NEXUS GAS TRANSMISSION PROJECT

RESOURCE REPORT 9

Air and Noise Quality

FERC Docket No. PF15-10-000

Pre-filing Draft
June 2015

NOTICE TO PUBLIC STAKEHOLDER REVIEWERS

This Draft Resource Report for the NEXUS Gas Transmission Project ("Project") is being filed as part of the Federal Energy Regulatory Commission's ("FERC's") pre-filing process. The pre-filing process allows interested stakeholders, FERC, and regulatory agency staff to engage in early dialogue to identify affected stakeholders, facilitate early issue identification and resolution, provide multiple opportunities for public meetings (e.g., open houses), and support the preparation of high-quality environmental Resource Reports and related documents that describe the Project, assess its potential impacts, identify measures to avoid and mitigate impacts, and analyze alternatives to the Project.

Since the initial filing of Draft Resource Report 1 (Project Description) and 10 (Alternatives) on January 23, 2015, NEXUS hosted eight Open Houses along the proposed pipeline route to inform stakeholders about the proposed Project and to answer questions. FERC staff also hosted six independent Public Scoping Meetings along the proposed route in April and May of 2015, as part of the National Environmental Policy Act ("NEPA") compliance process. This Draft Resource Report may contain items that are highlighted in grey that will be filed when NEXUS files its NGA 7(c) Certificate Application with the Commission in November 2015.

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Filing Requirement	**Location in Environmental Report**
☒ Describe existing air quality in the vicinity of the project. (§ 380.12(k)(1)) • Identify criteria pollutants that may be emitted above EPA-identified significance levels.	Section 9.2.3 and Section 9.2.4
☒ Quantify the existing noise levels (day-night sound level (L_{dn}) and other applicable noise parameters) at noise sensitive areas and at other areas covered by relevant state and local noise ordinances. (§ 380.12(k)(2)) • If new compressor station sites are proposed, measure or estimate the existing ambient sound environment based on current land uses and activities. • For existing compressor stations (operated at full load), include the results of a sound level survey at the site property line and nearby noise-sensitive areas. • Include a plot plan that identifies the locations and duration of noise measurements. • All surveys must identify the time of day, weather conditions, wind speed and direction, engine load, and other noise sources present during each measurement.	Section 9.3.4 • Section 9.3.4 and Appendix 9F • N/A • Appendix 9F • Appendix 9F
☒ Quantify existing and proposed emissions of compressor equipment, plus construction emissions, including nitrogen oxides (NO_X) and carbon monoxide (CO), and the basis for these calculations. Summarize anticipated air quality impacts for the project. (§ 380.12(k)(3)) • Provide the emission rate of NO_X from existing and proposed facilities, expressed in pounds per hour and tons per year for maximum operating conditions, include supporting calculations, emission factors, fuel consumption rate, and annual hours of operation.	Section 9.2.5, Appendix 9A [*Not included in this Filing*], and Appendix 9E [*Not included in this Filing*]
☒ Describe the existing compressor units at each station where new, additional, or modified compressor units are proposed, including the manufacturer, model number, and horsepower of the compressor units. For proposed new, additional, or modified compressor units include the horsepower, type, and energy source. (§ 380.12(k)(4))	Section 9.2.1
☒ Identify any nearby noise-sensitive area by distance and direction from the proposed compressor unit building/enclosure. (§ 380.12(k)(4))	Section 9.3.1 and Appendix 9F
☒ Identify any applicable state or local noise regulations. (§ 380.12(k)(4)) • Specify how the facility will meet the regulations.	Section 9.3.3
☒ Calculate the noise impact at noise-sensitive areas of the proposed compressor unit modifications or additions, specifying how the impact was calculated, including manufacturer's data and proposed noise control equipment. (§ 380.12(k)(4))	Section 9.3.4, Section 9.3.5, and Appendix 9F
Additional Information Often Missing and Resulting in Data Requests	
☒ Provide copies of application for state air permits and agency determinations, as appropriate.	Appendix 9A [*Not included in this Filing*]
☒ For major sources of air emissions (as defined by the EPA), provide copies of applications for permits to construct (and operate, if applicable) or for applicability determinations under regulations for the prevention of significant air quality deterioration and subsequent determinations.	N/A

RESOURCE REPORT 9 – AIR AND NOISE QUALITY	
Filing Requirement	**Location in Environmental Report**
☒ Describe measures and manufacturer's specifications for equipment proposed to mitigate impact to air and noise quality, including emission control systems, installation of filters, mufflers, or insulation of piping and building, and orientation of equipment away from noise-sensitive areas.	Section 9.2.5 and Section 9.3.5
☒ Provide greenhouse gas emission estimates for both construction and operation activities associated with the project.	Section 9.2.5, Appendix 9A [*Not included in this Filing*], and Appendix 9E [*Not included in this Filing*]
☒ Provide construction emission estimates resulting from all construction activities associated with the project.	Appendix 9E [*Not included in this Filing*]

ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
API *Compendium*	American Petroleum Institute *Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry*, August 2009
AQCR	air quality control region
A-wt.	A-weighted
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
dB	decibels
dBA	A-weighted decibels
DTE	DTE Energy Company
DTE Energy	DTE Energy Company
EGU	electric generating unit
FCVs	flow-control valves
FERC	Federal Energy Regulatory Commission
GHG	greenhouse gas
HAP	hazardous air pollutant
HDD	horizontal directional drilling
hp	horsepower
ICE	internal combustion engine
ISO	International Standard Operations
km	kilometers
L_{eq}	equivalent sound level in decibels
M&R	metering and regulating
MDEQ	Michigan Department of Environmental Quality
MMBtu/hr	million British thermal units per hour
MP	milepost
MPSC	Michigan Public Service Commission
NAAQS	National Ambient Air Quality Standards
NCDC	National Climatic Data Center
NESHAP	National Emission Standards for Hazardous Air Pollutants
NEXUS	NEXUS Gas Transmission, LLC
NEXUS Project	NEXUS Gas Transmission Project
NNSR	nonattainment area NSR
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
NSAs	noise-sensitive areas
NSPS	New Source Performance Standards
NSPS JJJJ	40 CFR Part 60, Subpart JJJJ
NSR	New Source Review
O_3	ozone
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency

Pb	lead
pCi/L	picocuries per liter
PD	pressure drop
PM	particulate matter
PM_{10}	particulate matter with a diameter $\leq$ 10 microns
$PM_{2.5}$	particulate matter with a diameter $\leq$ 2.5 microns
Project	NEXUS Gas Transmission Project
PSD	Prevention of Significant Deterioration
PTE	potential to emit
PTI	Permit-to-Install
PTIO	Permit-to-Install and Operate
PTO	Permit-to-Operate
RACT	Reasonably Available Control Technology
RICE	reciprocating internal combustion engine(s)
ROP	Renewable Operating Permit
RSI	Risk Sciences International
SER	significant emission rate
SI ICE	spark-ignition internal combustion engine
SIP	State Implementation Plan
SO_2	sulfur dioxide
Solar	Solar Turbines, Inc.
Spectra	Spectra Energy Partners, LP
Spectra Energy	Spectra Energy Partners, LP
Texas Eastern	Texas Eastern Transmission, LP
TGP	Tennessee Gas Pipeline L.L.C.
Title V PTO	Title V Permit-to-Operate
TPY	tons per year
U.S.	United States
USDOE	U.S. Department of Energy
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOC	volatile organic compound(s)

9.0 RESOURCE REPORT 9 – AIR AND NOISE QUALITY

9.1 Introduction

NEXUS Gas Transmission, LLC ("NEXUS") is seeking a Certificate of Public Convenience and Necessity ("Certificate") from the Federal Energy Regulatory Commission ("FERC") pursuant to Section 7(c) of the Natural Gas Act ("NGA") 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 ("Spectra" or "Spectra Energy") 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 billion cubic feet 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 ("Dawn"). Through interconnections with existing pipelines, shippers on the NEXUS Project will also be able to reach the Chicago Hub in Illinois and other Midwestern markets. The United States ("U.S.") portion of the NEXUS Project will traverse Pennsylvania, West Virginia, Ohio and Michigan, terminating at the 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 Dawn. A more detailed description of the Project is set forth in Draft Resource Report 1.

This Draft Resource Report 9 addresses air quality (Section 9.2) and noise effects (Section 9.3) related to the construction and operation of the proposed Project facilities. A checklist showing the status of the FERC filing requirements for Draft Resource Report 9 is included in the table of contents.

Project drawings, maps, alignment sheets, and aerials are provided in Draft Resource Report 1, Appendix 1A – Volume II-B.

9.2 Air Quality

The following subsections discuss air emissions and related effects associated with Project construction activities as well as from operation of stationary equipment proposed at Project facilities. Topics discussed within this section include proposed facilities and stationary equipment, existing ambient air quality, applicable permitting and regulatory requirements, air emissions, anticipated air quality effects, and potential air quality mitigation measures.

9.2.1 Aboveground Facilities

9.2.1.1 Compressor Stations

Four new compressor stations are proposed for the Project. The design of the compressor stations includes the following air emission sources at each facility. All horsepower ("hp") ratings for compressor turbines are provided using National Electrical Manufacturers Association ratings.

Hanoverton Compressor Station - Columbiana County, Ohio

The proposed Hanoverton Compressor Station will include the following point source emissions units:

- Two (2) 26,000 hp (52,000 hp total) Titan 250-30002 natural gas-fired turbine compressor units, manufactured by Solar Turbines, Inc. ("Solar");
- One (1) 1.2 million British thermal units per hour ("MMBtu/hr") natural gas-fired turbine compressor fuel heater; and
- One (1) Waukesha VGF48GL natural gas-fired emergency generator with a power output rating of 1,175 hp.

Wadsworth Compressor Station - Medina County, Ohio

The proposed Wadsworth Compressor Station will include the following point source emissions units:

- One (1) 26,000 hp Solar Titan 250-30002 natural gas-fired turbine compressor unit;
- One (1) 1.2 MMBtu/hr natural gas-fired turbine compressor fuel heater; and
- One (1) Waukesha VGF36GL natural gas-fired emergency generator with a power output rating of 880 hp.

Clyde Compressor Station - Sandusky County, Ohio

The proposed Clyde Compressor Station will include the following point source emissions units:

- One (1) 26,000 hp Solar Titan 250-30002 natural gas-fired turbine compressor unit;
- One (1) 1.2 MMBtu/hr natural gas-fired turbine compressor fuel heater; and
- One (1) Waukesha VGF36GL natural gas-fired emergency generator with a power output rating of 880 hp.

Waterville Compressor Station - Lucas County, Ohio

The proposed Waterville Compressor Station will include the following point source emissions units:

- One (1) 26,000 hp Solar Titan 250-30002 natural gas-fired turbine compressor unit;
- One (1) 1.2 MMBtu/hr natural gas-fired turbine compressor fuel heater; and
- One (1) Waukesha VGF36GL natural gas-fired emergency generator with a power output rating of 880 hp.

Included with the new turbine compressor units at the four Project compressor stations will be lube oil coolers, turbine exhaust systems, turbine air intake systems, and unit control panels. Operation of the new compressor units is not expected to have any significant impact on air quality. To minimize potential air quality effects, all of the new compressor turbines will be equipped with Solar's SoLoNO$_X$ emissions control technology. This technology incorporates low nitrogen oxides ("NO_X") combustors to limit emissions of NO_X and also limits emissions of carbon monoxide ("CO") and other pollutants. The new turbines will also be equipped with oxidation catalysts to further reduce CO, volatile organic compounds ("VOC"), and hazardous air pollutant ("HAP") emissions. Table 9.2-1 provides a summary of proposed compression facilities for the Project.

9.2.1.2 Other Aboveground Facilities

NEXUS will construct four new metering and regulating ("M&R") stations as presented in Table 1.1-2 of Draft Resource Report 1. Three of the new M&R stations (NEXUS/Kensington M&R Station, NEXUS/Texas Eastern M&R Station, and NEXUS/TGP M&R Station) will be constructed in Columbiana County, Ohio; and the fourth (NEXUS/Willow Run M&R Station) will be constructed in Washtenaw County, Michigan. The new M&R stations will contain meter runs with gas flow meters, regulator runs with flow- and pressure-control valves for measuring and controlling gas flow and regulating gas pressures, isolation block valves, and associated instrumentation/controls. Each of the new M&R stations will also include a small emergency generator with a natural gas-fired fuel heater.

There are other additional aboveground facilities proposed as part of NEXUS such as launcher and receiver facilities and mainline valve sites as presented in Table 1.1-2 of Draft Resource Report 1.

9.2.2 New Pipeline Facilities

The Project includes construction of approximately 250 miles of new 36-inch diameter natural gas transmission mainline pipeline, and approximately 0.9 miles of new 36-inch interconnecting pipeline to Tennessee Gas Pipeline L.L.C. ("TGP"), as described further in Section 1.1.1 of Draft Resource Report 1. The proposed pipeline facilities will be constructed in Ohio and Michigan.

9.2.3 Existing Conditions

This subsection discusses the existing air quality conditions in the vicinity of the proposed NEXUS facilities.

9.2.3.1 Climate

The Project pipeline facilities will cross from the Appalachian plateaus through the Great Lakes plains. The underlying geology of the Project includes relatively flat-lying Paleozoic sedimentary strata overlain by varying amounts of unconsolidated Pleistocene deposits. The landscape of the Project is a result of the inundation of the area by seas in the Paleozoic, the advance and retreat of continental ice sheets in the Pleistocene, and fluvial erosion in the Holocene.

The climate at the Project sites is primarily continental in character, but is subjected to modification by the Great Lakes, most notably, Lake Erie. The mid-latitude site location and proximity to Lake Erie exposes the region to a variety of meteorological conditions and events. A broad range of weather can occur at the Project sites, including blizzards, thunderstorms, and droughts, and extreme occurrences of such events have been recorded. The mid-latitude location exposes the area to large annual ranges in temperatures. Cold outbreaks originating from the northern latitudes contrast significantly with the heat and humidity that is often transported from the Gulf of Mexico. The primary interaction point between these regions experiences weather that is characterized by frequent, sometimes powerful, changes. At times, mesoscale influences alter this meteorological variety.

Stagnation in the weather pattern will expose the area to extended periods of a particular type of weather. When there is stagnation in the weather pattern, the weather experienced will depend on what local meteorological feature is being trapped by the stagnation. High pressure stalled in the Atlantic Ocean in the summer often results in extended periods of heat, humidity and, at times, drought. Conversely, a stalled frontal boundary can result in extended periods of rain, ice or snow in the winter.

Northcentral and Eastern Ohio

The climate in the vicinity of the mainline pipeline work from Erie County to Columbiana County; the Hanoverton, Wadsworth, and Clyde Compressor Stations; the TGP Interconnecting Pipeline work; and the Project M&R stations in Columbiana County is mid-latitude continental (USDA, 2006; CoCoRaHS, 2009). The primary airflow and weather systems that affect the area are either cold, dry air originating from sub-arctic North America or warm, moist air moving across the mid-continent from the Gulf of Mexico and sub-tropical waters of the Atlantic. Lake Erie provides a tempering influence during the summer and fall. Winter precipitation, frequently in the form of snow, results in a good accumulation of soil moisture by spring and minimizes drought during the summer. Precipitation is distributed equally throughout the year and temperatures fluctuate greatly on a daily and annual basis. Ohio experiences great diversity in weather over short periods of time and the climate for the same season or month of different years is often not comparable. Humidity tends to be lowest in the spring and highest in the late summer and early fall.

The National Climatic Data Center's ("NCDC") *1981-2010 Climate Normals* (NCDC, 2012) were evaluated from meteorological stations near Lisbon in Columbiana County, at the Akron Fulton Airport in Summit County, and in the City of Fremont in Sandusky County.

