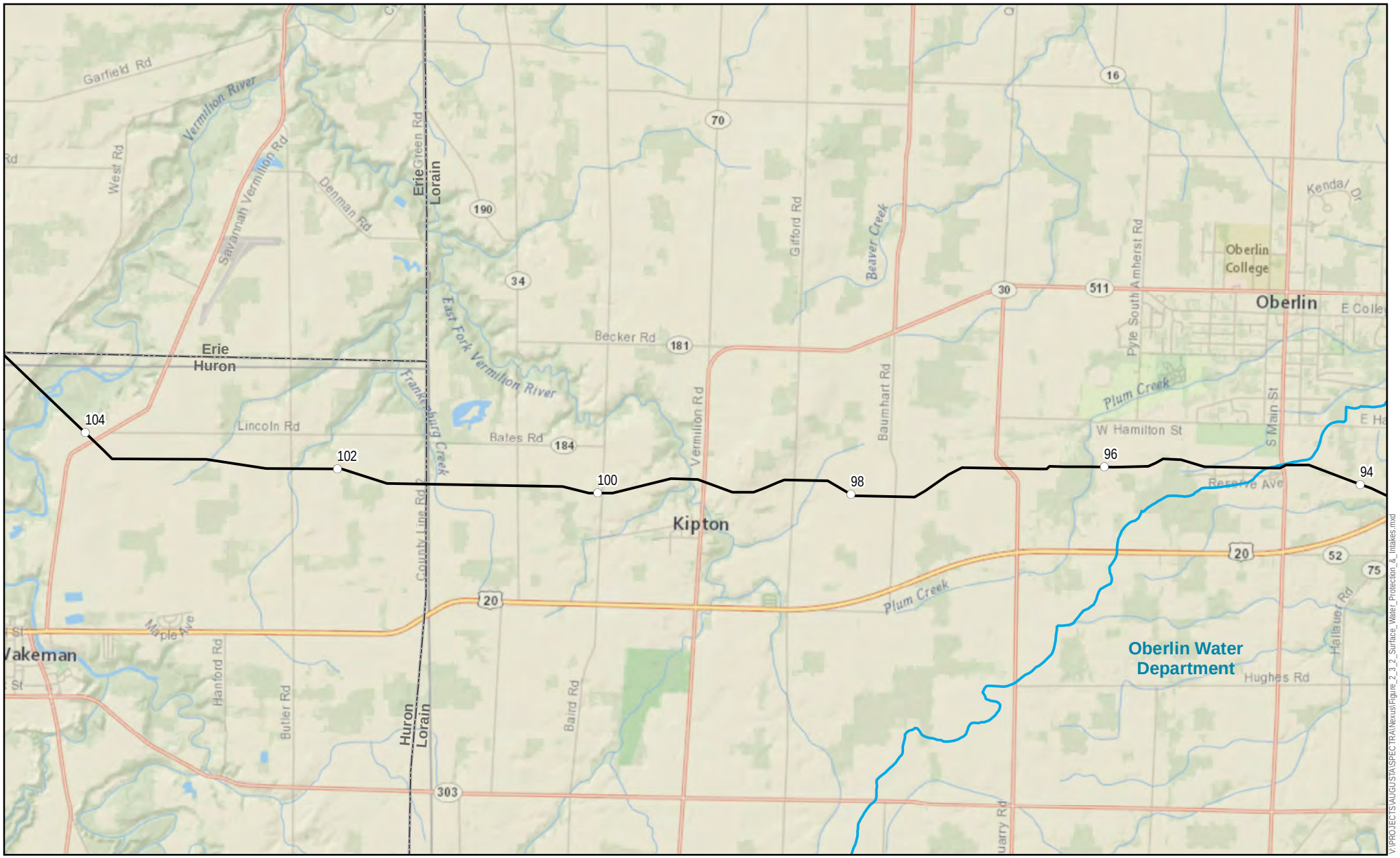

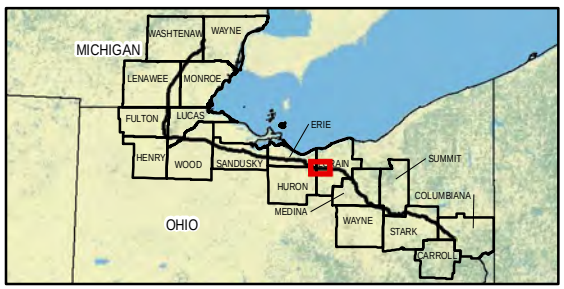

- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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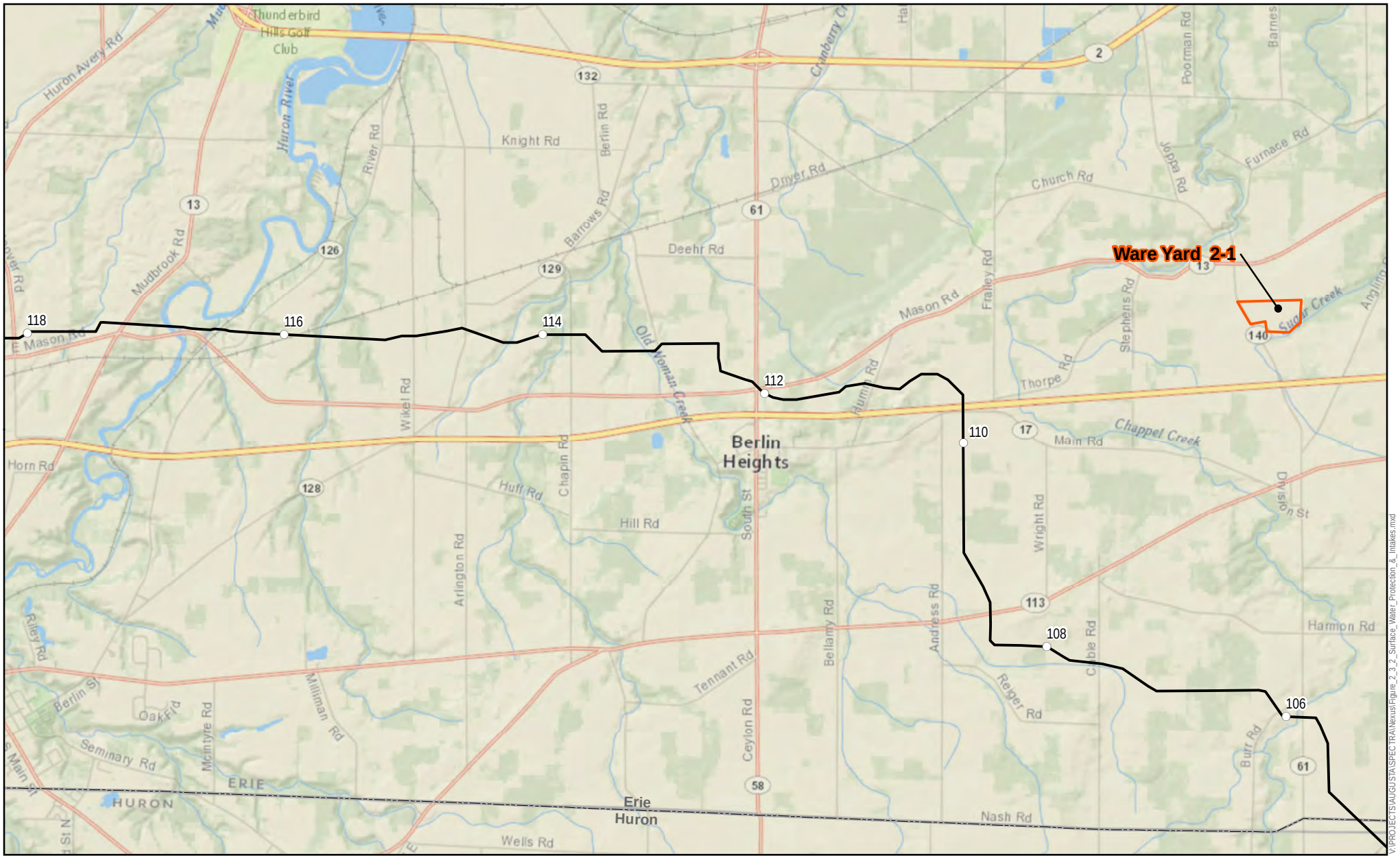
Figure 2.3-2

Public Surface Water Supplies
Located Along the NEXUS Project

Lorain, Erie and Huron Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015



Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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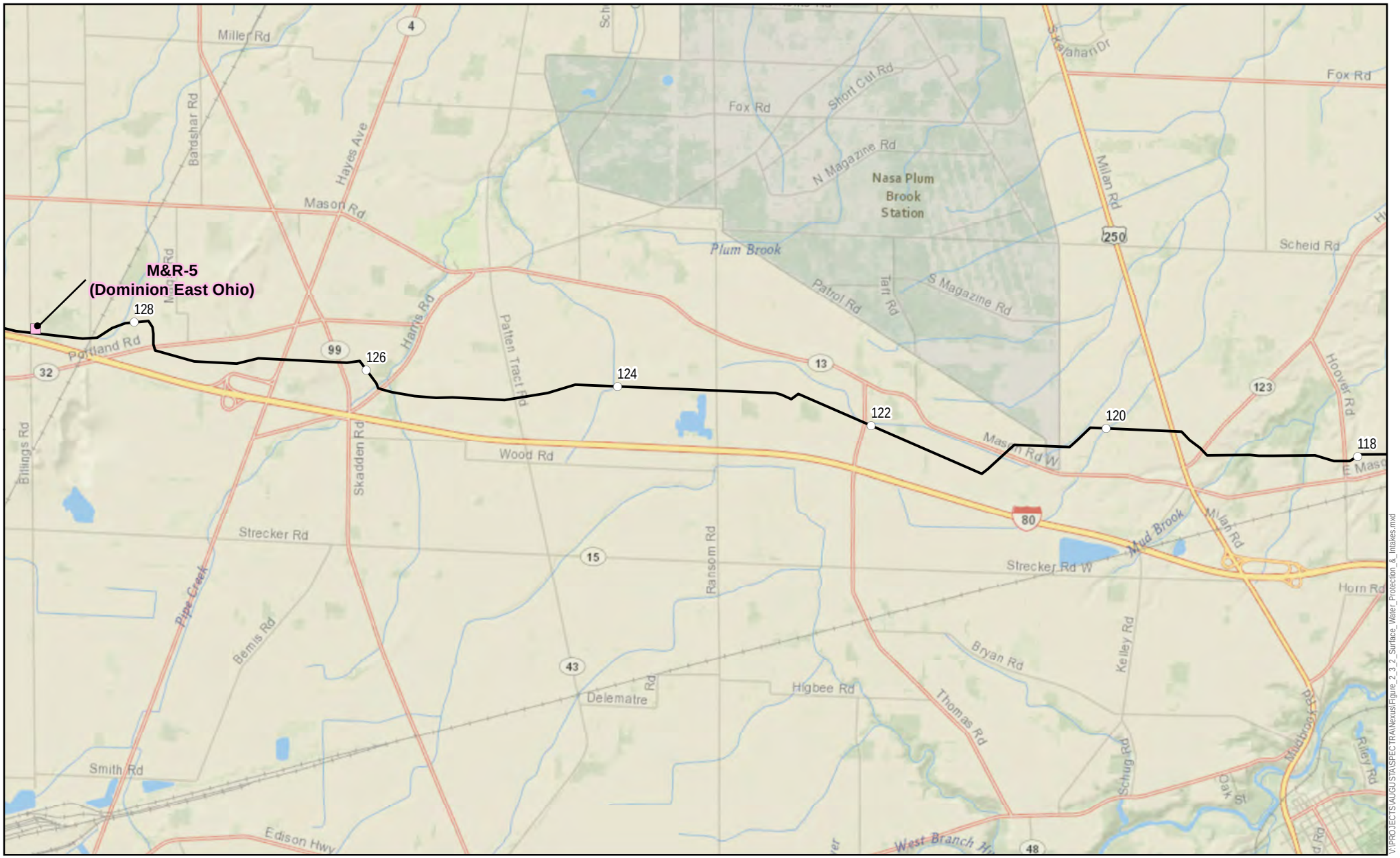
Figure 2.3-2

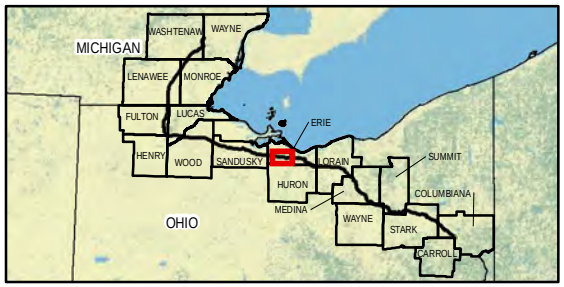
Public Surface Water Supplies
Located Along the NEXUS Project

Huron and Erie Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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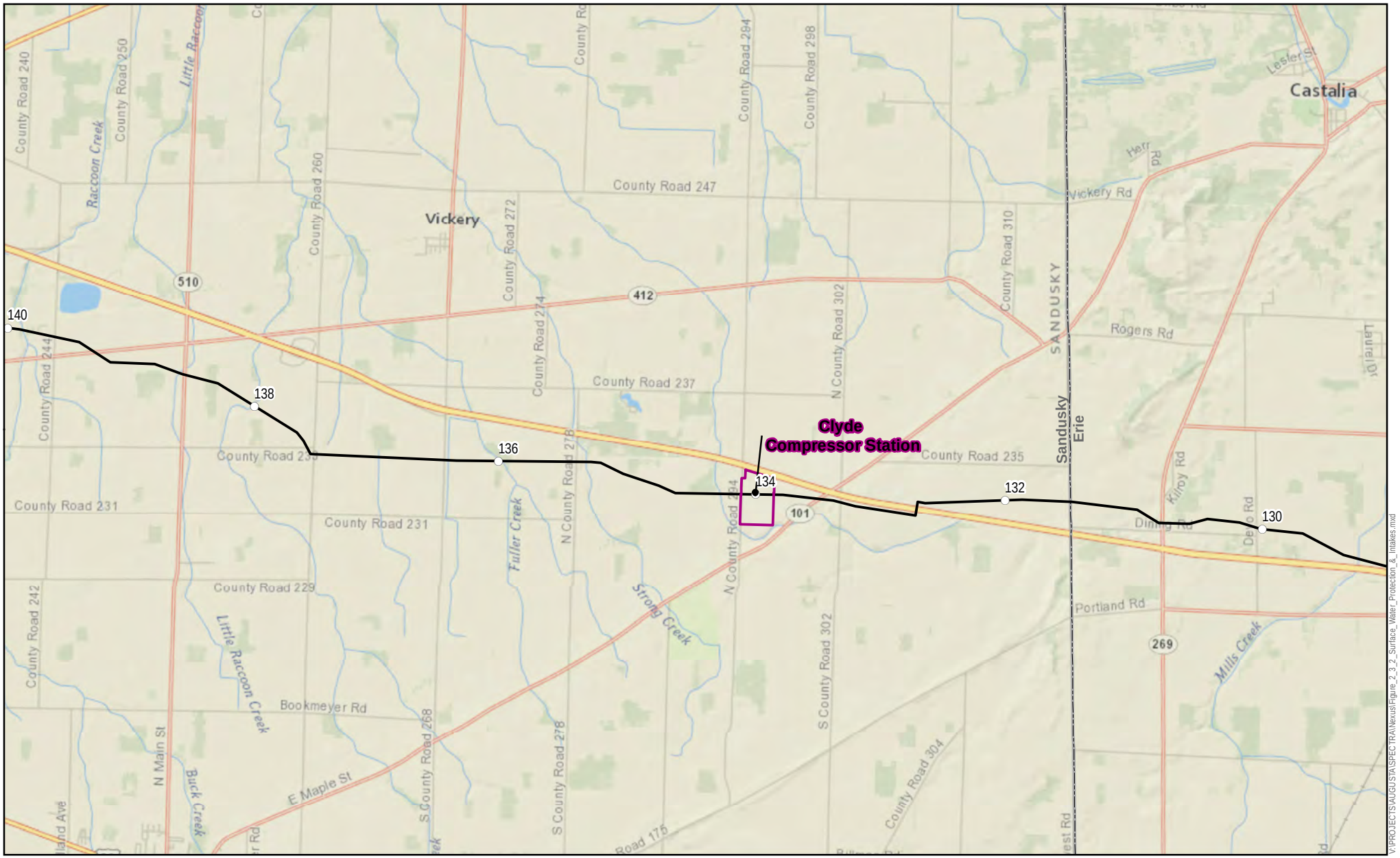
Figure 2.3-2

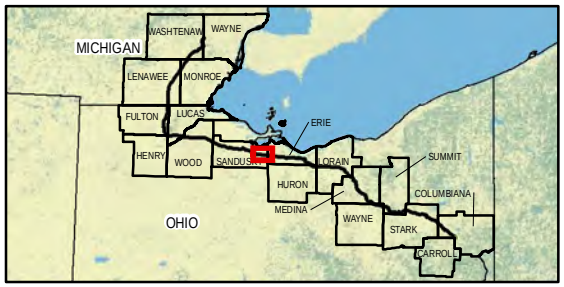
Public Surface Water Supplies
Located Along the NEXUS Project

Erie County, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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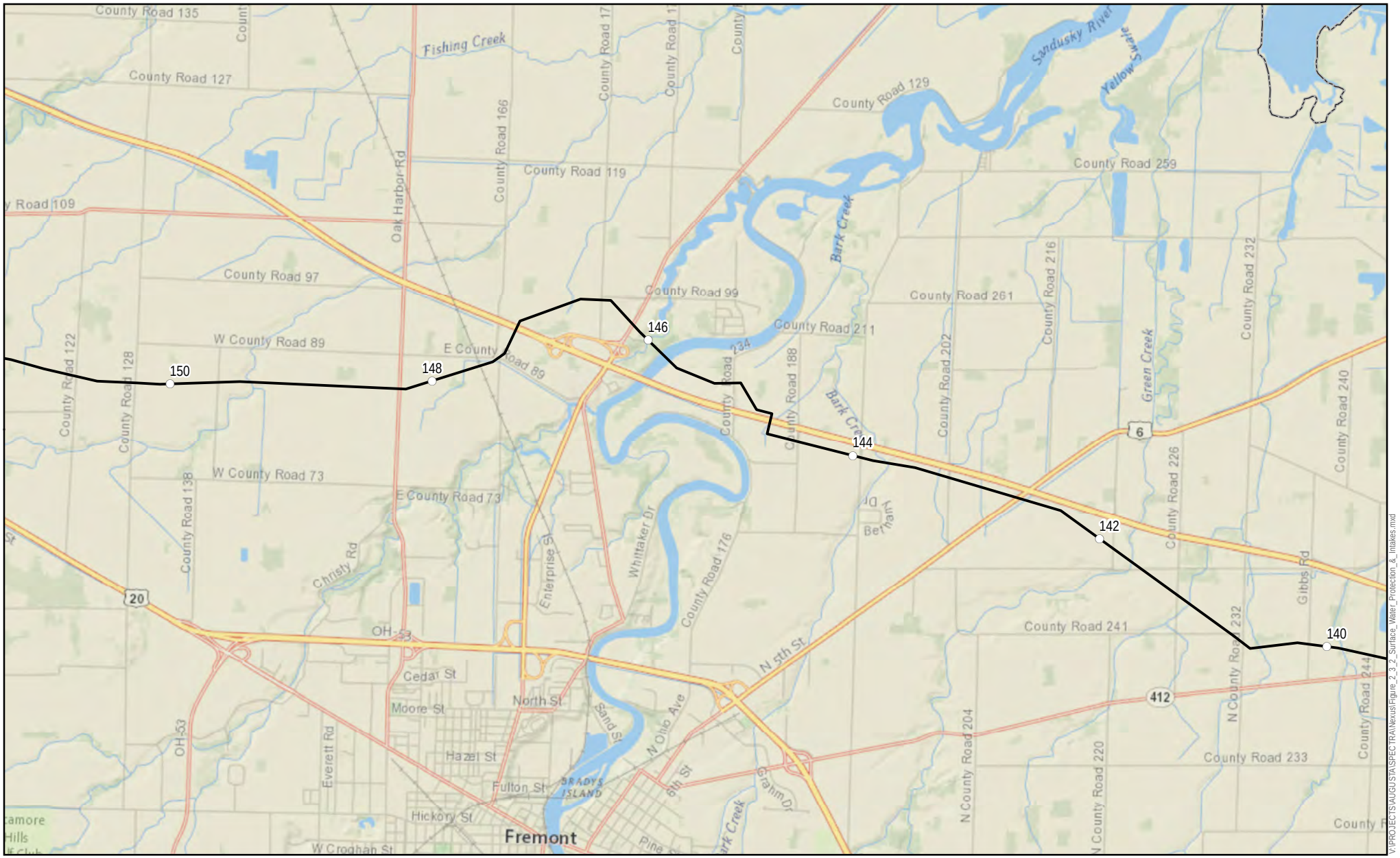
Figure 2.3-2

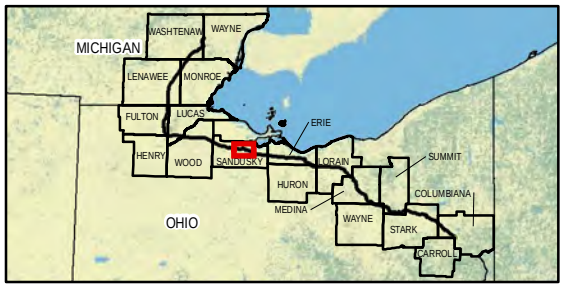
Public Surface Water Supplies
Located Along the NEXUS Project

Erie and Sandusky Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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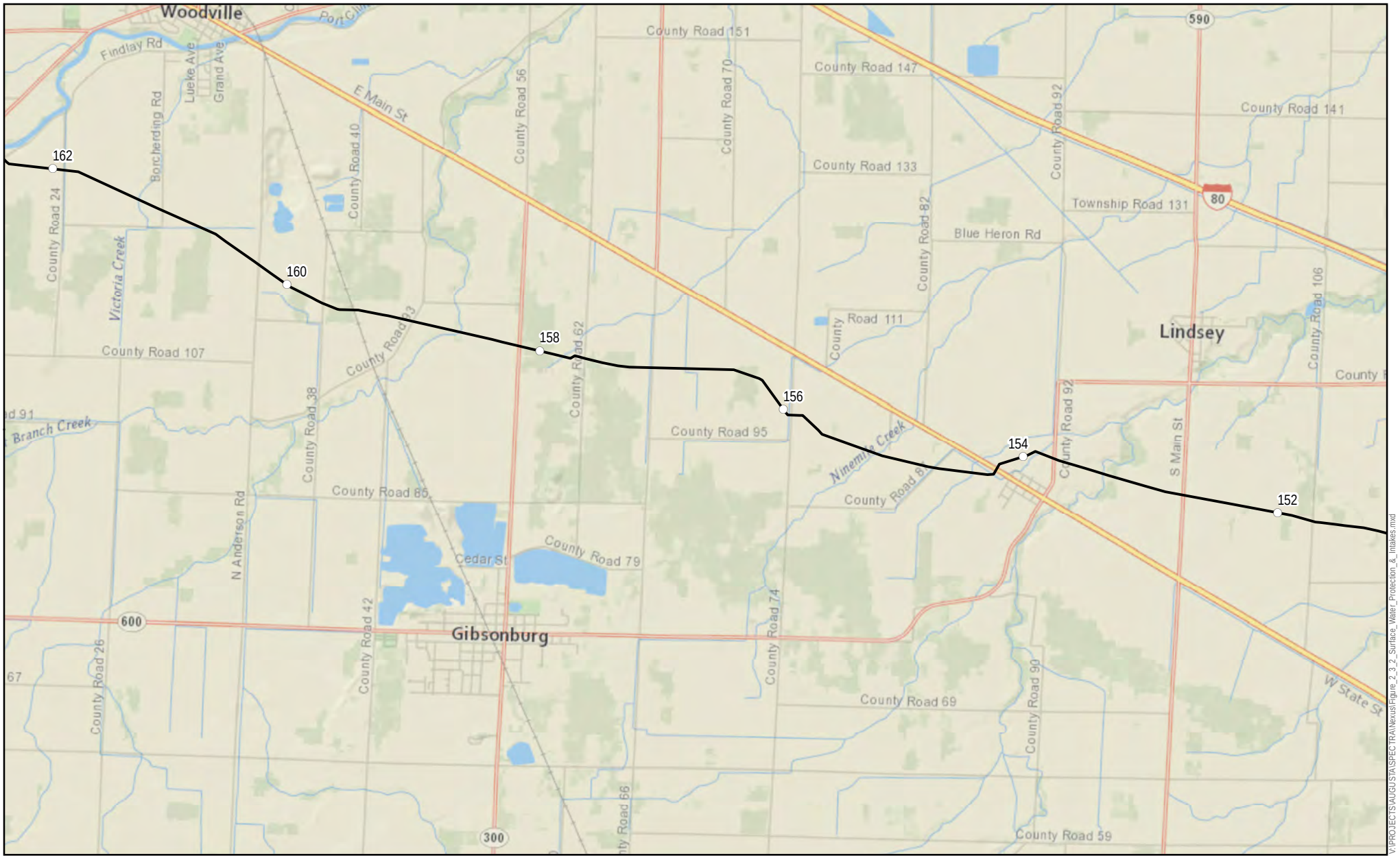
Figure 2.3-2

Public Surface Water Supplies
Located Along the NEXUS Project

Sandusky County, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015



- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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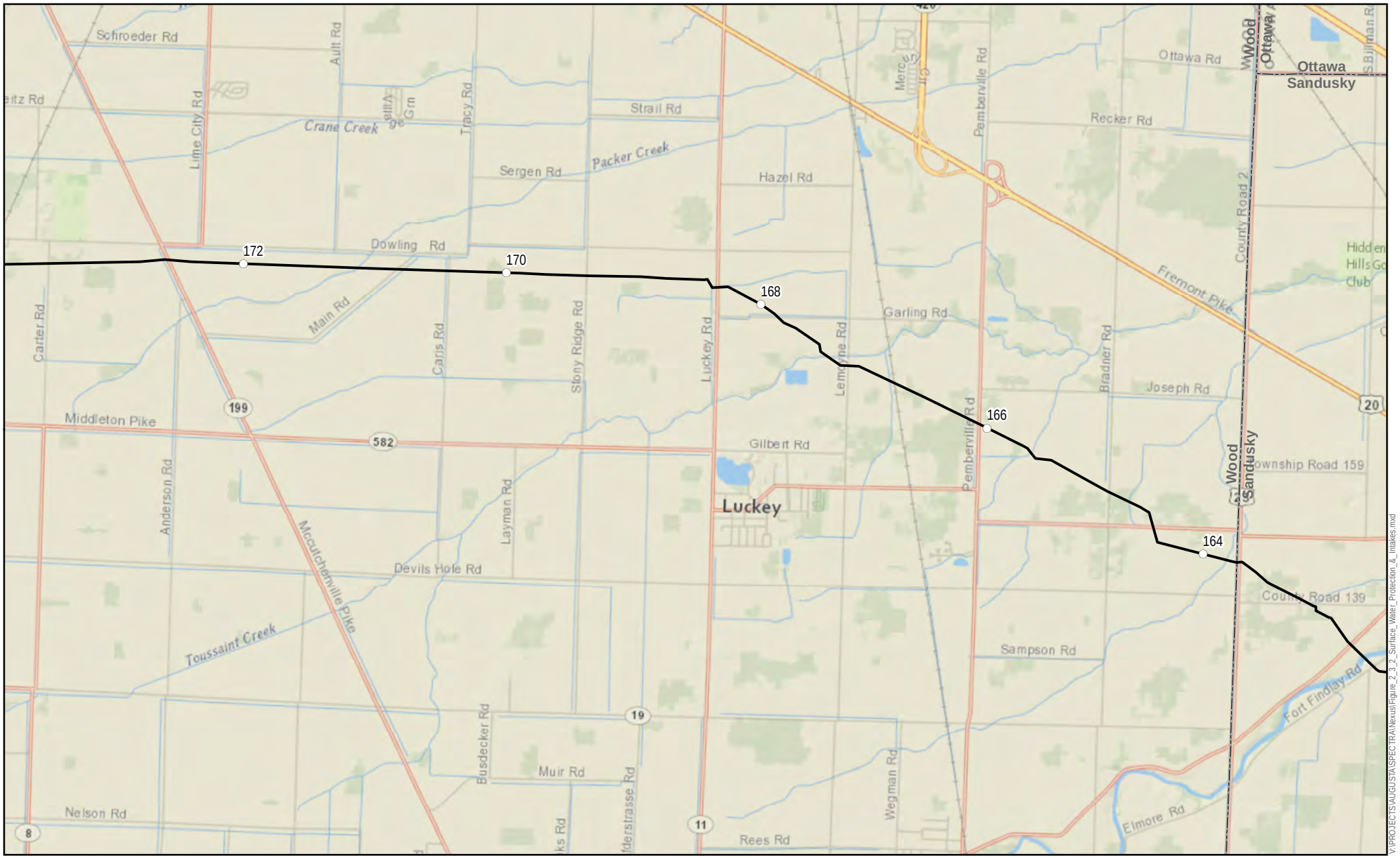
Figure 2.3-2

Public Surface Water Supplies
Located Along the NEXUS Project

Sandusky County, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015



- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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Figure 2.3-2

Public Surface Water Supplies
Located Along the NEXUS Project

Sandusky and Wood Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015

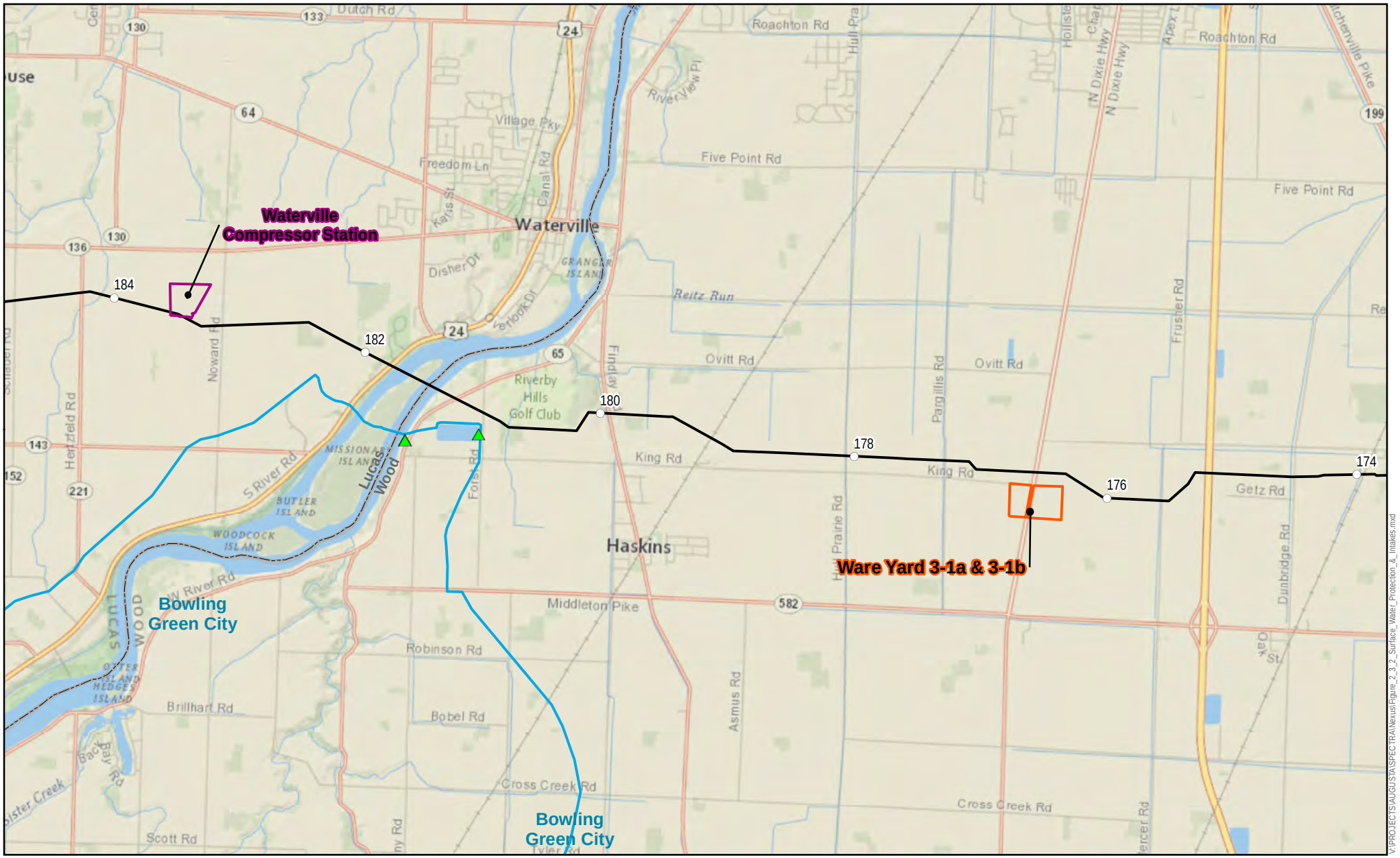


Figure 2.3-2

Public Surface Water Supplies
Located Along the NEXUS Project

Wood and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015

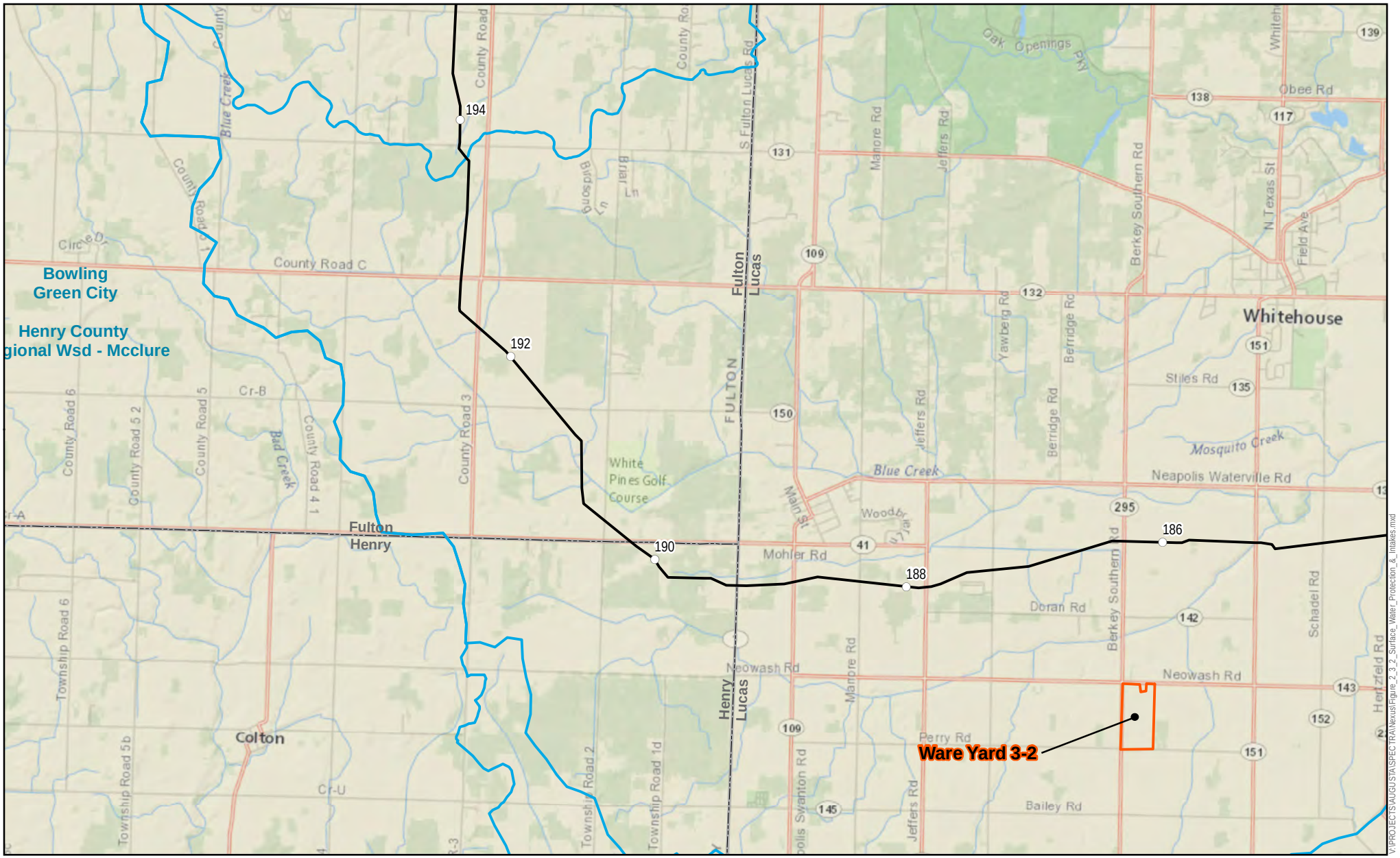


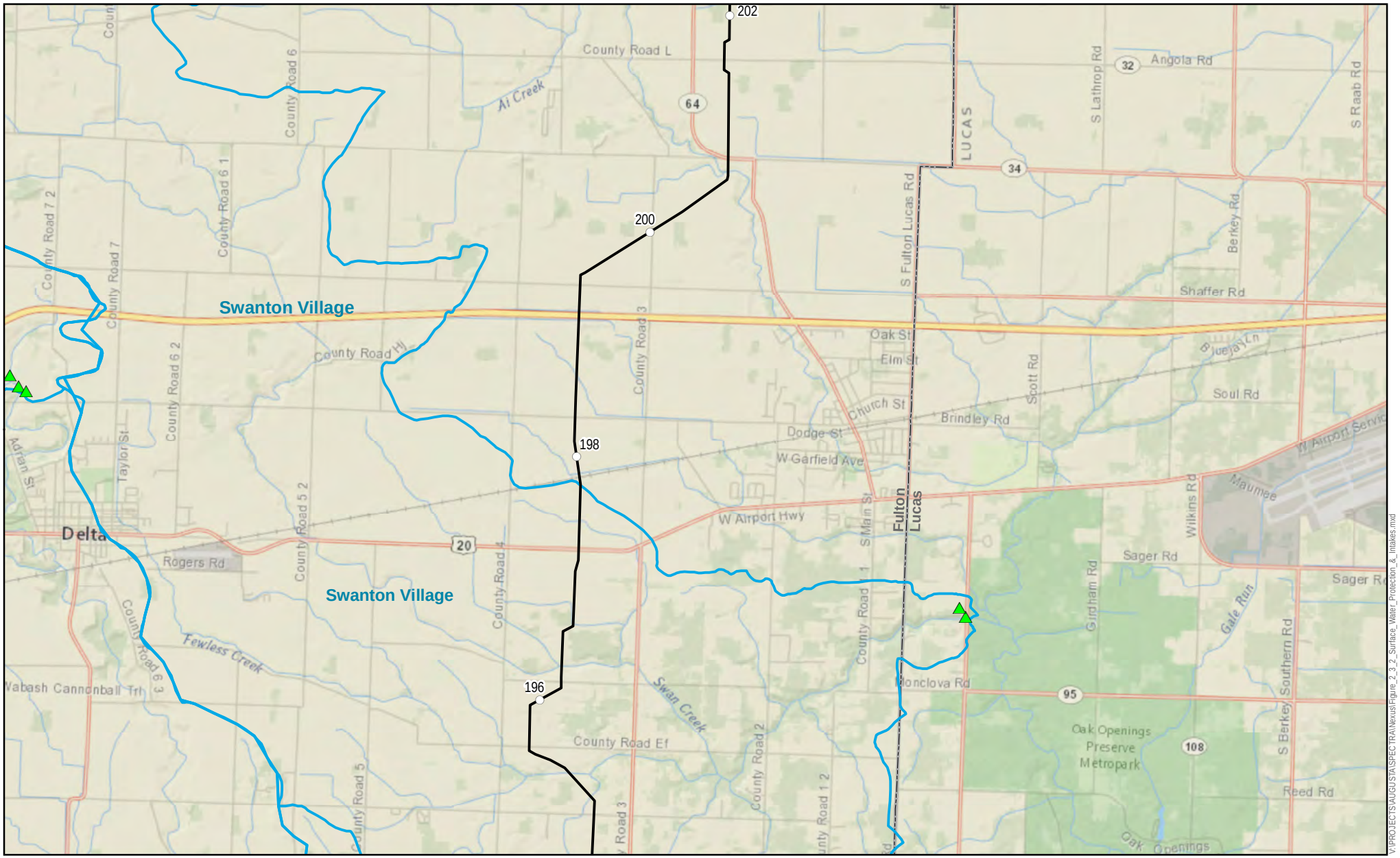
Figure 2.3-2

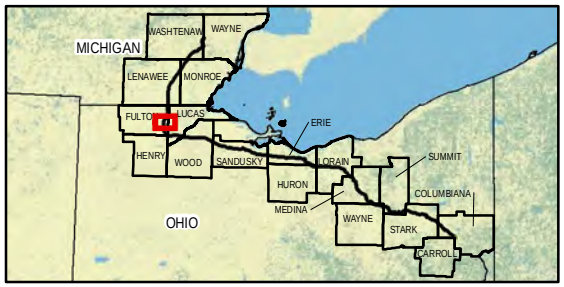
Public Surface Water Supplies
Located Along the NEXUS Project

Henry, Fulton and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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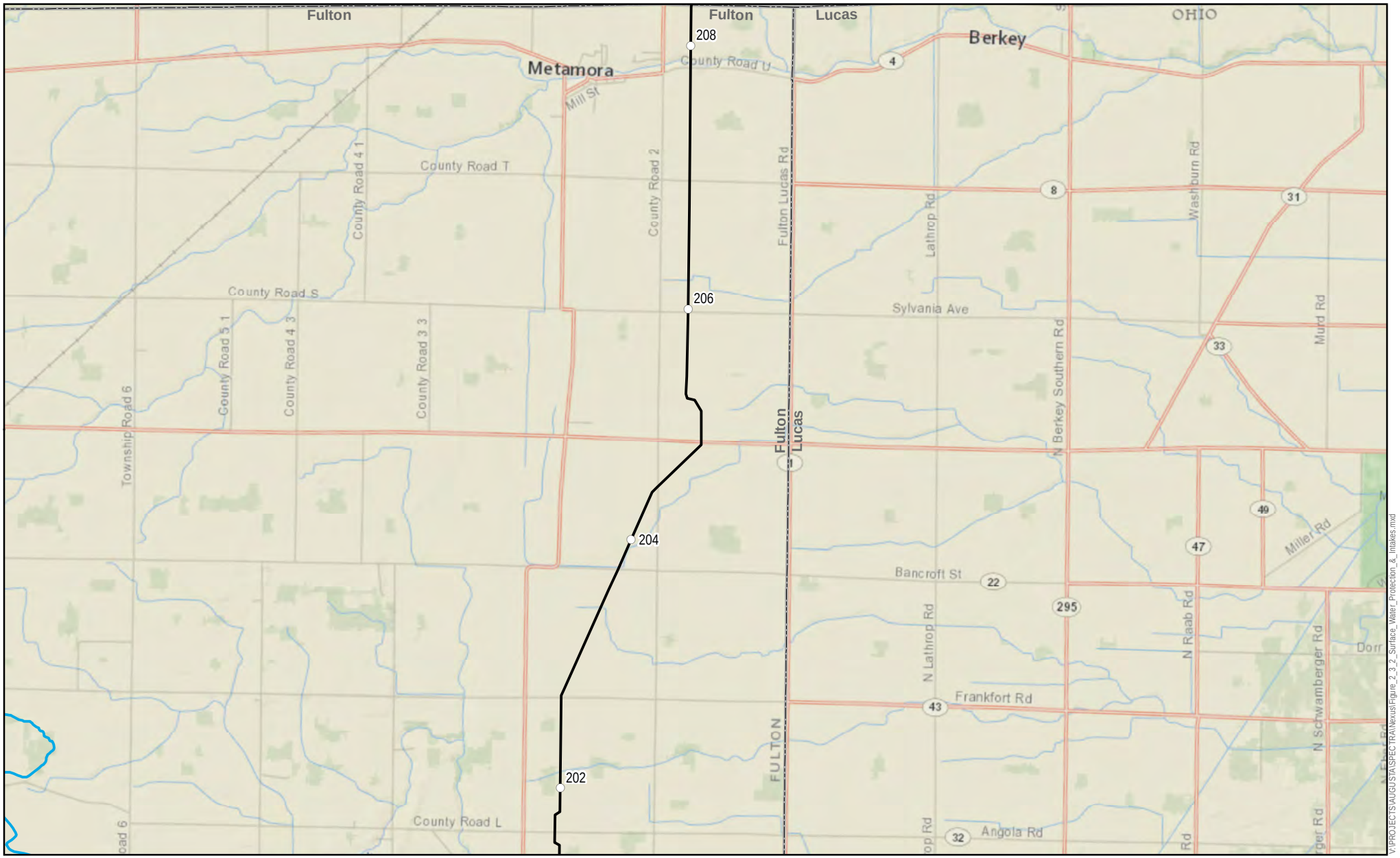
Figure 2.3-2

Public Surface Water Supplies
Located Along the NEXUS Project

Fulton and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015



- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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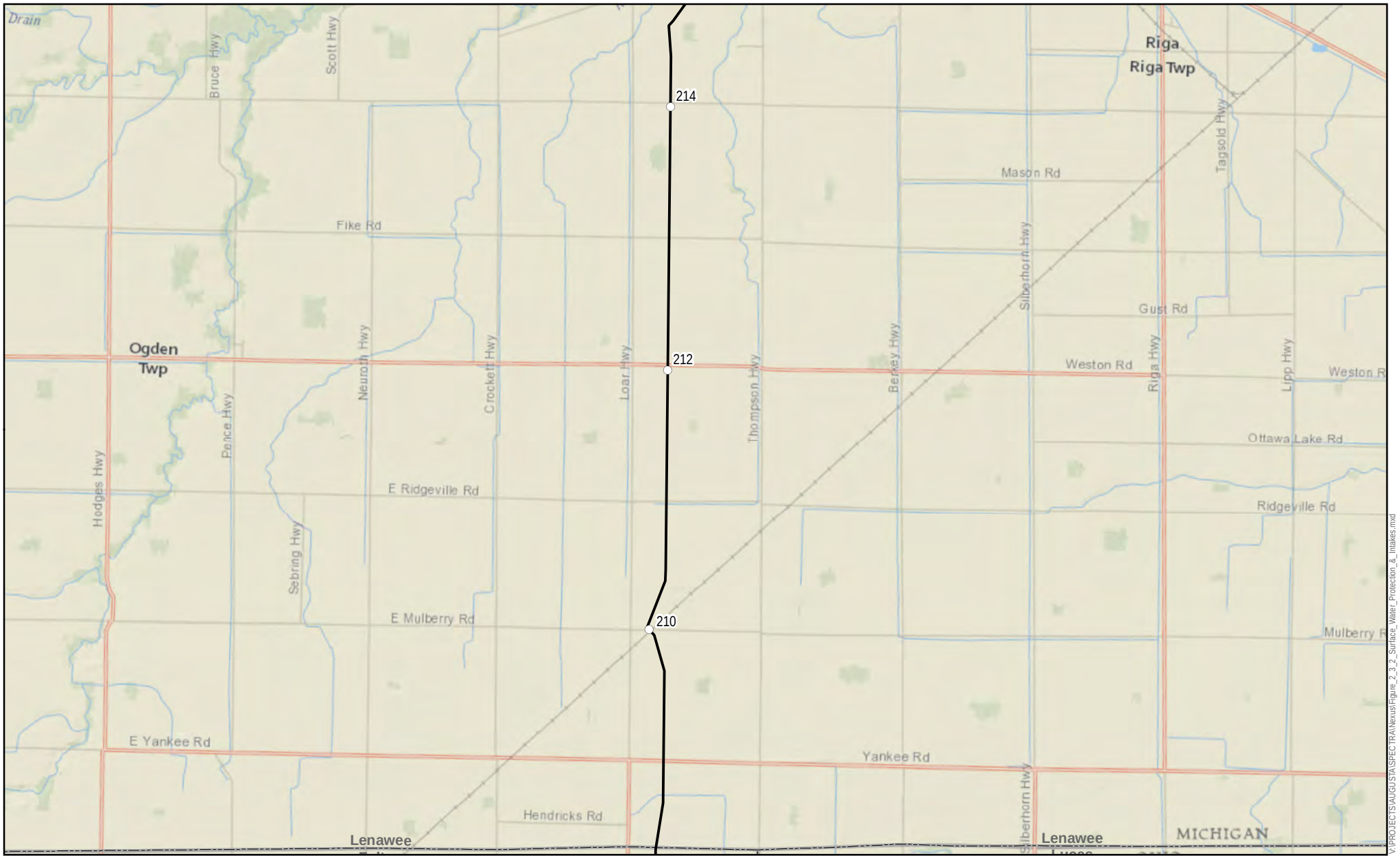
Figure 2.3-2

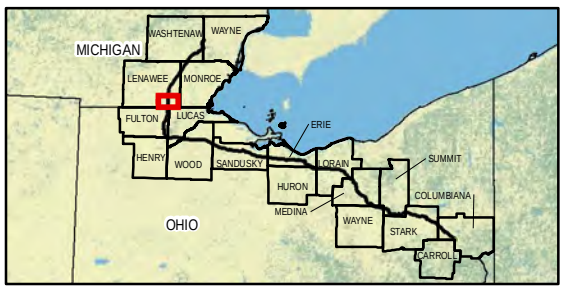
Public Surface Water Supplies
Located Along the NEXUS Project

Fulton and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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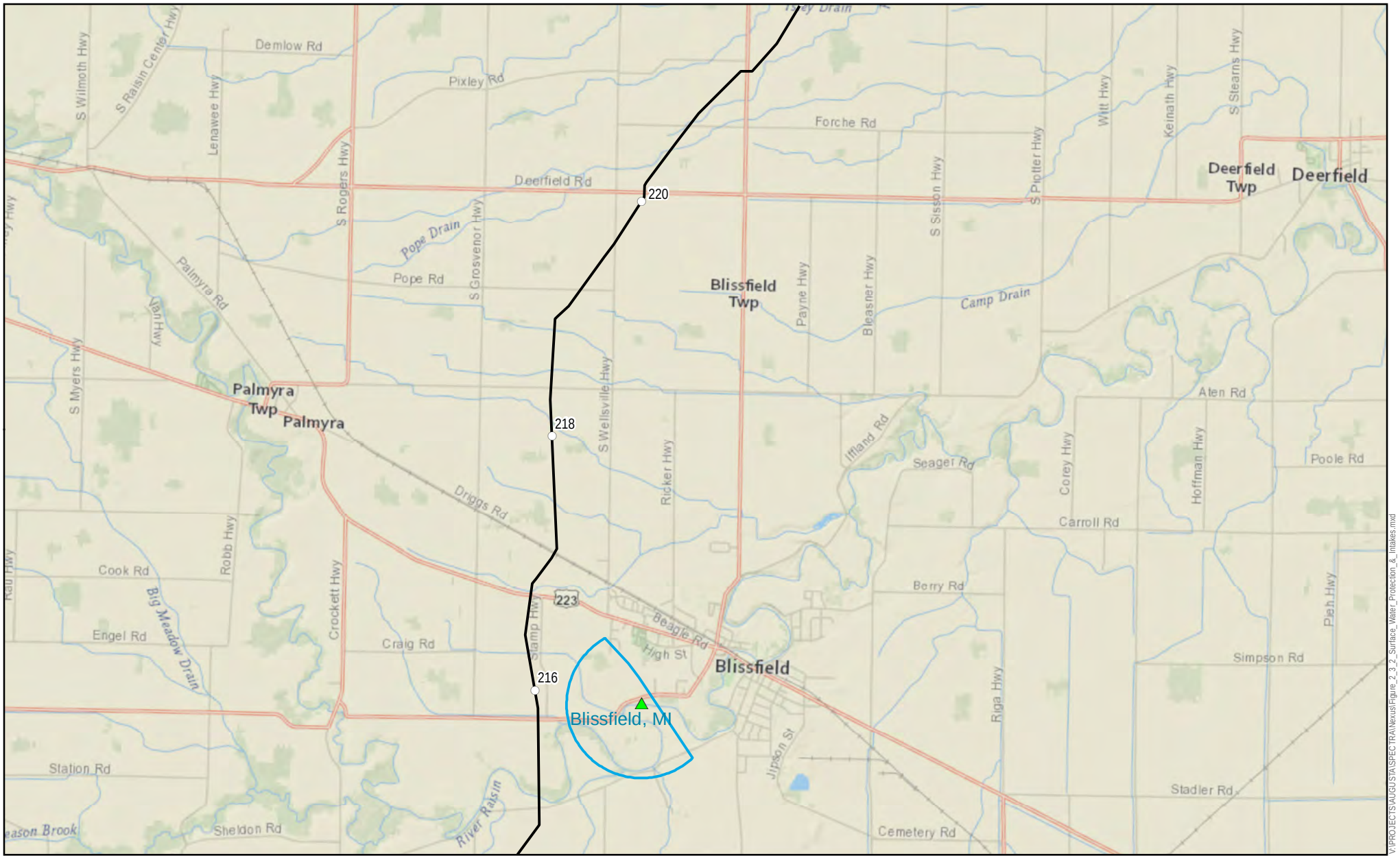
Figure 2.3-2

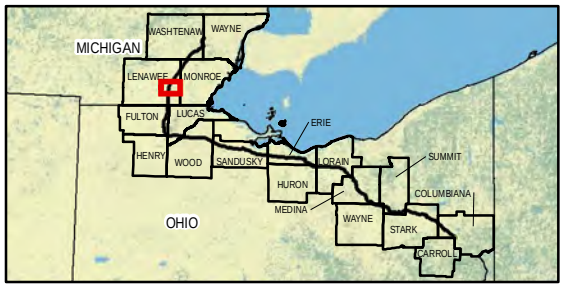
Public Surface Water Supplies
Located Along the NEXUS Project

Lenawee County, MI

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

0 1 2
Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

Figure 2.3-2

Public Surface Water Supplies
Located Along the NEXUS Project

Lenawee County, MI

NEXUS GAS TRANSMISSION

Created: 11/11/2015

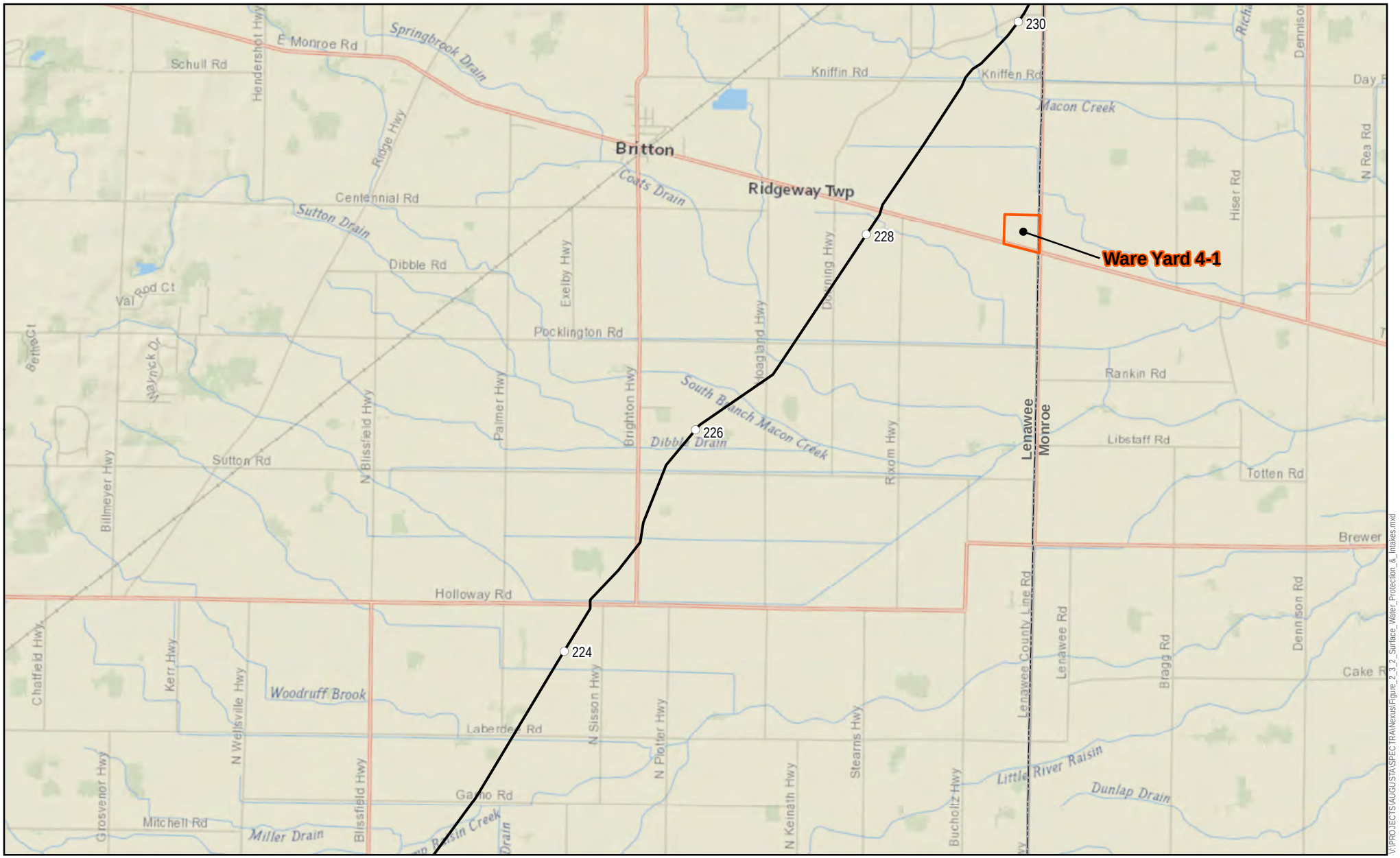


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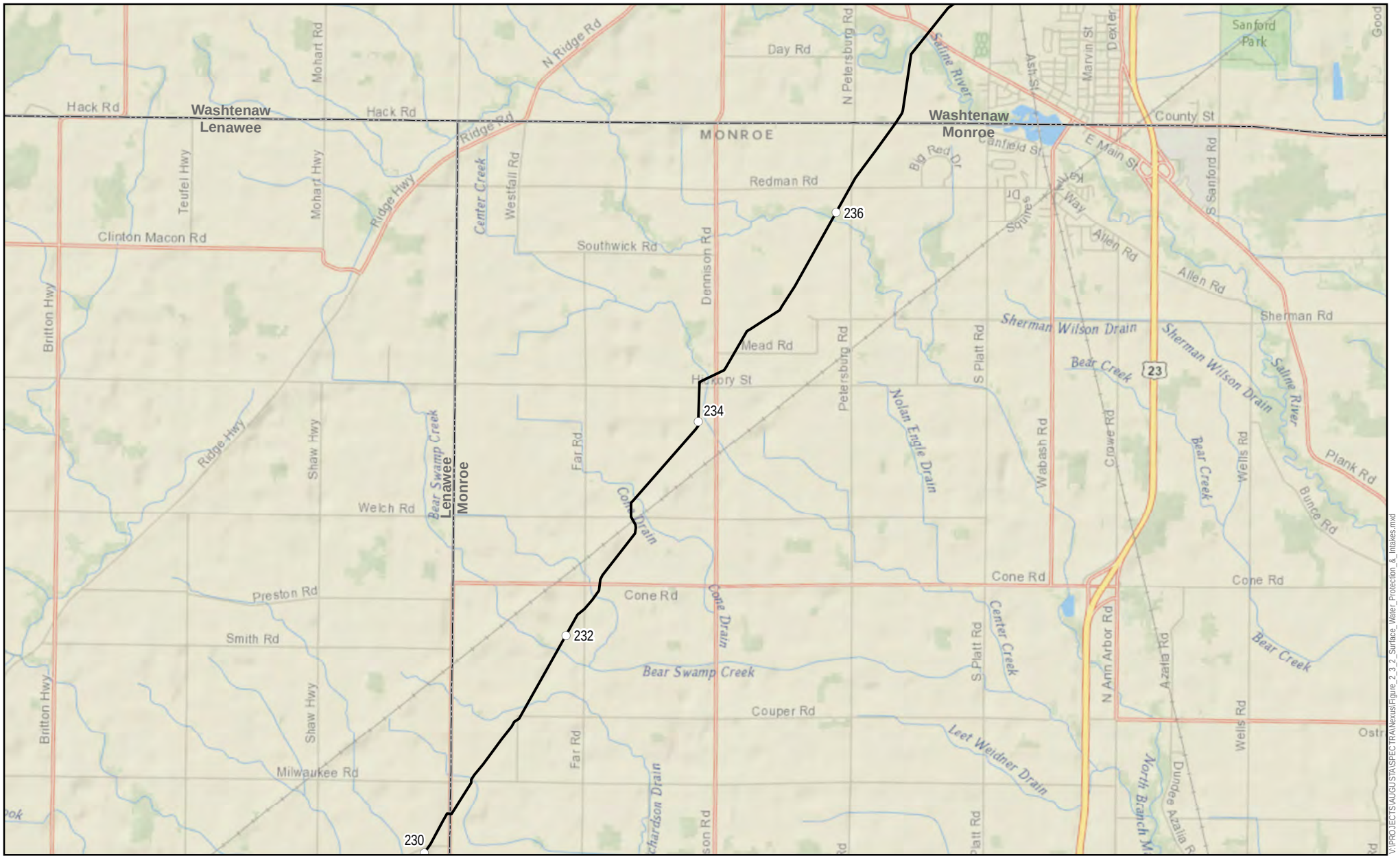
Figure 2.3-2

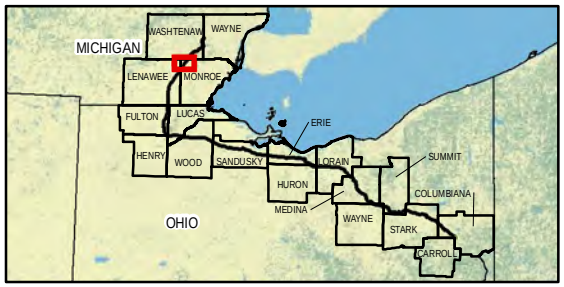
Public Surface Water Supplies
Located Along the NEXUS Project

Lenawee and Monroe Counties, MI

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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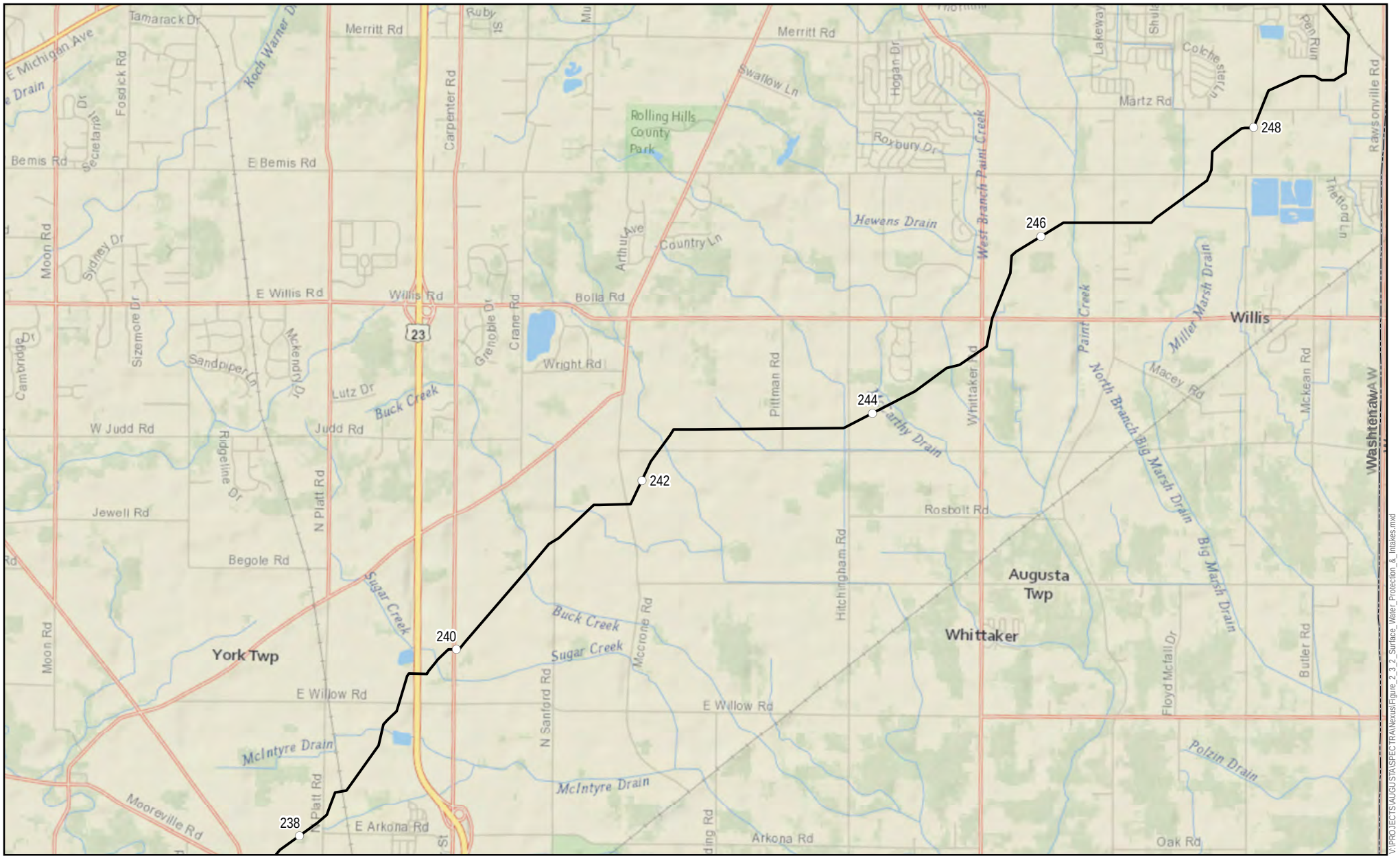
Figure 2.3-2

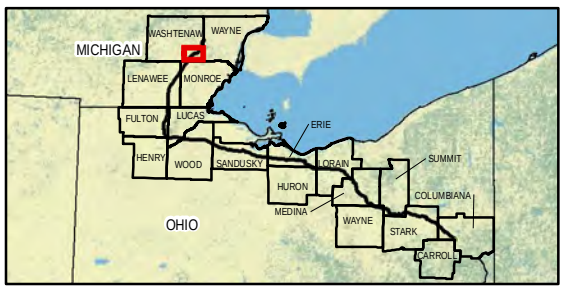
Public Surface Water Supplies
Located Along the NEXUS Project

Lenawee, Monroe and Washtenaw Counties, MI

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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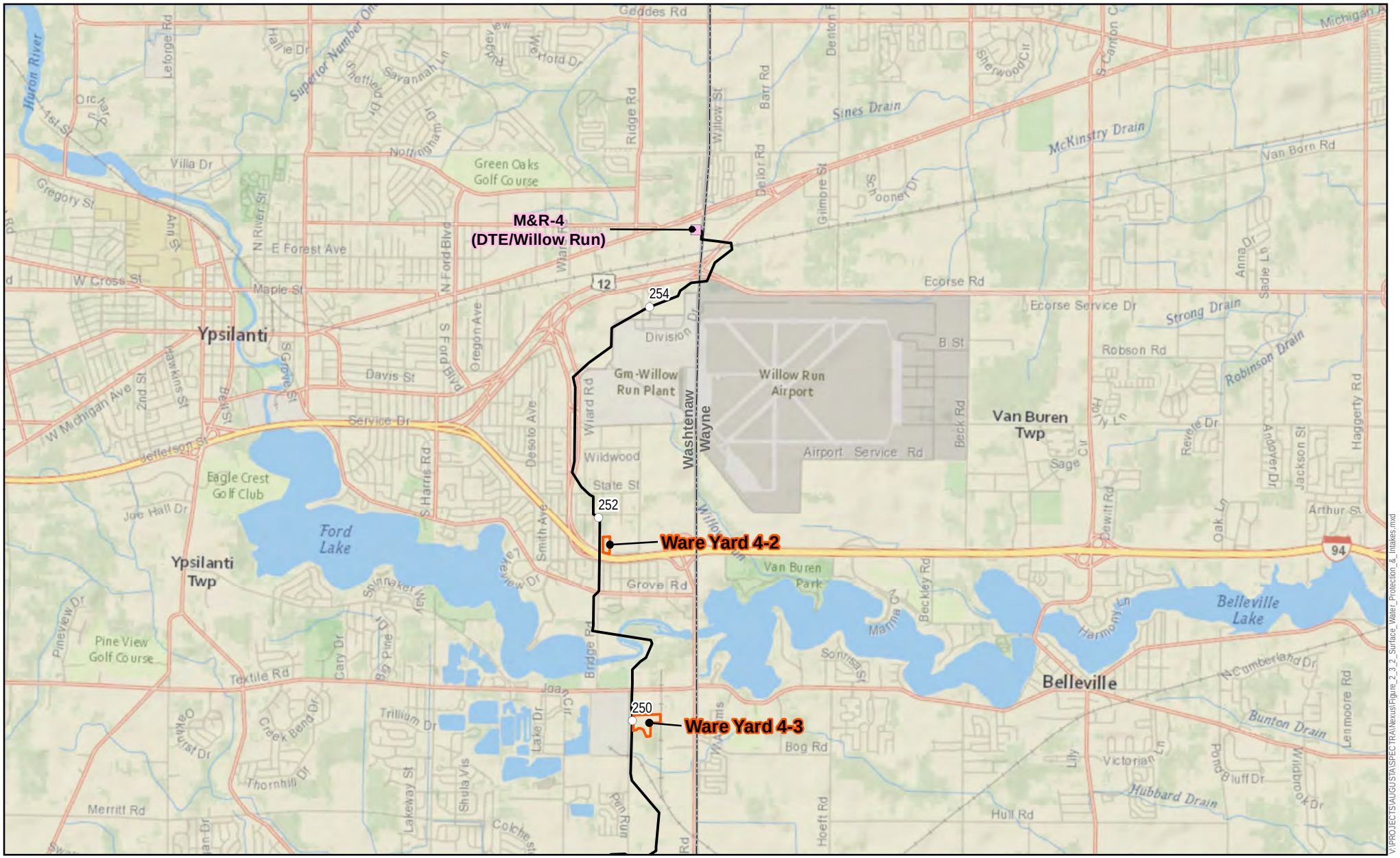
Figure 2.3-2

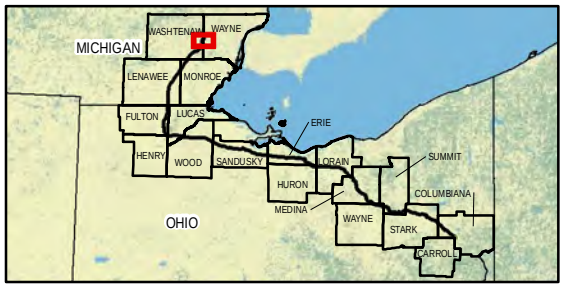
Public Surface Water Supplies
Located Along the NEXUS Project

Washtenaw County, MI

NEXUS GAS TRANSMISSION

Created: 11/11/2015





- Milepost (2 miles)
- Intake Locations
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- Surface Water Protection Areas

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, and TRC

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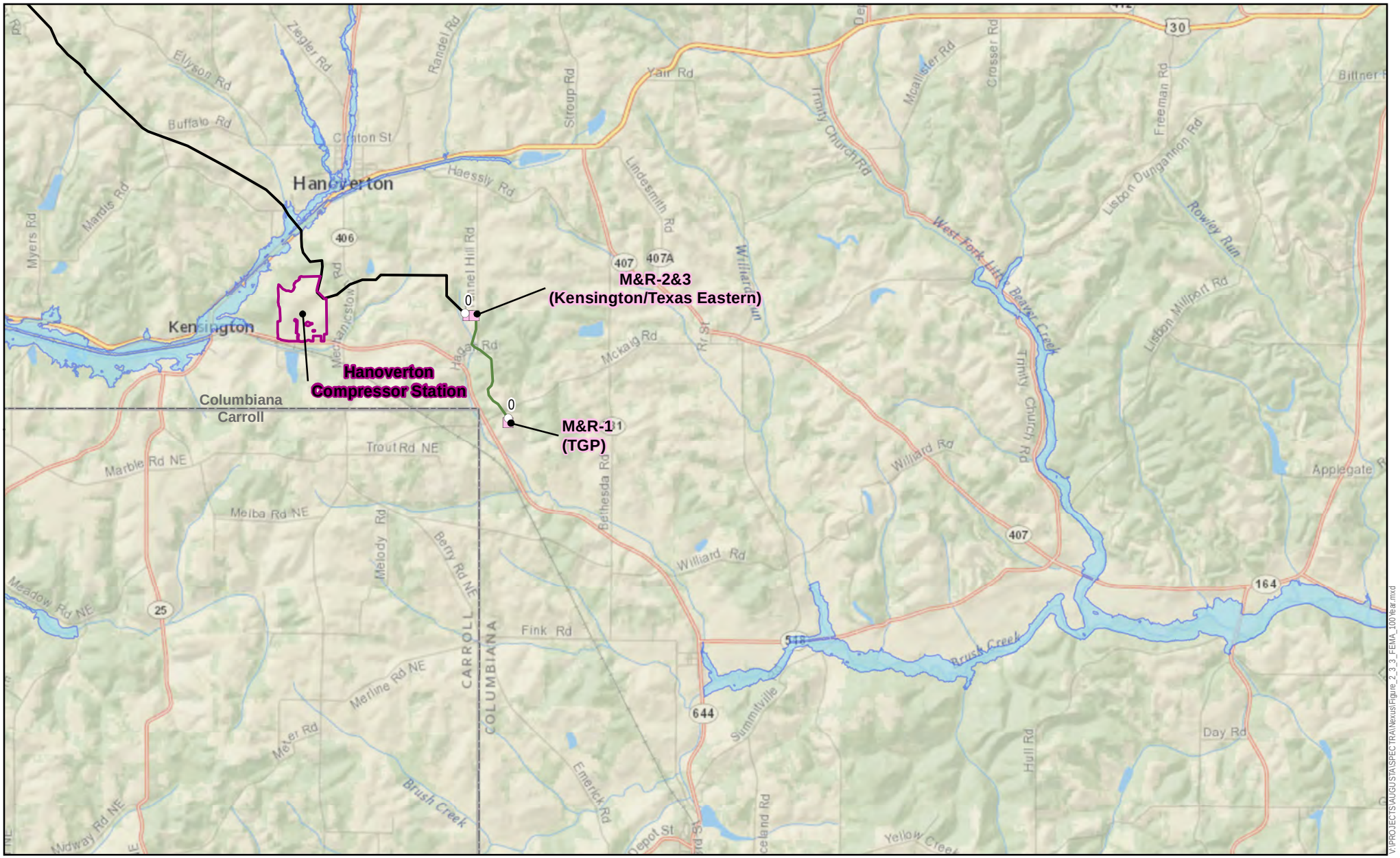
Figure 2.3-2

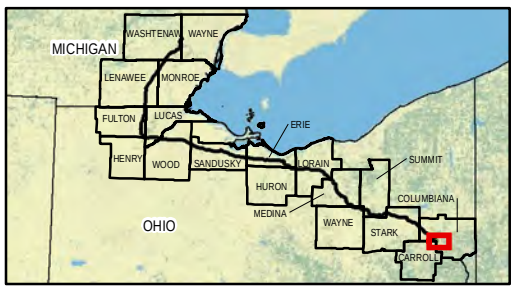
Public Surface Water Supplies
Located Along the NEXUS Project

