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2801 Wehrle Drive
Suite 8
Williamsville, NY 14221
716.204.9543 PHONE
716.204.9545 FAX
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RECEIVED
Dec 18 2015
Office of Coastal Management
2015-059

December 15, 2015

Ohio Coastal Management Program
ODNR Office of Coastal Management
ATTN: Steve Holland, MPA, Federal Consistency Administrator
105 West Shoreline Drive
Sandusky, Ohio 44870

RE: NEXUS Gas Transmission Project Coastal Zone Management Coordination – Federal Consistency

Dear Mr. Holland:

NEXUS Gas Transmission, LLC ("NEXUS") is seeking a Certificate of Public Convenience and Necessity from the Federal Energy Regulatory Commission ("FERC") pursuant to Section 7(c) of the Natural Gas Act authorizing the construction and operation of the proposed 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 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. The greenfield portion of the NEXUS Project will be constructed, owned and operated by NEXUS and will extend from Kensington Processing Plant located in Hanover Township, Ohio to the DTE Gas Company system west of Detroit in Ypsilanti Township, Michigan. A new 0.9 mile, 36-inch diameter, interconnecting pipeline is proposed to connect certain NEXUS facilities to Tennessee Gas Pipeline Company, LLC ("TGP"). The proposed Project will also include the construction of four (4) compressor stations, all located within Ohio, and five (5) metering and regulating stations. The FERC Certificate Project Number for reference is CP16-22-000.

TRC, on behalf of our client NEXUS, requests Federal Consistency review of the proposed crossing within the Lake Erie Coastal Management Zone by Ohio Department of Natural Resources Office of Coastal Management (ODNR – CZM). The proposed NEXUS Project will traverse approximately 255 miles through 13 counties in northern Ohio and four (4) counties in southeastern Michigan (**Figure 1**). Approximately 1.8 miles of the proposed pipeline, milepost 144.4 to 146.2, is located within the Lake Erie Coastal Management Zone (**Figure 2**). The Sandusky River will be crossed by the proposed Project near milepost 145.81 within the Lake Erie Coastal Management Zone (**Figure 3**).

The FERC application and accompanying Resource Reports that describe the proposed Project are provided in the enclosed CD. Project drawings, maps, and aerial photo based alignment sheets for

the entire Project route are provided in Appendix 1A in Resource Report 1. The necessary information requested for Federal Consistency review by ODNR-CZM, to include the description of the activity, associated facilities, coastal effects, maps and technical data; and other local, state, and federal permits for which NEXUS is applying for (**Table 1**) is provided in the FERC Application. To facilitate ODNR – CZM review, a summary of land uses crossed by the permanent easement and additional temporary workspaces associated with the Sandusky River and the land encompassed by the Lake Erie Coastal Zone Management Area is provided on **Figure 3** and **Table 2**. NEXUS' Consistency Certification Statement is attached to this letter. Specific alignment sheets as they pertain to portion of the proposed pipeline with the Lake Erie Coastal Management Zone, such as HDD profiles and cross sections are provided in Resource Report I Appendix IA (Volume IIB) and Resource Report II Appendix 2A, as well as attached to this letter.

Please contact me at (207) 232-1739 or mlychwala@trcsolutions.com if you have questions regarding Project or this submittal.

Sincerely,

TRC Environmental Corp.

Michael Lychwala
Senior Project Manager

cc:
Matt Barczyk – Spectra Energy Partners, LP
Kathleen-Redmond Miller – TRC Environmental Corp
John Kessler - ODNR

Attachments: Figures 1 – 3, Tables 1 -2, HDD profiles and cross sections (Sandusky River), Consistency Certification Statement

Enclosures: DVD Copy of FERC Application – November 20, 2015

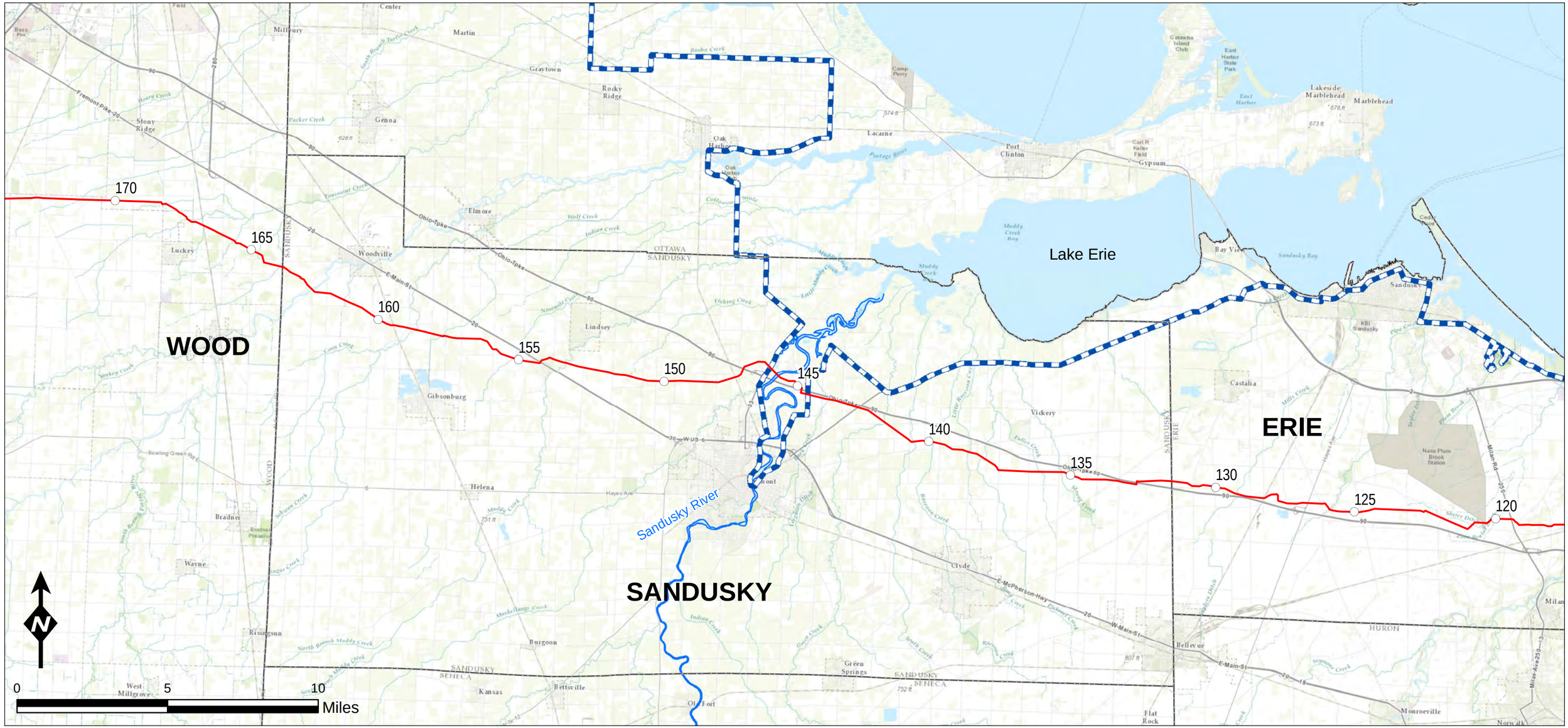
- Proposed NEXUS Mainline Pipeline
- Proposed Compressor Sites
- Proposed M & R Station
- Confirmed Market Connection
- County Boundary
- State Boundary