The *1981-2010 Climate Normals* for the meteorological station in Lisbon indicate temperatures in this portion of eastern Ohio are generally highest in July and lowest in January. Maximum temperatures of 90 °F or higher occur about four days per year on average, while minimum temperatures of 0 °F or lower occur about five days per year on average. The mean annual precipitation is 38.5 inches, with monthly average precipitation ranging from a low of 2.41 inches in February to a maximum of 4.09 inches in July. Precipitation of 0.01 inch or greater occurs on about 126 days per year on average. Precipitation of 1.0 inch or greater occurs on average about seven days per year. The average annual snowfall is 29.1 inches.

The *1981-2010 Climate Normals* for the Akron Fulton Airport meteorological station indicate temperatures in this portion of eastern Ohio are generally highest in July and lowest in January. Maximum temperatures of 90 °F or higher occur about six days per year on average, while minimum temperatures of 0 °F or lower occur about two days per year on average. The mean annual precipitation is 37.1 inches, with monthly average precipitation ranging from a low of 1.95 inches in February to a maximum of 4.13 inches in March.

The *1981-2010 Climate Normals* for the meteorological station in Fremont indicate temperatures in this portion of central Ohio are generally highest in July and lowest in January. Maximum temperatures of 90 °F or higher occur about 16 days per year on average, while minimum temperatures of 0 °F or lower occur about five days per year on average. The mean annual precipitation is 37.0 inches, with monthly average precipitation ranging from a low of 2.15 inches in February to a maximum of 4.07 inches in June. Precipitation of 0.01 inch or greater occurs on about 126 days per year on average. Precipitation of 1.0 inch or greater occurs on average about seven days per year. The average annual snowfall is 25.7 inches.

Southeast Michigan and Northwest Ohio

The climate in the vicinity of the mainline pipeline work from Washtenaw County, Michigan to Sandusky County, Ohio; the Waterville Compressor Station; and the NEXUS/Willow Run M&R Station in Washtenaw County is mid-latitude continental (USDA, 1984). Southeast Michigan and Northwest Ohio have a humid continental climate with four distinct seasons, which is the predominant climate for Michigan and Ohio. Summers are typically warm to hot, rainy, and humid, while winters are cold, windy, and snowy. Spring and fall are usually mild, but conditions are widely varied, depending on wind direction and jet stream positioning. The warmest month is July, with an average high temperature of 83 °F and an average low temperature of 61 °F. The coldest month is January, with an average high temperature of 31 °F and an average low temperature of 16 °F. Severe thunderstorms do occur occasionally, however tornados are a rare occurrence.

According to the *1981-2010 Climate Normals* for the Toledo Express Airport meteorological station in Lucas County, temperatures near the Waterville Compressor Station are generally highest in July and lowest in January. Maximum temperatures of 90 °F or higher occur about 14 days per year on average, while minimum temperatures of 0 °F or lower occur about five days per year on average. The mean annual precipitation is 34.2 inches, with monthly average precipitation ranging from a low of 2.05 inches in January to a maximum of 3.58 inches in May. Precipitation of 0.01 inch or greater occurs on about 132 days per year on average. Precipitation of 1.0 inch or greater occurs on average about six days per year. The average annual snowfall is 37.6 inches.

The *1981-2010 Climate Normals* for the Detroit Willow Run Airport meteorological station in Washtenaw County indicate temperatures in this portion of southeastern Michigan are generally highest in July and lowest in January. Maximum temperatures of 90 °F or higher occur about nine days per year on average, while minimum temperatures of 0 °F or lower occur about five days per year on average. The mean annual precipitation is 32.5 inches, with monthly average precipitation ranging from a low of 1.63 inches in January to a maximum of 3.48 inches in July.

9.2.3.2 National and State Ambient Air Quality Standards

The U.S. Environmental Protection Agency ("USEPA") has promulgated National Ambient Air Quality Standards ("NAAQS") to protect human health and welfare. The NAAQS include primary standards, which are designed to protect human health, including the health of sensitive subpopulations such as children and those with chronic respiratory problems. The NAAQS also include secondary standards designed to protect public welfare, including economic interests, visibility, vegetation, animal species, and other concerns not related to human health.

NAAQS currently apply to the following criteria pollutants: particulate matter ("PM") with a nominal aerodynamic diameter of 10 microns or less ("PM_{10}"); PM with a nominal aerodynamic diameter of 2.5 microns or less ("$PM_{2.5}$"); sulfur dioxide ("SO_2"); nitrogen dioxide ("NO_2"); CO; ozone ("O_3"); and lead

("Pb"). Each NAAQS is expressed in terms of a concentration level and an associated averaging period. The current NAAQS for these criteria pollutants are summarized in Table 9.2-2. Footnotes to Table 9.2-2 explain how compliance with each NAAQS is assessed.

The NAAQS apply in all Project areas. States and municipalities are free to adopt standards that are more stringent than the NAAQS. The Ohio Environmental Protection Agency ("OEPA") has adopted ambient air quality standards that differ in some respects from the current NAAQS, but pursuant to Ohio law, cannot be more stringent than the NAAQS.[1] The Michigan Department of Environmental Quality ("MDEQ") has adopted the NAAQS in full.

Table 9.2-3 summarizes the current Ohio Ambient Air Quality Standards promulgated in Chapter 3745-25 of the Ohio Administrative Code ("OAC"). Footnotes to Table 9.2-3 provide additional information concerning how compliance with these state standards is assessed.

9.2.3.3 Existing Ambient Air Quality

The NEXUS Project will involve construction in various counties in Ohio and Michigan. Many of these counties contain ambient air quality monitors that collect data concerning existing levels of various air pollutants. Summary data from the USEPA AirData database were reviewed in order to characterize maximum or near-maximum existing concentrations in representative counties in which Project facilities will be constructed (USEPA, 2015). In most cases, the counties in which a compressor station is located are used to represent existing air quality for the Project facilities in that vicinity, and in all cases ambient air quality concentrations were taken from the nearest monitoring station for each project component. In some cases in which no data were available from a representative county, data from a neighboring or nearby county were used as a substitute.

Ambient air quality monitoring data from the 3-year period 2012-2014 are summarized in Table 9.2-4 for those monitoring stations nearest to the proposed NEXUS Project facilities. For each project component, Table 9.2-4 lists the maximum annual mean concentration and/or a near-maximum short-term concentration in each year. Second-high short-term concentrations are listed for most pollutants, but Table 9.2-4 includes the fourth-highest 8-hour average concentration for ozone, the 98^{th} percentile 1-hour average concentration for NO_2, the 98^{th} percentile 24-hour average concentration for $PM_{2.5}$, and the 99^{th} percentile 1-hour average concentration for SO_2, consistent with the structure of the NAAQS for those pollutants and averaging periods.

9.2.3.4 Attainment Status

A useful way to characterize existing air quality in a given area is to identify the attainment status of the air quality control region ("AQCR") in which it is located. An AQCR, as defined in Section 107 of the Clean Air Act ("CAA"), is a federally-designated area in which NAAQS must be met. An implementation plan is developed for each AQCR describing how ambient air quality standards will be achieved and maintained.

USEPA designates the attainment status of an area on a pollutant-specific basis, based on whether an area meets the NAAQS. Areas that meet the NAAQS are termed "attainment areas." Areas that do not meet the NAAQS are termed "nonattainment areas." Areas for which insufficient data are available to determine attainment status are termed "unclassified areas." Areas formerly designated as nonattainment areas that have subsequently reached attainment are termed "maintenance areas."

The attainment status designations appear in the Code of Federal Regulations ("CFR") at 40 CFR Part 81. The attainment status of a region, in conjunction with projected emission rates or emissions increases, determines the regulatory review process for a new project. Table 9.2-5 summarizes the attainment status of the AQCRs in which Project facilities will be located. As shown in Table 9.2-5, all Project facilities will

[1] Ohio Revised Code, Title 37, Chapter 3704.03(D).

be located in areas designated as attainment or unclassifiable with the exception of Medina County, which is designated nonattainment for the 2008 8-hour ozone standard. In addition, several Project facilities are located in designated maintenance areas for the $PM_{2.5}$ standards.

9.2.4 Relevant Air Quality and Permitting Requirements

In addition to the NAAQS, Project air emissions and equipment will be subject to various other federal and state air quality regulations. Federal air quality requirements are contained in 40 CFR Parts 50 through 99. The following sections briefly discuss air regulations that potentially apply to Project facilities.

9.2.4.1 New Source Review Permitting/Licensing

Preconstruction air permitting programs that regulate the construction of new stationary sources of air pollution and the modification of existing stationary sources are commonly referred to as New Source Review ("NSR"). NSR can be divided into two categories: major NSR and minor NSR. Major NSR has two components: the Prevention of Significant Deterioration ("PSD") permitting program and the nonattainment area NSR ("NNSR") permitting program.

Major NSR requirements are established on a federal level but may be implemented by state or local permitting authorities under either a delegation agreement with USEPA or as a State Implementation Plan ("SIP") program approved by USEPA. For new major sources and major modifications located in attainment or unclassifiable areas, the PSD program applies, while the NNSR program applies for new major sources and major modifications located in nonattainment areas. Depending on its potential emissions and location, a new source or a modification to an existing source could be subject to both major NSR programs for various pollutants.

PSD requirements include the use of Best Available Control Technology, air quality impact analyses, and additional impact analyses. NNSR requirements for nonattainment pollutants include Lowest Achievable Emission Rate, emission offsets, and an alternatives analysis. In some cases, a net air benefits analysis may also be needed. One additional factor considered in the NSR process is the potential impact on protected Class I areas. Pristine natural areas or areas of natural significance are specifically designated as Class I areas. The remainder of the U.S. is classified as Class II. Class III designations, intended for heavily industrialized zones, can only be made upon request and must meet all requirements outlined in 40 CFR 51.166.

The requirements for the PSD and state NSR programs, as well as the implementation of NSR permitting in Ohio and Michigan, are discussed below. A copy of each air permit application that includes application forms and detailed emissions calculations for the Project compressor stations will be provided in Appendix 9A of the final version of Resource Report 9 that will accompany NEXUS' FERC application in November 2015.

<u>Ohio</u>

Paragraph (NNN) of rule 3745-31-01 of the OAC establishes the PSD major source threshold for all regulated NSR pollutants except for greenhouse gases ("GHG") as 100 tons per year ("TPY") for 28 specifically listed source categories. For unlisted source categories, such as natural gas pipeline compressor stations, the PSD major source threshold is 250 TPY of potential emissions of any air pollutant except for GHG. Paragraph (NNN) of rule 3745-31-01 of the OAC establishes the NNSR major source threshold as 100 TPY of a nonattainment pollutant. Additionally, the final PSD and Title V Greenhouse Gas Tailoring Rule was published in the Federal Register on June 3, 2010 (75 FR 31514) but was ultimately overturned on June 23, 2014 by the US Supreme Court[2]. Under the formerly effective rule, GHGs could, as of July 1, 2011, become "subject to regulation" under the PSD program for the construction of a source that would

[2] *Utility Air Regulatory Group v. EPA*, 134 S.Ct. 2427 (2014)

result in potential GHG emissions of 100,000 TPY carbon dioxide equivalents ("CO_2e") or more. However, *Utility Air Regulatory Group v. EPA* clarifies that construction projects cannot trigger major NSR for GHGs unless major NSR is otherwise triggered for criteria pollutants. Furthermore, in accordance with OAC 3745-31-34(C)(2), OEPA's permit to install permitting requirements for GHGs cease to be effective if a federal court issues a ruling limiting the administrator's authority to regulate GHGs under the Clean Air Act.

Columbiana, Sandusky, and Lucas Counties are all currently designated as attainment/unclassifiable for all NAAQS. Therefore, the PSD major source thresholds of 250 TPY for NO_X, CO, PM_{10}, $PM_{2.5}$, SO_2, and VOC apply to the Hanoverton, Clyde, and Waterville Compressor Stations. Medina County is currently designated as attainment/unclassifiable for all NAAQS except for the 8-hour ozone standard. Therefore, the PSD major source thresholds of 250 TPY for CO, PM_{10}, $PM_{2.5}$, and SO_2, and the NNSR major source threshold of 100 TPY for NO_X and VOC (i.e., the precursors to ozone formation) apply to the Wadsworth Compressor Station.

Emissions of all criteria pollutants from the Hanoverton, Wadsworth, Clyde, and Waterville Compressor Stations (i.e., those located in Columbiana, Medina, Sandusky, and Lucas Counties, respectively) will not exceed the respective major source permitting thresholds; therefore, neither PSD nor NNSR permitting requirements will apply to the Project. In addition, the closest Class I area to the Hanoverton, Wadsworth, Clyde, and Waterville Compressor Stations is the Otter Creek Wilderness in West Virginia, which is 216 kilometers ("km"), 286 km, 373 km, and 440 km, from each respective compressor station.

The emissions of criteria pollutants from the M&R stations to be constructed in Columbiana County, Ohio (i.e., NEXUS/Kensington M&R Station, NEXUS/Texas Eastern M&R Station, and NEXUS/TGP M&R Station) will not exceed the respective major source permitting thresholds.

In addition to PSD and NNSR permitting requirements, Ohio administers its own construction permitting requirements within Chapter 3745-31 of the OAC. At a minimum, new or modified stationary sources with potential air emissions that exceed the *de minimis* permitting thresholds of 10 pounds per day or 25 TPY for any air pollutant, or 1 TPY for total HAPs, are required to obtain a Permit-to-Install ("PTI") or Permit-to-Install and Operate ("PTIO"), unless specifically exempted by Rule 3745-15-05 or 3745-31-03. For each pollutant for which the requested allowable emissions exceed 10 TPY, the use of Best Available Technology, as defined in OAC 3745-31-01, is required.

The emissions from the Project compressor stations and M&R stations to be constructed in Ohio will exceed the *de minimis* thresholds and therefore each facility will be required to obtain a PTIO. Launcher or receiver facilities located at the Wadsworth and Waterville Compressor Stations will be incorporated into the PTIO for the respective station. The remaining launcher or receiver facilities to be constructed in Ohio as part of the NEXUS Project may exceed the *de minimis* thresholds and therefore may be required to obtain a PTIO. The potential air emissions from the proposed mainline valve sites in Ohio will be less than the *de minimis* thresholds and will be exempt from air permitting.

NEXUS will make its final determination whether the emissions from the launcher and receiver facilities to be constructed in Ohio will result in regulated air emissions requiring permitting or other authorization upon finalization of design information. This determination is expected to be made by the fourth quarter of 2015. If it is found that these activities will result in regulated air emissions, NEXUS will apply for the appropriate air authorizations.

Michigan

Michigan's construction permitting requirements are contained within the "Michigan Air Pollution Control Rules," adopted pursuant to Part 55, Air Pollution Control, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (ACT 451). Rule 336.1201 (Rule 201) states that a person must not install, construct, reconstruct, relocate, or modify an emission unit that may emit an air contaminant unless the MDEQ issues a PTI authorizing the action. Rules 280 through 290 contain permit exemptions which may relieve a facility of the requirement to obtain a PTI.

Paragraph (cc) of Rule 336.2801 (Rule 1801) establishes the PSD major source threshold for all regulated NSR pollutants except for GHGs as 100 TPY for 28 specifically listed source categories. For unlisted source categories, such as natural gas pipeline compressor stations, the PSD major source threshold is 250 TPY of potential emissions of any air pollutant except for GHG.

Paragraph (t) of Rule 336.2901 (Rule 1901) establishes the NNSR major source threshold as 100 TPY of a nonattainment pollutant. Lower major source thresholds may apply depending on the severity of nonattainment in the county in which the source will be located.

The new M&R station in Michigan (i.e., NEXUS/Willow Run M&R Station) will be constructed in Washtenaw County, which is currently designated as attainment/unclassifiable for all NAAQS. Therefore, the PSD major source threshold of 250 TPY applies for NO_X, CO, PM_{10}, $PM_{2.5}$, SO_2, and VOC. The emissions of all criteria pollutants from the NEXUS/Willow Run M&R Station will not exceed the respective major source permitting thresholds; therefore, neither PSD nor NNSR permitting requirements will apply. Additionally, emissions sources at the M&R station in Michigan qualify for the permitting exemptions provided in Rule 336.1282(b)(i) for gas-fired heaters, in Rule 336.1285(g) for emergency generators, in Rule 336.1285(mm)(i) for gas releases, in Rule 336.1284(e) for storage vessels, and in Rule 336.1290(a) for equipment leaks and truck loading. Therefore, NEXUS will not be required to obtain a PTI for the M&R station in Michigan. The potential air emissions from the mainline valve sites in Michigan will be exempt from air permitting as well.