Washtenaw and Wayne Counties, MI

NEXUS GAS TRANSMISSION

Created: 11/11/2015





Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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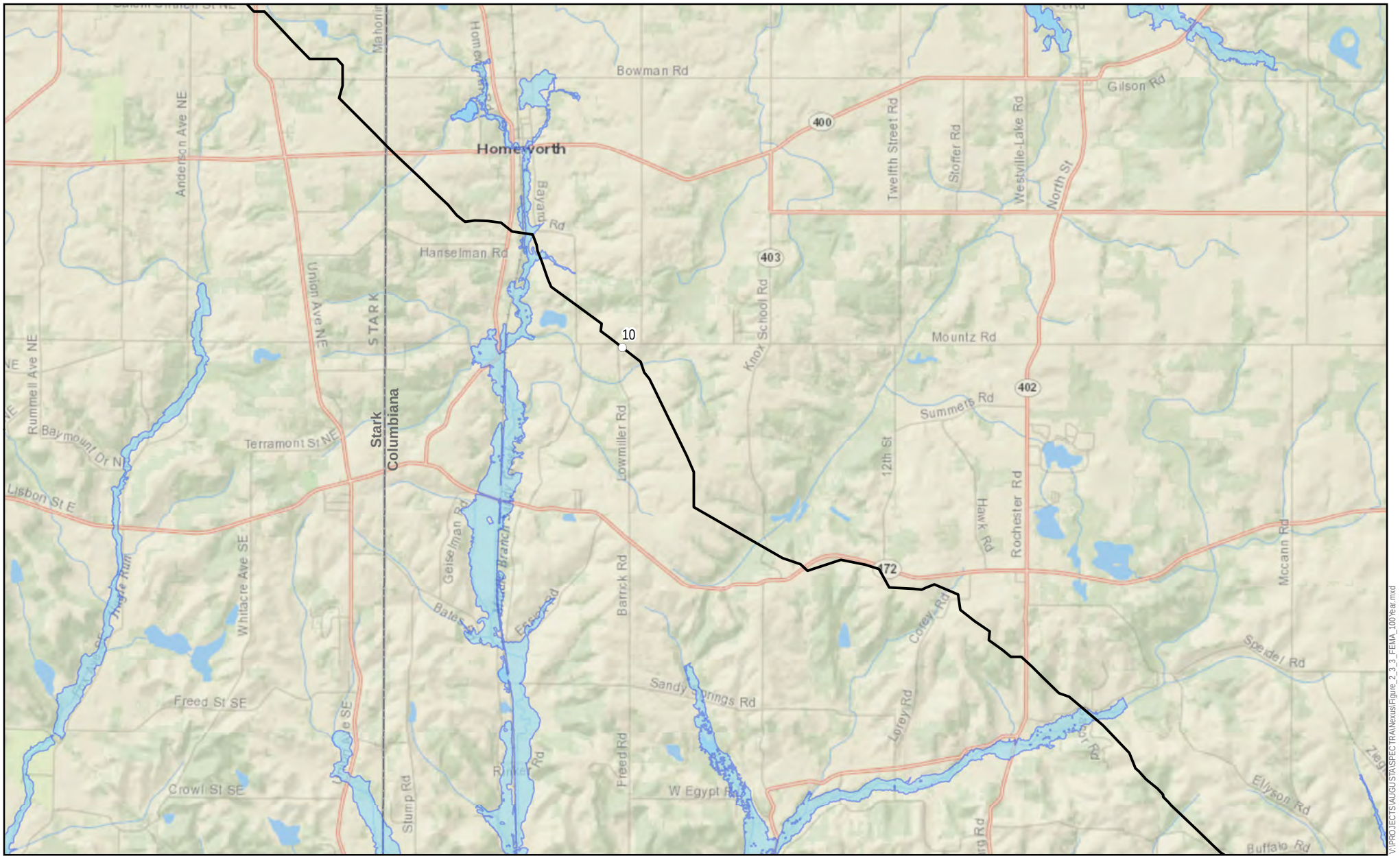
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Columbiana and Carroll Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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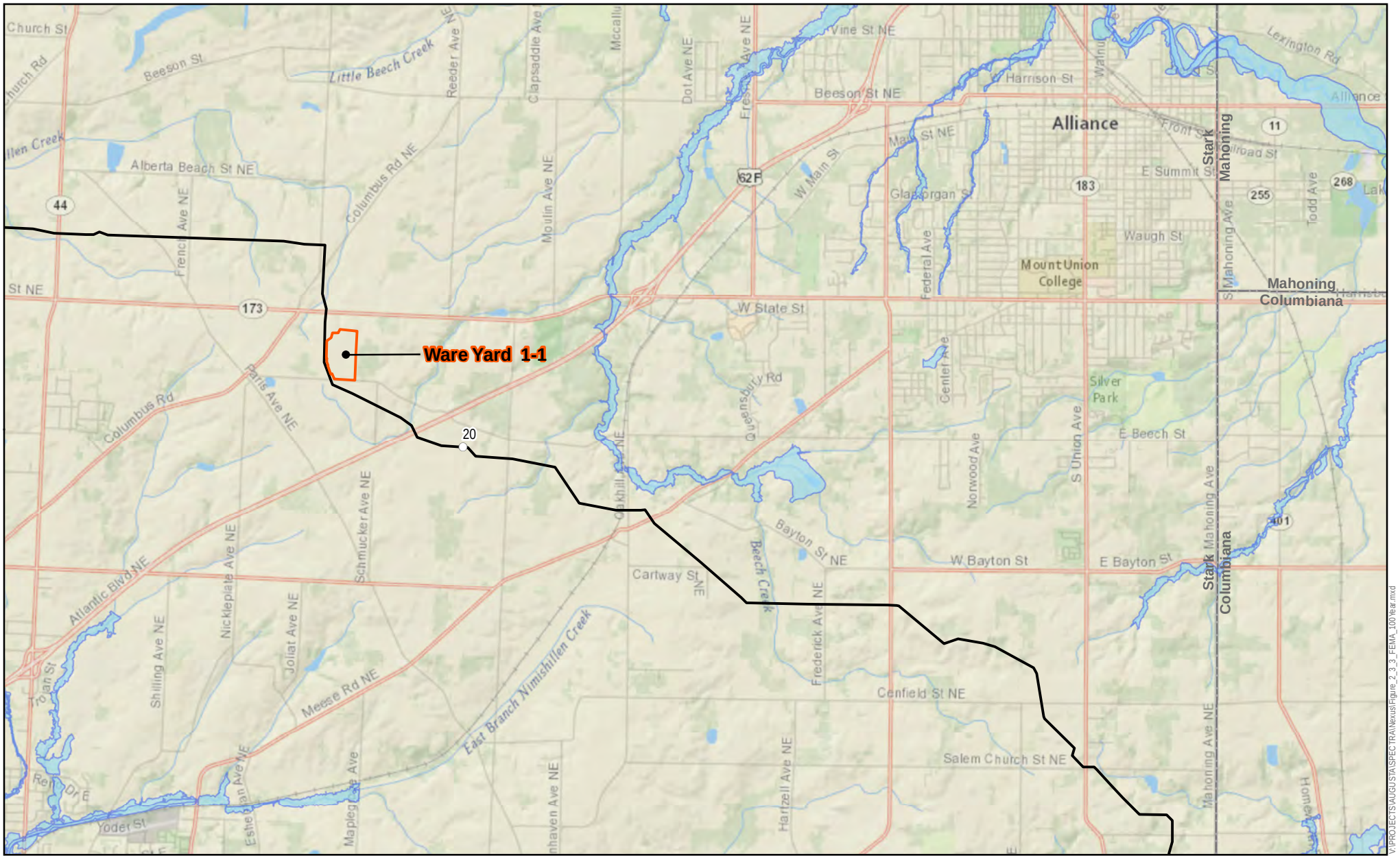
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Columbiana and Stark Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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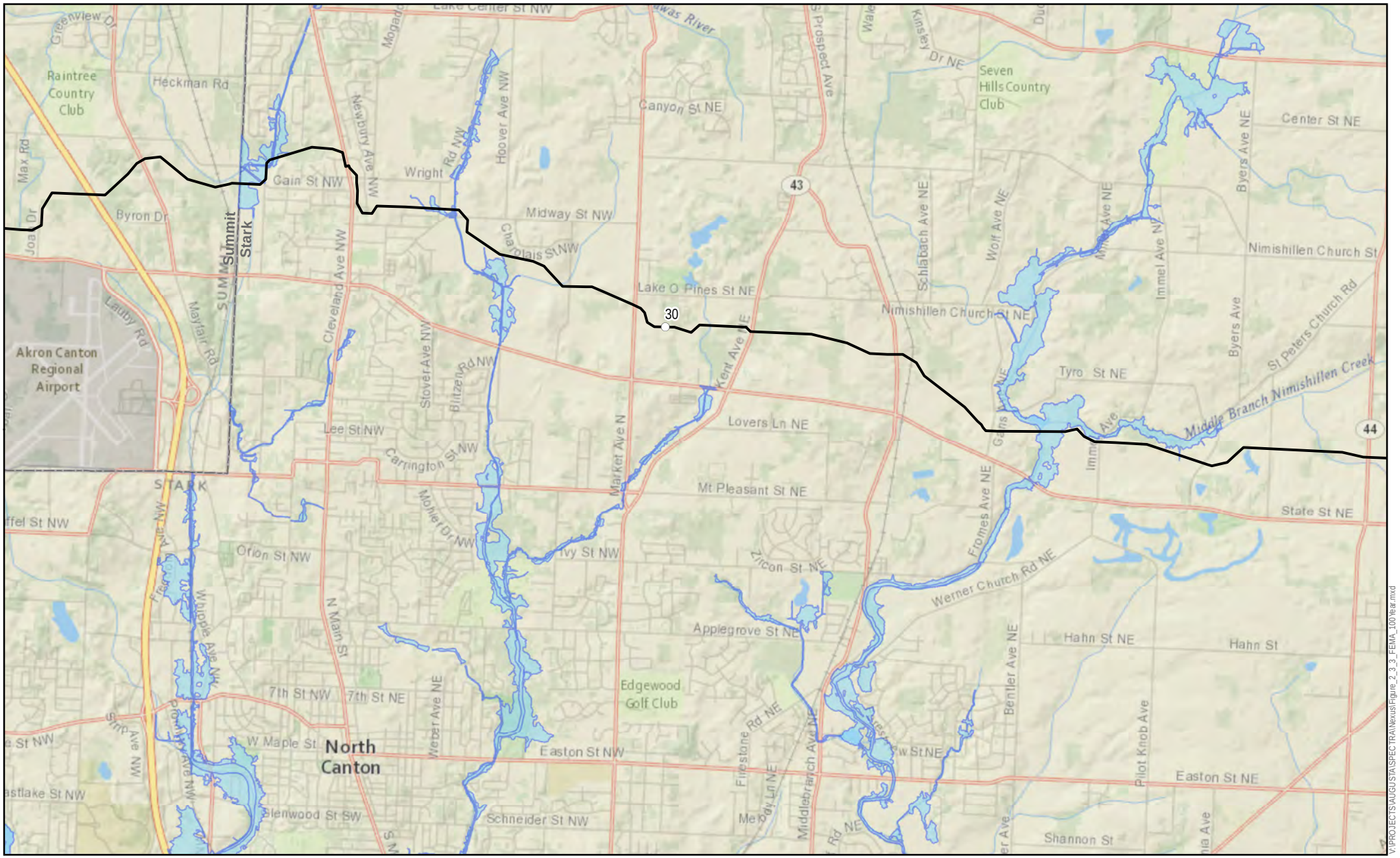
Figure 2.3-3

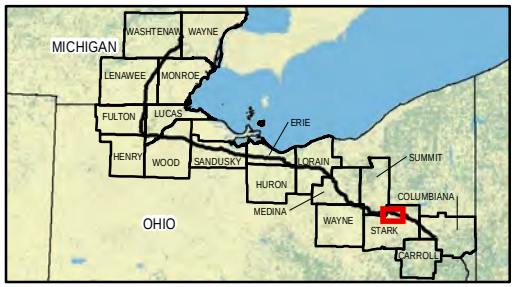
FEMA Flood Zones
Crossed by the NEXUS Project

Stark and Columbiana Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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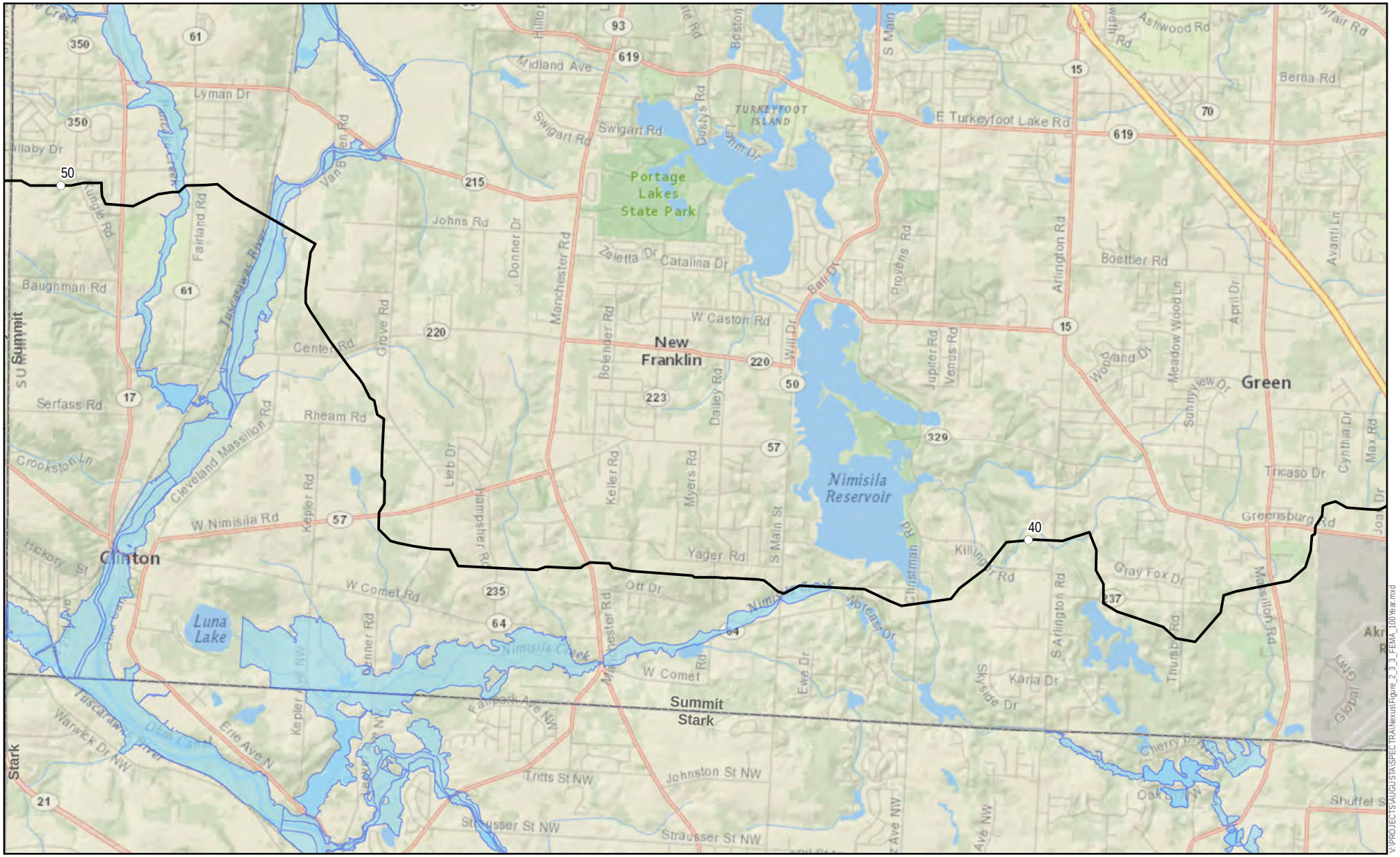
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Stark and Summit Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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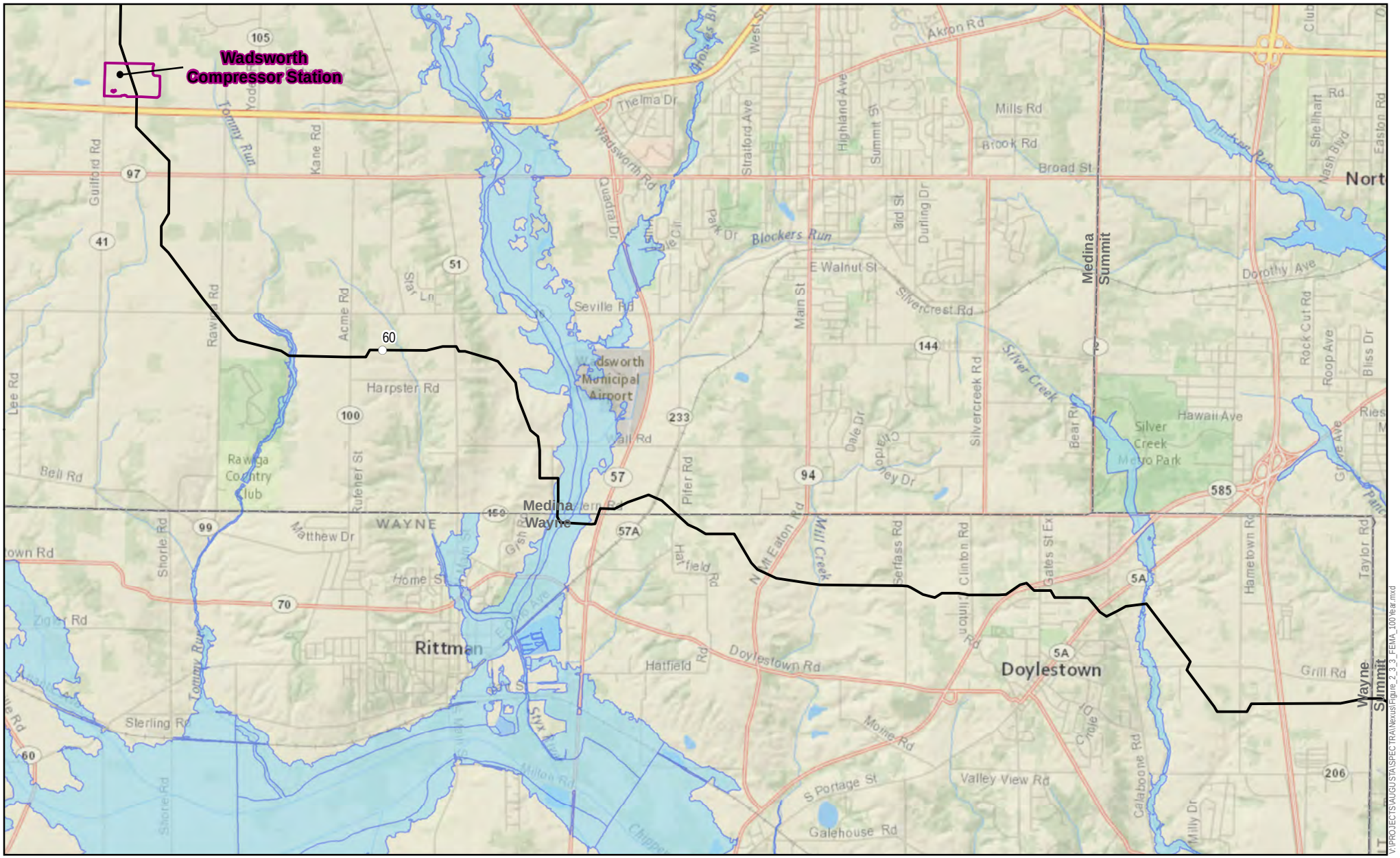
Figure 2.3-3

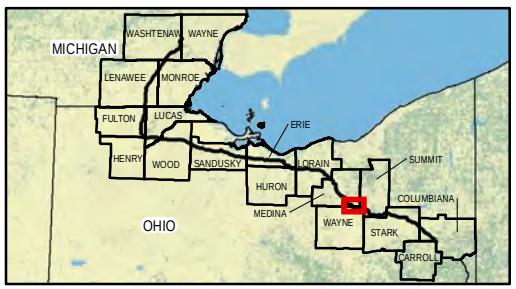
FEMA Flood Zones
Crossed by the NEXUS Project

Summit and Stark Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

N

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

V:\PROJECTS\AUGUSTA\SPECTRA\Nexus\Figure_2_3_3_FEMA_100Year.mxd

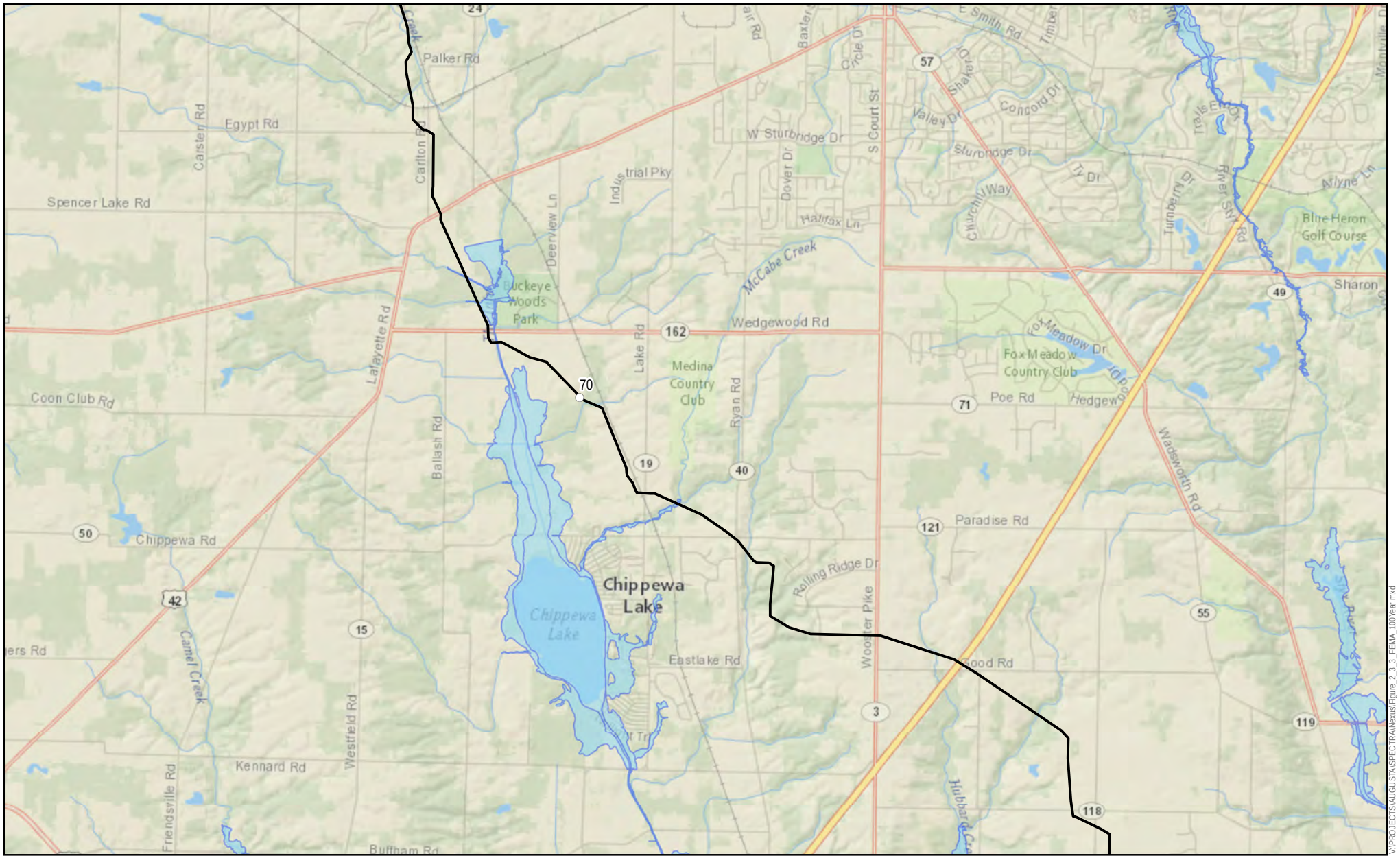
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Wayne, Summit and Medina Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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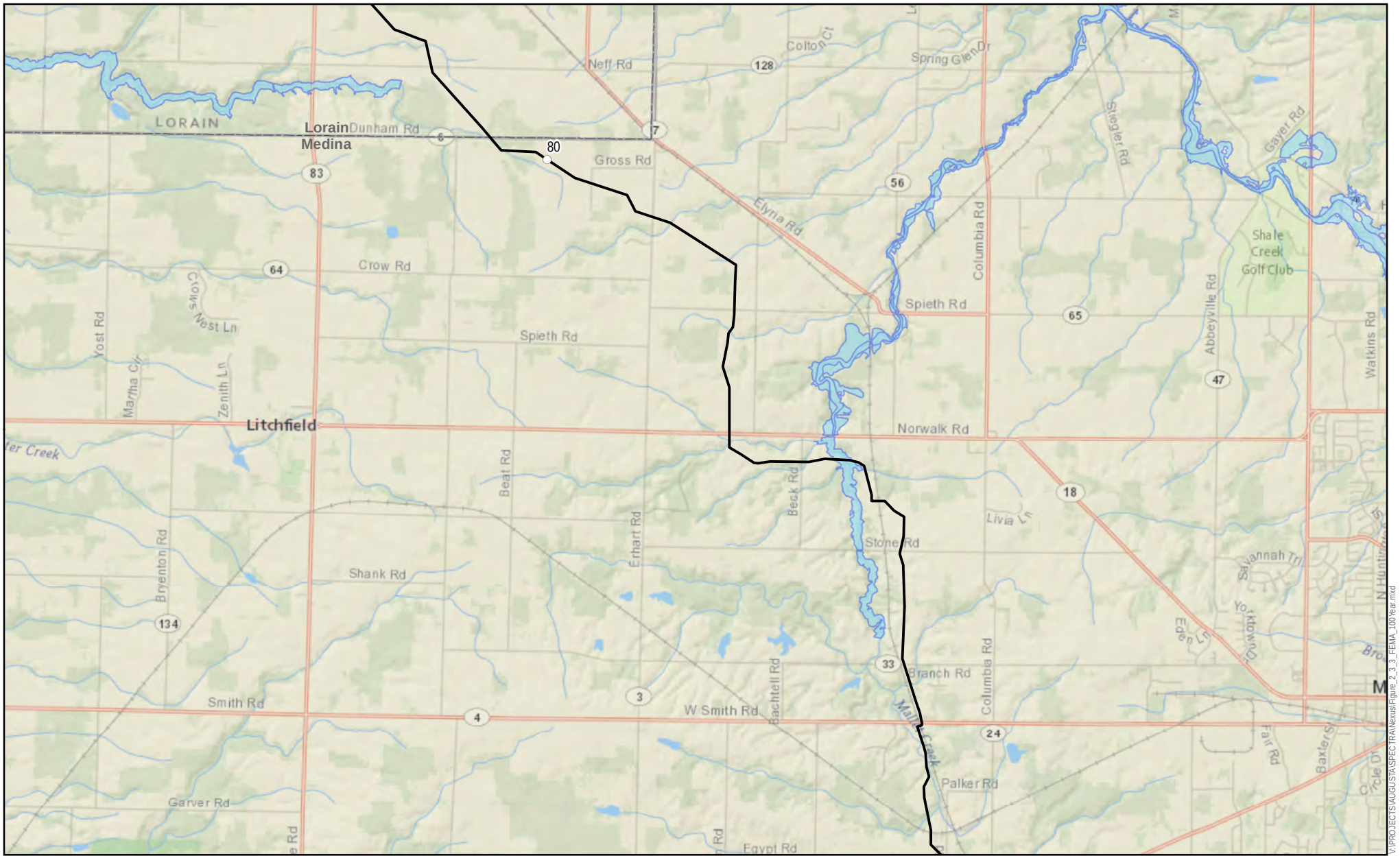
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Medina County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Medina and Lorain Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015

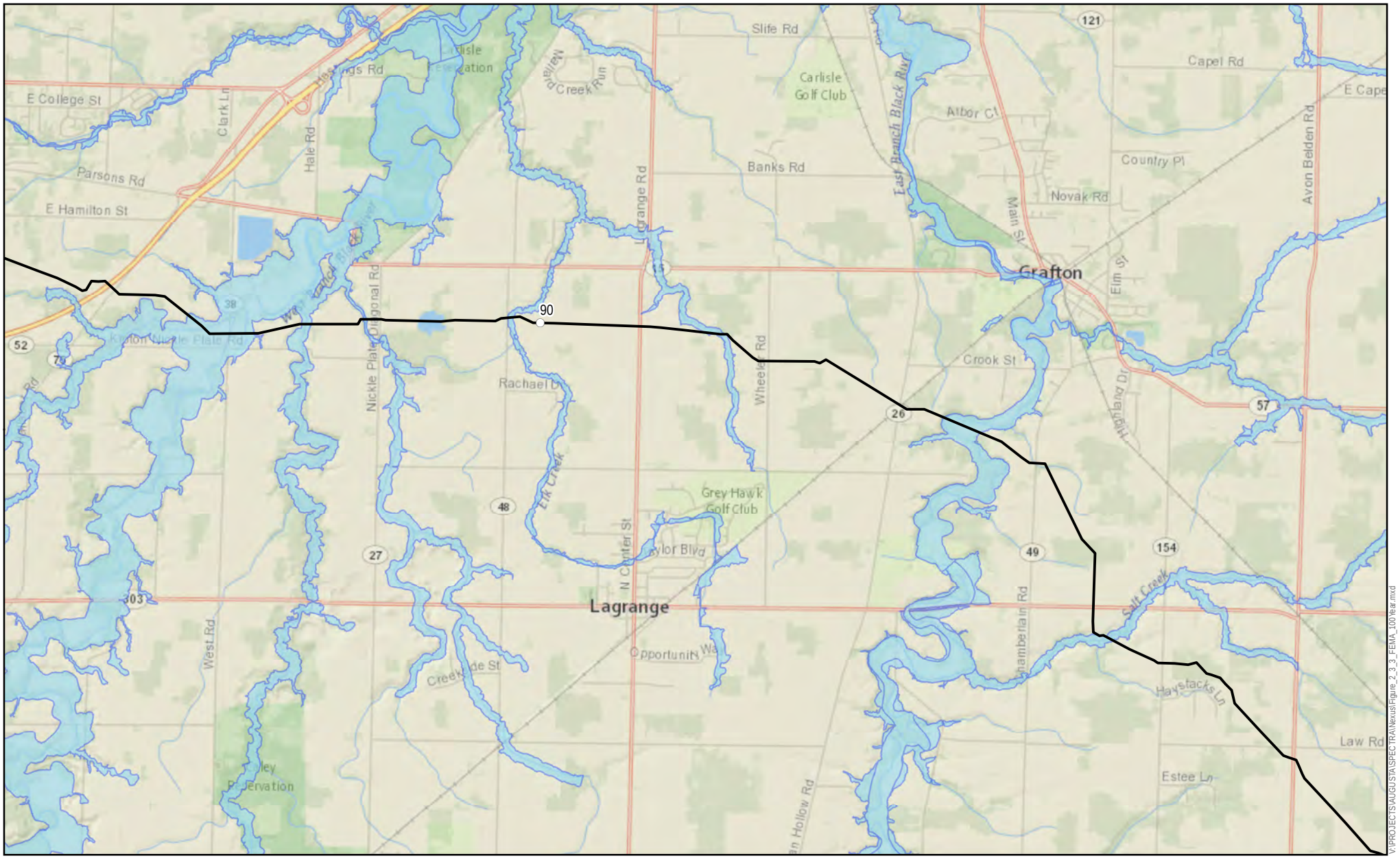


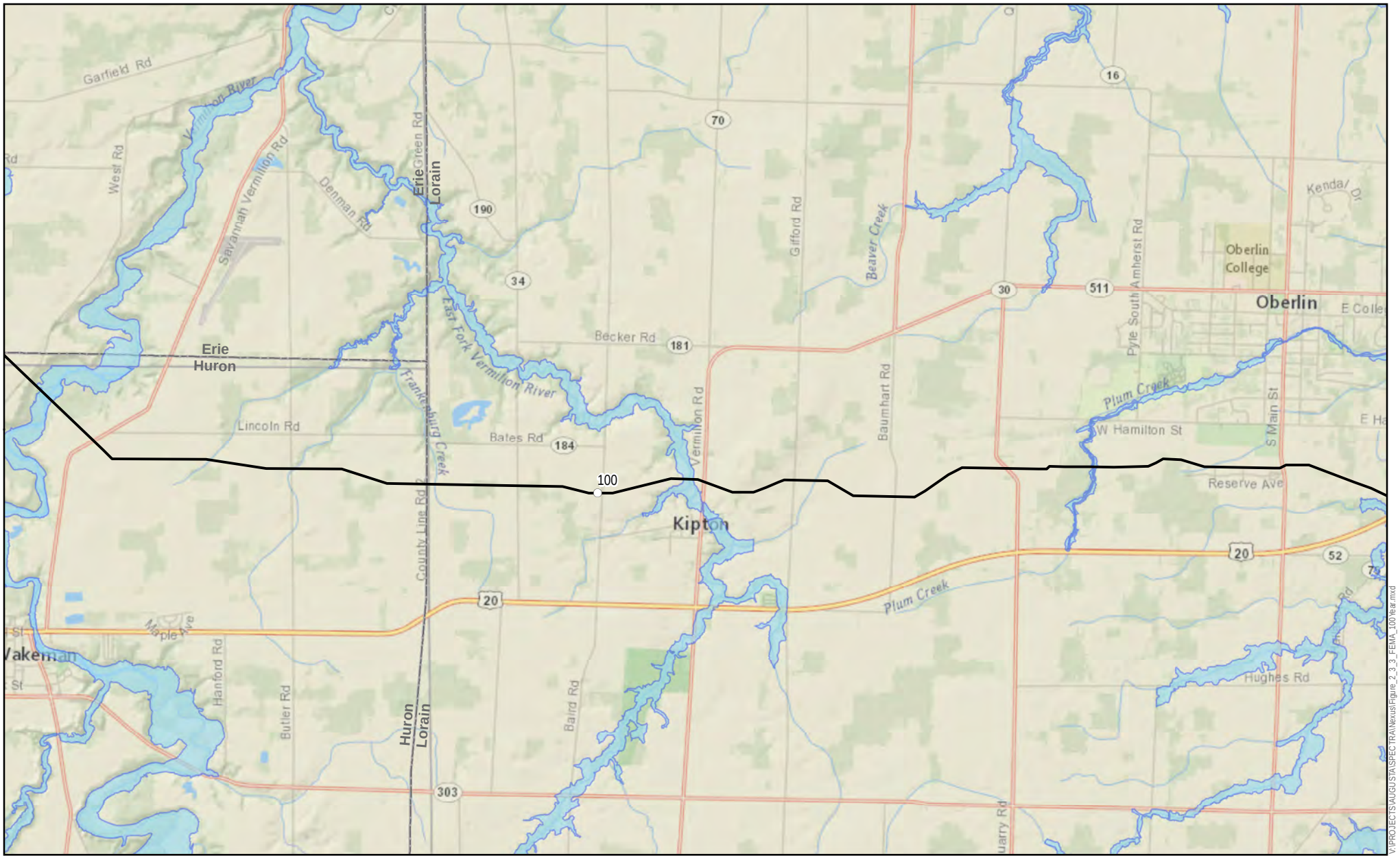
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Lorain County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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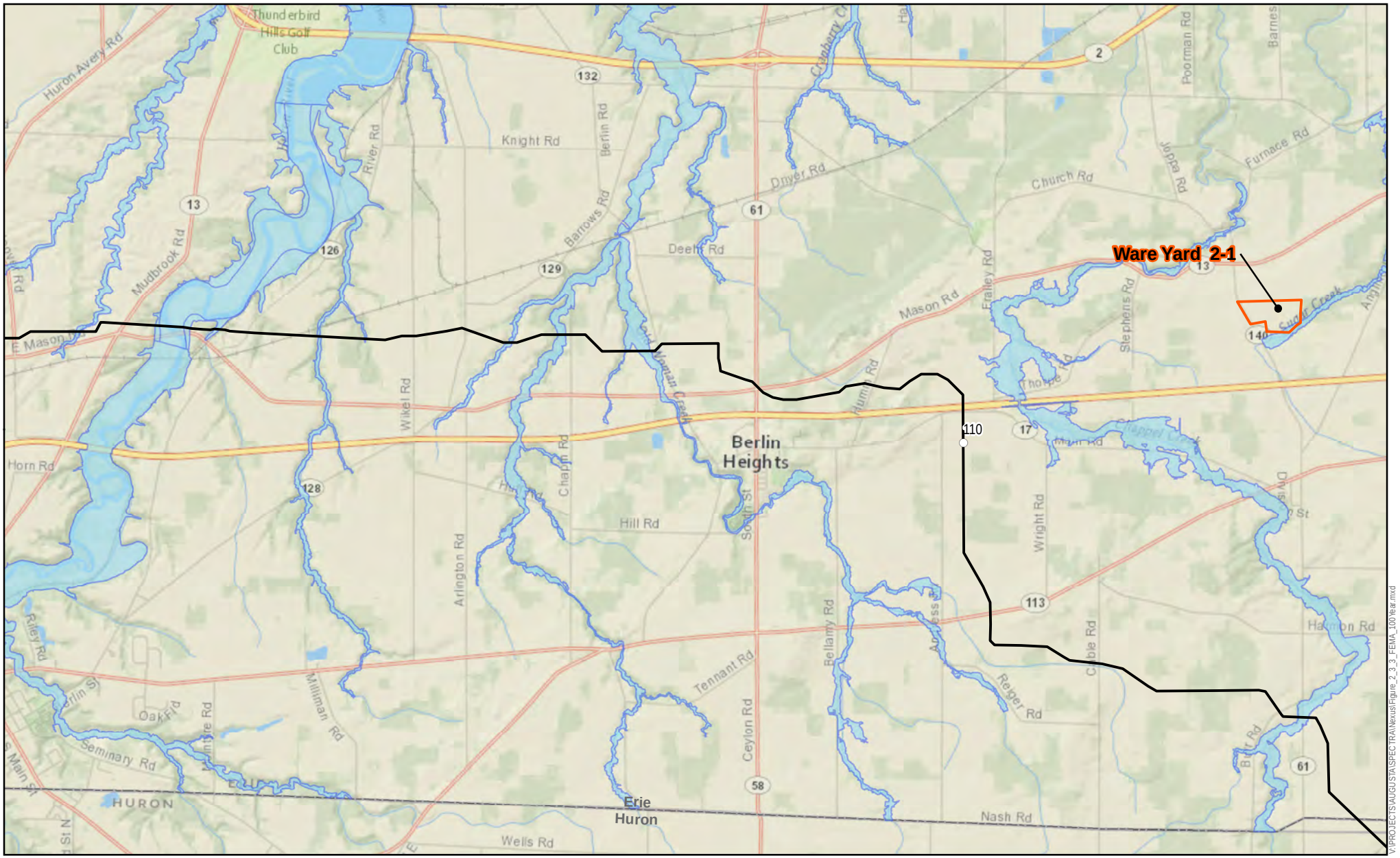
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Lorain, Erie and Huron Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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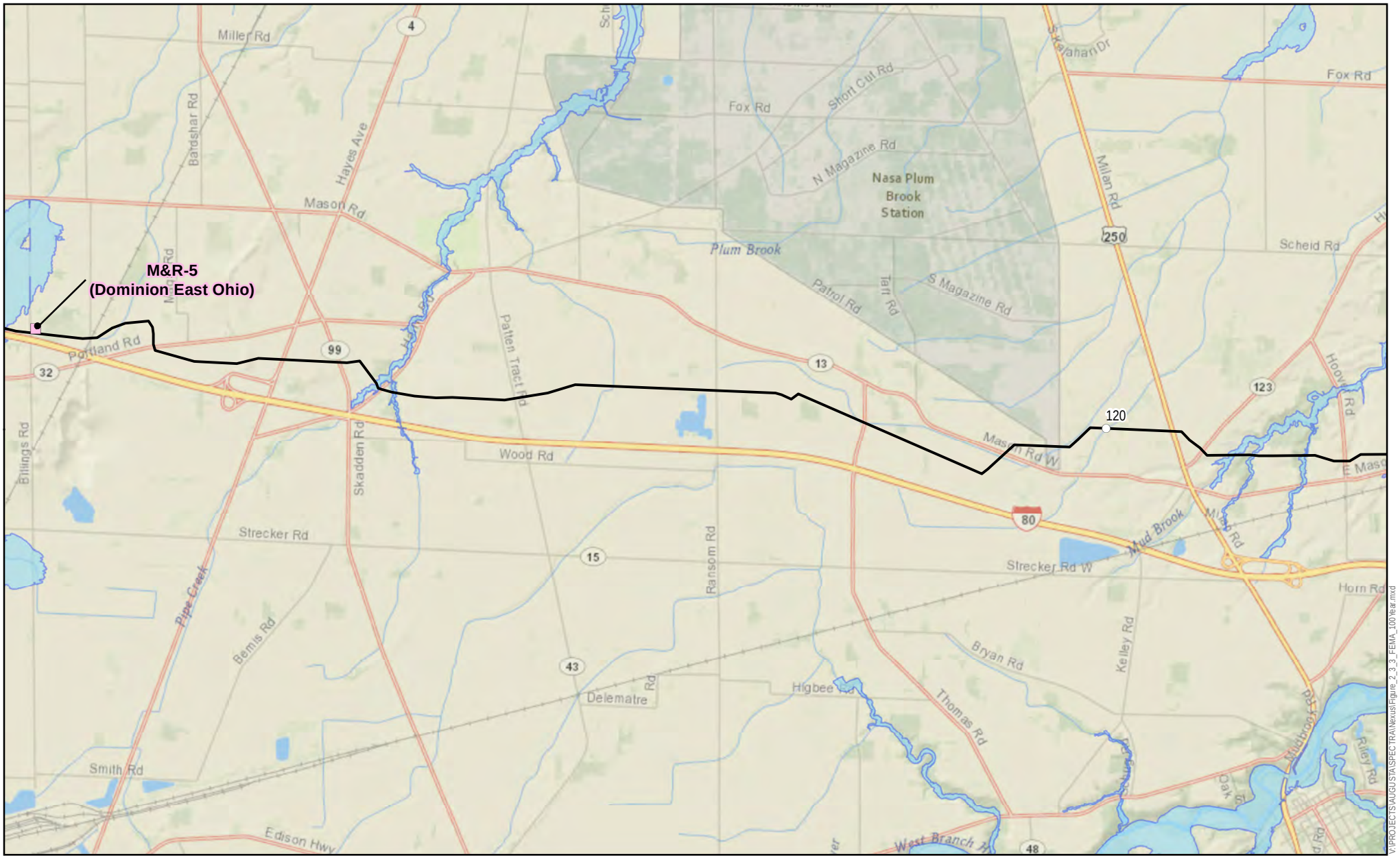
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Huron and Erie Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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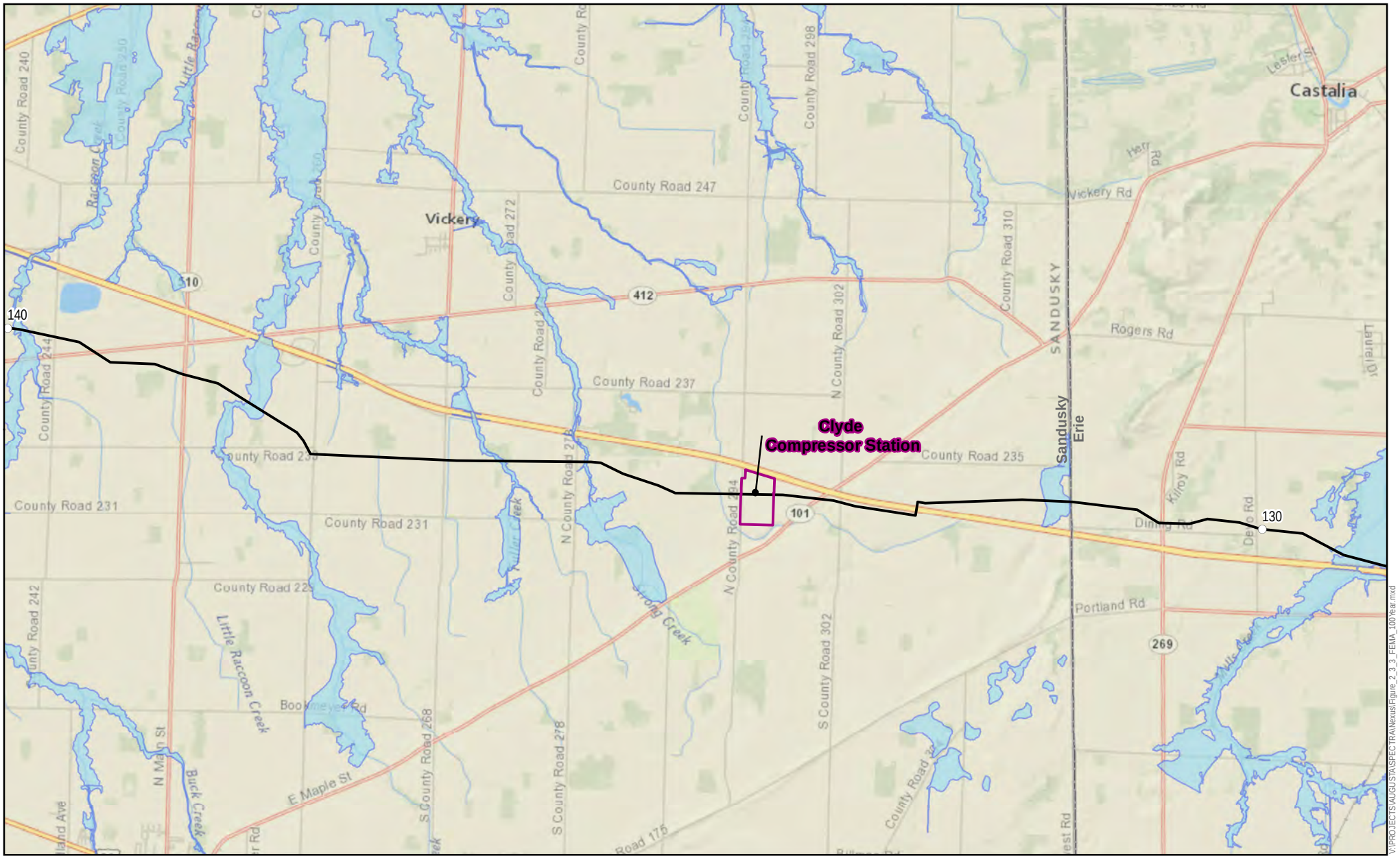
Figure 2.3-3

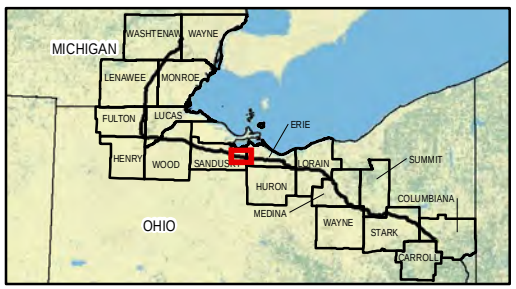
FEMA Flood Zones
Crossed by the NEXUS Project

Erie County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





Legend

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- Proposed Meter Stations
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- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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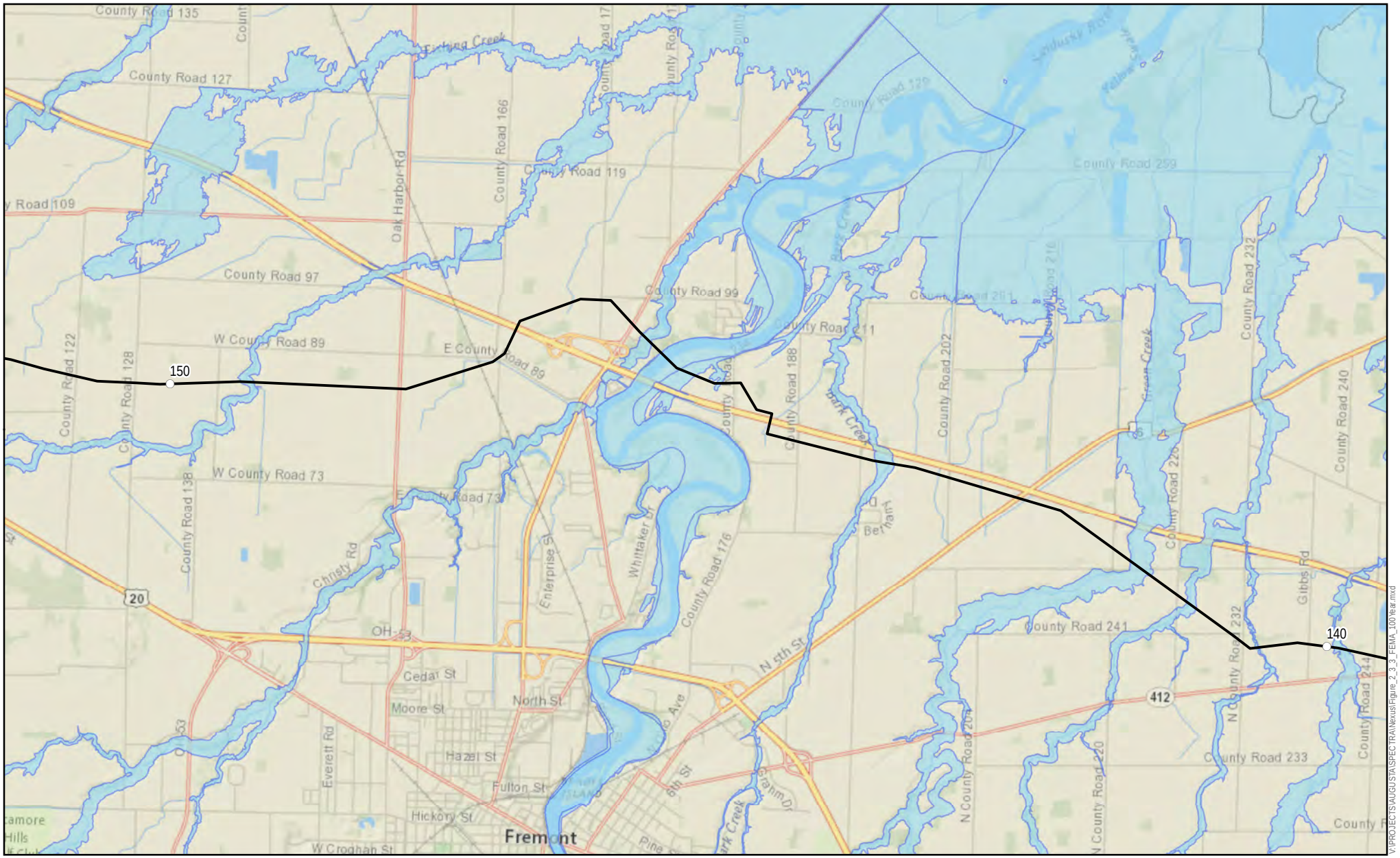
Figure 2.3-3

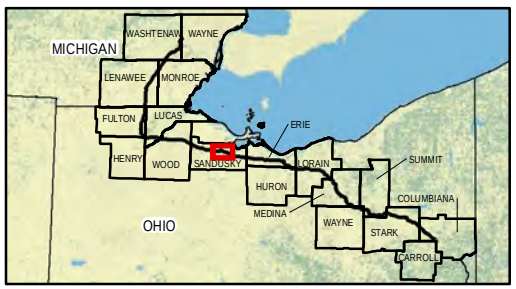
FEMA Flood Zones
Crossed by the NEXUS Project

Erie and Sandusky Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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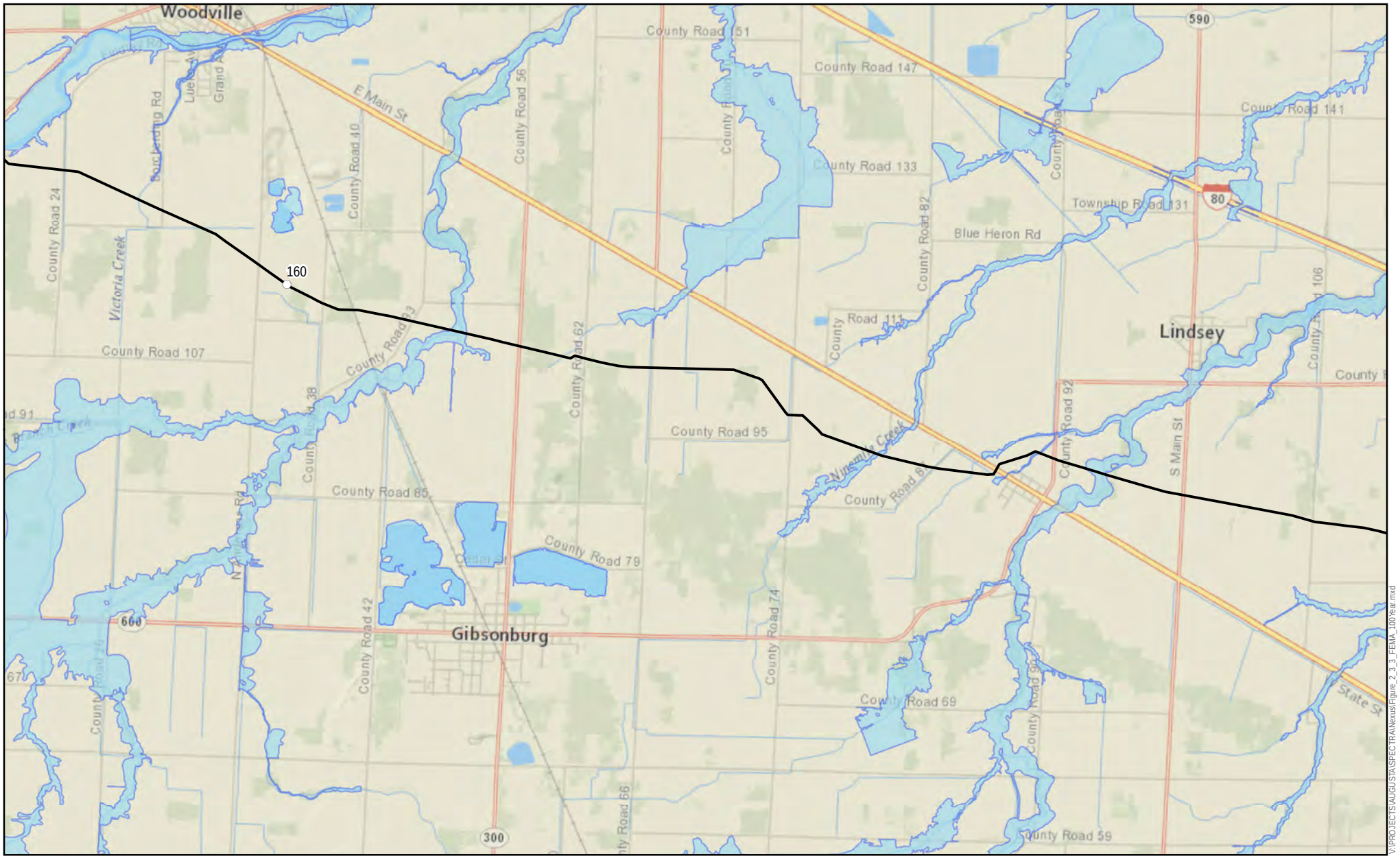
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Sandusky County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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Miles

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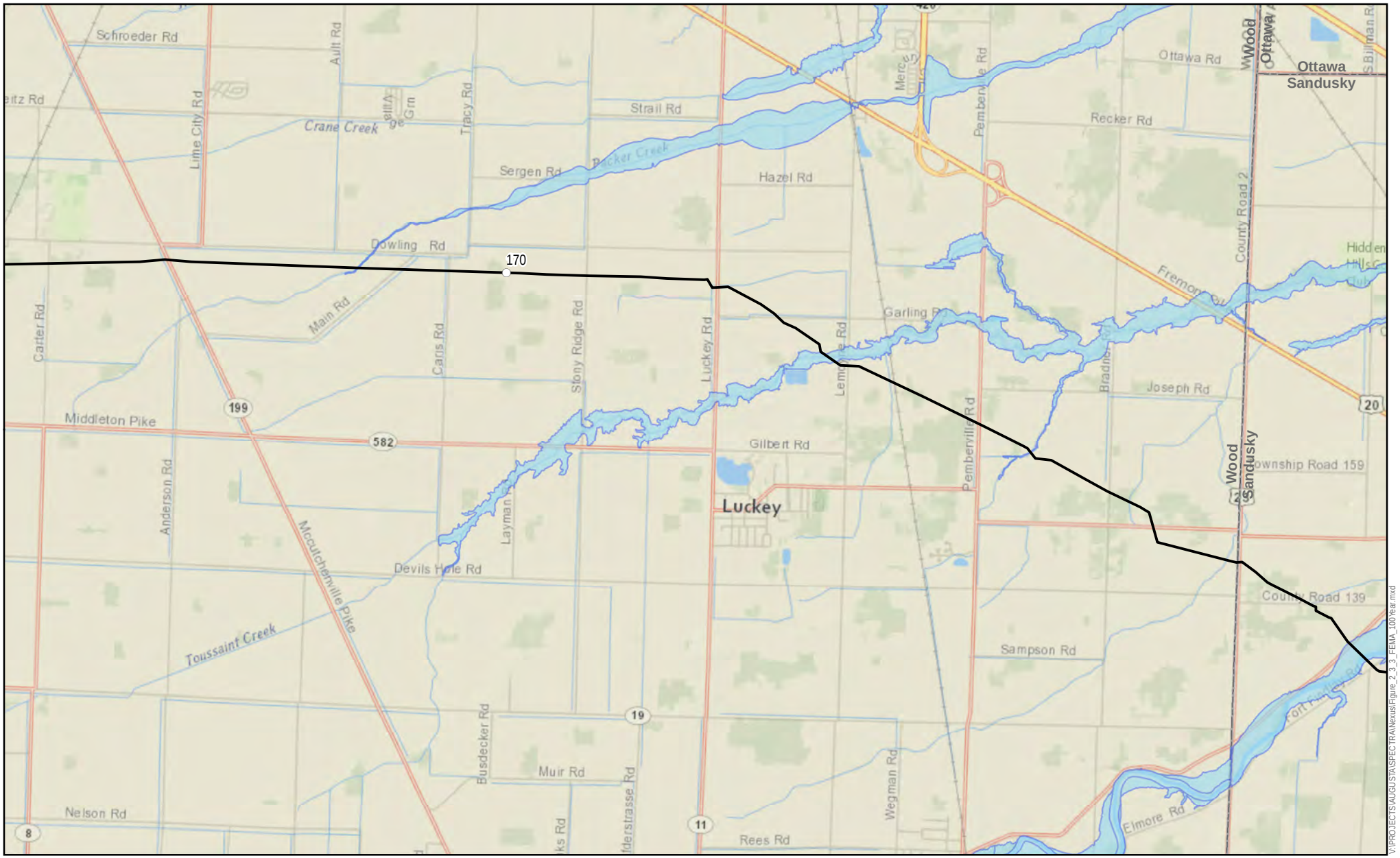
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Sandusky County, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

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Miles

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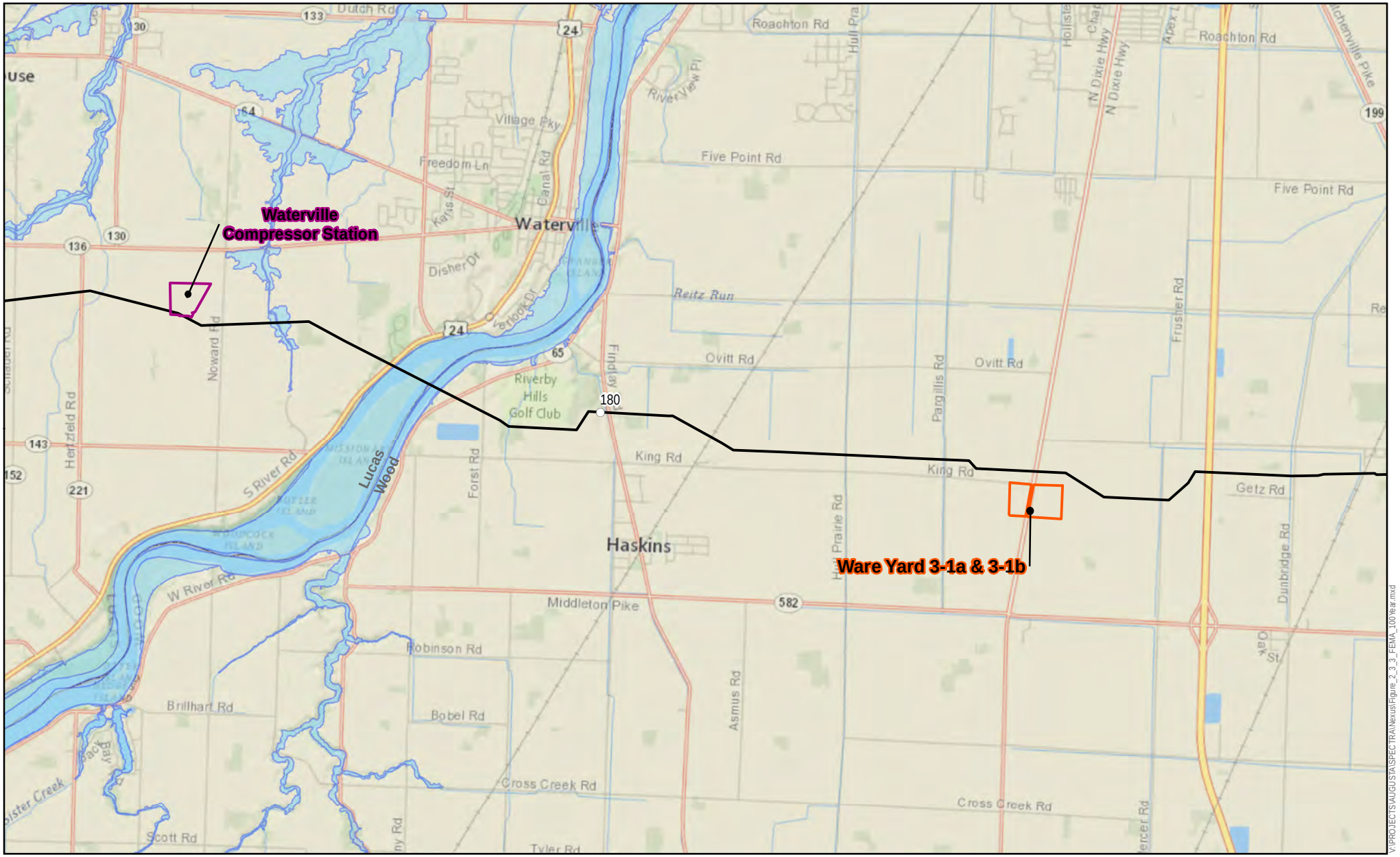
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Sandusky and Wood Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

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- Proposed TGP Interconnect
- Proposed Ware Yards
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- Project Counties
- FEMA 100 Year Flood Zones

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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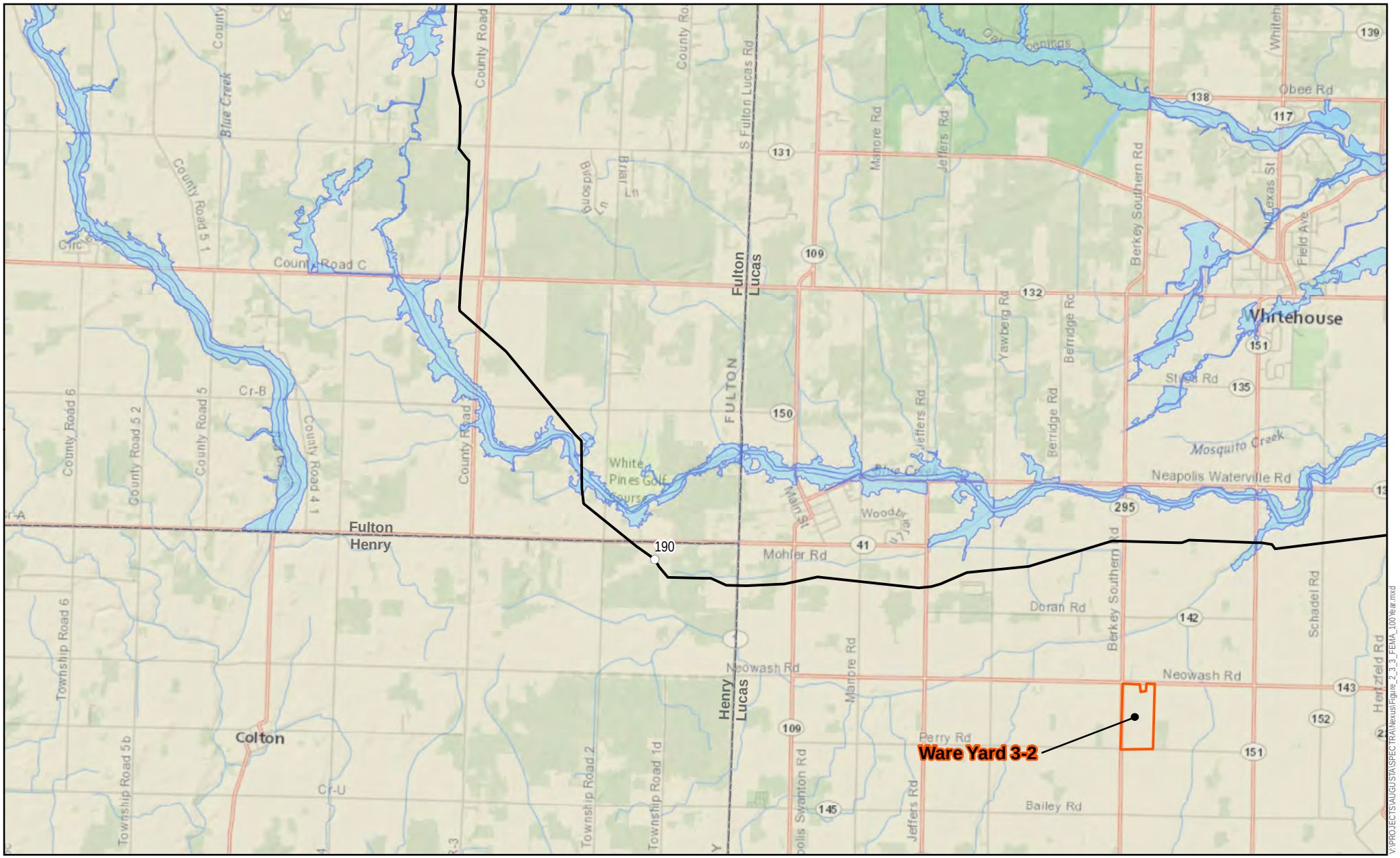
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Wood and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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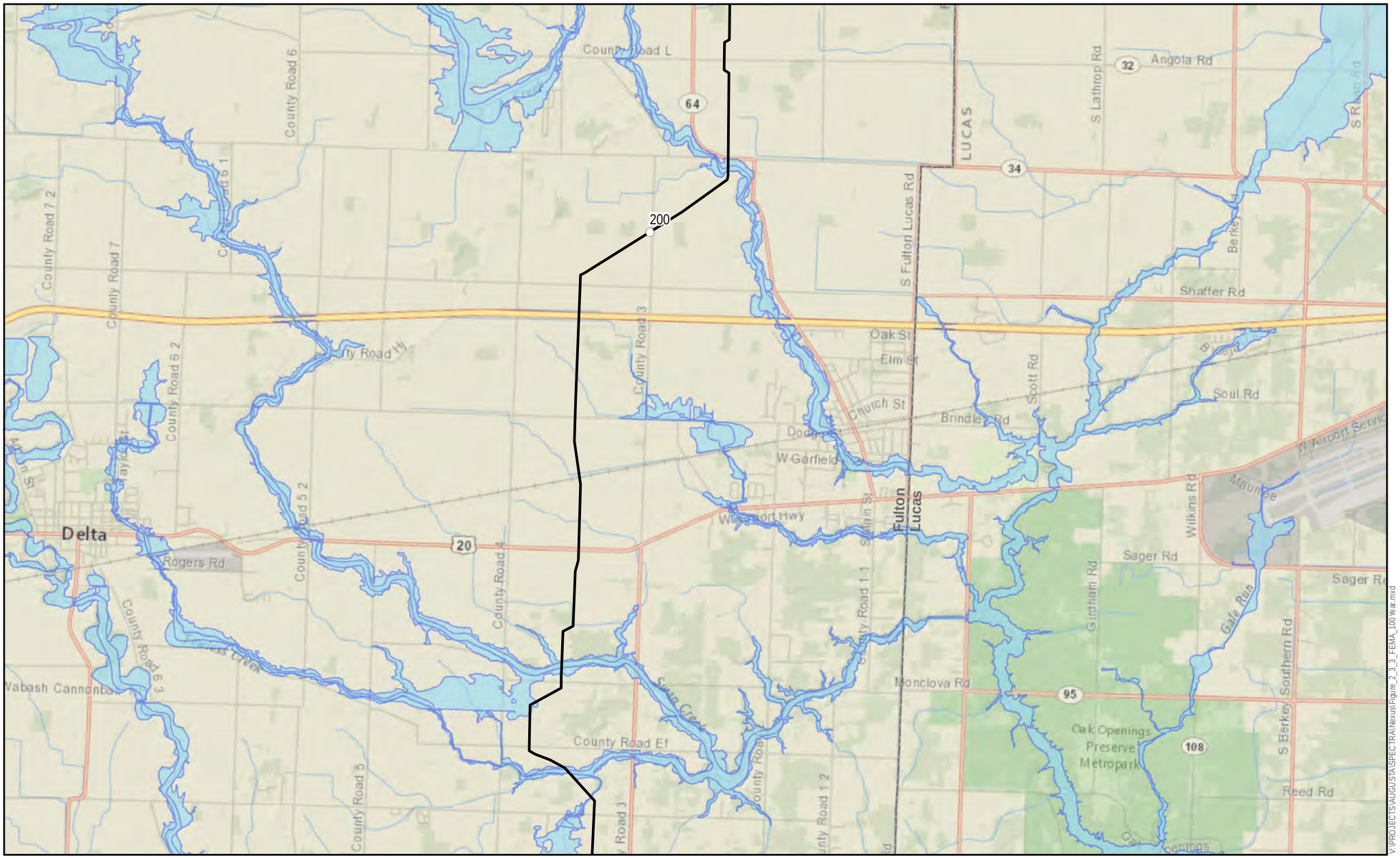
Figure 2.3-3

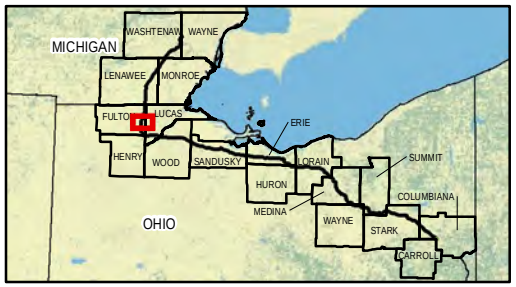
FEMA Flood Zones
Crossed by the NEXUS Project

Henry, Fulton and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





Legend

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- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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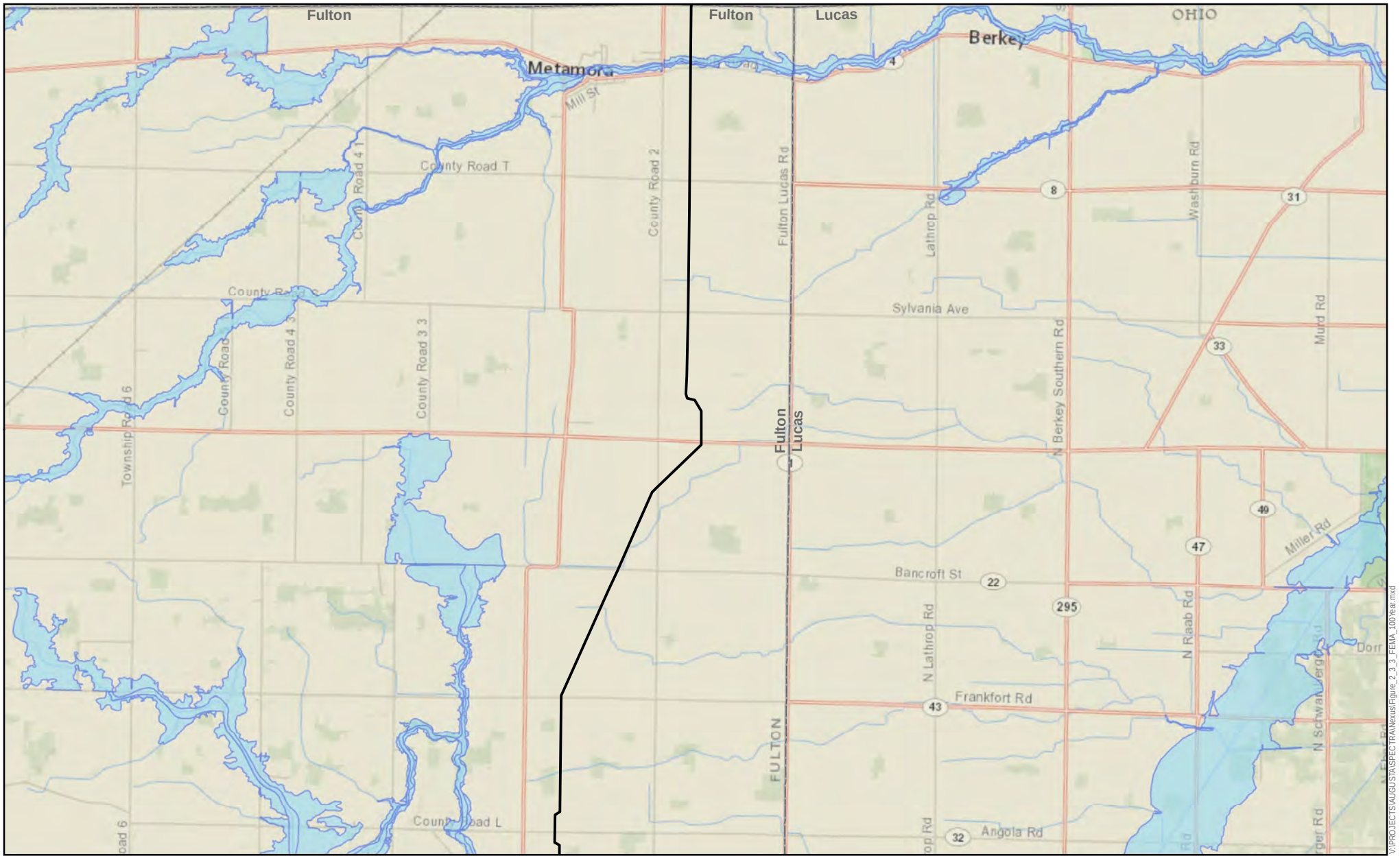
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Fulton and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

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- Project Counties
- FEMA 100 Year Flood Zones

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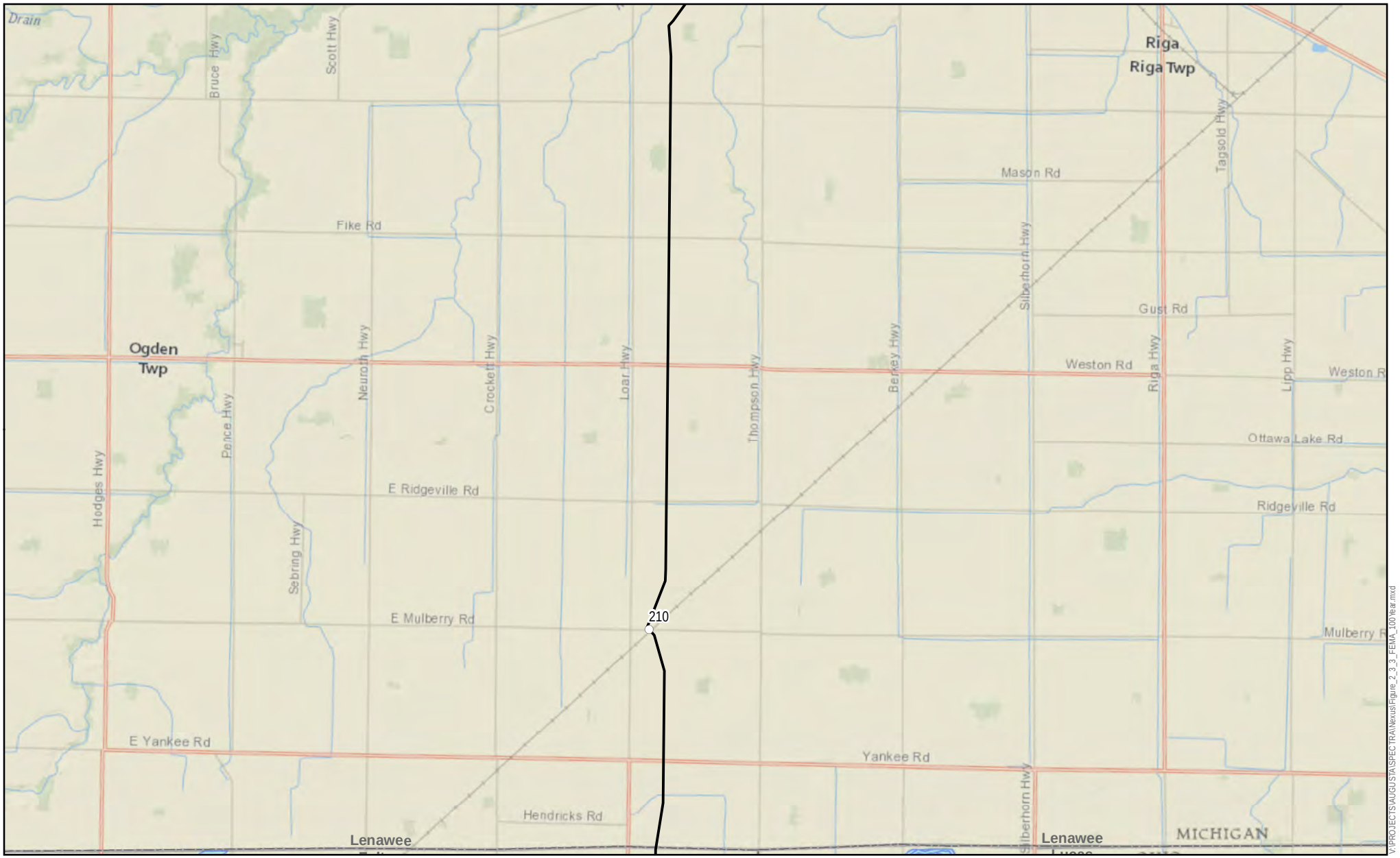
Figure 2.3-3