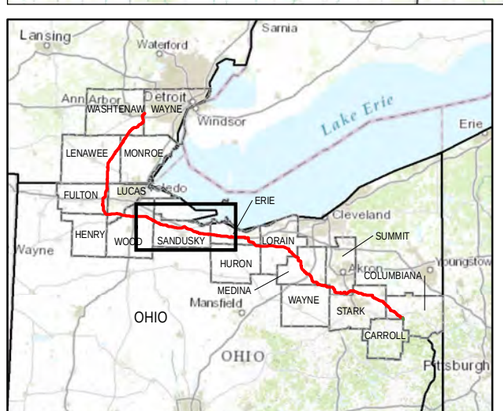
Figure 1

NEXUS Project Location Map

NEXUS GAS TRANSMISSION

11/16/2015





- Milepost (5 miles)
- Proposed NEXUS Mainline Pipeline
- Proposed TGP Interconnect
- Sandusky River
- Lake Erie Coastal Zone Management Area Boundary
- Project Counties

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

Figure 2

Lake Erie Coastal Zone Management Area Crossed by Pipeline Facilities

Overview

NEXUS GAS TRANSMISSION

Created: 12/1/2015

Sandusky River

County Road 645

Proposed HDD Enter Location

Proposed HDD Exit Location

D15-104 D15-104-S1 D15-104 AWB-SA-207 D15-102 D14-28-WB D15-104 D15-104-WB D15-104 D15-103 AWB-SA-205 AWB-SA-209 AWB-SA-205 AWB-SA-203 AS-SA-204

146.3 146.2 146.1 146 145.9 145.8 145.7 145.6 145.5 145.4 145.3 145.2 145.1 145 144.9 144.8 144.7 144.6 144.5 144.4 144.3

County Road 103

OH-53

I-90 W
I-90 E

I-80 W
I-80 E

County Road 234

D15-103-S1

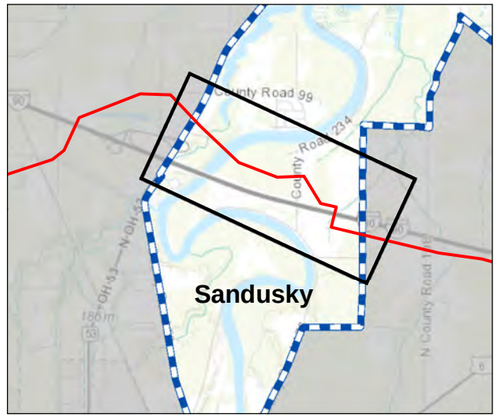
Werth Road

E County Road 186

Meyer Road

County Road 584

County Road 583



Legend

- Proposed HDD Enter or Exit Location
- Milepost (0.5 miles)
- Proposed NEXUS Mainline Pipeline
- Temporary Workspace
- ATWS
- Permanent Easement
- Lake Erie Coastal Zone Management Area Boundary

Land Use

- Agricultural
- Commercial/Industrial
- Forest/Woodland
- Open Land
- Open Water
- Residential
- Approximated Water Polygon
- Approximated Wetland Polygon
- Delineated Water Edge/TOB
- Delineated Wetland Boundary Line
- Delineated Water Polygon
- Delineated Wetland Polygon

N

0 1 2 Miles

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

Figure 3

Lake Erie Coastal Zone Management Area Crossed by Pipeline Facilities

Aerial

NEXUS GAS TRANSMISSION

Created: 12/1/2015

Table 1. Local, state and federal permit applications sought for the proposed NEXUS Gas Transmission Project.

	Agency		Permit	Initiated	Submitted	Anticipated Approval Date
	Federal					
1	Federal Energy Regulatory Commission	FERC	Certificate of Public Convenience and Necessity - Section 7(c) of the Natural Gas Act requires preparation of an ER (consisting of 12 Resource Reports) to be included with the Section 7(c) application. NEXUS used FERC's Pre-filing Process which involved conducting public open houses, preparation of responses to comments received on the Project during early scoping, and preparation of draft and final Resource Reports. Following submittal of the ER, support activities include responding to FERC staff data requests, reviewing FERC's EIS and preparing the Implementation Plan.	17-Dec-14	20-Nov-15	Nov-16
2	U.S. Army Corps of Engineers (USACE) Buffalo, Pittsburgh, Huntington, and Detroit Districts	USACE	1) Dredge and Fill Permit under Section 10 of the Rivers and Harbors Act of 1899 (33 USC § 403) 2) Dredge and Fill Permit under Section 404 of the Clean Water Act (33 USC § 1344)	31-Oct-14	Dec-15	Sept-Oct 2016
3	United States Department of the Interior, U.S. Fish and Wildlife Service, Midwest Region 3 (Columbus, OH and East Lansing, MI Field offices)	USFWS	1) Consultation under Section 7 of the Endangered Species Act 2) Coordination per the Migratory Bird Treaty Act; and the Fish and Wildlife Coordination Act (16 USC §§ 661 et seq.)	18-Sep-14	20-Nov-15	Sept-Oct 2016
4	U.S. Department of the Interior, National Park Service	NPS	Wild and Scenic Rivers Act Section 7(a) Determination	31-Oct-14	20-Nov-15	Sept-Oct 2016
5	U. S. Environmental Protection Agency, Region 3	US EPA	1) NGA Section 7(c) application ER Review 2) Section 404 of the CWA (USEPA review of wetland permits issued by the USACE) 3) Determination of General Conformity Applicability	31-Oct-14	20-Nov-15	Sept-Oct 2016
6	National Marine Fisheries Service	NMFS	Federal Endangered Species Act	31-Oct-14	N/A	N/A

Table 1. Local, state and federal permit applications sought for the proposed NEXUS Gas Transmission Project.

	Agency		Permit	Initiated	Submitted	Anticipated Approval Date
7	Advisory Council on Historic Preservation and Consultation with Native American Tribes	ACHP	Section 106 Consultation, National Historic Preservation Act ("NHPA") - Section 106 Consultation	5-Nov-14	20-Nov-15	Sept-Oct 2016
			1) Ohio SHPO introductory letter	5-Nov-14	20-Nov-15	Sept-Oct 2016
			2) Michigan SHPO introductory letter	4-Dec-14	20-Nov-15	Sept-Oct 2016
	Ohio					
8	Ohio Environmental Protection Agency ("OEPA")	OEPA	1) Section 401 Water Quality Certification	17-Dec-14	Planned for Dec. 2015	Aug-Sept 2016
			2) Clean Air Act, Air Permit-to-Install-and-Operate			
			3) NPDES Hydrostatic Test			
9	Ohio Department of Natural Resources ("ODNR")	ODNR	1) Consultation on Threatened and Endangered Species	18-Sep-14	20-Nov-15	Sept-Oct 2016
			2) Water Withdrawal Facility Registration (>100,000 gallons per day)	2-Dec-14	Planned for Dec 2016	Jan-17
			3) Coastal Management Program	19-Nov-15	Planned for Dec. 2015	Aug-Sept 2016
10	Ohio Historic Preservation Office	OHPO	Section 106 NHPA Consultation	5-Nov-14	20-Nov-15	Sept-Oct 2016
	Michigan					
11	Michigan Department of Natural Resources , Wildlife Division	MDNR	1) State listed species consultation	22-Sep-14	20-Nov-15	Aug-Sept 2016
			2) Public Lands consultation, Permit to Use State Lands			

Table 1. Local, state and federal permit applications sought for the proposed NEXUS Gas Transmission Project.