9.2.4.2 State and Title V Operating Permit Programs

The Title V permit program in 40 CFR Part 70 requires major sources of air pollutants to obtain federal operating permits. The major source thresholds under the Title V program, as defined in 40 CFR 70.2 and which are different from the federal NSR major source thresholds, are 100 TPY of any air pollutant, 10 TPY of any single HAP, or 25 TPY of total HAPs. More stringent Title V major source thresholds apply for VOC and NO_X in ozone nonattainment areas, namely 50 TPY of VOC or NO_X in areas defined as serious, 25 TPY in areas defined as severe, and 10 TPY in areas classified as extreme. As with NSR, *Utility Air Regulatory Group v. EPA* and USEPA's July 24, 2014 guidance memo clarify that a source will not be required to obtain a Title V permit on the sole basis of emissions levels of GHG (i.e., exceeding the Title V major source threshold for GHG only).

Ohio

The authority to issue Title V operating permits has been delegated to OEPA by USEPA. Ohio administers the Title V operating permit program through Chapter 3745-77 and a state operating permit program through its PTIO Program in OAC Chapter 3745-31.

As mentioned previously, OEPA issues new stationary sources a PTIO if the unrestricted potential emissions do not exceed Title V major source thresholds. These PTIOs authorize both the construction and operation of the permitted source. For major sources, there is also the option to accept federally enforceable limitations within a Federally Enforceable Permit-to-Install-and-Operate that limit the facility-wide potential to emit to below Title V thresholds. Both the PTIO and Federally Enforceable Permit-to-Install-and-Operate are applied for and issued through one application process. For Title V major sources, the permit process is split into two steps requiring that a source first apply for and be issued a PTI and then apply for a Title V Permit-to-Operate ("Title V PTO").

Emissions from the Hanoverton, Wadsworth, Clyde, and Waterville Compressor Stations, and Project M&R stations in Ohio will not exceed the relevant Title V major source thresholds of 100 TPY of any air pollutant, 10 TPY of any single HAP, or 25 TPY of total HAPs. Therefore, these sites will not be subject to the Title V permitting program. Each of these sites will, however, be required to obtain a PTIO. As mentioned previously, the launcher or receiver facilities located at the Wadsworth and Waterville Compressor Stations will be incorporated into the PTIO for the respective station. The remaining aboveground facilities to be constructed in Ohio as part of the NEXUS Project will not require a PTIO.

Michigan

The authority to issue Title V operating permits has been delegated to MDEQ by USEPA. Michigan administers the Title V operating permit program through Rule 210 and Rule 211 via the Renewable Operating Permit ("ROP") program.

As mentioned previously, MDEQ issues new stationary sources a PTI. For Title V major sources, the permit process is split into two steps requiring that a source first apply for and be issued a PTI and then apply for a Renewable Operating Permit (i.e., Title V operating permit).

Based on NEXUS' past experience, the aboveground facilities to be constructed in Michigan as part of the NEXUS Project will not require a ROP from MDEQ.

9.2.4.3 Standards of Performance for New Stationary Sources

New Source Performance Standards ("NSPS") in 40 CFR Part 60 regulate certain emissions from specific source categories. Facilities associated with the Project include equipment in some source categories that could be subject to NSPS requirements as discussed below.

40 CFR Part 60, Subpart Dc (Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units)

40 CFR Part 60, Subpart Dc applies to steam generating units with a maximum design heat input capacity of greater than or equal to 10 MMBtu/hr but less than or equal to 100 MMBtu/hr for which construction, modification, or reconstruction is commenced after June 9, 1989. It is not expected that the Project will include any new boilers installed with a maximum heat input capacity greater than 10 MMBtu/hr. Therefore, the requirements of Subpart Dc will not apply.

40 CFR Part 60, Subpart Kb (Standards of Performance for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) for Which Construction, Reconstruction, or Modification Commenced After July 23, 1984)

40 CFR Part 60, Subpart Kb potentially applies to storage vessels with a capacity greater than 75 cubic meters (m^3) that will store volatile organic liquids. A capacity of 75 m^3 is equal to approximately 19,813 gallons. The Project does not include the construction, reconstruction, or modification of any storage vessels containing volatile organic liquids with a capacity that exceeds this threshold. Therefore, Subpart Kb will not apply to the proposed Project activities.

40 CFR Part 60, Subpart JJJJ (Standards of Performance for Stationary Spark Ignition Internal Combustion Engines)

40 CFR Part 60, Subpart JJJJ ("NSPS JJJJ"), is applicable to owners and operators of new or existing stationary spark ignition internal combustion engines that commence construction, modification, or reconstruction after June 12, 2006. The Project includes a new emergency stationary spark-ignition internal combustion engine ("SI ICE") to be installed at each compressor station and M&R station. Based on preliminary design, the new emergency stationary SI ICE will be greater than 25 hp and will therefore be subject to requirements under NSPS JJJJ.

40 CFR Part 60, Subpart KKKK (Standards of Performance for Stationary Combustion Turbines)

Stationary combustion turbines with a heat input rate at peak load of 10 MMBtu/hr or greater that commenced construction, modification (as defined in 40 CFR 60.14), or reconstruction (as defined in 40 CFR 60.15) after February 18, 2005 are regulated under Subpart KKKK. Subpart KKKK limits emissions of NO_X as well as the sulfur content of fuel that is combusted in subject units. The Project involves the installation of new stationary combustion turbines at each compressor station. Therefore, the Project will trigger the emissions limitations as well as the monitoring, reporting, recordkeeping, and testing requirements under Subpart KKKK.

40 CFR Part 60, Subpart OOOO (Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution)

40 CFR Part 60, Subpart OOOO applies to storage vessels that are located in the oil and natural gas production segment, natural gas processing segment or natural gas transmission and storage segment, and have the potential for VOC emissions equal to or greater than 6 TPY, as determined according to 40 CFR 60.5365(e) by April 15, 2014, or 30 days after startup (whichever is later) for storage vessels for which construction, modification or reconstruction has commenced after April 12, 2013. Natural gas transmission is defined as the pipelines used for the long distance transport of natural gas (excluding processing). Specific equipment used in natural gas transmission includes the land, mains, valves, meters, boosters, regulators, storage vessels, dehydrators, compressors, and their driving units and appurtenances, and equipment used for transporting gas from a production plant, delivery point of purchased gas, gathering system, storage area, or other wholesale source of gas to one or more distribution area(s).

The regulation at 40 CFR 60.5365(e) specifies that VOC emissions from the storage vessels must be calculated based on the maximum average daily throughput determined for a 30-day period of production. Estimated VOC emissions from all of the tanks at the compressor stations associated with the Project are significantly below 6 TPY, therefore the requirements of Subpart OOOO will not apply to the proposed Project.

9.2.4.4 National Emission Standards for Hazardous Air Pollutants

The USEPA has established National Emission Standards for Hazardous Air Pollutants ("NESHAP") for specific pollutants and industries in 40 CFR Part 61. The Project does not include any of the specific sources for which NESHAP have been established in Part 61. Therefore, Part 61 NESHAP requirements will not apply to the Project.

The USEPA has also established NESHAP requirements in 40 CFR Part 63 for various source categories. The Part 63 NESHAP generally apply to certain emission units at facilities that are major sources of HAP. Additionally, some NESHAP apply to non-major sources (area sources) of HAP.

40 CFR Part 63, Subpart HH (National Emission Standards for Hazardous Air Pollutants from Oil and Natural Gas Production Facilities)

40 CFR 63, Subpart HH applies to emission points at oil and natural gas production facilities that are major or area sources of HAP that process, upgrade, or store either hydrocarbon liquids or natural gas prior to the point of custody transfer. The proposed compressor stations associated with the Project are natural gas transmission facilities; therefore, the Project will not trigger the requirements of Subpart HH.

40 CFR Part 63, Subpart HHH (National Emission Standards for Hazardous Air Pollutants from Natural Gas Transmission and Storage Facilities)

40 CFR Part 63, Subpart HHH applies to natural gas transmission and storage facilities that are major sources of HAP and that transport or store natural gas prior to entering the pipeline to a local distribution company or to a final end user (if there is no local distribution company). The affected source is each new and existing glycol dehydration unit located at the facility. The owner or operator of a facility that does not contain an affected source is not subject to the requirements of this subpart. The proposed compressor stations associated with the Project will not be major sources of HAP and will not include any glycol dehydration units. Therefore, the requirements of Subpart HHH will not apply to the Project.

40 CFR Part 63, Subpart YYYY (National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines)

40 CFR Part 63, Subpart YYYY applies to stationary combustion turbines at major sources of HAP. Emissions and operating limitations under Subpart YYYY apply to new and reconstructed stationary combustion turbines. The proposed compressor stations associated with the Project are not considered major sources of HAP. Therefore, the Project will not trigger any requirements under Subpart YYYY.

40 CFR Part 63, Subpart ZZZZ (National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines)

40 CFR Part 63, Subpart ZZZZ, applies to existing, new, and reconstructed stationary reciprocating internal combustion engines ("RICE") located at either major or area sources of HAP. The Project includes a new emergency stationary RICE at each of the compressor stations and M&R stations associated with the Project, which will be area sources of HAP. However, new stationary RICE located at area sources of HAP must meet the requirements of Subpart ZZZZ by meeting the NSPS standards at 40 CFR Part 60, Subpart JJJJ. As discussed above in Section 9.2.5.3, the new emergency stationary RICE at the compressor stations and M&R stations will be subject to the requirements of NSPS JJJJ.

40 CFR Part 63, Subpart DDDDD (National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters)

40 CFR Part 63, Subpart DDDDD applies to certain new and existing boilers and process heaters at major HAP sources. The Project does not involve the installation of any subject boilers or heaters at major sources of HAP. Therefore the Project will not trigger any Subpart DDDDD requirements.

40 CFR Part 63, Subpart JJJJJJ (National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources)

40 CFR Part 63, Subpart JJJJJJ applies only to certain new and existing boilers at area sources, where a boiler is defined as "enclosed device using controlled flame combustion in which water is heated to recover thermal energy in the form of steam and/or hot water." The rule does not apply to natural gas-fired boilers. The heating devices proposed as part of the Project will be fired by natural gas and therefore will not be subject to Subpart JJJJJJ requirements.

9.2.4.5 State Air Regulations

Ohio

In addition to the federal air quality requirements identified above, there are several other state air pollution regulations administered by OEPA that are potentially applicable to the Project. OEPA air pollution regulations are located in the OAC in chapters 3745-14 to 3745-26, 3745-31, 3745-71 to 3745-80, 3745-100 to 3745-101, 3745-103 to 3745-105, 3745-109, and 3745-112 to 3745-114.

State requirements that will apply to the Project are the Particulate Matter Standards at OAC 3745-17, the Open Burning Standards at OAC 3745-19, and the VOC Emission Standards at OAC 3745-21-09(O) for solvent metal cleaning.

Ohio Particulate Matter Standards

The turbines and emergency generators proposed as part of the Project will be subject to OAC 3745-17-07(A)(1)(a), which establishes that visible particulate emissions from any stack shall not exceed twenty percent opacity as a six-minute average except as provided by rule. The turbines will be subject to OAC 3745-17-11(B)(4), which establishes that particulate emissions from any stationary gas turbine shall not exceed 0.04 pounds per million British thermal units of actual heat input. Also, the emergency generators will be subject to OAC 3745-17-11(B)(5), which establishes limits for particulate emissions from stationary internal combustion engines based on the size of the engine in question.

Ohio NO_X Budget Trading Program

OAC 3745-14 contains Ohio's NO_X Budget Trading Program rules and applies to electric generating units ("EGU"), cogeneration units, and other large fossil fuel-fired stationary boilers, combustion turbines, or combined cycle systems. In accordance with OAC 3745-14-01(C)(1)(b), non-EGU's with a maximum design heat input greater than 250 MMBtu/hr that commence operation on or after January 1, 1999 are subject to the NO_X Budget Trading Program as NO_X budget units. The Project involves the installation of new stationary combustion turbines at the associated compressor stations. However, the maximum design heat input of each unit will be less than 250 MMBtu/hr and therefore the requirements of the NO_X Budget Trading Program will not apply to the Project.

Ohio Sulfur Dioxide Regulations

OAC 3745-18 contains Ohio's Sulfur Dioxide Regulations which apply to fuel burning equipment, stationary gas turbines, jet engine test stands and stationary internal combustion engines. However, in accordance with OAC 3745-18-06(A), these sources are exempt from the sulfur dioxide emission limits during any calendar day in which natural gas is the only fuel burned. Therefore, the Sulfur Dioxide Regulations will not apply to the Project.

Ohio Open Burning Standards

The Open Burning Standards at OAC 3745-19 will apply to Project construction if and to the extent this means of disposal is used for land-clearing waste. Land-clearing waste, such as tree trimmings, stumps, brush, weeds, shrubbery, and crop residues may be burned on the property where it was generated, with prior written permission from OEPA. Open burning of land-clearing waste is only permitted outside of restricted areas, which include: within the boundaries of any municipal corporation; within corporation limits and a 1,000 foot zone outside any municipal corporation having a population of 1,000 to 10,000; and within corporation limits and a 1 mile zone outside any municipal corporation with a population of more than 10,000. Any open burning that occurs as part of the Project construction will not be conducted in a restricted area. A request to conduct open burning of land-clearing waste must be submitted to OEPA at least ten working days prior to the burn, and OEPA must issue written approval prior to the burn.

Ohio VOC Emission Standards

The VOC Emission Standards at OAC 3745-21-09(L) prohibit the storage of any petroleum liquid with a true vapor pressure greater than 1.52 actual pounds per square inch in fixed roof tanks unless such tanks meet the specified design requirements. Fixed roof tanks with capacities less than 40,000 gallons are exempt from the requirements of OAC 3745-21-09(L)(1). All of the storage vessels to be installed at the compressor stations associated with the Project will have nominal storage capacities of less than 40,000 gallons. Therefore, the requirements of OAC 3745-21-09(L) will not apply to the Project.

Ohio Clean Air Interstate Rule

OAC 3745-109 contains Ohio's Clean Air Interstate Rule ("CAIR") which establishes the annual and seasonal NO_X budget trading program and annual SO_2 budget trading program for stationary fossil-fuel-fired boilers or stationary fossil-fuel fired combustion turbines serving a generator with a nameplate capacity of more than twenty-five megawatts producing electricity for sale; fossil-fuel fired units and certain cogeneration units with a maximum design heat input greater than 250 MMBtu/hr; and solid waste incineration units. The Project involves the installation of new stationary combustion turbines at the four compressor stations. However, the maximum design heat input of each unit will be less than 250 MMBtu/hr and therefore the requirements of the CAIR Program will not apply to the Project.

On October 23, 2014, the U.S. Court of Appeals for the D.C. Circuit lifted the stay of the Cross-State Air Pollution Rule which will replace CAIR.[3] Because Cross-State Air Pollution Rule regulates only EGUs, USEPA has provided guidance for the techniques states should use to ensure that large non-EGUs (i.e., non-EGUs > 250 MMBtu/hr) continue to comply with NO_X SIP Call requirements.[4] The maximum design heat input capacity of the proposed stationary combustion turbines at the Project compressor stations will be less than 250 MMBtu/hr and will not be required to comply with these interim provisions for large non-EGUs under the NO_X SIP Call.