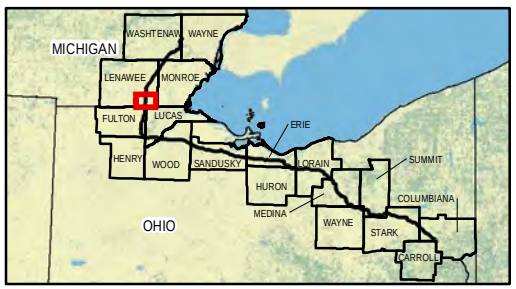
FEMA Flood Zones
Crossed by the NEXUS Project

Fulton and Lucas Counties, OH

NEXUS GAS TRANSMISSION

Created: 11/12/2015





Legend

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- Project Counties
- FEMA 100 Year Flood Zones

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Miles

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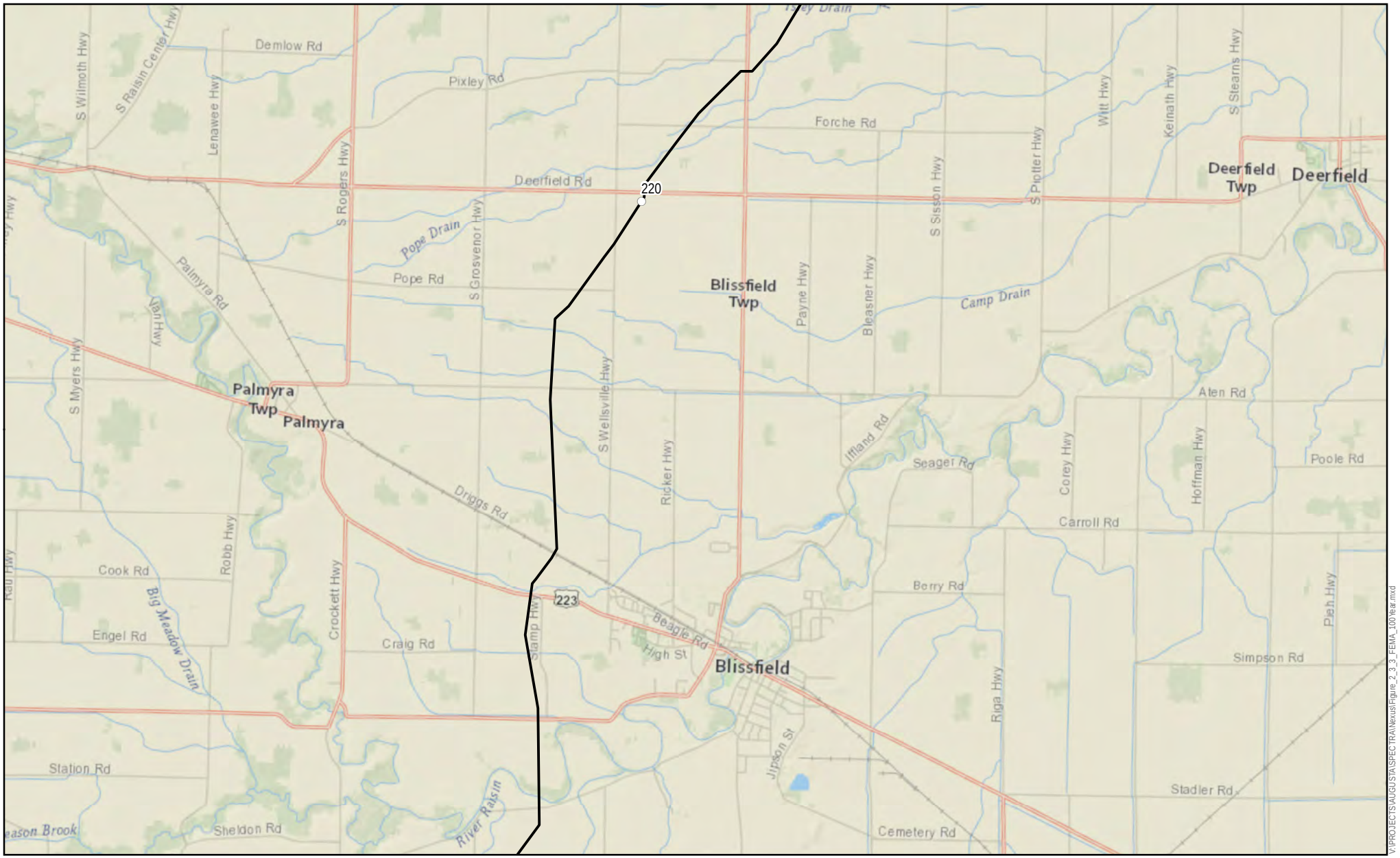
Figure 2.3-3

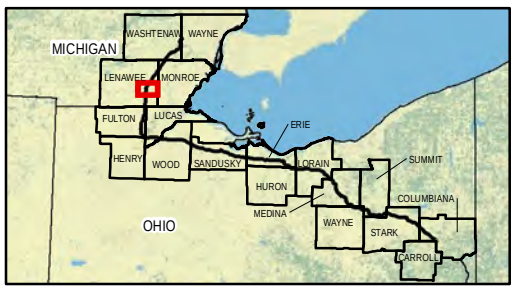
FEMA Flood Zones
Crossed by the NEXUS Project

Lenawee County, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015





Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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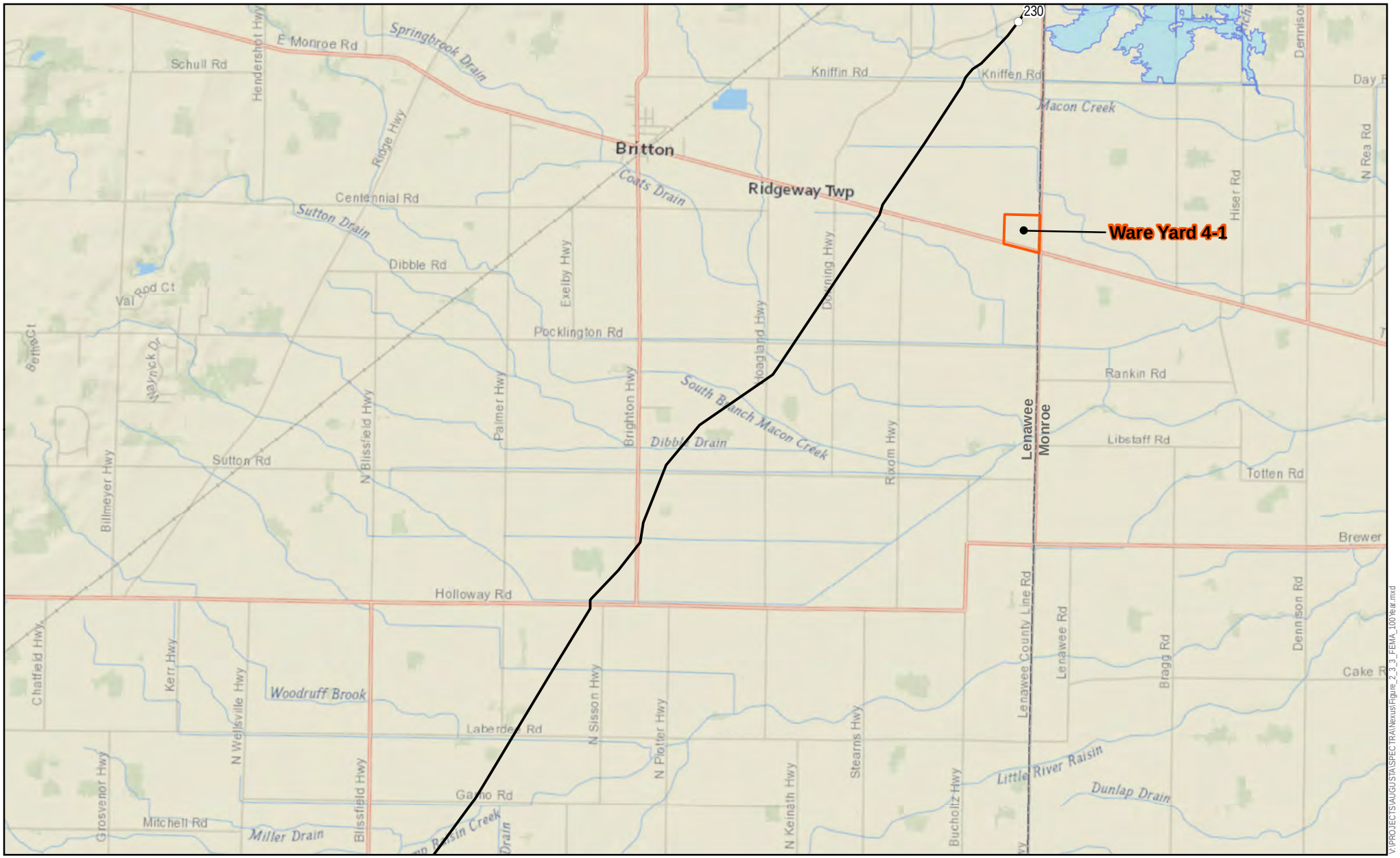
Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Lenawee County, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015



Legend

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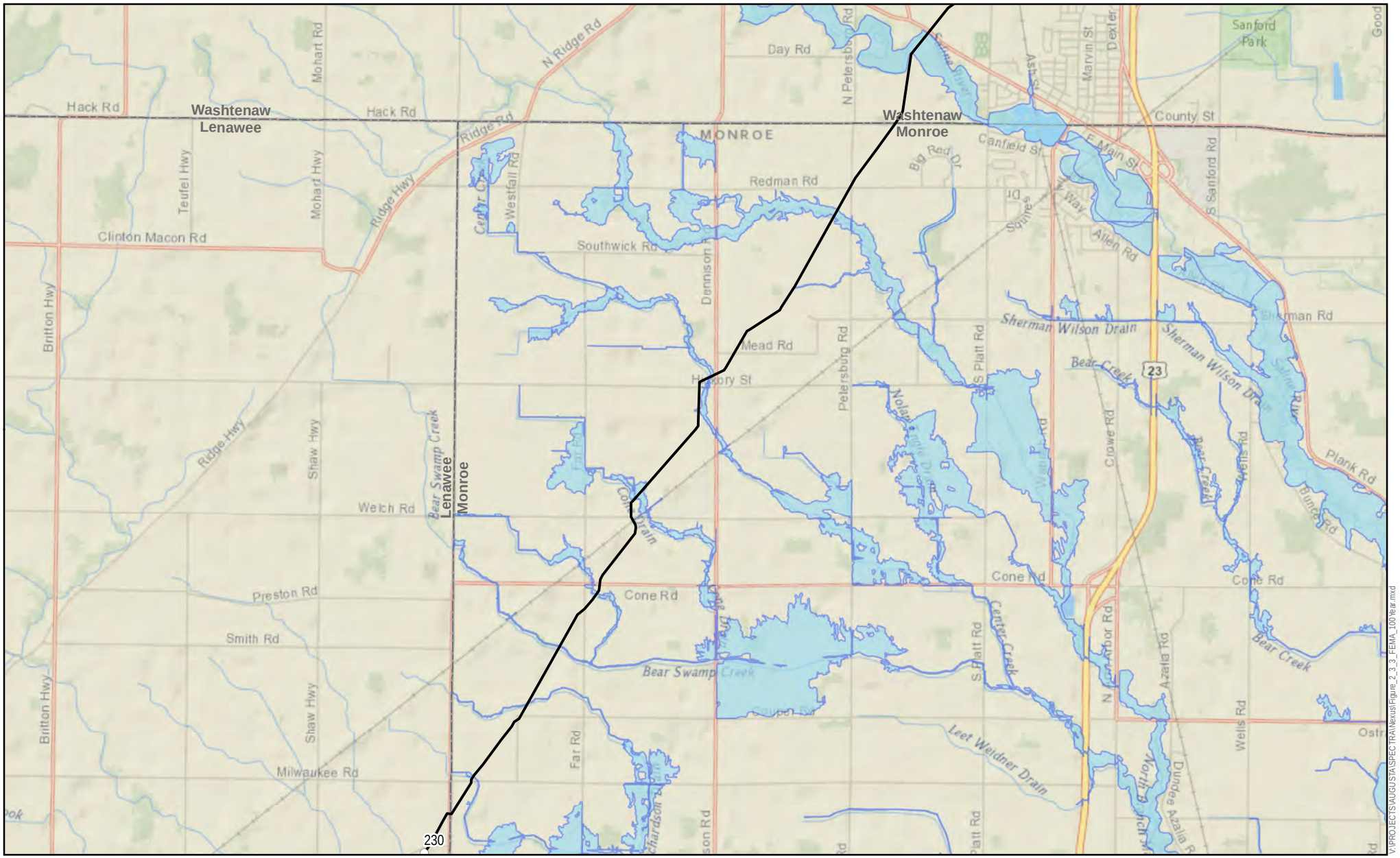
Figure 2.3-3

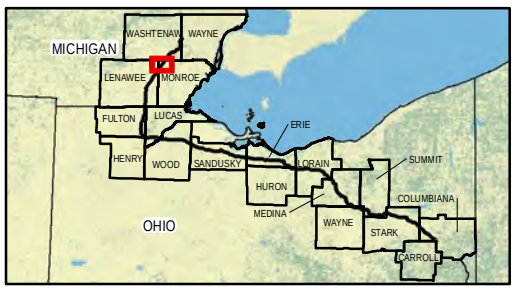
FEMA Flood Zones
Crossed by the NEXUS Project

Lenawee and Monroe Counties, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015





Legend

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- Proposed Ware Yards
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- Project Counties
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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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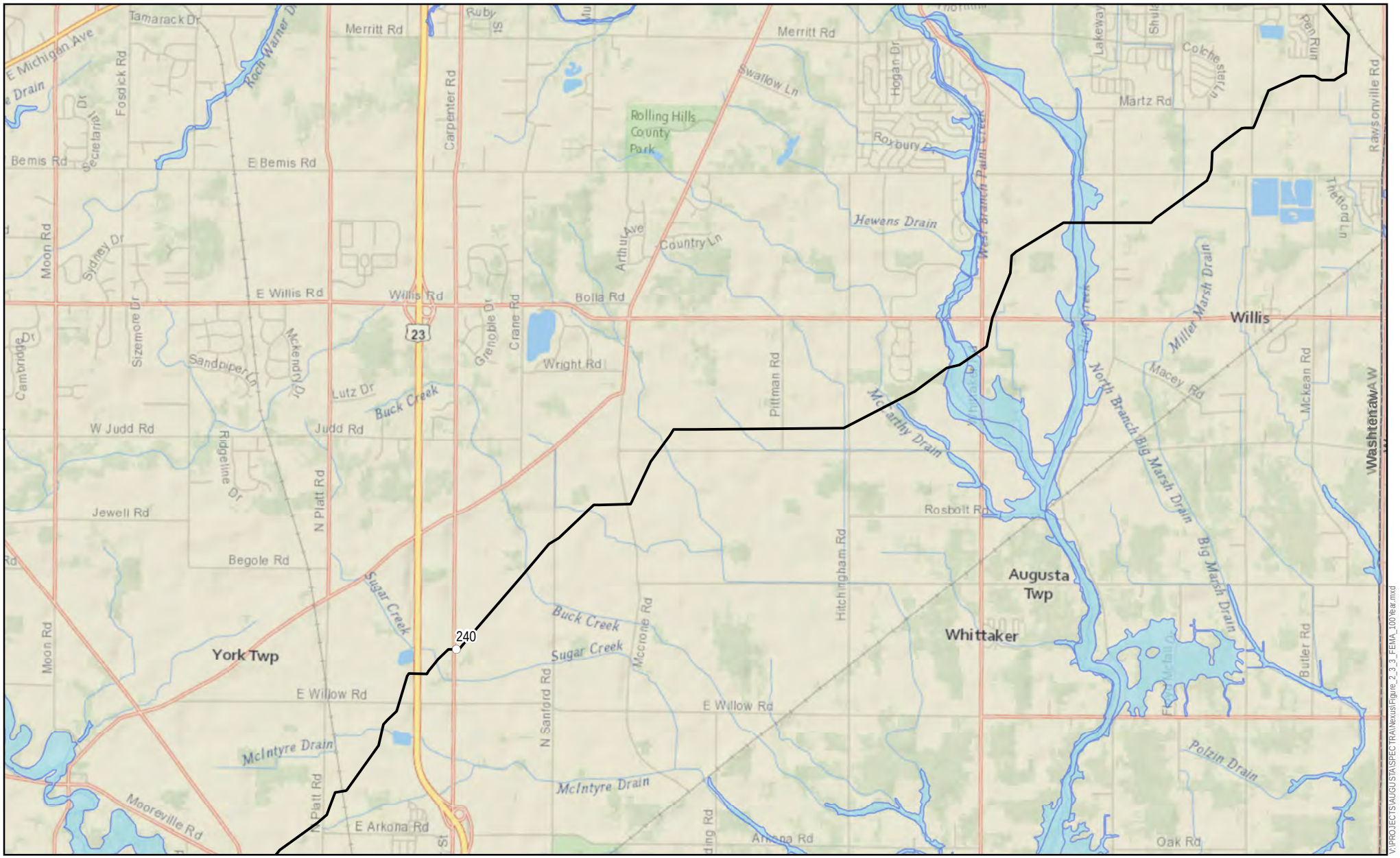
Figure 2.3-3

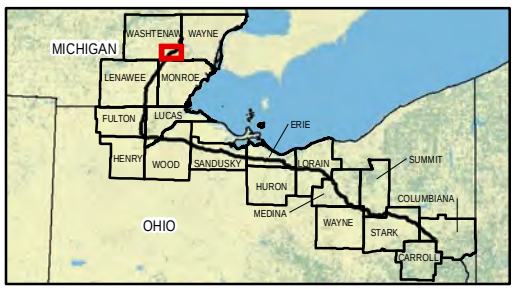
FEMA Flood Zones
Crossed by the NEXUS Project

Lenawee, Monroe and Washtenaw Counties, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015





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Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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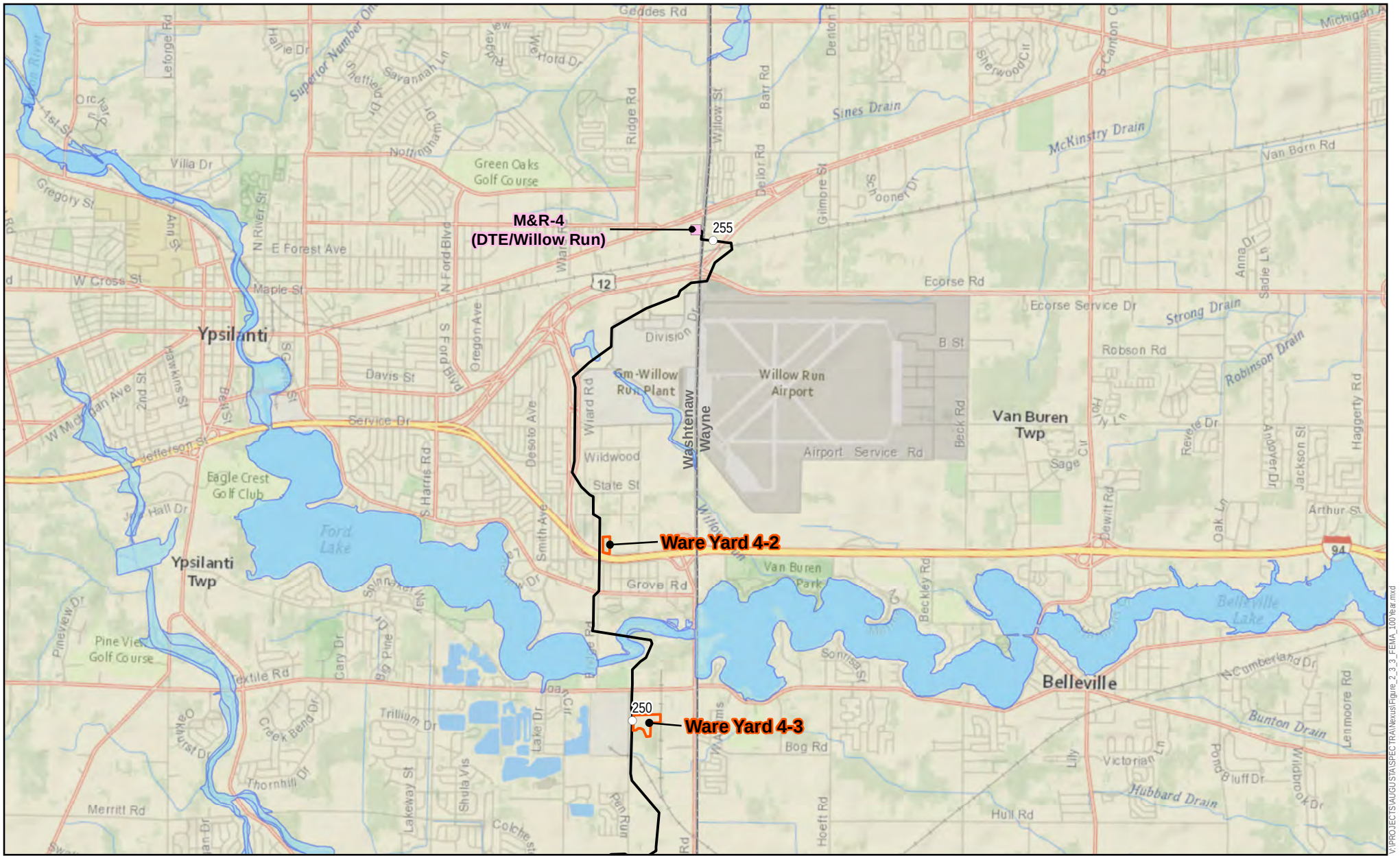
Figure 2.3-3

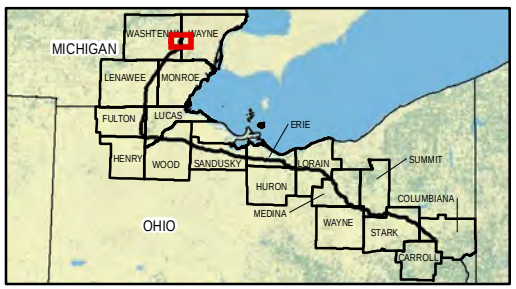
FEMA Flood Zones
Crossed by the NEXUS Project

Washtenaw County, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015





Legend

- Milepost (10 miles)
- Proposed Meter Stations
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Proposed Ware Yards
- Proposed Compressor Sites
- Project Counties
- FEMA 100 Year Flood Zones

N

0 1 2

Miles

Projection: NAD83, UTM Zone 17N US Survey Feet, Grid North. Data Sources: ESRI, SPECTRA, MI GIS, OH GIS, FEMA and TRC.

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Figure 2.3-3

FEMA Flood Zones
Crossed by the NEXUS Project

Washtenaw and Wayne Counties, MI

NEXUS GAS TRANSMISSION

Created: 11/12/2015

APPENDIX 2A

HDD Design Report and HDD Monitoring and Contingency Plan

HDD Design Report, Revision 0
Nexus Pipeline Project

October 21, 2015

Prepared for:

FLUOR.

FLUOR ENTERPRISES, INC.
1 Fluor Daniel Drive
Sugarland, Texas 77478

Prepared by

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October 21, 2015

Fluor Enterprises, Inc.
1 Fluor Daniel Drive
Sugarland, TX 77478

Attention: Mr. Rollins Brown, P.E.

SUBJECT: HDD Design Report
Nexus Pipeline Project

Gentlemen:

J. D. Hair & Associates, Inc. (JDH&A) is pleased to submit the following report titled "HDD Design Report, Revision 0, Nexus Pipeline Project." The report presents site-specific feasibility evaluations, design considerations, supporting calculations, and other details relative to obstacle crossings on the proposed Nexus Pipeline Project to be installed using horizontal directional drilling (HDD).

We appreciate your confidence in JDH&A. If you have any questions or need additional information, please do not hesitate to contact us.

Sincerely,

J. D. HAIR & ASSOCIATES, INC.

Jeffrey M. Scholl, P.E.
Engineering Manager

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APPENDIX - CROSSING SPECIFIC REPORTS

1. INTRODUCTION

This report provides a summary of design considerations and engineering calculations associated with horizontal directionally drilled (HDD) crossings on the 36-inch pipeline for the Nexus Gas Transmission Project. J. D. Hair & Associates, Inc. (JDH&A) has undertaken this report as part of the scope outlined in Fluor Enterprises, Inc. (FLUOR) Purchase Order No: GS15-337208.

The report is divided into two primary sections. The first section provides a general overview of the HDD construction method including a description of the HDD process, feasibility considerations, and details with respect to calculation methods used during the design process. The second section of the report contains site-specific crossing evaluations that include the following topics:

- General Site Descriptions
- Subsurface Conditions
- Design Geometry and Layout
- Assessment of Feasibility
- Risk Identification and Assessment
- Installation Loading Analysis
- Hydraulic Fracture Evaluation
- Estimated Construction Duration

HDD crossings proposed for the Nexus Project that served as the focus of this report are included in Table 1.

Table 1: Proposed HDD Crossings on the Nexus Project

Mile Post	Location	Crossing Name	Length
7.9	Columbiana County, Ohio	Wetland	2,931 feet
41.1	Summit County, Ohio	Nimisila Reservoir	1,536 feet
47.8	Summit County, Ohio	Tuscarawas River	3,261 feet
71.1	Median County, Ohio	Wetland	1,628 feet
86.9	Lorain County, Ohio	East Branch Black River	1,869 feet
92.5	Lorain County, Ohio	West Branch Black River	1,669 feet
104.1	Huron County, Ohio	Vermilion River	2,945 feet
110.3	Erie County, Ohio	Interstate 80	1,432 feet
116.8	Erie County, Ohio	Huron River	2,423 feet
146.1	Sandusky County, Ohio	Sandusky River	2,159 feet
162.7	Sandusky County, Ohio	Portage River	1,620 feet
180.1	Wood County, Ohio	Findlay Road	1,522 feet
181.2	Wood and Lucas Counties, Ohio	Maumee River	3,999 feet
215.0	Lenawee County, Michigan	River Raisin	1,479 feet
237.4	Washtenaw County, Michigan	Saline River	1,315 feet
250.7	Washtenaw County, Michigan	Hydro Park	2,280 feet
251.5	Washtenaw County, Michigan	Interstate 94	1,359 feet

2. HDD PROCESS DESCRIPTION

Installation of a pipeline by HDD is accomplished in three stages as illustrated in Figure 1. The first stage consists of directionally drilling a small diameter pilot hole along a designed directional path. The second stage involves enlarging this pilot hole to a diameter suitable for installation of the pipeline. The third stage consists of pulling the pipeline back into the enlarged hole.

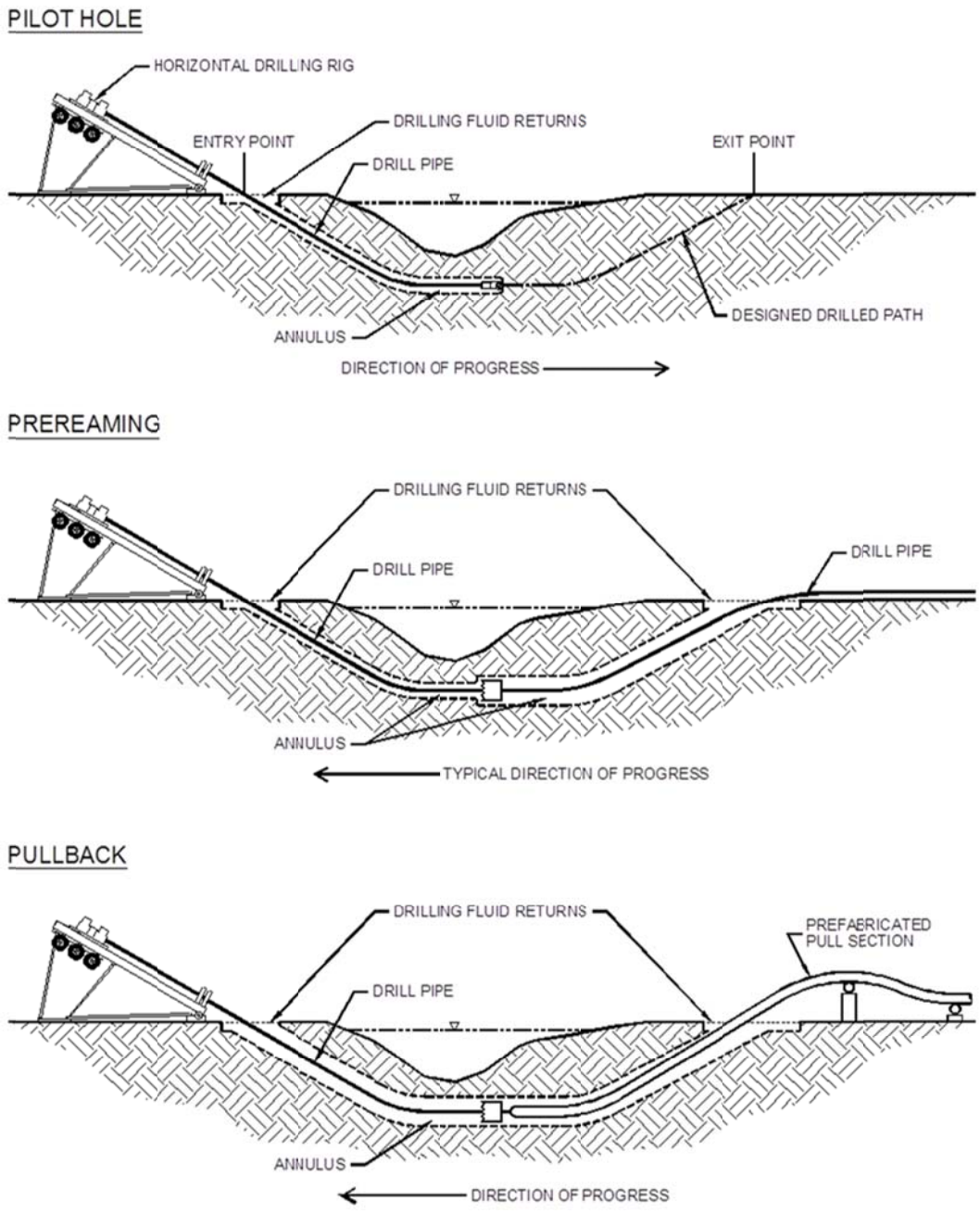

Figure 1: The HDD Process

2.1. Pilot Hole Directional Drilling

2.1.1. Pilot Hole

Pilot hole directional control is achieved by using a non-rotating drill string with an asymmetrical leading edge. The asymmetry of the leading edge creates a steering bias while the non-rotating aspect of the drill string allows the steering bias to be held in a specific position while drilling. If a change in direction is required, the drill string is rolled so that the direction of bias is the same as the desired change in direction. Leading edge asymmetry is typically accomplished with either a bent sub or a bent motor housing located behind the bit.

In loose soils, drilling progress may achieved by hydraulic cutting with a jet nozzle. If hard zones are encountered, the drill string may be rotated to drill without directional control until the hard zone has been penetrated. Mechanical cutting action required for harder soils and rock is provided by a mud motor, which converts hydraulic energy from drilling fluid to mechanical energy at the drill bit. This allows for bit rotation without drill string rotation.

The path of the pilot hole is monitored during drilling using a steering tool positioned near the bit. The steering tool provides continuous readings of the inclination and azimuth at the leading edge of the drill string. These readings, in conjunction with measurements of the distance drilled, are used to calculate the horizontal and vertical coordinates of the steering tool relative to the initial entry point on the surface. The path of the pilot hole can also be determined with a surface monitoring system that induces an artificial magnetic field using a wire placed on the surface. Measurements of this magnetic field's properties by instruments in the steering tool allow the position of the steering tool to be determined using triangulation. This provides data that can be used to correct downhole survey inaccuracy that results from inconsistencies in the earth's magnetic field.

2.1.2. Prereaming

Enlarging the pilot hole is accomplished using prereaming passes prior to pipe installation. Reaming tools generally consist of a circular array of cutters and drilling fluid jets and are often custom made by contractors for a particular hole size or type of soil. These tools are attached to the drill string and rotated and drawn along the pilot hole. Drill pipe is added behind the tools as they progress along the drilled path to ensure that a string of pipe always extends between the entry and exit points.

2.1.3. Pullback

Pipe installation is accomplished by attaching a pipeline pull section behind a reaming assembly at the exit point, then pulling the reaming assembly and pull section back to the drilling rig. This is undertaken after completion of prereaming or, for smaller diameter lines in loose soils, directly after completion of the pilot hole. A swivel is utilized to connect the pull section to the reaming assembly to minimize torsion transmitted to the pipe. The pull section is supported using some combination of roller stands and pipe handling equipment to minimize tension and prevent damage to the pipe.

3. TECHNICAL FEASIBILITY CONSIDERATIONS

For a pipeline to be installed by HDD, either an open hole must be cut into the subsurface material so that installation of a pipeline by the pullback method is possible, or the properties of the subsurface material must be modified so that the soil behaves in a fluid manner allowing a pipeline to pass through it.

In the open hole condition, a cylindrical hole is drilled through the subsurface. Drilling fluid flows to the surface in the annulus between the pipe and the wall of the hole. Drilled spoil is transported in the drilling fluid to the surface. This is generally applicable to rock and cohesive soils. It may also apply to some sandy or silty soils depending on the density of the material, the specific makeup of the coarse fraction, and the binding or structural capacity of the fine fraction.

The open hole condition is difficult to achieve in loose cohesionless soils over a long horizontally drilled length. Nevertheless, pipelines are routinely installed by HDD in loose soils. The mechanical agitation of the reaming tool coupled with the injection of drilling fluid will cause the soil to experience a decrease in shear strength. If the resulting shear strength is low enough, the soil will behave in a fluid manner allowing a pipe to be pulled through it.

3.1. Pilot Hole Limitations

A pilot hole must be drilled in compression. That is, weight on bit must be achieved by thrusting the drill pipe away from the drilling rig. Drill pipe buckling becomes a problem, depending on soil conditions, and the combination of pipe bending and rotation can lead to failure through low cycle fatigue. Pilot hole length is limited by the capacity of the drill pipe to withstand the combination of compressive, bending, and torsional loads.

Pilot holes are directionally drilled by orienting the asymmetry of the bottom hole assembly by rotating the drill string at the drilling rig. As pilot hole distances increase, the orientation of the bottom hole assembly becomes more difficult to control. Actions taken at the drilling rig several thousand feet behind the bottom hole assembly may not translate clearly to reactions at the leading edge. Pilot hole length is limited by the ability to accurately steer.

A pilot hole must achieve either an open hole or fluidized condition in the soil to allow penetration. Depending on the characteristics of the soil, these two conditions may be difficult to achieve over long horizontal lengths. Suspension of cuttings is difficult to maintain over long horizontal distances. Cuttings may accumulate around the pipe causing it to get stuck. Experience has shown that the fluidized condition degrades over time if the soil is not agitated and exposed to bentonite drilling fluid flow. Drill pipe, and pipelines, have become stuck during HDD operations and have been abandoned in place. Pilot hole length is limited by the ability to maintain a hole in the subsurface.

Despite the above limitations, experience in the HDD industry indicates that pilot holes up to approximately 7,000 feet are feasible when drilling with a single rig in one direction, and significantly longer lengths are possible through the use of the drilled intersect technique. A drilled intersect involves drilling a pilot hole with two rigs from opposite ends of a drilled segment. The pilot holes are essentially drilled into one another. The intersect technique theoretically doubles the maximum feasible length of a pilot hole from 7,000 feet to 14,000 feet.

The practical limits of the intersect technique may be closer to 12,500 feet to allow for some overlap as one pilot hole is sought out by another.

HDD crossings under consideration on the Nexus Project have proposed lengths ranging from 1,320 feet to 4,018 feet, easily within the lengths attainable using a single HDD rig. Therefore, utilization of the intersect technique is not envisioned.

3.2. Prereaming and Pullback Limitations

Since drill pipe is usually rotated in tension during prereaming and pullback, the length limitations associated with drill pipe compression and low cycle fatigue experienced in pilot hole drilling do not come into play. Concerns with steering are also not applicable. Horizontal length during prereaming and pullback is limited by the ability to maintain an open hole or fluid condition to such an extent that drill pipe, reaming tools, and product pipe can be moved along the drilled path without exceeding the capacity of the pipe or drilling rig.

Pipeline diameter is limited by the capacity of drill pipe for the transmission of torque to reaming tools. Commercially available drill pipe is limited to 7-5/8 inches in diameter. This limitation notwithstanding, experience in the HDD industry has demonstrated that installation of 56-inch diameter steel pipe is feasible in amenable subsurface conditions. HDD installation of 36-inch diameter steel pipe, once again in amenable subsurface conditions, is relatively common.

3.3. Subsurface Material

While length, diameter, and subsurface material work in combination to limit the technical feasibility of a HDD installation, technical feasibility is primarily limited by subsurface material. The problematic subsurface condition most often encountered in evaluating the feasibility of a HDD installation is large grain content in the form of gravel, cobbles, and boulders. Other subsurface conditions that can affect the feasibility of a HDD installation include excessive rock strength and abrasivity, poor rock quality, solution cavities, and artesian conditions.

3.3.1. Large Grained Formations

Soils consisting principally of coarse-grained material present a serious restriction on the feasibility of HDD. Coarse gravel, cobbles, and boulders, cannot be readily fluidized by the drilling fluid, nor are they stable enough to be cut and removed in a drilling fluid stream as is the case with a crossing installed in competent rock. A boulder or cluster of cobbles will remain in the drilled path and present an obstruction to a bit, reamer, or pipeline. Such obstructions must be mechanically displaced by drilling tools. If the characteristics of the coarse grained materials are such that mechanical displacement with HDD tools is not possible, HDD installation may not be technically feasible.

Fortunately, problematic coarse grained soils are normally encountered in limited quantities. Coarse overburden may overlay bedrock or a finer grained formation amenable to penetration by HDD. If the overburden is not too deep, it can be removed by excavation or penetrated with a surface casing. HDD can then proceed through the amenable formation.

3.3.2. Excessive Rock Strength and Abrasivity

Exceptionally strong and abrasive rock can hamper all phases of a HDD project. Slow penetration rates and frequent stoppages to replace worn bits and reamers can result in extended construction durations and unacceptable increases in construction cost. Excessive rock strength and abrasivity can also lead to tool or drill pipe failures downhole as a result of premature wear and excessive torque. Experience has shown that competent rock with unconfined compressive strengths as high as 50,000 psi can be negotiated with today's technology. However, entry of such materials at depth can be problematic, as the drill string may tend to deflect rather than penetrate.

3.3.3. Poor Rock Quality

A HDD installation through poor quality (extensively fractured or jointed) rock can present the same problems as coarse-grained deposits. Cutting a hole through such materials may cause the overlying rock to collapse, creating obstructions during subsequent passes.

3.3.4. Solution Cavities

Solution cavities present in karst formations can have a substantial impact on the feasibility of a HDD installation. While the wall of a competent rock hole serves to limit the deflection of the drill string, penetration of a void leaves the drill string unconstrained potentially allowing it to deflect laterally. Continued rotation of a drill string subjected to such a deflection can result in failure of the drill pipe due to low-cycle fatigue.

3.3.5. Artesian Conditions

Penetration of an artesian aquifer during drilling or reaming operations can result in a sustained flow of groundwater and fine soils into the drilled hole. This can cause several serious problems including degradation of drilling fluid, deterioration of the hole, drilling fluid storage and disposal issues, and stuck pipe or downhole tools.

4. DRILLING FLUIDS

4.1. Introduction

The primary impact of HDD on the environment revolves around the use of drilling fluids. Where regulatory problems are experienced, the majority of concerns and misunderstandings are associated with drilling fluids. An awareness of the function and composition of HDD drilling fluids is imperative in producing a permittable and constructible HDD design.

Drilling fluid is used in all phases of the HDD process. Figure 2 shows the relationship of the elements typically associated with a HDD drilling fluid system.

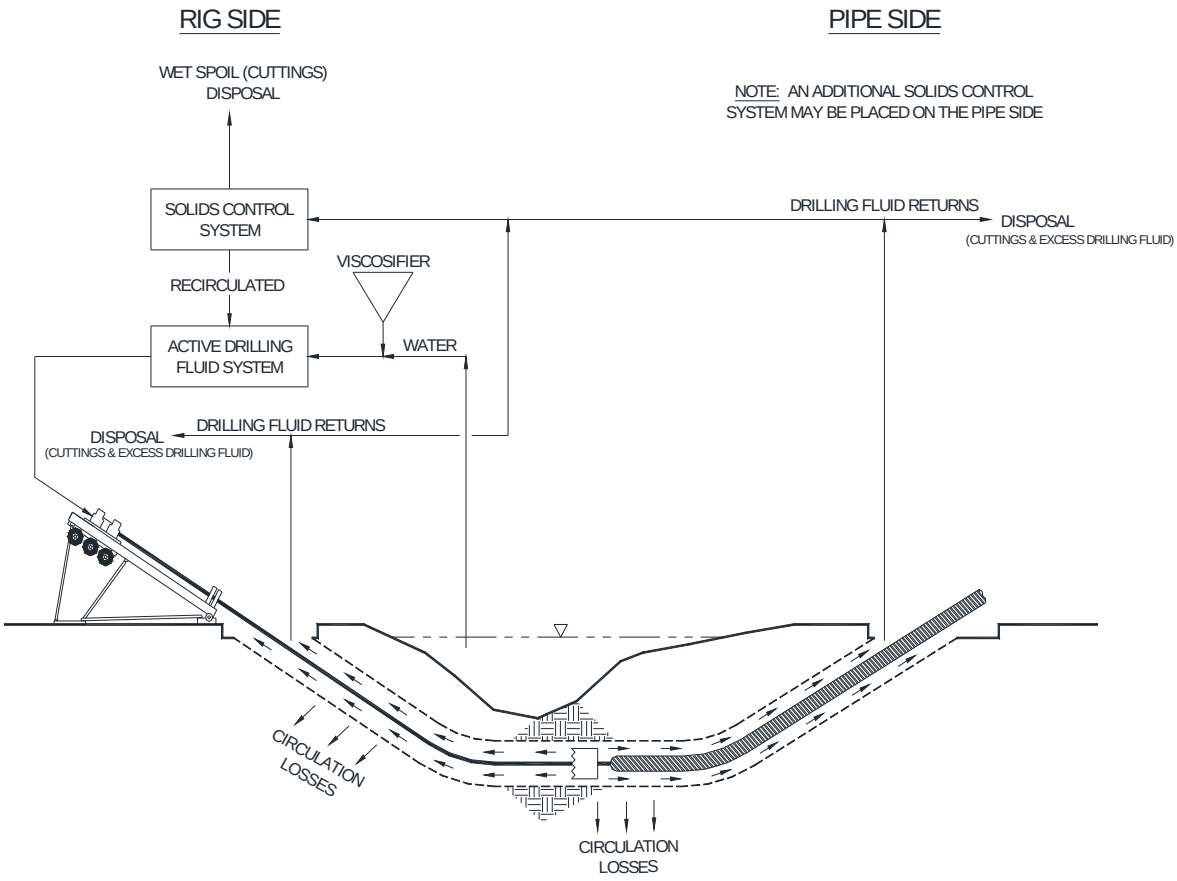

Figure 2: HDD Drilling Fluid Flow Schematic

4.2. Functions of Drilling Fluid

The principal functions of drilling fluid in HDD pipeline installation are as listed below:

- **Transportation of Spoil –** Drilled spoil, consisting of excavated soil or rock cuttings, is suspended in the fluid and carried to the surface by the fluid stream flowing in the annulus between the wall of the hole and the pipe.
- **Cooling and Cleaning of Cutters** – High velocity fluid streams directed at the cutters remove drilled spoil build-up on bit or reamer cutters. The fluid also cools the cutters.
- **Reduction of Friction** – Friction between the pipe and the wall of the hole is reduced by the lubricating properties of the drilling fluid.
- **Hole Stabilization** – The drilling fluid stabilizes the drilled or reamed hole. This is critical in HDD pipeline installation as holes are often in loose soil formations and are uncased. Stabilization is accomplished by the drilling fluid building up a wall cake and exerting a positive pressure on the hole wall. Ideally, the wall cake will seal pores and produce a bridging mechanism to hold soil particles in place.

- **Transmission of Hydraulic Power** – Power required to turn a bit and mechanically drill a hole is transmitted to a downhole motor by the drilling fluid.
- **Hydraulic Excavation –** Soil is excavated by erosion from high velocity fluid streams directed from jet nozzles on bits or reaming tools.
- **Soil Modification –** Mixing of the drilling fluid with the soil along the drilled path facilitates installation of a pipeline by reducing the shear strength of the soil to a near fluid condition. The resulting soil mixture can then be displaced as a pipeline is pulled into it.

4.3. Composition of Drilling Fluid

The major component of drilling fluid used in HDD pipeline installation is fresh water obtained at the crossing location. In order for water to perform the functions listed above, it is generally necessary to modify its properties by adding a viscosifier. The viscosifier used almost exclusively in HDD drilling fluids is naturally occurring clay in the form of bentonite mixed with small amounts of extending polymers to increase its yield (high yield bentonite).

Increasing the yield of bentonite allows more drilling fluid to be produced with less viscosifier (dry bentonite). For example, Wyoming bentonite yields in excess of 85 barrels of drilling fluid per US ton of dry viscosifier. Addition of polymers to produce high yield bentonite can increase the yield to more than 200 barrels of fluid per ton of viscosifier. Typical HDD drilling fluids are composed of less than 2% high yield bentonite by volume with the remaining components being water and drilled spoil. Solids control equipment should be utilized to remove drilled spoil from the fluid to the extent practical, maintaining total solids (high yield bentonite and drilled spoil) at around 6% by volume.

4.4. Inadvertent Returns

HDD involves the subsurface discharge of drilling fluids. Once discharged downhole, drilling fluid is uncontrolled and will flow in the path of least resistance. The annulus of the drilled hole is intended to provide a controlled path of least resistance. However, in some cases the drilling fluid will disperse into the surrounding soils or discharge to the surface at some random location, which may not be a critical problem in an undeveloped location. However, in an urban environment or a high profile recreational area, inadvertent returns can be a major problem. In addition to the obvious public nuisance, drilling fluid flow can buckle streets or wash out embankments.

Drilling parameters may be adjusted to maximize drilling fluid circulation and minimize the risk of inadvertent returns. However, the possibility of lost circulation and inadvertent returns cannot be eliminated. Contingency plans addressing possible remedial action should be made in advance of construction and regulatory bodies should be informed.

Inadvertent returns are more likely to occur in less permeable soils with existing flow paths. Examples are slickensided clay or fractured rock structures. Coarse grained, permeable soils exhibit a tendency to absorb circulation losses. Manmade features, such as exploratory boreholes or piles, may also serve as conduits to the surface for drilling fluids. Inadvertent drilling fluid

returns in a waterway are shown in Figure 3 and drilling fluid returns surfacing through cracks in pavement along a roadway in Figure 4.

Research projects have been conducted in an attempt to identify the mechanisms that cause inadvertent returns and develop analytical methods for use in predicting their occurrence. Efforts have centered on predicting the point at which hydraulic fracture of the native soils will occur. These programs have met with limited success in providing a reliable prediction method. Engineering judgment and experience must be applied in utilizing hydraulic fracture models to predict the occurrence, or nonoccurrence, of inadvertent returns. Additional information relative to evaluating the potential for hydraulic fracture is presented in Section 5.

Figure 3: Inadvertent drilling fluid return in waterway

Figure 4: Inadvertent drilling fluid return surfacing through cracks in pavement

5. HYDRAULIC FRACTURE EVALUATION

As mentioned briefly above, hydraulic fracture, also known as hydrofracture, is a phenomenon that occurs when drilling fluid pressure in the annular space of the drilled hole exceeds the strength of the surrounding soil mass, resulting in deformation, cracking, and fracturing. The fractures may then serve as flow conduits for drilling fluid allowing the fluid to escape into the formation and possibly up to the ground surface. Drilling fluid that makes its way to the ground surface is known as an inadvertent drilling fluid return or, more commonly, a “frac-out.”

Although hydrofracture may be one mechanism by which frac-outs occur, it is not the only one. In fact, it is thought that frac-outs due to true hydrofracture occur in only a small percentage of cases. Drilling fluid flows in the path of least resistance. Ideally, the path of least resistance is through the annulus of the drilled hole and back to the fluid containment pits at the entry or exit points. However, the path of least resistance may also be through naturally occurring subsurface features such as fissures in the soil, shrinkage cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface alongside piers, piles, utility poles, or other structures.

The risk of hydrofracture can be determined by comparing the formation limit pressure (confining capacity) of the subsurface soils to the estimated annular pressure necessary to conduct HDD operations. If the drilling fluid pressure in the annulus exceeds the confining

capacity of the overlying soils, there is risk that inadvertent drilling fluid returns due to hydrofracture will occur. A discussion of the methods used to predict the formation limit pressure and the minimum required annular pressure on the Nexus Project is provided in the sections below.

5.1. Formation Limit Pressure

For HDD crossings on the Nexus Project that involve passing through uncemented soil (i.e. silt, sand, clay), the formation limit pressure was calculated using the "Delft Method." The Delft Method is described in Appendix A of an Army Corps of Engineers publication (CPAR-GL-98) titled *Recommended Guidelines for Installation of Pipelines beneath Levees using Horizontal Directional Drilling.*[1]

The Delft Method assumes uniform soil conditions in the soil column above the point along the drilled path that is being analyzed and requires engineering judgment with respect to the selection of geotechnical parameters that are used in the Delft equations. With respect to the Nexus Project, subsurface parameters were estimated based on site-specific standard penetration test (SPT) data presented in the geotechnical reports prepared by Fugro Consultants, Inc. Since the Delft Method assumes uniform soil conditions, weighted averages of the various material properties of the overburden soils were used in assessing the confining capacity.

5.2. Estimated Annular Pressure

The estimated minimum annular pressure necessary for HDD pilot hole operations was calculated using the Bingham Plastic Model. The Bingham Plastic Model is described in Chapter 4 of Society of Petroleum Engineer's *Applied Drilling Engineering*.[2] Variables with respect to drilling fluid rheology and tooling used in the annular pressure calculations are provided in Table 2.

Table 2: Drilling Fluid Parameters

Drilling Fluid Parameter	Value
Effective Pilot Hole Diameter	14 inches
Drill Pipe Diameter	6.625 inches
Drilling Fluid Weight	11 pounds per gallon
Pump Flow Rate	210 gallons per minute
Yield Point	29 pounds per 100 ft^2
Plastic Viscosity	15 centipoise

[1] *Recommended Guidelines for Installation of Pipelines beneath Levees using Horizontal Directional Drilling*, prepared for U.S. Army Corps of Engineers, Kimberlie Staheli [et al], April 1998

[2] *Applied Drilling Engineering*, Society of Petroleum Engineers, Richardson, Texas, A. T. Bourgoyne, Jr. [et al], 1991

5.3. Hydrofracture Risk Assessment

The results of the hydrofracture risk assessments for applicable crossings on the Nexus Project are included in the site-specific reports.

6. DESIGN CRITERIA

6.1. HDD Path Centerline

An HDD profile design is defined by the following six parameters:

- Entry Point
- Exit Point
- Entry Angle
- Exit Angle
- P.I. Elevation
- Radius Of Curvature

The relationship of these parameters to each other is illustrated in Figure 5.

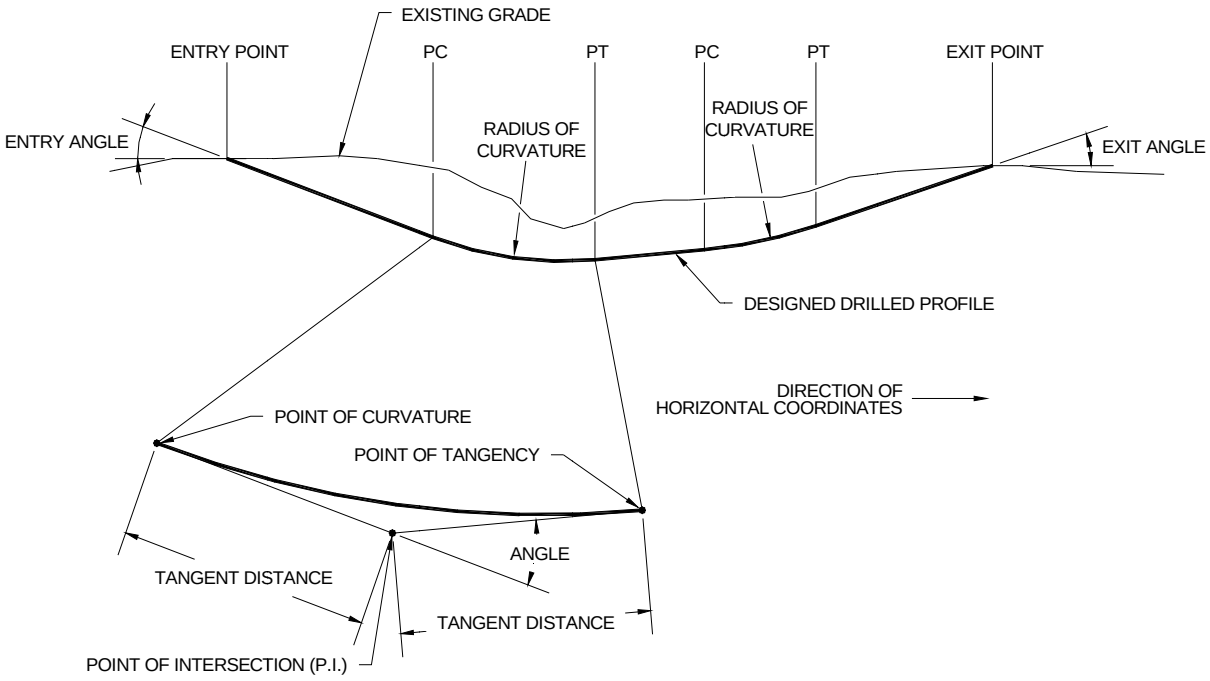

Figure 3: Horizontal Directional Drilling Terminology

6.2. Entry and Exit Points

The entry and exit points are the endpoints of the designed drilled segment on the ground surface. The drilling rig is positioned at the entry point and the pipeline is pulled into the drilled hole through the exit point. The relative locations of the entry and exit points, and consequently

the direction of pilot hole drilling and pullback, should be established by the site's geotechnical and topographical conditions.

The following criteria were used as the basis for selecting entry and exit points on the Nexus Project: 1) steering precision and drilling effectiveness are greater near the drilling rig; 2) drilling fluid returns to the rig are enhanced if the entry point is lower than the exit point; 3) pullback operations are enhanced if there is sufficient work space in line with the drilled path to allow the pull section to be fabricated in one continuous string. It is also important to recognize that the position of the drilling rig may be changed during construction to facilitate operations and a dual rig scenario may be employed during prereaming. In a dual rig scenario rigs are positioned at both ends of the drilled segment and work in tandem.

6.3. Entry and Exit Angles

Ideal or target entry angles are between 8-degrees and 12-degrees, which accommodate most HDD drilling rigs. Target exit angles are between 8-degrees and 10-degrees to facilitate breakover support during pullback. These are consistent with HDD industry design standards.[3] In some cases, where topographic considerations or other site-specific conditions dictated, angles greater than the target values have been used.

6.4. P.I. Elevation

The P.I. elevation defines the depth of cover that the HDD installation will provide under the obstacle. Although experience and judgement with respect to depth of cover must be used on a crossing specific basis, it is generally thought that areas along the HDD alignment with less than 40 feet of cover have a greater susceptibility to inadvertent drilling fluid returns.[4] Standard practice with respect to design depth has slowly evolved over the years, primarily based on field experience and observations as opposed to theoretical methods. Therefore, in order to reduce the risk of drilling fluid impacts (heaving, settlement, and inadvertent returns) the majority of the HDD crossings on the Nexus Project were designed with 40 feet of cover at the target obstacle. However, in some cases, designs may involve less cover if adverse subsurface conditions or other site-specific constraints dictated otherwise.

6.5. Radius of Curvature

The design radius of curvature for HDD segments was set at 3,600 feet. This is consistent with the HDD industry standard design radius of 1,200 times the nominal outside diameter.[5] This relationship has been developed over a period of years in the HDD industry and is based on experience with constructability as opposed to any theoretical analysis.

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[3] *Manual of Practice No. 108, Pipeline Design for Installation by Horizontal Directional Drilling* (Reston, VA: American Society of Civil Engineers, 2005), 15.

[4] *Manual of Practice No. 108*, 50.

[5] *Manual of Practice No. 108*, 16.

7. INSTALLATION LOADS AND STRESSES

During HDD installation, a pipeline segment is subjected to tension, bending, and external pressure as it is pulled through a prereamed hole. The stresses in the pipe and its potential for failure are a result of the interaction of these loads.[6,7] In order to determine if a given pipe specification is adequate, HDD installation loads must first be estimated so that the stresses resulting from these loads can be calculated. A thorough design process requires examination of the stresses that result from each individual installation loading condition as well as an examination of the combined stresses that result from the interaction of these loads.

7.1. HDD Installation Stress Analysis

Calculation of the approximate tensile load required to install a pipeline by HDD is relatively complicated due to the fact that the geometry of the drilled path must be considered along with the properties of the pipe being installed and the subsurface conditions. Assumptions and simplifications are required. A method to accomplish this is presented in *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, published by the Pipeline Research Council International (PRCI).[8]

The PRCI Method involves modeling the drilled path as a series of segments to define its shape and properties during installation. The individual loads acting on each segment are then resolved to determine a resultant tensile load for each segment. The estimated force required to install the entire pull section in the reamed hole is equal to the sum of the tensile loads acting on all of the defined segments. When utilizing the PRCI Method, pulling loads are affected by numerous variables, many of which are dependent upon site-specific conditions and individual contractor practices. These include prereaming diameter, hole stability, removal of cuttings, soil and rock properties, drilling fluid properties, and the effectiveness of buoyancy control measures.[9]

It is important to keep in mind that the PRCI Method considers pulling tension, pipe bending, and external pressure. It does not consider point loads that may result from subsurface conditions such as a rock ledge or boulder. Indeed, we know of no way to analyze potential point loads that may develop due to subsurface conditions. Although this type of damage is relatively rare, several cases have been observed over the last ten years where pipelines suffered damage in the form of dents or pipe deformation due to point loads encountered during HDD installation.

Pulling load calculations for the Nexus Project were completed under two separate installation scenarios. The first is based on the exact design geometry shown on the preliminary plan and profile drawings. The second is based on an assumed worse case installation model in which the pilot hole is drilled 25 feet deeper and 50 feet longer than the designed path with a radius of curvature equal to 50 percent of the design radius (1,800 feet).

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6 Fowler, J.R. and C.G. Langner. "Performance Limits for Deepwater Pipelines." Presentation, OTC 6757, 23rd Annual Offshore Technology Conference, Houston, TX, May 6-9, 1991.

7 Loh, J.T. "A Unified Design Procedure for Tubular Members." Presentation, OTC 6310, 22nd Annual Offshore Technology Conference, Houston, TX, May 7-10, 1990.

8 *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide* (Arlington, VA: Pipeline Research Council International, Inc., 2008), 26-36.

9 *Manual of Practice No. 108*, 42.

The installation stress calculations are based on several assumptions with respect to pipe/soil interaction, conditions of the hole, and drilling fluid properties. One variable, which plays a significant role in the calculated pulling load is the fluid drag coefficient. For pulling load calculations on the Nexus Project, a fluid drag coefficient of 0.025 was assumed. This value is based on research conducted by Jeffrey Puckett[10] and is referenced in the 2008 edition of the PRCI's *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide.* Another variable that has substantial impact on the calculated pulling load is the soil friction coefficient. In this case, a value of 0.30 was assumed, which is generally considered a conservative, upper bound, but reasonable value for pipe and soil interaction in a drilling fluid filled hole. For drilling fluid density, it was assumed the reamed hole would contain a heavy 12 pounds per gallon mixture of drilling fluid and soil cuttings during pullback. For conservative results, it was assumed the pipe will be installed empty, without ballast during pullback.

Anticipated pulling loads as well as the results of the pipe stress calculations can be found in the site-specific reports.

7.2. Operating Stress Analysis

As with a pipeline installed by conventional methods, a pipeline installed by HDD will be subjected to internal pressure, thermal expansion, and external pressure during normal operation. A welded pipeline installed by HDD will also be subjected to elastic bending. The operating loads imposed on a pipeline installed by either of these methods are addressed in Chapter 5 of *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide.*

With one exception, the operating stresses in a pipeline installed by HDD are not materially different from those experienced by pipelines installed by cut and cover techniques. As a result, past procedures for calculating and limiting stresses can be applied. However, unlike a cut and cover installation in which the pipe is bent to conform to the ditch, a pipeline installed by HDD will contain elastic bends.

Flexural stresses associated with elastic bends were analyzed in combination with longitudinal and hoop stresses that develop during hydrostatic testing and subsequent operation of the pipeline to verify that stresses conform to applicable limits specified in ASME B31.8 (2010).

Three scenarios were investigated for the Nexus Project. In the first two scenarios, it was assumed the pipeline would be fully restrained underground, with an initial restraint temperature of 55 °F and an operating temperature of 120 °F. The first scenario involved an elastic radius of 3,600 feet under an operating pressure 1,440 psig. The second scenario involved the same operating pressure but reduces the radius to 1,800 feet. The third scenario assumed that temperatures would be constant under a hydrostatic test pressure of 2,160 psig and a bending radius of 1,800 feet. A summary of the assumptions used in each loading scenario is provided in Table 3.

[10] Puckett, Jeffrey S. "Analysis of Theoretical Versus Actual HDD Pulling Loads." *Volume Two, New Pipeline Technologies, Security and Safety*, 1352. Presentation, Proceedings of the ASCE International Conference on Pipeline Engineering and Construction from The Technical Committee on Trenchless Installation of Pipelines (TIPS) of the Pipeline Division of ASCE, Baltimore, Maryland, July 13-16, 2003.

Table 3: Operational & Hydrotesting Parameters

Scenario	Radius (ft.)	Max. Pressure (psig)	Installation Temperature (ºF)	Max Operating Temperature (ºF)
Number 1 (Operation)	3,600 (Design)	1,440	55	120
Number 2 (Operation)	1,800 50% of Design	1,440	55	120
Number 3 (Hydrotesting)	1,800 50% of Design	2,160	50	50

In summary, pipe stress resulting from each of the loading scenarios is within acceptable limits as defined by B31.8 (2010). A summary of the results is provided in Table 4.

7.3. Minimum Radius

As mentioned previously in this report, the HDD design radius is 3,600 feet. However, since the pilot hole generally deviates from the exact design during construction, a minimum allowable radius has been specified as part of the allowable pilot hole tolerances called out on the drawings. The radius is typically analyzed over a distance of approximately 90 feet (three joints of range 2 drill pipe) during pilot hole drilling and compared against the allowable minimum. In order to facilitate pilot hole drilling and allow the contractor flexibility in the event that steering issues result due to subsurface conditions, JDH&A recommends setting the minimum radius to 50 percent of the design radius (1,800 feet). Operational stress calculations demonstrating the acceptability of the recommended minimum radius are provided in Table 4. Installation loading stresses associated with the minimum radius are provided with the site-specific reports included in the Appendix.

Table 4: Operational Stress Summary

Pipe Properties			
	Scenario 1	Scenario 2	Scenario 3
Pipe Outside Diameter =	36.000 in	36.000 in	36.000 in
Wall Thickness =	0.741 in	0.741 in	0.741 in
Specified Minimum Yield Strength =	70,000 psi	70,000 psi	70,000 psi
Young's Modulus =	2.9E+07 psi	2.9E+07 psi	2.9E+07 psi
Moment of Inertia =	12755.22 in^4	12755.22 in^4	12755.22 in^4
Pipe Face Surface Area =	82.08 in^2	82.08 in^2	82.08 in^2
Diameter to Wall Thickness Ratio, D/t =	49	49	49
Poisson's Ratio =	0.3	0.3	0.3
Coefficient of Thermal Expansion =	6.5E-06 in/in/°F	6.5E-06 in/in/°F	6.5E-06 in/in/°F
Pipe Weight in Air =	279.04 lb/ft	279.04 lb/ft	279.04 lb/ft
Pipe Interior Volume =	6.50 ft^3/ft	6.50 ft^3/ft	6.50 ft^3/ft
Pipe Exterior Volume =	7.07 ft^3/ft	7.07 ft^3/ft	7.07 ft^3/ft
Operating Parameters			
Maximum Allowable Operating Pressure =	1,440 psig	1,440 psig	2,160 psig
Radius of Curvature =	3,600 ft	1,800 ft	1,800 ft
Restraint Temperature =	55 °F	55 °F	55 °F
Operating Temperature =	120 °F	120 °F	55 °F
Groundwater Table Head =	0 ft	0 ft	0 ft
Operating Stress Check	Scenario 1	Scenario 2	Scenario 3
Hoop Stress =	34,980 psi	34,980 psi	52,470 psi
% SMYS =	50%	50%	75%
Longitudinal Stress from Internal Pressure =	10,494 psi	10,494 psi	15,741 psi
% SMYS =	15%	15%	22%
Longitudinal Stress from Temperature Change =	-12,253 psi	-12,253 psi	0 psi
% SMYS =	18%	18%	0%
Longitudinal Stress from Bending =	12,083 psi	24,167 psi	24,167 psi
% SMYS =	17%	35%	35%
Net Longitudinal Stress (taking bending in tension) =	10,325 psi	22,408 psi	39,908 psi
Limited to 90% of SMYS by ASME B31.8 (2010) B31.4 (2012) =	15% ok	32% ok	57%
Net Longitudinal Stress (taking bending in compression) =	-13,842 psi	-25,925 psi	-8,426 psi
Limited to 90% of SMYS by ASME B31.8 (2010) B31.4 (2012) =	20% ok	37% ok	12%
Combined Stress (NLS w/bending in tension) - Max Shear Stress Theory =	24,655 psi	12,572 psi	12,562 psi
Limited to 90% of SMYS by ASME B31.8 (2010) B31.4 (2012) =	35% ok	18% ok	18%
Combined Stress (NLS w/bending in compression) - Max Shear Stress Theory =	48,822 psi	60,905 psi	60,895 psi
Limited to 90% of SMYS by ASME B31.8 (2010) B31.4 (2012) =	70% ok	87% ok	87%
Combined Stress (NLS w/bending in tension) - Max. Distortion Energy Theory =	31,129 psi	30,690 psi	47,453 psi
Limited to 90% of SMYS by ASME B31.8 (2010) B31.4 (2012) =	44% ok	44% ok	68%
Combined Stress (NLS w/bending in compress.) - Max. Distortion Energy Theory =	43,582 psi	52,939 psi	57,150 psi
Limited to 90% of SMYS by ASME B31.8 (2010) B31.4 (2012) =	62% ok	76% ok	82%

8. CONSTRUCTION DURATION

Estimates of the duration of HDD activities at each crossing site have been prepared based on assumed production rates for the various phases of HDD operations taking into account the crossing lengths, the product line diameter, and subsurface conditions. The duration estimates cover drilling services only (pilot hole through pullback) and do not include installation of surface casings that may be installed at the contractor's option or support operations that are typically provided by a prime contractor (i.e. site preparation & restoration, pull section

fabrication, hydrostatic testing). Additionally, the duration estimates do not include contingency to account for operational problems that may occur during construction. Bearing in mind that unanticipated operational problems are relatively common on HDD installations, actual construction durations can be expected to exceed the estimated durations by some amount. In some extreme cases, the duration may be increased by 50 to 100 percent.

Estimated durations for each crossing are presented in Table 5. Details with respect to the individual crossing estimates are provided in the site-specific reports.

Table 5: Estimated HDD Construction Durations

Mile Post	Crossing Name	True Length (feet)	Construction Duration (days)
7.9	Wetland	2,959	73
40.8	Nimisila Reservoir	1,543	15*
47.8	Tuscarawas River	3,304	88
71.1	Wetland	1,634	13
86.5	East Branch Black River	1,882	48
92.2	West Branch Black River	1,681	39*
104.1	Vermilion River	2,968	73
110.1	Interstate 80	1,439	38
116.8	Huron River	2,437	60
145.7	Sandusky River	2,172	56
162.4	Portage River	1,629	42
179.8	Findlay Road	1,528	13
181.2	Maumee River	4,018	81
215.0	River Raisin	1,485	13
237.4	Saline River	1,320	12
250.7	Hydro Park	2,291	26
251.5	Interstate 94	1,366	12

*Based on assumed subsurface conditions

9. RISK ASSESSMENT

The relative risk associated with installation by HDD at each crossing location has been categorized as Low, Average, or High. This categorization is presented in the site specific reports under the sections titled “Risk Identification and Assessment.

For the purposes of this report, risk is defined as the possibility of experiencing serious operational problems that result in significant delays or cost overruns. For example, an HDD pull section may become stuck during pull back requiring either remedial action to recover the partially installed pipeline or abandonment of the pipeline in place. The latter instance would require a new pilot hole to be drilled and reamed with a probable doubling of drilling duration and cost. This would be a significant delay and cost overrun.

Additional discussions relative to site-specific operational problems that may occur during HDD construction on the Nexus Project are in the site-specific reports included in the Appendix. Further discussion concerning HDD operational problems and contingency planning is included

in the project-specific document titled “Nexus Gas Transmission Project, HDD Monitoring and Contingency Plan.”

APPENDIX

Crossing Specific Reports

MP 7.9 Wetland

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR and traditional survey data covering the proposed crossing location
- Draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Wetland No. 7 HDD Crossing, Nexus Gas Transmission Project, Columbiana County, Ohio" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The proposed 36-inch wetland crossing at pipeline Mile Post 7.9 is located near the intersection of Knox School Road and New Garden Avenue, about 5 miles northeast of Minerva, Ohio. The crossing involves passing beneath the wetland and Knox School Road. The wetland is approximately 450 feet wide and is located in a topographically low-lying area bound to the east by Knox School Road and open farm fields to the west. The east side of the crossing involves a mixture of wooded plots surrounding a commercial orchard. The west side of the crossing is primarily open farm fields. The topography in the area is gently rolling with steep slopes down to the wetland. The relief from the top of the slopes to the bottom of the valley where the wetland is located is about 150 feet. Figure 1 provides a general overview of the vicinity of the crossing.

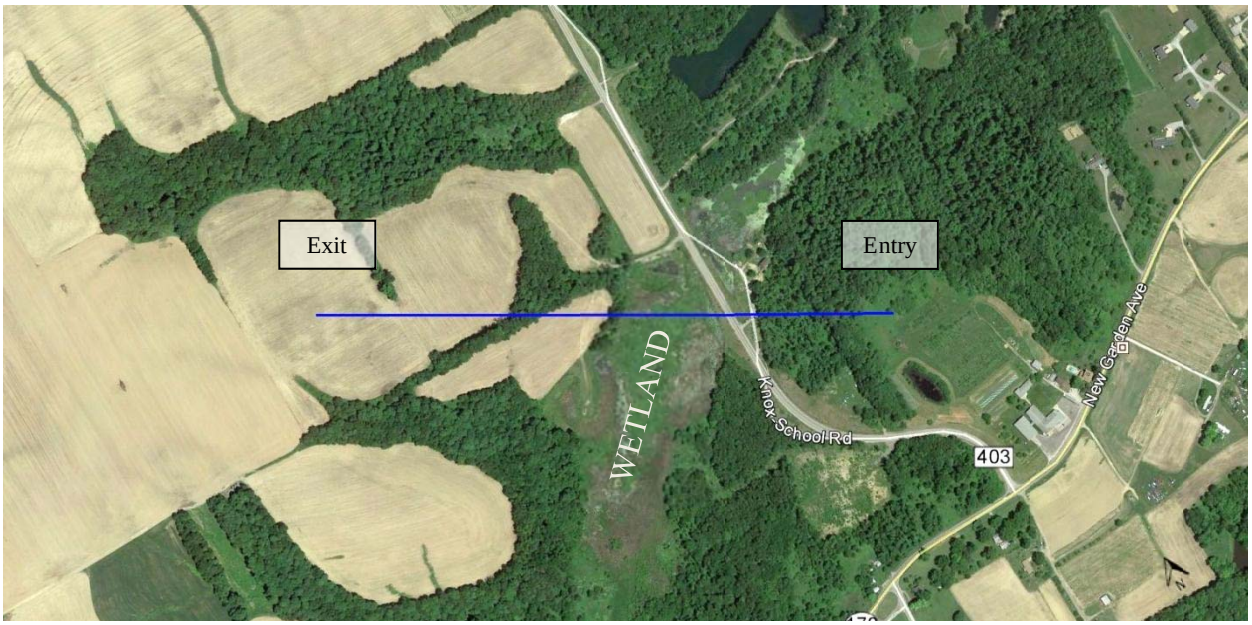


Figure 1: Overview of the Wetland Crossing at M.P. 7.9

Subsurface Conditions

Four geotechnical exploratory borings were taken as part of the site investigation conducted by Fugro Consultants, Inc. Borings WL7-01 and WL7-02 were taken on the east side of the wetland and borings WL7-03 and WL7-04 were taken on the west side of the wetland. Each of the borings encountered approximately 15 to 30 feet of overburden soil (sand, silty sand, clayey sand and some gravel) overlying sedimentary bedrock in the form of sandstone, siltstone, claystone, shale, and occasional coal beds. Unconfined compressive strength of the bedrock generally fell in the range of 2,000 psi to 6,000 psi. Rock quality designation (RQD) indicates good quality, competent bedrock overall.

Refer to the draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Wetland No. 7 HDD Crossing, Nexus Gas Transmission Project, Columbiana County, Ohio" and dated September 11, 2015 for detailed information relative to the subsurface layers.

Design Geometry & Layout

The proposed wetland crossing involves a horizontal length of 2,931 feet. It utilizes a 12-degree entry angle, an 8-degree exit angle, and a radius of curvature of 3,600 feet. The crossing design is based on obtaining a minimum of 40 feet of cover beneath the wetland and Knox School Road.

The exit point is located on the west side of the crossing to take advantage of available workspace for pull section fabrication, which will allow the pull section to be fabricated in a single segment, thus avoiding the potential risk of getting stuck during downtime associated with a tie-in weld during pullback. The entry point is located in an open field behind a commercial orchard.

The proposed HDD design, as well as available workspace for HDD operations, is shown on the preliminary HDD plan and profile drawing included at the end of this site-specific report.

Assessment of Feasibility

Based on a review of available geotechnical and other site-specific mapping, the proposed 36-inch wetland crossing is feasible. Although large diameter rock crossings do involve higher risk of HDD operational problems, given the proposed length and the fact that the crossing involves passing through relatively soft sedimentary rock formations, it is our opinion that with the right downhole tool selections and sound planning, skilled and experienced HDD contractors will not have significant difficulties.

Risk Identification and Assessment

Potential construction impacts resulting from installation by HDD include damage to Knox School Road in the form of heaving or settlement, as well as drilling fluid surfacing within the wetland. In this case, due to the topographic relief and relative depth of the crossing compared to the entry point (177 feet), annular pressure will be high due to the height of the drilling fluid column. Since the crossing will be installed through bedrock, drilling fluid may flow through existing fractures or joints and make its way to the ground surface. Therefore, the risk of

inadvertent drilling fluid returns within the wetland is increased at this location. There is also increased risk of the development of sinkholes or surface settlement along the HDD alignment on the west end of the crossing during reaming operations. This is due to the 16 foot elevation differential between the entry and exit points. The risk of sinkholes is greatest within 115 feet of the exit point.

HDD construction and operational risks associated with the crossing include failure of large diameter rock reaming tools downhole, hole misalignment at the soil/rock interface which can lead to downhole tools or the pull section getting lodged, and loss of drilling fluid circulation through existing fractures which could negatively impact cuttings removal. In addition, sink holes (hole collapse) on the west side resulting from the elevation differential may increase the difficulty of reaming and cuttings removal.