	Agency		Permit	Initiated	Submitted	Anticipated Approval Date
12	Michigan Department of Environmental Quality , Water Resources Division	MDEQ	1) MDEQ/USACE Joint Permit for impacts to wetlands, inland lakes, streams and floodplains	18-Dec-14	Planned Dec. 2015	Aug-Sept 2016
			2) NPDES Permit for Storm Water Discharge from Construction			Aug-Sept 2016
			3) NPDES General Permit for Hydrostatic Test Water Discharge and Water Withdrawal Authorization			Jan-17
			4) Possible permit to install for facility meter station air emissions	16-Sep-15	N/A	N/A
13	Michigan Natural Resources Inventory	MNRI	State-listed threatened and endangered species consultations	23-Sep-14	20-Nov-15	Aug-Sept 2016
14	Michigan State Housing and Development Authority – Michigan Office of Historic Preservation	MSHD	Section 106 NHPA Consultation	4-Dec-14	20-Nov-15	Sept-Oct 2016

Table 2. NEXUS landuse and workspace within the Coastal Zone Management Area of the Sandusky River, Ohio.

Landuse	Construction Workspace[1] (Acres)	ATWS (Acres)	Temporary Workspace (Acres)	Permanent Easement[2] (Acres)	Permanent Easement in HDD Workspace[3] (Acres)
Agriculture	34.84	18.23	16.60	8.15	0.02
Forested Upland	0.00	0.00	0.00	0.76	0.76
Open Land - Emergent Wetland	0.00	0.00	0.00	0.35	0.35
Open Land - Scrub Shrub	0.00	0.00	0.00	0.12	0.12
Upen Upland	0.90	0.26	0.64	0.64	0.13
Other*	0.21	0.06	0.15	0.86	0.77
Total	35.95	18.56	17.39	10.89	2.15

* Other = Industrial, commercial, and residential land uses as defined in Resource Report 8. Also includes "open water" land use, i.e. water crossings greater than 100 feet wide and streams visible on aerial photography but less than 100 feet in width.

[1] Construction workspace is the additional temporary workspace (ATWS) plus temporary workspace.

[2] The acres associated with the permament easement are included in the temporary workspace.

[3] The acres associated with the permanent easement in HDD workspace are not included in the temorary workspace.

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.

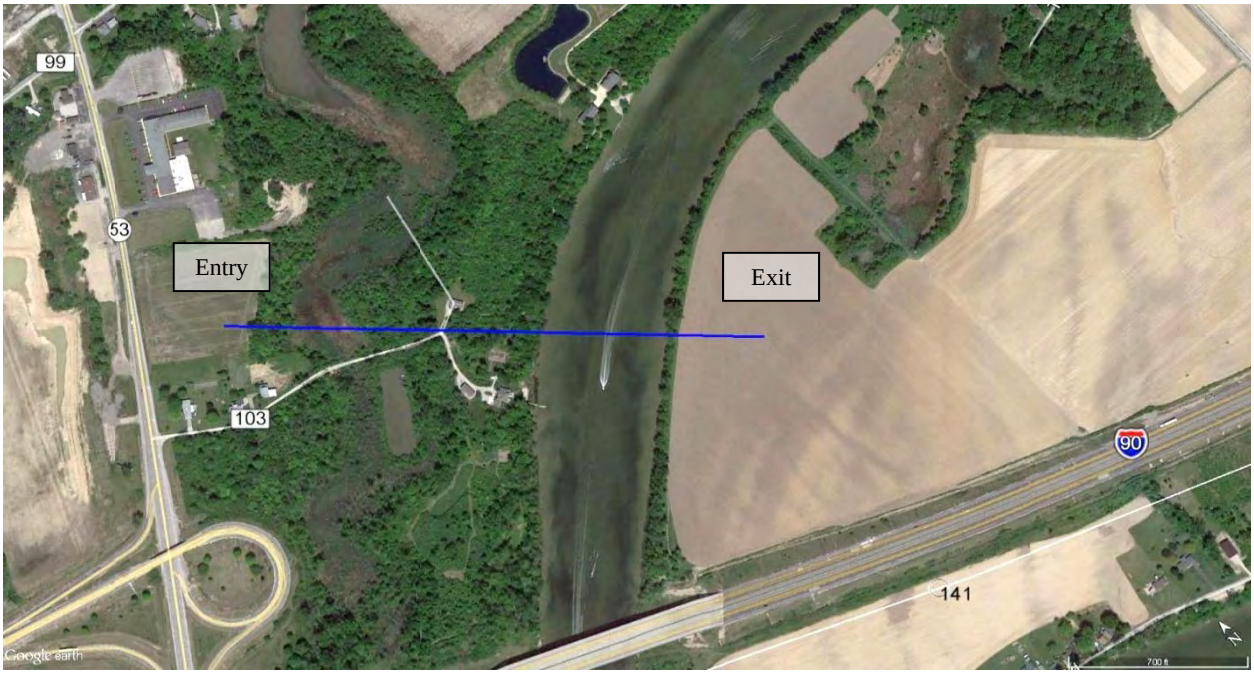


Figure 1: Overview of the Sandusky River Crossing

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 =	38,669	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 (1 - cosh(U/2)$^{-1}$] =	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 =	264.3	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 = $W_e L \mu \cos\theta$ =	70,928	lb
Fluidic Drag = $12 \pi D L C_d$ =	22,790	lb
Axial Segment Weight = $W_e L \sin\theta$ =	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

$h = R [1 - \cos(\alpha/2)]$ =	4.38	ft	$j = [(E I) / T]^{1/2}$ =	1,496	
$Y = [18 (L)^2] - [(j)^2 (1 - \cosh(U/2)^{-1}]$ =	3.4E+05		$X = (3 L) - [(j / 2) \tanh(U/2)]$ =	181.81	
$U = (12 L) / j$ =	2.02		$N = [(T h) - W_e \cos\theta (Y/144)] / (X / 12)$ =	103,168	lb

Bending Frictional Drag = $2 \mu N$ =	61,901	lb
Fluidic Drag = $12 \pi D L C_d$ =	8,527	lb
Axial Segment Weight = $W_e L \sin\theta$ =	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 = $W_e L \mu$ =	45,213	lb
Fluidic Drag = $12 \pi D L C_d$ =	14,386	lb
Axial Segment Weight = $W_e L \sin\theta$ =	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

$h = R [1 - \cos(\alpha/2)]$ =	6.85	ft	$j = [(E I) / T]^{1/2}$ =	1,107	
$Y = [18 (L)^2] - [(j)^2 (1 - \cosh(U/2)^{-1}]$ =	9.8E+05		$X = (3 L) - [(j / 2) \tanh(U/2)]$ =	424.44	
$U = (12 L) / j$ =	3.40		$N = [(T h) - W_e \cos\theta (Y/144)] / (X / 12)$ =	126,765	lb

Bending Frictional Drag = $2 \mu N$ =	76,059	lb	
Fluidic Drag = $12 \pi D L C_d$ =	10,659	lb	
Axial Segment Weight = $W_e L \sin\theta$ =	-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 = $W_e L \mu \cos\theta$ =	59,406	lb	
Fluidic Drag = $12 \pi D L C_d$ =	19,194	lb	
Axial Segment Weight = $W_e L \sin\theta$ =	-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	