Reasonably Available Control Technology for NO_X

OAC 3745-110 contains Ohio's NO_X Reasonably Available Control Technology ("RACT"). For new sources, NO_X RACT applies to any stationary source of NO_X emissions that is a very large boiler, large boiler, mid-size boiler, small boiler, stationary combustion turbine, stationary internal combustion engine, or reheat furnace, except where the emission limitations and requirements of an applicable NSPS under 40 CFR Part 60 are more stringent than the NO_X RACT emission limitations and requirements. The stationary combustion turbines to be installed at the compressor stations associated with the Project will be subject to the NO_X standard of 40 CFR Part 60, Subpart KKKK, which is more stringent than the NO_X RACT standard. Though the emergency generators proposed as part of the Project are stationary internal combustion engines, they will be less than 2,000 hp and therefore no applicable emission limitations are established by the NO_X RACT regulation. Finally, the small natural gas-fired heating devices proposed as part of the Project all have heat input capacities less than the threshold for a "small boiler" as defined at OAC 3745-110-01.[5]

Additional Ohio Requirements

The new permitted air contaminant sources proposed as part of the Project will also be subject to OAC 3745-16, which establishes good engineering stack height requirements for all new air contaminant sources at OAC 3745-16-01(F) and the Fee Emission Reporting requirements at OAC 3745-78.

Michigan

In addition to the federal air quality requirements identified above that are administered by MDEQ, there are other state air pollution regulations potentially applicable to the Project. MDEQ air pollution regulations are located in the Michigan Air Pollution Control Rules (i.e., R 336).

State requirements that will apply to the NEXUS/Willow Run M&R Station are the VOC standards in Rule 702, the opacity standards in Rule 301, and the open burning standards in Rule 310.

Michigan VOC Emission Standards

Rule 702 states that any new source of VOC emissions must not allow the emission of VOCs from the new source in excess of the lowest maximum allowable emission rate as determined by one of the following:

1. Listed by the MDEQ on its own initiative or based upon the application of Best Available Control Technology;
2. Specified by an NSPS requirement;
3. Specified as a condition of a PTI or a Permit-to-Operate ("PTO"); or

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[3] *EPA v. EME Homer City Generation, L.P.*, 134 S. Ct. 1584, 1593 (2014).

[4] http://www.epa.gov/airtransport/CSAPR/faqs.html

[5] "Small boiler" means an industrial boiler with a maximum heat input capacity greater than 20 MMBtu/hr and equal to or less than 50 MMBtu/hr.

4. Specified in part 6 of the rules for emissions of VOC from existing sources.

Because the NEXUS/Willow Run M&R Station will be exempt from air permitting requirements, emission limitations on the emission units at the M&R station will only be imposed under Rule 702 if MDEQ initiates a specific action to impose such limits.

Michigan Opacity Standards

Rule 301 states that visible emissions into the outer air from a process or process equipment must not exceed the most stringent of the following opacity standards:

1. A 6-minute average of 20 percent opacity, except for one 6-minute average per hour of not more than 27 percent opacity;
2. A limit specified by an applicable federal NSPS requirement; or
3. A limit specified as a condition of a PTI or PTO.

The provisions of Rule 301 do not apply to process equipment for which fugitive visible emissions limitations are specified by another MDEQ rule, or for visible emissions due to uncombined water vapor.

The Project will be subject to the opacity requirements of Rule 301.

Michigan Open Burning Standards

The open burning standards found in Rule 310 will apply to Project construction, assuming the contractor(s) elect to utilize this means of disposal of land-clearing waste. Land-clearing waste, such as trees, logs, brush, and stumps may be burned in accordance with applicable state and local requirements if the burning is not conducted within a Priority I or Priority II area as identified in Table 33 and Table 34 of Rule 331, respectively, nor closer than 1,400 feet to an incorporated city or village limit, and if the burning does not violate any other department rules.

Michigan Annual Emissions Reporting

Air Quality Division Policy and Procedure No. AQD-013 outlines the requirements for annual emissions reporting of criteria pollutants from point sources. In accordance with AQD-013, the following sources are required to submit annual emissions reports:

1. Sources with actual emissions that are expected to be greater than 100 TPY of CO, 40 TPY of NO_X, 25 TPY of PM, 15 TPY of PM_{10}, 10 TPY of VOC, or 0.5 TPY of Pb;
2. Sources that are specifically required to report emissions or compliance status in accordance with a Michigan Air Pollution Control Rule or federal CAA requirement;
3. Sources that have an active Opt-out Permit; and
4. Sources that are considered Category I or Category II Fee-subject sources pursuant to PA 451.

As the M&R station to be constructed for the Project will not meet any of the above four criteria, the Project will not be subject to annual emissions reporting to MDEQ.

9.2.4.6 Risk Management Program

USEPA has established accidental release prevention and risk management plan requirements as part of 40 CFR Part 68 (Chemical Accident Prevention Provisions). Part 68 lists regulated substances along with thresholds for determining the applicability of the associated requirements. If a regulated substance is handled, stored, or processed in greater than threshold quantities at a stationary source, then a risk management plan must be prepared.

Even if a facility is not required to prepare a risk management plan, requirements of the General Duty Clause in the CAA still apply if the facility produces, processes, handles, or stores regulated substances or other extremely hazardous substances on site. Compliance with the General Duty Clause requires that owners of facilities be continuously vigilant about potential hazards and methods of minimizing the consequences of accidental releases.

Except for constituents of natural gas, such as ethane and methane, the Project is not expected to produce, process, handle, or store any substance regulated under Part 68 in quantities exceeding applicability thresholds. Natural gas pipelines are not subject to Part 68 if they are subject to U.S. Department of Transportation ("USDOT") requirements or to a state natural gas program certified by USDOT. In addition, the storage of natural gas incidental to transportation (i.e., natural gas taken from a pipeline during non-peak periods, placed in storage fields, and then returned to the pipeline when needed) is not subject to Part 68. Consequently, the Project will not be subject to Part 68 requirements.

9.2.4.7 General Conformity

General conformity regulations in 40 CFR Part 93, Subpart B, are designed to ensure that federal actions that occur in nonattainment and maintenance areas do not interfere with a state's ability to attain or maintain compliance with NAAQS. The Project is considered to be a federal action, since a Federal agency (i.e., FERC) will be licensing, permitting, or otherwise approving portions of the Project. Many of the proposed Project activities will occur in federally designated nonattainment or maintenance areas. Consequently, a general conformity applicability analysis is required to determine if a conformity determination is required. A conformity determination, if required, documents that a Federal action will conform to the applicable implementation plan for the nonattainment or maintenance area and meet other requirements of Subpart B of Part 93.

As part of the general conformity applicability determination process, the sum of non-exempt direct and indirect emissions of nonattainment pollutants or designated precursors associated with a Federal action is compared to annual general conformity applicability emissions thresholds in 40 CFR 93.153. If an applicability threshold is exceeded, then general conformity applies and a conformity determination is required. If emissions are below the applicability thresholds, then the emissions are considered to be *de minimis*, general conformity requirements do not apply, and a conformity determination is not required.

The general conformity regulations were revised on April 5, 2010, and the changes to the regulations became effective on July 6, 2010. Under the revised general conformity regulations, emissions from stationary sources that are covered by any NSR permit (major or minor) are exempt from general conformity. Therefore, emissions covered by a NSR permit do not count towards the general conformity applicability thresholds. The emissions associated with the operation of proposed new emissions units at the affected compressor stations will be permitted and will not count towards the general conformity applicability thresholds. Any new emissions from the new M&R stations that are required to be permitted will similarly not count towards the general conformity applicability thresholds. However, emissions from other Project activities, such as emissions from construction, need to be considered. Under the revised regulations, USEPA clarified that if emissions from a federal action occur in more than one nonattainment or maintenance area, then each area is evaluated separately. Emissions from separate nonattainment or maintenance areas are treated as if they result from separate actions.

A general conformity applicability analysis will be provided in Appendix 9B of the final version of Resource Report 9 that will accompany NEXUS' FERC application to demonstrate whether the non-exempt Project emissions will be below the applicable general conformity applicability thresholds (i.e., *de minimis*), or if a general conformity determination will be required.

9.2.5 Anticipated Air Quality Impacts

9.2.5.1 Air Quality Mitigation Measures

Air quality impacts from operation of the Hanoverton, Wadsworth, Clyde, and Waterville Compressor Stations will be minimized by the use of equipment, emissions controls, and operating practices that meet or exceed Best Available Technology. Measures proposed to minimize air quality impacts include the use of clean burning natural gas as the fuel for all combustion devices and the use of low-NO_X combustors. The turbines will also be equipped with oxidation catalysts to reduce CO, VOC, and HAP emissions. Implementation of NEXUS' preventive maintenance program, as discussed further in Draft Resource Report 11, to identify and prevent leaks, repair quickly any leaks that are found, and reduce the frequency and extent of unscheduled maintenance requiring evacuating the gas from the compressor station and/or a portion of the pipeline ("blowdowns") will minimize fugitive VOC and GHG emissions. As discussed previously, the compressor stations associated with the Project will not be subject to PSD or NNSR permitting requirements, and will be classified as true minor sources with regard to Title V permitting and OEPA requirements. Compliance with federal and state air regulations and state permit requirements will ensure that the compressor stations minimize air quality impacts.

Fugitive dust emissions during construction will be mitigated, as necessary, by spraying water or other commercially-available dust control agents on unpaved areas subject to frequent vehicle traffic in accordance with the NEXUS Project Dust Control Plan provided in Appendix 9C. In addition, construction equipment will be properly tuned and operated only on an as-needed basis to minimize the combustion emissions from diesel and gasoline engines. Should the contractor(s) use open burning as a means of disposing of land-clearing waste in Ohio, the burning locations will be selected to avoid restricted areas, as defined at OAC 3745-19, nearby residences, and weather conditions that could exacerbate the impact on local residences. A request to conduct open burning of land-clearing waste will be submitted to OEPA at least ten working days prior to the burn. All open burning will be conducted in accordance with the required written approval received from OEPA. Should the contractor(s) use open burning as a means of land-clearing waste in Michigan, the burning locations will be selected to avoid Priority I and II areas, as identified in Tables 33 and 34 of Rule 331, and will be located greater than 1,400 feet from any incorporated city or village.

9.2.5.2 Emissions from Operation of the Affected Compressor Stations

Maximum potential air emissions estimates from operation of the proposed compressor stations are summarized in Tables 9.2-6 through 9.2-9. As shown in the tables, the emissions of criteria air pollutants and HAPs from station operations will be below the applicable major source thresholds.

<u>Ambient Air Quality Analyses</u>

The Project compressor stations will not be major sources with regard to NSR, therefore a PSD ambient air quality analysis is not required. Although not required for permitting, NEXUS will complete screening level ambient air quality analyses to demonstrate compliance with all ambient air quality standards for criteria pollutants for the new air emissions sources proposed as part of the Project. The screening level air quality analyses will be completed using AERSCREEN, and will be provided in Appendix 9D of the final version of Resource Report 9 that will accompany NEXUS' FERC application. Additional details about the screening level air quality analyses, including the selection of representative monitoring sites for use as background and associated modeling inputs, will also be provided in Appendix 9D.

9.2.5.3 Emissions from Operation of Project M&R Stations

The design of the NEXUS Project M&R stations is ongoing at this time and accurate emissions estimates for these stations are not available. Final equipment selection and piping configurations are needed to provide an accurate estimate, so NEXUS is providing emissions information that is considered to be representative of the emissions that could result from operation of these facilities, but will vary depending on the final design and actual operation.

The primary source of air emissions at the new M&R stations will be an emergency generator with a small natural gas-fired fuel gas heater. These fuel gas heaters are expected to have a rated maximum heat input capacity less than 1 MMBtu/hr. Estimated potential emissions from the emergency generator are expected to be on the order of 72 TPY CO_2e and 3 TPY NO_X, with the emissions of all other pollutants less than 1

TPY. The potential emissions from any new heaters are expected to be less than 1 TPY of each criteria pollutant.

Additional emissions from the operation of all Project M&R stations result from fugitive releases from piping components, such as valves and fittings, as well as "non-routine" activities, such as pigging operations and other non-routine maintenance activities requiring blowdown of either the M&R station or a section of pipeline with a terminus at the M&R station. Table 9.2-10 provides NEXUS' estimated fugitive and non-routine emissions from operation of all of the new M&R stations proposed as part of the Project combined. This estimate utilizes industry emission factors provided in Table 5-26 and Table 6-6 of the *Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry*, prepared by the American Petroleum Institute in August 2009 ("API *Compendium*"). The fugitive emission factor from the API *Compendium* is an average of the emissions measured at M&R stations included in a June 1996 methane emissions study completed by the Gas Research Institute and USEPA. The non-routine emissions factor was developed from the *Updated Canadian National Greenhouse Gas Inventory for 1995, Emission Factor Documentation, Technical Memorandum*, Final, October 2001, prepared by the URS Corporation. The emission factors in the API *Compendium* were adjusted based on the expected methane ("CH_4") content of the site-specific gas.

9.2.5.4 Emissions from Operation of the NEXUS Pipelines

Emissions from the operation of natural gas transmission pipelines result from fugitive releases from piping components. Occasionally, non-routine activities, such as maintenance activities, will require venting/blowdown of a section of pipe between valves located along the pipeline. Table 9.2-11 presents an estimate of the actual emissions from operation of the proposed NEXUS pipeline (approximately 250.9 miles of pipe), using industry emission factors provided in Table 5-26 and Table 6-6 of the API *Compendium*. The emission factors were adjusted based on the expected CH_4 content of the site-specific gas.

9.2.5.5 Construction Emissions

NEXUS will estimate construction-related emissions of criteria pollutants and greenhouse gases for the Project. Tables 9.2-12 through 9.2-17 in the final version of Resource Report 9 will provide a summary of estimated emissions from construction activities. Detailed construction emissions calculations along with the methodology and emissions factors used will be provided in Appendix 9E of the final version of Resource Report 9 that will be filed with NEXUS' FERC application. Construction of the Project will result in temporary increases in emissions of some pollutants due to the use of equipment powered by diesel fuel or gasoline engines. Construction activities may also result in the temporary generation of fugitive dust due to disturbance of the ground surface and other dust generating actions. There may also be some temporary indirect emissions attributable to construction workers commuting to and from work sites during construction.

Fugitive Dust Emissions

Construction activities along the pipeline right-of-ways and at the compressor station and M&R station sites will result in emissions of fugitive dust from vehicular traffic and soil disturbance, and combustion emissions from diesel and gasoline fired construction equipment. Such air quality effects, however, will generally be temporary and localized, and are not expected to cause or significantly contribute to an exceedance of the NAAQS. Large earth-moving equipment and other mobile sources are sources of combustion-related emissions, including criteria pollutants (i.e., NO_X, CO, VOC, SO_2, and PM_{10}) and small amounts of HAPs. Air pollutants from the construction equipment will be limited to the immediate vicinity of the construction area and will be temporary.

Fugitive dust will result from land clearing, grading, excavation, concrete work, and vehicle traffic on paved and unpaved roads. The amount of dust generated will be a function of construction activity, soil type, soil moisture content, wind speed, precipitation, vehicle traffic, vehicle types, and roadway characteristics.

Emissions will be greater during dry periods and in areas of fine-textured soils subject to surface activity. NEXUS will employ proven construction-related practices to control fugitive dust such as application of water or other commercially-available dust control agents on unpaved areas subject to frequent vehicle traffic in accordance with the NEXUS Project Dust Control Plan included in Appendix 9C. In addition, construction equipment will be operated only on an as-needed basis.

Table 9.2-12 will provide estimates of fugitive dust emissions associated with construction activities.

Construction Engine Emissions

Construction-related emissions estimates will be based on a typical construction equipment list, hours of operation, and vehicle miles traveled by the construction equipment and supporting vehicles for each pipeline segment of the Project and for work planned at aboveground facilities and ware yards. This will be a very conservative estimate based on worst case assumptions and USEPA emission factors. Nevertheless, the estimated air emissions from construction of the NEXUS Project are expected to be transient in nature, with negligible impact on the regional air quality.