The overall risk level associated with the proposed 36-inch wetland crossing is considered average.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the crossing, without ballast, is 492,725 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 521,640 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 2. Detailed calculations for each loading scenario are summarized in Figures 3 and 4.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 2: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	1131.7	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	119,497	lb			
Fluidic Drag = 12 π D L C_d =	38,396	lb			
Axial Segment Weight = W_e L sinθ =	55,981	lb			
Pulling Load on Exit Tangent =	**213,875**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	270,090	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	8.77	ft	j = [(E I) / T]$^{1/2}$ =	1.170	
Y = [18 (L)^2] - [(j^6 (1 - cosh(U/2)$^{-1}$] =	3.4E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	929.55	
U = (12 L) / j =	5.15		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	138,187	lb
Bending Frictional Drag = 2 μ N =	82,912	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	12,463	lb			
Pulling Load on Exit Sag Bend =	**112,430**	**lb**			
Total Pulling Load =	**326,305**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	100.0	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	10,664	lb			
Fluidic Drag = 12 π D L C_d =	3,393	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**14,057**	**lb**			
Total Pulling Load =	**340,362**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	754.0	ft	Average Tension, T =	401,395	lb
Segment Angle with Horizontal, θ =	12.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	6.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	19.72	ft	j = [(E I) / T]$^{1/2}$ =	960	
Y = [18 (L)^2] - [(j^6 (1 - cosh(U/2)$^{-1}$] =	9.3E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1782.04	
U = (12 L) / j =	9.43		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	207,497	lb
Bending Frictional Drag = 2 μ N =	124,498	lb			
Fluidic Drag = 12 π D L C_d =	25,582	lb			
Axial Segment Weight = W_e L sinθ =	-28,013	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**122,067**	**lb**			
Total Pulling Load =	**462,429**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	470.9	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	12.0	°			
Frictional Drag = W_e L μ cosθ =	49,120	lb			
Fluidic Drag = 12 π D L C_d =	15,979	lb			
Axial Segment Weight = W_e L sinθ =	-34,802	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**30,296**	**lb**			
Total Pulling Load =	**492,725**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	6,003	ok	0	ok	0	ok	0.10	ok	0.01	ok
	5,634	ok	0	ok	1483	ok	0.09	ok	0.06	ok
PC	5,634	ok	12,083	ok	1483	ok	0.35	ok	0.17	ok
	4,147	ok	12,083	ok	2674	ok	0.33	ok	0.27	ok
PT	4,147	ok	0	ok	2674	ok	0.07	ok	0.15	ok
	3,975	ok	0	ok	2674	ok	0.06	ok	0.15	ok
PC	3,975	ok	12,083	ok	2674	ok	0.33	ok	0.27	ok
	2,606	ok	12,083	ok	2143	ok	0.31	ok	0.19	ok
PT	2,606	ok	0	ok	2143	ok	0.04	ok	0.09	ok
Exit Point	0	ok	0	ok	-242	ok	0.00	ok	0.00	ok

Figure 3: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	
Pipe Weight, W =	279.0	lb/ft	
Coefficient of Soil Friction, μ =	0.30		
Fluid Drag Coefficient, C_d =	0.025	psi	
Ballast Weight / ft Pipe, W_b =	405.5	lb	(If Ballasted)
Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb	(If Submerged)
Above Ground Load =	0	lb	

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	1437.2	ft	Effective Weight, $W_e = W + W_b - W_m$ = -355.4 lb/ft
Exit Angle, θ =	8.0	°	
Frictional Drag = W_e L μ cosθ =	151,756	lb	
Fluidic Drag = 12 π D L C_d =	48,762	lb	
Axial Segment Weight = W_e L sinθ =	71,093	lb	
Pulling Load on Exit Tangent =	**271,612**	**lb**	

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	313,529	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-4.0	°	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1,086	
Y = [18 $(L)^2$] - [(j^2 (1 - cosh(U/2)$^{-1}$] =	5.1E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	274.54	
U = (12 L) / j =	2.78		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	115,128	lb
Bending Frictional Drag = 2 μ N =	69,077	lb			
Fluidic Drag = 12 π D L C_d =	8,527	lb			
Axial Segment Weight = W_e L sinθ =	6,231	lb			
Pulling Load on Exit Sag Bend =	**83,836**	**lb**			
Total Pulling Load =	**355,447**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	169.6	ft	Effective Weight, $W_e = W + W_b - W_m$ = -355.4 lb/ft
Frictional Drag = W_e L μ =	18,081	lb	
Fluidic Drag = 12 π D L C_d =	5,753	lb	
Axial Segment Weight = W_e L sinθ =	0	lb	
Pulling Load on Bottom Tangent =	**23,834**	**lb**	
Total Pulling Load =	**379,281**	**lb**	

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	377.0	ft	Average Tension, T =	425,360	lb
Segment Angle with Horizontal, θ =	12.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	6.0	°	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	9.86	ft	j = [(E I) / T]$^{1/2}$ =	933	
Y = [18 $(L)^2$] - [(j^2 (1 - cosh(U/2)$^{-1}$] =	1.8E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	671.94	
U = (12 L) / j =	4.85		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	155,622	lb
Bending Frictional Drag = 2 μ N =	93,373	lb			
Fluidic Drag = 12 π D L C_d =	12,791	lb			
Axial Segment Weight = W_e L sinθ =	-14,007	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**92,158**	**lb**			
Total Pulling Load =	**471,439**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	780.4	ft	Effective Weight, $W_e = W + W_b - W_m$ = -355.4 lb/ft
Entry Angle, θ =	12.0	°	
Frictional Drag = W_e L μ cosθ =	81,394	lb	
Fluidic Drag = 12 π D L C_d =	26,477	lb	
Axial Segment Weight = W_e L sinθ =	-57,669	lb	Negative value indicates axial weight applied in direction of installation
Pulling Load on Entry Tangent =	**50,202**	**lb**	
Total Pulling Load =	**521,640**	**lb**	

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	6,355	ok	0	ok	0	ok	0.10	ok	0.01	ok
	5,744	ok	0	ok	2457	ok	0.09	ok	0.14	ok
PC	5,744	ok	24,167	ok	2457	ok	0.62	ok	0.48	ok
	4,621	ok	24,167	ok	3052	ok	0.60	ok	0.54	ok
PT	4,621	ok	0	ok	3052	ok	0.07	ok	0.20	ok
	4,330	ok	0	ok	3052	ok	0.07	ok	0.19	ok
PC	4,330	ok	24,167	ok	3052	ok	0.60	ok	0.53	ok
	3,309	ok	24,167	ok	2787	ok	0.58	ok	0.47	ok
PT	3,309	ok	0	ok	2787	ok	0.05	ok	0.16	ok
Exit Point	0	ok	0	ok	-242	ok	0.00	ok	0.00	ok

Figure 4: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

The proposed wetland crossing will be installed almost entirely through sedimentary bedrock. Since the Delft Method (discussed previously in Section 5) is only applicable to uncemented subsurface material, a hydrofracture evaluation was not completed. In general, inadvertent drilling fluid returns due to hydrofracture do not typically occur on rock crossings, but instead occur by flowing through existing fractures, joints, or solution cavities.

Construction Duration

The estimated duration of construction is 73 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as JDH&A's past experience in similar subsurface conditions. Refer to Figure 5 for details relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments						
Work Schedule, hours/shift =	12.0	36" Wetland Crossing (MP 7.9)						
days/week =	7.0							
Drilled Length, feet =	2,959							
Pilot Hole								
Production Rate, feet/hour =	20							
shifts/day =	1							
Drilling Duration, hours =	148.0							
shifts =	12.3							
Trips to change tools, shifts =	1.0							
Pilot Hole Duration, days =	13.3							
Ream and Pull Back								
Pass Description =	24-inch	36-inch	48-inch			Swab	Pull Back	Total
Travel Speed, feet/minute =	0.3	0.3	0.3			8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0	15.0			15.0	15.0	
shifts/day =	1	1	1			1	1	
Reaming Duration, hours =	200.4	200.4	200.4			9.3	11.4	622.1
shifts =	16.7	16.7	16.7			0.8	1.0	51.8
Rig up, shifts =	0.5	0.5	0.5			0.5	0.5	2.5
Trips to change tools, shifts =	1.0	1.0	1.0			0.0		3.0
Pass Duration, days =	18.2	18.2	18.2			1.3	1.5	57.3
Summary								
HDD Duration at Site, days =	72.7							
Site Establishment	Move in	Rig Up	Rig Down	Move Out				
shifts/day =	1	1	1	1				
shifts =	0.5	1.0	1.0	0.5				
days =	0.5	1.0	1.0	0.5				

Figure 5: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.

PLAN

SCALE: 1" = 200'

EXIT POINT @ 8°
29+30.81, 1279.18
N 14815990.51, E 1629787.83

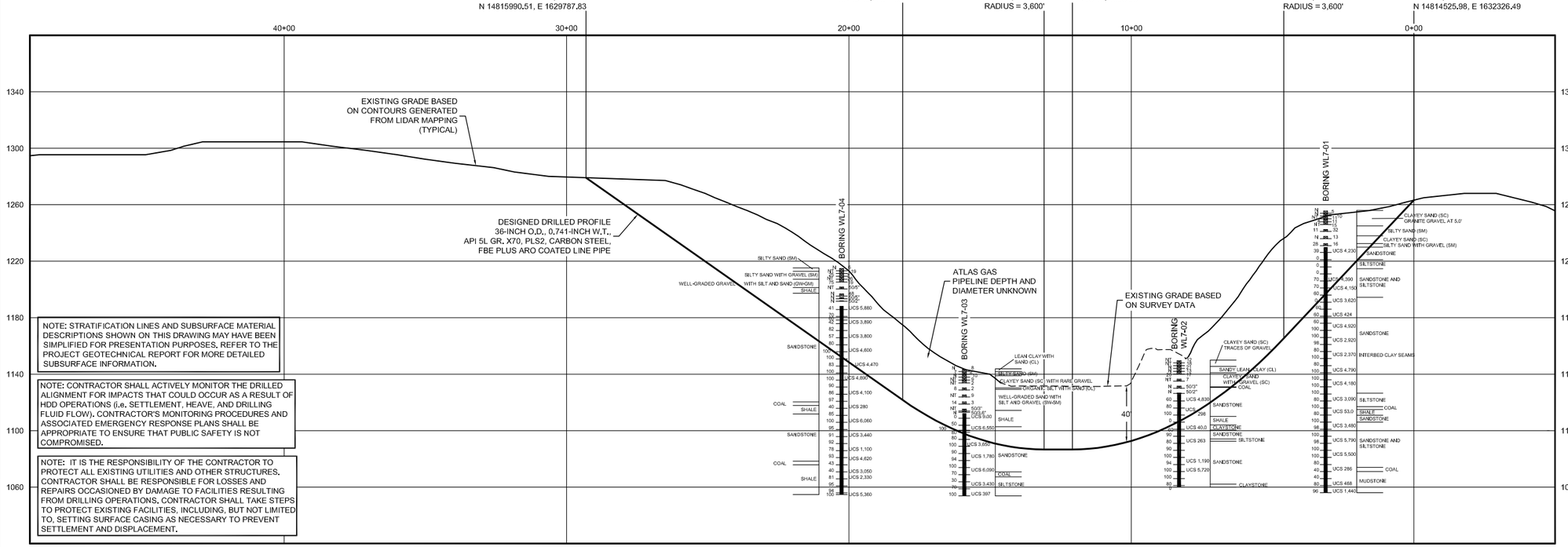
P.T. 8° SAG BEND
18+10.16, 1121.69

P.C. 8° SAG BEND
13+09.13, 1086.65
RADIUS = 3,600'

P.T. 12° SAG BEND
12+09.13, 1086.65

P.C. 12° SAG BEND
4+60.65, 1165.32
RADIUS = 3,600'

ENTRY POINT @ 12°
0+00.00, 1263.23
N 14814525.98, E 1632326.49



NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

PROFILE

SCALE: 1" = 200' HORIZONTAL
1" = 40' VERTICAL

500 400 300 200 100 0

40 20 0

ALIGNMENT LEGEND

- PIPELINE MILEPOST (M 0.0 P)
- PIPELINE
- INTERCONNECTING PIPELINE
- CONSTRUCTION LIMIT
- STUDY CORRIDOR
- STAGING AREA
- WAREYARD
- PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- METERING & REGULATION STATION (M&R)
- COMPRESSOR STATION SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- APPROXIMATE WETLAND BOUNDARY
- APPROXIMATE WATERBODY BANK
- APPROXIMATE WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD (PAR-0.0)
- TEMPORARY ACCESS ROAD (TAR-0.0)
- PARCEL TRACT NO (CH-CO-011.0000-SC)
- PROPERTY LINE
- CONTOUR (--120'--)
- MUNICIPALITY LINE
- FENCE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- TELEPHONE
- TEE TAP
- BLOW OFF VALVE
- TOWER
- HORIZONTAL DIRECTIONAL DRILLING
- TANK (LIGHT POLE, FIRE HYDRANT)
- WELL: GAS, WATER, OIL, UNKNOWN
- UTILITY LINES
- MAINLINE VALVE (MLV)
- MICROWAVE TOWER

GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

Ⓑ BORING LOCATION

SPLIT SPOON SAMPLE

53 / X / 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE

UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
TSS 1,350 — TENSILE SPLITTING STRENGTH (PSI)
53 / 6 — MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA, REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.

2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.

3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW, HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
HANO-A-1010	ALIGNMENT SHEET M.P. 7.97 TO M.P. 8.91				
HANO-A-1009	ALIGNMENT SHEET M.P. 7.02 TO M.P. 7.97	0	LKB	ACM	ISSUED FOR FERC

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS	PRELIMINARY		CONSTRUCTION		
DRAWN BY:	ACM	08/07			
PROJECT MANAGER	JMS	08/07			
DESIGN ENGINEER	ACM	08/07			
DESIGN CHECKER	DLB	08/07			
TITLE	SIGNATURE	DATE	SIGNATURE	DATE	

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH WETLAND CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING
COLUMBIANA COUNTY, OHIO

NEXUS SM
GAS TRANSMISSION

M.P. 7.9	W.O.	SCALE: AS SHOWN	DWG. HANO-H-1001	REV. 0

MP 40.8 Nimisila Reservoir

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR, hydrographic, and traditional survey data covering the proposed crossing location
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The 36-inch Nimisila Reservoir Crossing is located near the intersection of East Comet Road and Christman Road, just south of Akron, Ohio. The primary obstacles that will be crossed are Christman Road and the Nimisila Reservoir. The reservoir is approximately 315 feet wide, and based on hydrographic survey points, about 5 feet deep. The proposed HDD alignment follows an existing overhead power corridor. Both sides of the crossing consist of wooded and agricultural land. The topography in the area is gently rolling. Refer to Figure 1 for a general overview of the vicinity of the crossing.

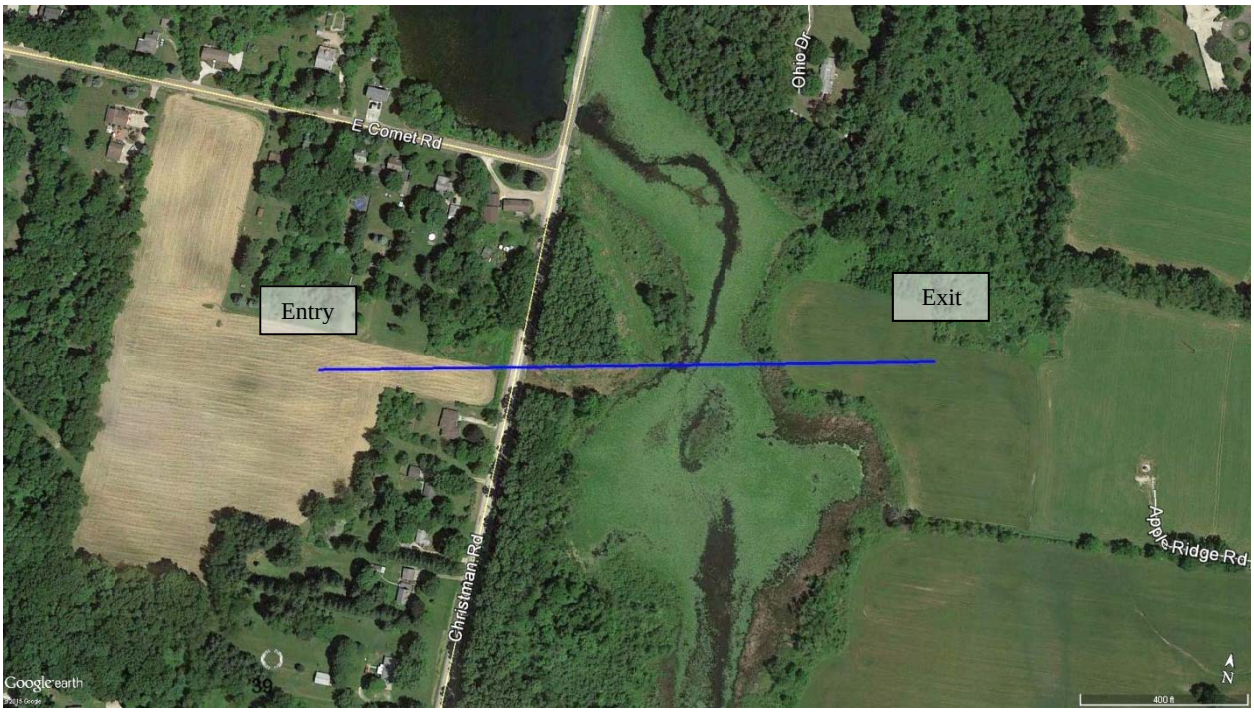


Figure 1: Overview of the Nimisila Reservoir Crossing

Subsurface Conditions

At the time of this writing, site-specific subsurface information is not yet available.

Design Geometry & Layout

The proposed Nimisila Reservoir HDD design involves a horizontal length of 1,536 feet. It utilizes a 10-degree entry angle, an 8-degree exit angle, and a radius of curvature of 3,600 feet. The crossing design is based on obtaining 40 feet of cover beneath the reservoir and Christman Road, and 20 feet of cover beneath the top of the slope on the west side of Christman Road.

The entry point is located on the west side of Christman Road in an open farm field. The exit point is located on the east side of the crossing to take advantage of available workspace for pull section fabrication, which allows the pull section to be fabricated in a single segment.

The proposed HDD design, as well as available workspace for HDD operations, is shown on the preliminary HDD plan and profile drawing included in this site-specific report.

Assessment of Feasibility

Overall, given the length and diameter of the proposed installation, it is within the range of what has been successfully completed using HDD in the past. However, the feasibility will need to be confirmed when site-specific geotechnical data is available.

Risk Identification and Assessment

Potential construction impact resulting from HDD operations include damage to Christman Road in the form of heaving or settlement, drilling fluid surfacing within the reservoir, and formation of sink holes on the west side of the crossing during reaming operations due to the 15 foot elevation differential between the entry and exit points.

Based on the length of the proposed Nimisila Reservoir crossing, it is considered to have a low level of risk. However, risk should be re-evaluated after site-specific geotechnical information is available.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 267,635 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 289,163 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 2. Detailed calculations for each loading scenario are summarized in Figures 3 and 4.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 2: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	148.5	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	15,679	lb			
Fluidic Drag = 12 π D L C_d =	5,038	lb			
Axial Segment Weight = W_e L sinθ =	7,345	lb			
Pulling Load on Exit Tangent =	**28,062**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	80,392	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	8.77	ft	j = [(E I) / T]$^{1/2}$ =	2,145	
Y = [18 $(L)^2$] - [(j / 2) tanh(U/2)] =	2.1E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	557.02	
U = (12 L) / j =	2.81		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	125,236	lb
Bending Frictional Drag = 2 μ N =	75,141	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	12,463	lb			
Pulling Load on Exit Sag Bend =	**104,659**	**lb**			
Total Pulling Load =	**132,721**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	171.9	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	18,326	lb			
Fluidic Drag = 12 π D L C_d =	5,831	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**24,158**	**lb**			
Total Pulling Load =	**156,879**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	206,239	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	1,339	
Y = [18 $(L)^2$] - [(j / 2) tanh(U/2)] =	5.5E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1220.13	
U = (12 L) / j =	5.63		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	161,443	lb
Bending Frictional Drag = 2 μ N =	96,866	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	-19,464	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**98,720**	**lb**			
Total Pulling Load =	**255,599**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	92.0	ft	Effective Weight, W_e = W + W_b - W_m =	279.0	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	7,581	lb			
Fluidic Drag = 12 π D L C_d =	0	lb	Fluidic drag is calculated as zero unless entire segment is submerged in drilling fluid. Please reference Step 2 Drilled Path Input		
Axial Segment Weight = W_e L sinθ =	4,456	lb			
Pulling Load on Entry Tangent =	**12,036**	**lb**			
Total Pulling Load =	**267,635**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,261	ok	0	ok	0	ok	0.05	ok	0.00	ok
	3,114	ok	0	ok	0	ok	0.05	ok	0.00	ok
PC	3,114	ok	12,083	ok	0	ok	0.31	ok	0.07	ok
	1,911	ok	12,083	ok	831	ok	0.30	ok	0.09	ok
PT	1,911	ok	0	ok	831	ok	0.03	ok	0.02	ok
	1,617	ok	0	ok	831	ok	0.03	ok	0.02	ok
PC	1,617	ok	12,083	ok	831	ok	0.29	ok	0.09	ok
	342	ok	12,083	ok	300	ok	0.27	ok	0.06	ok
PT	342	ok	0	ok	300	ok	0.01	ok	0.00	ok
Exit Point	0	ok	0	ok	-12	ok	0.00	ok	0.00	ok

Figure 3: Installation Loading and Stress Analysis (As-Designed Scenario)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	
Pipe Weight, W_s =	279.0	lb/ft	
Coefficient of Soil Friction, μ =	0.30		
Fluid Drag Coefficient, C_d =	0.025	psi	
Ballast Weight / ft Pipe, W_b =	405.5	lb	(If Ballasted)
Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb	(If Submerged)
Above Ground Load =	0	lb	

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	454.0	ft	
Exit Angle, θ =	8.0	°	
Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft	
Frictional Drag = W_e L μ cosθ =	47,938	lb	
Fluidic Drag = 12 π D L C_d =	15,403	lb	
Axial Segment Weight = W_e L sinθ =	22,458	lb	
Pulling Load on Exit Tangent =	**85,799**	**lb**	

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	123,105	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-4.0	°	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1,733	
Y = [18 (L^2) - [(j)^2 (1 - cosh(U/2)$^{-1}$)] =	2.7E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	146.12	
U = (12 L) / j =	1.74		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	99,753	lb
Bending Frictional Drag = 2 μ N =	59,852	lb			
Fluidic Drag = 12 π D L C_d =	8,527	lb			
Axial Segment Weight = W_e L sinθ =	6,231	lb			
Pulling Load on Exit Sag Bend =	**74,611**	**lb**			
Total Pulling Load =	**160,410**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	185.5	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Frictional Drag = W_e L μ =	19,785	lb			
Fluidic Drag = 12 π D L C_d =	6,295	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**26,081**	**lb**			
Total Pulling Load =	**186,491**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	222,638	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
h = R[1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,289	
Y = [18 (L^2) - [(j)^2 (1 - cosh(U/2)$^{-1}$)] =	8.5E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	363.66	
U = (12 L) / j =	2.92		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	118,944	lb
Bending Frictional Drag = 2 μ N =	71,366	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**72,293**	**lb**			
Total Pulling Load =	**258,784**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	393.4	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	41,312	lb			
Fluidic Drag = 12 π D L C_d =	13,348	lb			
Axial Segment Weight = W_e L sinθ =	-24,282	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**30,379**	**lb**			
Total Pulling Load =	**289,163**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,523	ok	0	ok	0	ok	0.06	ok	0.00	ok
	3,153	ok	0	ok	795	ok	0.05	ok	0.02	ok
PC	3,153	ok	24,167	ok	795	ok	0.58	ok	0.28	ok
	2,272	ok	24,167	ok	1210	ok	0.57	ok	0.29	ok
PT	2,272	ok	0	ok	1210	ok	0.04	ok	0.03	ok
	1,954	ok	0	ok	1210	ok	0.03	ok	0.03	ok
PC	1,954	ok	24,167	ok	1210	ok	0.56	ok	0.28	ok
	1,045	ok	24,167	ok	944	ok	0.55	ok	0.25	ok
PT	1,045	ok	0	ok	944	ok	0.02	ok	0.02	ok
Exit Point	0	ok	0	ok	-12	ok	0.00	ok	0.00	ok

Figure 4: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

At the time of this writing, site-specific geotechnical data is not available. Therefore, a hydrofracture evaluation could not be completed.

Construction Duration

The estimated duration of construction is 15 days based on assumed subsurface conditions consisting of silt, sand, and clay. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as JDH&A's past experience in similar subsurface conditions. Refer to Figure 5 for details relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments
Work Schedule, hours/shift =	12.0	36" Nimisila Reservoir Crossing. Subsurface assumed to consist of silt/sand/clay.
days/week =	7.0	
Drilled Length, feet =	1,543	
Pilot Hole		
Production Rate, feet/hour =	50	
shifts/day =	1	
Drilling Duration, hours =	30.9	
shifts =	2.6	
Trips to change tools, shifts =	0.5	
Pilot Hole Duration, days =	3.1	

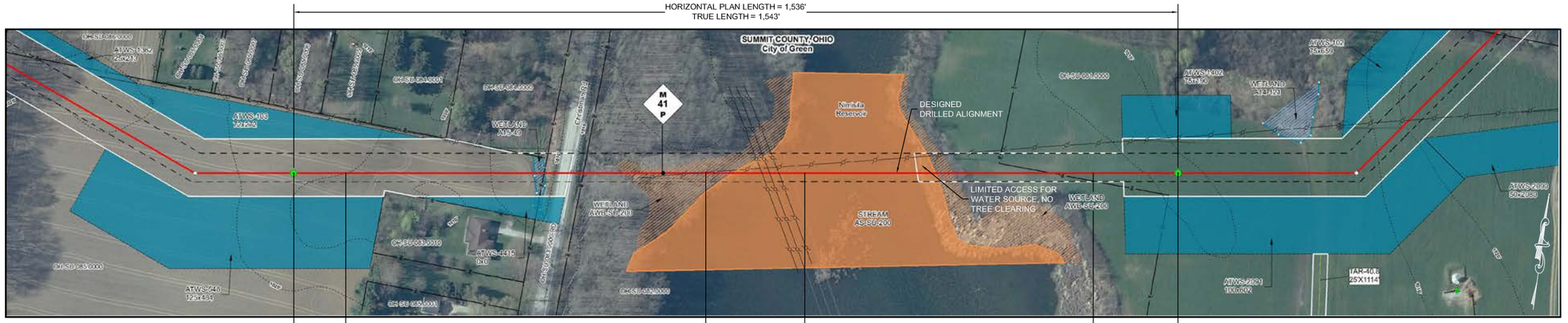
Ream and Pull Back								
Pass Description =	36-inch	48-inch				Swab	Pull Back	Total
Travel Speed, feet/minute =	1.0	1.0				8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0				15.0	15.0	
shifts/day =	1	1				1	1	
Reaming Duration, hours =	27.4	27.4				4.9	5.9	65.6
shifts =	2.3	2.3				0.4	0.5	5.5
Rig up, shifts =	0.5	0.5				0.5	0.5	2.0
Trips to change tools, shifts =	1.0	1.0				0.0		2.0
Pass Duration, days =	3.8	3.8				0.9	1.0	9.5

Summary	
HDD Duration at Site, days =	14.5

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 5: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN
SCALE: 1" = 100'

ENTRY POINT @ 10°
0+00.00, 1023.78
N 14863117.81, E 1497500.44

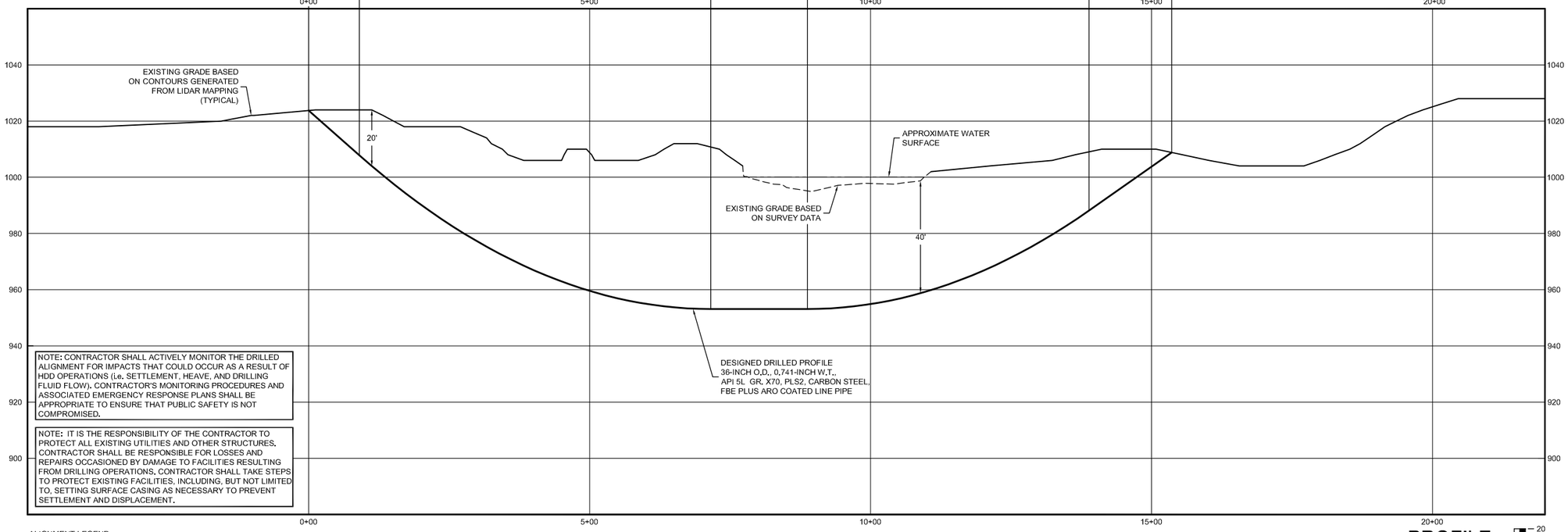
P.C. 10° SAG BEND
0+90.53, 1007.82
RADIUS = 3,600'

P.T. 10° SAG BEND
7+15.67, 953.12

P.C. 8° SAG BEND
8+87.55, 953.12
RADIUS = 3,600'

P.T. 8° SAG BEND
13+88.58, 988.16

EXIT POINT @ 8°
15+35.62, 1008.82
N 14863326.65, E 1499021.79



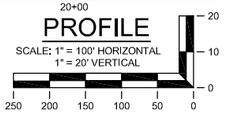
NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PIPELINE
- INTERCONNECTING PIPELINE
- CONSTRUCTION LIMIT
- STUDY CORRIDOR
- STAGING AREA
- WAREYARD
- PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- METERING & REGULATION STATION (M&R)
- COMPRESSOR STATION SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- APPROXIMATE WETLAND BOUNDARY
- APPROXIMATE WATERBODY BANK
- APPROXIMATE WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD (PAR-0.0)
- TEMPORARY ACCESS ROAD (TAR-0.0)
- PARCEL TRACT NO (OH-CG-011.0000-SC)
- PROPERTY LINE
- CONTOUR (120')
- MUNICIPALITY LINE
- FENCE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- TELEPHONE
- TEE TAP
- BLOW OFF VALVE
- TOWER
- HORIZONTAL DIRECTIONAL DRILLING
- TANK
- WELL: GAS, WATER, OIL
- UTILITY LINES
- MAINLINE VALVE (MLV)
- MICROWAVE TOWER
- LIGHT POLE
- FIRE HYDRANT
- UNKNOWN

PROFILE
SCALE: 1" = 100' HORIZONTAL
1" = 20' VERTICAL



GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW. HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE.

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
HANO-A-1048	ALIGNMENT SHEET M.P. 40.41 TO M.P. 41.36	0	LKB	ACM	ISSUED FOR FERC

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	LKB	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	LKB	08/07		
DESIGN CHECKER	DLB	08/07		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH NIMISILA RESERVOIR CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING
SUMMIT COUNTY, OHIO

NEXUS SM
GAS TRANSMISSION

M.P. 40.8 | W.O. | SCALE: AS SHOWN | DWG. HANO-H-1002 | REV. 0

MP 47.8 Tuscarawas River

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR, hydrographic, and traditional survey data covering the proposed crossing location
- Draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Tuscarawas River HDD Crossing, Nexus Gas Transmission Project, Summit County, Ohio" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The 36-inch Tuscarawas River Crossing is located near pipeline Mile Post 48, south of Barberton, Ohio. It involves passing beneath the Tuscarawas River, a railroad, and Van Buren Road. The Tuscarawas River is approximately 80 feet from bank to bank at the crossing location, and less than 2 feet deep at the deepest point. The proposed HDD alignment runs parallel to an existing power line corridor. The topography slopes moderately steeply toward the river with an elevation change of approximately 160 feet over approximately 1,000 feet horizontal. The land on each side of the river consists of a mixture of wooded patches and agricultural land. An overview of the proposed crossing location is provided in Figure 1 through Figure 3.

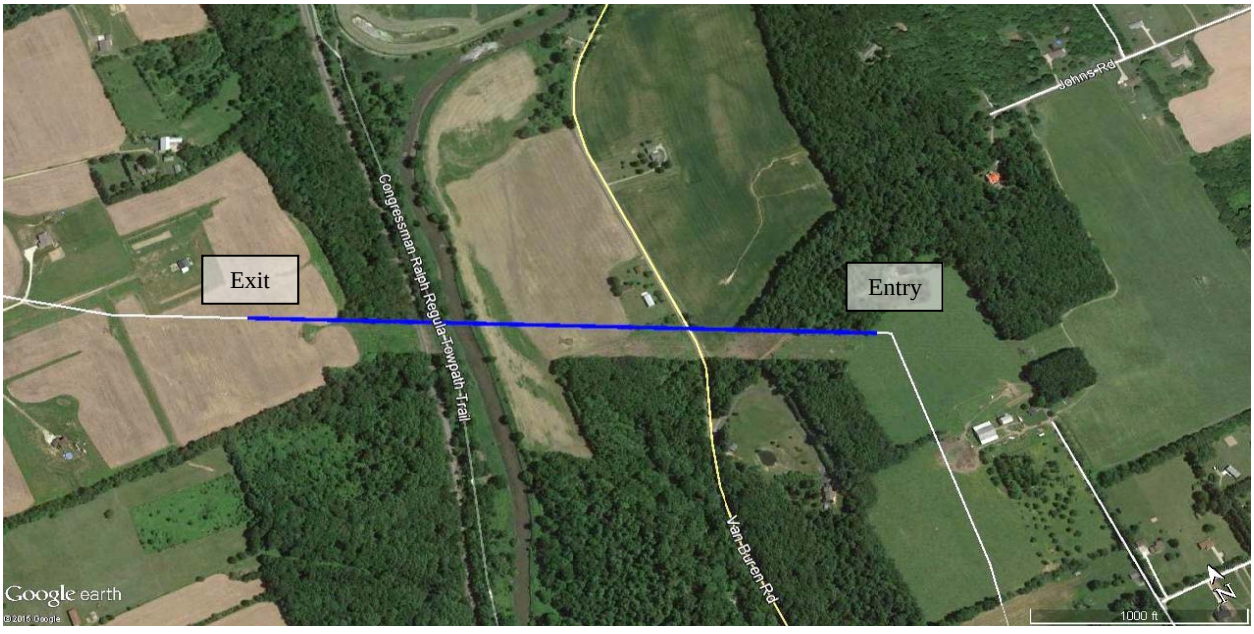


Figure 1: Overview of the Tuscarawas River Crossing

Figure 2: View west along proposed HDD alignment from Van Buren Road

Figure 3: View east from Van Buren Road toward slope which extends upwards toward the proposed entry point

Subsurface Conditions

Two geotechnical borings were taken on the east side of the river as part of the geotechnical exploration program conducted by Fugro Consultants, Inc. Both of the borings were taken between Van Buren Road and the east edge of Tuscarawas River. The first boring, TUS-01, encountered mixtures of sand with silt, lean clay, and sandy lean clay, sand, and occasional gravel to the termination depth of 76 feet below grade. The second boring, TUS-02, taken near the bank of the river, encountered relatively sandy lean clay, sand, and silt until 20 feet below ground surface, followed by sandstone and siltstone bedrock to the termination of 100 feet. Rock quality designation (RQD) index values indicate good to excellent quality bedrock overall. Results for unconfined compressive strength (UCS) average 8,189 psi. As we understand, additional borings are planned to further characterize the site.

At the time of this writing, preliminary geophysical studies defining the area along the HDD alignment between borings TUS-1 and TUS-2 indicate the bedrock dips to the east from TUS-2 falling to an elevation of about 855 before climbing upwards toward boring TUS-1. The bedrock surface looks to be at approximate elevation 875 at boring TUS-1.

Refer to the draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Tuscarawas River HDD Crossing, Nexus Gas Transmission Project, Summit County, Ohio" and dated September 11, 2015 for detailed information relative to the subsurface conditions.

Design Geometry & Layout

The proposed Tuscarawas River HDD design has a horizontal length of 3,263 feet. It utilizes a 16-degree entry angle, an 8-degree exit angle, and a design radius of curvature of 3,600 feet. The design maintains a minimum of 40 feet of cover at the west edge of the Tuscarawas River, 50 feet of cover beneath the railroad tracks, 40 feet beneath Van Buren Road, and 35 feet of cover beneath the bottom of the hillside on the east side of the river. The entry point was located as far to the east as possible without extending beyond the pipeline alignment point of intersection (P.I.). In order to maintain suitable cover along the hillside, a 16-degree entry angel was necessary.

An alternate entry point located at the bottom of the slope just east of Van Buren road was investigated. However, the location was seen an unfavorable due to the inability to gain sufficient cover beneath Van Buren Road (less than 20 feet), as well as the large elevation differential between the entry and exit points (107 feet), which would leave much of the reamed hole on the west side unsupported with drilling fluid, increasing the risk of HDD operational problems

Due to workspace considerations, the exit point is located on the west side of the crossing, which provides the better option for pull section fabrication across relatively open fields. The entry point on the east side is approximately 48 feet higher topographically. Some HDD contractors may elect to drill the pilot hole and ream from the exit (low) side since there are benefits with respect to drilling fluid flow and fluid handling, and then move the HDD rig spread over to west side for pullback.

A copy of the HDD design plan and profile drawing for crossing the Tuscarawas River is attached to this report for reference.

Assessment of Feasibility

Although the feasibility of the proposed crossing of the Tuscarawas cannot be ruled out, uncertainties with respect to subsurface conditions make it difficult to assess with any certainty. Based on the two geotechnical borings as well as geophysical studies, the bedrock surface is variable along the HDD alignment. Boring TUS-02, taken closes to the river, encountered bedrock at only 20 feet below the surface, whereas the other boring, TUS-01, taken roughly 800 feet to the east TUS-02, was drilled to 100 feet and did not encounter bedrock. At the time of this writing, subsurface data to characterize the east and west hillsides, is not available.

Ideally, since boring TUS-02 encountered bedrock at a shallow depth, thus making it impossible to avoid bedrock, the crossing should be designed to stay within bedrock over the majority of the length of the crossing. This minimizes the risk of HDD operational problems associated with passing in and out of bedrock, or skimming across the top of the bedrock surface. The current HDD design presents a challenging installation since it looks to involve, in the best case, a partial rock crossing, or in worst-case, drilling out of bedrock into overburden, and then back into bedrock. Therefore, pending the results of additional subsurface information, the vertical depth of the HDD design will likely need to be increased to provide greater cover along the east hillside. To accomplish this, the existing pipeline point of intersection (P.I.) on the east side may need to change to allow the HDD entry point to be shifted further east.

Risk Identification and Assessment

Potential construction impacts resulting from installation by HDD are damage to Van Buren Road and the railroad due to heaving or settlement, as well as drilling fluid surfacing within the river channel. The risk of inadvertent drilling fluid returns is increased due to the topographic nature of the site and the relative pressure head associated with the depth of the HDD segment in relation to its entry and exit points.

The overall risk associated with installation by HDD is questionable due to uncertainties relative to subsurface conditions. At a minimum, there is risk of drilling along the top of the bedrock surface on each hillside within the bedrock transition zone, which generally contains adverse materials not conducive to installation by HDD. There is risk of drilling into bedrock, and then out of bedrock, and then back into bedrock, which can cause numerous HDD operational problems.

Additional geotechnical/geophysical data is necessary to better define the bedrock surface along the hillsides so that the HDD design can be optimized and the level of risk better assessed.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 529,282 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 558,336 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 3. Detailed calculations for each scenario are summarized in Figures 4 and 5.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 4: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	1152.3	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	121,673	lb			
Fluidic Drag = 12 π D L C_d =	39,096	lb			
Axial Segment Weight = W_e L sinθ =	57,000	lb			
Pulling Load on Exit Tangent =	**217,769**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	274,067	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-4.0	°	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	8.77	ft	j = [(E I) / T]$^{1/2}$ =	1,162	
Y = [18 (L_s^2) - [(j^2 (1 - cosh(U/2)$^{-1}$] =	3.4E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	933.51	
U = (12 L) / j =	5.19		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	138,463	lb
Bending Frictional Drag = 2 μ N =	83,078	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	12,463	lb			
Pulling Load on Exit Sag Bend =	**112,596**	**lb**			
Total Pulling Load =	**330,365**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	263.4	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Frictional Drag = W_e L μ =	28,090	lb			
Fluidic Drag = 12 π D L C_d =	8,938	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**37,028**	**lb**			
Total Pulling Load =	**367,393**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	1005.3	ft	Average Tension, T =	441,030	lb
Segment Angle with Horizontal, θ =	16.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	8.0	°	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	35.03	ft	j = [(E I) / T]$^{1/2}$ =	916	
Y = [18 (L_s^2) - [(j^2 (1 - cosh(U/2)$^{-1}$] =	1.7E+07		X = (3 L) - [(j / 2) tanh(U/2)] =	2558.02	
U = (12 L) / j =	13.17		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	271,490	lb
Bending Frictional Drag = 2 μ N =	162,894	lb			
Fluidic Drag = 12 π D L C_d =	34,109	lb			
Axial Segment Weight = W_e L sinθ =	-49,730	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**147,273**	**lb**			
Total Pulling Load =	**514,666**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	380.0	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Entry Angle, θ =	16.0	°			
Frictional Drag = W_e L μ cosθ =	38,954	lb			
Fluidic Drag = 12 π D L C_d =	12,894	lb			
Axial Segment Weight = W_e L sinθ =	-37,233	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**14,615**	**lb**			
Total Pulling Load =	**529,282**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	6,448	ok	0	ok	0	ok	0.10	ok	0.01	ok
	6,270	ok	0	ok	847	ok	0.10	ok	0.03	ok
PC	6,270	ok	12,083	ok	847	ok	0.36	ok	0.14	ok
	4,476	ok	12,083	ok	2959	ok	0.34	ok	0.31	ok
PT	4,476	ok	0	ok	2959	ok	0.07	ok	0.18	ok
	4,025	ok	0	ok	2959	ok	0.06	ok	0.18	ok
PC	4,025	ok	12,083	ok	2959	ok	0.33	ok	0.30	ok
	2,653	ok	12,083	ok	2428	ok	0.31	ok	0.22	ok
PT	2,653	ok	0	ok	2428	ok	0.04	ok	0.12	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (As Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	1421.8	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	150,139	lb			
Fluidic Drag = 12 π D L C_d =	48,242	lb			
Axial Segment Weight = W_e L sinθ =	70,335	lb			
Pulling Load on Exit Tangent =	**268,716**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	310,563	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-4.0	°	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1,091	
Y = [18 (L_s^2) - [(j^2 (1 - cosh(U/2)$^{-1}$] =	5.1E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	273.05	
U = (12 L) / j =	2.76		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	114,889	lb
Bending Frictional Drag = 2 μ N =	68,934	lb			
Fluidic Drag = 12 π D L C_d =	8,527	lb			
Axial Segment Weight = W_e L sinθ =	6,231	lb			
Pulling Load on Exit Sag Bend =	**83,693**	**lb**			
Total Pulling Load =	**352,409**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	480.2	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Frictional Drag = W_e L μ =	51,207	lb			
Fluidic Drag = 12 π D L C_d =	16,293	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**67,500**	**lb**			
Total Pulling Load =	**419,909**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	475,570	lb
Segment Angle with Horizontal, θ =	16.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	8.0	°	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	17.52	ft	j = [(E I) / T]$^{1/2}$ =	882	
Y = [18 (L_s^2) - [(j^2 (1 - cosh(U/2)$^{-1}$] =	3.8E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1067.94	
U = (12 L) / j =	6.84		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	198,555	lb
Bending Frictional Drag = 2 μ N =	119,133	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	-24,865	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**111,322**	**lb**			
Total Pulling Load =	**531,231**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	705.6	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Entry Angle, θ =	16.0	°			
Frictional Drag = W_e L μ cosθ =	72,322	lb			
Fluidic Drag = 12 π D L C_d =	23,939	lb			
Axial Segment Weight = W_e L sinθ =	-69,126	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**27,135**	**lb**			
Total Pulling Load =	**558,366**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	6,803	ok	0	ok	0	ok	0.11	ok	0.01	ok
	6,472	ok	0	ok	2206	ok	0.10	ok	0.12	ok
PC	6,472	ok	24,167	ok	2206	ok	0.63	ok	0.47	ok
	5,116	ok	24,167	ok	3262	ok	0.61	ok	0.58	ok
PT	5,116	ok	0	ok	3262	ok	0.08	ok	0.23	ok
	4,293	ok	0	ok	3262	ok	0.07	ok	0.22	ok
PC	4,293	ok	24,167	ok	3262	ok	0.60	ok	0.56	ok
	3,274	ok	24,167	ok	2996	ok	0.58	ok	0.50	ok
PT	3,274	ok	0	ok	2996	ok	0.05	ok	0.18	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 6: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

Based on subsurface information available to date, the Tuscarawas River crossing will likely involve passing through bedrock over the portion of the crossing beneath the river that is of interest. Since the Delft Equation (Discussed previously in Section 5 of this report) is only applicable to uncemented subsurface material, a hydrofracture evaluation was not completed. In general, inadvertent drilling fluid returns due to hydrofracture do not typically occur on rock crossings, but instead occur by flowing through existing fractures, joints, or solution cavities.

Construction Duration

The estimated duration of construction for the Tuscarawas River Crossing, assuming it is installed entirely through bedrock, is 88 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated by JDH&A based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as past experience in similar subsurface conditions. Refer to Figure 7 for details relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments
Work Schedule, hours/shift =	12.0	36" Tuscarawas Crossing.
days/week =	7.0	
Drilled Length, feet =	3,304	
Pilot Hole		
Production Rate, feet/hour =	15	
shifts/day =	1	
Drilling Duration, hours =	220.3	
shifts =	18.4	
Trips to change tools, shifts =	1.0	
Pilot Hole Duration, days =	19.4	

Ream and Pull Back

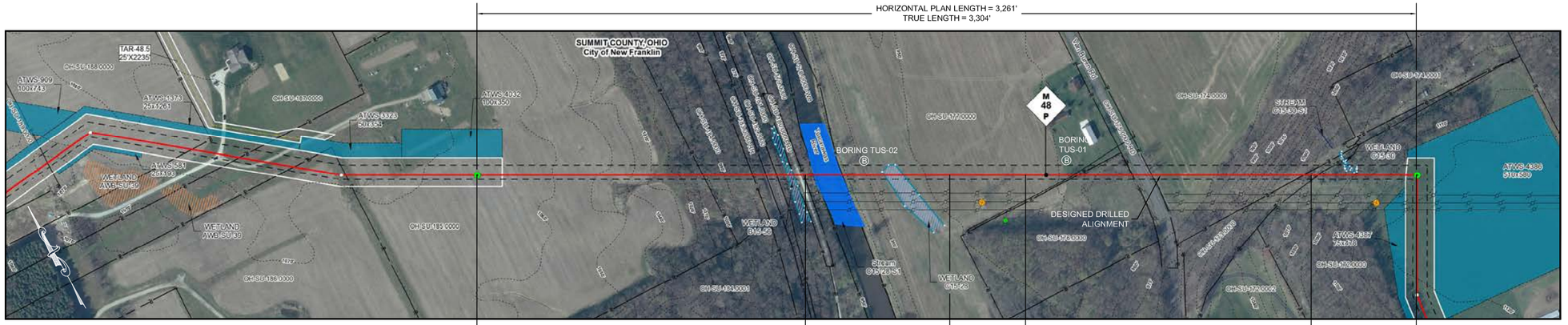
Pass Description =	24-inch	36-inch	48-inch			Swab	Pull Back	Total
Travel Speed, feet/minute =	0.3	0.3	0.3			8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0	15.0			15.0	15.0	
shifts/day =	1	1	1			1	1	
Reaming Duration, hours =	223.8	223.8	223.8			10.4	12.7	694.6
shifts =	18.7	18.7	18.7			0.9	1.1	57.9
Rig up, shifts =	0.5	0.5	0.5			0.5	0.5	2.5
Trips to change tools, shifts =	2.0	2.0	2.0			0.0		6.0
Pass Duration, days =	21.2	21.2	21.2			1.4	1.6	66.4

Summary	
HDD Duration at Site, days =	87.7

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 7: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN

SCALE: 1" = 200'

EXIT POINT @ 8°
32+61.10, 1066.45
N 14879218.12, E 1471002.64

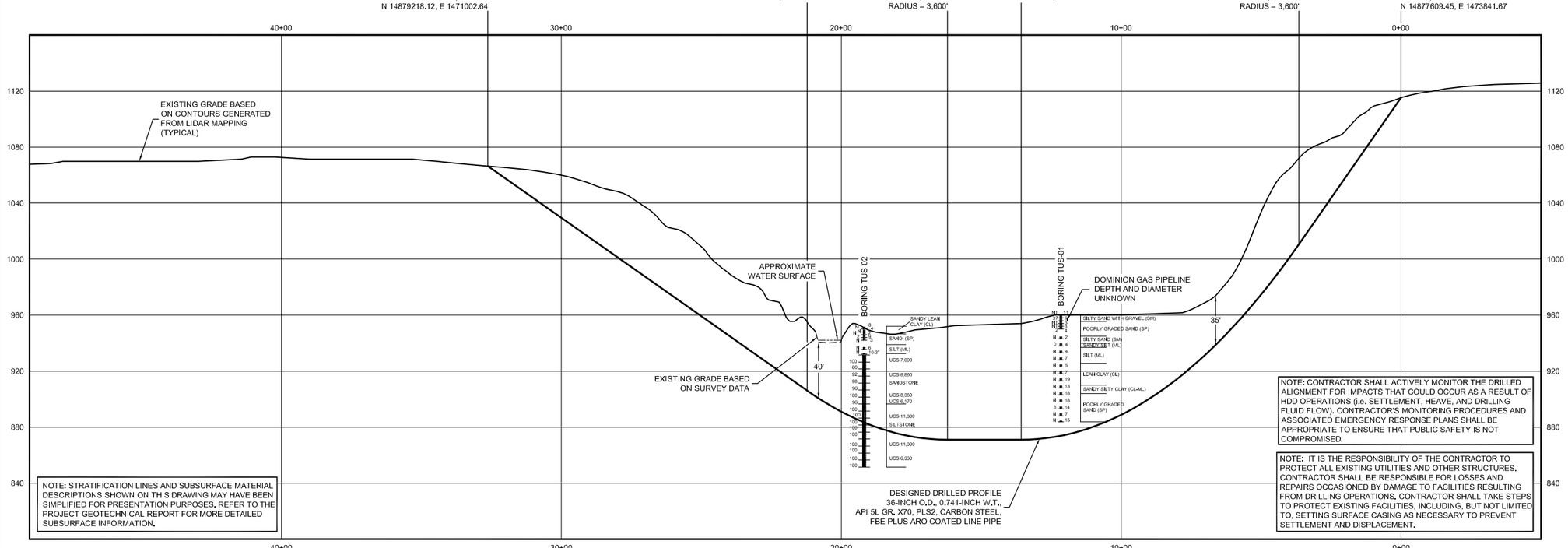
P.T. 8° SAG BEND
21+22.04, 906.08

P.C. 8° SAG BEND
16+21.02, 871.05
RADIUS = 3,600'

P.T. 16° SAG BEND
13+57.61, 871.05

P.C. 16° SAG BEND
3+65.32, 1010.51
RADIUS = 3,600'

ENTRY POINT @ 16°
0+00.00, 1115.26
N 14877609.45, E 1473841.67



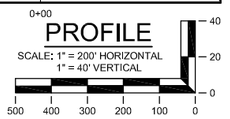
NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

PROFILE

SCALE: 1" = 200' HORIZONTAL
1" = 40' VERTICAL



ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PIPELINE
- INTERCONNECTING PIPELINE
- CONSTRUCTION LIMIT
- STUDY CORRIDOR
- STAGING AREA
- WAREYARD
- PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- METERING & REGULATION STATION (M&R)
- COMPRESSOR STATION SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- APPROXIMATE WETLAND BOUNDARY
- APPROXIMATE WATERBODY BANK
- APPROXIMATE WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD (PAR-0.0)
- TEMPORARY ACCESS ROAD (TAR-0.0)
- PARCEL TRACT NO (OH-CO-011.0000-SC)
- PROPERTY LINE
- CONTOUR
- MUNICIPALITY LINE
- FENCE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- TELEPHONE
- TEE TAP
- UTILITY LINES
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- TOWER
- MICROWAVE TOWER
- HORIZONTAL DIRECTIONAL DRILLING
- TANK
- LIGHT POLE
- FIRE HYDRANT
- WELL: GAS, WATER, OIL, UNKNOWN

GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

Ⓑ BORING LOCATION

SPLIT SPOON SAMPLE

53 N 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE

UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
53 6 — MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA. REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.

2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.

3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW, HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE.

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
HANO–A–1056	ALIGNMENT SHEET M.P. 47.99 TO M.P. 48.93				
HANO–A–1055	ALIGNMENT SHEET M.P. 47.04 TO M.P. 47.99	0	LKB	AM	ISSUED FOR FERC

IG #

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS				
	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	KMN	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	KMN	08/07		
DESIGN CHECKER	DLB	08/07		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH TUSCARAWAS RIVER CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING

SUMMIT COUNTY, OHIO

NEXUS SM
GAS TRANSMISSION

M.P. 47.8	W.O.	SCALE: AS SHOWN	DWG. HANO–H–1003	REV. 0

MP 71.1 Wetland

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR and traditional survey data covering the proposed crossing location
- Draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Wetland No. 68 HDD Crossing, Nexus Gas Transmission Project, Medina County, Ohio" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The proposed 36-inch category 3 wetland crossing at approximate pipeline Mile Post 71.1 is located about 4 miles south of Medina, Ohio near the intersection of Wedgewood Road and Lafayette Road. The crossing involves passing beneath a wooded wetland that is approximately 900 feet wide. Both sides of the crossing are open farm fields. The south side of the crossing is bound to the south by Wedgewood Road and to the north by Chippewa Inlet Trail. The topography in the area is flat. Figure 1 provides a general overview of the vicinity of the crossing. Figures 2 and 3 provide site photos showing the general vicinity of the entry and exit locations.

Figure 1: Overview of the Wetland Crossing at MP 71.1

Figure 2: View looking toward exit location

Figure 3: View toward entry location from Wedgewood Road

Subsurface Conditions

Two site-specific geotechnical borings were taken as part of the site investigation conducted by Fugro Consultants, Inc. One boring (WL68-02) was taken on the north side of the crossing near the tree line and the second (WL68-01) was taken on the south side of the crossing near the tree line. Both terminated at a depth of 100 feet below the ground surface. Boring WL68-02 encountered primarily sand and lean clay, with occasional gravel. Where encountered, gravel content ranged from 32% to 36% at depths of approximately 44 feet and 94 feet in boring WL68-01. Boring WL68-02 encountered similar soils. Where encountered, gravel content ranged from 3% to 18%.

Refer to the geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Wetland No. 68 HDD Crossing, Nexus Gas Transmission Project, Medina County, Ohio" and dated September 11, 2015 for additional information.

Design Geometry & Layout

The proposed wetland crossing involves a horizontal length of 1,623 feet. It utilizes a 10-degree entry angle, an 8-degree exit angle, and a radius of curvature of 3,600 feet. The crossing design is based on obtaining a minimum of 40 feet of cover at the north and south edges of the wetland and just under 20 feet beneath the small drainage ditch on the north side of the wetland.

The exit point is located on the north side of the crossing to take advantage of available workspace for pull section fabrication, which will allow the pull section to be fabricated in a single segment, and thus avoid the risk of getting stuck during downtime associated with a tie-in weld. The entry point is located in an open field south of Wedgewood Road.

The proposed HDD design, as well as available workspace, is shown on the preliminary plan and profile drawing included at the end of this site-specific report.

Assessment of Feasibility

Given the relatively short length of the crossing, as well as the anticipated subsurface conditions consisting of mixtures of sand and lean clay with minor gravel, the proposed wetland crossing is feasible and should be a straightforward installation.

Risk Identification and Assessment

Potential construction impacts that may result from installation by HDD include inadvertent drilling fluid returns surfacing within the wetland. Provided subsurface conditions across the site are consistent with those encountered in the site-specific geotechnical borings, the overall risk of HDD operational problems is considered low.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 284,045 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 311,156 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 4. Detailed calculations for each loading scenario are summarized in Figures 5 and 6.

Line Pipe Properties			
Pipe Outside Diameter =	36.000	in	
Wall Thickness =	0.741	in	
Specified Minimum Yield Strength =	70,000	psi	
Young's Modulus =	2.9E+07	psi	
Moment of Inertia =	12755.22	in^4	
Pipe Face Surface Area =	82.08	in^2	
Diameter to Wall Thickness Ratio, D/t =	49		
Poisson's Ratio =	0.3		
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F	
Pipe Weight in Air =	279.04	lb/ft	
Pipe Interior Volume =	6.50	ft^3/ft	
Pipe Exterior Volume =	7.07	ft^3/ft	
HDD Installation Properties			
Drilling Mud Density =	12.0	ppg	
=	89.8	lb/ft^3	
Ballast Density =	62.4	lb/ft^3	
Coefficient of Soil Friction =	0.30		
Fluid Drag Coefficient =	0.025	psi	
Ballast Weight =	405.51	lb/ft	
Displaced Mud Weight =	634.48	lb/ft	

Figure 4: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	210.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	22,215	lb			
Fluidic Drag = 12 π D L C_d =	7,138	lb			
Axial Segment Weight = W_e L sinθ =	10,407	lb			
Pulling Load on Exit Tangent =	**39,759**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	92,329	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	8.77	ft	j = [(E I) / T]$^{1/2}$ =	2,002	
Y = [18 (L^2) - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	2.2E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	600.88	
U = (12 L) / j =	3.01		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	126,037	lb
Bending Frictional Drag = 2 μ N =	75,622	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	12,463	lb			
Pulling Load on Exit Sag Bend =	**105,140**	**lb**			
Total Pulling Load =	**144,899**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	262.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	27,975	lb			
Fluidic Drag = 12 π D L C_d =	8,901	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**36,876**	**lb**			
Total Pulling Load =	**181,775**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	231,752	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	1,263	
Y = [18 (L^2)] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	5.7E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1256.49	
U = (12 L) / j =	5.97		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	163,499	lb
Bending Frictional Drag = 2 μ N =	98,100	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	-19,464	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**99,954**	**lb**			
Total Pulling Load =	**281,729**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	30.0	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	3,150	lb			
Fluidic Drag = 12 π D L C_d =	1,018	lb			
Axial Segment Weight = W_e L sinθ =	-1,852	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**2,317**	**lb**			
Total Pulling Load =	**284,045**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,461	ok	0	ok	0	ok	0.05	ok	0.00	ok
	3,432	ok	0	ok	79	ok	0.05	ok	0.00	ok
PC	3,432	ok	12,083	ok	79	ok	0.32	ok	0.08	ok
	2,215	ok	12,083	ok	907	ok	0.30	ok	0.10	ok
PT	2,215	ok	0	ok	907	ok	0.04	ok	0.02	ok
	1,765	ok	0	ok	907	ok	0.03	ok	0.02	ok
PC	1,765	ok	12,083	ok	907	ok	0.29	ok	0.09	ok
	484	ok	12,083	ok	376	ok	0.27	ok	0.06	ok
PT	484	ok	0	ok	376	ok	0.01	ok	0.00	ok
Exit Point	0	ok	0	ok	-67	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	519.8	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	54,891	lb			
Fluidic Drag = 12 π D L C_d =	17,637	lb			
Axial Segment Weight = W_e L sinθ =	25,715	lb			
Pulling Load on Exit Tangent =	**98,243**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	135,859	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-4.0	°	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1,650	
Y = [18 (L)^2] - [(j)^2 (1 - cosh(U/2)$^{-1}$)] =	3.0E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	157.49	
U = (12 L) / j =	1.83		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	100,787	lb
Bending Frictional Drag = 2 μ N =	60,472	lb			
Fluidic Drag = 12 π D L C_d =	8,527	lb			
Axial Segment Weight = W_e L sinθ =	6,231	lb			
Pulling Load on Exit Sag Bend =	**75,231**	**lb**			
Total Pulling Load =	**173,474**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	272.1	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Frictional Drag = W_e L μ =	29,017	lb			
Fluidic Drag = 12 π D L C_d =	9,233	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**38,249**	**lb**			
Total Pulling Load =	**211,723**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	248,643	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,220	
Y = [18 (L)^2] - [(j)^2 (1 - cosh(U/2)$^{-1}$)] =	9.0E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	385.67	
U = (12 L) / j =	3.09		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	121,520	lb
Bending Frictional Drag = 2 μ N =	72,912	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**73,839**	**lb**			
Total Pulling Load =	**285,562**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	331.4	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	34,806	lb			
Fluidic Drag = 12 π D L C_d =	11,246	lb			
Axial Segment Weight = W_e L sinθ =	-20,458	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**25,594**	**lb**			
Total Pulling Load =	**311,156**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,791	ok	0	ok	0	ok	0.06	ok	0.00	ok
	3,479	ok	0	ok	871	ok	0.08	ok	0.02	ok
RC	3,479	ok	24,167	ok	871	ok	0.58	ok	0.29	ok
	2,579	ok	24,167	ok	1285	ok	0.57	ok	0.30	ok
PT	2,579	ok	0	ok	1285	ok	0.04	ok	0.04	ok
	2,113	ok	0	ok	1285	ok	0.03	ok	0.04	ok
RC	2,113	ok	24,167	ok	1285	ok	0.56	ok	0.29	ok
	1,197	ok	24,167	ok	1020	ok	0.55	ok	0.25	ok
PT	1,197	ok	0	ok	1020	ok	0.02	ok	0.02	ok
Exit Point	0	ok	0	ok	-75	ok	0.00	ok	0.00	ok

Figure 6: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

The risk of inadvertent drilling fluid returns due to hydrofracture was evaluated using the Delft Method. In summary, under normal drilling operations, the risk of inadvertent drilling fluid returns due to hydrofracture is low over the majority of the length of the crossing. The factor of safety remains above 2.0, with an estimated low risk of hydrofracture until the last 132 feet of the crossing. It is only as the bit begins making its way to the surface when depth of cover drops to 20 feet or less that the risk of hydrofracture is pronounced. At approximately station 14+90, the estimated annular pressure exceeds the formation limit pressure, indicating a high risk of inadvertent drilling fluid returns. Refer to Figure 7 for results presented in graphical format.

It is important to keep in mind that inadvertent drilling fluid returns may occur due to mechanisms unrelated to hydrofracture. It remains possible that inadvertent drilling fluid returns will occur by flowing to the ground surface through preexisting fractures or porous seams in the soil mass.

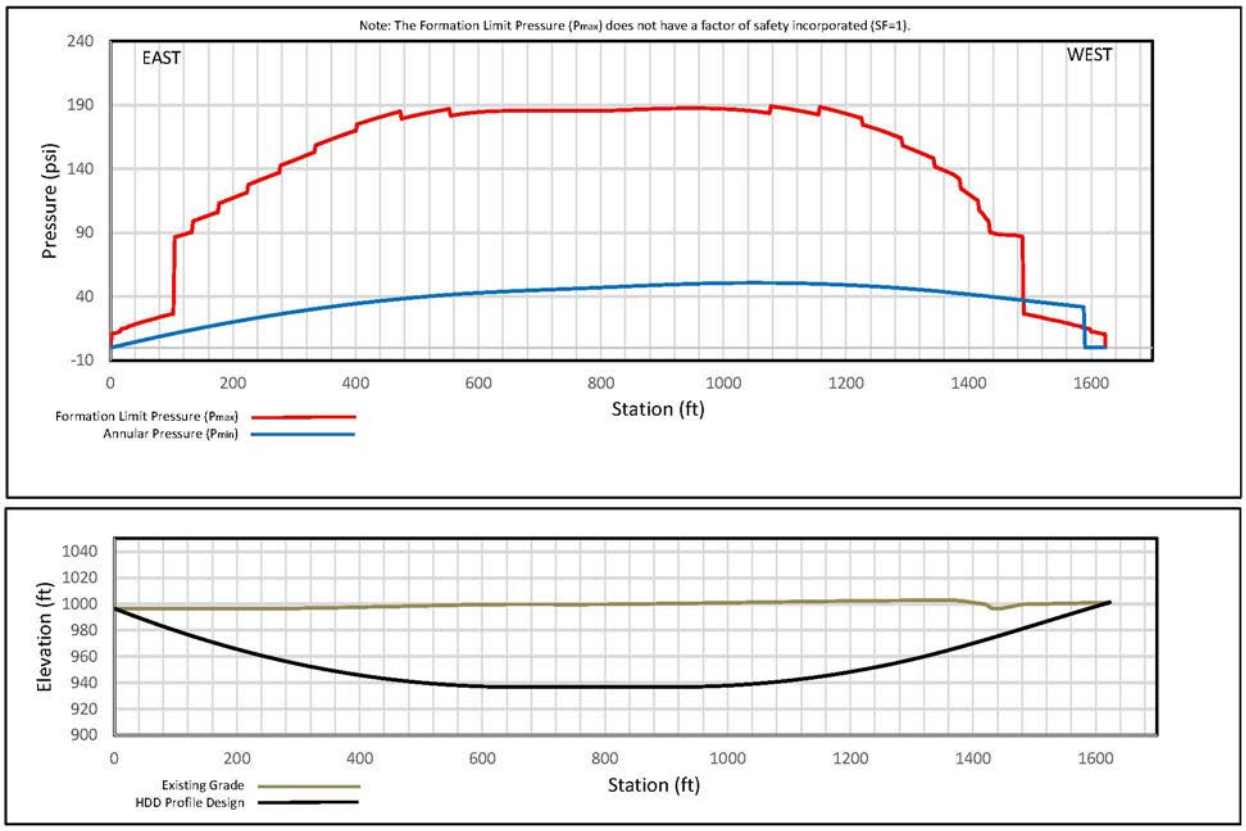


Figure 7: Hydrofracture Evaluation (Formation Limit Pressure –vs-Annular Pressure)

Construction Duration

The estimated duration of construction is 13 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated by JDH&A based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as past experience in similar subsurface conditions. Refer to Figure 8 for details relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments
Work Schedule, hours/shift =	12.0	36" Wetland Crossing (MP 71.1)
days/week =	7.0	
Drilled Length, feet =	1,634	
Pilot Hole		
Production Rate, feet/hour =	50	
shifts/day =	1	
Drilling Duration, hours =	32.7	
shifts =	2.7	
Trips to change tools, shifts =	0.5	
Pilot Hole Duration, days =	3.2	

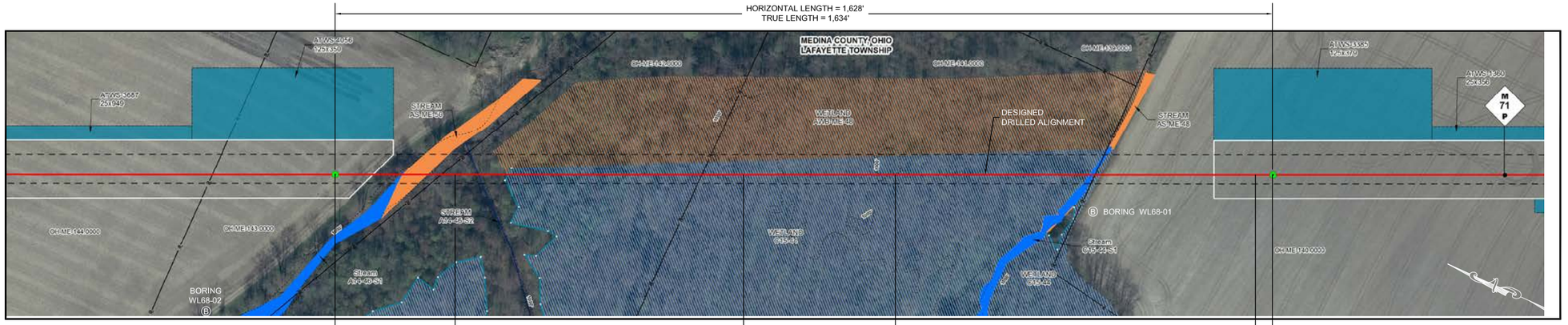
Ream and Pull Back									
Pass Description =	36-inch	48-inch				Swab	Pull Back	Total
Travel Speed, feet/minute =	2.0	2.0				8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0				15.0	15.0	
shifts/day =	1	1				1	1	
Reaming Duration, hours =	15.4	15.4				5.2	6.3	42.2
shifts =	1.3	1.3				0.4	0.5	3.5
Rig up, shifts =	0.5	0.5				0.5	0.5	2.0
Trips to change tools, shifts =	1.0	1.0				0.0		2.0
Pass Duration, days =	2.8	2.8				0.9	1.0	7.5

Summary	
HDD Duration at Site, days =	12.7

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 8: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN
SCALE: 1" = 100'

EXIT POINT @ 8°
16+27.94, 1001.13
N 14930688.08, E 1385671.82

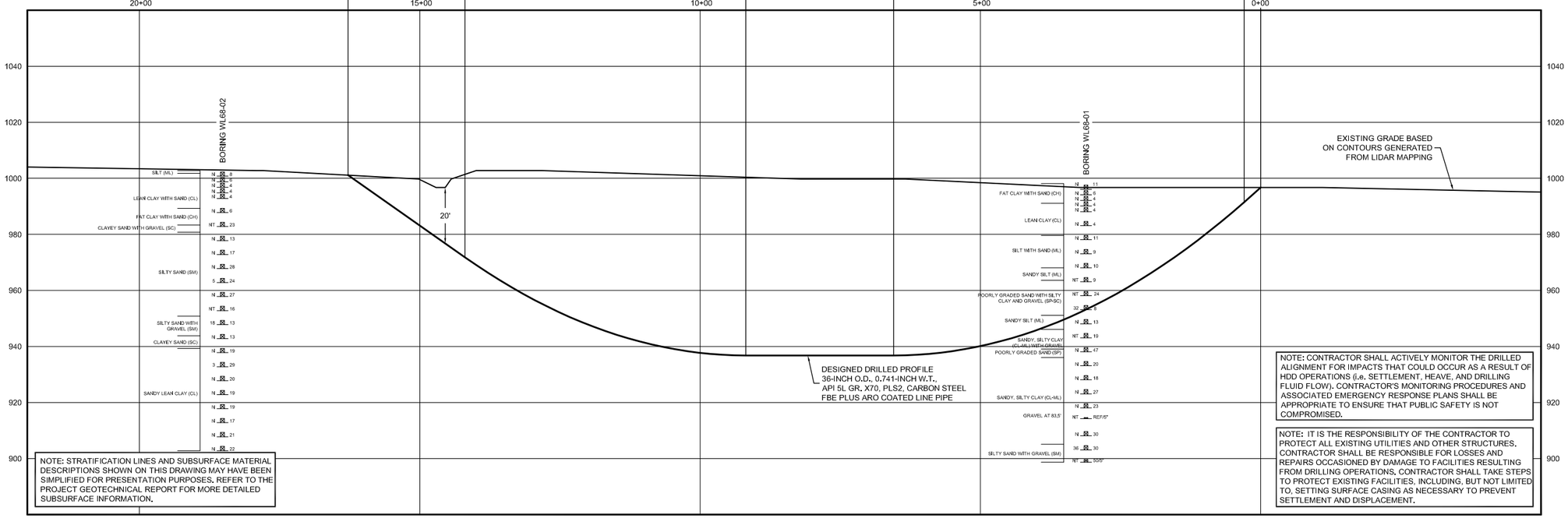
P.T. 8° SAG BEND
14+19.46, 971.83

P.C. 8° SAG BEND
9+18.44, 936.80
RADIUS = 3,600'

P.T. 10° SAG BEND
6+54.68, 936.80

P.C. 10° SAG BEND
0+29.54, 991.49
RADIUS = 3,600'

ENTRY POINT @ 10°
0+00.00, 996.70
N 14929204.08, E 1386341.09

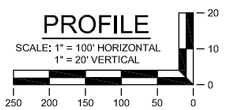


NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

PROFILE
SCALE: 1" = 100' HORIZONTAL
1" = 20' VERTICAL



ALIGNMENT LEGEND

PIPELINE MILEPOST
PIPELINE
INTERCONNECTING PIPELINE
CONSTRUCTION LIMIT
STUDY CORRIDOR
STAGING AREA
WAREYARD
PERMANENT ROW
ADDITIONAL TEMPORARY WORKSPACE
METERING & REGULATION STATION (M&R)
COMPRESSOR STATION SITE
FACILITIES TEMPORARY WORKSPACE
FACILITIES PERMANENT WORKSPACE

DELINEATED WETLAND BOUNDARY
DELINEATED WATERBODY BANK
DELINEATED WATERBODY CENTERLINE
APPROXIMATE WETLAND BOUNDARY
APPROXIMATE WATERBODY BANK
APPROXIMATE WATERBODY CENTERLINE
PERMANENT ACCESS ROAD (PAR-0.0)
TEMPORARY ACCESS ROAD (TAR-0.0)
PARCEL TRACT NO (OH-CO-011.0000-SC)
PROPERTY LINE
CONTOUR
MUNICIPALITY LINE

FENCE
FOREIGN PIPELINE
POWERLINE
WATER PIPELINE
RAILROAD TRACK
TELEPHONE
TEE TAP
BLOW OFF VALVE
TOWER
HORIZONTAL DIRECTIONAL DRILLING
TANK
WELL: GAS WATER OIL UNKNOWN
UTILITY LINES
MAINLINE VALVE (MLV)
MICROWAVE TOWER
LIGHT POLE
FIRE HYDRANT

GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

B BORING LOCATION

SPLIT SPOON SAMPLE
53 N 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE
UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
53 6 — MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA, REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.

2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.

3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW. HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE.

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
WADS–A–1081	ALIGNMENT SHEET M.P. 71.07 TO M.P. 72.02	0	LKB	ACM	ISSUED FOR FERC

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	DMP	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	LKB	08/07		
DESIGN CHECKER	DLB	08/07		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH WETLAND CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING
MEDINA COUNTY, OHIO

NEXUS SM
GAS TRANSMISSION

M.P. 71.1	W.O.	SCALE: AS SHOWN	DWG. WADS–H–1004	REV. 0

MP 86.5 East Branch Black River

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR, hydrographic, and traditional survey data covering the proposed crossing location
- Draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, East Branch Black River HDD Crossing, Nexus Gas Transmission Project, Lorain County Ohio" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The 36-inch East Branch Black River Crossing is located just southwest of Grafton, Ohio near the intersection of Indian Hollow Road and Crook Street. The crossing involves passing beneath East Branch Black River, as well as wetland areas on both sides of the channel. The proposed pipeline alignment cuts perpendicularly across a cut bank/point bar at the crossing location. The topography in the vicinity of the crossing is essentially flat, but with the west side cut bank of the river approximately 22 feet higher than the east side and point bar deposit. Both sides of the river are open farmland surrounded by forest land. An overview of the crossing site is provided in Figure 1.