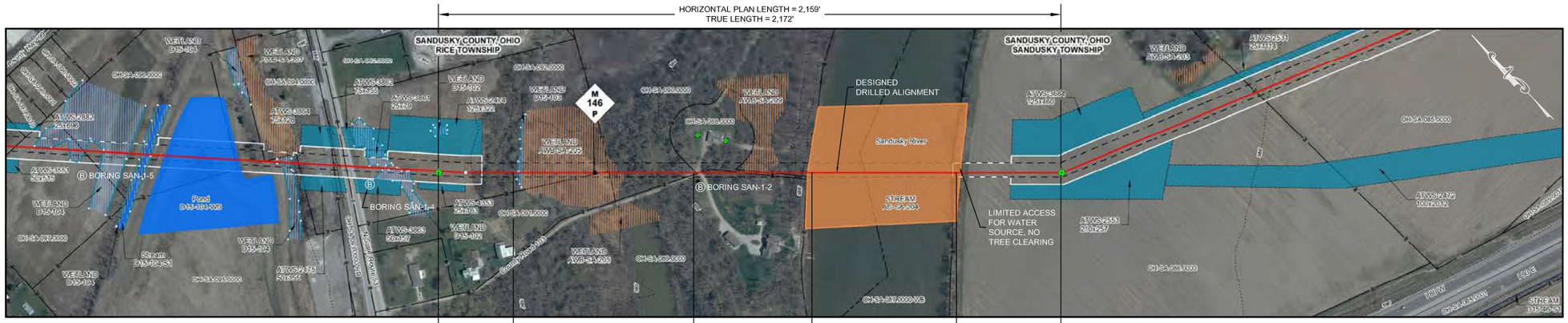
Ream and Pull Back								
Pass Description =	24-inch	36-inch	48-inch			Swab	Pull Back	Total
Travel Speed, feet/minute =	0.3	0.3	0.3			8.0	6.0	
Mud Flow Rate, barrels/minute =	15.0	15.0	15.0			15.0	15.0	
shifts/day =	1	1	1			1	1	
Reaming Duration, hours =	147.1	147.1	147.1			6.9	8.4	456.6
shifts =	12.3	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

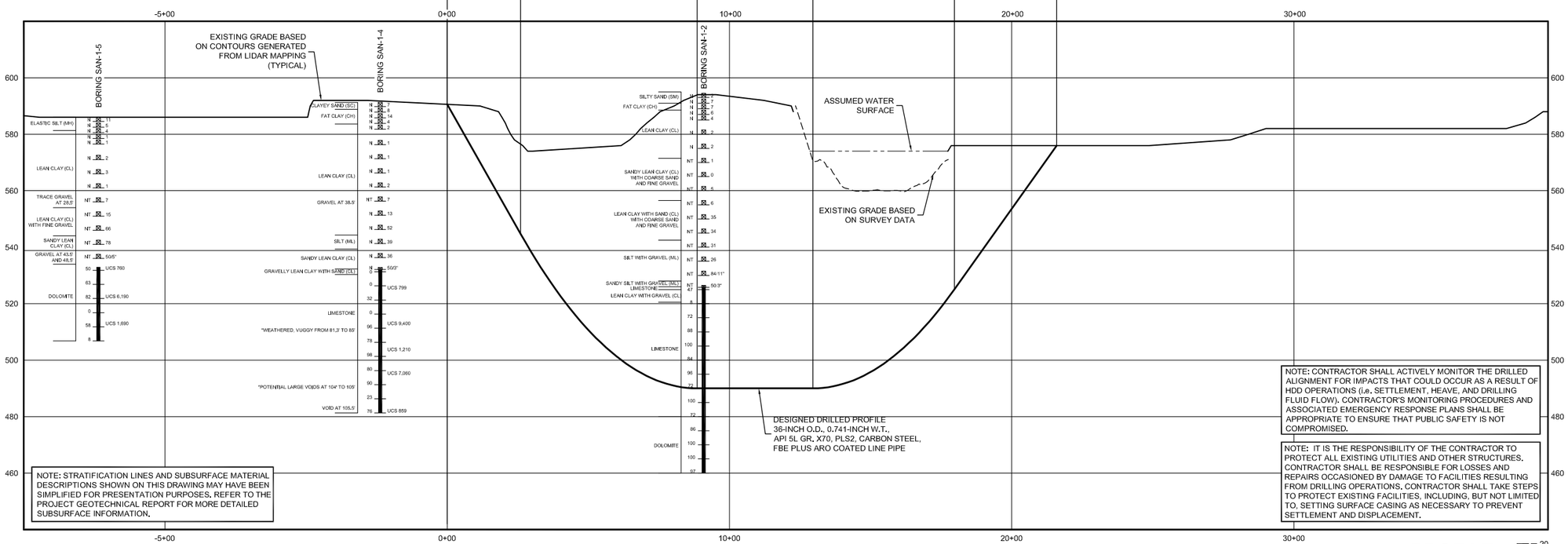
P.C. 10° SAG BEND
2+60.26, 544.69
RADIUS = 3,600'

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.

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
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 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.

PROFILE

SCALE: 1" = 200' HORIZONTAL
1" = 20' VERTICAL

500 400 300 200 100 0
20 10 0

FOR INFORMATION ONLY - NOT FOR CONSTRUCTION

DWG. NO.	REFERENCE DWG.	REV	DSN	CK	DESCRIPTION
CLYD–A–1161	ALIGNMENT SHEET M.P. 145.34 TO M.P. 146.29	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	08/24		
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 GAS TRANSMISSION

M.P. 145.7 | W.O. | SCALE: AS SHOWN | DWG. CLYD–H–1010 | REV. 0

RIGHT-OF-WAY

TRACT NUMBERS

Start STA.	Tract	Length	Rods	End STA.
7624+21	OH-SA-078.0000	188 FT.	11.4 RODS	7626+09
7626+09	OH-SA-079.0000-RD	24 FT.	1.5 RODS	7626+33
7626+33	OH-SA-080.0000	1251 FT.	75.8 RODS	7638+84
7638+84	OH-SA-081.0000	417 FT.	25.3 RODS	7643+01
7643+01	OH-SA-082.0000-RD	239 FT.	14.5 RODS	7645+39
7645+39	OH-SA-081.0000	23 FT.	1.4 RODS	7645+62
7645+62	OH-SA-083.0000	410 FT.	24.8 RODS	7649+72
7649+72	OH-SA-081.0000	1910 FT.	115.8 RODS	7668+82
7668+82	OH-SA-084.0000-RD	18 FT.	1.1 RODS	7669+01
7669+01	OH-SA-085.0000	520 FT.	31.5 RODS	7674+21

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

STA. 7625+25 ROAD EDGE
STA. 7625+51 ROAD EDGE
STA. 7626+10 ROAD EDGE
STA. 7626+19 PAVED, CR 188 CENTERLINE
STA. 7626+28 ROAD EDGE
STA. 7626+31 TOP BANK
STA. 7626+50 DITCH, DEPTH 0.2 FT. CENTERLINE
STA. 7626+58 TOP BANK
STA. 7627+08 ROAD EDGE
STA. 7627+39 ROAD EDGE
STA. 7638+71 PI ~ 90°0'0" RT
STA. 7642+98 FENCE
STA. 7643+86 I 80 E CENTERLINE (SCALED)
STA. 7644+53 I 80 W CENTERLINE (SCALED)
STA. 7646+93 PI ~ 89°59'59" LT
STA. 7653+31 PI ~ 44°59'59" RT
STA. 7665+90 PI ~ 60°0'0" LT
STA. 7668+61 TOP BANK
STA. 7668+65 DITCH, DEPTH 0 FT. CENTERLINE
STA. 7668+75 TOP BANK
STA. 7668+85 PAVED, CR 234 CENTERLINE
STA. 7668+94 TOP BANK
STA. 7669+01 DITCH, DEPTH 0 FT. CENTERLINE
STA. 7669+02 TOP BANK
STA. 7669+05 POWERLINE, CLEARANCE 22 FT.