There will be some emissions attributable to vehicles delivering materials to the construction site and from on-road support vehicles at the construction site (i.e., mechanic trucks, water trucks, pickup trucks, etc.). Emission factors in grams per vehicle mile traveled for on-road vehicles will be obtained from the USEPA MOVES (Motor Vehicle Emission Simulator) model. Emissions from non-road construction equipment engines used during Project construction will be estimated based on the anticipated types of non-road equipment and their associated levels of use. Emission factors in grams per hp-hour will be obtained using the most recent version of USEPA's NONROAD model (NONROAD2008a).

Table 9.2-13 will summarize the estimated emissions of criteria pollutants and total HAPs from construction equipment and material deliveries and Table 9.2-14 will summarize the estimated GHG emissions from construction equipment and material deliveries. For the types of sources of GHG emissions associated with Project construction, total carbon dioxide ("CO_2") is essentially the same as CO_2e.

Emissions from Commuting

There also will be some emissions attributable to vehicles driven by construction workers commuting to and from the Project work sites during construction. Emission factors in grams per vehicle mile traveled for on-road vehicles will be obtained from the USEPA MOVES model.

Table 9.2-15 will provide estimates of tailpipe emissions of criteria pollutants from vehicles used by commuting construction workers and Table 9.2-16 will provide estimates of emissions of GHG emissions from vehicles used by commuting construction workers.

Emissions from Open Burning

Any open burning of land clearing debris will be conducted in accordance with all applicable state and local regulations and requirements. Table 9.2-17 will provide estimates of criteria pollutant and GHG emissions resulting from open burning of the forested land to be cleared prior to construction.

9.2.5.6 Radon

Radon is a naturally occurring radioactive gas that is odorless and tasteless. It is produced by the radioactive decay of radium-226, which is found in uranium ores; phosphate rock; shales; igneous and metamorphic rocks such as granite, gneiss, and schist; and, to a lesser degree, in common rocks such as limestone. Radioactive decay is a natural, spontaneous process in which an atom of one element decays or breaks down to form another element by losing atomic particles (protons, neutrons, or electrons) (USGS, 2014). Radon can be entrained in fossil fuels including natural gas.

Health studies conducted for the U.S. Department of Energy ("USDOE") and the USEPA, Office of Radiation Programs,[6] and reports prepared by Dr. Lynn R. Anspaugh[7] and Risk Sciences International ("RSI")[8] have found that radon in natural gas does not pose a health risk to end users. The Gogolak/USDOE study looked at the radon concentration in natural gas from eight wells in West Virginia and Kentucky and found an average radon concentration of 151 picocuries per liter ("pCi/L"). The Johnson/USEPA study found an average concentration of radon in natural gas of 37 pCi/L from over 2,000 wells nationwide. The Anspaugh study focused on gas samples taken at eight locations on the Texas Eastern system in West Virginia, Pennsylvania and New Jersey and found an average radon concentration of 29 pCi/L. In addition to these studies, the U.S. Geological Survey ("USGS") released a report in 2012 regarding radon activities in natural gas from certain wells.[9] The USGS found an average concentration of radon of 37 pCi/L based on gas samples from eleven wells in Pennsylvania.

The Gogolak/USDOE and Johnson/USEPA studies examined the deterioration/reduction of radon in the gas during transmission, processing, and at combustion. These studies concluded that due to radon's deterioration half-life of less than four days, the amount of radon entrained in natural gas rapidly diminishes as the natural gas is gathered from the wellhead, is processed to remove liquids and other elements, and is stored or delivered into a natural gas transmission pipeline system.

In its consideration of this issue in the New Jersey-New York Expansion Project, Algonquin Incremental Market Project, and the Constitution Pipeline and Wright Interconnect Projects certificate proceedings, the FERC considered many of these same studies and, based on those studies, concluded that the transportation of gas by the Projects did not result in a significant risk of exposure to radon and would not pose a health hazard to end users.[10] Similarly, radon exposure related to the NEXUS Project will not pose a health hazard and no mitigation measures are necessary.

9.3 Noise Quality

This section of Draft Resource Report 9 and associated appendices provide an overview of applicable noise regulations; an assessment of the existing ambient noise levels at nearby noise-sensitive areas ("NSAs") such as a residence, school, hospital, etc.; and a noise impact evaluation of new aboveground permanent facilities (i.e., new compressor stations and new M&R stations), which includes an acoustical analysis at nearby NSAs surrounding each respective facility for the Project. In addition, this section includes a summary of noise mitigation measures to be implemented to ensure compliance with the FERC noise standard during operation of the Project compressor stations and M&R stations. Also, a noise assessment of horizontal directional drilling ("HDD") operations at the potential trenchless crossings associated with

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[6] Texas Eastern Transmission, LP, 141 FERC ¶ 61,043 at n. 78 (2012) (Texas Eastern) (Gogolak, C., Review of 222RN in Natural Gas Produced from Unconventional Sources. Prepared for the U.S. Department of Energy, Environmental Measurements Laboratory as DOE/EML-385, New York, New York (1980), and Johnson, R., D. Bernhardt, N. Nelson, and H. Calley, Assessment of Potential Radiological Health Effects from Radon in Natural Gas, Prepared for the U.S. Environmental Protection Agency, Office of Radiation Programs as EPA-520/1-83-004, Washington, D.C. (1973)).

[7] Id. at n. 82 (Lynn R. Anspaugh, Scientific Issues Concerning Radon in Natural Gas (July 5, 2012)).

[8] Id. at n. 82 and 86 (RSI, An Assessment of the Lung Cancer Risk Associated with the Presence of Radon in Natural Gas Used for Cooking in Homes in New York State (July 4, 2012)).

[9] Rowan, E.L. and Kraemer, T.F., Radon-222 Content of Natural Gas Samples from Upper and Middle Devonian Sandstone and Shale Reservoirs in Pennsylvania: Preliminary Data, Prepared for the U.S. Department of the Interior, U.S. Geological Survey, Open-File Report Series 2012–1159, Reston, Virginia (2012).

[10] Texas Eastern Transmission, LP, 141 FERC ¶ 61,043 at P 56; Final Environmental Impact Statement, Constitution Pipeline and Wright Interconnect Projects, FERC Docket Nos. CP13-499-000 and CP13-502-00, Volume I at pages 4-187 to 4-188, published October 2014, by the Federal Energy Regulatory Commission; Final Environmental Impact Statement, Algonquin Incremental Market Project, FERC Docket No. CP14-96-000, Volume I at pages 4-241 to 4-245, published January 2015, by the Federal Energy Regulatory Commission.

the installation of the new pipeline is included along with a discussion regarding the noise impact from other construction activities.

On-site ambient sound surveys and/or acoustical analyses for the Project compressor stations, new M&R stations, and HDD crossing were conducted by Hoover & Keith Inc., an acoustical engineering company headquartered in Houston, Texas.

In general, the operation of the Project compressor stations and M&R stations associated with the Project will result in an increase in noise levels in the vicinity of the respective facilities over the life of the facilities. In addition, the installation of the new pipeline segments for the Project and other project-related construction activities will result in short-term increases in noise in the vicinity of those activities.

9.3.1 Aboveground Facilities

9.3.1.1 Compressor Stations

Table 9.3-1 summarizes the four new natural gas compressor stations associated with the Project along with the general location of those facilities and a summary of the anticipated equipment that could result in a noise impact at nearby NSAs during compressor station operation.

Hanoverton Compressor Station - Columbiana County, Ohio

A noise report entitled *Hanoverton Compressor Station - Results of an Ambient Sound Survey and Acoustical Analysis of the Natural Gas Compressor Station Associated with the NEXUS Gas Transmission Project* is provided in Appendix 9F, which includes an area layout of the compressor station showing the NSAs within 1 mile of the compressor station site and sound measurement positions near the identified nearby NSAs around the compressor station.

The Hanoverton Compressor Station will be located in Columbiana County near the town of Hanoverton, Ohio. The following describes the identified closest NSAs in each cardinal direction.

- NSA #1: Residences located approximately 1,040 feet south-southeast of the station site center (i.e., anticipated location of the compressor building);
- NSA #2: Residence located approximately 1,680 feet west of the station site center;
- NSA #3: Residence located approximately 1,800 feet northeast of the station site center;
- NSA #4: Residence located approximately 1,740 feet south of the station site center; and
- NSA #5: Residence located approximately 1,900 feet southwest of the station site center.

Currently, the Hanoverton Compressor Station will consist of two (2) Solar Titan 250 natural gas turbine compressor units and gas cooling that will serve all compressor units at the station. The new turbine compressor units will be installed inside an acoustically-insulated building. Primary auxiliary equipment for the new turbine compressor units will include: (1) lube oil cooler; (2) turbine exhaust system with exhaust stack; (3) turbine air intake system; (4) gas piping; and (5) a unit blowdown silencer for each compressor unit.

Wadsworth Compressor Station - Medina County, Ohio

A noise report entitled *Wadsworth Compressor Station - Results of an Ambient Sound Survey and Acoustical Analysis of the Natural Gas Compressor Station Associated with the NEXUS Gas Transmission Project* is provided in Appendix 9F, which includes an area layout of the compressor station showing the NSAs within 1 mile of the compressor station site and sound measurement positions near the identified nearby NSAs around the compressor station.

The Wadsworth Compressor Station will be located in Medina County, approximately 6 miles west of Wadsworth, Ohio and approximately 7 miles south of Medina, Ohio. The following describes the identified closest NSAs in each cardinal direction.

- NSA #1: Residences located 1,800 feet west of the station site center;
- NSA #2: Residences located 1,840 feet west-northwest of the station site center; and
- NSA #3: Residences located 2,490 feet northeast of the station site center.

Currently, the Wadsworth Compressor Station will consist of one (1) Solar Titan 250 natural gas turbine compressor unit and gas cooling that will serve the compressor station. The new turbine compressor unit will be installed inside an acoustically-insulated building. Primary auxiliary equipment for the new turbine compressor unit will include: (1) lube oil cooler; (2) turbine exhaust system with exhaust stack; (3) turbine air intake system; (4) gas piping; and (5) a unit blowdown silencer for the compressor unit.

Clyde Compressor Station - Sandusky County, Ohio

A noise report entitled *Clyde Compressor Station - Results of an Ambient Sound Survey and Acoustical Analysis of the Natural Gas Compressor Station Associated with the NEXUS Gas Transmission Project* is provided in Appendix 9F, which includes an area layout of the compressor station showing the NSAs within 1 mile of the compressor station site and sound measurement positions near the identified nearby NSAs around the compressor station.

The Clyde Compressor Station will be located in Sandusky County, approximately 5 miles northeast of Clyde, Ohio, and Interstate 80 is located relatively close to the station site. The following describes the identified closest NSAs in each cardinal direction.

- NSA #1: Residences located 1,450 feet north-northwest of the station site center;
- NSA #2: Residences located 810 feet southwest of the station site center; and
- NSA #3: Residence located 1,160 feet southeast of the station site center.

Currently, the Clyde Compressor Station will consist of one (1) Solar Titan 250 natural gas turbine compressor unit and gas cooling that will serve the compressor station. The new turbine compressor unit will be installed inside an acoustically-insulated building. Primary auxiliary equipment for the new turbine compressor unit will include: (1) lube oil cooler; (2) turbine exhaust system with exhaust stack; (3) turbine air intake system; (4) gas piping; and (5) a unit blowdown silencer for the compressor unit.

Waterville Compressor Station - Lucas County, Ohio

A noise report entitled *Waterville Compressor Station - Results of an Ambient Sound Survey and Acoustical Analysis of the Natural Gas Compressor Station associated with the NEXUS Gas Transmission Project* is provided in Appendix 9F, which includes an area layout of the compressor station showing the NSAs within 1 mile of the compressor station site and sound measurement positions near the identified nearby NSAs around the compressor station.

The Waterville Compressor Station will be located in Lucas County near Waterville, Ohio and 2.5 miles southeast of Whitehouse, Ohio. The following describes the identified closest NSAs in each cardinal direction.

- NSA #1: Residence located 1,390 feet east of the station site center;
- NSA #2: Residence located 1,990 feet north of the station site center;
- NSA #3: Residence located 3,790 feet west of the station site center; and
- NSA #4: Residence located 1,660 feet southeast of the station site center.

Currently, the Waterville Compressor Station will consist of one (1) Solar Titan 250 natural gas turbine compressor unit and gas cooling that will serve the compressor station. The turbine compressor unit will be installed inside an acoustically-insulated building. Primary auxiliary equipment for the new turbine compressor unit will include: (1) lube oil cooler; (2) turbine exhaust system with exhaust stack; (3) turbine air intake system; (4) gas piping; and (5) a unit blowdown silencer for the compressor unit.

9.3.1.6 Meter Stations

Table 9.3-2 summarizes the proposed new M&R stations associated with the Project along with the general location of each and the anticipated equipment that could affect the noise generated by the M&R station.

A noise report entitled *Acoustical Assessment of the Meter/Regulator Stations ("M&R Stations") Associated with the Proposed NEXUS Gas Transmission Project [Columbiana County (Ohio) and Washtenaw County (Michigan)]* is provided in Appendix 9G. A general layout of each respective M&R station showing its location, nearby NSAs, and other areas of interest are included in the subject noise report in Appendix 9G.

Each new M&R station will consist of meter runs with gas flow meters, regulator runs with flow-control valves ("FCVs") employed for gas flow-control and gas pressure regulation, isolation block valve(s), some aboveground piping/components and associated instrumentation/controls. An acoustical analysis was conducted for each M&R station.

9.3.2 Horizontal Directional Drilling

Table 9.3-3 provides a list and description of the planned HDDs for the Project. Currently, the trenchless method for installing the pipeline (via HDD) will be used to cross 11 areas located along the planned route of the new pipeline installation for the Project. For most of the HDDs, it is expected that the drilling rig will be located at the "HDD entry site" (i.e., drilling rig will not be utilized at the "HDD exit site").

A noise report entitled *Acoustical Assessment of the Potential HDDs (Ohio and Michigan) for the New Natural Gas Pipeline System Associated with the NEXUS Project* is provided in Appendix 9H.

9.3.3 Applicable Noise Guidelines and Summary of Acoustical Terminology

The unit of noise measurement is the decibel ("dB"), which measures the energy of noise. Because the human ear is not uniformly sensitive to all noise frequencies, the A-weighted ("A-wt.") frequency scale (denoted as "dBA") was devised to correspond with the ear's sensitivity.

The equivalent sound level ("L_{eq}", an A-wt. sound level or "dBA") is considered an average A-wt. sound level measured during a period of time, including any fluctuating sound levels during that period. The L_{eq} is equal to the level of a steady (in time) A-wt. sound level that would be equivalent to the sampled A-wt. sound level on an energy basis for a specified measurement interval. The concept of measuring L_{eq} has been used broadly to relate individual and community reaction to aircraft and other environmental noises.

The daytime sound level (L_d) is the equivalent A-wt. sound level (dBA) for a 15 hour time period, between 7:00 am and 10:00 pm. The nighttime sound level (L_n) is the equivalent A-wt. sound level (dBA) for a nine hour time period, between 10:00 pm and 7:00 am.

The L_{dn} is a 24-hour average A-wt. equivalent sound level (i.e., L_{eq}) of the measured daytime L_{eq} (i.e., L_d) and measured nighttime L_{eq} (i.e., L_n) with 10 dB added to the sound levels occurring during the nighttime hours between 10:00 pm and 7:00 am to compensate for enhanced receptor sensitivity during the nighttime. Rather than being a true measure of the sound level, the L_{dn} represents a skewed average that correlates generally with the results of studies relating environmental sound levels to physiological reaction and effects. For a source that operates at a continuous sound level over a 24-hour period, such as a compressor station, the L_{dn} is approximately 6.4 dB above the measured L_{eq}. Consequently, an L_{dn} of 55 dBA corresponds to a L_{eq} of 48.6 dBA. If both the L_d and L_n are measured, then the L_{dn} is calculated using the following formula:

$$L_{\mathrm{dn}} = 10\log_{10}\left(\frac{15}{24}10^{L_{\mathrm{d}}/10} + \frac{9}{24}10^{(L_{\mathrm{n}}+10)/10}\right)$$

9.3.3.1 Federal Energy Regulatory Commission Guidelines

In 1974, the USEPA published a document evaluating the effects of environmental noise with respect to health and safety. Using results presented in this document, the USEPA determined that noise levels should not exceed an L_{dn} of 55 dBA, defined as the level that protects the public from indoor and outdoor activity interference. This noise level has been referenced by state and federal agencies to establish noise limitations for various noise sources, such as natural gas compressor stations. However, this noise level is not a regulatory standard.