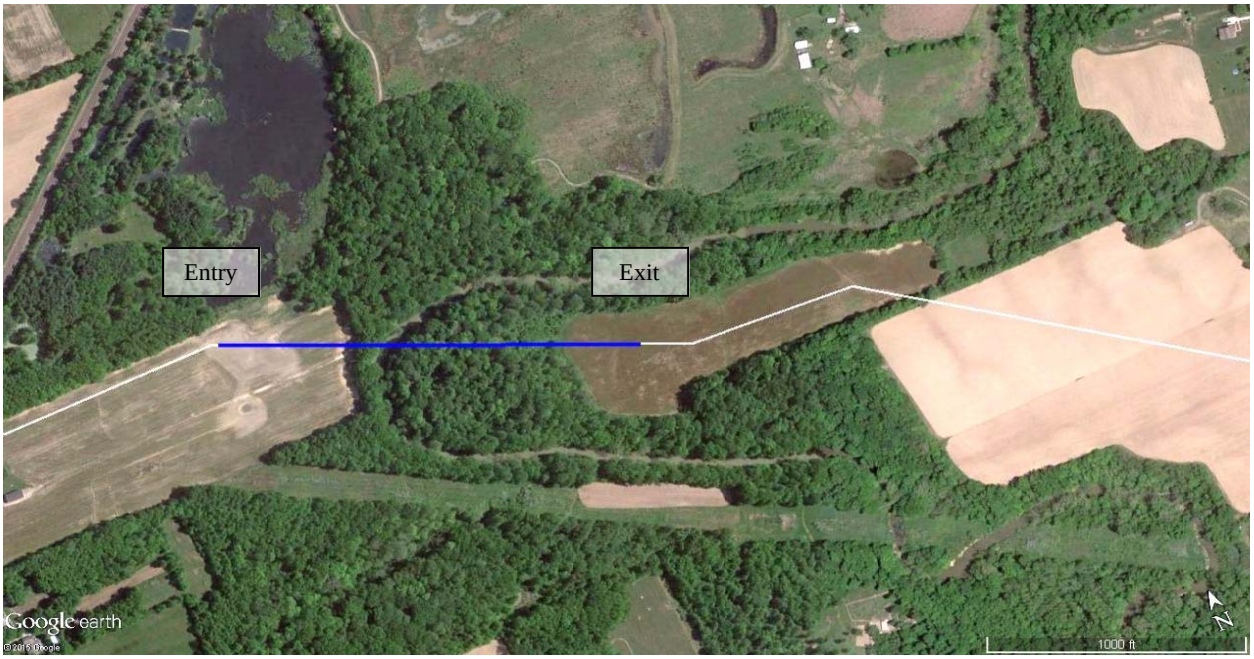


Figure 1: Overview of the East Branch Black River Crossing

Subsurface Conditions

Three geotechnical borings were drilled as part of the site investigation conducted by Fugro Consultants, Inc. Two of the borings (EBL-04, and EBL-03) were taken on the west side of the river and one of the borings (EBL-01) was taken on the east side of the river. The borings generally encountered lean clay, fat clay, silty sand, and clayey sand, with gravel, overlying sedimentary bedrock (sandstone and shale). Unconfined compressive strength tests were performed on select rock samples. The strength averaged 4,280 psi, with the lowest value recorded being 30 psi and highest being 11,300 psi. The rock quality designation (RQD) generally indicates good quality bedrock, with the exception of some of the shale cores recovered, which indicate poor quality.

Refer to the report titled "Geotechnical Data Report, East Branch Black HDD Crossing, Nexus Gas Transmission Project, Lorain County Ohio" and dated September 11, 2015, for additional information.

Design Geometry & Layout

The East Branch Black River HDD design involves a horizontal length of 1,869 feet. The design entry point is located on the west side of the river at the pipeline point of intersection (P.I.). The location results from obtaining 40 feet of depth at the edge of the wetland with a 12-degree entry angle. The exit point location on the east side of the river is based on an 8-degree angle with 40 feet of cover at the edge of the east wetland. The design achieves over 70 feet of clearance beneath the bottom of the river. The design employs a radius of curvature of 3,600 feet, the industry standard for a 36-inch pipeline installation.

The exit point is located on the east side of the crossing. This is to take advantage of the long linear stretch of available right-of-way (ROW) for pull section fabrication. In this case, the pull section can be fabricated in a single segment and thus avoid downtime associated with performing tie-in welds.

The preliminary HDD plan and profile design drawing for crossing the East Branch Black River is attached to this report for reference.

Assessment of Feasibility

Based on a review of available geotechnical information, the drilled path will pass thorough sedimentary sandstone and shale bedrock over the majority of the length of the crossing. Although the shale may involve significant fractures at depth as indicated by low RQD values, it is our experience that shale is typically conducive to the HDD process despite displaying what are often low RQD values. Therefore, given the proposed length of 1,869 feet and the anticipated subsurface conditions, the crossing is feasible.

Risk Identification and Assessment

Potential construction impacts associated with the proposed Black River Crossing are inadvertent drilling fluid returns surfacing within the wetlands or within the river. There is also risk that sink holes will develop during reaming operations on the west side of the crossing along the HDD

alignment. This is due to the 22 foot elevation differential between the entry and exit points. The sinkholes are most likely to form within 100 feet of the entry point.

HDD construction and operational risks associated with a large diameter rock crossing include failure of large diameter rock reaming tools downhole; hole misalignment at the soil/rock interface; and loss of drilling fluid circulation through existing fractures which could negatively impact cuttings removal. In addition, sink holes and hole collapse on the west side resulting from the elevation differential may increase the difficulty of reaming and cuttings removal over the west segment of the crossing.

The overall level of risk associated with installation of the proposed 36-inch pipeline under the East Branch Black River by HDD is average.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 324,874 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 340,362 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 3. Detailed calculations for each loading scenario are summarized in Figures 4 and 5.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 3: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	360.7	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	38,092	lb			
Fluidic Drag = 12 π D L C_d =	12,240	lb			
Axial Segment Weight = W_e L sinθ =	17,845	lb			
Pulling Load on Exit Tangent =	**68,176**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	121,333	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	8.77	ft	j = [(E I) / T]$^{1/2}$ =	1,746	
Y = [18 (L)^2] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	2.5E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	688.43	
U = (12 L) / j =	3.45		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	127,992	lb
Bending Frictional Drag = 2 μ N =	76,795	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	12,463	lb			
Pulling Load on Exit Sag Bend =	**106,313**	**lb**			
Total Pulling Load =	**174,489**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	127.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	13,589	lb			
Fluidic Drag = 12 π D L C_d =	4,324	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**17,913**	**lb**			
Total Pulling Load =	**192,402**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	754.0	ft	Average Tension, T =	249,026	lb
Segment Angle with Horizontal, θ =	12.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	6.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	19.72	ft	j = [(E I) / T]$^{1/2}$ =	1,219	
Y = [18 (L)^2] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	8.8E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1653.29	
U = (12 L) / j =	7.42		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	192,797	lb
Bending Frictional Drag = 2 μ N =	115,678	lb			
Fluidic Drag = 12 π D L C_d =	25,582	lb			
Axial Segment Weight = W_e L sinθ =	-28,013	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**113,247**	**lb**			
Total Pulling Load =	**305,649**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	137.4	ft	Effective Weight, W_e = W + W_b - W_m =	279.0	lb/ft
Entry Angle, θ =	12.0	°			
Frictional Drag = W_e L μ cosθ =	11,252	lb			
Fluidic Drag = 12 π D L C_d =	0	lb	Fluidic drag is calculated as zero unless entire segment is submerged in drilling fluid. Please reference Step 2, Drilled Path Input		
Axial Segment Weight = W_e L sinθ =	7,972	lb			
Pulling Load on Entry Tangent =	**19,225**	**lb**			
Total Pulling Load =	**324,874**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

		Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point		3,958	ok	0	ok	0	ok	0.06	ok	0.00	ok
		3,724	ok	0	ok	0	ok	0.06	ok	0.00	ok
PC		3,724	ok	12,083	ok	0	ok	0.32	ok	0.08	ok
		2,344	ok	12,083	ok	1291	ok	0.30	ok	0.12	ok
PT		2,344	ok	0	ok	1291	ok	0.04	ok	0.04	ok
		2,126	ok	0	ok	1291	ok	0.03	ok	0.04	ok
PC		2,126	ok	12,083	ok	1291	ok	0.30	ok	0.12	ok
		831	ok	12,083	ok	760	ok	0.28	ok	0.08	ok
PT		831	ok	0	ok	760	ok	0.01	ok	0.01	ok
Exit Point		0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 4: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in		
Pipe Weight, W =	279.0	lb/ft		
Coefficient of Soil Friction, μ =	0.30			
		Fluid Drag Coefficient, C_d =	0.025	psi
		Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
		Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	666.2	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4 lb/ft
Exit Angle, θ =	8.0	°		
Frictional Drag = W_e L μ cosθ =	70,351	lb		
Fluidic Drag = 12 π D L C_d =	22,605	lb		
Axial Segment Weight = W_e L sinθ =	32,957	lb		
Pulling Load on Exit Tangent =	**125,913**	**lb**		

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	184,218	lb	
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	1,800	ft	
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft	
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1.501		
Y = [18 (L)^2] - [(]^2 (1 - cosh(U/2)$^{-1}$) =	3.4E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	180.98		
U = (12 L) / j =	2.01		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	103,082	lb	
Bending Frictional Drag = 2 μ N =	61,849	lb				
Fluidic Drag = 12 π D L C_d =	8,527	lb				
Axial Segment Weight = W_e L sinθ =	6,231	lb				
Pulling Load on Exit Sag Bend =	**76,608**	**lb**				
Total Pulling Load =	**202,522**	**lb**				

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	197.0	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4 lb/ft
Frictional Drag = W_e L μ =	21,006	lb		
Fluidic Drag = 12 π D L C_d =	6,684	lb		
Axial Segment Weight = W_e L sinθ =	0	lb		
Pulling Load on Bottom Tangent =	**27,690**	**lb**		
Total Pulling Load =	**230,212**	**lb**		

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	377.0	ft	Average Tension, T =	270,914	lb	
Segment Angle with Horizontal, θ =	12.0	°	Radius of Curvature, R =	1,800	ft	
Deflection Angle, α =	6.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft	
h = R [1 - cos(α/2)] =	9.86	ft	j = [(E I) / T]$^{1/2}$ =	1,168		
Y = [18 (L)^2] - [(]^2 (1 - cosh(U/2)$^{-1}$) =	1.6E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	570.56		
U = (12 L) / j =	3.87		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	137,699	lb	
Bending Frictional Drag = 2 μ N =	82,620	lb				
Fluidic Drag = 12 π D L C_d =	12,791	lb				
Axial Segment Weight = W_e L sinθ =	-14,007	lb	Negative value indicates axial weight applied in direction of installation			
Pulling Load on Entry Sag Bend =	**81,404**	**lb**				
Total Pulling Load =	**311,616**	**lb**				

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	446.9	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4 lb/ft
Entry Angle, θ =	12.0	°		
Frictional Drag = W_e L μ cosθ =	46,608	lb		
Fluidic Drag = 12 π D L C_d =	15,161	lb		
Axial Segment Weight = W_e L sinθ =	-33,022	lb	Negative value indicates axial weight applied in direction of installation	
Pulling Load on Entry Tangent =	**28,746**	**lb**		
Total Pulling Load =	**340,362**	**lb**		

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	4,147	ok	0	ok	0	ok	0.07	ok	0.01	ok
	3,796	ok	0	ok	1074	ok	0.06	ok	0.03	ok
PC	3,796	ok	24,167	ok	1074	ok	0.59	ok	0.31	ok
	2,805	ok	24,167	ok	1669	ok	0.57	ok	0.34	ok
PT	2,805	ok	0	ok	1669	ok	0.04	ok	0.06	ok
	2,467	ok	0	ok	1669	ok	0.04	ok	0.06	ok
PC	2,467	ok	24,167	ok	1669	ok	0.57	ok	0.33	ok
	1,534	ok	24,167	ok	1404	ok	0.55	ok	0.29	ok
PT	1,534	ok	0	ok	1404	ok	0.02	ok	0.04	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

The East Branch Black River crossing will be installed almost entirely through sedimentary bedrock. Since the Delft Equation (discussed in Section 5) is only applicable to uncemented subsurface material, an assessment of the risk of hydrofracture was not completed. In general, inadvertent drilling fluid returns due to hydrofracture do not typically occur on rock crossings. Instead, on crossings through bedrock, inadvertent drilling fluid returns are more likely to occur by flowing through existing fractures, joints, or solution cavities.

Construction Duration

The estimated duration of construction for the East Branch Black River Crossing is 48 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated based on typical production rates for various subsurface materials outlined in the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as JDH&A's past experience in similar subsurface conditions. Details relative to the estimate are provided in Figure 6.

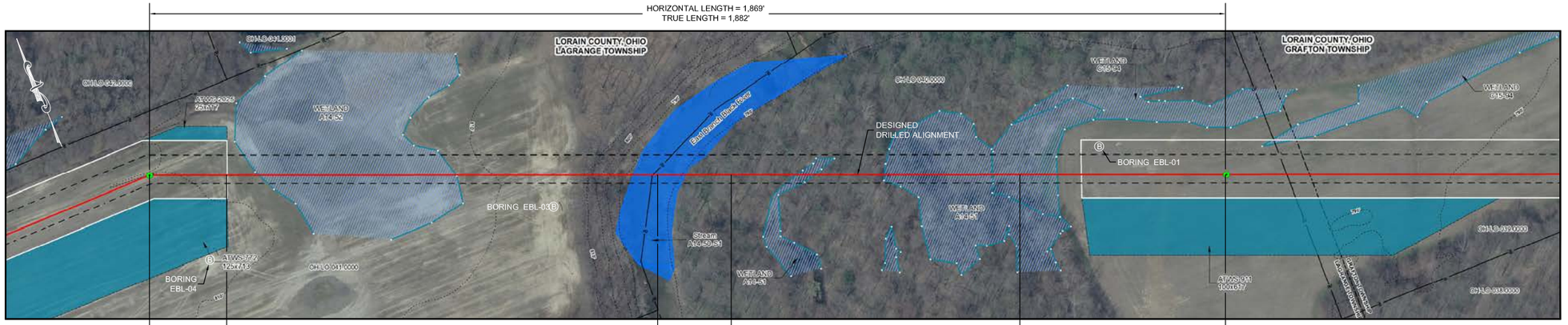
Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments						
Work Schedule, hours/shift =	12.0	36" East Branch Black River Crossing						
days/week =	7.0							
Drilled Length, feet =	1,882							
Pilot Hole								
Production Rate, feet/hour =	25							
shifts/day =	1							
Drilling Duration, hours =	75.3							
shifts =	6.3							
Trips to change tools, shifts =	0.5							
Pilot Hole Duration, days =	6.8							
Ream and Pull Back								
Pass Description =	24-inch	36-inch	48-inch			Swab	Pull Back	Total
Travel Speed, feet/minute =	0.3	0.3	0.3			8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0	15.0			15.0	7.0	
shifts/day =	1	1	1			1	1	
Reaming Duration, hours =	127.5	127.5	127.5			5.9	7.3	395.7
shifts =	10.6	10.6	10.6			0.5	0.6	33.0
Rig up, shifts =	0.5	0.5	0.5			0.5	0.5	2.5
Trips to change tools, shifts =	1.0	1.0	1.0			0.0		3.0
Pass Duration, days =	12.1	12.1	12.1			1.0	1.1	38.5
Summary								
HDD Duration at Site, days =	47.2							

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 6: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN

SCALE: 1" = 100'

ENTRY POINT @ 12°
0+00.00, 810.00
N 14987252.31, E 1344193.18

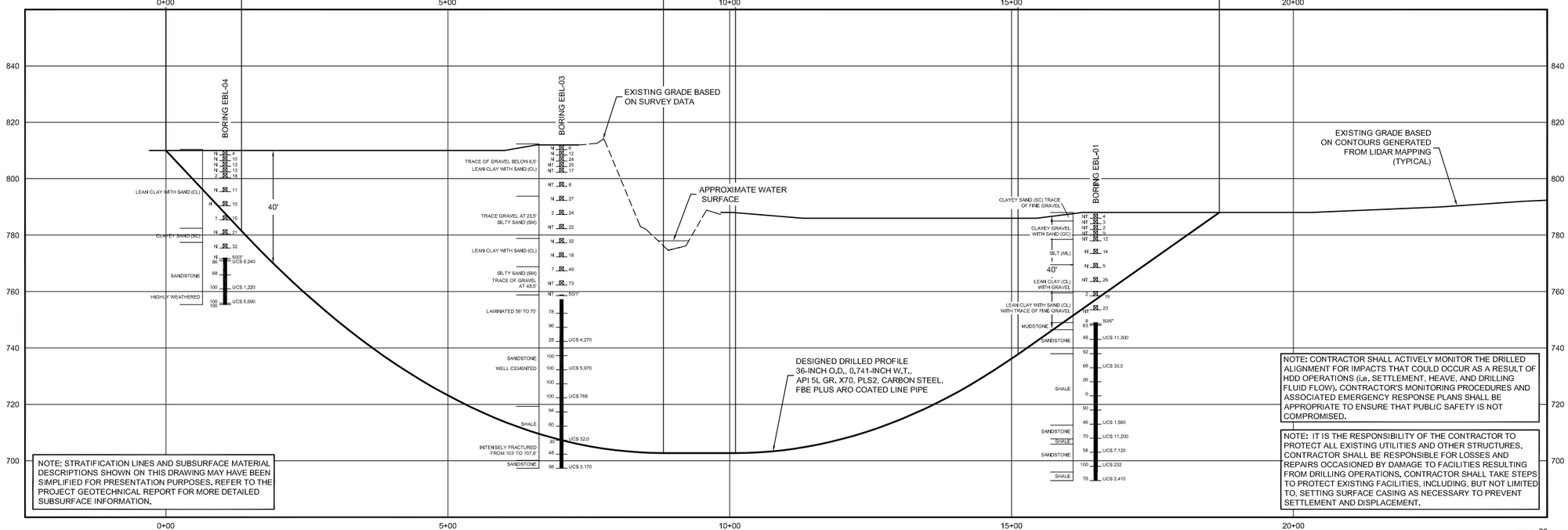
P.C. 12° SAG BEND
1+34.42, 781.43
RADIUS = 3,600'

P.T. 12° SAG BEND
8+82.90, 702.76

P.C. 8° SAG BEND
10+10.35, 702.76
RADIUS = 3,600'

P.T. 8° SAG BEND
15+11.37, 737.80

EXIT POINT @ 8°
18+68.59, 788.00
N 14986529.27, E 1345916.22



NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

PROFILE

SCALE: 1" = 100' HORIZONTAL
1" = 20' VERTICAL

250 200 150 100 50 0
20 10 0

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PIPELINE
- INTERCONNECTING PIPELINE
- CONSTRUCTION LIMIT
- STUDY CORRIDOR
- STAGING AREA
- WAREYARD
- PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- METERING & REGULATION STATION (M&R)
- COMPRESSOR STATION SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- APPROXIMATE WETLAND BOUNDARY
- APPROXIMATE WATERBODY BANK
- APPROXIMATE WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD (PAR-0.0)
- TEMPORARY ACCESS ROAD (TAR-0.0)
- PARCEL TRACT NO (CH-CO-011.0000-SC)
- PROPERTY LINE
- CONTOUR
- MUNICIPALITY LINE
- FENCE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- TELEPHONE
- TEE TAP
- BLOW OFF VALVE
- TOWER
- HORIZONTAL DIRECTIONAL DRILLING
- TANK
- WELL: GAS, WATER, OIL, UNKNOWN
- UTILITY LINES
- MAINLINE VALVE (MLV)
- MICROWAVE TOWER
- LIGHT POLE
- FIRE HYDRANT

GENERAL LEGEND

- DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

- Ⓑ BORING LOCATION

SPLIT SPOON SAMPLE

- 53 N 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
- PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE

- UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
- 53 6 — MOHS HARDNESS
- ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA. REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.

2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.

3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW, HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE.

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
WADS–A–1097	ALIGNMENT SHEET M.P. 86.18 TO M.P. 87.13	0	LKB	ACM	ISSUED FOR FERC

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	JMS	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	LKB/ACM	08/07		
DESIGN CHECKER	ACM	08/07		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH EAST BRANCH BLACK RIVER CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING

LORAIN COUNTY, OHIO

NEXUS SM
GAS TRANSMISSION

M.P. 86.5	W.O.	SCALE: AS SHOWN	DWG. WADS–H–1005	REV. 0

MP 92.2 West Branch Black River

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR and traditional survey data covering the proposed crossing location
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The 36-inch West Branch Black River Crossing is located approximately 2.5 miles southeast of Oberlin, Ohio near the intersection of West Road and Kipton Nickle Plate Road. The crossing involves passing beneath the meandering channel of the West Branch Black River, as well as West Road. The topography in the vicinity of the crossing is essentially flat, but with a topographic rise of approximately 20 feet conforming to the east bank of the river. Both sides of the river are mixtures of wooded patches and open farmland.

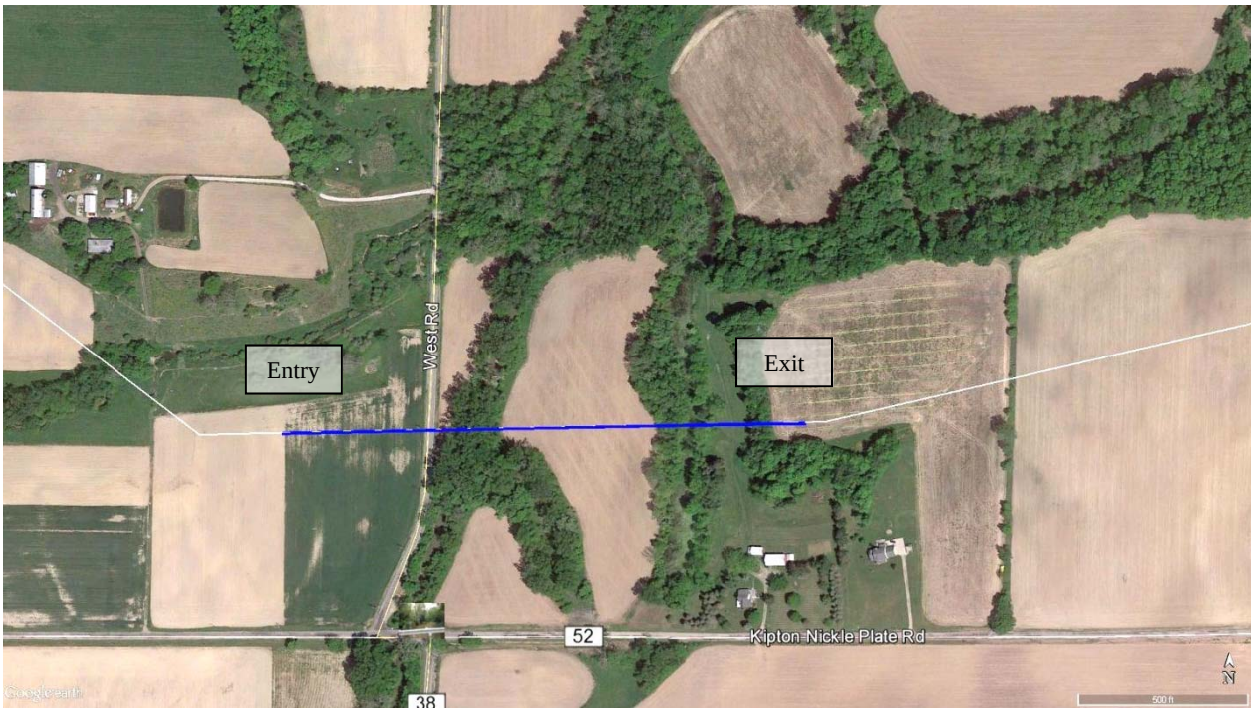


Figure 1: Overview of the West Branch Black River Crossing

Subsurface Conditions

At the time of this writing, site-specific subsurface information is not yet available.

Design Geometry & Layout

The West Branch Black River HDD design involves a horizontal length of 1,669 feet. The design geometry involves a 10-degree entry angle, a 12-degree exit angle, and radius of curvature of 3,600 feet. The HDD design achieves 40 feet of cover at the edge of the easternmost channel of the West Branch Black River, 58 feet beneath the western channel, and 62 feet of cover beneath West Road. The original conceptual design for the crossing involved entering on the east side of the river with a 12-degree entry angle and exiting on the west side of the river with an 8-degree exit angle. However, based on false right-of-way and pull section handling considerations, the design team chose to revise temporary workspace to accommodate pull section stringing on the east side of the crossing. Although the east side is superior for pull section layout, there is a pipeline point of intersection (P.I.) that limits the distance east the exit point can be located. With the current exit point located as far as east possible at the location of the P.I., a 12-degree exit angle was required to maintain suitable cover beneath the river. Although a 12-degree exit angle is feasible, it makes pipeline break over more difficult and may require cranes to achieve the required lifting height. At the time of this writing, it is envisioned that the pipeline P.I. location will be optimized prior to construction allowing the exit point to shift further east in order to accommodate a shallower 8-degree to 10-degree exit angle.

The proposed HDD design for crossing the West Branch Black River, as well as available workspace for HDD operations, is shown on the preliminary HDD plan and profile drawing attached at the end of this report.

Assessment of Feasibility

Overall, given the length the proposed 36-inch installation, it is easily within the range of what has been successfully installed using HDD. It is anticipated the subsurface will consist of sedimentary bedrock conducive to the HDD process. However, the feasibility will need to be confirmed when site-specific geotechnical data is available.

Risk Identification and Assessment

Potential construction impacts due to installation by HDD include damage to West Road in the form of heaving or settlement, as well as drilling fluid surfacing with the West Branch Black River.

Based on the proposed length of the crossing, the overall risk of HDD operational problems and subsequent delays at this location are likely to be average. However, risk should be re-evaluated after site-specific geotechnical information is available.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 289,063 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 322,044 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 2. Detailed calculations for each loading scenario are summarized in Figures 3 and 4.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 2: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	61.6	ft	Effective Weight, W_e = W + W_b - W_m =	279.0	lb/ft
Exit Angle, θ =	12.0	°			
Frictional Drag = W_e L μ cosθ =	5,047	lb			
Fluidic Drag = 12 π D L C_d =	0	lb	Fluidic drag is calculated as zero unless entire segment is submerged in drilling fluid. Please reference Step 2, Drilled Path Input		
Axial Segment Weight = W_e L sinθ =	-3,576	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Exit Tangent =	**1,471**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	754.0	ft	Average Tension, T =	81,720	lb
Segment Angle with Horizontal, θ =	-12.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-6.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	19.72	ft	j = [(E I) / T]$^{1/2}$ =	2,128	
Y = [18 $(L)^3$] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	6.8E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1228.02	
U = (12 L) / j =	4.25		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	178,171	lb
Bending Frictional Drag = 2 μ N =	106,903	lb			
Fluidic Drag = 12 π D L C_d =	25,582	lb			
Axial Segment Weight = W_e L sinθ =	28,013	lb			
Pulling Load on Exit Sag Bend =	**160,498**	**lb**			
Total Pulling Load =	**161,969**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	140.0	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	14,929	lb			
Fluidic Drag = 12 π D L C_d =	4,750	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**19,680**	**lb**			
Total Pulling Load =	**181,649**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	231,622	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	1,264	
Y = [18 $(L)^3$] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	5.7E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1256.32	
U = (12 L) / j =	5.97		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	163,489	lb
Bending Frictional Drag = 2 μ N =	98,093	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	-19,464	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**99,947**	**lb**			
Total Pulling Load =	**281,596**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	96.7	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	10,155	lb			
Fluidic Drag = 12 π D L C_d =	3,281	lb			
Axial Segment Weight = W_e L sinθ =	-5,969	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**7,467**	**lb**			
Total Pulling Load =	**289,063**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,522	ok	0	ok	0	ok	0.06	ok	0.00	ok
	3,431	ok	0	ok	254	ok	0.05	ok	0.01	ok
PC	3,431	ok	12,083	ok	254	ok	0.32	ok	0.08	ok
	2,213	ok	12,083	ok	1082	ok	0.30	ok	0.11	ok
PT	2,213	ok	0	ok	1082	ok	0.04	ok	0.03	ok
	1,973	ok	0	ok	1082	ok	0.03	ok	0.03	ok
PC	1,973	ok	12,083	ok	1082	ok	0.30	ok	0.10	ok
	18	ok	12,083	ok	-109	ok	0.27	ok	0.05	ok
PT	18	ok	0	ok	-109	ok	0.00	ok	0.00	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 3: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	371.1	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	12.0	°			
Frictional Drag = W_e L μ cosθ =	38,703	lb			
Fluidic Drag = 12 π D L C_d =	12,590	lb			
Axial Segment Weight = W_e L sinθ =	27,422	lb			
Pulling Load on Exit Tangent =	**78,716**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	377.0	ft	Average Tension, T =	128,435	lb
Segment Angle with Horizontal, θ =	-12.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-6.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	9.86	ft	j = [(E I) / T]$^{1/2}$ =	1,697	
Y = [18 $(L)^2$] - [(j / 2) $\tanh(U/2)^{-1}$] =	1.1E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	392.79	
U = (12 L) / j =	2.67		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	121,069	lb
Bending Frictional Drag = 2 μ N =	72,641	lb			
Fluidic Drag = 12 π D L C_d =	12,791	lb			
Axial Segment Weight = W_e L sinθ =	14,007	lb			
Pulling Load on Exit Sag Bend =	**99,439**	**lb**			
Total Pulling Load =	**178,155**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	277.3	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	29,567	lb			
Fluidic Drag = 12 π D L C_d =	9,408	lb			
Axial Segment Weight = W_e L sinα =	0	lb			
Pulling Load on Bottom Tangent =	**38,974**	**lb**			
Total Pulling Load =	**217,129**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	254,214	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,206	
Y = [18 $(L)^2$] - [(j / 2) $\tanh(U/2)^{-1}$] =	9.1E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	390.10	
U = (12 L) / j =	3.13		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	122,071	lb
Bending Frictional Drag = 2 μ N =	73,243	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**74,170**	**lb**			
Total Pulling Load =	**291,299**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	398.2	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	41,811	lb			
Fluidic Drag = 12 π D L C_d =	13,509	lb			
Axial Segment Weight = W_e L sinθ =	-24,575	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**30,745**	**lb**			
Total Pulling Load =	**322,044**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,924	ok	0	ok	0	ok	0.06	ok	0.00	ok
	3,549	ok	0	ok	1047	ok	0.06	ok	0.03	ok
PC	3,549	ok	24,167	ok	1047	ok	0.59	ok	0.30	ok
	2,645	ok	24,167	ok	1461	ok	0.57	ok	0.31	ok
PT	2,645	ok	0	ok	1461	ok	0.04	ok	0.05	ok
	2,170	ok	0	ok	1461	ok	0.03	ok	0.04	ok
PC	2,170	ok	24,167	ok	1461	ok	0.56	ok	0.31	ok
	959	ok	24,167	ok	865	ok	0.54	ok	0.24	ok
PT	959	ok	0	ok	865	ok	0.02	ok	0.02	ok
Exit Point	0	ok	0	ok	-303	ok	0.00	ok	0.00	ok

Figure 4: Installation Loading and Stress Analysis (Worse Case)

Hydrofracture Evaluation

At the time of this writing, site-specific geotechnical data is not available. Therefore, a hydrofracture evaluation could not be completed.

Construction Duration

The estimated duration of construction is 39 days based on assumed subsurface conditions consisting of sedimentary bedrock. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as JDH&A's past experience in similar subsurface conditions. Refer to Figure 5 for details relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments
Work Schedule, hours/shift =	12.0	36" West Branch Black River Crossing. Subsurface conditions assumed to consist of sedimentary bedrock.
days/week =	7.0	
Drilled Length, feet =	1,681	
Pilot Hole		
Production Rate, feet/hour =	25	
shifts/day =	1	
Drilling Duration, hours =	67.2	
shifts =	5.6	
Trips to change tools, shifts =	0.5	
Pilot Hole Duration, days =	6.1	

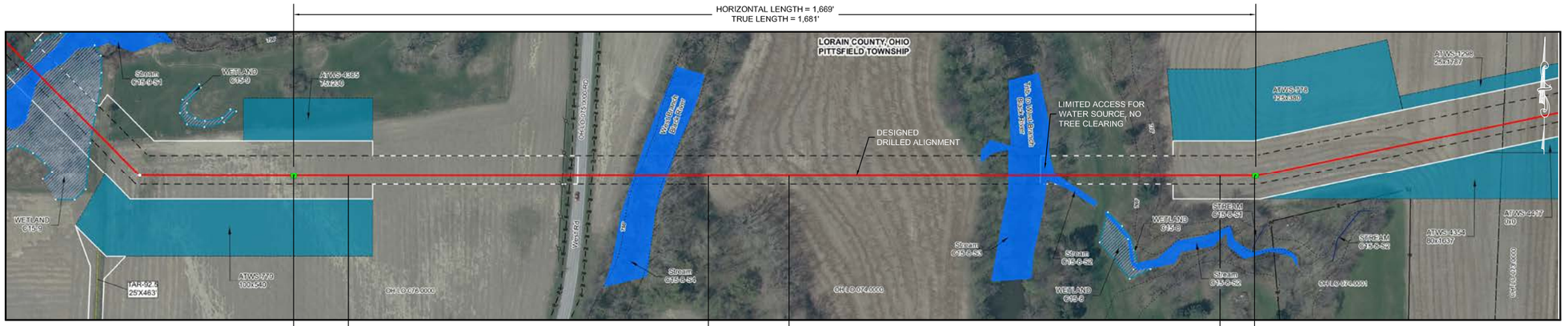
Ream and Pull Back								
Pass Description =	24-inch	36-inch	48-inch			Swab	Pull Back	Total
Travel Speed, feet/minute =	0.3	0.3	0.3			8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0	15.0			15.0	15.0	
shifts/day =	1	1	1			1	1	
Reaming Duration, hours =	95.2	95.2	95.2			5.3	6.5	297.4
shifts =	7.9	7.9	7.9			0.4	0.5	24.8
Rig up, shifts =	0.5	0.5	0.5			0.5	0.5	2.5
Trips to change tools, shifts =	1.0	1.0	1.0			0.0		3.0
Pass Duration, days =	9.4	9.4	9.4			0.9	1.0	30.3

Summary	
HDD Duration at Site, days =	38.4

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 5: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN
SCALE: 1" = 100'

ENTRY POINT @ 10°
0+00.00, 754.00
N 14990295.50, E 1315811.17

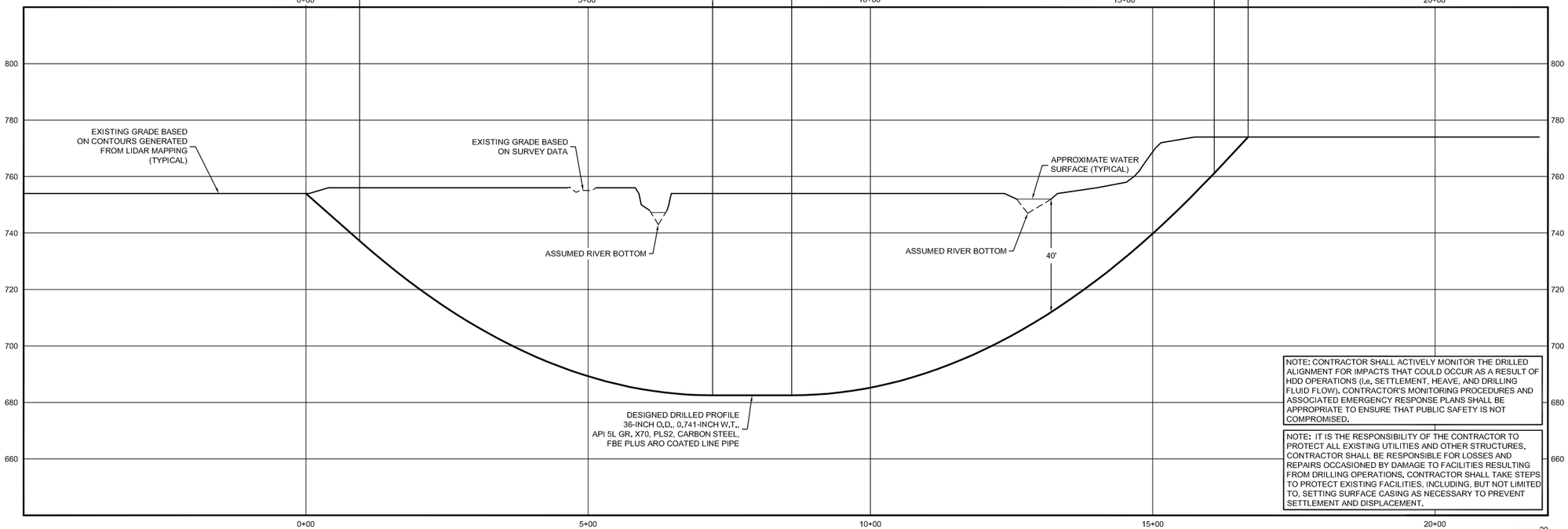
P.C. 10° SAG BEND
0+95.23, 737.21
RADIUS = 3,600'

P.C. 10° SAG BEND
7+20.37.682.52

P.T. 12° SAG BEND
8+60.37, 682.52
RADIUS = 3,600'

P.C. 12° SAG BEND
16+08.86, 761.18

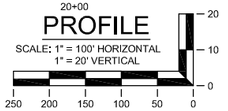
EXIT POINT @ 12°
16+69.15, 774.00
N 14990308.59, E 1317480.27



NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (I.e, SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

PROFILE
SCALE: 1" = 100' HORIZONTAL
1" = 20' VERTICAL



ALIGNMENT LEGEND

PIPELINE MILEPOST
PIPELINE
INTERCONNECTING PIPELINE
CONSTRUCTION LIMIT
STUDY CORRIDOR
STAGING AREA
WAREYARD
PERMANENT ROW
ADDITIONAL TEMPORARY WORKSPACE
METERING & REGULATION STATION (M&R)
COMPRESSOR STATION SITE
FACILITIES TEMPORARY WORKSPACE
FACILITIES PERMANENT WORKSPACE

DELINEATED WETLAND BOUNDARY
DELINEATED WATERBODY BANK
DELINEATED WATERBODY CENTERLINE
APPROXIMATE WETLAND BOUNDARY
APPROXIMATE WATERBODY BANK
APPROXIMATE WATERBODY CENTERLINE
PERMANENT ACCESS ROAD
TEMPORARY ACCESS ROAD
PARCEL TRACT NO
PROPERTY LINE
CONTOUR
MUNICIPALITY LINE

FENCE
FOREIGN PIPELINE
POWERLINE
WATER PIPELINE
RAILROAD TRACK
TELEPHONE
TEE TAP
BLOW OFF VALVE
TOWER
HORIZONTAL DIRECTIONAL DRILLING
TANK
WELL: GAS WATER OIL UNKNOWN
UTILITY LINES
MAINLINE VALVE (MLV)
MICROWAVE TOWER
LIGHT POLE
FIRE HYDRANT

GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW. HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE.

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

IGI#						
WADS–A–1103	ALIGNMENT SHEET M.P. 91.86 TO M.P. 92.81	0	LKB	ACM	ISSUED FOR FERC	
DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION	

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS				
	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	LKB	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	LKB	08/07		
DESIGN CHECKER	DLB	08/07		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH WEST BRANCH BLACK RIVER CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING

LORAIN COUNTY, OHIO

NEXUS SM
GAS TRANSMISSION

M.P. 92.2	W.O.	SCALE: AS SHOWN	DWG. WADS–H–1006	REV. 0

MP 104.1 Vermilion Crossing

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR and traditional survey data covering the proposed crossing location
- Draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Vermilion River (Rev-1) HDD Crossing, Nexus Gas Transmission Project, Huron County, Ohio" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The 36-inch crossing of the Vermilion River is located near pipeline Mile Post 104.1, about two miles north of Wakeman, Ohio. Obstacles to be crossed include a shallow braided river and wetland complex, and Highway 62 (West Road). The area surrounding the river, approximately 800 feet on both sides, is wooded. In each direction beyond the woodlands are open farm fields. The topography on both sides is generally flat but drops off quickly toward the river. The elevation change is approximately 80 feet to the bottom of the river valley.

An overview of the proposed crossing location is provided in Figure 1. Photographs taken during the site reconnaissance are included as Figure 2 and Figure 3.

Figure 1: Overview of the Vermillion River Crossing

Figure 2: View west toward entry location

Figure 3: View west toward exit location from West Road

Subsurface Conditions

Four site-specific geotechnical borings were taken as part of the site investigation undertaken by Fugro Consultants, Inc. Two borings were taken on each side of the river. Each encountered approximately 20 feet of overburden soil (lean clay and sandy lean clay) overlying sedimentary bedrock consisting primarily of shale and siltstone, but with some claystone and sandstone. The unconfined compressive strength (UCS) of the bedrock ranged from 10 psi to 4,690 psi. In general, strength increases with depth. The majority of UCS values were less than 1,000 psi above elevation 760. Below elevation 760, UCS averaged 2,528 psi on the west side and 1,853 on the east side. Rock quality designation (RQD) generally indicates good quality bedrock, though the boring logs indicate several areas described as extremely fractured that did not necessarily correlate with the RQD values.

For detailed information relative to the subsurface investigation, refer to the draft geotechnical data report prepared by Fugro Consultants, Inc. titled “Geotechnical Data Report, Vermilion River (Rev-1) HDD Crossing, Nexus Gas Transmission Project, Huron County, Ohio” and dated September 11, 2015.

Design Geometry & Layout

The proposed crossing design involves a horizontal length of 2,945 feet. It utilizes 10-degree entry and exit angles, with a radius of curvature of 3,600 feet. The crossing maintains a minimum of 35 feet of cover beneath W Road, 30 feet of cover beneath the bottom of the slope on the west side of the crossing, and in excess of 40 feet of cover beneath the Vermilion River as well as the bottom of the slope on the east side of the crossing. Pull section fabrication will take place on the west side of the crossing since it provides sufficient unobstructed space for pull section stringing. The location of the exit point on the west side of the crossing was specified by Fluor Enterprises, Inc. Therefore, in order to gain sufficient depth of cover beneath W Road and the bottom of the slope on the west hillside, a 10-degree exit angle was necessary. It is envisioned that the HDD design will be optimized prior to construction allowing the exit point to shift further west in order to accommodate a shallower 8-degree exit angle and greater cover beneath the roadway and the bottom of the slope.

The proposed HDD design, as well as available workspace for HDD operations, is shown on the preliminary HDD plan and profile drawing included in this site-specific report.

Assessment of Feasibility

Based on available geotechnical data, it appears the crossing will be installed entirely through relatively weak sedimentary bedrock. HDD crossings with similar lengths and diameters have been installed through similar subsurface conditions in the past. Therefore, it is our opinion that with the right downhole tool selections and sound planning, skilled and experienced HDD contractors will be able to install the Vermilion River Crossing.

Risk Identification and Assessment

Notable risks associated with installation by HDD are the possibility of damage to West Road due to heaving or settlement, as well as inadvertent drilling fluid returns surfacing within the

wetlands and river channels. The risk of inadvertent drilling fluid returns is elevated at this location due to the elevation differential of approximately 100 feet between the entry point and the bottom of the river valley, which results in increased annular pressure.

Potential HDD construction and operational risks associated with the crossing include failure of large diameter rock reaming tools downhole, hole misalignment at the soil/rock interface, which may cause downhole tools to bind or the pull section to become lodged, and loss of drilling fluid circulation through existing joints and fractures within the sedimentary bedrock. Loss of circulation may negatively impact cuttings removal.

Overall, the proposed Vermilion River crossing is considered to have an average level of risk.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 479,079 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 505,493 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 4. Detailed calculations for each scenario are summarized in Figures 5 and 6.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 4: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	505.3	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	53,065	lb			
Fluidic Drag = 12 π D L C_d =	17,145	lb			
Axial Segment Weight = W_e L sinθ =	31,189	lb			
Pulling Load on Exit Tangent =	**101,399**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	169,343	lb
Segment Angle with Horizontal, θ =	-10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	1,478	
Y = [18 $(L)^2$] - [(j^2 (1 - cosh(U/2)$^{-1}$] =	5.3E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1154.92	
U = (12 L) / j =	5.10		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	158,507	lb
Bending Frictional Drag = 2 μ N =	95,104	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	19,464	lb			
Pulling Load on Exit Sag Bend =	**135,887**	**lb**			
Total Pulling Load =	**237,286**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	651.8	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	69,500	lb			
Fluidic Drag = 12 π D L C_d =	22,114	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**91,614**	**lb**			
Total Pulling Load =	**328,900**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	382,623	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	983	
Y = [18 $(L)^2$] - [(j^2 (1 - cosh(U/2)$^{-1}$] =	6.2E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1393.80	
U = (12 L) / j =	7.67		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	175,985	lb
Bending Frictional Drag = 2 μ N =	105,591	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	-19,464	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**107,445**	**lb**			
Total Pulling Load =	**436,345**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	553.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	58,114	lb			
Fluidic Drag = 12 π D L C_d =	18,777	lb			
Axial Segment Weight = W_e L sinθ =	-34,157	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**42,734**	**lb**			
Total Pulling Load =	**479,079**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	5,837	ok	0	ok	0	ok	0.09	ok	0.01	ok
	5,316	ok	0	ok	1329	ok	0.08	ok	0.05	ok
PC	5,316	ok	12,083	ok	1329	ok	0.35	ok	0.16	ok
	4,007	ok	12,083	ok	2157	ok	0.33	ok	0.21	ok
PT	4,007	ok	0	ok	2157	ok	0.06	ok	0.10	ok
	2,891	ok	0	ok	2157	ok	0.05	ok	0.10	ok
PC	2,891	ok	12,083	ok	2157	ok	0.31	ok	0.20	ok
	1,235	ok	12,083	ok	1329	ok	0.28	ok	0.11	ok
PT	1,235	ok	0	ok	1329	ok	0.02	ok	0.04	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	811.5	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	85,216	lb			
Fluidic Drag = 12 π D L C_d =	27,533	lb			
Axial Segment Weight = W_e L sinθ =	50,087	lb			
Pulling Load on Exit Tangent =	**162,836**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	208,288	lb
Segment Angle with Horizontal, θ =	-10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,333	
Y = [18 (L^2) - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	8.2E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	350.50	
U = (12 L) / j =	2.83		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	117,522	lb
Bending Frictional Drag = 2 μ N =	70,513	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	9,732	lb			
Pulling Load on Exit Sag Bend =	**90,904**	**lb**			
Total Pulling Load =	**253,741**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	733.1	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	78,176	lb			
Fluidic Drag = 12 π D L C_d =	24,875	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**103,051**	**lb**			
Total Pulling Load =	**356,791**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	398,136	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	964	
Y = [18 (L^2)] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	1.1E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	479.45	
U = (12 L) / j =	3.91		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	136,272	lb
Bending Frictional Drag = 2 μ N =	81,763	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**82,690**	**lb**			
Total Pulling Load =	**439,482**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	854.9	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	89,770	lb			
Fluidic Drag = 12 π D L C_d =	29,005	lb			
Axial Segment Weight = W_e L sinθ =	-52,763	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**66,012**	**lb**			
Total Pulling Load =	**505,493**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	6,159	ok	0	ok	0	ok	0.10	ok	0.01	ok
	5,354	ok	0	ok	2134	ok	0.08	ok	0.11	ok
PC	5,354	ok	24,167	ok	2134	ok	0.61	ok	0.44	ok
	4,347	ok	24,167	ok	2548	ok	0.60	ok	0.46	ok
PT	4,347	ok	0	ok	2548	ok	0.07	ok	0.14	ok
	3,091	ok	0	ok	2548	ok	0.05	ok	0.13	ok
PC	3,091	ok	24,167	ok	2548	ok	0.58	ok	0.44	ok
	1,984	ok	24,167	ok	2134	ok	0.56	ok	0.37	ok
PT	1,984	ok	0	ok	2134	ok	0.03	ok	0.09	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

Based on available geotechnical information, it is anticipated that the proposed crossing will be installed almost entirely through sedimentary bedrock. Since the Delft Method (discussed previously in Section 5) is only applicable to soil, a hydrofracture evaluation was not completed. In general, inadvertent drilling fluid returns due to hydrofracture do not typically occur on rock crossings, but instead occur by flowing through existing fractures, joints, or solution cavities.

Construction Duration

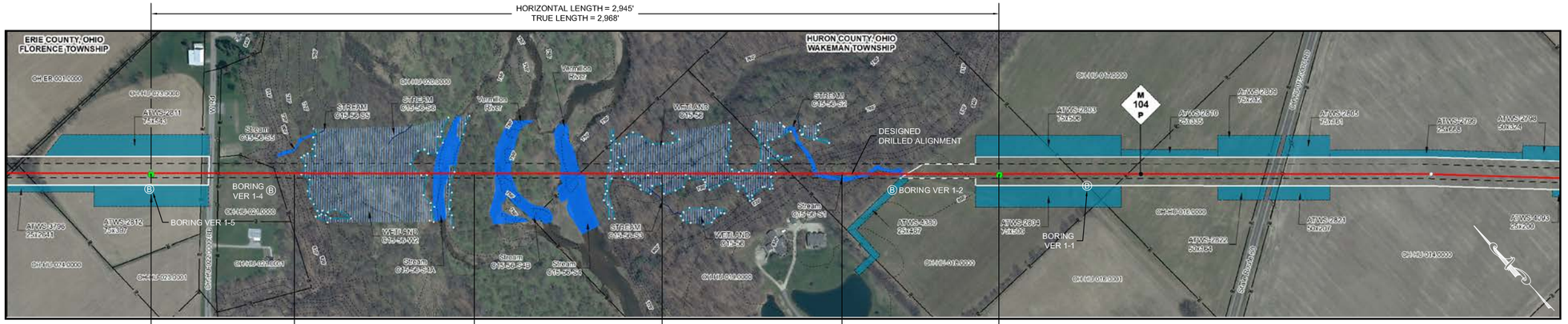
The estimated duration of construction for the proposed crossing is 73 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated by JDH&A based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as past experience in similar subsurface conditions. Refer to Figure 7 for details relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments						
Work Schedule, hours/shift =	12.0	36" Vermillion River Crossing						
days/week =	7.0							
Drilled Length, feet =	2,968							
Pilot Hole								
Production Rate, feet/hour =	20							
shifts/day =	1							
Drilling Duration, hours =	148.4							
shifts =	12.4							
Trips to change tools, shifts =	0.5							
Pilot Hole Duration, days =	12.9							
Ream and Pull Back								
Pass Description =	24-inch	36-inch	48-inch			Swab	Pull Back	Total
Travel Speed, feet/minute =	0.3	0.3	0.3			8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0	15.0			15.0	7.0	
shifts/day =	1	1	1			1	1	
Reaming Duration, hours =	201.1	201.1	201.1			9.4	11.4	624.0
shifts =	16.8	16.8	16.8			0.8	1.0	52.0
Rig up, shifts =	0.5	0.5	0.5			0.5	0.5	2.5
Trips to change tools, shifts =	1.0	1.0	1.0			0.0		3.0
Pass Duration, days =	18.3	18.3	18.3			1.3	1.5	57.5
Summary								
HDD Duration at Site, days =	72.4							
Site Establishment	Move in	Rig Up	Rig Down	Move Out				
shifts/day =	1	1	1	1				
shifts =	0.5	1.0	1.0	0.5				
days =	0.5	1.0	1.0	0.5				

Figure 7: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN
SCALE: 1" = 200'

EXIT POINT @ 10°
29+44.68, 845.24
N 14997126.84, E 1255407.46

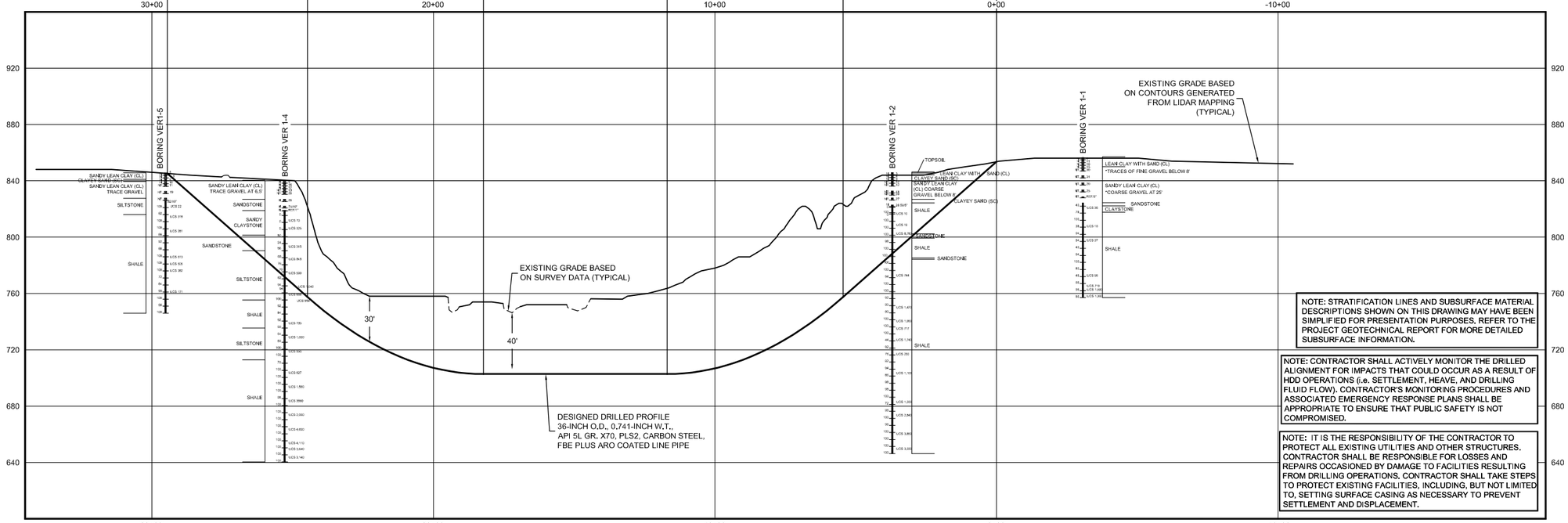
P.T. 10° SAG BEND
24+47.02, 757.49

P.C. 10° SAG BEND
18+21.89, 702.80
RADIUS = 3,600'

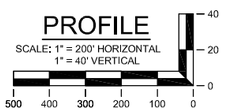
P.T. 10° SAG BEND
11+70.13, 702.80

P.C. 10° SAG BEND
5+45.00, 757.49
RADIUS = 3,600'

ENTRY POINT @ 10°
0+00, 853.59
N 14995086.27, E 1257529.00



PROFILE
SCALE: 1" = 200' HORIZONTAL
1" = 40' VERTICAL



NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

ALIGNMENT LEGEND

- PIPELINE MILEPOST (M 0.0 P)
- PIPELINE
- INTERCONNECTING PIPELINE
- CONSTRUCTION LIMIT
- STUDY CORRIDOR
- STAGING AREA
- WAREYARD
- PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- METERING & REGULATION STATION (M&R)
- COMPRESSOR STATION SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- APPROXIMATE WETLAND BOUNDARY
- APPROXIMATE WATERBODY BANK
- APPROXIMATE WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD (PAR-0.0)
- TEMPORARY ACCESS ROAD (TAR-0.0)
- PARCEL TRACT NO (OH-CO-011.0000-SC)
- PROPERTY LINE
- CONTOUR (120')
- MUNICIPALITY LINE
- FENCE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- TELEPHONE
- TEE TAP
- BLOW OFF VALVE
- TOWER
- HORIZONTAL DIRECTIONAL DRILLING
- TANK
- WELL: GAS WATER OIL UNKNOWN
- UTILITY LINES
- MAINLINE VALVE (MLV)
- MICROWAVE TOWER
- LIGHT POLE
- FIRE HYDRANT

GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

(B) BORING LOCATION

SPLIT SPOON SAMPLE
53 N 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE
UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
53 6 — MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA, REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.

2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.

3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW, HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE.

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
WADS–A–1116	ALIGNMENT SHEET M.P. 104.17 TO M.P. 105.12				
WADS–A–1115	ALIGNMENT SHEET M.P. 103.22 TO M.P. 104.17	0	LKB	ACM	ISSUED FOR FERC

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	JMS	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	ACM	08/07		
DESIGN CHECKER	DLB	08/05		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH VERMILION RIVER CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING
HURON COUNTY, OHIO

NEXUS SM GAS TRANSMISSION

M.P. 104.1	W.O.	SCALE: AS SHOWN	DWG. WADS–H–1007	REV. 0

MP 110.1 Interstate 80

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR and survey data covering the proposed crossing location
- Draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Interstate 80 Road Crossing, Nexus Gas Transmission Project, Lorain County Ohio" and dated August 11, 2015

General Site Description

The 36-inch Interstate 80 Crossing is located just east of Berlin Heights, Ohio. It involves passing beneath the eastbound and westbound lanes of I-80, as well as County Road 17 (Main Road), located immediately south of the interstate. Both sides of the interstate are open farm fields. The topography in the area is flat. An overview of the proposed crossing location is provided in Figure 1.

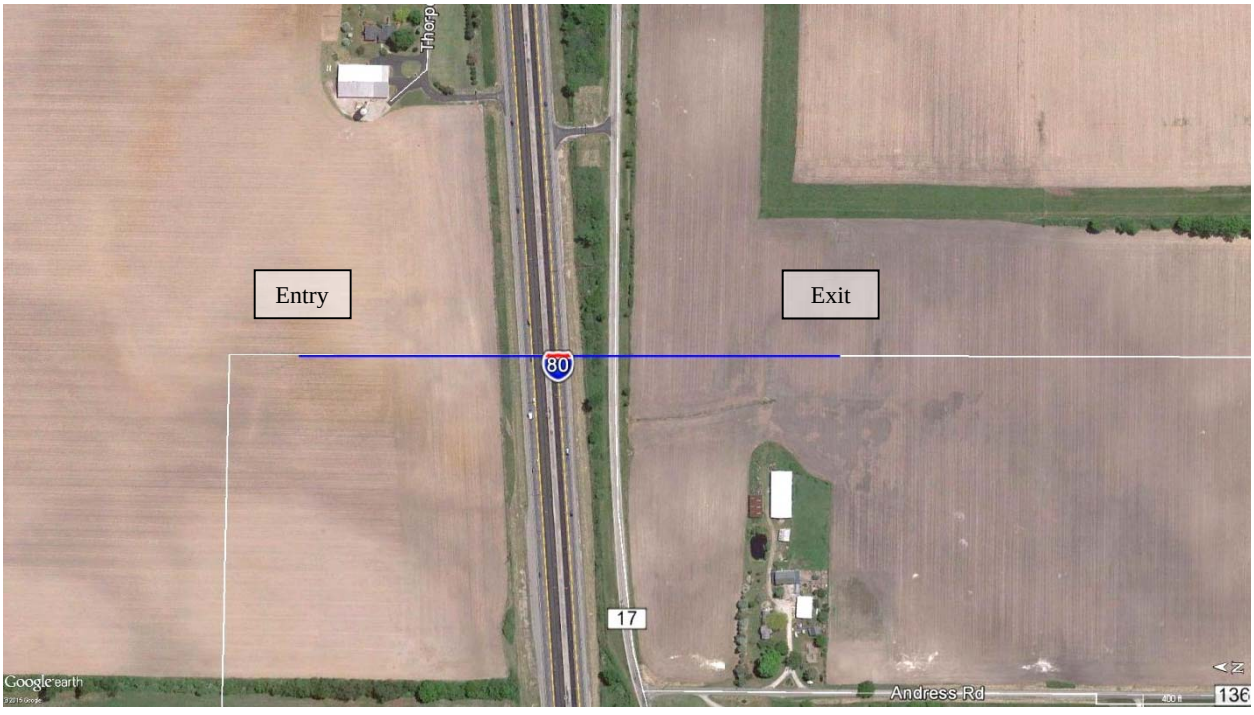


Figure 1: Overview of the Interstate 80 Crossing.

Subsurface Conditions

Two shallow borings to depths of approximately 30 feet were taken at the project site as part of a soils investigation for a previously planned conventional road bore crossing. The borings indicate mixtures of sand, silt, and clay, overlying shale sedimentary bedrock. Bedrock is estimated to begin around 29 feet below the ground surface.

Design Geometry & Layout

The proposed Interstate 80 Crossing has a horizontal length of 1,432 feet. It has been designed to achieve a minimum of 40 feet of cover beneath the bar ditch on the north side of Interstate 80. The design employs a 10-degree entry angle, an 8-degree exit angle, and a radius of curvature equal to 3,600 feet. The exit point is located on the south side of the interstate to take advantage of a linear stretch of pipeline right-of-way (ROW), which will allow the pull section to be fabricated in a single segment and thus avoid downtime associated with tie-in welds.

The preliminary HDD plan and profile design for crossing Interstate 80 is attached to this report for reference.

Assessment of Feasibility

Numerous 36-inch pipelines have been installed using HDD over similar distances through similar sedimentary bedrock. Therefore, unless subsurface conditions at depth change significantly from that anticipated, the proposed crossing of Interstate 80 is feasible.

Risk Identification and Assessment

Potential construction impacts associated with installation of the proposed crossing by HDD are heaving or ground settlement along the HDD alignment, resulting in damage to Interstate 80.

HDD construction and operational risks associated the proposed crossing include failure of large diameter rock reaming tools downhole, hole misalignment at the soil/rock interface which can lead to tools or the product pipeline getting lodged, and problems resulting from circulation loss through existing fractures in the bedrock.

The overall level of risk associated with installation of the Interstate 80 Crossing using HDD is considered low.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the conservative analysis described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 252,580 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 279,019 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 2. Detailed calculations for each loading scenario are summarized in Figures 3 and 4.

Line Pipe Properties		
Pipe Outside Diameter =	36.000 in	
Wall Thickness =	0.741 in	
Specified Minimum Yield Strength =	70,000 psi	
Young's Modulus =	2.9E+07 psi	
Moment of Inertia =	12755.22 in^4	
Pipe Face Surface Area =	82.08 in^2	
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06 in/in/°F	
Pipe Weight in Air =	279.04 lb/ft	
Pipe Interior Volume =	6.50 ft^3/ft	
Pipe Exterior Volume =	7.07 ft^3/ft	
HDD Installation Properties		
Drilling Mud Density =	12.0 ppg	
=	89.8 lb/ft^3	
Ballast Density =	62.4 lb/ft^3	
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025 psi	
Ballast Weight =	405.51 lb/ft	
Displaced Mud Weight =	634.48 lb/ft	

Figure 2: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	173.9	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	18,365	lb			
Fluidic Drag = 12 π D L C_d =	5,901	lb			
Axial Segment Weight = W_e L sinθ =	8,603	lb			
Pulling Load on Exit Tangent =	**32,869**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	85,298	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	8.77	ft	j = [(E I) / T]$^{1/2}$ =	2,082	
Y = [18 $(L)^2$] - [(j / 2) tanh(U/2)] =	2.1E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	575.71	
U = (12 L) / j =	2.90		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	125,564	lb
Bending Frictional Drag = 2 μ N =	75,339	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	12,463	lb			
Pulling Load on Exit Sag Bend =	**104,856**	**lb**			
Total Pulling Load =	**137,726**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	95.9	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	10,226	lb			
Fluidic Drag = 12 π D L C_d =	3,254	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**13,479**	**lb**			
Total Pulling Load =	**151,205**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	200,425	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	1,359	
Y = [18 $(L)^2$] - [(j)^2 (1 - cosh(U/2)$^{-1}$)] =	5.5E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1210.96	
U = (12 L) / j =	5.55		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	160,978	lb
Bending Frictional Drag = 2 μ N =	96,587	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	-19,464	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**98,440**	**lb**			
Total Pulling Load =	**249,646**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	38.0	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	3,990	lb			
Fluidic Drag = 12 π D L C_d =	1,289	lb			
Axial Segment Weight = W_e L sinθ =	-2,345	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**2,934**	**lb**			
Total Pulling Load =	**252,580**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,077	ok	0	ok	0	ok	0.05	ok	0.00	ok
	3,041	ok	0	ok	65	ok	0.05	ok	0.00	ok
PC	3,041	ok	12,083	ok	65	ok	0.31	ok	0.07	ok
	1,842	ok	12,083	ok	893	ok	0.29	ok	0.09	ok
PT	1,842	ok	0	ok	893	ok	0.03	ok	0.02	ok
	1,678	ok	0	ok	893	ok	0.03	ok	0.02	ok
PC	1,678	ok	12,083	ok	893	ok	0.29	ok	0.09	ok
	400	ok	12,083	ok	363	ok	0.27	ok	0.06	ok
PT	400	ok	0	ok	363	ok	0.01	ok	0.00	ok
Exit Point	0	ok	0	ok	-4	ok	0.00	ok	0.00	ok

Figure 3: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	479.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	50,624	lb			
Fluidic Drag = 12 π D L C_d =	16,266	lb			
Axial Segment Weight = W_e L sinθ =	23,716	lb			
Pulling Load on Exit Tangent =	**90,606**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	128,032	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1,700	
Y = [18 $(L)^2$] - [(j) ^{2} (1 - cosh(U/2)$^{-1}$] =	2.8E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	150.58	
U = (12 L) / j =	1.77		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	100,153	lb
Bending Frictional Drag = 2 μ N =	60,092	lb			
Fluidic Drag = 12 π D L C_d =	8,527	lb			
Axial Segment Weight = W_e L sinθ =	6,231	lb			
Pulling Load on Exit Sag Bend =	**74,850**	**lb**			
Total Pulling Load =	**165,457**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	109.6	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	11,685	lb			
Fluidic Drag = 12 π D L C_d =	3,718	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**15,403**	**lb**			
Total Pulling Load =	**180,859**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	216,833	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,306	
Y = [18 $(L)^2$] - [(j) ^{2} (1 - cosh(U/2)$^{-1}$] =	8.3E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	358.43	
U = (12 L) / j =	2.89		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	118,369	lb
Bending Frictional Drag = 2 μ N =	71,021	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**71,948**	**lb**			
Total Pulling Load =	**252,808**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	339.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	35,646	lb			
Fluidic Drag = 12 π D L C_d =	11,517	lb			
Axial Segment Weight = W_e L sinθ =	-20,951	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**26,212**	**lb**			
Total Pulling Load =	**279,019**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,399	ok	0	ok	0	ok	0.05	ok	0.00	ok
	3,080	ok	0	ok	858	ok	0.05	ok	0.02	ok
PC	3,080	ok	24,167	ok	858	ok	0.58	ok	0.28	ok
	2,203	ok	24,167	ok	1272	ok	0.56	ok	0.29	ok
PT	2,203	ok	0	ok	1272	ok	0.03	ok	0.03	ok
	2,016	ok	0	ok	1272	ok	0.03	ok	0.03	ok
PC	2,016	ok	24,167	ok	1272	ok	0.56	ok	0.29	ok
	1,104	ok	24,167	ok	1007	ok	0.55	ok	0.25	ok
PT	1,104	ok	0	ok	1007	ok	0.02	ok	0.02	ok
Exit Point	0	ok	0	ok	-4	ok	0.00	ok	0.00	ok

Figure 4: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

The Interstate 80 crossing will be installed almost entirely through bedrock. Since the Delft Equation (discussed previously in Section 5 of this report) is only applicable to uncemented subsurface material, a hydrofracture evaluation was not completed. In general, inadvertent drilling fluid returns due to hydrofracture do not typically occur on rock crossings, but instead occur by flowing through existing fractures, joints, or solution cavities.

Construction Duration

The estimated duration of construction is 38 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as JDH&A's past experience in similar subsurface conditions. Refer to Figure 5 for details relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments
Work Schedule, hours/shift =	12.0	36" Interstate 80 Crossing
days/week =	7.0	
Drilled Length, feet =	1,439	
Pilot Hole		
Production Rate, feet/hour =	25	
shifts/day =	1	
Drilling Duration, hours =	57.6	
shifts =	4.8	
Trips to change tools, shifts =	0.5	
Pilot Hole Duration, days =	5.3	

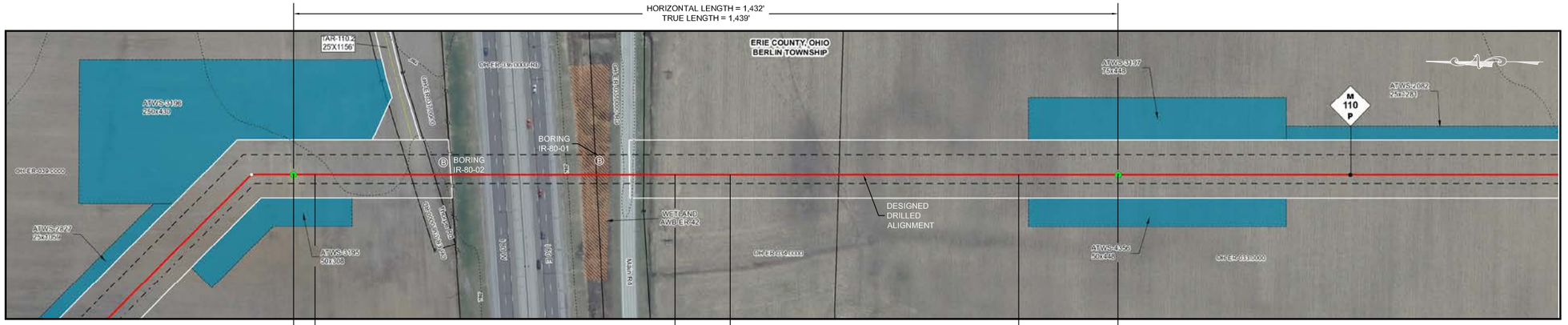
Ream and Pull Back								
Pass Description =	24-inch	36-inch	48-inch			Swab	Pull Back	Total
Travel Speed, feet/minute =	0.3	0.3	0.3			8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0	15.0			15.0	15.0	
shifts/day =	1	1	1			1	1	
Reaming Duration, hours =	97.5	97.5	97.5			4.5	5.5	302.5
shifts =	8.1	8.1	8.1			0.4	0.5	25.2
Rig up, shifts =	0.5	0.5	0.5			0.5	0.5	2.5
Trips to change tools, shifts =	1.0	1.0	1.0			0.0		3.0
Pass Duration, days =	9.6	9.6	9.6			0.9	1.0	30.7

Summary	
HDD Duration at Site, days =	38.0

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 5: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN

SCALE: 1" = 100'

ENTRY POINT @ 10°
0+00.00, 779.29
N 15014929.91, E 1238679.29

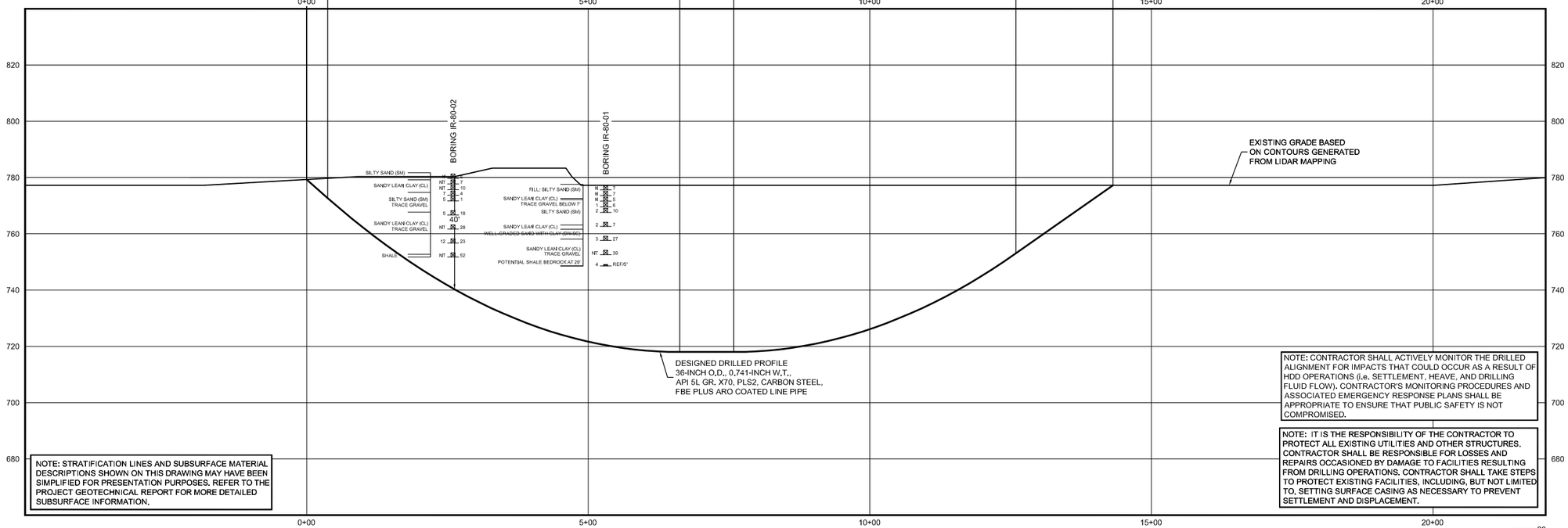
P.C. 10° SAG BEND
0+37.42, 772.69
RADIUS = 3,600'

P.T. 10° SAG BEND
6+62.55, 718.00

P.C. 8° SAG BEND
7+58.44, 718.00
RADIUS = 3,600'

P.T. 8° SAG BEND
12+59.47, 753.04

EXIT POINT @ 8°
14+31.70, 777.24
N 15013498.21, E 1238684.04



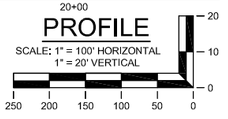
NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

PROFILE

SCALE: 1" = 100' HORIZONTAL
1" = 20' VERTICAL



ALIGNMENT LEGEND

PIPELINE MILEPOST
PIPELINE
INTERCONNECTING PIPELINE
CONSTRUCTION LIMIT
STUDY CORRIDOR
STAGING AREA
WAREYARD
PERMANENT ROW
ADDITIONAL TEMPORARY WORKSPACE
METERING & REGULATION STATION (M&R)
COMPRESSOR STATION SITE
FACILITIES TEMPORARY WORKSPACE
FACILITIES PERMANENT WORKSPACE

DELINEATED WETLAND BOUNDARY
DELINEATED WATERBODY BANK
DELINEATED WATERBODY CENTERLINE
APPROXIMATE WETLAND BOUNDARY
APPROXIMATE WATERBODY BANK
APPROXIMATE WATERBODY CENTERLINE
PERMANENT ACCESS ROAD (PAR-0.0)
TEMPORARY ACCESS ROAD (TAR-0.0)
PARCEL TRACT NO (OH-CO-011.0000-BC)
PROPERTY LINE
CONTOUR (---120'---)
MUNICIPALITY LINE

FENCE
FOREIGN PIPELINE
POWERLINE
WATER PIPELINE
RAILROAD TRACK
TELEPHONE
TEE TAP
BLOW OFF VALVE
TOWER
HORIZONTAL DIRECTIONAL DRILLING
TANK
WELL: GAS WATER OIL UNKNOWN
UTILITY LINES
MAINLINE VALVE (MLV)
MICROWAVE TOWER
LIGHT POLE
FIRE HYDRANT

GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR AND SURVEY DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

B BORING LOCATION

SPLIT SPOON SAMPLE
53 N 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE
UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
53 6 — MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA, REFER TO THE PROJECT GEOTECHNICAL REPORT DATED AUGUST 11, 2015 FOR ADDITIONAL INFORMATION.

2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.

3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW. HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE.

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

WADS-A-1123	ALIGNMENT SHEET M.P. 109.81 TO M.P. 110.57	0	LKB	ACM	ISSUED FOR FERC
DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	DMP	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	DMP	08/07		
DESIGN CHECKER	DLB	08/07		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH INTERSTATE 80 CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING
ERIE COUNTY, OHIO

NEXUS SM
GAS TRANSMISSION

M.P. 110.1	W.O.	SCALE: AS SHOWN	DWG. WADS-H-1008	REV. 0

MP 116.8 Huron River

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR, hydrographic, and traditional survey data covering the proposed crossing location
- Draft Geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Huron River HDD Crossing, Nexus Gas Transmission Project, Erie County, Ohio" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The 36-inch crossing of the Huron River is located near pipeline Mile Post 116.8, approximately 3 miles north of Milan, Ohio. The primary obstacles to be crossed are Highway 13 (Mudbrook Road) and the the Huron River. The Huron River channel is approximately 200 feet wide at the crossing location, and based on hydrographic survey data, about 10 feet deep. The proposed HDD alignment is located north of, and runs parallel to, an existing overhead power corridor. Both sides of the crossing consist of wooded and agricultural land. Refer to Figure 1 for a general overview of the vicinity of the crossing. Figures 2 and 3 provide overviews of the entry and exit areas taken during the site reconnaissance.