CLASS LOCATION

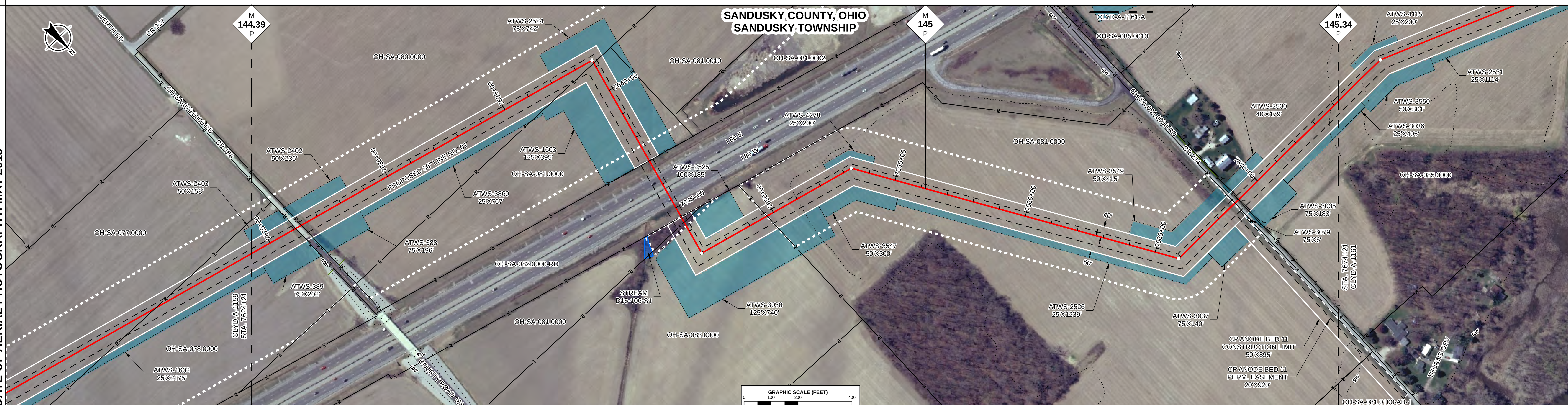
Class 1

PIPE MATERIAL

ALIGNMENT LEGEND

PIPELINE MILEPOST
PROPOSED NEXUS PIPELINE
INTERCONNECTING PIPELINE TO TGP
CONSTRUCTION LIMIT
STUDY CORRIDOR
STAGING AREA
WAREYARD
PERMANENT ROW
ADDITIONAL TEMPORARY WORKSPACE
METERING & REGULATION STATION (M&R) SITE
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
PROPERTY LINE
CONTOUR
MUNICIPALITY LINE
FENCE
FOREIGN PIPELINE
POWERLINE
WATER PIPELINE
RAILROAD TRACK
TELEPHONE LINE
TEE TAP — UTILITY LINES
BLOW OFF VALVE — MAINLINE VALVE (MLV)
TOWER — MICROWAVE TOWER
HORIZONTAL DIRECTIONAL DRILL ENTRY/EXIT
TANK — LIGHT POLE — FIRE HYDRANT
WELL: GAS — WATER — OIL — UNKNOWN

DATE OF AERIAL PHOTOGRAPHY: MAY 2015



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

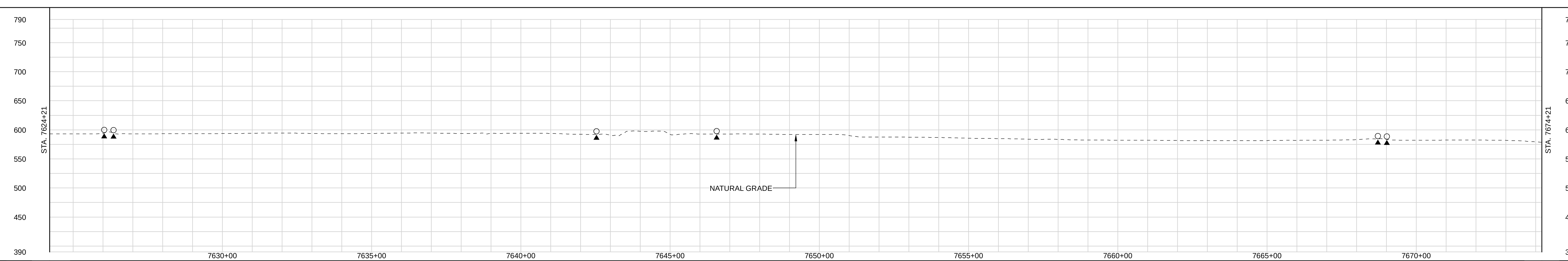
PROFILE

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING			
%SLOPE	SLOPE BREAKER SPACING (FT)	%SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	< 5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
> 30%	100 FT	15-30%	200 FT
		> 30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)



LAND USE CLASSIFICATION

AG	AGRICULTURAL	OL	OPEN LAND	I/C	INDUSTRIAL/COMMERCIAL
F/W	FOREST/WOODLAND	R	RESIDENTIAL	OW	OPEN WATER

SOILS

LAND USE: AG | I/C | OL | AG | OL | I/C | OL | AG | OL | I/C | OL | AG

% SLOPE: < 5%

DWG. NO.	DESCRIPTION
APPENDIX IA-4	SITE SPECIFIC RESIDENTIAL CROSSING PLANS

REFERENCE DRAWINGS

REV	DSN	CK	DESCRIPTION
0A			ISSUED FOR FERC FILING (11/2015)
0			ISSUED FOR FERC FILING (11/2015)

REVISIONS

ITEM	DESCRIPTION	QTY

MATERIALS

GENERAL NOTES:

1.) ALL STATIONING IS IN U.S. FEET.

2.) CONTOUR LINES AND ELEVATIONS ARE IN U.S. FEET.

ENGINEERING APPROVALS

DRAWN BY:	BID		CONSTRUCTION	
NAME	SIGNATURE	DATE	SIGNATURE	DATE

CLYD - WATE
NEXUS PROJECT
PROPOSED 36" LINE NO. 01
ALIGNMENT SHEET

LOC. SANDUSKY COUNTY, OHIO

NEXUS GAS TRANSMISSION

YEAR: 2017	W.B.S.	Scale 1" = 200'	CLYD-A-1160	REV. 0A

IG.#

P:\295_UPSTREAM_PIPELINE\295K_GIS\TurboRoute\ NEXUS PROPOSED MAINLINE PIPELINE 160 of 278.pdf - PLOT TIME: 2015-09-16 10:28:32

RIGHT-OF-WAY

TRACT NUMBERS

7674+21 | OH-SA-085.0000 1111 FT. 67.3 RODS | 7685+32 | OH-SA-086.0000 1112 FT. 67.4 RODS | 7696+44 | OH-SA-087.0000-WB 499 FT. 30.2 RODS | 7701+43 | OH-SA-090.0000 121 FT. 7.3 RODS | 7702+64 | OH-SA-088.0000 95 FT. 5.8 RODS | 7703+59 | OH-SA-089.0000 158 FT. 9.6 RODS | 7705+17 | OH-SA-088.0000 12 FT. 0.7 RODS | 7705+29 | OH-SA-090.0000 301 FT. 18.2 RODS | 7708+30 | OH-SA-091.0000 30 FT. 1.8 RODS | 7708+60 | OH-SA-092.0000 883 FT. 53.5 RODS | 7717+43 | OH-SA-093.0000-RD 43 FT. 2.6 RODS | 7717+86 | OH-SA-094.0000 122 FT. 7.4 RODS | 7719+08 | OH-SA-095.0000 220 FT. 13.3 RODS | 7721+28 | OH-SA-096.0000 293 FT. 17.8 RODS | 7724+21