Accordingly, the FERC Office of Energy Projects Certificate of Public Convenience and Necessity conditions require that sound attributable to a new compressor station not exceed an L_{dn} of 55 dBA at any nearby NSA, such as a residence, school, or hospital. This also can be utilized for new M&R stations. In addition, FERC guidelines require that the operation of a new compressor station should not result in a perceptible increase in vibration at any nearby NSA. The sound level of 55 dBA (L_{dn}) also can be used as a "benchmark sound criterion/guideline" for assessing the noise impact of temporary or intermittent noise such as site construction noise at a compressor station and a natural gas blowdown event of a compressor unit.

Regarding HDD construction sites, conditions set forth by the FERC typically require that the sound attributable to drilling operations should not exceed 55 dBA (L_{dn}) at any nearby NSA. If it is projected that this sound criterion/guideline could be exceeded at any nearby NSA, it will be necessary to describe noise mitigation measures/options which would be implemented during drilling activity to reduce the noise impact of the drilling operations and achieve the sound criterion/guideline.

9.3.3.2 State and Local Noise Regulations

Ohio

The State of Ohio and/or the OEPA do not have regulations related to acceptable noise levels, however the OEPA acknowledges that noise level regulations are sometimes covered under local ordinances and/or city codes (e.g., public nuisance and limiting excessive noise between certain hours).

Columbiana County

Columbiana County Code of Ordinances includes "nuisance-type" noise and vibration requirements for facilities in "Light Industrial Districts". In summary, the code of ordinances states that facilities should not be offensive to the occupants of adjacent premises or the community at large by reason of noise/vibration disturbances. No applicable noise regulations for those townships in Columbiana County have been identified, although any local noise regulations, if required, will be addressed during the local permitting process.

Medina County

No applicable county or township noise regulations have been identified, although any local noise regulations, if required, will be addressed during the local permitting process.

Sandusky County

No applicable county or township noise regulations have been identified, although any local noise regulations, if required, will be addressed during the local permitting process.

Lucas County

No applicable county or township noise regulations have been identified, although any local noise regulations, if required, will be addressed during the local permitting process.

Michigan

Under the Michigan Public Service Commission ("MPSC") requirements, the noise attributable to an oil or gas surface facility is regulated under Michigan's Oil and Gas Regulations, Rule 324.1015 *Nuisance noise* and Rule 324.1016 *Construction standards for noise abatement at compressors associated with surface facilities*. Note that that MPSC regulations may not be applicable to an interstate natural gas pipeline project. In summary, the State of Michigan requirements stipulate that the noise due to *compressors associated with surface facilities* must not exceed 45 dBA at 1,320 feet. However, the State regulations also stipulate that appropriate noise control measures can be authorized even if the 45 dBA noise level at 1,320 feet from the facility is not exceeded. A practical interpretation of this additional stipulation is that if a noise impact is assumed to exist by the State, that they can request additional noise control measures.

Ypsilanti Charter Township Noise Ordinance

The Ypsilanti Charter Township ordinance requirements at the property line (75 decibels daytime/70 decibels nighttime) are specific for land zoned as industrial; however, the existing zoning of the new NEXUS/Willow Run M&R Station may not be zoned industrial. If the land is not zoned industrial, it appears that the property line requirements are reduced to 60 decibels. Please note it is assumed that decibels imply "dBA".

9.3.4 Noise Quality Analysis and Effects

9.3.4.1 Compressor Stations

An acoustical analysis for each Project compressor station was performed since the noise of each respective Project compressor station could have a noise impact at the nearby NSAs. The existing ambient sound levels at nearby NSAs for each Project compressor station were determined from ambient sound surveys. The complete results of the acoustical analysis for each Project compressor station, including the current ambient noise levels, are provided in the noise reports in Appendix 9F. The acoustical analysis for each compressor station considers the noise that will be produced by all continuous-operating equipment at the compressor station that could impact the sound contribution at the nearby NSAs. For the acoustical analyses, the sound contribution of the Project compressor stations at the nearby NSAs along with the total station noise at the nearby NSAs is estimated (i.e., estimated sound level contribution of the proposed station plus the current ambient noise level). The following sound sources are considered significant at each compressor station:

- Noise generated by the turbine compressor units that penetrates the compressor building(s);
- Turbine exhaust noise (primary noise source that could generate perceptible vibration);
- Noise radiated from aboveground gas piping and related piping components;
- Noise of the outdoor lube oil cooler(s) and outdoor gas cooler(s); and
- Noise generated by the turbine air intake system.

Tables 9.3-4 through 9.3-7 provide a Noise Quality Analysis for the Project compressor stations, assuming operation of the station equipment at full load, noting that the estimated (calculated) A-wt. sound level was used to infer a representative L_{dn}. A description of the acoustical analysis methodology and source of sound data related to this Noise Quality Analysis is provided in the respective noise report in Appendix 9F.

Based on the acoustical analysis, if the anticipated and recommended noise control measures for the Project compressor stations, as discussed further in Section 9.3.5.1, are successfully implemented, the noise attributable to the station will be lower than 55 dBA (L_{dn}). In addition, since noise sources that could cause perceptible vibration (e.g., turbine exhaust noise) will be adequately mitigated, there should not be any perceptible increase in vibration at any NSA during compressor station operation after installation of the

Project modifications, and the noise of a gas blowdown associated with the new turbine compressor units will be lower than 55 dBA (L_{dn}).

9.3.4.2 Meter Stations

All Project M&R stations have NSAs within 0.5 mile of the M&R station site. Consequently, each M&R station required an acoustical analysis. The existing ambient sound levels at nearby NSAs for each Project M&R station were determined from ambient sound surveys. The complete results of the acoustical analyses, as related to the Project M&R stations, including the measured ambient noise levels and subsequent data calculations, are provided in the noise report in Appendix 9G. The acoustical analyses for the M&R stations consider the noise that will be produced by all continuous-operating equipment at each facility that could affect the sound levels at the nearby NSAs. For the acoustical analyses, the sound contribution at the nearby NSAs along with the total noise level at the nearby NSAs is estimated (i.e., estimated sound level contribution of the M&R station plus the existing ambient noise level).

The primary noise associated with an M&R station is related to the FCVs (i.e., regulator valve-generated noise) and the FCV noise radiated from aboveground gas piping. The level of piping noise is directly related to the gas pressure drop ("PD") and amount of gas flow across the FCVs. For the acoustical analysis of each facility, the operating condition that could generate the highest amount of the M&R station noise (i.e., so-called "worst case" condition) was evaluated. The analysis assumes that the valve-generated noise will be equal to or less than 90 dBA for the worst case operating condition (i.e., measured A-wt. sound level at 3 feet from the piping, downstream of the regulator valve during operation of the respective regulator run), and if necessary to achieve the noise criteria, additional noise control measures are included (e.g., acoustical building for the regulator skid, which is anticipated, and/or acoustical insulation for regulator skid piping).

Table 9.3-8 summarizes the Noise Quality Analysis for the new Project M&R stations. Based on the acoustical analysis, if the anticipated and/or recommended noise control measures for the Project M&R stations, as discussed further in Section 9.3.5.2, are successfully implemented, the noise attributable to each respective M&R station will be lower than 55 dBA (L_{dn}) at the nearby NSAs.

9.3.4.3 Construction Activities

Aboveground Facilities

Site construction noise associated with the installation of new Project compressor stations and new M&R stations should have a negligible impact on the nearby NSAs, noting that the construction will be primarily limited to daytime hours. Construction activities will be performed with standard heavy equipment such as a track-excavator, backhoe, as well as use of a bulldozer, dump truck(s) and concrete trucks. Many construction machines operate intermittently and the types of machines in use at a construction site changes with the construction phase.

An acoustical assessment indicates that the noise from construction activities at the Project compressor station sites and M&R stations should have a minimal impact on the surrounding environments (i.e., noise of construction activities should be lower than 55 dBA (L_{dn})). If necessary, pro-active measures will be used to further reduce noise levels during construction so that the estimated maximum construction-related sound levels at the closest NSAs will be less than 55 dBA (L_{dn}). For these reasons, it is not anticipated that construction-type noise at the Project compressor stations and at the Project M&R stations will have significant impacts on the surrounding environment, noting that aboveground facility construction activities only occur during the daytime hours.

Pipeline Construction

Pipeline construction activity and associated noise levels for the new and replacement pipeline will vary depending on the phase of construction in progress at any one time. These construction phases include site grading, clearing/grubbing, building construction, etc. The highest level of construction noise is assumed to occur during earth work.

Pipeline construction noise-related impacts from the Project are expected to be short in duration at any given location and, therefore, have minimal impact. The equipment likely to be used during pipeline construction and the associated noise levels are presented in Table 9.3-9. Construction equipment noise levels will typically be less than 85 dBA at 50 feet when equipment is operating at full load. People at nearby residences and buildings will hear the construction noise but the overall impact will be short-lived and insignificant. Construction will not result in the generation of, or exposure of persons to, excessive noise or vibration levels for lengthy periods.

Horizontal Directional Drilling

Ambient noise surveys at the potential HDD sites were conducted to quantify the current ambient noise levels and verify the nearby NSAs to each potential HDD site. Each potential HDD site has NSAs within 0.5 mile of the HDD entry and exit site, therefore a noise assessment (i.e., predicted sound contribution of HDD operations at the closest NSA during peak operating conditions) was conducted for all HDD entry and exit sites. Table 9.3-10 provides a Noise Quality Analysis for the closest NSAs to the entry and exit site for each HDD, and assumes that a "standard" drilling rig is employed (i.e., no additional noise mitigation measures included).

In summary, the acoustical assessment indicates that the noise of HDD operations at some of the HDD entry sites and exit sites could exceed the noise criterion/guideline at the closest NSAs if no additional noise mitigation measures are employed.

Table 9.3-11 provides an acoustical assessment of HDD operations at the HDD sites if additional noise mitigation measures are employed. It is anticipated that if adequate noise mitigations are successfully employed, the sound level due to HDD operations at the planned HDD construction sites should not exceed the 55 dBA (L_{dn}) FERC sound criterion/guideline at the nearby NSAs.

Additional discussion and summary of noise mitigation measures that could be implemented at the HDD sites is provided in Section 9.3.5.3 and in the noise report provided in Appendix 9H.

9.3.5 Noise Mitigation Measures

9.3.5.1 Compressor Stations

Noise control measures to be implemented at each new compressor station for the Project are currently being evaluated by NEXUS. The noise reports in Appendix 9F provide detailed recommendations for noise control measures and equipment sound requirements for the significant sound sources associated with each proposed station along with other assumptions that may affect the noise and vibration generated by the compressor station equipment. The following is a summary list of noise control measures that are being evaluated for the equipment at the compressor stations.

- Noise control measures for the compressor building enclosing the new turbine(s) and compressor(s), including the use of appropriate building materials;
- Adequate muffler system for each turbine exhaust system;
- Acoustical pipe insulation for outdoor aboveground gas piping, if necessary;
- Adequate silencer for each turbine air intake system;
- Low-noise lube oil cooler associated with the compressor unit; and
- Low-noise gas cooler(s).

Sound Contribution of a Blowdown Event for any New Compressor Unit: The noise of a unit blowdown venting event for each compressor unit will occur via a blowdown silencer that will be specified to meet an A-wt. sound level of 60 dBA at a distance of 300 feet, noting that a unit blowdown event occurs infrequently for a short time frame (e.g., 1 to 5 minute period). An updated Appendix 9F will be included in NEXUS' NGA 7(c) Certificate Application to be filed with the Commission in November 2015.

9.3.5.2 Meter Stations

Noise control measures to be implemented related to the Project M&R stations are currently being evaluated. The noise report in Appendix 9G provides noise control recommendations and equipment sound specifications for the respective M&R stations along with other assumptions that may affect the noise and vibration generated by these facilities. For each respective Project M&R station, FCVs associated with any new regulator runs should be designed to achieve 90 dBA for the full range of operating conditions (i.e., A-wt. sound level at 3 feet from the piping downstream of the FCV). In addition, to reduce pipe/valve–radiated noise associated with the regulator skid, it may be necessary to cover aboveground gas piping with a type of acoustical insulation if the FCVs cannot achieve 90 dBA for the full range of operating conditions. The regulator runs/valves (e.g., regulator skid) and metering skid/piping at each respective M&R station will be located inside an enclosure/building (e.g., acoustical-insulated "off-skid" building that covers the regulator skid, metering skid and associated aboveground gas piping). An updated Appendix 9G will be included in NEXUS' NGA 7(c) Certificate Application to be filed with the Commission in November 2015.

9.3.5.3 Construction Activities

Because of the temporary nature of construction noise during normal installation of the pipeline and aboveground facilities along the pipeline route, no adverse or long term effects are anticipated. Noise mitigation measures to be employed during construction include ensuring that sound muffling devices that are provided as standard equipment by the construction equipment manufacturer are kept in good working order. If needed, additional noise abatement techniques and other measures can be implemented during the construction phase to mitigate construction-related noise disturbances at nearby NSAs.

Construction noise, while varying according to equipment in use, will be mitigated by the attenuating effect of distance and the intermittent and short-lived character of the noise. Further, the nature of construction of a pipeline dictates that construction activities and associated noise levels will move along the corridor and that no single NSA will be exposed to significant noise levels for an extended period. Some discrete activities (e.g., hydrostatic testing, tie-ins, purge and packing the pipeline, etc.) may require 24-hour activity for limited periods of time (e.g., from one to three days). These 24-hour activities require only a few overnight construction personnel and do not result in significant noise generation.

There will be locations where pipeline construction will occur within 50 feet of residences. Noise and any vibration generated during construction at this distance will not be unusual in nature and will be similar to that which occurs during public works type projects (e.g., paving, trenching). This work will only occur for a few days or less at any location and any impacts will be temporary. This work will only occur during daytime hours in order to minimize impacts.

Horizontal Directional Drilling

NEXUS is evaluating implementation of specific noise mitigation measures for the HDDs proposed as part of the Project. For example, a temporary noise barrier could be employed prior to commencement of drilling operations and/or a temporary noise-reducing tent placed over the HDD workspace. In addition, residential–grade exhaust silencers should be employed on any engines associated with the operation of HDD equipment, and to insure that the HDD operational noise is below the sound level criterion at the HDD entry sites, the following additional noise mitigation measures may also have to be employed: (1) equipment relocation (e.g., relocate mud rig remotely); (2) install a partial barrier or enclosure around the hydraulic power unit; (3) install a partial barrier around other engine-driven equipment (e.g., pumps and generators); and/or (4) limit to daytime operation only.

Additional discussion and summary of noise mitigation measures that could be implemented at the HDD sites is provided in the noise report provided in Appendix 9H.

Blasting

As described in Draft Resource Report 1, Section 1.7.1.8, blasting may be required to install the proposed NEXUS pipeline in areas with shallow bedrock. Geological and soils information contained in Draft Resource Reports 6 and 7, respectively, identify the areas where shallow bedrock may be encountered at anticipated trench depths in the Project area. The amount of blasting required to construct the NEXUS Project will be minimized to the extent possible by utilizing mechanical methods for rock excavation. In the event that un-rippable subsurface rock is encountered, blasting for ditch excavation will be necessary.

Should blasting be required, nearby residents or businesses, if any, will hear and may feel the ground vibration resulting from a blast. Section 6.3 of Draft Resource Report 6 describes the types of procedures that will be used to mitigate potential adverse impacts from blasting, which include noise and ground vibration.