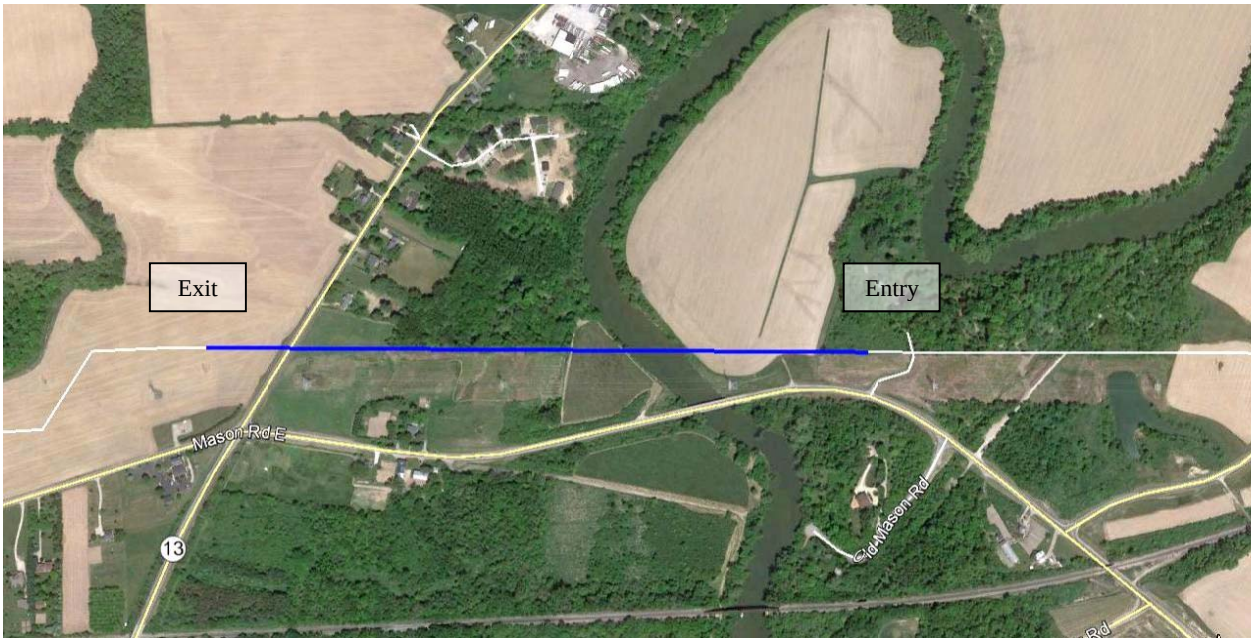


Figure 1: Overview of the Huron River Crossing

Figure 2: View looking north from Mason Road East toward entry point

Figure 3: View looking west from Mudbrook Road toward exit location

Subsurface Conditions

Four geotechnical borings were drilled at the proposed crossing site. Three of the borings were taken in a farm field on the east side of the river. One boring was taken west of Mudbrook Road on the west side. In general, the borings indicate mostly lean clay with increasing sand content with depth, overlying shale bedrock. The top of bedrock was encountered at approximately 30 feet below the ground surface on the east side and approximately 58 feet below the ground surface on the west side. In general, based on rock quality designation (RQD), the bedrock is fair to good quality, with unconfined compressive strength (UCS) ranging from 4,070 psi to 13,600 psi. Methane gas was encountered at approximately 55 feet below the ground surface in boring HUR-02 and at approximately 53 feet below the surface in boring HUR-02A.

Refer to the Draft Geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Huron River HDD Crossing, Nexus Gas Transmission Project, Erie County, Ohio" and dated September 11, 2015 for additional information.

Design Geometry & Layout

The proposed Huron River HDD design involves a horizontal length of 2,423 feet. It utilizes a 10-degree entry angle, an 8-degree exit angle, and radius of curvature of 3,600 feet. The crossing design is based on obtaining 40 feet of cover beneath the river and 40 feet of cover beneath Mudbrook Road.

The entry point is located on the east side of the crossing in a farm field, approximately 400 feet from the centerline of Huron River. The exit point is located on the west side of the crossing, approximately 250 feet west of Mudbrook Road in a farm field. The exit point is located on the west side to make use of the open farm fields for pull section fabrication, which allows continuous stringing and avoids the necessity for a tie-in weld during pullback.

Workspace available for HDD operations is shown on the HDD plan and profile drawing included in this site-specific report.

Assessment of Feasibility

Based on a review of available geotechnical and other site-specific mapping, the proposed 36-inch crossing of the Huron River is feasible. Although large diameter crossings through rock have a higher risk of operational problems, with the right downhole tool selections and sound planning, skilled and experienced HDD contractors will be able to complete the crossing. This is not to say the crossing will be easy. It involves an elevation differential of 47 feet. This means that during reaming operations, approximately 400 feet of the reamed hole on the west side will be empty as the drilling fluid seeks equilibrium at lower elevations. This can make hole stabilization difficult which in turn can complicate reaming operations.

Risk Identification and Assessment

The most significant risk at this location involves damage to Mudbrook Road due to sinkhole formation. As mentioned previously, the reamed hole on the west side beneath Mudbrook Road will likely be empty and will be susceptible to inflow of loose soil, which eventually can result in

sinkhole formation at the ground surface. The risk of sinkhole formation in the overburden is amplified by what are likely to be extended reaming durations associated with passing through hard rock. Temporary surface casing may be required to reduce the risk of settlement to Mudbrook Road. Inadvertent drilling fluid returns surfacing within the river are also a possibility. Given the depth of cover however, the risk of drilling fluid impact to the river is considered low.

HDD construction and operational problems involved with the Huron River Crossing include the possibility of failure of large diameter rock reaming tools downhole, hole misalignment at the soil/rock interface which can lead to tools binding or the product pipeline getting lodged, and operational problems resulting from circulation loss downhole. In addition, caving of the reamed hole on the west side resulting from lack of drilling fluid can complicate reaming operations. Finally, methane gas was detected in two of the borings. Although in JDH&A's experience it would be rare that a methane pocket would result in a failed HDD installation, there is the potential that methane gas, if the flow is great enough, could pose a safety risk during HDD operations. Prior to construction, HDD contractors should develop contingency measures to implement in the event that gas flow is encountered. Likewise, it also possible that the annulus surrounding the installed pipeline could serve as a conduit for continued gas flow to the surface. Therefore, a post-construction monitoring plan should be established so that remedial measures control or eliminate gas flow, if needed, can be employed.

Based on the length of the crossing as well as the subsurface conditions, the risk level is considered average.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 368,009 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 467,524 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 4. Detailed calculations for each scenario are summarized in Figures 5 and 6.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 4: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	406.0	ft	Effective Weight, W_e = W + W_b - W_m =	279.0	lb/ft
Exit Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	33,469	lb			
Fluidic Drag = 12 π D L C_d =	0	lb	Fluidic drag is calculated as zero unless entire segment is submerged in drilling fluid. Please reference Step 2, Drilled Path Input		
Axial Segment Weight = W_e L sinθ =	-19,671	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Exit Tangent =	**13,797**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	79,670	lb
Segment Angle with Horizontal, θ =	-10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	2,155	
Y = [18 $(L)^2$] - [(j / 2) $(1 - \cosh(U/2)^{-1})$] =	4.0E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	870.79	
U = (12 L) / j =	3.50		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	151,604	lb
Bending Frictional Drag = 2 μ N =	90,962	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	19,464	lb			
Pulling Load on Exit Sag Bend =	**131,745**	**lb**			
Total Pulling Load =	**145,542**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	762.3	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	81,290	lb			
Fluidic Drag = 12 π D L C_d =	25,866	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**107,156**	**lb**			
Total Pulling Load =	**252,698**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	304,462	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	1,102	
Y = [18 $(L)^2$] - [(j)^2 (1 - cosh(U/2)$^{-1}$)] =	6.0E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1335.01	
U = (12 L) / j =	6.84		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	169,456	lb
Bending Frictional Drag = 2 μ N =	101,673	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	-19,464	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**103,527**	**lb**			
Total Pulling Load =	**356,225**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	152.6	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	16,024	lb			
Fluidic Drag = 12 π D L C_d =	5,177	lb			
Axial Segment Weight = W_e L sinθ =	-9,418	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**11,783**	**lb**			
Total Pulling Load =	**368,009**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	4,484	ok	0	ok	0	ok	0.07	ok	0.01	ok
	4,340	ok	0	ok	401	ok	0.07	ok	0.01	ok
PC	4,340	ok	12,083	ok	401	ok	0.33	ok	0.10	ok
	3,079	ok	12,083	ok	1229	ok	0.31	ok	0.12	ok
PT	3,079	ok	0	ok	1229	ok	0.05	ok	0.04	ok
	1,773	ok	0	ok	1229	ok	0.03	ok	0.03	ok
PC	1,773	ok	12,083	ok	1229	ok	0.29	ok	0.11	ok
	168	ok	12,083	ok	401	ok	0.27	ok	0.06	ok
PT	168	ok	0	ok	401	ok	0.00	ok	0.00	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	707.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	74,289	lb			
Fluidic Drag = 12 π D L C_d =	24,003	lb			
Axial Segment Weight = W_e L sinθ =	43,664	lb			
Pulling Load on Exit Tangent =	**141,955**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	186,767	lb
Segment Angle with Horizontal, θ =	-10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,407	
Y = [18 $(L)^3$] - [(j^2 (1 - cosh(U/2)$^{-1}$] =	7.7E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	329.22	
U = (12 L) / j =	2.68		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	115,386	lb
Bending Frictional Drag = 2 μ N =	69,232	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	9,732	lb			
Pulling Load on Exit Sag Bend =	**89,623**	**lb**			
Total Pulling Load =	**231,578**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	843.7	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	89,970	lb			
Fluidic Drag = 12 π D L C_d =	28,627	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**118,597**	**lb**			
Total Pulling Load =	**350,175**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	391,319	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	972	
Y = [18 $(L)^3$] - [(j^2 (1 - cosh(U/2)$^{-1}$] =	1.1E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	476.07	
U = (12 L) / j =	3.88		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	135,602	lb
Bending Frictional Drag = 2 μ N =	81,361	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**82,288**	**lb**			
Total Pulling Load =	**432,463**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	454.0	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	47,680	lb			
Fluidic Drag = 12 π D L C_d =	15,405	lb			
Axial Segment Weight = W_e L sinθ =	-28,024	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**35,061**	**lb**			
Total Pulling Load =	**467,524**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point										
PC	5,696	ok	0	ok	0	ok	0.09	ok	0.01	ok
	5,269	ok	0	ok	1194	ok	0.08	ok	0.04	ok
PC	5,269	ok	24,167	ok	1194	ok	0.61	ok	0.34	ok
	4,266	ok	24,167	ok	1608	ok	0.60	ok	0.36	ok
PT	4,266	ok	0	ok	1608	ok	0.07	ok	0.06	ok
	2,821	ok	0	ok	1608	ok	0.04	ok	0.06	ok
PC	2,821	ok	24,167	ok	1608	ok	0.57	ok	0.33	ok
	1,729	ok	24,167	ok	1194	ok	0.56	ok	0.28	ok
PT	1,729	ok	0	ok	1194	ok	0.03	ok	0.03	ok
	0	ok	0	ok	-666	ok	0.00	ok	0.01	ok
Exit Point										

Figure 6: Installation Loading and Stress Analysis (Worse-Case Scenario)

Hydrofracture Evaluation

The Huron River Crossing will be installed almost entirely through bedrock. Since the Delft Equation (Discussed previously in Section 5 of this report) is only applicable to soil, a hydrofracture evaluation was not completed. In general, inadvertent drilling fluid returns due to hydrofracture do not typically occur on rock crossings, but instead occur by flowing through existing fractures, joints, or solution cavities.

Construction Duration

The estimated duration of construction for the proposed crossing is 60 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated by JDH&A based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as past experience in similar subsurface conditions. Refer to Figure 7 for details relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments
Work Schedule, hours/shift =	12.0	36" Huron River Crossing.
days/week =	7.0	
Drilled Length, feet =	2,437	
Pilot Hole		
Production Rate, feet/hour =	25	
shifts/day =	1	
Drilling Duration, hours =	97.5	
shifts =	8.1	
Trips to change tools, shifts =	1.0	
Pilot Hole Duration, days =	9.1	

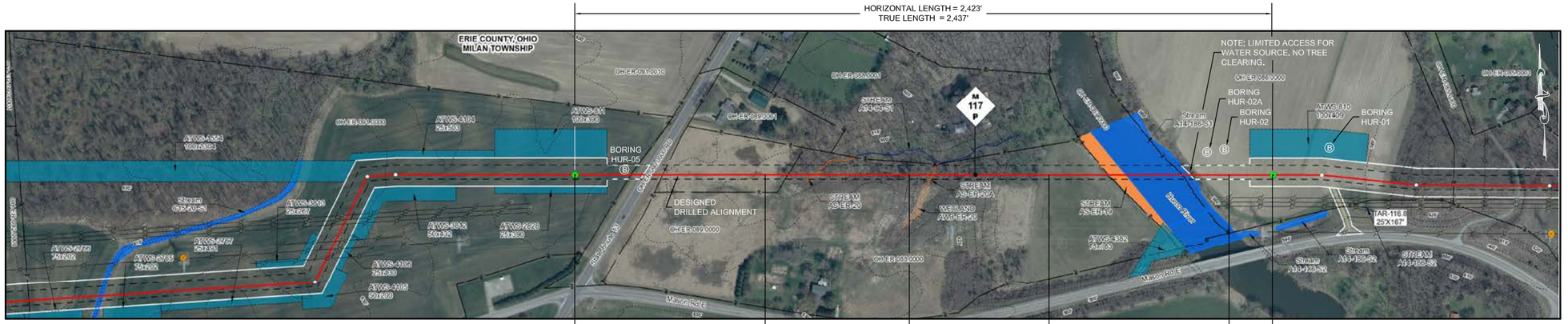
Ream and Pull Back								
Pass Description =	24-inch	36-inch	48-inch			Swab	Pull Back	Total
Travel Speed, feet/minute =	0.3	0.3	0.3			8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0	15.0			15.0	7.0	
shifts/day =	1	1	1			1	1	
Reaming Duration, hours =	165.1	165.1	165.1			7.7	9.4	512.3
shifts =	13.8	13.8	13.8			0.6	0.8	42.7
Rig up, shifts =	0.5	0.5	0.5			0.5	0.5	2.5
Trips to change tools, shifts =	1.0	1.0	1.0			0.0		3.0
Pass Duration, days =	15.3	15.3	15.3			1.1	1.3	48.2

Summary	
HDD Duration at Site, days =	59.3

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 7: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.


HORIZONTAL LENGTH = 2,423'
TRUE LENGTH = 2,437'
ERIE COUNTY, OHIO
MILAN TOWNSHIP
NOTE: LIMITED ACCESS FOR WATER SOURCE, NO TREE CLEARING.
BORING HUR-05
BORING HUR-02A
BORING HUR-02
BORING HUR-01
DESIGNED DRILLED ALIGNMENT
STREAM A1-188-S1
STREAM A1-188-S2
STREAM A1-188-S3
STREAM A1-188-S4
WETLAND A1-WE-S1
Huron River
Milan Rd E
TAR-116.8 25'X167'
ATWS-3104 25'X30'
ATWS-3105 25'X30'
ATWS-3106 25'X30'
ATWS-3107 25'X30'
ATWS-3108 25'X30'
ATWS-3109 25'X30'
ATWS-3110 25'X30'
ATWS-3111 25'X30'
ATWS-3112 50'X30'
ATWS-3113 25'X30'
ATWS-3114 25'X30'
ATWS-3115 25'X30'
ATWS-3116 25'X30'
ATWS-3117 25'X30'
ATWS-3118 25'X30'
ATWS-3119 25'X30'
ATWS-3120 25'X30'
ATWS-3121 25'X30'
ATWS-3122 25'X30'
ATWS-3123 25'X30'
ATWS-3124 25'X30'
ATWS-3125 25'X30'
ATWS-3126 25'X30'
ATWS-3127 25'X30'
ATWS-3128 25'X30'
ATWS-3129 25'X30'
ATWS-3130 25'X30'
ATWS-3131 25'X30'
ATWS-3132 25'X30'

MP 145.7 Sandusky River

Base Data

In performing the HDD design and engineering analysis**,** we have relied upon the following information:

- A combination of LiDAR, hydrographic, and traditional survey data covering the proposed crossing location
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A
- Draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Sandusky River HDD Crossing (REV-1), Nexus Gas Transmission Project, Sandusky County, Ohio" and dated September 11, 2015

General Site Description

The 36-inch Sandusky River Crossing is located near the intersection of State Highway 53 and Interstate 90 in Freemont, Ohio. The primary obstacles that will be crossed are the meandering Sandusky River as well a residential access road. The river is approximately 500 feet wide at the crossing location. At the time of this writing, the depth of the river is unknown. The west side of the crossing involves a mixture of wooded residential lots and topographically low wetlands. The east side of the crossing consists of open farm fields. On the west side of the river, the alignment passes within 100 feet of an existing residential development. An overview of the proposed crossing location is provided in Figures 1 through 3.

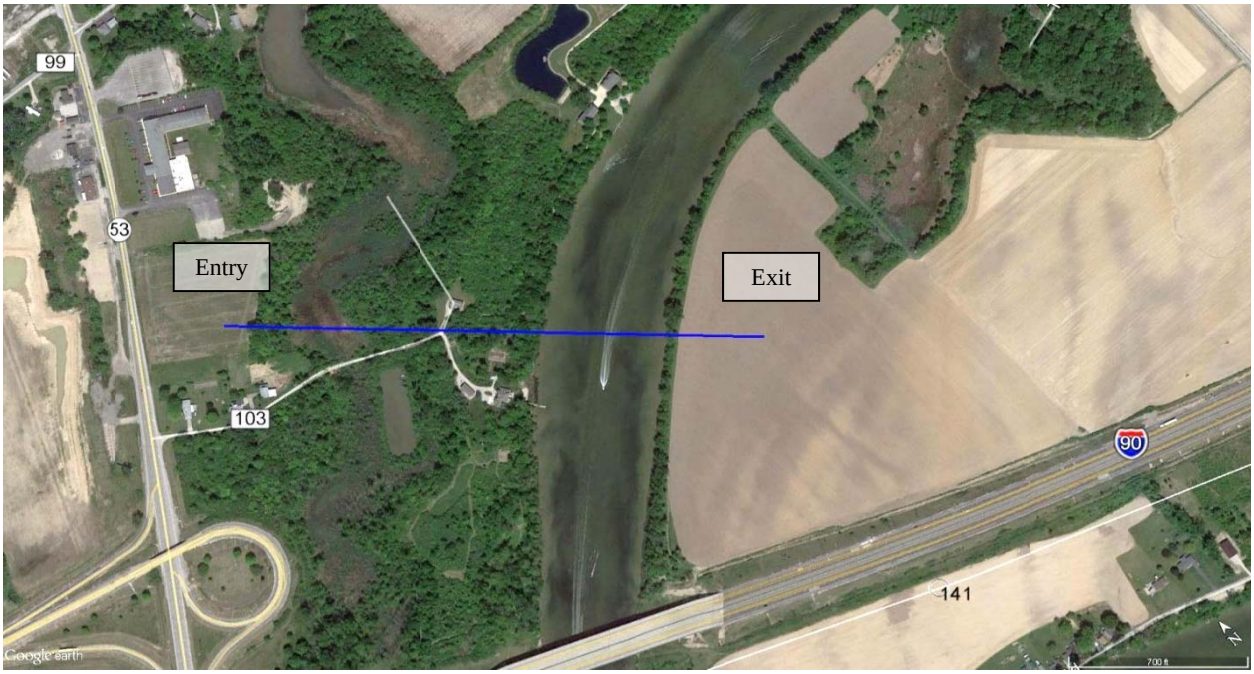


Figure 1: Overview of the Sandusky River Crossing

Figure 2: View north toward proposed exit location

Figure 3: View east toward proposed entry location

Subsurface Conditions

Three site-specific exploratory borings were taken as part of the geotechnical investigation conducted by Fugro Consultants, Inc. All of the borings are located on the west side of the river. Boring SAN-1-4 is located near the HDD entry point just south east of State Highway 53. Boring SAN-1-5 is located roughly 700 feet north east of the HDD entry point, and SAN-1-2 is located about 200 feet west of the river bank. SAN-1-4 encountered loose to very loose fat clay overlying dolomite bedrock. The top of bedrock was encountered at 60 feet. SAN-1-5 revealed loose to very loose fat clay to a depth of about 32 feet, and firm lean clay with gravel to 52 feet, overlying dolomite bedrock. Boring SAN-1-2 encountered similar soils, with primarily clayey soils overlying limestone bedrock at approximately 75 feet. Rock quality designation (RQD) averaged 57 for SAN-1-4, 44 for SAN-1-5, and 86 for SAN-1-2 indicating fair to good quality rock. Small solution cavities are noted in SAN-1-4 from 101.5 feet to 103 feet and again at 105.5 feet, and throughout SAN-1-2 after a depth of 85 feet. Unconfined compressive strength (UCS) of representative samples in borings SAN-1-4 and SAN-1-5 indicate values ranging from 760 psi to 9,400 psi, with an average of 3,496 psi.

In addition to the site-specific exploratory borings, four additional borings were taken as part of a subsurface investigation associated with a previous alignment located 1,200 to 2,000 feet to the southwest. The four additional borings encountered similar conditions to those encountered in the site-specific borings. Small voids or solution cavities were encountered in the dolomite/limestone bedrock in nearby borings SAN-02 and SAN-03 with similar loss of drilling fluids noted. UCS tests for bedrock ranged from 1,240 psi to 19,400 psi.

In addition to the possible voids in bedrock, other adverse soil conditions were encountered. Glacial till, while not revealed in the site-specific geotechnical borings, was observed in the four borings taken as part of the previous investigation, and therefore may be present at the crossing site. Cobble and boulders are commonly found in glacial deposits. Borings San-03 and San-05 revealed the presence of shale boulders but granite boulders were also suspected in the area.

Refer to the draft geotechnical data report prepared by Fugro Consultants, Inc. titled “Geotechnical Data Report, Sandusky River HDD Crossing (REV-1), Nexus Gas Transmission Project, Sandusky County, Ohio” and dated September 11, 2015 for additional information relative to the subsurface.

Design Geometry & Layout

The proposed crossing design involves a horizontal length of 2,159 feet. It utilizes a 10-degree entry angle and an 8-degree exit angle, and a radius of curvature of 3,600 feet. The crossing design is based on obtaining a minimum of 40 feet of cover beneath the bottom of the east edge of the Sandusky River.

The exit point is located on the east side in order to take advantage of open farm fields that can be used for pull section fabrication. Temporary workspace for pull section fabrication extends east and then curves to run parallel to Interstate 90, which allows for fabrication of the pull section in a single segment. The entry point is located on the west side of the river next to Ohio State Route 53 in an unoccupied field. A copy of the preliminary HDD plan and profile design drawing is included at the end of this section.

Assessment of Feasibility

Given solely the length and diameter of the proposed installation, it is within the range of what has been successfully completed using HDD. However, subsurface conditions have the potential to be problematic and increase the risk of HDD operational problems. More specifically, the borings logs indicate solution cavities are present in the limestone and dolomite bedrock. The risk of a twist-off during pilot hole drilling is magnified when large solution cavities are present. Penetration of a very large solution cavity during pilot hole drilling may leave the drill string and/or other tooling unconstrained potentially allowing it to deflect laterally. Continued rotation of a drill string when subjected to such deflection, particularly when it is under compression during pilot hole drilling, can result in failure of the drill pipe due to low-cycle fatigue.

Based on available geotechnical information, it appears that solution cavities are relatively small and limited in extent at the proposed crossing location, and therefore should not prevent a successful installation. However, the risk of a encountering a large void cannot be ruled out.

Risk Identification and Assessment

The primary construction impacts associated with installation by HDD are inadvertent drilling fluid returns surfacing within the river or within the topographically low marshy area near station 2+50 on the preliminary HDD plan and profile design drawing.

Notable risks that may complicate HDD construction include encountering cobble or boulders, or as mentioned previously, penetrating karst features in bedrock, which may result in a twist-off. Other operational problems include failure of large diameter rock reaming tools downhole, hole misalignment at the soil/rock interface and operational problems resulting from loss of circulation.

Due to subsurface conditions, the risk level associated with the proposed crossing of the Sandusky River is average to high.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the conservative analysis described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 356,185 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 383,874. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 4. Detailed calculations for each installation loading scenario are summarized in Figures 5 and 6.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 4: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	366.2	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	38,689	lb			
Fluidic Drag = 12 π D L C_d =	12,425	lb			
Axial Segment Weight = W_e L sinθ =	18,115	lb			
Pulling Load on Exit Tangent =	**69,208**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	122,386	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	8.77	ft	j = [(E I) / T]$^{1/2}$ =	1,739	
Y = [18 $(L)^2$] - [(j / 2) tanh(U/2)] =	2.6E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	691.20	
U = (12 L) / j =	3.47		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	128,063	lb
Bending Frictional Drag = 2 μ N =	76,838	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	12,463	lb			
Pulling Load on Exit Sag Bend =	**106,356**	**lb**			
Total Pulling Load =	**175,564**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	410.3	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	43,754	lb			
Fluidic Drag = 12 π D L C_d =	13,922	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**57,676**	**lb**			
Total Pulling Load =	**233,240**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	284,509	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	1,140	
Y = [18 $(L)^2$] - [(j)^2 (1 - cosh(U/2)$^{-1}$)] =	5.9E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1316.37	
U = (12 L) / j =	6.61		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	167,809	lb
Bending Frictional Drag = 2 μ N =	100,685	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	-19,464	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**102,539**	**lb**			
Total Pulling Load =	**335,779**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	284.3	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	27,750	lb			
Fluidic Drag = 12 π D L C_d =	8,966	lb			
Axial Segment Weight = W_e L sinθ =	-16,310	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**20,406**	**lb**			
Total Pulling Load =	**356,185**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point										
	4,339	ok	0	ok	0	ok	0.07	ok	0.01	ok
	4,091	ok	0	ok	474	ok	0.06	ok	0.01	ok
PC										
	4,091	ok	12,083	ok	474	ok	0.33	ok	0.10	ok
	2,842	ok	12,083	ok	1302	ok	0.31	ok	0.13	ok
PT										
	2,842	ok	0	ok	1302	ok	0.05	ok	0.04	ok
	2,139	ok	0	ok	1302	ok	0.03	ok	0.04	ok
PC										
	2,139	ok	12,083	ok	1302	ok	0.30	ok	0.12	ok
	843	ok	12,083	ok	772	ok	0.28	ok	0.08	ok
PT										
	843	ok	0	ok	772	ok	0.01	ok	0.01	ok
Exit Point										
	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	671.7	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	70,928	lb			
Fluidic Drag = 12 π D L C_d =	22,790	lb			
Axial Segment Weight = W_e L sinθ =	33,227	lb			
Pulling Load on Exit Tangent =	**126,945**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	165,275	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1,496	
Y = [18 $(L)^3$] - [(j^2 (1 - cosh(U/2)$^{-1}$] =	3.4E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	181.81	
U = (12 L) / j =	2.02		N = [(T h) - W_e cosθ (Y/144)] / (X/ 12) =	103,168	lb
Bending Frictional Drag = 2 μ N =	61,901	lb			
Fluidic Drag = 12 π D L C_d =	8,527	lb			
Axial Segment Weight = W_e L sinθ =	6,231	lb			
Pulling Load on Exit Sag Bend =	**76,660**	**lb**			
Total Pulling Load =	**203,605**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	424.0	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	45,213	lb			
Fluidic Drag = 12 π D L C_d =	14,386	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**59,599**	**lb**			
Total Pulling Load =	**263,204**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	301,697	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,107	
Y = [18 $(L)^3$] - [(j^2 (1 - cosh(U/2)$^{-1}$] =	9.8E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	424.44	
U = (12 L) / j =	3.40		N = [(T h) - W_e cosθ (Y/144)] / (X/ 12) =	126,765	lb
Bending Frictional Drag = 2 μ N =	76,059	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**76,986**	**lb**			
Total Pulling Load =	**340,190**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	565.7	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	59,406	lb			
Fluidic Drag = 12 π D L C_d =	19,194	lb			
Axial Segment Weight = W_e L sinθ =	-34,916	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**43,684**	**lb**			
Total Pulling Load =	**383,874**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point										
	4,677	ok	0	ok	0	ok	0.07	ok	0.01	ok
	4,145	ok	0	ok	1267	ok	0.07	ok	0.04	ok
PC										
	4,145	ok	24,167	ok	1267	ok	0.60	ok	0.33	ok
	3,207	ok	24,167	ok	1681	ok	0.58	ok	0.35	ok
PT										
	3,207	ok	0	ok	1681	ok	0.05	ok	0.06	ok
	2,481	ok	0	ok	1681	ok	0.04	ok	0.06	ok
PC										
	2,481	ok	24,167	ok	1681	ok	0.57	ok	0.33	ok
	1,547	ok	24,167	ok	1415	ok	0.55	ok	0.29	ok
PT										
	1,547	ok	0	ok	1415	ok	0.02	ok	0.04	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 6: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

The Sandusky River crossing will be installed almost entirely through bedrock. Since the Delft Equation (Discussed previously in Section 5 of this report) is only applicable to uncemented subsurface materials, a hydrofracture evaluation was not completed. In general, inadvertent drilling fluid returns due to hydrofracture do not typically occur on rock crossings, but instead occur by flowing through existing fracture, joints, or solution cavities.

Construction Duration

The estimated duration of construction for the Sandusky River Crossing is 56 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated by JDH&A based on information contained within the Pipeline Research Council International's "Installation of Pipelines by Horizontal Directional Drilling"[1], as well as past experience in similar subsurface conditions. Refer to Figure 7 for additional information relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments
Work Schedule, hours/shift =	12.0	36" Sandusky River Crossing
days/week =	7.0	
Drilled Length, feet =	2,172	
Pilot Hole		
Production Rate, feet/hour =	20	
shifts/day =	1	
Drilling Duration, hours =	108.6	
shifts =	9.1	
Trips to change tools, shifts =	0.5	
Pilot Hole Duration, days =	9.6	

Ream and Pull Back

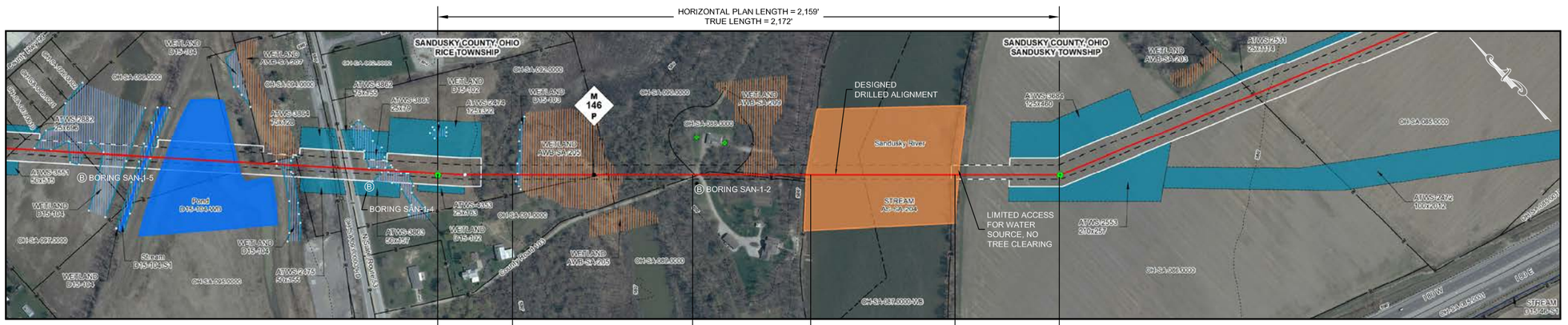
Pass Description =	24-inch	36-inch	48-inch			Swab	Pull Back	Total
Travel Speed, feet/minute =	0.3	0.3	0.3			8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0	15.0			15.0	15.0	
shifts/day =	1	1	1			1	1	
Reaming Duration, hours =	147.1	147.1	147.1			6.9	8.4	456.6
shifts =	12.3	12.3	12.3			0.6	0.7	38.1
Rig up, shifts =	0.5	0.5	0.5			0.5	0.5	2.5
Trips to change tools, shifts =	1.0	1.0	1.0			0.0		3.0
Pass Duration, days =	13.8	13.8	13.8			1.1	1.2	43.6

Summary	
HDD Duration at Site, days =	55.1

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 7: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN

SCALE: 1" = 200'

ENTRY POINT @ 10°
0+00.00, 590.58
N 15044812.13, E 1064124.15

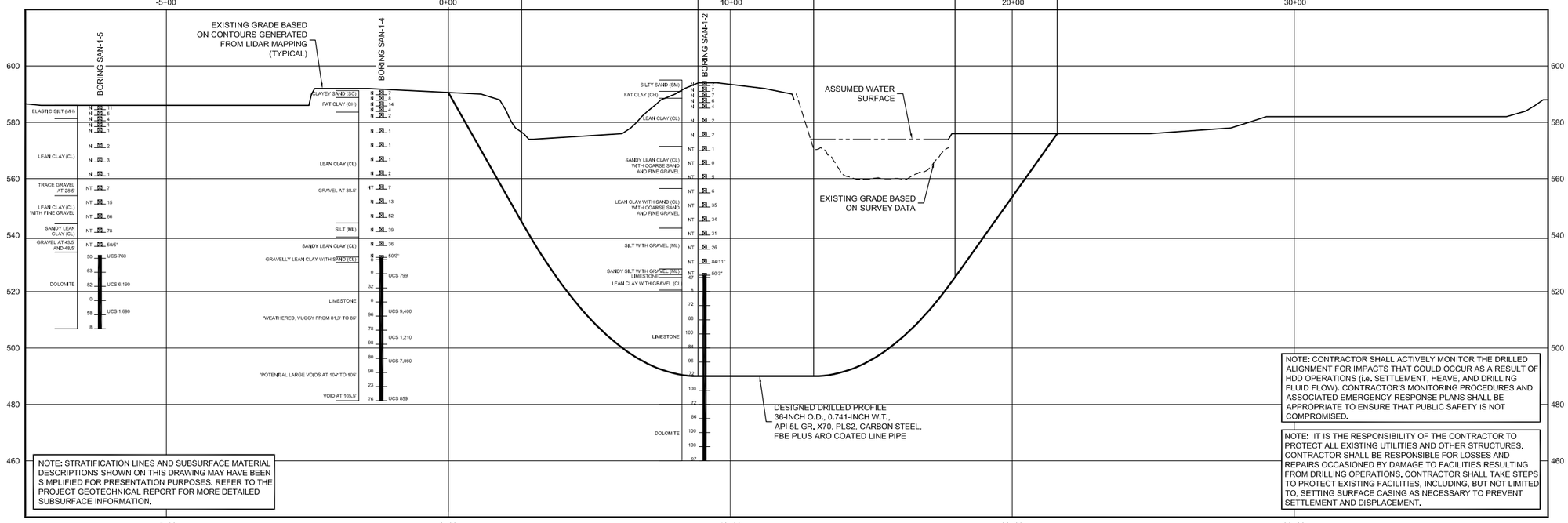
P.C. 10° SAG BEND
2+60.26, 544.69
RADIUS = 3,600'

P.T. 10° SAG BEND
8+85.40, 490.00

P.C. 8° SAG BEND
12+95.70, 490.00
RADIUS = 3,600'

P.T. 8° SAG BEND
17+96.72, 525.04

EXIT POINT @ 8°
21+59.36, 576.00
N 15043304.08, E 1065669.67



NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

PROFILE

SCALE: 1" = 200' HORIZONTAL
1" = 20' VERTICAL

20 10 0
500 400 300 200 100 0

ALIGNMENT LEGEND

PIPELINE MILEPOST (M 6.9 P)
PIPELINE
INTERCONNECTING PIPELINE
CONSTRUCTION LIMIT
STUDY CORRIDOR
STAGING AREA
WAREYARD
PERMANENT ROW
ADDITIONAL TEMPORARY WORKSPACE
METERING & REGULATION STATION (M&R)
COMPRESSOR STATION SITE
FACILITIES TEMPORARY WORKSPACE
FACILITIES PERMANENT WORKSPACE

DELINEATED WETLAND BOUNDARY
DELINEATED WATERBODY BANK
DELINEATED WATERBODY CENTERLINE
APPROXIMATE WETLAND BOUNDARY
APPROXIMATE WATERBODY BANK
APPROXIMATE WATERBODY CENTERLINE
PERMANENT ACCESS ROAD (PAR-0.0)
TEMPORARY ACCESS ROAD (TAR-0.0)
PARCEL TRACT NO (OH-CO-011.0000-SC)
PROPERTY LINE
CONTOUR
MUNICIPALITY LINE

FENCE
FOREIGN PIPELINE
POWERLINE
WATER PIPELINE
RAILROAD TRACK
TELEPHONE
TEE TAP
BLOW OFF VALVE
TOWER
HORIZONTAL DIRECTIONAL DRILLING
TANK
WELL: GAS WATER OIL UNKNOWN
UTILITY LINES
MAINLINE VALVE (MLV)
MICROWAVE TOWER
LIGHT POLE
FIRE HYDRANT

GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

(B) BORING LOCATION

SPLIT SPOON SAMPLE
53 N 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE
UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
53 6 — MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA. REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.

2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.

3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW. HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE.

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

CLYD-A-1161	ALIGNMENT SHEET M.P. 145.34 TO M.P. 146.29	0	LKB	ACM	ISSUED FOR FERC
DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS				
	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	DMP	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	LKB	08/24		
DESIGN CHECKER				
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH SANDUSKY RIVER CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING
SANDUSKY COUNTY, OHIO

NEXUS SM
GAS TRANSMISSION

M.P. 145.7	W.O.	SCALE: AS SHOWN	DWG. CLYD-H-1010	REV. 0

MP 162.4 Portage River Crossing

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR, hydrographic, and traditional survey data covering the proposed crossing location
- Draft geotechnical data report prepared by Fugro Consultants, Inc. "Geotechnical Data Report, Portage River HDD Crossing, Nexus Gas Transmission Project, Sandusky County, Ohio" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The 36-inch Portage River Crossing is located near pipeline Mile Post 162.4, southwest of Woodville, Ohio. The primary obstacles to be crossed are Pemberville Road, the channel of Portage River, and Fort Findlay Road. The land on each side of the river is essentially flat. Land use is agricultural. At the proposed crossing location, the Portage River is roughly 240 feet from bank to bank, and just over 4 feet deep at the deepest point based on hydrographic survey data. The topography slopes gently to the south toward Portage River, then rises approximately 20 feet up the south bank, and then flattens toward the south. An overview of the proposed crossing location is shown in Figure 1. Photographs taken during the site reconnaissance are provided in Figures 2 and 3.

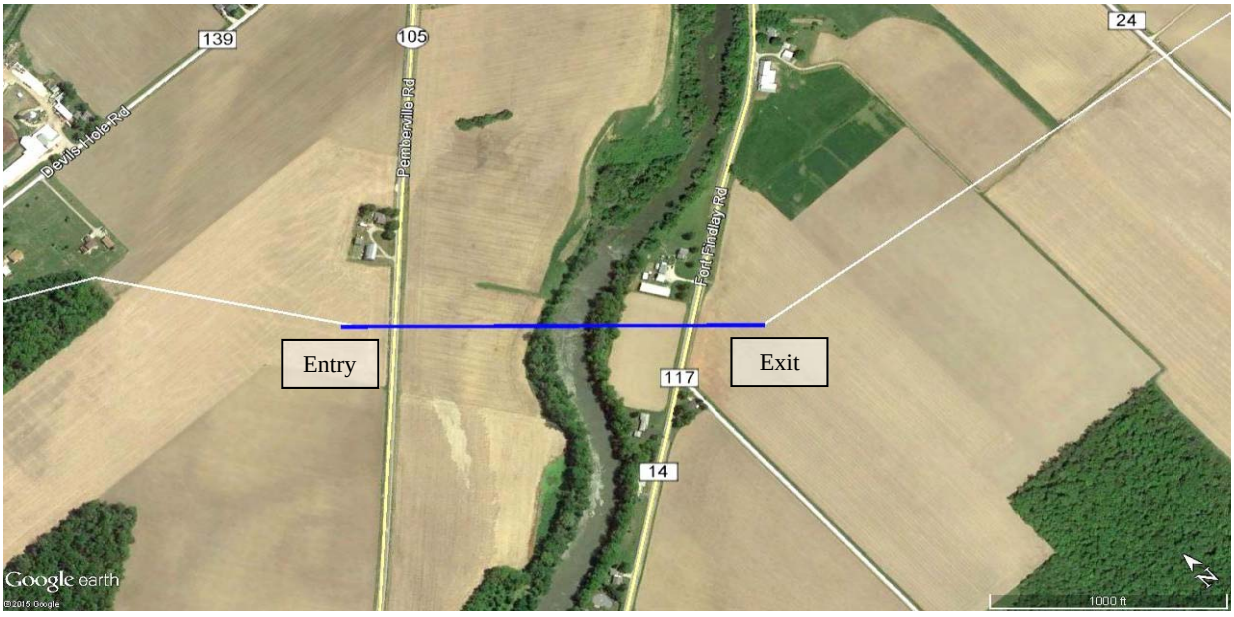


Figure 1: Overview of the Portage River Crossing

Figure 2: View looking west toward entry location

Figure 3: Portage River at proposed crossing location

Subsurface Conditions

Four geotechnical borings were taken at the proposed crossing site as part of the site-specific investigation conducted by Fugro Consultants, Inc. Two borings were taken on the north side of the river and two on the south side of the river. The borings generally encountered lean clay and gravel to depths of approximately 10 to 20 feet below the ground surface. Limestone was encountered beneath the clay at a depth of approximately 20 feet in all four borings. The boring logs indicate drilling fluid circulation was lost in three of the borings, with possible small voids encountered in two of the borings. Unconfined compressive strength for the limestone ranged from 1,380 psi to 8,800 psi. Rock Quality Designation (RQD) indicates good quality, competent bedrock overall.

Refer to the Draft Geotechnical data report prepared by Fugro Consultants, Inc. "Geotechnical Data Report, Portage River HDD Crossing, Nexus Gas Transmission Project, Sandusky County, Ohio" and dated September 11, 2015 for additional information.

Design Geometry & Layout

The proposed Portage River HDD design has a horizontal length of 1,620 feet. It utilizes 10-degree entry and exit angles and maintains over 26 feet of cover beneath Pemberville Road and more than 35 feet beneath Fort Findlay Road. The crossing passes deep within limestone bedrock and maintains more than 55 feet of separation from the bottom of Portage River.

The entry point is located on the north side of the crossing in a farm field, approximately 170 feet from the centerline of Pemberville Road and 930 feet from the centerline of Portage River. The exit point is located on the south side of Fort Findlay Road in a farm field, approximately 195 feet from the centerline of Fort Findlay Road and 690 feet from the centerline of the river. The exit point is located on the south side to make use of the open farm fields for pull section fabrication, which allows continuous stringing and avoids the necessity for a tie-in weld during pullback.

The entry and exit locations were limited by pipeline points of intersection (P.I.) on each side of the river. As such, design depth of cover beneath the roadways was less than the preferred 40 feet. At the time of this writing, it is envisioned that the pipeline P.I.'s on each side of the river will be shifted to prior to construction to accommodate an HDD design involving a shallower exit angle and greater depth of cover beneath the roads on each side of the river.

The proposed HDD design, as well as available workspace for HDD operations, is shown on the preliminary HDD plan and profile drawing included at the end of this site-specific report.

Assessment of Feasibility

Given solely the length and diameter of the proposed installation, it is within the range of what has been successfully completed using HDD. However, subsurface conditions have the potential to be problematic and increase the risk of HDD operational problems. More specifically, the borings logs indicate solution cavities are present in the limestone and dolomite bedrock. The risk of a twist-off during pilot hole drilling is magnified when large solution cavities are present. Penetration of a very large solution cavity during pilot hole drilling may leave the drill string and/or other tooling unconstrained potentially allowing it to deflect laterally. Continued rotation

of a drill string when subjected to such deflection, particularly when it is under compression during pilot hole drilling, can result in failure of the drill pipe due to low-cycle fatigue.

Based on available geotechnical information, it appears that solution cavities are relatively small and limited in overall extent. Therefore, the cavities should not prevent a successful installation. However, the risk of a encountering a large void cannot be ruled out.

Risk Identification and Assessment

Notable risks to consider at this crossing are impacts to both Pemberville and Fort Findlay Road resulting from drilling fluid flow (inadvertent returns, settlement, or heave), as well as inadvertent drilling fluid returns within the Portage River.

Construction risks associated with the Portage River Crossing include failure of large diameter rock reaming tools downhole, hole misalignment at the soil/rock interface which can lead to tools or the product pipeline getting lodged, and operational problems resulting from circulation loss through existing fractures or voids. Small solution cavities (voids) were noted in two of the borings. Although small voids can serve as a flow conduit for drilling fluid, they generally do not prevent a successful installation. However, a very large solution cavity, if encountered, can seriously restrict HDD operations.

Overall, the risk level for the Portage River crossing is considered average.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the conservative analysis described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 284,382 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 307,303 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 4. Detailed calculations for each installation loading scenario are summarized in Figures 5 and 6.

Line Pipe Properties		
Pipe Outside Diameter =	36.000 in	
Wall Thickness =	0.741 in	
Specified Minimum Yield Strength =	70,000 psi	
Young's Modulus =	2.9E+07 psi	
Moment of Inertia =	12755.22 in^4	
Pipe Face Surface Area =	82.08 in^2	
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06 in/in/°F	
Pipe Weight in Air =	279.04 lb/ft	
Pipe Interior Volume =	6.50 ft^3/ft	
Pipe Exterior Volume =	7.07 ft^3/ft	
HDD Installation Properties		
Drilling Mud Density =	12.0 ppg	
=	89.8 lb/ft^3	
Ballast Density =	62.4 lb/ft^3	
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025 psi	
Ballast Weight =	405.51 lb/ft	
Displaced Mud Weight =	634.48 lb/ft	

Figure 4: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (ff Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (ff Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	106.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	11,174	lb			
Fluidic Drag = 12 π D L C_d =	3,610	lb			
Axial Segment Weight = W_e L sinθ =	6,568	lb			
Pulling Load on Exit Tangent =	**21,353**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	87,399	lb
Segment Angle with Horizontal, θ =	-10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	2,057	
Y = [18 $(L)^2$] - [(j / 2) tanh(U/2)] =	4.2E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	907.68	
U = (12 L) / j =	3.66		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	152,183	lb
Bending Frictional Drag = 2 μ N =	91,310	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	19,464	lb			
Pulling Load on Exit Sag Bend =	**132,093**	**lb**			
Total Pulling Load =	**153,445**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	168.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	17,960	lb			
Fluidic Drag = 12 π D L C_d =	5,715	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**23,674**	**lb**			
Total Pulling Load =	**177,119**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	226,980	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	1,277	
Y = [18 $(L)^2$] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	5.6E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1250.13	
U = (12 L) / j =	5.91		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	163,113	lb
Bending Frictional Drag = 2 μ N =	97,868	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	-19,464	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**99,722**	**lb**			
Total Pulling Load =	**276,841**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	97.7	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	10,255	lb			
Fluidic Drag = 12 π D L C_d =	3,313	lb			
Axial Segment Weight = W_e L sinθ =	-6,028	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**7,541**	**lb**			
Total Pulling Load =	**284,382**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,465	ok	0	ok	0	ok	0.05	ok	0.00	ok
	3,373	ok	0	ok	257	ok	0.05	ok	0.01	ok
PC	3,373	ok	12,083	ok	257	ok	0.32	ok	0.08	ok
	2,158	ok	12,083	ok	1085	ok	0.30	ok	0.10	ok
PT	2,158	ok	0	ok	1085	ok	0.03	ok	0.03	ok
	1,869	ok	0	ok	1085	ok	0.03	ok	0.03	ok
PC	1,869	ok	12,083	ok	1085	ok	0.29	ok	0.10	ok
	260	ok	12,083	ok	257	ok	0.27	ok	0.05	ok
PT	260	ok	0	ok	257	ok	0.00	ok	0.00	ok
Exit Point	0	ok	0	ok	-23	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	409.2	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	42,969	lb			
Fluidic Drag = 12 π D L C_d =	13,883	lb			
Axial Segment Weight = W_e L sinθ =	25,255	lb			
Pulling Load on Exit Tangent =	**82,108**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	125,080	lb
Segment Angle with Horizontal, θ =	-10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,720	
Y = [18 $(L)^3$] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	6.0E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	255.38	
U = (12 L) / j =	2.19		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	109,255	lb
Bending Frictional Drag = 2 μ N =	65,553	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	9,732	lb			
Pulling Load on Exit Sag Bend =	**85,944**	**lb**			
Total Pulling Load =	**168,052**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	249.8	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	26,641	lb			
Fluidic Drag = 12 π D L C_d =	8,477	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**35,117**	**lb**			
Total Pulling Load =	**203,170**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	239,827	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,242	
Y = [18 $(L)^3$] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	8.8E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	378.45	
U = (12 L) / j =	3.04		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	120,647	lb
Bending Frictional Drag = 2 μ N =	72,388	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**73,315**	**lb**			
Total Pulling Load =	**276,485**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	399.1	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	41,911	lb			
Fluidic Drag = 12 π D L C_d =	13,541	lb			
Axial Segment Weight = W_e L sinθ =	-24,633	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**30,819**	**lb**			
Total Pulling Load =	**307,303**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,744	ok	0	ok	0	ok	0.06	ok	0.00	ok
	3,368	ok	0	ok	1049	ok	0.05	ok	0.03	ok
PC	3,368	ok	24,167	ok	1049	ok	0.58	ok	0.30	ok
	2,475	ok	24,167	ok	1463	ok	0.57	ok	0.31	ok
PT	2,475	ok	0	ok	1463	ok	0.04	ok	0.05	ok
	2,047	ok	0	ok	1463	ok	0.03	ok	0.04	ok
PC	2,047	ok	24,167	ok	1463	ok	0.56	ok	0.30	ok
	1,000	ok	24,167	ok	1049	ok	0.55	ok	0.25	ok
PT	1,000	ok	0	ok	1049	ok	0.02	ok	0.02	ok
Exit Point	0	ok	0	ok	-26	ok	0.00	ok	0.00	ok

Figure 6: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

The Portage River Crossing will be installed almost entirely through bedrock. Since the Delft Equation (Discussed previously in Section 5 of this report) is only applicable to soil, a hydrofracture evaluation was not completed. In general, inadvertent drilling fluid returns due to hydrofracture do not typically occur on rock crossings, but instead occur by flowing through existing fractures, joints, or solution cavities.

Construction Duration

The estimated duration of construction for the Portage River Crossing is 42 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated by JDH&A based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as past experience in similar subsurface conditions. Refer to Figure 7 for details relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments
Work Schedule, hours/shift =	12.0	36" Portage River Crossing
days/week =	7.0	
Drilled Length, feet =	1,629	
Pilot Hole		
Production Rate, feet/hour =	25	
shifts/day =	1	
Drilling Duration, hours =	65.2	
shifts =	5.4	
Trips to change tools, shifts =	0.5	
Pilot Hole Duration, days =	5.9	

Ream and Pull Back

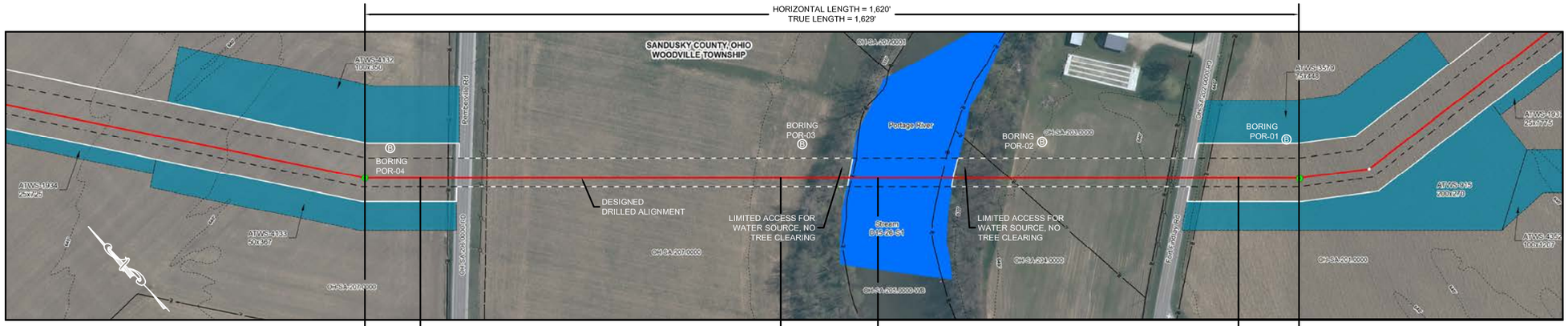
Pass Description =	24-inch	36-inch	48-inch			Swab	Pull Back	Total
Travel Speed, feet/minute =	0.3	0.3	0.3			8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0	15.0			15.0	15.0	
shifts/day =	1	1	1			1	1	
Reaming Duration, hours =	110.4	110.4	110.4			5.1	6.3	342.5
shifts =	9.2	9.2	9.2			0.4	0.5	28.5
Rig up, shifts =	0.5	0.5	0.5			0.5	0.5	2.5
Trips to change tools, shifts =	1.0	1.0	1.0			0.0		3.0
Pass Duration, days =	10.7	10.7	10.7			0.9	1.0	34.0

Summary	
HDD Duration at Site, days =	42.0

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 7: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN
SCALE: 1" = 100'

ENTRY POINT @ 10"
0+00.00, 636.65
N 15059536.51, E 982854.55

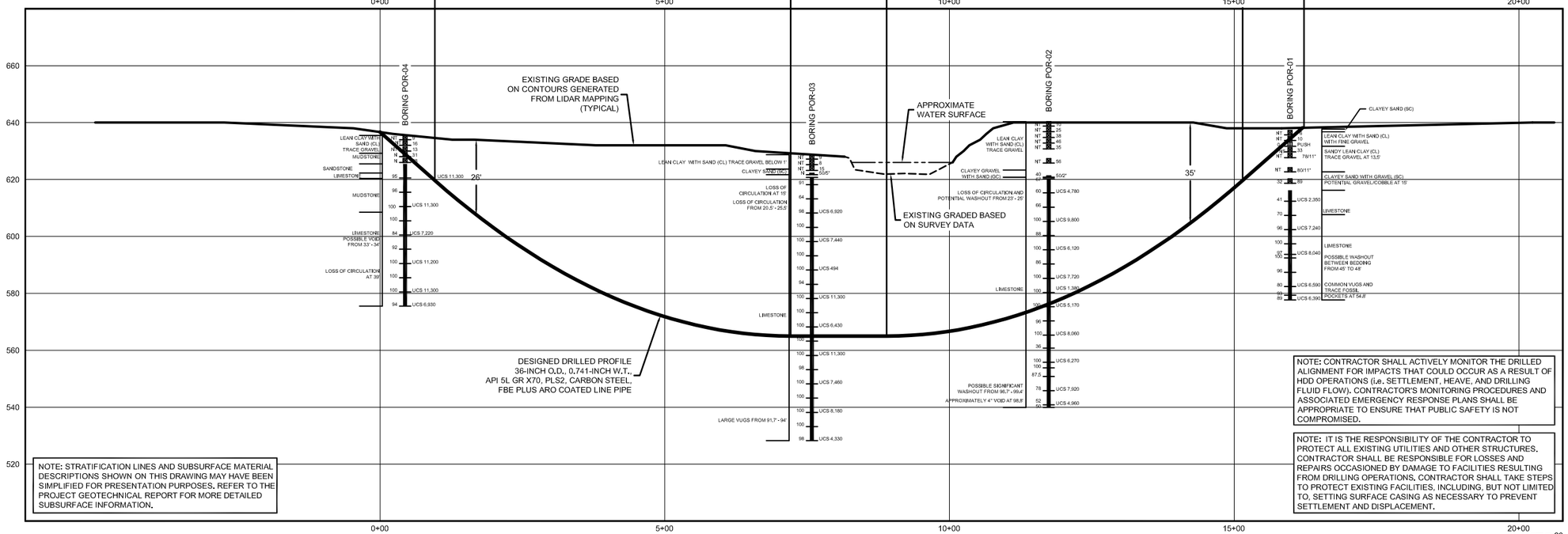
P.C. 10° SAG BEND
0+96.19, 619.69
RADIUS = 3,600'

P.T. 10° SAG BEND
7+21.33, 565.00

P.C. 10° SAG BEND
8+89.76, 565.00
RADIUS = 3,600'

P.T. 10° SAG BEND
15+14.89, 619.69

EXIT POINT @ 10°
16+19.66, 638.17
N 15058412.29, E 984020.49

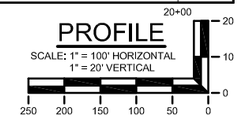


NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

PROFILE
SCALE: 1" = 100' HORIZONTAL
1" = 20' VERTICAL



ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PIPELINE
- INTERCONNECTING PIPELINE
- CONSTRUCTION LIMIT
- STUDY CORRIDOR
- STAGING AREA
- WAREYARD
- PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- METERING & REGULATION STATION (M&R)
- COMPRESSOR STATION SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- APPROXIMATE WETLAND BOUNDARY
- APPROXIMATE WATERBODY BANK
- APPROXIMATE WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD (PAR-0.0)
- TEMPORARY ACCESS ROAD (TAR-0.0)
- PARCEL TRACT NO (OH-CO-011.0000-SC)
- PROPERTY LINE
- CONTOUR
- MUNICIPALITY LINE
- FENCE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- TELEPHONE
- TEE TAP
- BLOW OFF VALVE
- TOWER
- HORIZONTAL DIRECTIONAL DRILLING
- TANK
- WELL: GAS, WATER, OIL, UNKNOWN
- UTILITY LINES
- MAINLINE VALVE (MLV)
- MICROWAVE TOWER
- LIGHT POLE
- FIRE HYDRANT

GENERAL LEGEND

- DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.
2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.
2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

- B — BORING LOCATION

SPLIT SPOON SAMPLE

- 53 / 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES; PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE

- UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
- TSS 1,350 — TENSILE SPLITTING STRENGTH (PSI)
- 53 / 6 — MOHS HARDNESS
- ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA, REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.
2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.
3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW, HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.
2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.
3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.
4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.
5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.
2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.
3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
CLYD-A-1179	ALIGNMENT SHEET M.P. 162.32 TO M.P. 163.27	0	LKB	ACM	ISSUED FOR FERC

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	ACM/DMP	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	DMP	08/07		
DESIGN CHECKER	DLB	08/07		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH PORTAGE RIVER CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING

SANDUSKY COUNTY, OHIO

NEXUS GAS TRANSMISSION

M.P. 162.4	W.O.	SCALE: AS SHOWN	DWG. CLYD-H-1011	REV. 0

MP 179.8 Findlay Road

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR and traditional survey data covering the proposed crossing location
- Draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, State Route No. 64 HDD Crossing, Nexus Gas Transmission Project, Wood County Ohio" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The 36-inch State Route 64 (Findlay Road) Crossing is located near pipeline Mile Post 179.8, approximately 1 mile east of the proposed Maumee River Crossing, and just south of Waterville, Ohio. The primary obstacles to be crossed include Findlay Road and a small stream that runs parallel to the road on the west side. The stream is approximately 75 feet wide from the top of west bank to the top of the east bank. The topography in the area is flat. The land is partially wooded in the proximity of the road. The east side of the crossing consists of open farm fields bound by a wooded patch to the south. The west side of the crossing is an open farm field bound by woods to the north and west. Refer to Figure 1 for a general overview of the crossing location and Figure 2 for a photo showing the general location of the exit point.

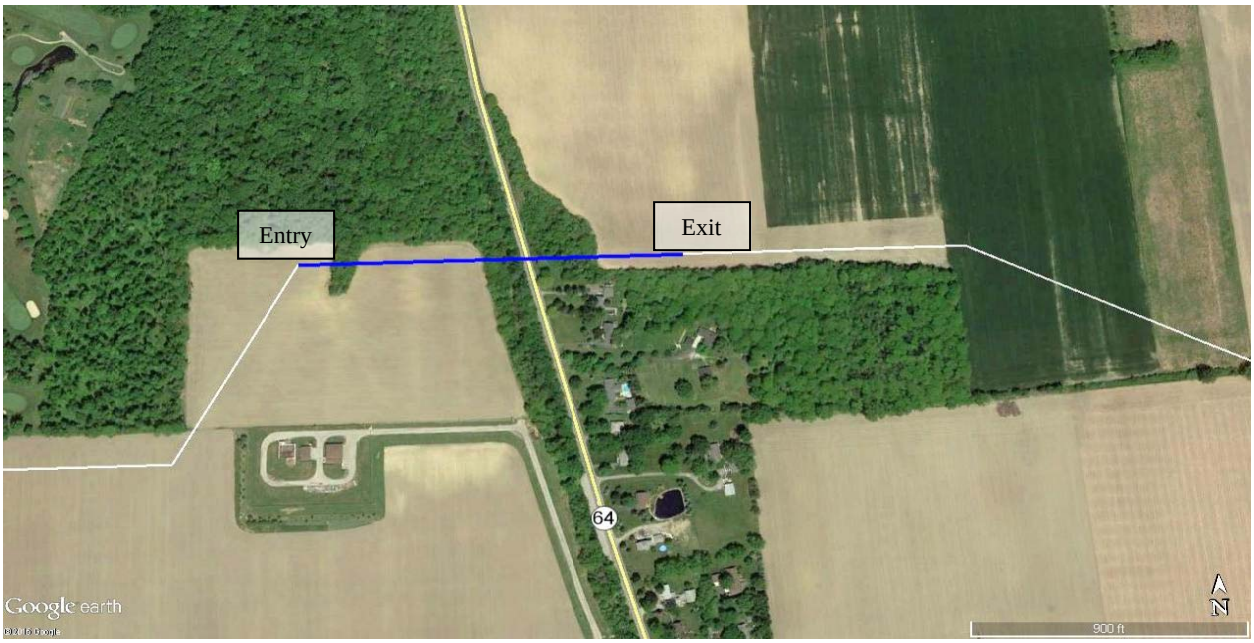


Figure 1: Overview of the State Route 64 (Findlay Road) Crossing

Figure 2: View looking east from tree line toward exit point

Subsurface Conditions

Four site-specific geotechnical borings were taken at the proposed crossing site as part of the site investigation conducted by Fugro Consultants, Inc. Borings SR-64-1 and SR-64-2 were taken on the east side of the Findlay Road and Borings SR-64-3 and SR-64-4 were taken on the west side. Two of the borings, SR-64-2 and SR-64-3, were terminated at a depth of 125 feet below the ground surface. The remaining were terminated at a depth of 75 feet below the ground surface. Each of the borings encountered mostly lean clay, silt, and sand overlying dolomite bedrock. The bedrock surface was encountered approximately 68 feet below the ground surface at approximate elevation 695.

For detailed information, refer to the draft geotechnical data report prepared by Fugro Consultants, Inc. titled “Geotechnical Data Report, State Route No. 64 HDD Crossing, Nexus Gas Transmission Project, Wood County Ohio” and dated September 11, 2015.

Design Geometry & Layout

The proposed Findlay Road HDD design involves a horizontal length of 1,522 feet. It is a minimum length design, which uses 8-degree entry and exit angles, and radius of curvature of 3,600 feet. The crossing design achieves a minimum of 30 feet of cover beneath the stream. In this case, a shallow entry angle and a reduced depth of cover beneath the stream was to keep the HDD segment above bedrock, within the overburden soils.

The entry point is located on the west side of the crossing in a farm field, approximately 790 feet from the centerline of Findley Road. The exit point is located on the east side of the crossing, approximately 730 feet east of Findlay Road, also in a farm field. The exit point is located on the east side to make use of the open farm fields for pull section fabrication, which allows continuous stringing and avoids the necessity for a tie-in weld during pullback.

The preliminary HDD plan and profile drawing is included in this site-specific report for reference.

Assessment of Feasibility

Based on the design length, pipeline diameter, and subsurface conditions consisting primarily of clay, it is our opinion that installation by HDD is feasible.

Risk Identification and Assessment

The most significant risk of impact due to installation by HDD at this location is the possibility of damaging Findlay Road due to heaving or settlement, or drilling fluid surfacing with the stream.

Based on the length and the anticipated subsurface conditions, the level of risk associated with the proposed Findlay Road Crossing is low.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in **Error! Reference source not found.**1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 267,646 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 294,338 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 3. Detailed calculations for each loading scenario are summarized in Figures 4 and 5.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 3: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	162.3	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	17,136	lb			
Fluidic Drag = 12 π D L C_d =	5,506	lb			
Axial Segment Weight = W_e L sinθ =	8,028	lb			
Pulling Load on Exit Tangent =	**30,670**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	83,053	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-4.0	°	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	8.77	ft	j = [(E I) / T]$^{1/2}$ =	2,110	
Y = [18 $(L)^3$ - $(j)^2$ (1 - cosh(U/2)$^{-1}$] =	2.1E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	567.27	
U = (12 L) / j =	2.86		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	125,414	lb
Bending Frictional Drag = 2 μ N =	75,248	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	12,463	lb			
Pulling Load on Exit Sag Bend =	**104,766**	**lb**			
Total Pulling Load =	**135,436**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	210.0	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Frictional Drag = W_e L μ =	22,393	lb			
Fluidic Drag = 12 π D L C_d =	7,125	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**29,519**	**lb**			
Total Pulling Load =	**164,954**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	207,408	lb
Segment Angle with Horizontal, θ =	8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	4.0	°	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	8.77	ft	j = [(E I) / T]$^{1/2}$ =	1,335	
Y = [18 $(L)^3$] - [$(j)^2$ (1 - cosh(U/2)$^{-1}$] =	3.1E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	854.67	
U = (12 L) / j =	4.52		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	133,862	lb
Bending Frictional Drag = 2 μ N =	80,317	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	-12,463	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**84,909**	**lb**			
Total Pulling Load =	**249,863**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	150.3	ft	Effective Weight, $W_e = W + W_b - W_m$ =	-355.4	lb/ft
Entry Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	15,869	lb			
Fluidic Drag = 12 π D L C_d =	5,099	lb			
Axial Segment Weight = W_e L sinθ =	-7,434	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**13,534**	**lb**			
Total Pulling Load =	**263,397**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point										
	3,209	ok	0	ok	0	ok	0.05	ok	0.00	ok
	3,044	ok	0	ok	317	ok	0.05	ok	0.01	ok
PC										
	3,044	ok	12,083	ok	317	ok	0.31	ok	0.08	ok
	2,010	ok	12,083	ok	847	ok	0.30	ok	0.09	ok
PT										
	2,010	ok	0	ok	847	ok	0.03	ok	0.02	ok
	1,650	ok	0	ok	847	ok	0.03	ok	0.02	ok
PC										
	1,650	ok	12,083	ok	847	ok	0.29	ok	0.09	ok
	374	ok	12,083	ok	317	ok	0.27	ok	0.06	ok
PT										
	374	ok	0	ok	317	ok	0.01	ok	0.00	ok
Exit Point	0	ok	0	ok	-25	ok	0.00	ok	0.00	ok

Figure 4: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	539.5	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	56,967	lb			
Fluidic Drag = 12 π D L C_d =	18,304	lb			
Axial Segment Weight = W_e L sinθ =	26,687	lb			
Pulling Load on Exit Tangent =	**101,959**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	139,667	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1.627	
Y = [18 $(L)^2$] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	3.0E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	160.79	
U = (12 L) / j =	1.85		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	101,095	lb
Bending Frictional Drag = 2 μ N =	60,657	lb			
Fluidic Drag = 12 π D L C_d =	8,527	lb			
Axial Segment Weight = W_e L sinθ =	6,231	lb			
Pulling Load on Exit Sag Bend =	**75,416**	**lb**			
Total Pulling Load =	**177,375**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	113.6	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	12,119	lb			
Fluidic Drag = 12 π D L C_d =	3,856	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**15,975**	**lb**			
Total Pulling Load =	**193,350**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	229,706	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1.269	
Y = [18 $(L)^2$] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	8.6E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	369.86	
U = (12 L) / j =	2.97		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	119,644	lb
Bending Frictional Drag = 2 μ N =	71,787	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**72,714**	**lb**			
Total Pulling Load =	**266,063**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	366.2	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	38,452	lb			
Fluidic Drag = 12 π D L C_d =	12,424	lb			
Axial Segment Weight = W_e L sinθ =	-22,600	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**28,275**	**lb**			
Total Pulling Load =	**294,338**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,586	ok	0	ok	0	ok	0.06	ok	0.00	ok
	3,242	ok	0	ok	963	ok	0.05	ok	0.02	ok
PC	3,242	ok	24,167	ok	963	ok	0.58	ok	0.29	ok
	2,356	ok	24,167	ok	1377	ok	0.57	ok	0.30	ok
PT	2,356	ok	0	ok	1377	ok	0.04	ok	0.04	ok
	2,161	ok	0	ok	1377	ok	0.03	ok	0.04	ok
PC	2,161	ok	24,167	ok	1377	ok	0.56	ok	0.30	ok
	1,242	ok	24,167	ok	1112	ok	0.55	ok	0.26	ok
PT	1,242	ok	0	ok	1112	ok	0.02	ok	0.03	ok
Exit Point	0	ok	0	ok	-25	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

The risk of inadvertent drilling fluid returns due to hydrofracture was evaluated using the Delft Method. The Delft Method is described in Section 5 of the report. In summary, the risk of inadvertent drilling fluid returns due to hydrofracture is low over the majority of the length of the crossing. The factor of safety remains above 2.0 until station 13+93. Therefore, inadvertent drilling fluid returns due to hydrofracture are not anticipated under normal drilling operations through station 13+93. At station 14+58, approximately 65 feet from the exit point, the factor of safety drops below 1.0, indicating an increased risk of inadvertent drilling fluid returns due to hydrofracture. Inadvertent drilling fluid returns due to hydrofracture near the exit point, where cover is shallow, is a common occurrence in the HDD industry during pilot hole drilling. These returns typically occur within temporary workspace and are easily contained. Refer to Figure 6 for results presented in graphical format.

It is important to keep in mind that inadvertent drilling fluid returns may occur due to mechanisms unrelated to hydrofracture. It remains possible that inadvertent drilling fluid returns will occur by flowing to the ground surface through preexisting fractures or porous seams in the soil mass.

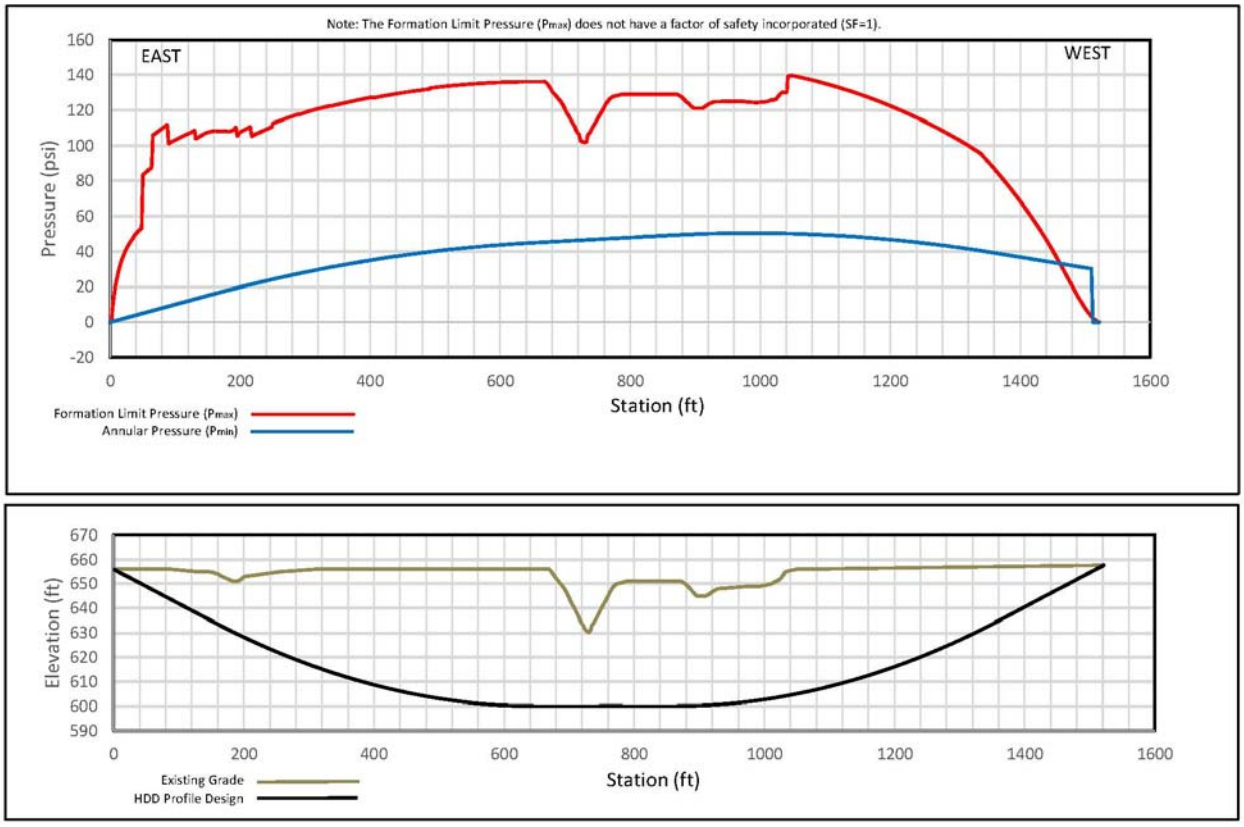


Figure 6: Hydrofracture Evaluation (Formation Limit Pressure –vs-Annular Pressure)

Construction Duration

The estimated duration of construction for the proposed crossing is 13 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated by JDH&A based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as past experience in similar subsurface conditions. Refer to Figure 7 for details relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments
Work Schedule, hours/shift =	12.0	36" Findlay Road Crossing
days/week =	7.0	
Drilled Length, feet =	1,528	
Pilot Hole		
Production Rate, feet/hour =	50	
shifts/day =	1	
Drilling Duration, hours =	30.6	
shifts =	2.5	
Trips to change tools, shifts =	0.5	
Pilot Hole Duration, days =	3.0	

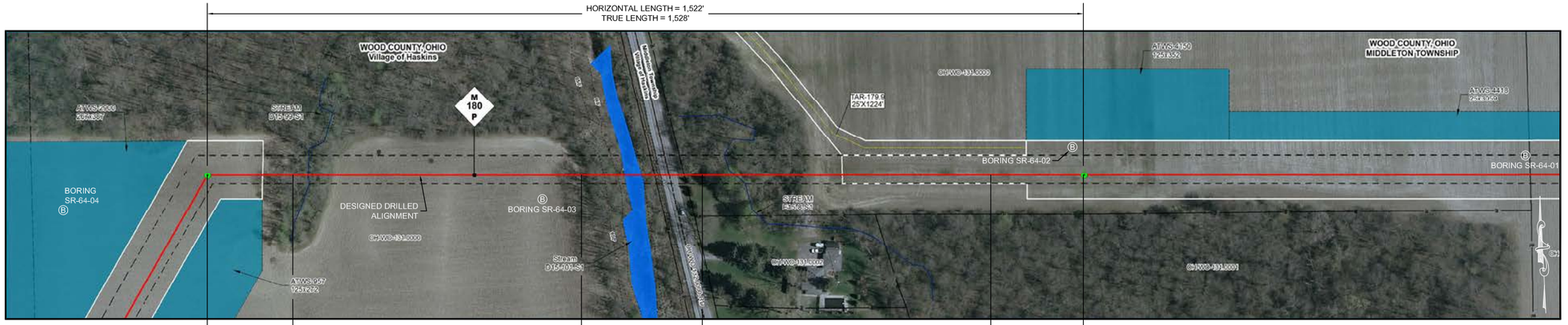
Ream and Pull Back								
Pass Description =	36-inch	48-inch				Swab	Pull Back	Total
Travel Speed, feet/minute =	2.0	2.0				8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0				15.0	15.0	
shifts/day =	1	1				1	1	
Reaming Duration, hours =	14.4	14.4				4.8	5.9	39.5
shifts =	1.2	1.2				0.4	0.5	3.3
Rig up, shifts =	0.5	0.5				0.5	0.5	2.0
Trips to change tools, shifts =	1.0	1.0				0.0		2.0
Pass Duration, days =	2.7	2.7				0.9	1.0	7.3

Summary	
HDD Duration at Site, days =	12.3

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 7: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN

SCALE: 1" = 100'

ENTRY POINT @ 8°
0+00.00, 656.00
N 15077191.37, E 897244.87

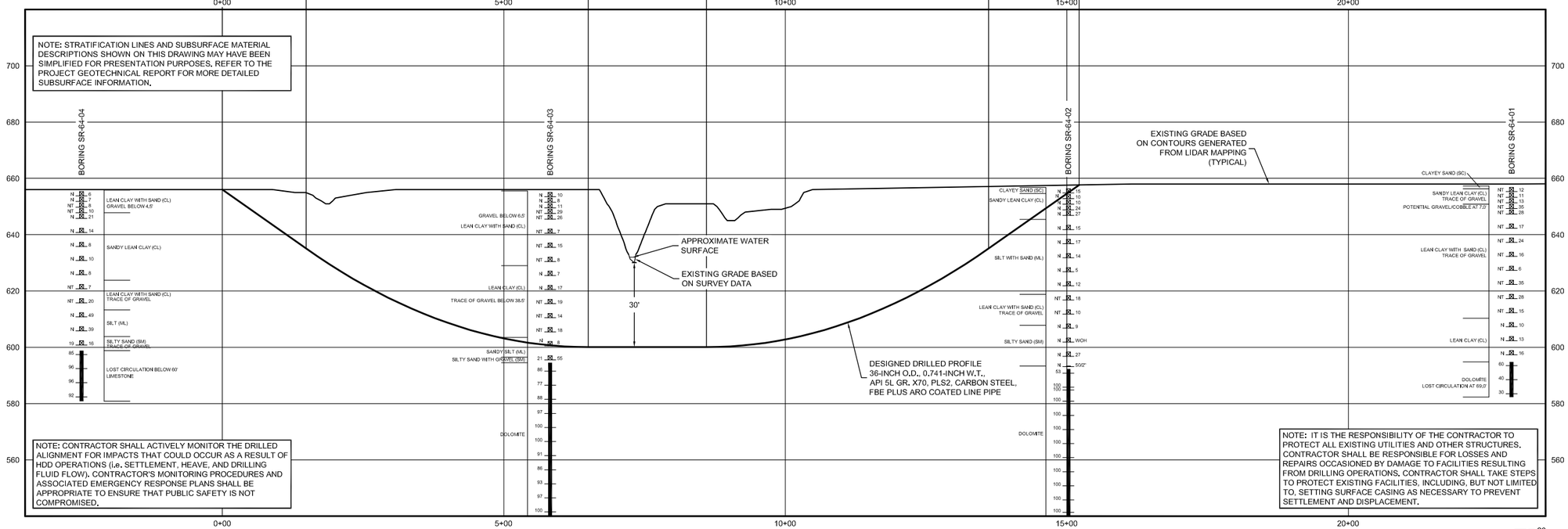
P.C. 8° SAG BEND
1+48.84, 635.08
RADIUS = 3,600'

P.T. 8° SAG BEND
6+49.86, 600.05

P.C. 8° SAG BEND
8+59.83, 600.05
RADIUS = 3,600'

P.T. 8° SAG BEND
13+60.86, 635.08

EXIT POINT @ 8°
15+21.57, 657.67
N 15077109.48, E 898764.24



NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

ALIGNMENT LEGEND

- PIPELINE MILEPOST (M 0.0 P)
- PIPELINE
- INTERCONNECTING PIPELINE
- CONSTRUCTION LIMIT
- STUDY CORRIDOR
- STAGING AREA
- WAREYARD
- PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- METERING & REGULATION STATION (M&R)
- COMPRESSOR STATION SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- APPROXIMATE WETLAND BOUNDARY
- APPROXIMATE WATERBODY BANK
- APPROXIMATE WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD (PAR-0.0)
- TEMPORARY ACCESS ROAD (TAR-0.0)
- PARCEL TRACT NO (OH-CO-011.0000-SC)
- PROPERTY LINE
- CONTOUR (---128'---)
- MUNICIPALITY LINE
- FENCE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- TELEPHONE
- TEE TAP
- BLOW OFF VALVE
- TOWER
- HORIZONTAL DIRECTIONAL DRILLING
- TANK
- WELL: GAS, WATER, OIL, UNKNOWN
- UTILITY LINES
- MAINLINE VALVE (MLV)
- MICROWAVE TOWER
- LIGHT POLE
- FIRE HYDRANT

PROFILE

SCALE: 1" = 100' HORIZONTAL
1" = 20' VERTICAL

250 200 150 100 50 0
20 10 0

GENERAL LEGEND

- DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.
2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.
2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

- (B) BORING LOCATION

SPLIT SPOON SAMPLE

- 53 / X / 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
- PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE

- UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
- TSS 1,350 — TENSILE SPLITTING STRENGTH (PSI)
- 53 / 6 — MOHS HARDNESS
- ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA. REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.
2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.
3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW, HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.
2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.
3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.
4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.
5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.
2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.
3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
CLYD-A-1197	ALIGNMENT SHEET M.P. 179.37 TO M.P. 180.32	0	LKB	JMS	ISSUED FOR FERC

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS	PRELIMINARY		CONSTRUCTION	
TITLE	SIGNATURE	DATE	SIGNATURE	DATE
DRAWN BY:	DMP	08/07		
PROJECT MANAGER	JSM	08/07		
DESIGN ENGINEER	DMP	08/07		
DESIGN CHECKER	DLB	08/07		

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH FINDLAY ROAD CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING

WOOD COUNTY, OHIO

NEXUS SM GAS TRANSMISSION

M.P. 179.8	W.O.	SCALE: AS SHOWN	DWG. CLYD-H-1012	REV. 0

IS.#

MP 181.2 Maumee River

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR, hydrographic, and traditional survey data covering the proposed crossing location
- Draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Maumee River HDD Crossing, Nexus Gas Transmission Project, Lucas County, Ohio" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The 36-inch Maumee River Crossing is located just south of Waterville, Ohio near the north edge of Missionary Island. The crossing involves passing beneath the Maumee River as well as US Highway 24 (Anthony Wayne Trail) on the west side of the West River Road on the east side of the river. The width of the river at the proposed crossing location is approximately 2,000 feet. The area is mostly comprised of agricultural land with a mix of woods. The terrain is relatively flat, but drops off near the Maumee River. From the plateaus on each side of the river, the elevation drops off about 40 to 50 feet from the upland farm fields on each side to the edge of water. An overview of the proposed crossing location is provided in Figures 1. Photos taken at the time of the site reconnaissance are included in Figures 2 and 3.