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

STA. 7676+38 PI – 22°30'0" RT | STA. 7692+63 PI – 22°30'0" RT STA. 7692+64 HDD EXIT | STA. 7699+45 MUNICIPALITY LINE | STA. 7705+34 COUNTY ROAD 103 CENTERLINE (SCALED) | STA. 7713+27 PI – 21°0'3" RT STA. 7713+28 HDD ENTRY | STA. 7717+09 TOE BANK STA. 7717+13 TOP BANK STA. 7717+20 ROAD EDGE STA. 7717+29 PAVED, SH 53 STA. 7717+30 CENTERLINE | STA. 7717+59 ROAD EDGE STA. 7717+60 TOP BANK STA. 7717+70 TOE BANK STA. 7717+75 POWERLINE CLEARANCE 17 FT. | STA. 7720+83 TOE BANK STA. 7721+02 TOP BANK | STA. 7723+83 TOP BANK STA. 7723+99 TOE BANK STA. 7724+05 TOE BANK

CLASS LOCATION

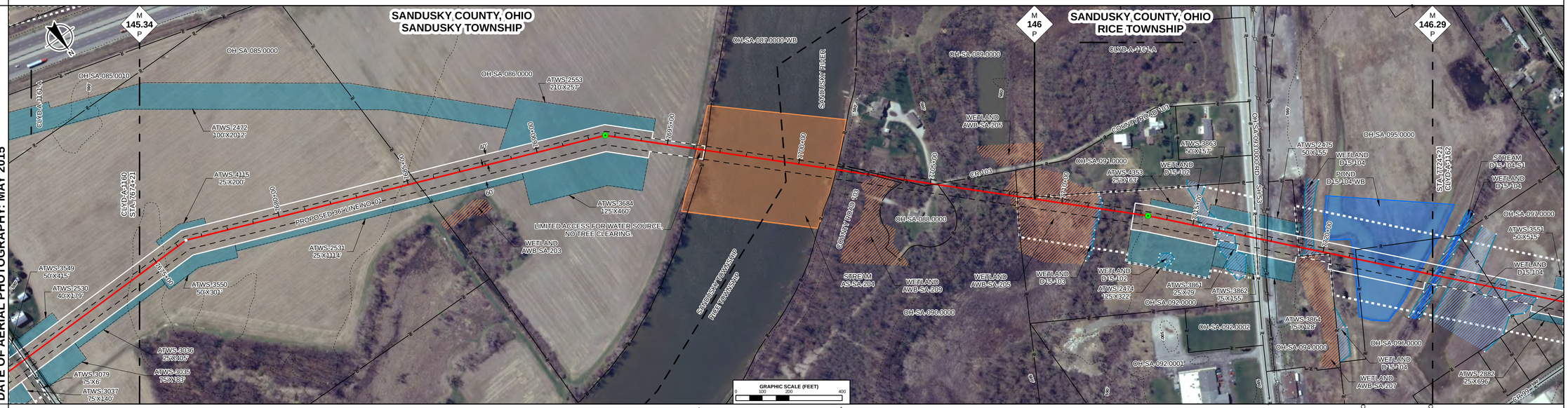
Class 1 | Class 2 | Class 3

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED NEXUS PIPELINE
- INTERCONNECTING PIPELINE TO TGP
- CONSTRUCTION LIMIT
- STUDY CORRIDOR
- STAGING AREA
- WAREYARD
- PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- METERING & REGULATION STATION (M&R) SITE
- 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)
- PROPERTY LINE
- CONTOUR
- MUNICIPALITY LINE
- FENCE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- TELEPHONE LINE
- TEE TAP
- UTILITY LINES
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- TOWER
- MICROWAVE TOWER
- HORIZONTAL DIRECTIONAL DRILL ENTRY/EXIT
- TANK
- LIGHT POLE
- FIRE HYDRANT
- WELL: GAS / WATER / OIL / UNKNOWN

DATE OF AERIAL PHOTOGRAPHY: MAY 2015



ENVIRONMENTAL DATA

STA. 7696+11 STREAM SANDUSKY RIVER AS-SA-204 ENTER | STA. 7701+44 STREAM SANDUSKY RIVER AS-SA-204 EXIT | STA. 7702+44 WETLAND AWB-SA-209 ENTER | STA. 7703+68 WETLAND AWB-SA-209 EXIT | STA. 7707+78 WETLAND AWB-SA-205 ENTER | STA. 7711+30 WETLAND D15-103 ENTER | STA. 7711+53 WETLAND AWB-SA-207 EXIT | STA. 7711+49 WETLAND D15-103 EXIT | STA. 7714+00 WETLAND D15-102 ENTER | STA. 7714+57 WETLAND D15-102 EXIT | STA. 7715+08 WETLAND D15-102 ENTER | STA. 7717+29 WETLAND D15-102 EXIT | STA. 7719+19 WETLAND D15-104 ENTER | STA. 7719+20 WETLAND AWB-SA-207 ENTER | STA. 7719+84 WETLAND D15-104 EXIT | STA. 7719+98 WETLAND AWB-SA-207 EXIT | STA. 7721+05 POND TRIBUTARY TO SANDUSKY RIVER D15-104-WB ENTER | STA. 7722+60 POND TRIBUTARY TO SANDUSKY RIVER D15-104-WB EXIT | STA. 7724+10 WETLAND D15-104 ENTER

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

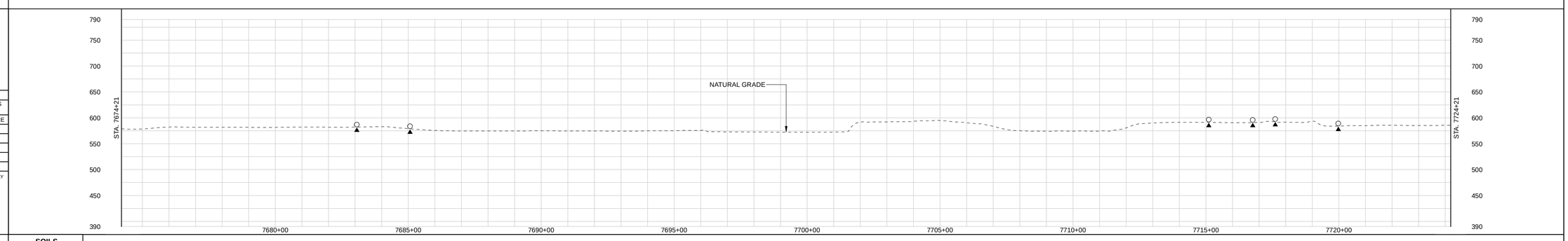
THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

PERMANENT SLOPE BREAKER & TRENCH PLUG SPACING

%SLOPE	SLOPE BREAKER SPACING (FT)	%SLOPE	TRENCH PLUG SPACING (FT)
5-15%	300 FT	< 5%	NO STRUCTURE
15-30%	200 FT	5-15%	300 FT
> 30%	100 FT	15-30%	200 FT
		> 30%	100 FT

IN AG FIELDS AND RESIDENTIAL AREAS WHERE SLOPE BREAKERS ARE NOT TYPICALLY REQUIRED, INSTALL PERMANENT TRENCH PLUGS AT THE SAME SPACING AS IF PERMANENT SLOPE BREAKERS WERE REQUIRED. (FERC PLAN)



LAND USE CLASSIFICATION

AG AGRICULTURAL | OL OPEN LAND | I/C INDUSTRIAL/COMMERCIAL
F/W FOREST/WOODLAND | R RESIDENTIAL | OW OPEN WATER

SOILS																							
LAND USE	AG	OL	OW	F/W	R	F/W	OL	F/W	AG	I/C	OL	OW	OL
% SLOPE	< 5%	15-30%	< 5%	5-15%	< 5%	5-15%	< 5%	5-15%	< 5%	5-15%	< 5%

GENERAL NOTES:

1.) ALL STATIONING IS IN U.S. FEET.