Any blasting that is required will be conducted during daylight hours. All blasting operations will be performed according to strict guidelines designed to control energy release and protect personnel and property in the vicinity of the blast zone. The guidelines are consistent with applicable federal and state regulations that apply to controlled-blasting and blast vibration limits in the vicinity of structures and underground utilities. Special care will be taken to monitor and assess blasting within 150 feet of buildings and water supply wells. Additional precautions shall be taken to prevent damage to livestock and other property and inconvenience to the property owner or tenant during blasting operations. This includes conducting preconstruction surveys of such homes, businesses, and wells, as approved by the landowner.

In addition to the measures cited above, the NEXUS Project Blasting Plan in Appendix 1B3 of Draft Resource Report 1 contains mitigation measures to reduce noise and vibration during blasting, including controlling excessive noise and vibration by limiting the size of charges and by using charge delays, which stagger or sequence the detonation times for each charge; and monitoring the ground vibration and air overpressure (i.e., airblast or noise) effects of each blast by seismographs. If a charge greater than eight pounds per delay is used, the distance of the ground vibration and air overpressure monitoring will be in accordance with the U.S. Bureau of Mines Report of Investigation 8507.

9.3.6 Post Construction Sound Survey(s)

Within 60 days of placing the Project compressor stations in-service, a "post-construction" sound survey will be performed to ensure that the sound level attributable to each respective new compressor station, at full load operation does not exceed the FERC sound level requirement and/or any applicable state/local noise regulations. The results of the post-construction sound surveys will be filed with the Secretary.

9.4 References

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TABLES

TABLE 9.2-1

Summary of Proposed NEXUS Project Compression Facilities

Unit ID	Make and Model	Rated Engine Output (hp/ISO)	Rated Engine Output (hp/NEMA)
Hanoverton Compressor Station, Columbiana County, OH			
P001	Solar Titan 250-30002 Turbine Engine	30,000	26,000
P002	Solar Titan 250-30002 Turbine Engine	30,000	26,000
	Station Subtotal:	***60,000***	***52,000***
Wadsworth Compressor Station, Medina County, OH			
P001	Solar Titan 250-30002 Turbine Engine	30,000	26,000
	Station Subtotal:	***30,000***	***26,000***
Clyde Compressor Station, Sandusky County, OH			
P001	Solar Titan 250-30002 Turbine Engine	30,000	26,000
	Station Subtotal:	***30,000***	***26,000***
Waterville Compressor Station, Lucas County, OH			
P001	Solar Titan 250-30002 Turbine Engine	30,000	26,000
	Station Subtotal:	***30,000***	***26,000***
	PROJECT TOTAL:	**150,000**	**130,000**

Notes:
hp = horsepower
ISO = International Standard Operations conditions.
NEMA = National Electrical Manufacturers Association conditions.

TABLE 9.2-2

National Ambient Air Quality Standards

Pollutant	Averaging Period	Standards	
		Primary	Secondary
Sulfur dioxide (SO_2)	1-hour [12,13]	75 ppb	
	3-hour [2]	--	0.5 ppm 1300 µg/m³
	Annual [1,13]	0.03 ppm 80 µg/m³	--
	24-hour [2,13]	0.14 ppm 365 µg/m³	--
PM_{10}	24-hour [4]	150 µg/m³	150 µg/m³
$PM_{2.5}$ (2012 Standard)	Annual [5,14]	12.0 µg/m³	15.0 µg/m³
$PM_{2.5}$ (2006 Standard)	24-hour [6]	35 µg/m³	35 µg/m³
$PM_{2.5}$ (1997 Standard)	Annual [5,14] 24-hour [6]	15.0 µg/m³ 65 µg/m³	15.0 µg/m³ 65 µg/m³

TABLE 9.2-2

National Ambient Air Quality Standards

Pollutant	Averaging Period	Standards	
		Primary	Secondary
Nitrogen Dioxide (NO_2)	Annual [1]	0.053 ppm (53 ppb) 100 µg/m^3	0.053 ppm (53 ppb) 100 µg/m^3
	1-hour [3]	100 ppb 188 ug/m^3	--
Carbon Monoxide (CO)	8-hour [2]	9 ppm 10,000 µg/m^3	--
	1-hour [2]	35 ppm 40,000 µg/m^3	--
Ozone (2008 Standard)	8-hour [7,8,9]	0.075 ppm	0.075 ppm
Ozone (O_3)	1-hour [10,11]	0.12 ppm	0.12 ppm
Lead (Pb)	Rolling 3-month [1]	0.15 µg/m^3	0.15 µg/m^3

Notes:
[1] Not to be exceeded.
[2] Not to be exceeded more than once per year.
[3] Compliance based on 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area.
[4] Not to be exceeded more than once per year on average over 3 years.
[5] Compliance based on 3-year average of weighted annual mean $PM_{2.5}$ concentrations at community-oriented monitors.
[6] Compliance based on 3-year average of 98th percentile of 24-hour concentrations at each population-oriented monitor within an area.
[7] Compliance based on 3-year average of fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area.
[8] USEPA is currently reconsidering the 8-hour ozone standard set in March 2008. However, EPA has moved forward with implementing the 2008 standard until the reconsideration is finalized.
[9] EPA has proposed to lower the 8-hour Ozone standard in a December 2014 proposal to a range of 0.065-0.070 ppm, which is expected to be finalized by October 2015.
[10] Maximum 1-hour daily average not to be exceeded more than one day per calendar year on average.
[11] The 1-hour ozone standard has been revoked in all areas in which Project activities will occur.
[12] Compliance based on 3-year average of 99th percentile of the daily maximum 1-hour average at each monitor within an area.
[13] The 24-hour and annual average primary standards for SO_2 remain in effect until one year after an area is designated for the 1-hour standard.
[14] The 1997 annual $PM_{2.5}$ standard and associated implementation rules remain in in effect until one year after an area is designated for the 2013 annual $PM_{2.5}$ standard. Area designations were finalized for the 2013 standard on January 15, 2015.

ppm = parts per million by volume.
ppb = parts per billion by volume.
µg/m^3 = micrograms per cubic meter.

TABLE 9.2-3

Ohio Primary and Secondary Standards

Pollutant	Averaging Period	Standards	
		Primary	Secondary
Sulfur dioxide (SO_2)	Annual [1]	0.03 ppm	--
	24-hour [2]	0.14 ppm	--
	3-hour [2]	--	0.5 ppm
	1-hour [3]	75 ppb	--
PM_{10}	24-hour [4]	150 µg/m^3	150 µg/m^3
$PM_{2.5}$	24-hour [5]	35 µg/m^3	35 µg/m^3
	Annual [6]	15 µg/m^3	15 µg/m^3
Nitrogen Dioxide (NO_2)	Annual [1]	53 ppb	53 ppb
	1-hour [7]	100 ppb	--
Carbon Monoxide (CO)	8-hour [2]	9 ppm	--
	1-hour [2]	35 ppm	--
Ozone	8-hour [8]	0.075 ppm	0.075 ppm

Notes:
[1] Not to be exceeded.
[2] Not to be exceeded more than once per year.
[3] Compliance based on 3-year average of 99th percentile of the daily maximum 1-hour average.
[4] Not to be exceeded more than once per year on average over 3 years.
[5] Compliance based on 3-year average of 98th percentile of 24-hour concentrations.
[6] Compliance based on 3-year average.
[7] Compliance based on 3-year average of the 98th percentile of the daily maximum 1-hour average.
[8] Compliance based on 3-year average of the annual fourth-highest daily maximum 8-hour average.
[9] Compliance based on maximum 3-month mean concentration for a three-year period.

ppm = parts per million by volume.
ppb = parts per billion by volume.
µg/m^3 = micrograms per cubic meter.

TABLE 9.2-4

Ambient Air Quality Concentrations Representative of NEXUS Project Facilities

Pollutant and Averaging Period	Rank	Project Component	2012	2013	2014	Units	Monitor ID
1-Hour CO	2nd	Hanoverton Compressor Station; NEXUS/Kensington M&R Station; NEXUS/Texas Eastern M&R Station; NEXUS/TGP M&R Station; and TGP Interconnecting Pipeline	1.8	1.3	1.5	ppm	S
		Mainline Route (Eastern Ohio Portion)	1.8	1.3	1.5	ppm	S
		Wadsworth Compressor Station	1.5	1.1	1.2	ppm	U
		Clyde Compressor Station	2.1	2.0	1.5	ppm	F
		Mainline Route (Central Ohio Portion)	7.5	7.8	7.1	ppm	K
		Mainline Route (Western Ohio Portion)	2.1	2.0	1.5	ppm	F
		Waterville Compressor Station	2.1	2.0	1.5	ppm	F
		NEXUS/Willow Run M&R Station	2.6	2.0	1.9	ppm	R
		Mainline Route (Michigan Portion)	2.1	2.0	1.5	ppm	F
8-Hour CO	2nd	Hanoverton Compressor Station; NEXUS/Kensington M&R Station; NEXUS/Texas Eastern M&R Station; NEXUS/TGP M&R Station; and TGP Interconnecting Pipeline	1.6	1.0	1.1	ppm	S
		Mainline Route (Eastern Ohio Portion)	1.6	1.0	1.1	ppm	S
		Wadsworth Compressor Station	1.2	1.0	0.7	ppm	U
		Clyde Compressor Station	1.3	1.3	1.1	ppm	F
		Mainline Route (Central Ohio Portion)	4.6	4.6	3.7	ppm	K
		Mainline Route (Western Ohio Portion)	1.3	1.3	1.1	ppm	F
		Waterville Compressor Station	1.3	1.3	1.1	ppm	F
		NEXUS/Willow Run M&R Station	2.5	1.7	1.4	ppm	R
		Mainline Route (Michigan Portion)	1.3	1.3	1.1	ppm	F
1-Hour NO_2	98%	Hanoverton Compressor Station; NEXUS/Kensington M&R Station; NEXUS/Texas Eastern M&R Station; NEXUS/TGP M&R Station; and TGP Interconnecting Pipeline	40.0	38.0	44.0	ppb	C
		Mainline Route (Eastern Ohio Portion)	48.0	53.0	48.0	ppb	L
		Wadsworth Compressor Station	48.0	53.0	48.0	ppb	L
		Clyde Compressor Station	48.0	53.0	48.0	ppb	L
		Mainline Route (Central Ohio Portion)	48.0	53.0	48.0	ppb	L
		Mainline Route (Western Ohio Portion)	43.0	43.0	51.0	ppb	R
		Waterville Compressor Station	43.0	43.0	51.0	ppb	R
		NEXUS/Willow Run M&R Station	43.0	43.0	51.0	ppb	R
		Mainline Route (Michigan Portion)	43.0	43.0	51.0	ppb	R

TABLE 9.2-4

Ambient Air Quality Concentrations Representative of NEXUS Project Facilities

Pollutant and Averaging Period	Rank	Project Component	2012	2013	2014	Units	Monitor ID
Annual NO_2	Maximum	Hanoverton Compressor Station; NEXUS/Kensington M&R Station; NEXUS/Texas Eastern M&R Station; NEXUS/TGP M&R Station; and TGP Interconnecting Pipeline	10.1	10.1	10.7	ppb	C
		Mainline Route (Eastern Ohio Portion)	13.8	12.9	12.5	ppb	L
		Wadsworth Compressor Station	13.8	12.9	12.5	ppb	L
		Clyde Compressor Station	13.8	12.9	12.5	ppb	L
		Mainline Route (Central Ohio Portion)	13.8	12.9	12.5	ppb	L
		Mainline Route (Western Ohio Portion)	12.9	12.1	12.2	ppb	R
		Waterville Compressor Station	12.9	12.1	12.2	ppb	R
		NEXUS/Willow Run M&R Station	12.9	12.1	12.2	ppb	R
		Mainline Route (Michigan Portion)	12.9	12.1	12.2	ppb	R
8-Hour Ozone	4th	Hanoverton Compressor Station; NEXUS/Kensington M&R Station; NEXUS/Texas Eastern M&R Station; NEXUS/TGP M&R Station; and TGP Interconnecting Pipeline	0.07	0.07	0.06	ppm	X
		Mainline Route (Eastern Ohio Portion)	0.07	0.07	0.06	ppm	X
		Wadsworth Compressor Station	0.07	0.07	0.06	ppm	G
		Clyde Compressor Station	0.08	0.07	0.07	ppm	Q
		Mainline Route (Central Ohio Portion)	0.08	0.06	0.07	ppm	M
		Mainline Route (Western Ohio Portion)	0.08	0.07	0.07	ppm	Q
		Waterville Compressor Station	0.07	0.07	0.06	ppm	O
		NEXUS/Willow Run M&R Station	0.09	0.07	0.07	ppm	E
		Mainline Route (Michigan Portion)	0.09	0.06	0.07	ppm	B
24-Hour PM_{10}	2nd	Hanoverton Compressor Station; NEXUS/Kensington M&R Station; NEXUS/Texas Eastern M&R Station; NEXUS/TGP M&R Station; and TGP Interconnecting Pipeline	32.0	31.0	28.0	ug/m^3	I
		Mainline Route (Eastern Ohio Portion)	29.0	25.0	24.0	ug/m^3	H
		Wadsworth Compressor Station	31.0	27.0	29.0	ug/m^3	V
		Clyde Compressor Station	21.0	21.0	19.0	ug/m^3	W
		Mainline Route (Central Ohio Portion)	21.0	21.0	19.0	ug/m^3	W
		Mainline Route (Western Ohio Portion)	31.0	27.0	33.0	ug/m^3	F
		Waterville Compressor Station	31.0	27.0	33.0	ug/m^3	F
		NEXUS/Willow Run M&R Station	31.0	27.0	33.0	ug/m^3	F
		Mainline Route (Michigan Portion)	31.0	27.0	33.0	ug/m^3	F
24-Hour $PM_{2.5}$	98%	Hanoverton Compressor Station; NEXUS/Kensington M&R Station;	22.7	24.3	23.5	ug/m^3	S

TABLE 9.2-4

Ambient Air Quality Concentrations Representative of NEXUS Project Facilities

Pollutant and Averaging Period	Rank	Project Component	2012	2013	2014	Units	Monitor ID
		NEXUS/Texas Eastern M&R Station; NEXUS/TGP M&R Station; and TGP Interconnecting Pipeline					
		Mainline Route (Eastern Ohio Portion)	22.7	24.3	23.5	ug/m^3	S
		Wadsworth Compressor Station	19.1	22.5	20.3	ug/m^3	G
		Clyde Compressor Station	24.7	20.1	24.4	ug/m^3	P
		Mainline Route (Central Ohio Portion)	22.0	20.9	23.2	ug/m^3	W
		Mainline Route (Western Ohio Portion)	24.7	20.1	24.4	ug/m^3	P
		Waterville Compressor Station	21.5	21.6	28.6	ug/m^3	N
		NEXUS/Willow Run M&R Station	22.6	18.5	24.5	ug/m^3	E
		Mainline Route (Michigan Portion)	26.6	16.8	23.0	ug/m^3	B
Annual $PM_{2.5}$	Maximum	Hanoverton Compressor Station; NEXUS/Kensington M&R Station; NEXUS/Texas Eastern M&R Station; NEXUS/TGP M&R Station; and TGP Interconnecting Pipeline	10.5	10.7	10.6	ug/m^3	S
		Mainline Route (Eastern Ohio Portion)	10.5	10.7	10.6	ug/m^3	S
		Wadsworth Compressor Station	9.3	9.2	8.6	ug/m^3	G
		Clyde Compressor Station	10.1	9.5	10.6	ug/m^3	P
		Mainline Route (Central Ohio Portion)	9.5	8.8	9.1	ug/m^3	W
		Mainline Route (Western Ohio Portion)	10.1	9.5	10.6	ug/m^3	P
		Waterville Compressor Station	10.0	9.6	10.3	ug/m^3	N
		NEXUS/Willow Run M&R Station	9.2	8.7	9.8	ug/m^3	E
		Mainline Route (Michigan Portion)	9.0	7.9	8.8	ug/m^3	B
1-Hour SO_2	99%	Hanoverton Compressor Station; NEXUS/Kensington M&R Station; NEXUS/Texas Eastern M&R Station; NEXUS/TGP M&R Station; and TGP Interconnecting Pipeline	32.0	23.0	23.0	ppb	D
		Mainline Route (Eastern Ohio Portion)	22.0	23.0	21.0	ppb	T
		Wadsworth Compressor Station	47.0	59.0	43.0	ppb	U
		Clyde Compressor Station	48.9	43.1	56.0	ppb	F
		Mainline Route (Central Ohio Portion)	83.0	63.0	65.0	ppb	J
		Mainline Route (Western Ohio Portion)	48.9	43.1	56.0	ppb	F
		Waterville Compressor Station	12.0	7.0	13.0	ppb	A
		NEXUS/Willow Run M&R Station	48.9	43.1	56.0	ppb	F
		Mainline Route (Michigan Portion)	48.9	43.1	56.0	ppb	F
24-Hour SO_2	2nd	Hanoverton Compressor Station; NEXUS/Kensington M&R Station; NEXUS/Texas Eastern M&R Station;	8.5	8.5	7.0	ppb	D