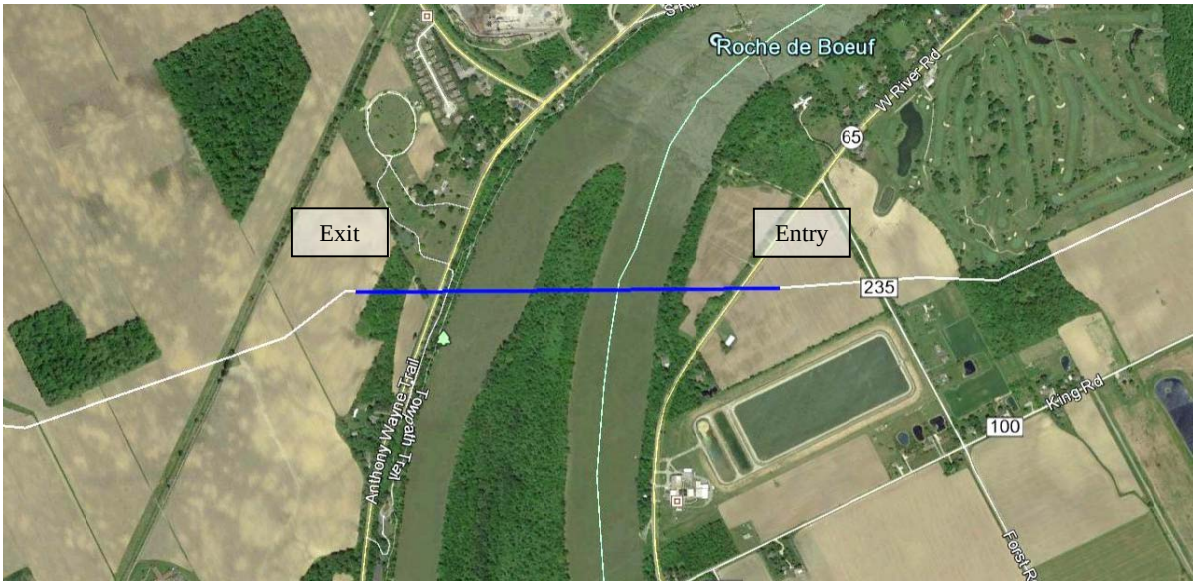


Figure 1: Overview of the Maumee River Crossing

Figure 2: View from West River Road toward entry location

Figure 3: Maumee River (west channel)

Subsurface Conditions

Four geotechnical borings have been taken as part of the site investigation conducted by Fugro Consultants, Inc. Two borings were taken on the west side of the river, both of which were drilled to a depth of 105 feet. Both borings encountered primarily lean clay to lean clay with sand overlying sedimentary bedrock. The top of bedrock was encountered at 85 feet in boring MAU-05 and 98 feet boring MAU-06. Borings MAU-01 and MAU-02 were drilled on the east side of the river. MAU-01 was drilled to 67 feet below the ground surface and encountered fat clay with occasional gravel and gravelly fat clay. Boring MAU-02 encountered mostly sandy lean clay with gravel to a depth of 78 feet. Sand with silt and gravel was encountered at 79 feet with sedimentary bedrock in the form of limestone and siltstone at a depth of 81 feet. The field logs indicate extensive fracturing in the limestone and siltstone. Rock quality designation (RQD) ranged from 0 to 54, with the average value being 12, indicating very poor quality bedrock. Unconfined compressive strength (UCS) of the bedrock averaged 5,988 psi.

Refer to the draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Maumee River HDD Crossing, Nexus Gas Transmission Project, Lucas County, Ohio" and dated September 11, 2015 for additional information.

Design Geometry & Layout

The Maumee River HDD design involves a horizontal length of 3,999 feet. The design length results from an entry angle of 12-degrees, an exit angle of 8-degrees, and a radius of curvature equal to 3,600 feet. In this case, it was not possible to maintain sufficient depth of cover beneath the river while staying above the bedrock surface. Therefore, the design is based on penetrating bedrock, which achieves 75 feet of cover beneath the Maumee River.

The west side of the crossing was chosen for the proposed exit point due to the open farm field which are free of obstructions, which allow the pipeline pull section to be fabricated in a single segment and thus avoid tie-in welds during pullback.

The preliminary HDD plan and profile design drawing for the Maumee River Crossing is attached to this report for reference.

Assessment of Feasibility

Based on a review of available geotechnical information, the HDD segment must pass through approximately 325 feet of overburden soil containing occasional coarse granular material on the east side of the crossing, before penetrating sedimentary bedrock at a depth of approximately 75 feet. According to preliminary field logs, the bedrock is characterized by extreme fracturing, which in some cases can be problematic for installation by HDD. Although the feasibility of the Maumee River cannot be ruled out, subsurface conditions are present that increase the risk of HDD operational problems.

Risk Identification and Assessment

Potential construction impacts resulting from installation by HDD include possible damage to U.S. Highway 24 and West River Road due to heaving or settlement. In addition, there is risk that inadvertent drilling fluid returns will surface within the Maumee River.

HDD construction and operational risks associated with the crossing involve penetrating bedrock at depths in excess of 75 feet on the east side and almost 100 feet on the west side. Penetrating a deep bedrock surface during pilot hole drilling can sometimes be difficult due to bit deflection. The bit may deflect and skip across the top of the bedrock instead of penetrating it, resulting in unacceptable radius of curvature. A deep bedrock surface can be problematic during reaming and pullback operations due to misalignment at the soil/rock interface. Downhole reaming tools or the pull section may also hang up on the rock interface. Additional risks include failure of large diameter rock reaming tools downhole and operational problems associated with fractured bedrock, including loss of drilling fluid circulation.

Due to subsurface conditions, the risk level associated with the proposed crossing of the Maumee River is high.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 632,344 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 662,330 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 4. Detailed calculations for each scenario are summarized in Figures 5 and 6.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 4: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	362.6	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	38,289	lb			
Fluidic Drag = 12 π D L C_d =	12,303	lb			
Axial Segment Weight = W_e L sinθ =	17,937	lb			
Pulling Load on Exit Tangent =	**68,529**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	121,693	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	8.77	ft	j = [(E I) / T]$^{1/2}$ =	1,743	
Y = [18 $(L)^2$] - [(j / 2) $(1 - \cosh(U/2)^{-1})$] =	2.6E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	689.38	
U = (12 L) / j =	3.46		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	128,017	lb
Bending Frictional Drag = 2 μ N =	76,810	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	12,463	lb			
Pulling Load on Exit Sag Bend =	**106,328**	**lb**			
Total Pulling Load =	**174,857**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	2316.0	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	246,962	lb			
Fluidic Drag = 12 π D L C_d =	78,581	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**325,543**	**lb**			
Total Pulling Load =	**500,400**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	558,632	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	814	
Y = [18 $(L)^2$] - [(j)^2 (1 - cosh(U/2)$^{-1}$)] =	6.5E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1478.17	
U = (12 L) / j =	9.27		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	191,018	lb
Bending Frictional Drag = 2 μ N =	114,611	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	-19,464	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**116,465**	**lb**			
Total Pulling Load =	**616,865**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	200.5	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	21,050	lb			
Fluidic Drag = 12 π D L C_d =	6,801	lb			
Axial Segment Weight = W_e L sinθ =	-12,372	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**15,479**	**lb**			
Total Pulling Load =	**632,344**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	7,704	ok	0	ok	0	ok	0.12	ok	0.02	ok
	7,515	ok	0	ok	466	ok	0.12	ok	0.03	ok
PC	7,515	ok	12,083	ok	466	ok	0.38	ok	0.14	ok
	6,096	ok	12,083	ok	1295	ok	0.38	ok	0.16	ok
PT	6,096	ok	0	ok	1295	ok	0.10	ok	0.05	ok
	2,130	ok	0	ok	1295	ok	0.03	ok	0.04	ok
PC	2,130	ok	12,083	ok	1295	ok	0.30	ok	0.12	ok
	835	ok	12,083	ok	764	ok	0.28	ok	0.08	ok
PT	835	ok	0	ok	764	ok	0.01	ok	0.01	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	668.1	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	70,548	lb			
Fluidic Drag = 12 π D L C_d =	22,668	lb			
Axial Segment Weight = W_e L sinθ =	33,050	lb			
Pulling Load on Exit Tangent =	**126,266**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	164,579	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1,499	
Y = [18 $(L)^2$] - [(j / 2) $(1 - \cosh(U/2)^{-1})$] =	3.4E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	181.26	
U = (12 L) / j =	2.01		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	103,112	lb
Bending Frictional Drag = 2 μ N =	61,867	lb			
Fluidic Drag = 12 π D L C_d =	8,527	lb			
Axial Segment Weight = W_e L sinθ =	6,231	lb			
Pulling Load on Exit Sag Bend =	**76,626**	**lb**			
Total Pulling Load =	**202,892**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	2329.7	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	248,421	lb			
Fluidic Drag = 12 π D L C_d =	79,045	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**327,466**	**lb**			
Total Pulling Load =	**530,358**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	576,966	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	801	
Y = [18 $(L)^2$] - [(j / 2) $(1 - \cosh(U/2)^{-1})$] =	1.3E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	549.29	
U = (12 L) / j =	4.71		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	153,813	lb
Bending Frictional Drag = 2 μ N =	92,288	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**93,215**	**lb**			
Total Pulling Load =	**623,573**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	501.9	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	52,706	lb			
Fluidic Drag = 12 π D L C_d =	17,029	lb			
Axial Segment Weight = W_e L sinθ =	-30,978	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**38,757**	**lb**			
Total Pulling Load =	**662,330**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	8,069	ok	0	ok	0	ok	0.13	ok	0.02	ok
	7,597	ok	0	ok	1259	ok	0.12	ok	0.06	ok
PC	7,597	ok	24,167	ok	1259	ok	0.65	ok	0.40	ok
	6,461	ok	24,167	ok	1673	ok	0.63	ok	0.41	ok
PT	6,461	ok	0	ok	1673	ok	0.10	ok	0.08	ok
	2,472	ok	0	ok	1673	ok	0.04	ok	0.06	ok
PC	2,472	ok	24,167	ok	1673	ok	0.57	ok	0.33	ok
	1,538	ok	24,167	ok	1408	ok	0.55	ok	0.29	ok
PT	1,538	ok	0	ok	1408	ok	0.02	ok	0.04	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 6: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

The majority of the Maumee River Crossing will be installed through bedrock. Since the Delft Method discussed in Section 5 of the report is only applicable to uncemented subsurface materials, a hydrofracture evaluation was not completed. In general, inadvertent drilling fluid returns due to hydrofracture do not typically occur on rock crossings, but instead occur by flowing through existing fractures, joints, or solution cavities.

Construction Duration

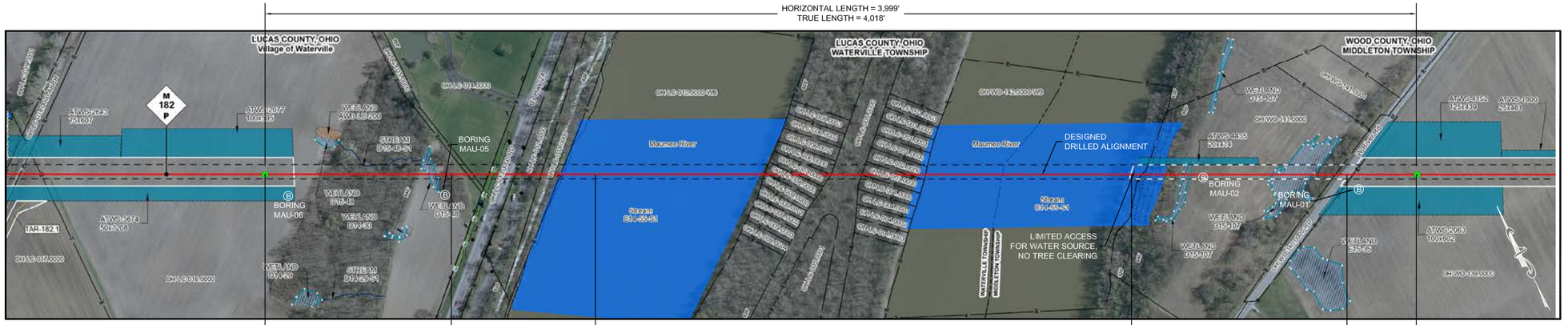
The estimated duration of construction for the Maumee River Crossing is 81 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated by JDH&A based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as past experience in similar subsurface conditions. Details relative to the estimate are provided in Figure 7.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments							
Work Schedule, hours/shift =	12.0	36" Maumee River Crossing							
days/week =	7.0								
Drilled Length, feet =	4,018								
Pilot Hole									
Production Rate, feet/hour =	20								
shifts/day =	1								
Drilling Duration, hours =	200.9								
shifts =	16.7								
Trips to change tools, shifts =	2.0								
Pilot Hole Duration, days =	18.7								
Ream and Pull Back									
Pass Description =	24-inch	36-inch	48-inch			Swab	Pull Back	Total	
Travel Speed, feet/minute =	0.4	0.4	0.4			8.0	6.0		
Mud Flow Rate, barrels/minute =	15.0	15.0	15.0			15.0	15.0		
shifts/day =	1	1	1			1	1		
Reaming Duration, hours =	195.7	195.7	195.7			12.7	15.5	615.1	
shifts =	16.3	16.3	16.3			1.1	1.3	51.3	
Rig up, shifts =	0.5	0.5	0.5			0.5	0.5	2.5	
Trips to change tools, shifts =	2.0	2.0	2.0			0.0		6.0	
Pass Duration, days =	18.8	18.8	18.8			1.6	1.8	59.8	
Summary									
HDD Duration at Site, days =	80.5								
Site Establishment	Move in	Rig Up	Rig Down	Move Out					
shifts/day =	1	1	1	1					
shifts =	0.5	1.0	1.0	0.5					
days =	0.5	1.0	1.0	0.5					

Figure 7: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN

SCALE: 1" = 200'

EXIT POINT @ 8°
39+98.66, 652.00
N 15079456.49, E 888593.45

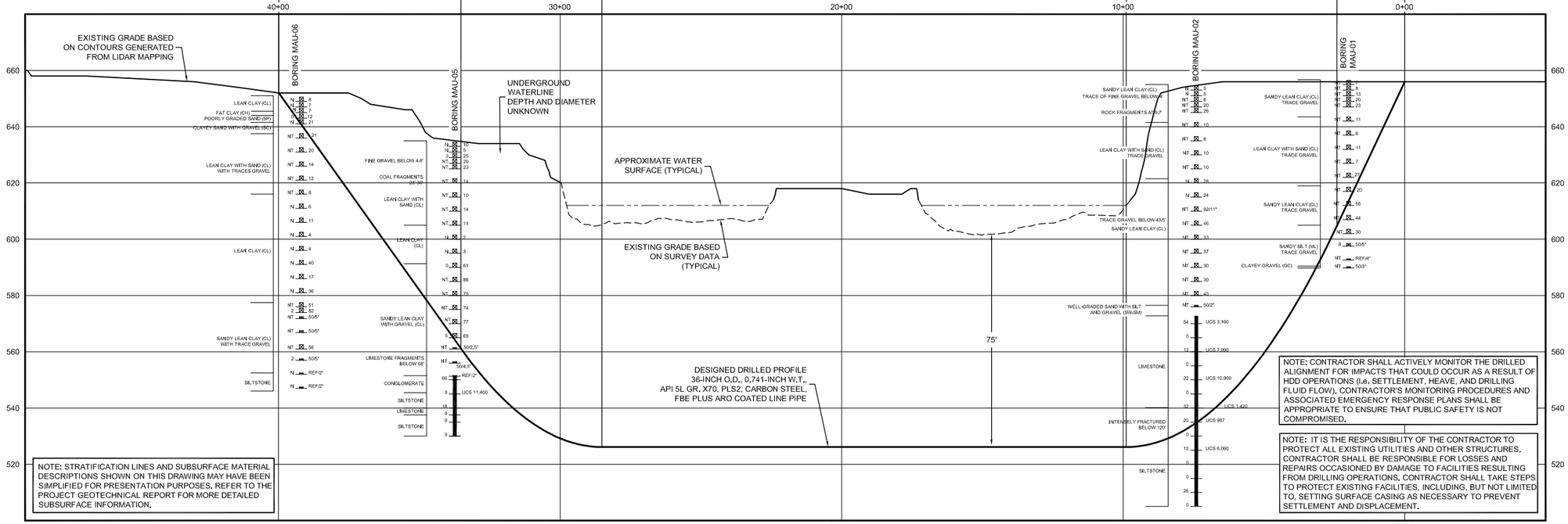
P.T. 8° SAG BEND
33+52.44, 561.18

P.C. 8° SAG BEND
28+51.42, 526.15
RADIUS = 3,600'

P.T. 12° SAG BEND
9+89.30, 526.15

P.C. 12° SAG BEND
2+40.82, 604.81
RADIUS = 3,600'

ENTRY POINT @ 12°
0+00.00, 656.00
N 15077627.81, E 892149.47



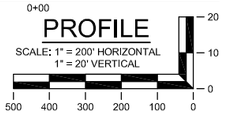
NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (I.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

PROFILE

SCALE: 1" = 200' HORIZONTAL
1" = 20' VERTICAL



ALIGNMENT LEGEND

PIPELINE MILEPOST
PIPELINE
INTERCONNECTING PIPELINE
CONSTRUCTION LIMIT
STUDY CORRIDOR
STAGING AREA
WAREYARD
PERMANENT ROW
ADDITIONAL TEMPORARY WORKSPACE
METERING & REGULATION STATION (M&R)
COMPRESSOR STATION SITE
FACILITIES TEMPORARY WORKSPACE
FACILITIES PERMANENT WORKSPACE

DELINEATED WETLAND BOUNDARY
DELINEATED WATERBODY BANK
DELINEATED WATERBODY CENTERLINE
APPROXIMATE WETLAND BOUNDARY
APPROXIMATE WATERBODY BANK
APPROXIMATE WATERBODY CENTERLINE
PERMANENT ACCESS ROAD (PAR-0.0)
TEMPORARY ACCESS ROAD (TAR-0.0)
PARCEL TRACT NO (OH-CO-011.0000-SC)
PROPERTY LINE
CONTOUR
MUNICIPALITY LINE

FENCE
FOREIGN PIPELINE
POWERLINE
WATER PIPELINE
RAILROAD TRACK
TELEPHONE
TEE TAP
BLOW OFF VALVE
TOWER
HORIZONTAL DIRECTIONAL DRILLING
TANK
WELL: GAS WATER OIL UNKNOWN
UTILITY LINES
MAINLINE VALVE (MLV)
MICROWAVE TOWER
LIGHT POLE
FIRE HYDRANT

GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

B BORING LOCATION

SPLIT SPOON SAMPLE
53 / 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE
UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
TSS 1,350 — TENSILE SPLITTING STRENGTH (PSI)
53 / 6 — MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA. REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.

2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.

3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW, HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
CLYD–A–1199	ALIGNMENT SHEET M.P. 181.26 TO M.P. 182.21				
CLYD–A–1198	ALIGNMENT SHEET M.P. 180.32 TO M.P. 181.26	0	LKB	ACM	ISSUED FOR FERC

IG.#

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS				
	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	DMP	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	LKB	08/26		
DESIGN CHECKER	AM	08/26		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH MAUMEE RIVER CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING
WOOD AND LUCAS COUNTIES, OHIO

NEXUS SM GAS TRANSMISSION

M.P. 181.2	W.O.	SCALE: AS SHOWN	DWG. CLYD–H–1013	REV. 0

MP 215.0 River Raisin

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR and traditional survey data covering the proposed crossing location
- Draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Raisin River HDD Crossing (REV-1), Nexus Gas Transmission Project, Lenawee County, Ohio" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The proposed 36-inch River Raisin Crossing at approximately pipeline Mile Post 215.0, approximately 2 miles south of Blissfield, Michigan. The proposed crossing alignment trends in the north-south direction, cutting perpendicularly across Beamer Road. The river is approximately 100 feet wide at the crossing location. At the time of this writing, hydrographic survey shots indicating the depth of the river were not yet available. The land on the south side of the crossing consists of open farm fields. Immediately north of the river, the land is wooded. The wooded land is followed by open farm fields. An overview of the proposed crossing location is provided in Figures 1 through 3.

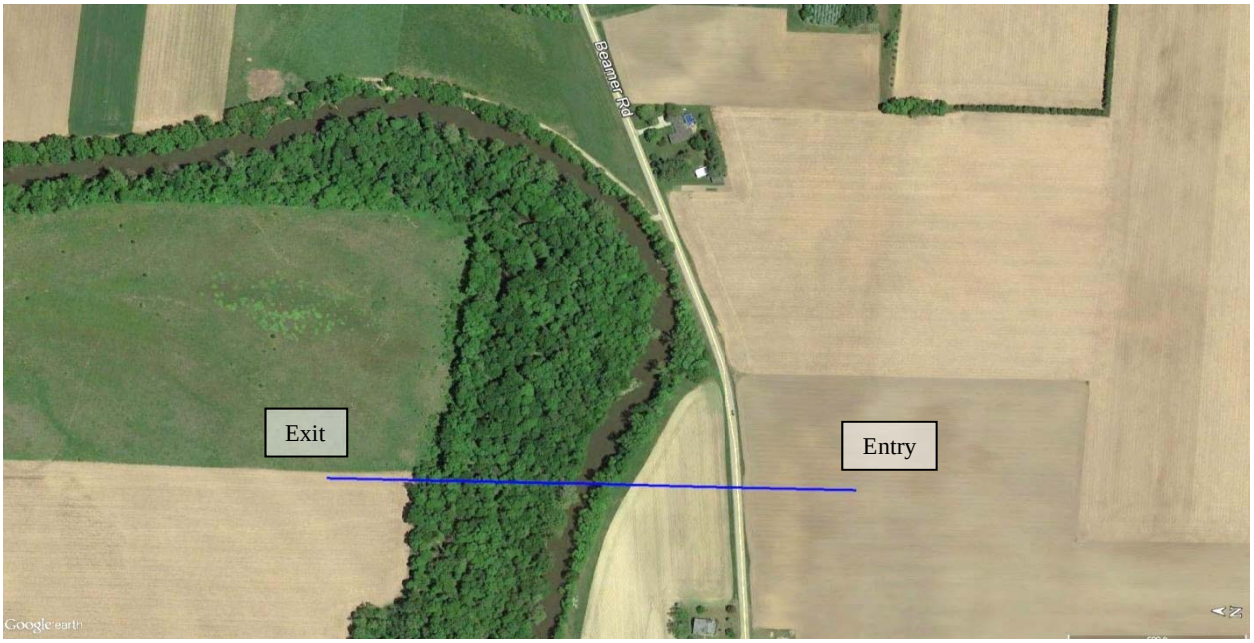


Figure 1: Overview of the River Raisin Crossing

Figure 2: View toward entry location from Beamer Road

Figure 3: View toward exit location

Subsurface Conditions

Three site-specific geotechnical borings were taken as part of the site-investigation conducted by Fugro Consultants, Inc. Borings RAI-1-1 and RAI-1-2, taken on the north side of the river, encountered primarily lean clay, lean clay with sand, sand, silt, and silt with clay and gravel. Boring RAI-1-3, taken on the south side of the river, primarily encountered lean clay, silty sand, and sand with silt.

Design Geometry & Layout

The proposed crossing involves a horizontal length of 1,479 feet. It utilizes a 10-degree entry angle, an 8-degree exit angle, and a radius of curvature of 3,600 feet. The crossing design is based on obtaining a minimum of 40 feet of cover at the edge of Beamer Road and tree line/slope on the north side of the crossing.

The exit point is located on the south side of the crossing to take advantage of available workspace for pull section fabrication, which will allow the pull section to be fabricated in a single segment. Pulling in a single segment will eliminate risk of getting the pull section stuck during downtime associated with a tie-in weld. The entry point is located in an open field on the north side

The preliminary HDD design, as well as available workspace for HDD operations, is shown on the plan and profile drawing included in this site-specific report.

Assessment of Feasibility

The proposed River Raisin installation is feasible. With a horizontal length of 1,479 feet and subsurface conditions consisting of mixtures of lean clay and sand, the River Raisin crossing should be a straightforward installation. Numerous 36-inch HDD installations of similar distances through similar subsurface conditions have been completed.

Risk Identification and Assessment

Possible construction impacts associated with installation by HDD include damage to Beamer Road in the form of heaving or settlement, as well as drilling fluid surfacing in the river.

Based on the proposed length of the crossing and anticipated subsurface conditions, the overall risk level associated with installation by HDD is considered low.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 259,367 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 284,195 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 4. Detailed calculations for each scenario are summarized in Figures 4 and 6.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 4: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (ff Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (ff Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	135.6	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	14,315	lb			
Fluidic Drag = 12 π D L C_d =	4,600	lb			
Axial Segment Weight = W_e L sinθ =	6,706	lb			
Pulling Load on Exit Tangent =	**25,620**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	77,899	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	8.77	ft	j = [(E I) / T]$^{1/2}$ =	2,179	
Y = [18 $(L)^2$] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	2.0E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	547.15	
U = (12 L) / j =	2.77		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	125,069	lb
Bending Frictional Drag = 2 μ N =	75,041	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	12,463	lb			
Pulling Load on Exit Sag Bend =	**104,559**	**lb**			
Total Pulling Load =	**130,179**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	188.9	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	20,140	lb			
Fluidic Drag = 12 π D L C_d =	6,408	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**26,549**	**lb**			
Total Pulling Load =	**156,728**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	206,084	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	1,340	
Y = [18 $(L)^2$] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	5.5E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1219.89	
U = (12 L) / j =	5.63		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	161,431	lb
Bending Frictional Drag = 2 μ N =	96,858	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	-19,464	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**98,712**	**lb**			
Total Pulling Load =	**255,440**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	30.0	ft	Effective Weight, W_e = W + W_b - W_m =	279.0	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	2,473	lb			
Fluidic Drag = 12 π D L C_d =	0	lb	Fluidic drag is calculated as zero unless entire segment is submerged in drilling fluid. Please reference Step 2 Drilled Path Input		
Axial Segment Weight = W_e L sinθ =	1,454	lb			
Pulling Load on Entry Tangent =	**3,927**	**lb**			
Total Pulling Load =	**259,367**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,160	ok	0	ok	0	ok	0.05	ok	0.00	ok
	3,112	ok	0	ok	0	ok	0.05	ok	0.00	ok
PC	3,112	ok	12,083	ok	0	ok	0.31	ok	0.07	ok
	1,909	ok	12,083	ok	816	ok	0.30	ok	0.09	ok
PT	1,909	ok	0	ok	816	ok	0.03	ok	0.02	ok
	1,586	ok	0	ok	816	ok	0.03	ok	0.01	ok
PC	1,586	ok	12,083	ok	816	ok	0.29	ok	0.08	ok
	312	ok	12,083	ok	286	ok	0.27	ok	0.05	ok
PT	312	ok	0	ok	286	ok	0.00	ok	0.00	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	441.1	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	46,574	lb			
Fluidic Drag = 12 π D L C_d =	14,965	lb			
Axial Segment Weight = W_e L sinθ =	21,818	lb			
Pulling Load on Exit Tangent =	**83,357**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	120,602	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1,751	
Y = [18 $(L)^3$] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	2.7E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	143.83	
U = (12 L) / j =	1.72		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	99,551	lb
Bending Frictional Drag = 2 μ N =	59,730	lb			
Fluidic Drag = 12 π D L C_d =	8,527	lb			
Axial Segment Weight = W_e L sinθ =	6,231	lb			
Pulling Load on Exit Sag Bend =	**74,489**	**lb**			
Total Pulling Load =	**157,846**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	202.6	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	21,599	lb			
Fluidic Drag = 12 π D L C_d =	6,873	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**28,472**	**lb**			
Total Pulling Load =	**186,318**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	222,459	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,289	
Y = [18 $(L)^3$] - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	8.5E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	363.50	
U = (12 L) / j =	2.92		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	118,926	lb
Bending Frictional Drag = 2 μ N =	71,356	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**72,283**	**lb**			
Total Pulling Load =	**258,601**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	331.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	34,806	lb			
Fluidic Drag = 12 π D L C_d =	11,246	lb			
Axial Segment Weight = W_e L sinθ =	-20,458	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**25,594**	**lb**			
Total Pulling Load =	**284,195**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point										
	3,462	ok	0	ok	0	ok	0.05	ok	0.00	ok
	3,151	ok	0	ok	781	ok	0.05	ok	0.02	ok
PC										
	3,151	ok	24,167	ok	781	ok	0.58	ok	0.27	ok
	2,270	ok	24,167	ok	1195	ok	0.57	ok	0.29	ok
PT										
	2,270	ok	0	ok	1195	ok	0.04	ok	0.03	ok
	1,923	ok	0	ok	1195	ok	0.03	ok	0.03	ok
PC										
	1,923	ok	24,167	ok	1195	ok	0.56	ok	0.28	ok
	1,016	ok	24,167	ok	929	ok	0.55	ok	0.25	ok
PT										
	1,016	ok	0	ok	929	ok	0.02	ok	0.02	ok
	0	ok	0	ok	0	ok	0.00	ok	0.00	ok
Exit Point										

Figure 6: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

The risk of inadvertent drilling fluid returns due to hydrofracture was evaluated using the Delft Method. The Delft Method is described in Section 5 of the report. In summary, the risk of inadvertent drilling fluid returns due to hydrofracture is low over the first 1,000 feet of the crossing. However, after station 12+45, the factor of safety drops below 2.0, indicating a moderate risk of hydrofracture. By station 14+00, the factor of safety falls below 1.0, indicating an increased risk of hydrofracture over the remaining roughly 80 feet of the crossing. Inadvertent drilling fluid returns due to hydrofracture near the exit point, where cover is shallow, is a common occurrence in the HDD industry during pilot hole drilling. These returns typically occur within the temporary workspace and are easily contained. Refer to Figure 7 for results presented in graphical format.

It is important to keep in mind that inadvertent drilling fluid returns may occur due to mechanisms unrelated to hydrofracture. It remains possible that inadvertent drilling fluid returns will occur by flowing to the ground surface through preexisting fractures or porous seams in the soil mass.

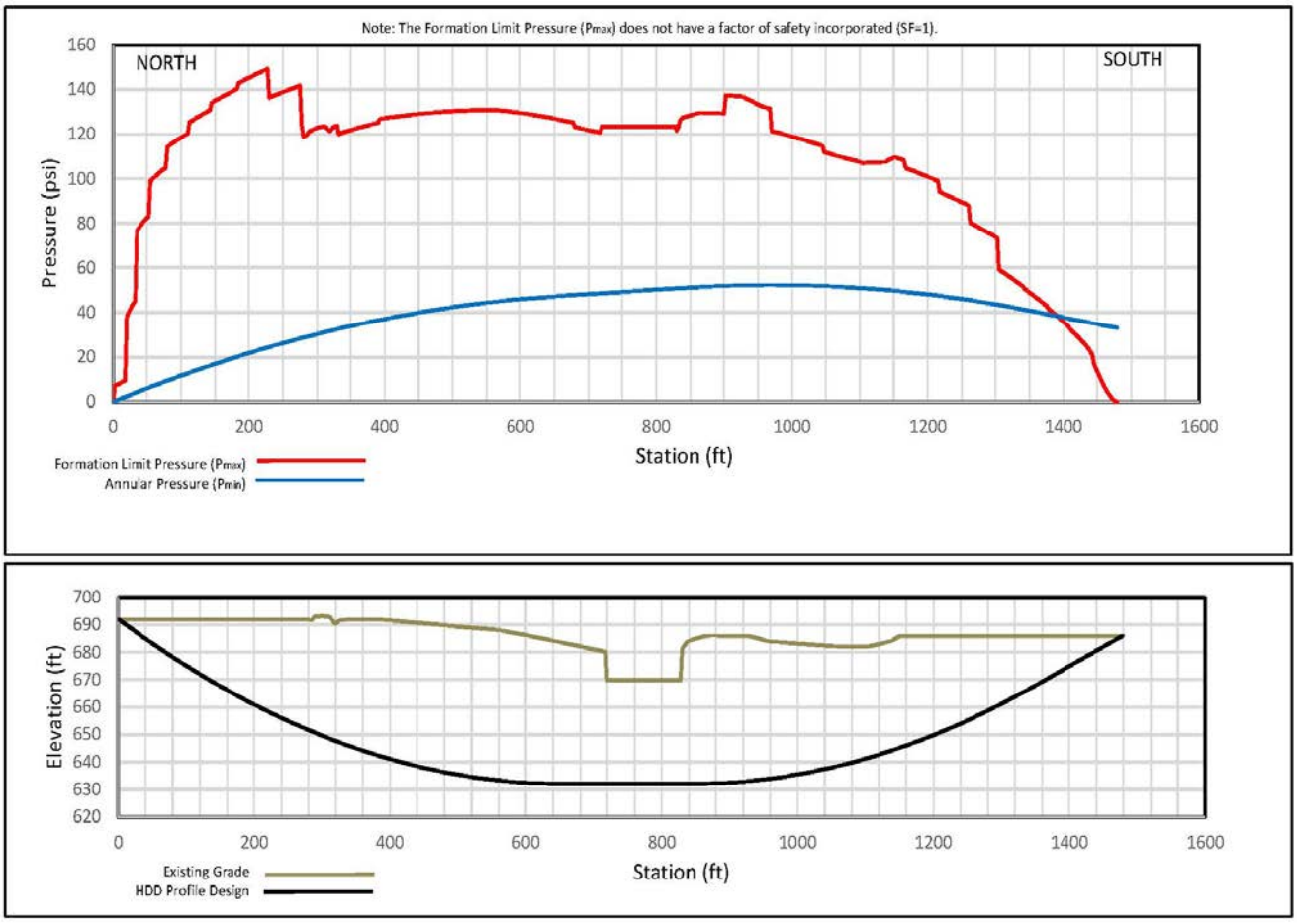


Figure 7: Hydrofracture Evaluation (Formation Limit Pressure - vs - Annular Pressure)

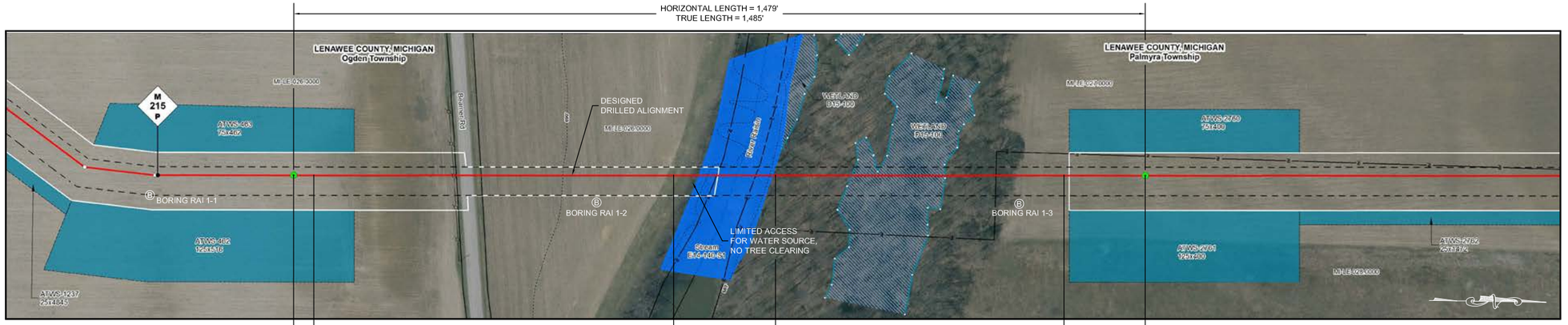
Construction Duration

The estimated duration of construction is 13 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated based on information contained within the Pipeline Research Council International's "Installation of Pipelines by Horizontal Directional Drilling", as well as JDH&A's previous experience in similar subsurface conditions. Refer to Figure 8 for details relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments						
Work Schedule, hours/shift =	12.0	36" Raisin River Crossing						
days/week =	7.0							
Drilled Length, feet =	1,485							
Pilot Hole								
Production Rate, feet/hour =	50							
shifts/day =	1							
Drilling Duration, hours =	29.7							
shifts =	2.5							
Trips to change tools, shifts =	0.5							
Pilot Hole Duration, days =	3.0							
Ream and Pull Back								
Pass Description =	36-ich	48-inch				Swab	Pull Back	Total
Travel Speed, feet/minute =	2.0	2.0				8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0				15.0	7.0	
shifts/day =	1	1				1	1	
Reaming Duration, hours =	14.0	14.0				4.7	5.7	38.4
shifts =	1.2	1.2				0.4	0.5	3.2
Rig up, shifts =	0.5	0.5				0.5	0.5	2.0
Trips to change tools, shifts =	1.0	1.0				0.0		2.0
Pass Duration, days =	2.7	2.7				0.9	1.0	7.2
Summary								
HDD Duration at Site, days =	12.2							
Site Establishment	Move in	Rig Up	Rig Down	Move Out				
shifts/day =	1	1	1	1				
shifts =	0.5	1.0	1.0	0.5				
days =	0.5	1.0	1.0	0.5				

Figure 8: Estimated Construction Duration



PLAN

SCALE: 1" = 100'

ENTRY POINT @ 10°
0+00.00, 692.00
N 15201282.37, E 851878.97

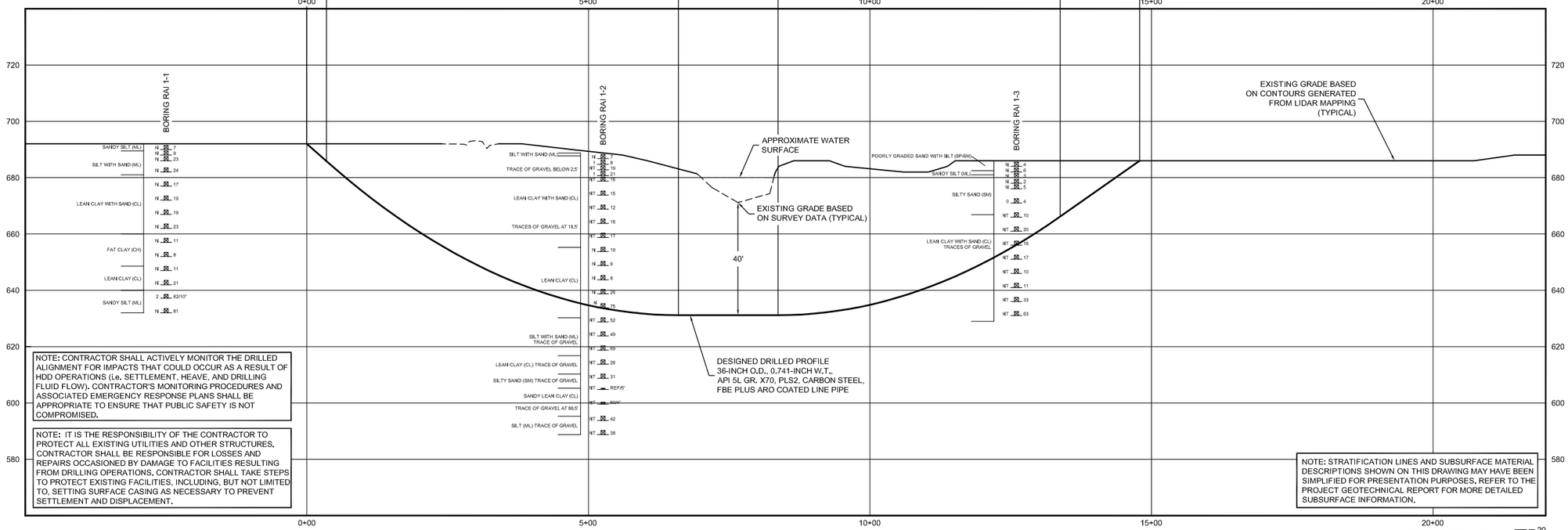
P.C. 10° SAG BEND
0+34.87, 685.85
RADIUS = 3,600'

P.T. 10° SAG BEND
6+60.00, 631.16

P.C. 8° SAG BEND
8+36.87, 631.16
RADIUS = 3,600'

P.T. 8° SAG BEND
13+37.89, 666.19

EXIT POINT @ 8°
14+78.82, 686.00
N 15202761.07, E 851860.29



NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

PROFILE

SCALE: 1" = 100' HORIZONTAL
1" = 20' VERTICAL

20 10 0
250 200 150 100 50 0

ALIGNMENT LEGEND

- PIPELINE MILEPOST (M 0.0 P)
- PIPELINE
- INTERCONNECTING PIPELINE
- CONSTRUCTION LIMIT
- STUDY CORRIDOR
- STAGING AREA
- WAREYARD
- PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- METERING & REGULATION STATION (M&R)
- COMPRESSOR STATION SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- APPROXIMATE WETLAND BOUNDARY
- APPROXIMATE WATERBODY BANK
- APPROXIMATE WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD (PAR-0.0)
- TEMPORARY ACCESS ROAD (TAR-0.0)
- PARCEL TRACT NO (OH-CO-011.0000-SC)
- PROPERTY LINE
- CONTOUR (120' ---)
- MUNICIPALITY LINE
- FENCE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- TELEPHONE
- TEE TAP
- UTILITY LINES
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- TOWER
- MICROWAVE TOWER
- HORIZONTAL DIRECTIONAL DRILLING
- TANK
- LIGHT POLE
- FIRE HYDRANT
- WELL: GAS, WATER, OIL, UNKNOWN

GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR AND SURVEY DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.
2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.
2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

B BORING LOCATION

SPLIT SPOON SAMPLE

53 / 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE

UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
TSS 1,350 — TENSILE SPLITTING STRENGTH (PSI)
53 / 6 — MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA. REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.
2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.
3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW, HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.
2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.
3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.
4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.
5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.
2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.
3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
WATE–A–1236	ALIGNMENT SHEET M.P. 214.93 TO M.P. 215.88	0	LKB	ACM	ISSUED FOR FERC

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	LKB	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	LKB	08/07		
DESIGN CHECKER	DLB	08/07		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH RIVER RAISIN CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING

LENAWEE COUNTY, MICHIGAN

NEXUS SM GAS TRANSMISSION

M.P. 215.0	W.O.	SCALE: AS SHOWN	DWG. WATE–H–1014	REV. 0

MP 237.4 Saline River

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR, hydrographic, and traditional survey data covering the proposed crossing location
- Draft Geotechnical data report prepared by Fugro Consultants, Inc. "Geotechnical Data Report, Saline HDD Crossing, Nexus Gas Transmission Project, Washtenaw County, Michigan" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The 36-inch Saline River Crossing is located just northwest of Milan, Michigan near pipeline Mile Post 237.4. The crossing involves passing beneath the channel of Saline River as well as Mooreville Road, which is located just east of the river. The Saline River is roughly 60 feet from bank to bank, and about 7 feet deep based on hydrographic survey data. Both sides of the river are relatively flat and currently in use for agricultural purposes. The topography rises with the northeast bank of the river, and then levels off on the northeast side Mooreville Road. The elevation change is approximately 20 feet. An overview of the crossing location is provided in Figure 1 and Figure 2.

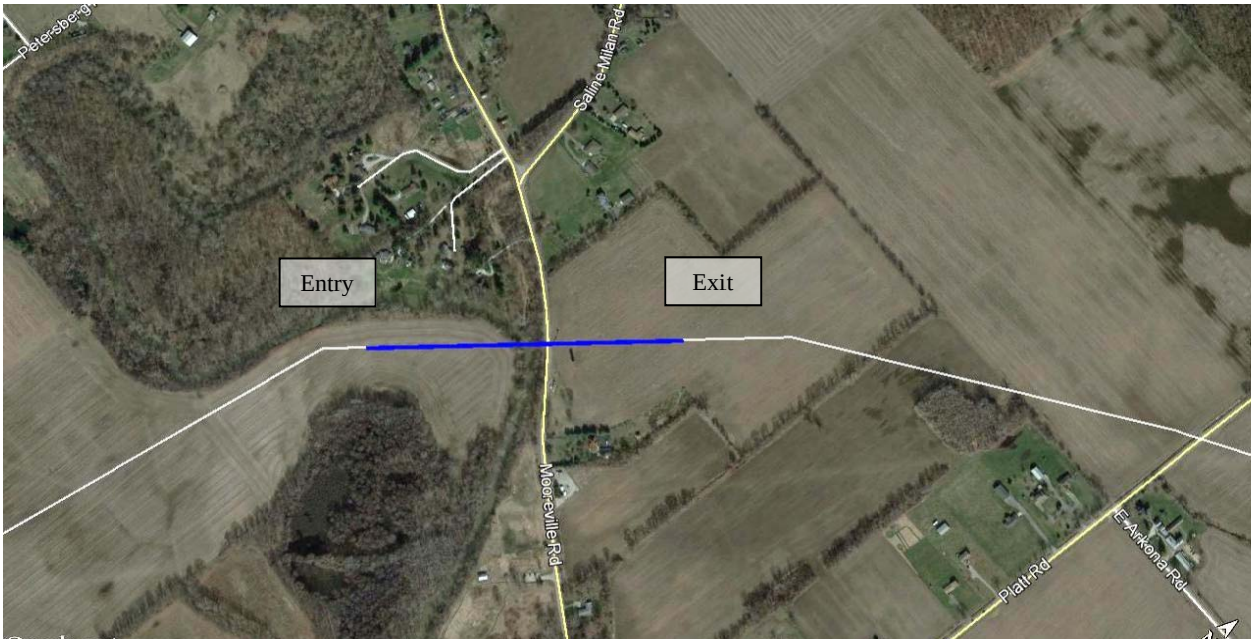


Figure 1: Overview of the Saline River Crossing

Figure 2: Looking south at proposed entry location from treeline near river

Subsurface Conditions

Four geotechnical borings were taken as part of the site investigation conducted by Fugro Consultants, Inc. Two borings were taken on the southwest side of the river and two on the northeast side of the river. The borings generally encountered lean clay, sandy lean clay, and gravelly lean clay overlying shale and limestone bedrock. Two of the borings on the southwest side of the river encountered potential cobbles/bounders at depths ranging from 34 feet to 43 feet. The top of the bedrock surface was encountered near elevation 590 to 600 feet (90 to 110 feet below the ground surface) in Borings SAL-01 through SAL-03. Boring SAL-04 was drilled to a depth of 75 feet without encountering the top of bedrock. Unconfined compressive strength on representative rock samples ranged from 5,420 psi to 11,000 psi for the shale in Boring SAL-03 and from 4,520 psi to 11,200 psi for the limestone encountered in Boring SAL-02.

Refer to the draft report titled “Geotechnical Data Report, Saline River HDD Crossing, Nexus Gas Transmission Project, Washtenaw County Michigan” and dated September 11, 2015, for additional information.

Design Geometry & Layout

The proposed HDD design for crossing Saline River is a minimum length crossing with a horizontal length of 1,315 feet. The entry point is located in an open field on the southwest side of the river, the topographically lower side. This has benefits from a drilling fluid flow and handling perspective. The entry point is located approximately 600 feet from the southwest bank of the river. The exit point is located on the high side of the crossing, approximately 710 feet

northeast of Mooreville Roads. Pull section fabrication will take place along the proposed pipeline right-of-way (ROW), which will allow pulling in a single continuous segment, and thus avoids the requirement for a tie-in weld.

Shallow angles (8-degree entry and exit angles) and a reduced depth of cover beneath the river (30 feet) have been utilized in an attempt reduce the risk of HDD operational problems by minimizing exposure to potentially adverse gravel/cobbles/boulders noted in Borings SAL-01 and SAL-02. A radius of curvature equal to 3,600 feet is used.

Assessment of Feasibility

Based on a review of available geotechnical information, the HDD segment must pass through coarse granular material in the form of gravel, and possibly cobbles and boulders on the southwest side of the crossing. As mentioned previously in this report, coarse granular material such as gravel, and cobbles, and boulders can be problematic to HDD operations. That said, given the relatively short length of the crossing (1,320 feet), skilled HDD contractors should be able to overcome the adverse conditions and successfully install the crossing.

Risk Identification and Assessment

Notable risks associated with pipeline installation by HDD include potential damage to Mooreville Road resulting from drilling fluid flow (inadvertent returns, settlement, or heave).

Although there is risk of HDD operational problems resulting from random gravel, cobbles and boulders, given the short length of the crossing, the overall risk level is considered average.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 212,230 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 270,033 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation

properties are provided in Figure 3. Detailed calculations for each installation loading scenario are summarized in Figures 4 and 5.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 3: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	180.5	ft	Effective Weight, W_e = W + W_b - W_m =	279.0	lb/ft
Exit Angle, θ =	8.0	°			

Frictional Drag = W_e L μ cosθ = 14,959 lb

Fluidic Drag = 12 π D L C_d = 0 lb

Fluidic drag is calculated as zero unless entire segment is submerged in drilling fluid. Please reference Step 2, Drilled Path Input

Axial Segment Weight = W_e L sinθ = -7,008 lb

Negative value indicates axial weight applied in direction of installation

Pulling Load on Exit Tangent = 7,951 lb

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	59,869	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft

h = R [1 - cos(α/2)] = 8.77 ft

j = [(E I) / T]$^{1/2}$ = 2,486

Y = [18 (L_s^2) - [(j^2 (1 - cosh(U/2)$^{-1}$)] = 1.7E+06

X = (3 L) - [(j / 2) tanh(U/2)] = 466.88

U = (12 L) / j = 2.43

N = [(T h) - W_e cosθ (Y/144)] / (X / 12) = 123,864 lb

Bending Frictional Drag = 2 μ N = 74,318 lb

Fluidic Drag = 12 π D L C_d = 17,055 lb

Axial Segment Weight = W_e L sinα = 12,463 lb

Pulling Load on Exit Sag Bend = 103,836 lb

Total Pulling Load = 111,787 lb

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L = 100.1 ft

Effective Weight, W_e = W + W_b - W_m = -355.4 lb/ft

Frictional Drag = W_e L μ = 10,670 lb

Fluidic Drag = 12 π D L C_d = 3,395 lb

Axial Segment Weight = W_e L sinα = 0 lb

Pulling Load on Bottom Tangent = 14,065 lb

Total Pulling Load = 125,852 lb

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	167,486	lb
Segment Angle with Horizontal, θ =	8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft

h = R [1 - cos(α/2)] = 8.77 ft

j = [(E I) / T]$^{1/2}$ = 1,486

Y = [18 (L_s^2) - [(j^2 (1 - cosh(U/2)$^{-1}$)] = 2.9E+06

X = (3 L) - [(j / 2) tanh(U/2)] = 790.13

U = (12 L) / j = 4.06

N = [(T h) - W_e cosθ (Y/144)] / (X / 12) = 131,128 lb

Bending Frictional Drag = 2 μ N = 78,677 lb

Fluidic Drag = 12 π D L C_d = 17,055 lb

Axial Segment Weight = W_e L sinθ = -12,463 lb

Negative value indicates axial weight applied in direction of installation

Pulling Load on Entry Sag Bend = 83,269 lb

Total Pulling Load = 209,121 lb

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	34.5	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	8.0	°			

Frictional Drag = W_e L μ cosθ = 3,646 lb

Fluidic Drag = 12 π D L C_d = 1,171 lb

Axial Segment Weight = W_e L sinθ = -1,708 lb

Negative value indicates axial weight applied in direction of installation

Pulling Load on Entry Tangent = 3,109 lb

Total Pulling Load = 212,230 lb

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	2,586	ok	0	ok	0	ok	0.04	ok	0.00	ok
	2,548	ok	0	ok	73	ok	0.04	ok	0.00	ok
PC	2,548	ok	12,083	ok	73	ok	0.31	ok	0.07	ok
	1,533	ok	12,083	ok	603	ok	0.29	ok	0.08	ok
PT	1,533	ok	0	ok	603	ok	0.02	ok	0.01	ok
	1,362	ok	0	ok	603	ok	0.02	ok	0.01	ok
PC	1,362	ok	12,083	ok	603	ok	0.29	ok	0.07	ok
	97	ok	12,083	ok	73	ok	0.27	ok	0.05	ok
PT	97	ok	0	ok	73	ok	0.00	ok	0.00	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 4: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	486.0	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	51,315	lb			
Fluidic Drag = 12 π D L C_d =	16,488	lb			
Axial Segment Weight = W_e L sinθ =	24,039	lb			
Pulling Load on Exit Tangent =	**91,842**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	129,298	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1,691	
Y = [18 (L_s^2) - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	2.8E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	151.71	
U = (12 L) / j =	1.78		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	100,255	lb
Bending Frictional Drag = 2 μ N =	60,153	lb			
Fluidic Drag = 12 π D L C_d =	8,527	lb			
Axial Segment Weight = W_e L sinθ =	6,231	lb			
Pulling Load on Exit Sag Bend =	**74,912**	**lb**			
Total Pulling Load =	**166,754**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	46.0	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	4,908	lb			
Fluidic Drag = 12 π D L C_d =	1,562	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**6,470**	**lb**			
Total Pulling Load =	**173,224**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	206,318	lb
Segment Angle with Horizontal, θ =	8.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1,339	
Y = [18 (L_s^2) - [(j)^2 (1 - cosh(U/2)$^{-1}$] =	4.0E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	211.89	
U = (12 L) / j =	2.25		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	106,486	lb
Bending Frictional Drag = 2 μ N =	63,891	lb			
Fluidic Drag = 12 π D L C_d =	8,527	lb			
Axial Segment Weight = W_e L sinθ =	-6,231	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**66,187**	**lb**			
Total Pulling Load =	**239,411**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	340.0	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	35,905	lb			
Fluidic Drag = 12 π D L C_d =	11,537	lb			
Axial Segment Weight = W_e L sinθ =	-16,820	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**30,621**	**lb**			
Total Pulling Load =	**270,033**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	3,290	ok	0	ok	0	ok	0.05	ok	0.00	ok
	2,917	ok	0	ok	717	ok	0.05	ok	0.01	ok
PC	2,917	ok	24,167	ok	717	ok	0.58	ok	0.27	ok
	2,110	ok	24,167	ok	982	ok	0.56	ok	0.27	ok
PT	2,110	ok	0	ok	982	ok	0.03	ok	0.02	ok
	2,032	ok	0	ok	982	ok	0.03	ok	0.02	ok
PC	2,032	ok	24,167	ok	982	ok	0.56	ok	0.27	ok
	1,119	ok	24,167	ok	717	ok	0.55	ok	0.23	ok
PT	1,119	ok	0	ok	717	ok	0.02	ok	0.01	ok
Exit Point	0	ok	0	ok	-308	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

The risk of inadvertent drilling fluid returns due to hydrofracture was evaluated using the Delft Method described previously in Section 5 of the report. In summary, the risk of inadvertent drilling fluid returns due to hydrofracture is low over the majority of the length of the crossing, with the exception of the first and last 50 feet of the installation, near the entry and exit points. Therefore, under normal drilling operations, inadvertent drilling fluid returns due to hydrofracture are not anticipated. Refer to Figure 6 for results presented in graphical format

It is important to keep in mind that inadvertent drilling fluid returns may occur due to mechanisms unrelated to hydrofracture. It remains possible that inadvertent drilling fluid returns will occur by flowing to the ground surface through preexisting fractures or porous seams in the soil mass.

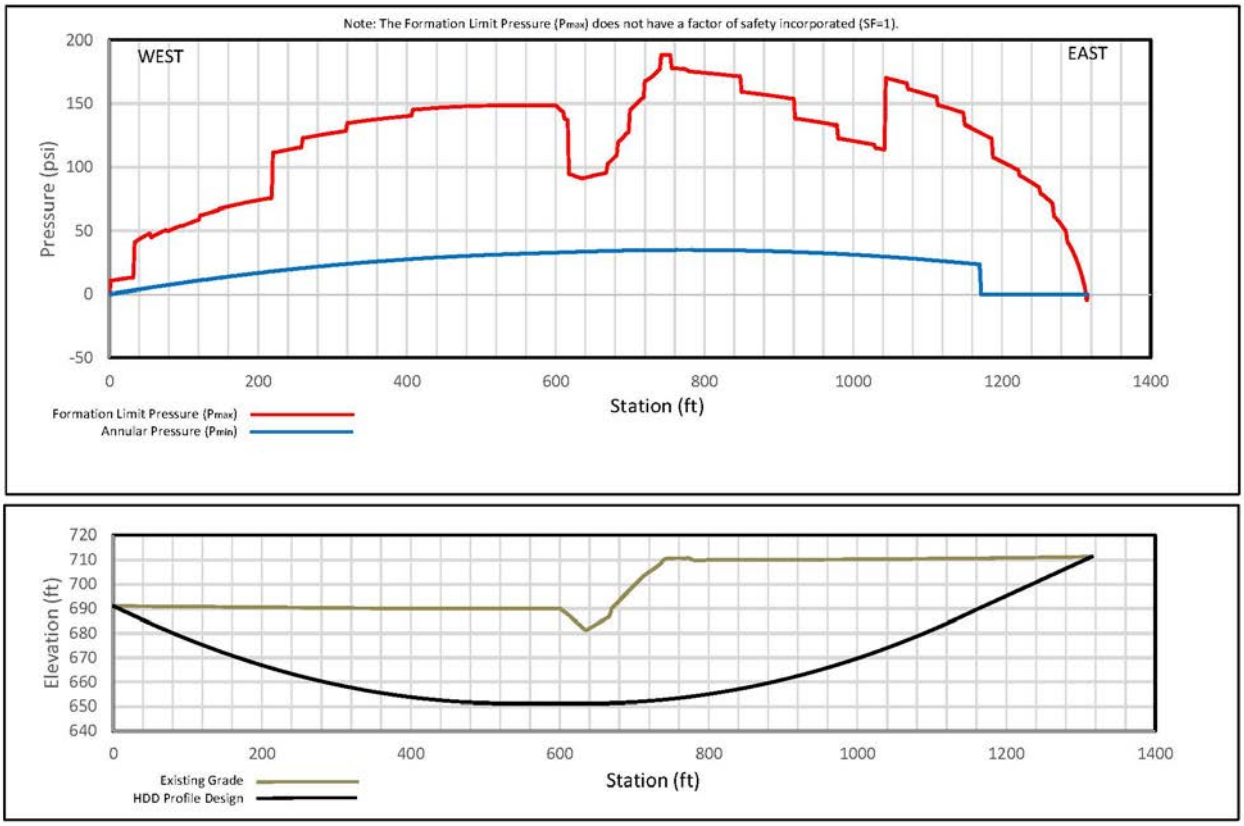


Figure 6: Hydrofracture Evaluation (Formation Limit Pressure –vs-Annular Pressure)

Construction Duration

The estimated duration of construction for the Saline River Crossing is 12 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated by JDH&A based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as past experience in similar subsurface conditions. Refer to Figure 7 for additional information relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments
Work Schedule, hours/shift =	12.0	36" Saline River Crossing
days/week =	7.0	
Drilled Length, feet =	1,320	
Pilot Hole		
Production Rate, feet/hour =	50	
shifts/day =	1	
Drilling Duration, hours =	26.4	
shifts =	2.2	
Trips to change tools, shifts =	0.5	
Pilot Hole Duration, days =	2.7	

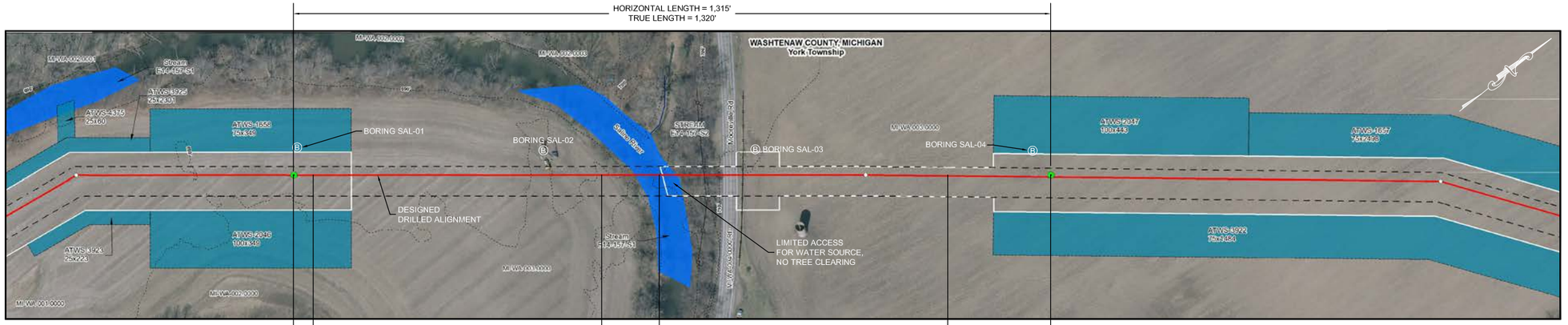
Ream and Pull Back								
Pass Description =	36-inch	48-inch				Swab	Pull Back	Total
Travel Speed, feet/minute =	2.0	2.0				8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0				15.0	15.0	
shifts/day =	1	1				1	1	
Reaming Duration, hours =	12.4	12.4				4.2	5.1	34.1
shifts =	1.0	1.0				0.3	0.4	2.8
Rig up, shifts =	0.5	0.5				0.5	0.5	2.0
Trips to change tools, shifts =	1.0	1.0				0.0		2.0
Pass Duration, days =	2.5	2.5				0.8	0.9	6.8

Summary	
HDD Duration at Site, days =	11.5

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 7: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN

SCALE: 1" = 100'

ENTRY POINT @ 8°
0+00.00, 691.05
N 15300350.01, E 906066.89

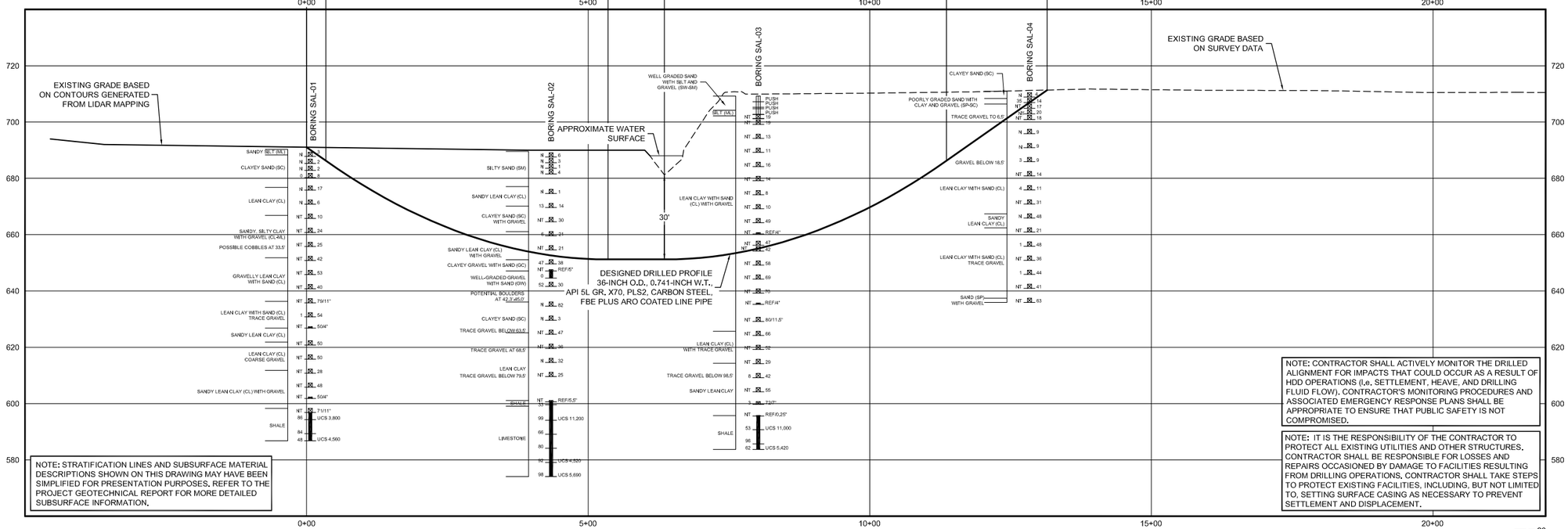
P.C. 8° SAG BEND
0+34.21, 686.24
RADIUS = 3,600'

P.T. 8° SAG BEND
5+35.23, 651.21

P.C. 8° SAG BEND
6+35.23, 651.21
RADIUS = 3,600'

P.T. 8° SAG BEND
11+36.25, 686.24

EXIT POINT @ 8°
13+15.00, 711.36
N 15301378.37, E 906886.46



NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (I.e, SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

PROFILE

SCALE: 1" = 100' HORIZONTAL
1" = 20' VERTICAL

250 200 150 100 50 0
20 10 0

ALIGNMENT LEGEND

- PIPELINE MILEPOST (M 0.0 P)
- PIPELINE
- INTERCONNECTING PIPELINE
- CONSTRUCTION LIMIT
- STUDY CORRIDOR
- STAGING AREA
- WAREYARD
- PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- METERING & REGULATION STATION (M&R)
- COMPRESSOR STATION SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE
- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- APPROXIMATE WETLAND BOUNDARY
- APPROXIMATE WATERBODY BANK
- APPROXIMATE WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD (PAR-0.0)
- TEMPORARY ACCESS ROAD (TAR-0.0)
- PARCEL TRACT NO (CH-CO-011.0000-SC)
- PROPERTY LINE
- CONTOUR (---120'---)
- MUNICIPALITY LINE
- FENCE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- TELEPHONE
- TEE TAP
- BLOW OFF VALVE
- TOWER
- HORIZONTAL DIRECTIONAL DRILLING
- TANK
- WELL: GAS WATER OIL UNKNOWN
- UTILITY LINES
- MAINLINE VALVE (MLV)
- MICROWAVE TOWER
- LIGHT POLE
- FIRE HYDRANT

GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

Ⓑ BORING LOCATION

SPLIT SPOON SAMPLE

53 / 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE

UCS 6,250 — UNCONFINED COMPRESSIVE STRESSTH (PSI)
TSS 1,350 — TENSILE SPLITTING STRENGTH (PSI)
53 / 6 — MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA. REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.

2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.

3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW, HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
WATE–A–1260	ALIGNMENT SHEET M.P. 237.66 TO M.P. 238.60				
WATE–A–1259	ALIGNMENT SHEET M.P. 236.71 TO M.P. 237.66	0	LKB	JMS	ISSUED FOR FERC

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	DMP	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	DMP	08/07		
DESIGN CHECKER	ACM	08/07		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH SALINE RIVER CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING

WASHTENAW COUNTY, MICHIGAN

NEXUS SM GAS TRANSMISSION

M.P. 237.4	W.O.	SCALE: AS SHOWN	DWG. WATE–H–1015	REV. 0

MP 250.7 Hydro Park Crossing

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- LiDAR and survey data covering the proposed crossing location
- Draft geotechnical data report prepared by Fugro Consultants, Inc. "Geotechnical Data Report, Hydro Park Ford River HDD Crossing, Nexus Gas Transmission Project, Washtenaw County Michigan" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The 36-inch Hydro Park Crossing is located near pipeline Mile Post 250.7 just south of Ypsilanti, Michigan. The primary obstacles that will be crossed are a meandering river just downstream of Ford Lake Dam, as well as Bridge Road. The river is approximately 175 feet wide at the crossing location and about 5 feet deep. Both sides of the crossing are wooded. The proposed HDD alignment crosses perpendicularly to Bridge Road, extends across the river cut-bank, and onto the point bar within South Hydro Park. An overview of the proposed crossing location is provided in Figure 1. Additional site photos taken during the reconnaissance are provided in Figures 2 and 3.

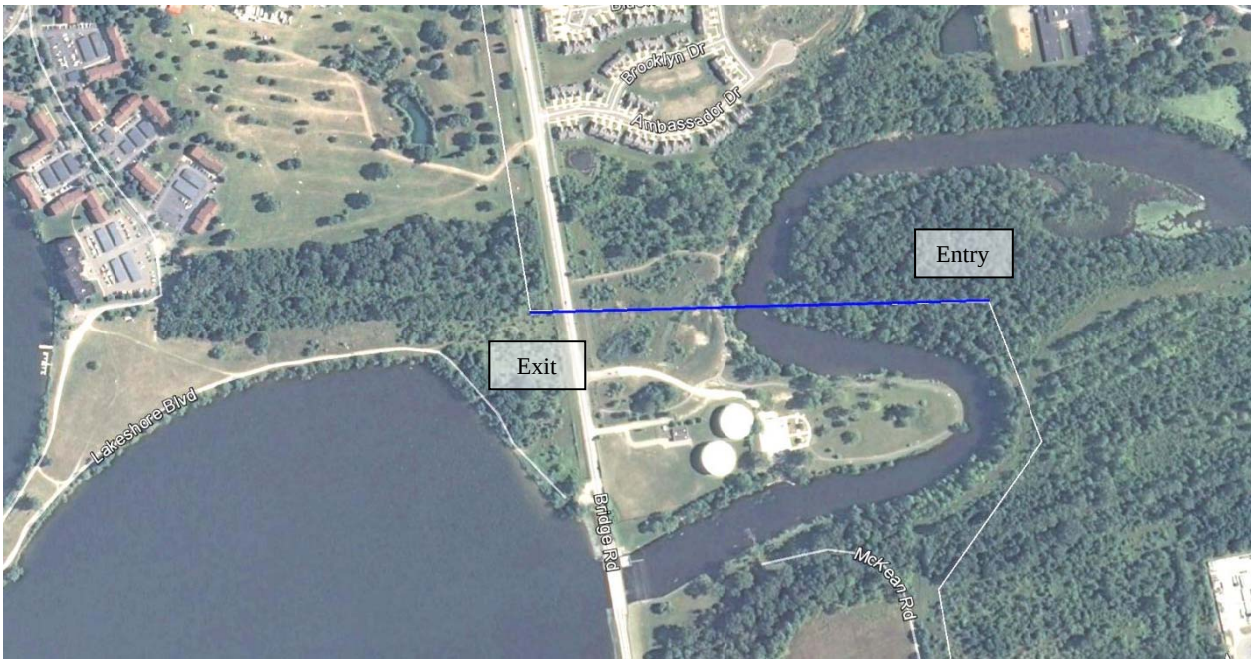


Figure 1: Overview of the Hydro Park Crossing

Figure 2: View looking east from approximate exit point

Figure 3: View looking south at water body from approximately 150 feet south of entry point

Subsurface Conditions

Four geotechnical borings were drilled at the proposed crossing site as part of the site investigation conducted by Fugro Consultants, Inc. Boring HYD-01, taken near the proposed entry point on the east side of the crossing, encountered layers of silty sand, lean clay with sand, sandy lean clay, sand with clay, and gravel with clay, overlying dolomite and shale bedrock. Top of bedrock was at approximately 99 feet below the ground surface. Grain size curves indicate gravel content as high as 71 percent. Boring HYD-02, taken approximately 610 feet south of the HDD alignment, was drilled to a depth of 79 feet and encountered mixtures of sandy lean clay, silty sand, clayey gravel, sand, with silt and gravel, gravel with silt and gravel with sand. A possible cobble was noted at about 65 feet. Grain size curves indicate gravel as high as 73 percent. Bedrock was not encountered in Boring HYD-02. Boring HYD-03 was located on the west side of the crossing, approximately 400 feet west of Bridge Road. Conditions encountered were consistent with the other borings. Top of bedrock occurred at a depth of 103 feet. Grain size curves indicate up to 41 percent gravel. Boring HYD-04, taken near the proposed HDD exit point, also encountered mixtures of clay, silt, sand, and gravel, but with less gravel after about 35 feet. Grain size curves indicate a gravel content of 72 percent at a depth of about 19 feet.

Design Geometry & Layout

The proposed crossing design involves a horizontal length of 2,280 feet. It utilizes 10-degree entry and exit angles, and a radius of curvature of 3,600 feet. The crossing design is based on obtaining a minimum of 30 feet of cover beneath the slope on the east end of the crossing, 30 feet of cover at the centerline of Bridge Road, and 40 feet of cover beneath the river. Note that the depth of cover beneath Bridge Road was dictated by the location of the pipeline centerline point of intersection (P.I.). It is envisioned that the P.I. may be shifted sometime prior to construction so that the HDD exit point can be optimized to gain 40 feet of cover beneath Bridge Road.

Due to workspace considerations, the exit point is located on the west side of the crossing to take advantage of open space parallel to Lakeshore Boulevard for pull section fabrication. The entry point is located on the east side of the crossing.

A copy of the preliminary HDD plan and profile drawing is included at the end of this report.

Assessment of Feasibility

Although the feasibility of the Hydro Park crossing cannot be ruled out, adverse subsurface conditions in the form of coarse granular material are present. Passing through significant coarse granular material (gravel) will increase the risk of HDD operational problems.

Risk Identification and Assessment

Notable risks at this location include damage to Bridge Road in the form of heaving or settlement, as well as drilling fluid surfacing with the water body.