2.) CONTOUR LINES AND ELEVATIONS ARE IN U.S. FEET.

DRAWN BY:		ENGINEERING APPROVALS			
		BID		CONSTRUCTION	
NAME		SIGNATURE	DATE	SIGNATURE	DATE

CLYD - WATE
NEXUS PROJECT
PROPOSED 36" LINE NO. 01
ALIGNMENT SHEET

LOC. SANDUSKY COUNTY, OHIO

NEXUS GAS TRANSMISSION

YEAR: 2017	W.B.S.	Scale 1" = 200'	CLYD-A-1161	REV. 0A

DWG. NO.	DESCRIPTION	REV	DSN	CK	DESCRIPTION	ITEM	DESCRIPTION	QTY
		0A			ISSUED FOR FERC FILING (11/2015)			
APPENDIX IA-5	HDD CROSSING PLANS	0			ISSUED FOR FERC FILING (11/2015)			
REFERENCE DRAWINGS		REVISIONS				MATERIALS		

P:\205_UPSTREAM_PIPELINE\205K_CDS\TurboRoute\NEXUS PROPOSED MAINLINE PIPELINE 161 of 278.pdf, PLOT TIME: 2015-09-16 11:11:59

IG.#

RIGHT-OF-WAY

TRACT NUMBERS

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

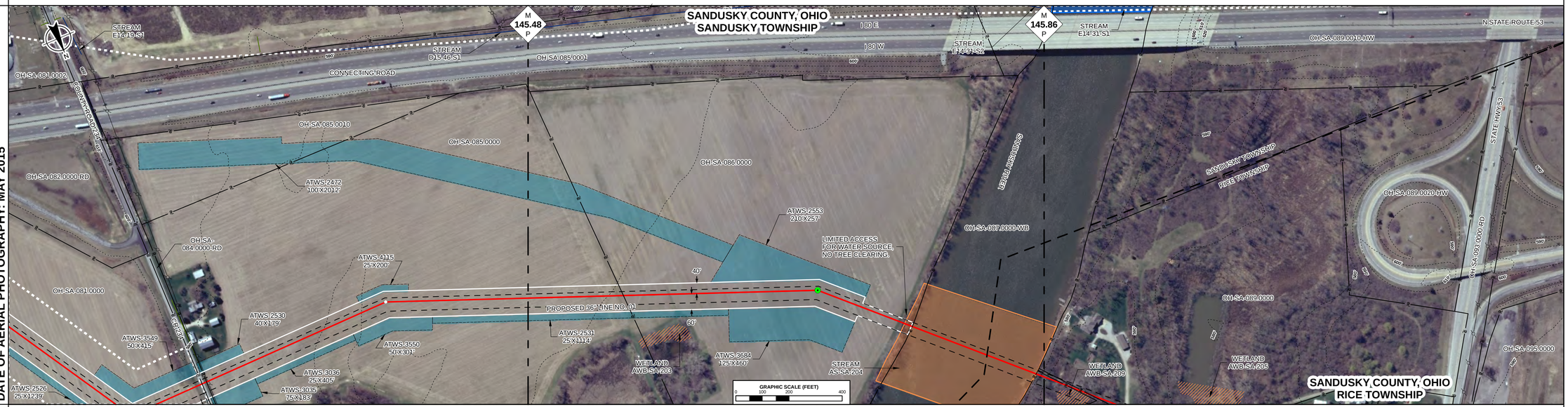
CLASS LOCATION

PIPE MATERIAL

ALIGNMENT LEGEND

- PIPELINE MILEPOST
- PROPOSED NEXUS PIPELINE
- INTERCONNECTING PIPELINE TO TGP
- CONSTRUCTION LIMIT
- STUDY CORRIDOR
- STAGING AREA
- WAREYARD
- PERMANENT ROW
- ADDITIONAL TEMPORARY WORKSPACE
- METERING & REGULATION STATION (M&R) SITE
- 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)
- PROPERTY LINE
- CONTOUR
- MUNICIPALITY LINE
- FENCE
- FOREIGN PIPELINE
- POWERLINE
- WATER PIPELINE
- RAILROAD TRACK
- TELEPHONE LINE
- TEE TAP
- UTILITY LINES
- BLOW OFF VALVE
- MAINLINE VALVE (MLV)
- TOWER
- MICROWAVE TOWER
- HORIZONTAL DIRECTIONAL DRILL ENTRY/EXIT
- TANK
- LIGHT POLE
- FIRE HYDRANT
- WELL: GAS
- WATER
- OIL
- UNKNOWN

DATE OF AERIAL PHOTOGRAPHY: MAY 2015



ENVIRONMENTAL DATA

E & S TYPICALS

E&S TYPICALS WILL BE USED AS A PLAN AND WILL HAVE FURTHER INPUT FROM ENVIRONMENTAL INSPECTOR.

PROFILE

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD.

SLOPE BREAKERS ○
TRENCH PLUG ▲

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LAND USE CLASSIFICATION

AG	AGRICULTURAL	OL	OPEN LAND	I/C	INDUSTRIAL/COMMERCIAL
F/W	FOREST/WOODLAND	R	RESIDENTIAL	OW	OPEN WATER

SOILS
LAND USE
% SLOPE

DWG. NO.	DESCRIPTION
APPENDIX IA-4	SITE SPECIFIC RESIDENTIAL CROSSING PLANS
CLYD-A-1161	ALIGNMENT SHEET
APPENDIX IA-5	HDD CROSSING PLANS

REFERENCE DRAWINGS

REV	DSN	CK	DESCRIPTION
0A			ISSUED FOR FERC FILING (11/2015)
0			ISSUED FOR FERC FILING (11/2015)

REVISIONS

ITEM	DESCRIPTION	QTY

MATERIALS

GENERAL NOTES:

1.) ALL STATIONING IS IN U.S. FEET.

2.) CONTOUR LINES AND ELEVATIONS ARE IN U.S. FEET.

DRAWN BY:

NAME	ENGINEERING APPROVALS BID SIGNATURE	BID DATE	CONSTRUCTION SIGNATURE	CONSTRUCTION DATE

CLYD - WATE
NEXUS PROJECT
PROPOSED 36" LINE NO. 01
ALIGNMENT SHEET

LOC. SANDUSKY COUNTY, OHIO

NEXUS GAS TRANSMISSION

YEAR: 2017 | W.B.S. | Scale 1" = 200' | CLYD-A-1161-A | REV. 0A

IG.#

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RIGHT-OF-WAY

TRACT NUMBERS

Station	Tract	Length	Rods
7724+21 – 7726+54	OH-SA-096.0000	233 FT.	14.1 RODS
7726+54 – 7728+92	OH-SA-097.0000	238 FT.	14.4 RODS
7728+92 – 7734+52	OH-SA-098.0000	560 FT.	33.9 RODS
7734+52 – 7734+69	OH-SA-099.0000-RD	17 FT.	1.0 RODS
7734+69 – 7747+73	OH-SA-100.0000	1304 FT.	79.0 RODS
7747+73 – 7762+47	OH-SA-101.0000	1474 FT.	89.3 RODS
7762+47 – 7770+90	OH-SA-102.0000	843 FT.	51.1 RODS

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

STA. 7724+28 TOP BANK
STA. 7724+41 TOP BANK
STA. 7724+54 TOE BANK
STA. 7724+97 TOE BANK

STA. 7730+64 PI ~ 44°59'59" LT

STA. 7734+23 POWERLINE, CLEARANCE 18 FT.
STA. 7734+32 TOE BANK
STA. 7734+39 MUNICIPALITY LINE
STA. 7734+42 TOP BANK
STA. 7734+50 PAVED, CR 170 CENTERLINE
STA. 7734+71 DITCH, DEPTH 0 FT. CENTERLINE
STA. 7734+75 POWERLINE, CLEARANCE 19 FT.