The overall risk of constructional operational problems and delays is considered high due to an abundance of coarse granular material over the duration of the crossing.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse-case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 383,375 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 407,188 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 4. Detailed calculations for each installation loading scenario are summarized in Figures 5 and 6.

Line Pipe Properties		
Pipe Outside Diameter =	36.000 in	
Wall Thickness =	0.741 in	
Specified Minimum Yield Strength =	70,000 psi	
Young's Modulus =	2.9E+07 psi	
Moment of Inertia =	12755.22 in^4	
Pipe Face Surface Area =	82.08 in^2	
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06 in/in/°F	
Pipe Weight in Air =	279.04 lb/ft	
Pipe Interior Volume =	6.50 ft^3/ft	
Pipe Exterior Volume =	7.07 ft^3/ft	
HDD Installation Properties		
Drilling Mud Density =	12.0 ppg	
=	89.8 lb/ft^3	
Ballast Density =	62.4 lb/ft^3	
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025 psi	
Ballast Weight =	405.51 lb/ft	
Displaced Mud Weight =	634.48 lb/ft	

Figure 4: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	179.2	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	18,818	lb			
Fluidic Drag = 12 π D L C_d =	6,080	lb			
Axial Segment Weight = W_e L sinθ =	11,061	lb			
Pulling Load on Exit Tangent =	**35,959**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	102,344	lb
Segment Angle with Horizontal, θ =	-10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	1,901	
Y = [18 $(L)^2$] - [(j^2 (1 - cosh(U/2)$^{-1}$] =	4.5E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	969.75	
U = (12 L) / j =	3.97		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	153,313	lb
Bending Frictional Drag = 2 μ N =	91,988	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	19,464	lb			
Pulling Load on Exit Sag Bend =	**132,770**	**lb**			
Total Pulling Load =	**168,729**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	699.9	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	74,634	lb			
Fluidic Drag = 12 π D L C_d =	23,748	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**98,382**	**lb**			
Total Pulling Load =	**267,111**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	319,242	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	1,076	
Y = [18 $(L)^2$] - [(j^2 (1 - cosh(U/2)$^{-1}$] =	6.0E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1347.72	
U = (12 L) / j =	7.00		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	170,682	lb
Bending Frictional Drag = 2 μ N =	102,409	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	-19,464	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**104,263**	**lb**			
Total Pulling Load =	**371,374**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	155.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	16,321	lb			
Fluidic Drag = 12 π D L C_d =	5,273	lb			
Axial Segment Weight = W_e L sinθ =	-9,593	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**12,001**	**lb**			
Total Pulling Load =	**383,375**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	4,671	ok	0	ok	0	ok	0.07	ok	0.01	ok
	4,525	ok	0	ok	395	ok	0.07	ok	0.01	ok
PC	4,525	ok	12,083	ok	395	ok	0.34	ok	0.10	ok
	3,254	ok	12,083	ok	1224	ok	0.32	ok	0.12	ok
PT	3,254	ok	0	ok	1224	ok	0.05	ok	0.04	ok
	2,056	ok	0	ok	1224	ok	0.03	ok	0.03	ok
PC	2,056	ok	12,083	ok	1224	ok	0.30	ok	0.11	ok
	438	ok	12,083	ok	395	ok	0.27	ok	0.06	ok
PT	438	ok	0	ok	395	ok	0.01	ok	0.00	ok
Exit Point	0	ok	0	ok	-76	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	480.6	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	50,474	lb			
Fluidic Drag = 12 π D L C_d =	16,308	lb			
Axial Segment Weight = W_e L sinθ =	29,666	lb			
Pulling Load on Exit Tangent =	**96,449**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	139,862	lb
Segment Angle with Horizontal, θ =	-10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,626	
Y = [18 $(L)^2$] - [(j / 2) $(1 - \cosh(U/2)^{-1})^2$ =	6.4E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	275.11	
U = (12 L) / j =	2.32		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	110,726	lb
Bending Frictional Drag = 2 μ N =	66,435	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	9,732	lb			
Pulling Load on Exit Sag Bend =	**86,827**	**lb**			
Total Pulling Load =	**183,275**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	781.3	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	83,313	lb			
Fluidic Drag = 12 π D L C_d =	26,509	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**109,823**	**lb**			
Total Pulling Load =	**293,098**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	332,503	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,055	
Y = [18 $(L)^2$] - [(j / 2) $(1 - \cosh(U/2)^{-1})^2$ =	1.0E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	443.87	
U = (12 L) / j =	3.57		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	129,806	lb
Bending Frictional Drag = 2 μ N =	77,884	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**78,811**	**lb**			
Total Pulling Load =	**371,909**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	456.9	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	47,977	lb			
Fluidic Drag = 12 π D L C_d =	15,501	lb			
Axial Segment Weight = W_e L sinθ =	-28,199	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**35,279**	**lb**			
Total Pulling Load =	**407,188**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	4,961	ok	0	ok	0	ok	0.08	ok	0.01	ok
	4,531	ok	0	ok	1188	ok	0.07	ok	0.04	ok
PC	4,531	ok	24,167	ok	1188	ok	0.60	ok	0.33	ok
	3,571	ok	24,167	ok	1602	ok	0.59	ok	0.34	ok
PT	3,571	ok	0	ok	1602	ok	0.06	ok	0.06	ok
	2,233	ok	0	ok	1602	ok	0.04	ok	0.05	ok
PC	2,233	ok	24,167	ok	1602	ok	0.56	ok	0.32	ok
	1,175	ok	24,167	ok	1188	ok	0.55	ok	0.27	ok
PT	1,175	ok	0	ok	1188	ok	0.02	ok	0.03	ok
Exit Point	0	ok	0	ok	-76	ok	0.00	ok	0.00	ok

Figure 6: Installation Loading and Stress Analysis (Worse-Case)

Hydrofracture Evaluation

The risk of inadvertent drilling fluid returns due to hydrofracture was reviewed using the Delft Method. The Delft Method is described in Section 5 of the report. In summary, under normal drilling operations, the risk of inadvertent drilling fluid returns due to hydrofracture is low over the majority of the length of the crossing with the exception of the last 60 feet of the drill where cover is shallow as the bit begins to make its way to the surface. The factor of safety remains above 2.0 until station 22+12 indicating a low risk of hydrofracture. After station 22+12, the factor of safety begins dropping until reaching 1.0 at station 22+22, approximately 58 feet from the exit point, indicating an increased risk inadvertent drilling fluid returns. Inadvertent drilling fluid returns due to hydrofracture near the exit point, where cover is shallow, is a common occurrence in the HDD industry during pilot hole drilling. These returns typically occur within the project right-of-way and are easily contained and collected. Refer to Figure 7 for results presented in graphical format.

It is important to keep in mind that inadvertent drilling fluid returns may occur due to mechanisms unrelated to hydrofracture. It remains possible that inadvertent drilling fluid returns will occur by flowing to the ground surface through preexisting fractures or porous seams in the soil mass.

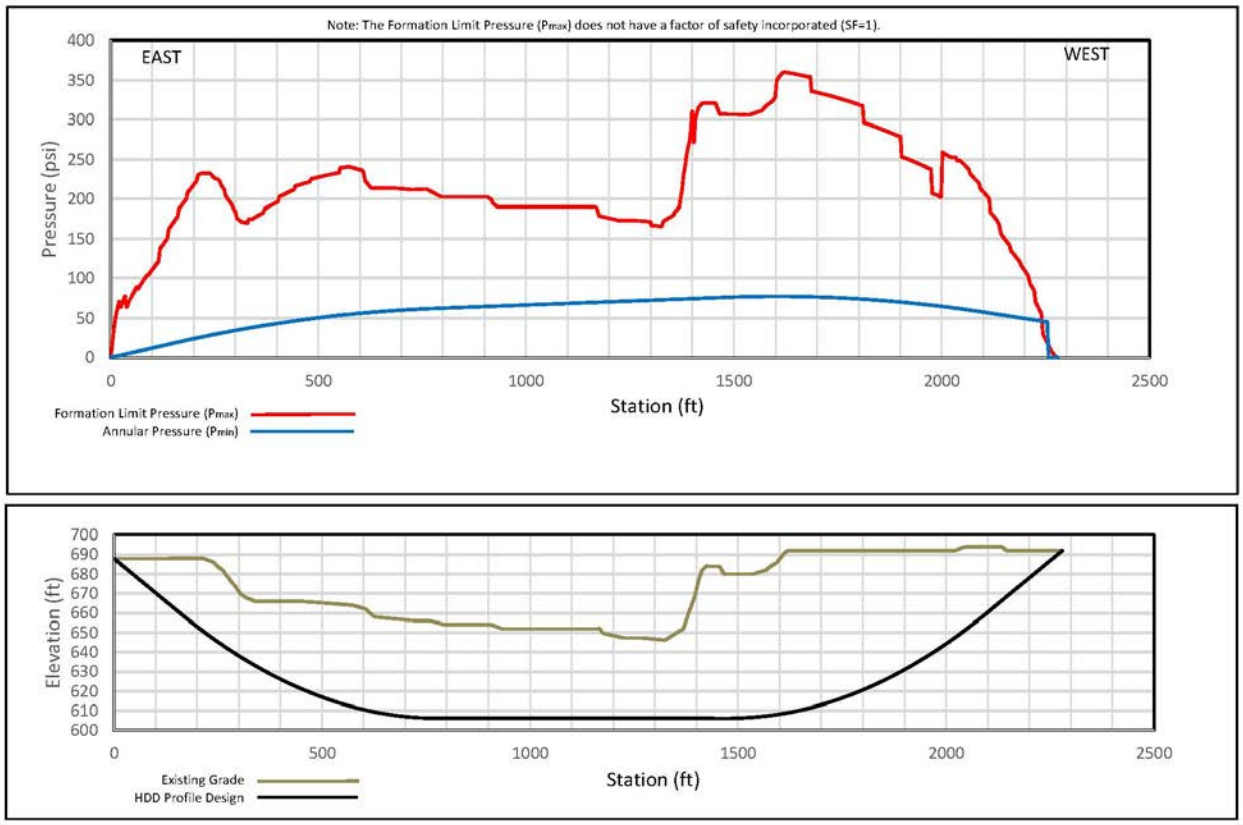


Figure 7: Hydrofracture Evaluation (Formation Limit Pressure –vs-Annular Pressure)

Construction Duration

The estimated duration of construction for the proposed crossing is 26 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated by JDH&A based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as past experience in similar subsurface conditions. Refer to Figure 8 for additional information relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments
Work Schedule, hours/shift =	12.0	36" Hydro Park Crossing
days/week =	7.0	
Drilled Length, feet =	2,291	
Pilot Hole		
Production Rate, feet/hour =	30	
shifts/day =	1	
Drilling Duration, hours =	76.4	
shifts =	6.4	
Trips to change tools, shifts =	0.5	
Pilot Hole Duration, days =	6.9	

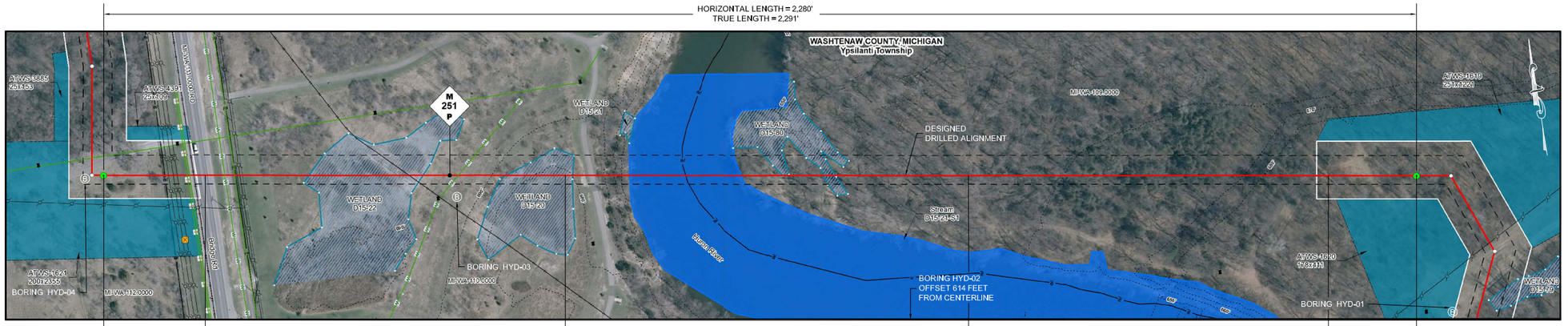
Ream and Pull Back								
Pass Description =	24-inch	36-inch	48-inch			Swab	Pull Back	Total
Travel Speed, feet/minute =	1.0	1.0	1.0			8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0	15.0			15.0	15.0	
shifts/day =	1	1	1			1	1	
Reaming Duration, hours =	40.6	40.6	40.6			7.2	8.8	138.0
shifts =	3.4	3.4	3.4			0.6	0.7	11.5
Rig up, shifts =	0.5	0.5	0.5			0.5	0.5	2.5
Trips to change tools, shifts =	1.0	1.0	1.0			0.0		3.0
Pass Duration, days =	4.9	4.9	4.9			1.1	1.2	17.0

Summary	
HDD Duration at Site, days =	25.9

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 8: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN

SCALE: 1" = 100'

EXIT POINT @ 10°
22+79.72, 692.00
N 15341864.26, E 947526.93

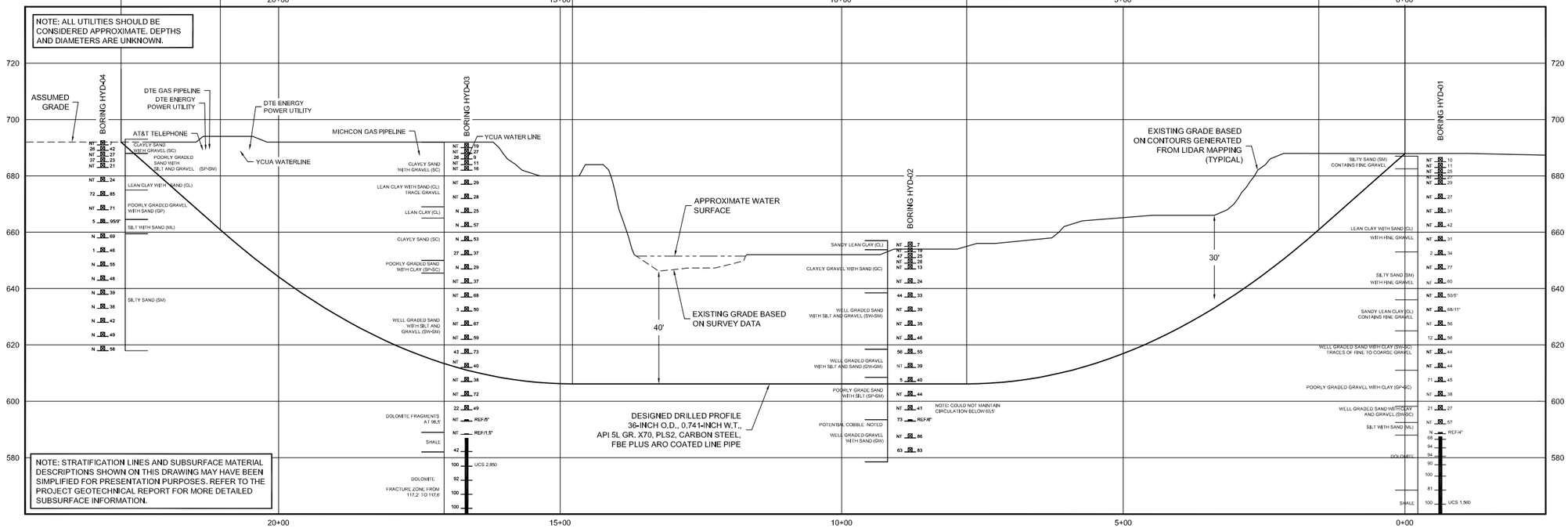
P.T. 10° SAG BEND
21+03.24, 660.88

P.C. 10° SAG BEND
14+78.11, 606.19
RADIUS = 3,600'

P.T. 10° SAG BEND
7+78.18, 606.19

P.C. 10° SAG BEND
1+53.05, 660.88
RADIUS = 3,600'

ENTRY POINT @ 10°
0+00.00, 687.87
N 15341505.54, E 949778.25



NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PIPELINE
- INTERCONNECTING PIPELINE
- CONSTRUCTION LIMIT
- STUDY CORRIDOR
- STAGING AREA
- WAREYARD
- PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- METERING & REGULATION STATION (M&R)
- COMPRESSOR STATION SITE
- FACILITIES TEMPORARY WORKSPACE
- FACILITIES PERMANENT WORKSPACE

- DELINEATED WETLAND BOUNDARY
- DELINEATED WATERBODY BANK
- DELINEATED WATERBODY CENTERLINE
- APPROXIMATE WETLAND BOUNDARY
- APPROXIMATE WATERBODY BANK
- APPROXIMATE WATERBODY CENTERLINE
- PERMANENT ACCESS ROAD (PAR-0.0)
- TEMPORARY ACCESS ROAD (TAR-0.0)
- PARCEL TRACT NO (OH-CO-011.0000-SC)
- PROPERTY LINE
- CONTOUR
- MUNICIPALITY LINE

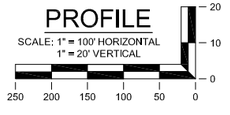
- FENCE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- TELEPHONE
- TEE TAP
- BLOW OFF VALVE
- TOWER
- HORIZONTAL DIRECTIONAL DRILLING
- TANK
- WELL: GAS, WATER, OIL
- UTILITY LINES
- MAINLINE VALVE (MLV)
- MICROWAVE TOWER
- LIGHT POLE
- FIRE HYDRANT
- UNKNOWN

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

PROFILE

SCALE: 1" = 100' HORIZONTAL
1" = 20' VERTICAL



GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR, SURVEY, AND HYDROGRAPHIC DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

Ⓑ BORING LOCATION

SPLIT SPOON SAMPLE

53 / 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE

UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
53 / 6 — MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA. REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.

2. THE LETTER "NT" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.

3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW. HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE.

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
WATE–A–1274	ALIGNMENT SHEET M.P. 250.89 TO M.P. 251.84				
WATE–A–1273	ALIGNMENT SHEET M.P. 249.49 TO M.P. 250.89	0	LKB	JMS	ISSUED FOR FERC

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	LKB	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	LKB	08/07		
DESIGN CHECKER	DLB	08/07		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH HYDRO PARK CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING

WASHTENAW COUNTY, MICHIGAN

NEXUS SM
GAS TRANSMISSION

M.P. 250.7	W.O.	SCALE: AS SHOWN	DWG. WATE–H–1016	REV. 0

MP 251.5 Interstate 94

Base Data

In performing the HDD design and engineering analysis presented in this report, we have relied upon the following information:

- A combination of LiDAR and traditional survey data covering the proposed crossing location
- Draft geotechnical data report prepared by Fugro Consultants, Inc. titled "Geotechnical Data Report, Interstate 94 HDD Crossing, Nexus Gas Transmission Project, Washtenaw County Michigan" and dated September 11, 2015
- A reconnaissance of the proposed crossing location conducted in July of 2015 by a representative of JDH&A

General Site Description

The 36-inch Interstate 94 Crossing is located in Rawsonville, Michigan. It involves passing beneath the eastbound and westbound lanes of Interstate 94, as well as the northbound and southbound lanes of the access roads (Ward Road and Lakeview Avenue). The proposed HDD alignment is located within an existing power line easement, which also contains an existing water line and an existing gas pipeline. An overview of the proposed crossing location is provided in Figures 1 through 3.

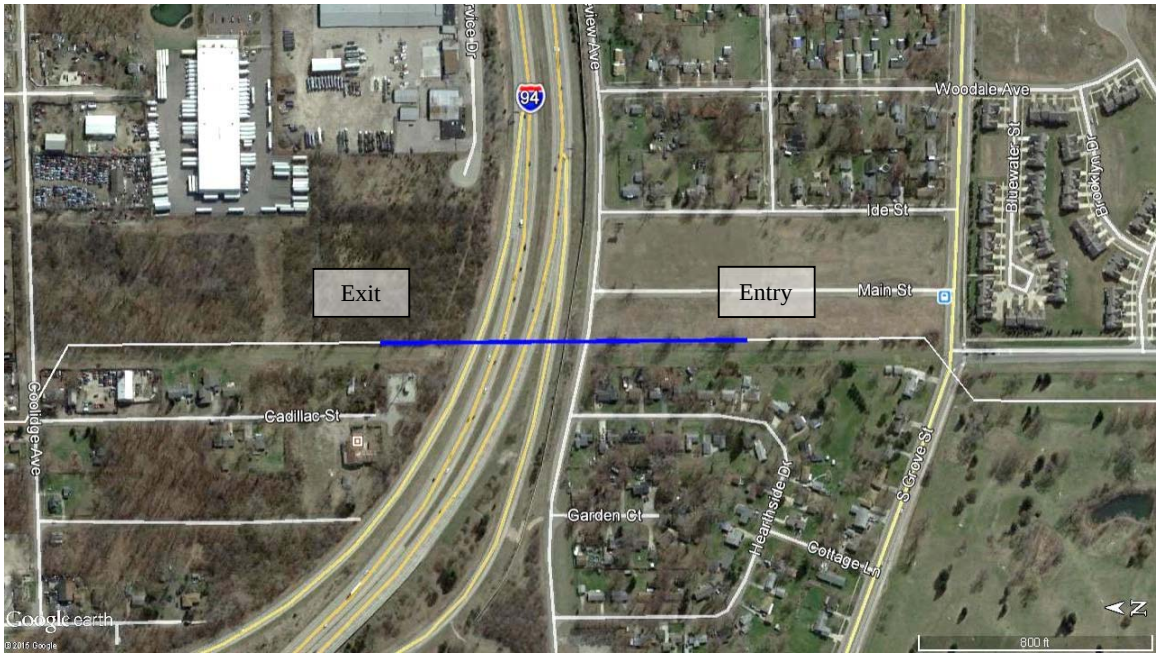


Figure 1 – Overview of the Interstate 94 Crossing

Figure 2: View looking west toward entry location

Figure 3: View looking east along power line ROW toward exit point

Subsurface Conditions

Four geotechnical borings were taken as part of the site investigation conducted by Fugro Consultants, Inc. Two of the borings were taken on the north side of the interstate and two of the borings were taken on the south side of the interstate. The borings generally encountered sand with some gravel to depths of approximately 15 to 20 feet below the ground surface, overlying mixtures of lean clay and sand to the termination depths of the borings.

Refer to the report titled "Geotechnical Data Report, Interstate 94 HDD Crossing, Nexus Gas Transmission Project, Washtenaw County Michigan" and dated September 11, 2015, for additional information.

Design Geometry & Layout

The proposed Interstate 94 Crossing has a horizontal length of 1,359 feet. It has been designed to achieve a minimum of 40 feet of cover beneath Interstate 94 and the associated access roads. The design employs a 10-degree entry angle, an 8-degree exit angle, and a radius of curvature equal to 3,600 feet. The exit point is located on the north side of the interstate to take advantage of greater available workspace for pull section fabrication. The exit point on the north side of the crossing was positioned to be as far south as possible while still maintaining adequate cover beneath the access road. This provides the HDD contractor with approximately 1,000 feet of workspace for pull section fabrication. A copy of the proposed HDD design for Interstate 94 is included at the end of this section.

Workspace on both sides of the crossing runs along the existing power line easement and extends from just east of the existing gas pipeline for a distance of approximately 180 feet, providing ample working area for HDD rig side and pipe side activities. The power line easement crosses a residential street to the north approximately 1,150 feet from the point of exit. Therefore, the 36-inch pull section segment will have to be fabricated in two segments and welded during pullback.

The proposed HDD design, as well as available workspace for HDD operations, is shown on the HDD plan and profile drawing included in this site-specific report.

Assessment of Feasibility

Based on a review of available geotechnical information, subsurface conditions are conducive to the HDD process. Given the length, the proposed 36-inch diameter Interstate 94 Crossing is feasible.

Risk Identification and Assessment

Notable risks and potential construction impact associated with installation by HDD include impact to Interstate 94, Ward Road, and Lakeview Avenue in the form of heave, settlement, or inadvertent drilling fluid returns. In addition, because the crossing involves a tie-in weld during pullback, there is a chance the pull section could become silted or sanded in place while down for the weld, making it difficult to get the pipe moving again.

Overall, the level of risk associated with the proposed Interstate 94 Crossing is considered low.

Installation Loading Analysis

Two installation scenarios were evaluated for the proposed crossing. The first scenario assumed the pilot hole would be drilled to the exact design centerline shown on the plan and profile drawing. The second scenario assumed a worse case model in which the pilot hole is drilled 25 feet deeper than the design profile with a radius of curvature reduced to 50 percent of the design radius. A summary of the assumptions used in each loading scenario is provided in Table 1.

Table 1: Loading Scenarios

Loading Scenario	Path Geometry	Drilling Fluid Weight	Buoyancy Condition	Above Ground Load
Number 1 As-Designed	Length: As designed Depth: As designed Radius: 3,600’	12 ppg	Empty	Assumed Negligible
Number 2 Worse-Case	Length: Increased by 50’ Depth: Increased by 25’ Radius: 1,800’	12 ppg	Empty	Assumed Negligible

Based on the loading scenarios described above, the estimated pulling load for the “as-designed” crossing, without ballast, is 242,597 pounds. In the “worse-case” installation scenario, the anticipated pulling load without ballast is 268,806 pounds. In both cases, loads and stresses fall within acceptable limits as defined by the PRCI method. Pipe parameters and other installation properties are provided in Figure 4. Detailed calculations for each scenario are summarized in Figures 5 and 6.

Line Pipe Properties		
Pipe Outside Diameter =	36.000	in
Wall Thickness =	0.741	in
Specified Minimum Yield Strength =	70,000	psi
Young's Modulus =	2.9E+07	psi
Moment of Inertia =	12755.22	in^4
Pipe Face Surface Area =	82.08	in^2
Diameter to Wall Thickness Ratio, D/t =	49	
Poisson's Ratio =	0.3	
Coefficient of Thermal Expansion =	6.5E-06	in/in/°F
Pipe Weight in Air =	279.04	lb/ft
Pipe Interior Volume =	6.50	ft^3/ft
Pipe Exterior Volume =	7.07	ft^3/ft
HDD Installation Properties		
Drilling Mud Density =	12.0	ppg
=	89.8	lb/ft^3
Ballast Density =	62.4	lb/ft^3
Coefficient of Soil Friction =	0.30	
Fluid Drag Coefficient =	0.025	psi
Ballast Weight =	405.51	lb/ft
Displaced Mud Weight =	634.48	lb/ft

Figure 4: Pipe and Installation Properties

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	176.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	18,631	lb			
Fluidic Drag = 12 π D L C_d =	5,986	lb			
Axial Segment Weight = W_e L sinθ =	8,728	lb			
Pulling Load on Exit Tangent =	**33,345**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	502.7	ft	Average Tension, T =	85,783	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	8.77	ft	j = [(E I) / T]$^{1/2}$ =	2,077	
Y = [18 $(L)^2$] - [(j / 2) tanh(U/2)] =	2.1E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	577.50	
U = (12 L) / j =	2.90		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	125,597	lb
Bending Frictional Drag = 2 μ N =	75,358	lb			
Fluidic Drag = 12 π D L C_d =	17,055	lb			
Axial Segment Weight = W_e L sinθ =	12,463	lb			
Pulling Load on Exit Sag Bend =	**104,876**	**lb**			
Total Pulling Load =	**138,221**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	29.1	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	3,104	lb			
Fluidic Drag = 12 π D L C_d =	988	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**4,092**	**lb**			
Total Pulling Load =	**142,313**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	628.3	ft	Average Tension, T =	191,315	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	3,600	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	13.70	ft	j = [(E I) / T]$^{1/2}$ =	1,390	
Y = [18 $(L)^2$] - [(j / 2) tanh(U/2)$^{-1}$] =	5.4E+06		X = (3 L) - [(j / 2) tanh(U/2)] =	1195.82	
U = (12 L) / j =	5.42		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	160,250	lb
Bending Frictional Drag = 2 μ N =	96,150	lb			
Fluidic Drag = 12 π D L C_d =	21,318	lb			
Axial Segment Weight = W_e L sinθ =	-19,464	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**98,004**	**lb**			
Total Pulling Load =	**240,317**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	29.5	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	3,101	lb			
Fluidic Drag = 12 π D L C_d =	1,002	lb			
Axial Segment Weight = W_e L sinθ =	-1,823	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**2,280**	**lb**			
Total Pulling Load =	**242,597**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

	Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point	2,956	ok	0	ok	0	ok	0.05	ok	0.00	ok
	2,928	ok	0	ok	74	ok	0.05	ok	0.00	ok
PC	2,928	ok	12,083	ok	74	ok	0.31	ok	0.07	ok
	1,734	ok	12,083	ok	902	ok	0.29	ok	0.09	ok
PT	1,734	ok	0	ok	902	ok	0.03	ok	0.02	ok
	1,684	ok	0	ok	902	ok	0.03	ok	0.02	ok
PC	1,684	ok	12,083	ok	902	ok	0.29	ok	0.09	ok
	406	ok	12,083	ok	372	ok	0.27	ok	0.06	ok
PT	406	ok	0	ok	372	ok	0.01	ok	0.00	ok
Exit Point	0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 5: Installation Loading and Stress Analysis (As-Designed)

Pipe and Installation Properties

Pipe Diameter, D =	36.000	in	Fluid Drag Coefficient, C_d =	0.025	psi
Pipe Weight, W =	279.0	lb/ft	Ballast Weight / ft Pipe, W_b =	405.5	lb (If Ballasted)
Coefficient of Soil Friction, μ =	0.30		Drilling Mud Displaced / ft Pipe, W_m =	634.5	lb (If Submerged)
			Above Ground Load =	0	lb

Exit Tangent - Summary of Pulling Load Calculations

Segment Length, L =	480.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Exit Angle, θ =	8.0	°			
Frictional Drag = W_e L μ cosθ =	50,730	lb			
Fluidic Drag = 12 π D L C_d =	16,301	lb			
Axial Segment Weight = W_e L sinθ =	23,766	lb			
Pulling Load on Exit Tangent =	**90,797**	**lb**			

Exit Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	251.3	ft	Average Tension, T =	128,227	lb
Segment Angle with Horizontal, θ =	-8.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	-4.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	4.38	ft	j = [(E I) / T]$^{1/2}$ =	1,698	
Y = [18 $(L)^2$] - [(j / 2) tanh(U/2)] =	2.8E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	150.75	
U = (12 L) / j =	1.78		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	100,168	lb
Bending Frictional Drag = 2 μ N =	60,101	lb			
Fluidic Drag = 12 π D L C_d =	8,527	lb			
Axial Segment Weight = W_e L sinθ =	6,231	lb			
Pulling Load on Exit Sag Bend =	**74,860**	**lb**			
Total Pulling Load =	**165,656**	**lb**			

Bottom Tangent - Summary of Pulling Load Calculations

Segment Length, L =	43.8	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Frictional Drag = W_e L μ =	4,674	lb			
Fluidic Drag = 12 π D L C_d =	1,487	lb			
Axial Segment Weight = W_e L sinθ =	0	lb			
Pulling Load on Bottom Tangent =	**6,162**	**lb**			
Total Pulling Load =	**171,818**	**lb**			

Entry Sag Bend - Summary of Pulling Load Calculations

Segment Length, L =	314.2	ft	Average Tension, T =	207,515	lb
Segment Angle with Horizontal, θ =	10.0	°	Radius of Curvature, R =	1,800	ft
Deflection Angle, α =	5.0	°	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
h = R [1 - cos(α/2)] =	6.85	ft	j = [(E I) / T]$^{1/2}$ =	1,335	
Y = [18 $(L)^2$] - [(j)^2 (1 - cosh(U/2)$^{-1}$)] =	8.1E+05		X = (3 L) - [(j / 2) tanh(U/2)] =	349.77	
U = (12 L) / j =	2.82		N = [(T h) - W_e cosθ (Y/144)] / (X / 12) =	117,445	lb
Bending Frictional Drag = 2 μ N =	70,467	lb			
Fluidic Drag = 12 π D L C_d =	10,659	lb			
Axial Segment Weight = W_e L sinθ =	-9,732	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Sag Bend =	**71,394**	**lb**			
Total Pulling Load =	**243,212**	**lb**			

Entry Tangent - Summary of Pulling Load Calculations

Segment Length, L =	331.4	ft	Effective Weight, W_e = W + W_b - W_m =	-355.4	lb/ft
Entry Angle, θ =	10.0	°			
Frictional Drag = W_e L μ cosθ =	34,805	lb			
Fluidic Drag = 12 π D L C_d =	11,245	lb			
Axial Segment Weight = W_e L sinθ =	-20,457	lb	Negative value indicates axial weight applied in direction of installation		
Pulling Load on Entry Tangent =	**25,594**	**lb**			
Total Pulling Load =	**268,806**	**lb**			

Summary of Calculated Stress vs. Allowable Stress

		Tensile Stress		Bending Stress		External Hoop Stress		Combined Tensile & Bending		Combined Tensile, Bending & Ext. Hoop	
Entry Point		3,275	ok	0	ok	0	ok	0.05	ok	0.00	ok
		2,963	ok	0	ok	864	ok	0.05	ok	0.02	ok
PC		2,963	ok	24,167	ok	864	ok	0.58	ok	0.28	ok
		2,093	ok	24,167	ok	1278	ok	0.56	ok	0.29	ok
PT		2,093	ok	0	ok	1278	ok	0.03	ok	0.03	ok
		2,018	ok	0	ok	1278	ok	0.03	ok	0.03	ok
PC		2,018	ok	24,167	ok	1278	ok	0.56	ok	0.29	ok
		1,106	ok	24,167	ok	1012	ok	0.55	ok	0.25	ok
PT		1,106	ok	0	ok	1012	ok	0.02	ok	0.02	ok
Exit Point		0	ok	0	ok	0	ok	0.00	ok	0.00	ok

Figure 6: Installation Loading (Worse-Case)

Hydrofracture Evaluation

The risk of inadvertent drilling fluid returns due to hydrofracture was evaluated using the Delft Method. The Delft Method is described in Section 5 of the report. In summary, the risk of inadvertent drilling fluid returns due to hydrofracture is low over the majority of the length of the crossing. The factor of safety remains above 2.0 until the last 60 feet of the crossing where cover is shallow as the bit begins to make its way to the surface. Therefore, inadvertent drilling fluid returns due to hydrofracture are not anticipated under normal drilling operations at this location. Refer to Figure 7 for results presented in graphical format.

It is important to keep in mind that inadvertent drilling fluid returns may occur due to mechanisms unrelated to hydrofracture. It remains possible that inadvertent drilling fluid returns will occur by flowing to the ground surface through preexisting fractures or porous seams in the soil mass.

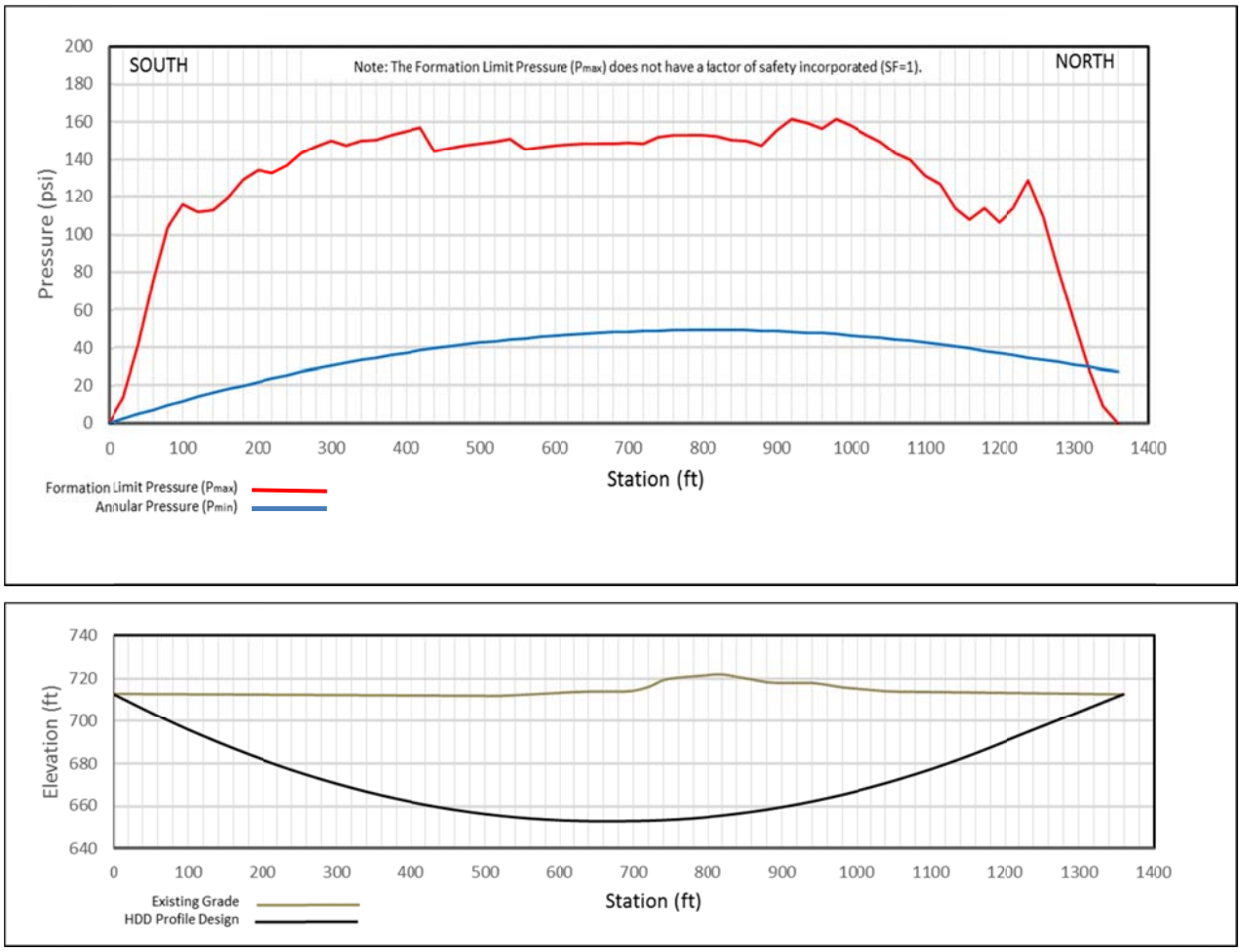


Figure 7: Hydrofracture Evaluation (Formation Limit Pressure - vs - Annular Pressure)

Construction Duration

The estimated duration of construction for the I-94 Crossing is 12 days. The estimate assumes single 12-hour shifts during pilot hole, reaming, and pullback operations. The pilot hole production rate and reaming travel speed were estimated by JDH&A based on information contained within the Pipeline Research Council International's "*Installation of Pipelines by Horizontal Directional Drilling*"[1], as well as past experience in similar subsurface conditions. Refer to Figure 8 for additional information relative to the estimate.

Please note that the estimated duration is based on operations proceeding according to plan and does not include contingency. The occurrence of unanticipated operational problems could increase the duration of operations by 50 to 100 percent.

General Data		Comments
Work Schedule, hours/shift =	12.0	36" Interstate 94 Crossing
days/week =	7.0	
Drilled Length, feet =	1,366	
Pilot Hole		
Production Rate, feet/hour =	50	
shifts/day =	1	
Drilling Duration, hours =	27.3	
shifts =	2.3	
Trips to change tools, shifts =	0.5	
Pilot Hole Duration, days =	2.8	

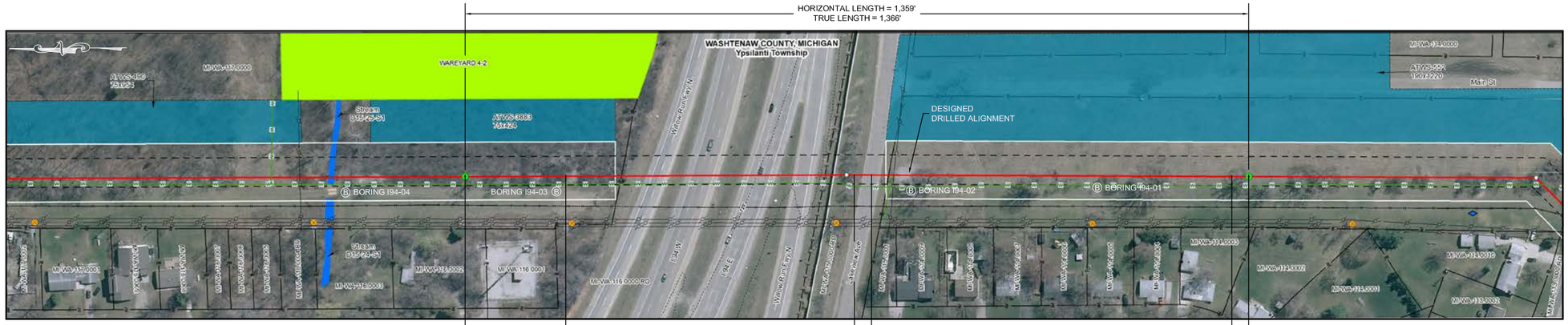
Ream and Pull Back								
Pass Description =	36-inch	48-inch				Swab	Pull Back	Total
Travel Speed, feet/minute =	2.0	2.0				8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0				15.0	15.0	
shifts/day =	1	1				1	1	
Reaming Duration, hours =	12.9	12.9				4.3	5.3	35.3
shifts =	1.1	1.1				0.4	0.4	2.9
Rig up, shifts =	0.5	0.5				0.5	0.5	2.0
Trips to change tools, shifts =	1.0	1.0				0.0		2.0
Pass Duration, days =	2.6	2.6				0.9	0.9	6.9

Summary	
HDD Duration at Site, days =	11.7

Site Establishment	Move in	Rig Up	Rig Down	Move Out
shifts/day =	1	1	1	1
shifts =	0.5	1.0	1.0	0.5
days =	0.5	1.0	1.0	0.5

Figure 8: Estimated Construction Duration

[1] *Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide*, prepared under the sponsorship of the Pipeline Research Committee at the American Gas Association, April 15, 1995, Revised under the sponsorship of the Pipeline Research Council International, Inc., 2008.



PLAN

SCALE: 1" = 100'

EXIT POINT @ 8°
13+59.07, 712.67
N 15345325.30, E 947790.22

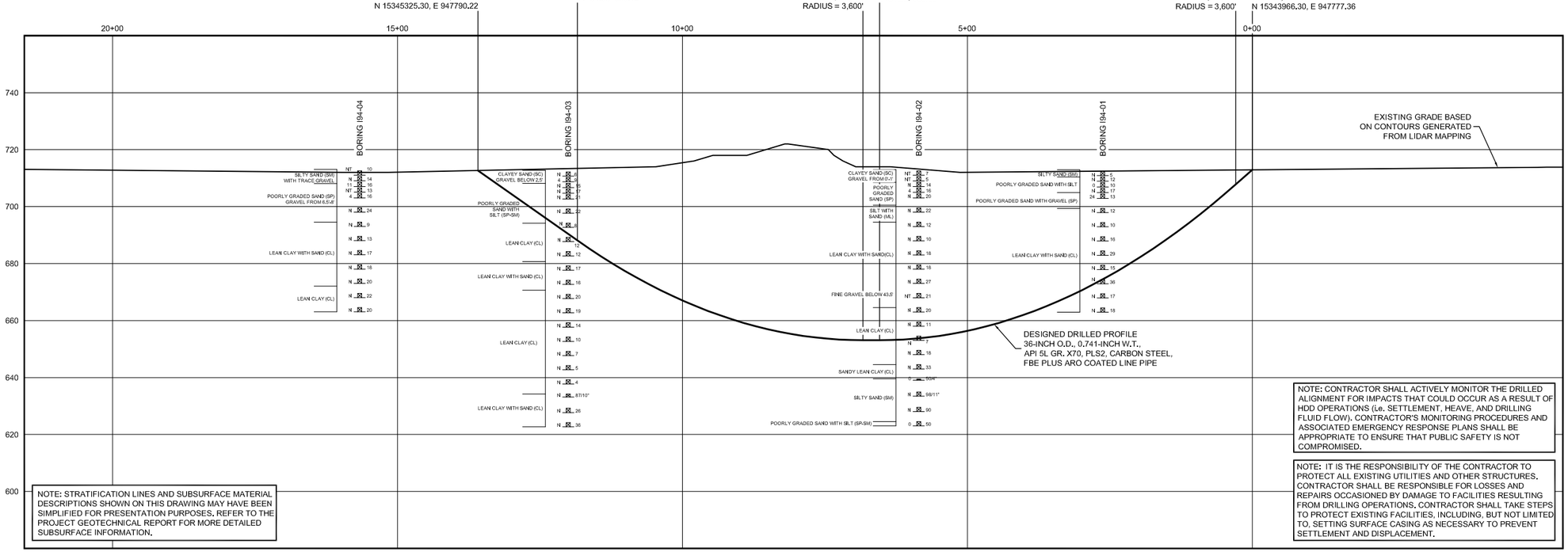
P.T. 8° SAG BEND
11+84.36, 688.12

P.C. 8° SAG BEND
6+83.34, 653.08
RADIUS = 3,600'

P.T. 10° SAG BEND
6+54.22, 653.08

P.C. 10° SAG BEND
0+29.09, 707.77
RADIUS = 3,600'

ENTRY POINT @ 10°
0+00.00, 712.90
N 15343966.30, E 947777.36



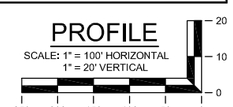
NOTE: STRATIFICATION LINES AND SUBSURFACE MATERIAL DESCRIPTIONS SHOWN ON THIS DRAWING MAY HAVE BEEN SIMPLIFIED FOR PRESENTATION PURPOSES. REFER TO THE PROJECT GEOTECHNICAL REPORT FOR MORE DETAILED SUBSURFACE INFORMATION.

NOTE: CONTRACTOR SHALL ACTIVELY MONITOR THE DRILLED ALIGNMENT FOR IMPACTS THAT COULD OCCUR AS A RESULT OF HDD OPERATIONS (i.e. SETTLEMENT, HEAVE, AND DRILLING FLUID FLOW). CONTRACTOR'S MONITORING PROCEDURES AND ASSOCIATED EMERGENCY RESPONSE PLANS SHALL BE APPROPRIATE TO ENSURE THAT PUBLIC SAFETY IS NOT COMPROMISED.

NOTE: IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ALL EXISTING UTILITIES AND OTHER STRUCTURES. CONTRACTOR SHALL BE RESPONSIBLE FOR LOSSES AND REPAIRS OCCASIONED BY DAMAGE TO FACILITIES RESULTING FROM DRILLING OPERATIONS. CONTRACTOR SHALL TAKE STEPS TO PROTECT EXISTING FACILITIES, INCLUDING, BUT NOT LIMITED TO, SETTING SURFACE CASING AS NECESSARY TO PREVENT SETTLEMENT AND DISPLACEMENT.

PROFILE

SCALE: 1" = 100' HORIZONTAL
1" = 20' VERTICAL



GENERAL LEGEND

DRILLED PATH ENTRY/EXIT POINT

TOPOGRAPHIC SURVEY NOTES

1. LIDAR AND SURVEY DATA PROVIDED BY FLUOR ENTERPRISES, INC., SUGARLAND, TEXAS.

2. NORTHINGS AND EASTINGS ARE IN U.S. SURVEY FEET REFERENCED TO UTM ZONE 17N, NAD83.

DRILLED PATH NOTES

1. DRILLED PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS REFERENCED TO CONTROL ESTABLISHED FOR THE DRILLED SEGMENT.

2. DRILLED PATH COORDINATES REFER TO CENTERLINE OF PIPE.

GEOTECHNICAL LEGEND

Ⓑ BORING LOCATION

SPLIT SPOON SAMPLE

53 | 23 — PENETRATION RESISTANCE IN BLOWS PER FOOT FOR A 140 POUND HAMMER FALLING 30 INCHES
PERCENTAGE OF GRAVEL BY WEIGHT FOR SAMPLES CONTAINING GRAVEL

PUSH SAMPLE

CORE BARREL SAMPLE

UCS 6,250 — UNCONFINED COMPRESSIVE STRENGTH (PSI)
TSS 1,350 — TENSILE SPLITTING STRENGTH (PSI)
53 | 6 — MOHS HARDNESS
ROCK QUALITY DESIGNATION (PERCENT)

GEOTECHNICAL NOTES

1. GEOTECHNICAL DATA PROVIDED BY FUGRO CONSULTANTS, INC, BATON ROUGE, LOUISIANA. REFER TO THE PROJECT GEOTECHNICAL REPORT DATED SEPTEMBER 11, 2015 FOR ADDITIONAL INFORMATION.

2. THE LETTER "N" TO THE LEFT OF A SPLIT SPOON SAMPLE INDICATES THAT NO GRAVEL WAS OBSERVED IN THE SAMPLE. THE LETTERS "NT" INDICATE THAT GRAVEL WAS OBSERVED BUT NO GRADATION TESTS WERE PERFORMED.

3. THE GEOTECHNICAL DATA IS ONLY DESCRIPTIVE OF THE LOCATIONS ACTUALLY SAMPLED. EXTENSION OF THIS DATA OUTSIDE OF THE ORIGINAL BORINGS MAY BE DONE TO CHARACTERIZE THE SOIL CONDITIONS, HOWEVER, COMPANY DOES NOT GUARANTEE THESE CHARACTERIZATIONS TO BE ACCURATE. CONTRACTOR MUST USE HIS OWN EXPERIENCE AND JUDGEMENT IN INTERPRETING THIS DATA.

PILOT HOLE TOLERANCES

THE PILOT HOLE SHALL BE DRILLED TO THE TOLERANCES LISTED BELOW. HOWEVER, IN ALL CASES, RIGHT-OF-WAY RESTRICTIONS AND CONCERN FOR ADJACENT FACILITIES SHALL TAKE PRECEDENCE OVER THESE TOLERANCES.

1. ENTRY POINT: UP TO 5 FEET FORWARD OR BACK FROM THE DESIGNED ENTRY POINT; UP TO 1 FOOT RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

2. EXIT POINT: UP TO 5 FEET SHORT OR 20 FEET LONG RELATIVE TO THE DESIGNED EXIT POINT; UP TO 5 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

3. ELEVATION: UP TO 5 FEET ABOVE AND 15 FEET BELOW THE DESIGNED PROFILE.

4. ALIGNMENT: UP TO 10 FEET RIGHT OR LEFT OF THE DESIGNED ALIGNMENT.

5. CURVE RADIUS: NO LESS THAN 1,800 FEET BASED ON A 3-JOINT AVERAGE

PROTECTION OF UNDERGROUND FACILITIES

CONTRACTOR SHALL UNDERTAKE THE FOLLOWING STEPS PRIOR TO COMMENCING DRILLING OPERATIONS:

1. CONTACT THE UTILITY LOCATION/NOTIFICATION SERVICE FOR THE CONSTRUCTION AREA.

2. POSITIVELY LOCATE AND STAKE ALL EXISTING UNDERGROUND FACILITIES. ANY FACILITIES LOCATED WITHIN 10 FEET OF THE DESIGNED DRILLED PATH SHALL BE EXPOSED.

3. MODIFY DRILLING PRACTICES AND DOWNHOLE ASSEMBLIES AS NECESSARY TO PREVENT DAMAGE TO EXISTING FACILITIES.

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
WATE–A–1274	ALIGNMENT SHEET M.P. 250.89 TO M.P. 251.84	0	LKB	JMS	ISSUED FOR FERC
WATE–A–1275	ALIGNMENT SHEET M.P. 251.84 TO M.P. 252.78				

John D. Hair, P.E.
Consulting Engineer
2424 East 21st Street
Suite 510
Tulsa, Oklahoma 74114

ENGINEERING APPROVALS	PRELIMINARY		CONSTRUCTION	
DRAWN BY:	LKB	08/07		
PROJECT MANAGER	JMS	08/07		
DESIGN ENGINEER	LKB	08/07		
DESIGN CHECKER	ACM	08/07		
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

PLAN AND PROFILE
NEXUS PROPOSED MAINLINE PIPELINE
36-INCH INTERSTATE 94 CROSSING
BY HORIZONTAL DIRECTIONAL DRILLING

WASHTENAW COUNTY, MICHIGAN

NEXUS SM GAS TRANSMISSION

M.P. 251.5	W.O.	SCALE: AS SHOWN	DWG. WATE–H–1017	REV. 0

NEXUS Gas Transmission, LLC

NEXUS Project

FERC Docket No. CP16-__-000

HDD Monitoring and Inadvertent Return Contingency Plan

November 2015

NEXUS GAS TRANSMISSION

NEXUS Project HDD Monitoring and Inadvertent Return Contingency Plan

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1 INTRODUCTION

NEXUS proposes to install multiple pipeline crossings on the proposed 36-inch NEXUS Gas Transmission Project by horizontal directional drilling (HDD). HDD is a widely used trenchless construction method which accomplishes the installation of pipelines and buried utilities with minimal impact to the obstacle being crossed. However, HDD is not totally without impact. The primary impact associated with HDD revolves around the use of drilling fluids. Additionally, the HDD installation method involves the risk of failure when certain adverse subsurface conditions are encountered. The purpose of this document is to present contingency plans that may be implemented, in the event that problems develop during HDD operations, in order to complete the crossings successfully while minimizing potential associated impact.

1.1 Background

The tools and techniques used in the HDD process are an outgrowth of the oil well drilling industry. The components of a horizontal drilling rig used for pipeline construction are similar to those of an oil well drilling rig with the major exception being that a horizontal drilling rig is equipped with an inclined ramp as opposed to a vertical mast. HDD pilot hole operations are not unlike those involved in drilling a directional oil well. Drill pipe and downhole tools are generally interchangeable and drilling fluid is used throughout the operation to transport drilled spoil, reduce friction, stabilize the hole, etc. Because of these similarities, the process is generally referred to as drilling as opposed to boring.

Installation of a pipeline by HDD is generally accomplished in three stages. The first stage consists of directionally drilling a small diameter pilot hole along a designed directional path. The second stage involves enlarging this pilot hole to a diameter suitable for installation of the pipeline. The third stage consists of pulling a prefabricated pipeline segment into the enlarged hole.

The major component of drilling fluid used in HDD pipeline installation is fresh water obtained at the crossing location. In order for water to perform the required functions, it is generally necessary to modify its properties by adding a viscosifier. The viscosifier used almost exclusively in HDD drilling fluids is a naturally occurring bentonite clay typically mined by “open pit” methods from locations in Wyoming and South Dakota. Bentonite is a soft clay, formed by the weathering of volcanic ash, with the unique characteristic of swelling to several times its original volume when in contact with water. It is not a hazardous material as defined by the U.S. Environmental Protection Agency's characteristics of ignitability, corrosivity, reactivity, or commercial chemicals. It is also used to seal earth structures such as ponds or dams and as a suspending component in livestock feeds.

1.2 Technical Team

In order to ensure the highest probability of success on the proposed HDD installation, NEXUS has assembled a technical team which includes consultants having expertise in HDD design and construction and environmental issues specific to the proposed HDD crossing locations. This approach enhances the prospect of a successful HDD installation by bringing together more resources than those available to any single team member working independently.

1.3 Anticipated Subsurface Conditions

An extensive geotechnical exploration program was undertaken to aid in assessing the feasibility of HDD crossings on the NEXUS Project. Between the beginning of March and the end of August, 2015, exploratory borings were performed at those HDD crossing locations where access was available. In addition, geophysical techniques were used at select HDD crossing locations to supplement the exploratory borings. Based on the subsurface data collected to date, none of the sites have subsurface conditions that are expected to prevent installation by HDD.

2 FAILURE SCENARIOS

It is difficult to define a set of circumstances in advance that define "failure" of the HDD method as the decision to abandon HDD should take into account the conditions encountered on a given crossing. Following is a discussion of serious operational problems that might ultimately lead to abandoning the HDD installation method.

2.1 Problems During Pilot Hole Drilling

Problems during pilot hole drilling generally occur in the form of high compressive or torsional loads on the drill string. Loads such as these typically result from unconsolidated or coarse-grained material packing around the drill pipe as it is advanced. As friction on the drill string increases, the rig must apply greater torque and thrust. If the torque applied by the rig exceeds the strength of the drill pipe, the pipe will be sheared into two pieces, commonly referred to as "twisting off". Ultimately, friction can increase to the point that the drill string cannot be advanced or retracted, at which point it may be abandoned in place or parted by some means including intentionally twisting it off with the rig.

A skilled contractor will not continue drilling the pilot hole until it becomes stuck. As loads on the drill string increase, the contractor will adjust drilling fluid properties and work the hole by tripping the drill string out and back in. These measures are generally successful and abandonment of an HDD crossing due to excessive loads during pilot hole drilling is very rare.

Another problem that can occur during pilot hole drilling is a lack of directional control resulting in either a violation of pilot hole position tolerances or an unacceptable angular change. This can occur when the drill bit is deflected off a boulder or cobble lens or when attempting to penetrate a hard bedrock formation at depth. If left uncorrected, an unacceptable angular change can result in failure of the drill pipe due to a combination of excessive bending stress and rotation. However, redrilling efforts are usually successful and abandonment of an HDD crossing due to a lack of directional control is very rare.

Solution cavities, occasionally present in limestone and dolomite formations, can cause serious problems on an HDD installation, especially during pilot hole drilling when the drill string is in compression. While the wall of a competent borehole serves to limit the deflection of the drill string, penetration of a void leaves the drill string unconstrained, potentially allowing it to deflect substantially. Continued rotation of a drill string subjected to such a deflection often results in failure of the drill pipe due to low-cycle fatigue. If efforts to avoid extensive solution cavities are unsuccessful, the HDD installation method is typically abandoned. Limestone and dolomite are present on some of the proposed vertical alignments. However, the size of the cavities encountered in the exploratory borings is not expected to prevent installation by HDD.

2.2 Problems During Prereaming

Problems during prereaming generally involve excessive tensile or torsional loads when enlarging a hole through either hard rock or discontinuous materials such as fractured rock or glacial till. In this situation, application of excessive torque from the rig can easily result in the drill pipe being twisted off downhole. Accumulation of cuttings in the hole can cause tensile loads to become excessive, ultimately resulting in the reamer becoming stuck. If the reamer cannot be freed, the drill pipe is generally twisted off, either intentionally or unintentionally, and both the reamer and some amount of drill pipe are abandoned downhole.

A skilled contractor can typically avoid getting the reamer stuck downhole. As loads increase, the contractor will adjust drilling fluid properties and trip the reamer out of the hole to mechanically displace material. A stuck reamer is more difficult to free up than a pilot hole drill bit. Reamers are generally designed to move forward, not backward.

Prereaming through hard or unusually abrasive rock can lead to failure of reaming tools downhole due to excessive wear. This often results in roller cones or other portions of the reaming tool being lost downhole where they can present an obstacle to subsequent reaming passes or installation of the pipeline. Fishing operations to retrieve pieces of a reaming tool lost downhole are time consuming and often unsuccessful.

Penetration of an artesian aquifer on an HDD installation can cause significant problems, especially during prereaming operations when attempting to move a large volume of material out of the hole. A steady flow of groundwater into the hole from an aquifer tends to bring in fine soils, which eventually accumulate in the hole and can cause the reamer or drill pipe to bind. Additionally, a significant flow of water into the reamed hole can have a negative effect on drilling fluid properties. If drilling fluid returns to the HDD endpoints are maintained, the additional water returning to the surface can become overwhelming, resulting in drilling fluid storage and disposal issues.

2.3 Problems During Pullback

As with prereaming, problems during pullback generally involve excessive tensile or torsional loads which can ultimately result in the pull section becoming stuck. Excessive torque and pulling forces applied in an attempt to free the pipe can result in twisting off downhole. Removal of the pull section from the hole can be difficult and is sometimes impossible. If a partially installed pull section cannot not be withdrawn, the contractor’s only option is to start over, offsetting to one side and drilling a new pilot hole. Pipe left in the hole has to be replaced and a new pull section has to be fabricated.

Stuck pipe can also occur due to the relative stiffness of the pull section. During prereaming operations, it is possible for the reaming tool to "walk" around a boulder since it is being pulled and followed by a slender 5-inch drill pipe. However, when the same boulder is encountered during pullback, the reamer is forced to cut through it by the relatively rigid pull section.

Another issue that may occur during pullback, specific to installations through bedrock, is difficulties associated with transitioning from the overburden soil into the rock hole. Misalignment of the pull section as it moved into the reamed rock hole can result in the product line becoming lodged.

3 CONTINGENCY PLANS

Courses of action to consider if serious operational problems occur are outlined below. These contingency plans are meant to serve as guidelines and tools for advanced planning. The actual course of action to be employed will be based on an analysis of the conditions encountered during construction. In the event that a re-drill is necessary, the horizontal offset distance will be based on an analysis of the cause of failure and the as-built position of existing drilled hole. In most cases, the horizontal offset will be within 10 feet to 20 feet of the original alignment.

3.1 Twist Off During Pilot Hole

If there is a reasonable chance that the bottom hole assembly and/or drill pipe lost downhole can be retrieved using fishing tools, commence fishing operations. Otherwise, offset and redrill the pilot hole around the twisted off segment.

3.2 Solution Cavity Encountered During Pilot Hole

If the solution cavity is not extensive (i.e. extending no more than a few feet along the drilled path) and the bit successfully reenters the formation after passing through the void, proceed with the pilot hole at the contractor's discretion. If the solution cavity is extensive, offset and begin a new pilot hole in an effort to avoid the solution cavity.

3.3 Twist Off During Prereaming

If the failure is to the pipe side of the reamer, trip the reamer out with the rig, trip out the failed drill pipe with pipe side equipment, and trip back through the partially reamed pilot hole with a directional drilling assembly. If the failure is to the rig side of the reamer, trip out the failed pipe on the rig side. Attempt to separate the drill pipe on the pipe side of the reamer from the reamer and recover the drill pipe using pipe side equipment. If it is possible to redrill around the reamer and reenter the completed pilot hole without violating pilot hole tolerances, do so. If not, offset and drill a new pilot hole.

3.4 Twist Off During Pullback

If possible, recover the pull section using pipe side equipment or other means as available. Trip out the failed drill pipe and trip back through the reamed hole with a directional drilling assembly. Otherwise, salvage as much pipe as possible, offset, and begin a new pilot hole.

3.5 Failed Installation

A single occurrence of the problem scenarios described previously would not constitute a failure. Typically, there would have to be at least two occurrences resulting in stuck or twisted off drill pipe before an HDD contractor would consider abandoning the crossing. If it is ultimately determined that an HDD installation cannot be completed at any of the proposed crossing locations, NEXUS's contingency plan will be to install the crossing on the current alignment using a method other than HDD or, where this is not possible, install the crossing on a new alignment using HDD or another method, with the selected method being dependent on the topographic, hydrographic and geotechnical conditions on the new alignment. Any drilled or reamed hole which is abandoned will be filled with a mixture of drilling fluid and drilled spoil.

4 DRILLING FLUID IMPACT

All stages of HDD involve circulating drilling fluid from equipment on the surface, through a drill pipe to a downhole bit or reamer, and back to the surface through the annular space between the pipe and the wall of the hole. Drilling fluid returns collected at the entry and exit points are stored in steel tanks and processed through a solids control system which removes spoil from the drilling fluid allowing the fluid to be reused. The basic method used by the solids control system is mechanical separation using shakers, desanders, and desilters. Excess spoil and drilling fluid are transported to, and disposed of, at an approved disposal site.

Under ideal circumstances, drilling fluid exhausted at the bit or reamer will flow back to the entry or exit point through the drilled annulus. Under actual conditions, this happens inconsistently. Drilling fluid expended downhole will flow in the path of least resistance. In the drilled annulus, this path may be an existing fracture or fissure in the soil. This can result in dispersal of drilling fluid into the surrounding soils (lost circulation) or discharge to the surface at some random location (inadvertent returns). Lost circulation and inadvertent returns are common occurrences in pipeline installation by HDD and do not prevent completion. However, the environment may be temporarily impacted if drilling fluid inadvertently returns to the surface at a location on a waterway's banks or within a waterway. Drilling parameters may be adjusted to maximize circulation and minimize the risk of inadvertent returns. However, the possibility of lost circulation and inadvertent returns cannot be eliminated.

4.1 The Principal Functions of Drilling Fluid in HDD Pipeline Installation are Listed Below:

- **Hydraulic Excavation.** On crossings through soft soils, soil is excavated by erosion from high velocity fluid streams through jet nozzles on bits or reaming tools.

- **Transmission of Hydraulic Power**. On crossings through harder soils or rock, power required to turn a bit and mechanically drill a hole is transmitted to a downhole motor by the drilling fluid.

- **Transportation of Spoil**. Drilled spoil, consisting of excavated soil or rock cuttings, is suspended in the fluid and carried to the surface by the fluid stream flowing in the annulus between the pipe and the wall of the hole.

- **Hole Stabilization.** Stabilization of the drilled hole is accomplished by the drilling fluid building up a "wall cake" which seals pores and holds soil particles in place. This is critical in HDD pipeline installation as holes are often in unconsolidated formations and are uncased.

- **Cooling and Cleaning of Cutters.** Drilled spoil build-up on bit or reamer cutters is removed by high velocity fluid streams directed at the cutters. Cutters are also cooled by the fluid.

- **Reduction of Friction**. Friction between the pipe and the wall of the hole is reduced by the lubricating properties of the drilling fluid.

- **Modification of Soil Properties.** Mixing of the drilling fluid with the soil along the drilled path facilitates installation of a pipeline by reducing the shear strength of the soil to a near fluid condition. The resulting soil mixture can then be displaced as a pipeline is pulled into it.

4.2 Drilling Fluid Composition

The major component of drilling fluid used in HDD pipeline installation is fresh water. In order for water to perform the required functions, it is generally necessary to modify its properties by adding a viscosifier. The viscosifier used almost exclusively in HDD drilling fluids is a naturally occurring bentonite clay typically mined by "open pit" methods from locations in Wyoming and South Dakota. Bentonite is a soft clay, formed by the weathering of volcanic ash, with the unique characteristic of swelling to several times its original volume when in contact with water. It is not a hazardous material as defined by the U.S. Environmental Protection Agency's characteristics of ignitability, corrosivity, reactivity, or commercial chemicals. It is also used to seal earth structures such as ponds or dams and as a suspending component in livestock feeds.

The properties of bentonite used in drilling fluids are often enhanced by the addition of polymers. This enhancement typically involves increasing the yield. That is, reducing the amount of dry bentonite required to produce a given amount of drilling fluid. Untreated bentonite yields in excess of 85 barrels (3,570 gallons) of drilling fluid per ton of material. Addition of polymers to produce high yield bentonite can increase the yield to more than 200 barrels (8,400 gallons) per ton of material. Typical HDD drilling fluids are made with high yield bentonite and are composed of less than 4% viscosifier by volume, with the remaining components being water and drilled spoil.

4.3 Disposal Of Excess Drilling Fluid

Disposal of excess drilling fluid will be the responsibility of the selected HDD contractor. Prior to beginning HDD operations, the contractor will be required to submit their proposed drilling fluid disposal procedures to NEXUS for approval. NEXUS will review these procedures and verify that they comply with all environmental regulations, right-of-way and workspace agreements, and permit requirements.

The method of disposal applied to each crossing will be dependent upon applicable regulations. Potential disposal methods include transportation to a remote disposal site and land farming on the construction right-of-way or an adjacent property. Land farming involves distributing the excess drilling fluid evenly over an open area and mechanically incorporating it into the soil. Where land farming is employed, the condition of the land farming site will be governed by NEXUS's standard clean up and site restoration specifications.

4.4 Minimization Of Environmental Impact

The most effective way to minimize environmental impact associated with HDD drilling fluids is to maintain drilling fluid circulation to the extent practical. However, resources spent in an effort to maintain circulation should be weighed against the potential benefits achieved through full circulation. It should be recognized that in subsurface conditions which are not conducive to annular flow, restoration of circulation may not be practical or possible. In such cases, environmental impact can often be minimized most effectively by completing HDD operations in the shortest possible amount of time.

Steps which may be taken by the contractor to either prevent lost circulation or regain circulation include, but are not limited to, the following:

- Size the hole frequently by advancing and retracting the drill string in order to keep the annulus clean and unobstructed.

- When drilling fluid flow has been suspended, establish circulation slowly and before advancing.

- Minimize annular pressures by minimizing density and flow losses. Viscosity should be minimized, consistent with hole cleaning and stabilization requirements.

- Minimize gel strength.

- Control balling of material on bits, reaming tools, and pipe in order to prevent a plunger effect from occurring.

- Control penetration rates and travel speeds in order to prevent a plunger effect from occurring.

- Seal a zone of lost circulation using a high viscosity bentonite plug.

- Seal a zone of lost circulation using lost circulation materials. Note that any lost circulation materials proposed for use must be approved by NEXUS prior to utilization.

- Suspend drilling activities for a period of six to eight hours.

If inadvertent surface returns occur on dry land, it will be the responsibility of the HDD contractor to contain, collect, and restore the disturbed area in accordance with the requirements of NEXUS's construction specifications. Should inadvertent returns occur within a waterway, NEXUS will notify appropriate parties and evaluate the potential impact of the returns in order to determine an appropriate course of action. In general, NEXUS does not believe that it is environmentally beneficial to try to contain and collect drilling fluid returns in a waterway. HDD drilling fluids are nontoxic and discharge of the amounts normally associated with inadvertent returns, in most cases, do not pose a threat to the environment or public health and safety. Placement of containment structures and attempts to collect drilling fluid within a waterway often result in greater environmental impact than simply allowing the drilling fluid returns to dissipate naturally.

4.5 Requirements of HDD Contractor

The requirements that will be placed on the HDD contractor with respect to drilling fluid related issues are included in NEXUS's construction specifications. Excerpts from the HDD technical specification defining the contractor's responsibilities are presented below.

- **Instrumentation.** CONTRACTOR shall at all times provide and maintain instrumentation which will accurately locate the pilot hole, measure drill string axial and torsional loads, and measure drilling fluid discharge rate and pressure. NEXUS will have access to these instruments and their readings at all times. A log of all recorded readings shall be maintained and will become a part of the "As-Built" information to be supplied by CONTRACTOR.

- **Composition.** The composition of all drilling fluids proposed for use shall be submitted to NEXUS for approval. No fluid will be approved or utilized that does not comply with permit requirements and environmental regulations.

- **Recirculation.** CONTRACTOR shall maximize recirculation of drilling fluid surface returns. CONTRACTOR shall provide solids control and fluid cleaning equipment of a configuration and capacity that can process surface returns and produce drilling fluid suitable for reuse. NEXUS may specify standards for solids control and cleaning equipment performance or for treatment of excess drilling fluid and drilled spoil. NEXUS specified standards, if any, are listed in the General Requirements.

- **Loss of Circulation.** CONTRACTOR shall employ his best efforts to maintain full annular circulation of drilling fluids. Drilling fluid returns at locations other than the entry and exit points shall be minimized. In the event that annular circulation is lost, CONTRACTOR shall take steps to restore circulation.

- **Inadvertent Returns.** If inadvertent surface returns of drilling fluids occur, they shall be immediately contained with hand placed barriers (i.e. hay bales, sand bags, silt fences, etc.) and collected using pumps as practical. If the amount of the surface return is not great enough to allow practical collection, the affected area shall be diluted with fresh water and the fluid will be allowed to dry and dissipate naturally. If the amount of the surface return exceeds that which can be contained with hand placed barriers, small collection sumps (less than 5 cubic yards) may be used. If the amount of the surface return exceeds that which can be contained and collected using small sumps, drilling operations shall be suspended until surface return volumes can be brought under control.

- **Disposal.** Disposal of excess drilling fluids is the responsibility of the CONTRACTOR and shall be conducted in compliance with all environmental regulations, right-of-way and workspace agreements, and permit requirements. Drilling fluid disposal procedures proposed for use shall be submitted to NEXUS for approval. No procedure may be used which has not been approved by NEXUS. NEXUS, at its option, may secure an excess drilling fluid disposal site for CONTRACTOR. Excess drilling fluid disposal sites secured by NEXUS are listed in the General Requirements.

5 MONITORING

In order to ensure that HDD operations are conducted in accordance with established requirements and standard HDD industry practice, NEXUS will provide an inspector experienced in HDD construction to monitor the HDD contractor's performance at the jobsite. The primary functions of NEXUS's environmental inspector will be to document construction activities, report on the HDD contractor's performance, and notify the NEXUS Environmental Project Manager if the HDD contractor fails to conform to established requirements. Established requirements to which the HDD contractor must conform include, but are not limited to, the construction drawings, technical specifications, permits, easement agreements, and contractor submittals. The monitoring protocol which will be applied by NEXUS's environmental inspector relative to drilling fluid related issues is described in detail on the following pages.

5.1 Drilling Fluid Monitoring Protocol

The drilling fluid monitoring protocol to be applied will vary depending upon the following operational conditions.

Condition 1: Full Circulation

Condition 2: Loss of Circulation

Condition 3: Inadvertent Returns

5.1.1 Monitoring Protocol for Condition 1 – Full Circulation

When HDD operations are in progress and full drilling fluid circulation is being maintained at one or both of the HDD endpoints, the following monitoring protocol will be implemented.

- The presence of drilling fluid returns at one or both of the HDD endpoints will be periodically documented.
- Land-based portions of the drilled alignment will be periodically walked and visually inspected for signs of inadvertent drilling fluid returns as well as surface heaving and settlement. Waterways will be visually inspected from the banks for a visible drilling fluid plume.
- Drilling fluid products present at the jobsite will be documented.

If an inadvertent drilling fluid return is detected during routine monitoring, the monitoring protocol associated with Condition 3 will immediately be implemented.

5.1.2 Monitoring Protocol for Condition 2 – Loss of Circulation

When HDD operations are in progress and drilling fluid circulation to the HDD endpoints is lost or severely diminished, the following monitoring protocol will be implemented. It should be noted that lost circulation is common and anticipated during HDD installation and does not necessarily indicate that drilling fluid is inadvertently returning to a point on the surface.

- NEXUS's environmental inspector will notify the Environmental Project Manager that drilling fluid circulation to the HDD endpoints has been lost or severely diminished.
- NEXUS's environmental inspector will document steps taken by the HDD contractor to restore circulation. Should the contractor fail to comply with the requirements of the HDD Specification, NEXUS's environmental inspector will notify the Environmental Project Manager so that appropriate actions can be taken.
- If circulation is regained, NEXUS's environmental inspector will inform the Environmental Project Manager and resume the monitoring protocol associated with Condition 1.

- If circulation is not re-established, NEXUS's environmental inspector will increase the frequency of visual inspection along the drilled path alignment as appropriate. Additionally, NEXUS's environmental inspector will document periods of contractor downtime (during which no drilling fluid is pumped) and the contractor's drilling fluid pumping rate in case it should become necessary to estimate lost circulation volumes.

5.1.3 Monitoring Protocol for Condition 3 – Inadvertent Returns

If an inadvertent return of drilling fluids is detected, the following monitoring protocol will be implemented.

- NEXUS's environmental inspector will inform the Environmental Project Manager that an inadvertent drilling fluid return has occurred and provide documentation with respect to the location, magnitude, and potential impact of the return.

- If the inadvertent return occurs on land, NEXUS's environmental inspector will document steps taken by the HDD contractor to contain and collect the return. Should the contractor fail to comply with the requirements of the HDD Specification, NEXUS's environmental inspector will notify the Environmental Project Manager so that appropriate actions can be taken.

- If the inadvertent return occurs in a waterway, NEXUS, in consultation with appropriate parties, will determine if the return poses a threat to the environment or public health and safety.

- If it is determined that the return does not pose a threat to the environment or public health and safety, HDD operations will continue. NEXUS's environmental inspector will monitor and document the inadvertent return as well as periods of contractor downtime and the contractor's drilling fluid pumping rate in case it should become necessary to estimate inadvertent return volumes.

- If it is determined that the return does pose a threat to the environment or public health and safety, drilling operations will be suspended until containment measures can be implemented by the contractor. Documentation of any containment measures employed will be provided by NEXUS's environmental inspector. Once adequate containment measures are in place, the contractor will be permitted to resume drilling operations subject to the condition that drilling operations will again be suspended immediately should the containment measures fail. NEXUS's environmental inspector will periodically monitor and document both the inadvertent return and the effectiveness of the containment measures. Periods of contractor downtime and the contractor's drilling fluid pumping rate will also be documented in case it should become necessary to estimate inadvertent return volumes. Upon completion of the HDD installation, NEXUS will ensure that the inadvertent drilling fluid returns are cleaned up to the satisfaction of governing agencies and any affected parties.

6 NOTIFICATION

In the event of an inadvertent drilling fluid return within a waterway, NEXUS will immediately contact applicable agencies by telephone and/or e-mail detailing:

- the location and nature of the inadvertent return,
- corrective actions being taken, and
- whether the inadvertent return poses any threat to the environment or public health and safety.