STA. 7742+69 PI ~ 22°30'0" LT

STA. 7745+93 TOP BANK
STA. 7746+02 DITCH, DEPTH 0.6 FT. CENTERLINE
STA. 7746+14 TOP BANK

STA. 7762+53 POWERLINE, CLEARANCE 34 FT.

STA. 7768+65 PI ~ 44°59'59" LT

CLASS LOCATION

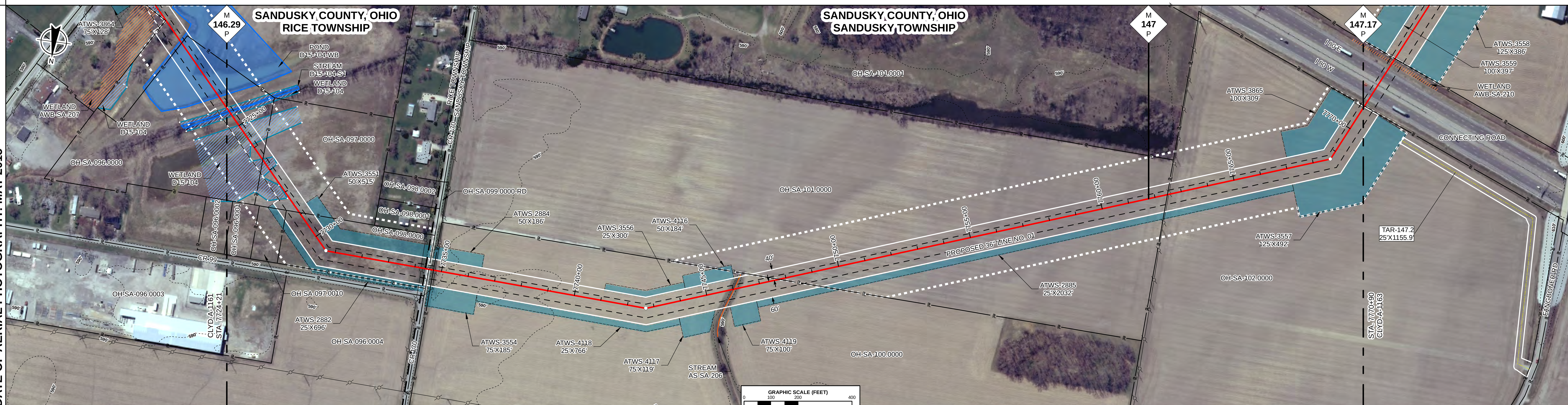
Class 3 | Class 2 | Class 1

PIPE MATERIAL

ALIGNMENT LEGEND

PIPELINE MILEPOST
PROPOSED NEXUS PIPELINE
INTERCONNECTING PIPELINE TO TGP
CONSTRUCTION LIMIT
STUDY CORRIDOR
STAGING AREA
WAREYARD
PERMANENT ROW
ADDITIONAL TEMPORARY WORKSPACE
METERING & REGULATION STATION (M&R) SITE
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
PROPERTY LINE
CONTOUR
MUNICIPALITY LINE
FENCE
FOREIGN PIPELINE
POWERLINE
WATER PIPELINE
RAILROAD TRACK
TELEPHONE LINE
TEE TAP — UTILITY LINES
BLOW OFF VALVE — MAINLINE VALVE (MLV)
TOWER — MICROWAVE TOWER
HORIZONTAL DIRECTIONAL DRILL ENTRY/EXIT
TANK — LIGHT POLE — FIRE HYDRANT
WELL: GAS — WATER — OIL — UNKNOWN

DATE OF AERIAL PHOTOGRAPHY: MAY 2015



ENVIRONMENTAL DATA

STA. 7724+23 STREAM TRIB TO SANDUSKY RIVER D15-104-S1 ENTER
STA. 7724+52 STREAM TRIB TO SANDUSKY RIVER D15-104-S1 EXIT
STA. 7724+66 WETLAND D15-104 EXIT
STA. 7724+88 WETLAND D15-104 ENTER
STA. 7726+21 WETLAND D15-104 EXIT
STA. 7726+36 WETLAND D15-104 ENTER
STA. 7727+07 WETLAND D15-104 EXIT
STA. 7727+11 WETLAND D15-104 ENTER
STA. 7728+24 WETLAND D15-104 EXIT

STA. 7746+04 CENTERLINE OF STREAM AS-SA-206 TRIBUTARY TO GREESMAN DITCH

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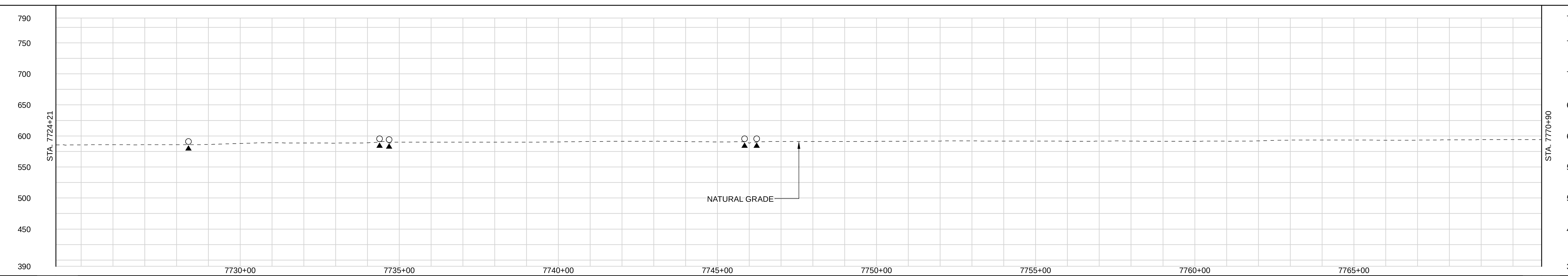

LAND USE CLASSIFICATION

AG	AGRICULTURAL	OL	OPEN LAND	I/C	INDUSTRIAL/COMMERCIAL
F/W	FOREST/WOODLAND	R	RESIDENTIAL	OW	OPEN WATER

SOILS

LAND USE: OL | OW | AG | I/C | OL | AG | OL | OW | OL | AG

% SLOPE: < 5%

DWG. NO.	DESCRIPTION
APPENDIX IA-4	SITE SPECIFIC RESIDENTIAL CROSSING PLANS

REFERENCE DRAWINGS

REV	DSN	CK	DESCRIPTION
0B			ISSUED FOR FERC FILING (11/2015)
0A			ISSUED FOR FERC FILING (11/2015)
0			ISSUED FOR FERC FILING (11/2015)

REVISIONS

ITEM	DESCRIPTION	QTY

MATERIALS

GENERAL NOTES:

1.) ALL STATIONING IS IN U.S. FEET.

2.) CONTOUR LINES AND ELEVATIONS ARE IN U.S. FEET.

ENGINEERING APPROVALS

DRAWN BY:	BID		CONSTRUCTION	
NAME	SIGNATURE	DATE	SIGNATURE	DATE

CLYD - WATE
NEXUS PROJECT
PROPOSED 36" LINE NO. 01
ALIGNMENT SHEET

LOC. SANDUSKY COUNTY, OHIO

NEXUS GAS TRANSMISSION

YEAR: 2017	W.B.S.	Scale 1" = 200'	CLYD-A-1162	REV. 0B

IG.#

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