TABLE 9.2-4

Ambient Air Quality Concentrations Representative of NEXUS Project Facilities

Pollutant and Averaging Period	Rank	Project Component	2012	2013	2014	Units	Monitor ID
		NEXUS/TGP M&R Station; and TGP Interconnecting Pipeline					
		Mainline Route (Eastern Ohio Portion)	8.4	8.0	6.7	ppb	T
		Wadsworth Compressor Station	15.8	19.3	19.1	ppb	U
		Clyde Compressor Station	12.5	8.9	11.9	ppb	F
		Mainline Route (Central Ohio Portion)	23.4	25.1	21.6	ppb	J
		Mainline Route (Western Ohio Portion)	12.5	8.9	11.9	ppb	F
		Waterville Compressor Station	4.1	3.8	5.4	ppb	A
		NEXUS/Willow Run M&R Station	12.5	8.9	11.9	ppb	F
		Mainline Route (Michigan Portion)	12.5	8.9	11.9	ppb	F

Monitor Key

A: Lima Bath, 2850 Bible Road, Lima, Allen, Ohio
B: 6792 Raisen Center Highway, Tecumseh, Lenawee, Michigan
C: Eight Street And River Alley, Beaver Falls, Beaver, Pennsylvania
D: Chester - Allison Elementary School, 647 Railroad Street, Chester, Hancock, West Virginia
E: Towner St, South, Hospital, 555 Towner St, Ypsilanti, Washtenaw, Michigan
F: Allen Park, 14700 Goddard, Allen Park, Wayne, Michigan
G: Chippewa, Ballash Road, Medina, Ohio
H: Warren Wtp, 2323 Main Ave., Warren, Trumbull, Ohio
I: School, 500 Maryland, East Liverpool, Columbiana, Ohio
J: St. Theodosius, 2547 St Tikhon, Cleveland, Cuyahoga, Ohio
K: Galleria, 1301 E. 9th St., Cleveland, Cuyahoga, Ohio
L: Gt Craig, E. 14th & Orange, Cleveland, Cuyahoga, Ohio
M: Sheffield, 4706 Detroit Rd., Sheffield, Lorain, Ohio
N: Raps, 4208 Airport Highway, Toledo, Lucas, Ohio
O: Waterville, 200 South River Rd., Waterville, Lucas, Ohio
P: Toledo Water Filtration, 3040 York St., Toledo, Lucas, Ohio
Q: 306 N. Yondota, Lucas, Ohio
R: 23751 Fenkell St, Detroit, Wayne, Michigan
S: Sears Bldg., 420 Market, Canton, Stark, Ohio
T: East High School, 80 Brittain, Akron, Summit, Ohio
U: Morley Health Bldg., 177 S. Broadway, Akron, Summit, Ohio
V: Brookpark, 16900 Holland Rd., Brook Park, Cuyahoga, Ohio
W: Barr School, 2180 Lake Breeze, Sheffield, Lorain, Ohio
X: Alliance, 1175 West Vine, Alliance, Stark, Ohio

TABLE 9.2-5

Attainment Status of Pipeline Facilities

Facility	County, State	Control Region	Attainment/ Unclassifiable	Nonattainment	Maintenance
Mainline Route TGP Interconnecting Pipeline Hanoverton Compressor Station NEXUS/Kensington M&R Station NEXUS/Texas Eastern M&R Station NEXUS/TGP M&R Station	Columbiana, OH	Youngstown-Warren-Sharon, OH-PA	SO_2, PM_{10}, $PM_{2.5}$, NO_2, CO, Pb		
Mainline Route	Stark, OH	Canton – Massillon, OH	SO_2, PM_{10}, NO_2, CO, Pb		$PM_{2.5}$
Mainline Route Wadsworth Compressor Station	Summit, OH Medina, OH Lorain, OH	Cleveland – Akron – Lorain, OH	SO_2, PM_{10}, NO_2, CO, Pb	2008 O_3	$PM_{2.5}$
Mainline Route Clyde Compressor Station	Wayne, OH Erie, OH Sandusky, OH Fulton, OH Henry, OH		SO_2, PM_{10}, CO NO_2, Pb, O_3, $PM_{2.5}$		
Mainline Route Waterville Compressor Station	Wood, OH Lucas, OH	Toledo, OH	SO_2, PM_{10}, $PM_{2.5}$, NO_2, CO, Pb		
Mainline Route NEXUS/Willow Run M&R Station	Monroe, MI Washtenaw, MI	Detroit – Ann Arbor, MI	SO_2, PM_{10}, NO_2, CO, Pb		$PM_{2.5}$
	Lenawee, MI		SO_2, PM_{10}, $PM_{2.5}$, NO_2, CO, Pb		

TABLE 9.2-6

Proposed Hanoverton Compressor Station Emissions Summary (TPY)

Maximum Potential Emissions

ID	Description	NO_X	CO	VOC	SO_2	PM / PM_{10} / $PM_{2.5}$	CO_2e	Hexane[1]	Total HAP
P001	Combustion Turbine #1	31.1	7.8	3.3	3.2	6.3	112,281	-	0.6
P002	Combustion Turbine #2	31.1	7.8	3.3	3.2	6.3	112,281	-	0.6
P003	Emergency Generator	1.3	2.6	1.2	0.0	0.0	576	0.0	0.7
P004	Gas Releases	-	-	24.6	-	-	19,114	0.7	2.0
P801	Equipment Leaks	-	-	10.1	-	-	1,419	0.2	1.2
P005	Separator Vessel #1	-	-	0.1	-	-	7	0.0	0.0
P006	Separator Vessel #2	-	-	0.1	-	-	7	0.0	0.0
P007	Separator Vessel #3	-	-	0.1	-	-	6	0.0	0.0
P008	Separator Vessel #4	-	-	0.6	-	-	18	0.0	0.0
P009	Separator Vessel #5	-	-	0.0	-	-	1	0.0	0.0
T001	Storage Tank #1	-	-	0.3	-	-	14	0.0	0.0
T002	Storage Tank #2	-	-	0.0	-	-	-	-	-
T003	Storage Tank #3	-	-	0.0	-	-	-	-	-
T004	Storage Tank #4	-	-	0.0	-	-	-	-	-
B001	Process Heater #1	0.7	0.4	0.2	0.0	0.0	554	0.0	0.0
B002	Process Heater #2	0.7	0.4	0.2	0.0	0.0	554	0.0	0.0
L001	Parts Washer	-	-	0.4	-	-	-	-	-
J001	Loading Operation	-	-	0.0	-	-	-	0.0	0.0
	Total	***65.0***	***19.1***	***44.5***	***6.4***	***12.6***	***246,832***	***1.0***	***5.3***

[1] Hexane(n-) emissions are presented for worst-case Individual HAP.

TABLE 9.2-7

Proposed Wadsworth Compressor Station Emissions Summary (TPY)

Maximum Potential Emissions

ID	Description	NO_X	CO	VOC	SO_2	PM / PM_{10} / $PM_{2.5}$	CO_2e	Hexane[1]	Total HAP
P001	Combustion Turbine	31.0	7.8	3.3	3.2	6.2	112,925	-	0.6
P002	Emergency Generator	1.0	1.9	0.9	0.0	0.0	432	0.0	0.5
P003	Gas Releases	-	-	19.8	-	-	15,401	0.6	1.6
P801	Equipment Leaks	-	-	6.3	-	-	997	0.1	0.8
P004	Separator Vessel #1	-	-	0.1	-	-	8	0.0	0.0
P005	Separator Vessel #2	-	-	0.1	-	-	8	0.0	0.0
P006	Separator Vessel #3	-	-	0.1	-	-	6	0.0	0.0
P007	Separator Vessel #4	-	-	0.6	-	-	18	0.0	0.0
P008	Separator Vessel #5	-	-	0.0	-	-	1	0.0	0.0
T001	Storage Tank #1	-	-	0.3	-	-	15	0.0	0.0
T002	Storage Tank #2	-	-	0.0	-	-	-	-	-
T003	Storage Tank #3	-	-	0.0	-	-	-	-	-
B001	Process Heater	0.7	0.4	0.2	0.0	0.0	554	0.0	0.0
L001	Parts Washer	-	-	0.4	-	-	-	-	-
J001	Loading Operation	-	-	0.0	-	-	1	0.0	0.0
	Total	***32.7***	***10.2***	***32.2***	***3.2***	***6.3***	***129,365***	***0.8***	***3.6***

[1] Hexane(n-) emissions are presented for worst-case Individual HAP.

TABLE 9.2-8

Proposed Clyde Compressor Station Emissions Summary (TPY)

Maximum Potential Emissions

ID	Description	NO_X	CO	VOC	SO_2	PM / PM_{10} / $PM_{2.5}$	CO_2e	Hexane[1]	Total HAP
P001	Combustion Turbine	31.1	7.8	3.3	3.2	6.3	112,238	-	0.6
P002	Emergency Generator	1.0	1.9	0.9	0.0	0.0	432	0.0	0.5
P003	Gas Releases	-	-	19.8	-	-	15,401	0.6	1.6
P801	Equipment Leaks	-	-	6.3	-	-	997	0.1	0.8
P004	Separator Vessel #1	-	-	0.1	-	-	8	0.0	0.0
P005	Separator Vessel #2	-	-	0.1	-	-	8	0.0	0.0
P006	Separator Vessel #3	-	-	0.1	-	-	6	0.0	0.0
P007	Separator Vessel #4	-	-	0.6	-	-	18	0.0	0.0
P008	Separator Vessel #5	-	-	0.0	-	-	1	0.0	0.0
T001	Storage Tank #1	-	-	0.3	-	-	15	0.0	0.0
T002	Storage Tank #2	-	-	0.0	-	-	-	-	-
T003	Storage Tank #3	-	-	0.0	-	-	-	-	-
B001	Process Heater	0.7	0.4	0.2	0.0	0.0	554	0.0	0.0
L001	Parts Washer	-	-	0.4	-	-	-	-	-
J001	Loading Operation	-	-	0.0	-	-	1	0.0	0.0
	Total	***32.8***	***10.2***	***32.2***	***3.2***	***6.3***	***129,678***	***0.8***	***3.6***

[1] Hexane(n-) emissions are presented for worst-case Individual HAP.

TABLE 9.2-9

Proposed Waterville Compressor Station Emissions Summary (TPY)

Maximum Potential Emissions

ID	Description	NO_X	CO	VOC	SO_2	PM / PM_{10} / $PM_{2.5}$	CO_2e	Hexane[1]	Total HAP
P001	Combustion Turbine	31.1	7.8	3.3	3.2	6.3	112,240	-	0.6
P002	Emergency Generator	1.0	1.9	0.9	0.0	0.0	432	0.0	0.5
P003	Gas Releases	-	-	19.8	-	-	15,401	0.6	1.6
P801	Equipment Leaks	-	-	6.3	-	-	997	0.1	0.8
P004	Separator Vessel #1	-	-	0.1	-	-	8	0.0	0.0
P005	Separator Vessel #2	-	-	0.1	-	-	8	0.0	0.0
P006	Separator Vessel #3	-	-	0.1	-	-	6	0.0	0.0
P007	Separator Vessel #4	-	-	0.6	-	-	18	0.0	0.0
P008	Separator Vessel #5	-	-	0.0	-	-	1	0.0	0.0
T001	Storage Tank #1	-	-	0.3	-	-	15	0.0	0.0
T002	Storage Tank #2	-	-	0.0	-	-	-	-	-
T003	Storage Tank #3	-	-	0.0	-	-	-	-	-
B001	Process Heater	0.7	0.4	0.2	0.0	0.0	554	0.0	0.0
L001	Parts Washer	-	-	0.4	-	-	-	-	-
J001	Loading Operation	-	-	0.0	-	-	1	0.0	0.0
	Total	***32.8***	***10.2***	***32.2***	***3.2***	***6.3***	***129,680***	***0.8***	***3.6***

[1] Hexane(n-) emissions are presented for worst-case Individual HAP.

TABLE 9.2-10

Estimated Actual Emissions from Non-Combustion Sources at Proposed M&R Stations (TPY)

	VOC	CO_2e
Fugitives	0.5	158.7
Non-Routine	8.7	3,007
Total	9.2	3,166

TABLE 9.2-11

Estimated Actual Emissions from Proposed NEXUS Pipelines (TPY)

	VOC	CO_2e
Fugitives	0.2	73.6
Non-Routine	15.8	5,449
Total	16.0	5,523

TABLE 9.2-12 [*Not included in this filing*]

Fugitive Dust Emissions from Construction Activities (TPY)

Year	PM_{10}	$PM_{2.5}$

Notes:
TPY = tons per year
PM_{10} = particulate matter with a diameter ≤ 10 microns
$PM_{2.5}$ = particulate matter with a diameter ≤ 2.5 microns

TABLE 9.2-13 [*Not included in this filing*]

Non-Road and On-Road Construction Vehicle Emissions of Criteria Pollutants and HAPs (TPY)

Year	NO_X	VOC	CO	SO_2	$PM_{10}/PM_{2.5}$	Total HAPs

Notes:
TPY = tons per year
NO_X = nitrogen oxides
VOC = volatile organic compounds
CO = carbon monoxide
SO_2 = sulfur dioxide
PM_{10} = particulate matter with a diameter ≤ 10 microns
$PM_{2.5}$ = particulate matter with a diameter ≤ 2.5 microns
HAP = hazardous air pollutants

TABLE 9.2-14 [*Not included in this filing*] **Non-Road and On-Road Construction Vehicle Emissions of Greenhouse Gases (TPY)**	
Year	**CO_2**

Notes:
TPY = tons per year
CO_2 = carbon dioxide

TABLE 9.2-15 [*Not included in this filing*] **Commuting Vehicles Emissions of Criteria Pollutants and HAPs (TPY)**						
Year	**NO_X**	**VOC**	**CO**	**SO_2**	**$PM_{10}/PM_{2.5}$**	**Total HAPs**

Notes:
TPY = tons per year
NO_X = nitrogen oxides
VOC = volatile organic compounds
CO = carbon monoxide
SO_2 = sulfur dioxide
PM_{10} = particulate matter with a diameter ≤ 10 microns
$PM_{2.5}$ = particulate matter with a diameter ≤ 2.5 microns
HAP = hazardous air pollutants

TABLE 9.2-16 [*Not included in this filing*] **Commuting Vehicles Emissions of Greenhouse Gases (TPY)**	
Year	**CO_2**

Notes:
TPY = tons per year
CO_2 = carbon dioxide

TABLE 9.2-17 [*Not included in this filing*]

Open Burning Emissions of Criteria Pollutants and Greenhouse Gases (TPY)

Year	NO_X	VOC	CO	SO_2	$PM_{10}/PM_{2.5}$	CO_2

Notes:
TPY = tons per year
NO_X = nitrogen oxides
VOC = volatile organic compounds
CO = carbon monoxide
SO_2 = sulfur dioxide
PM_{10} = particulate matter with a diameter ≤ 10 microns
$PM_{2.5}$ = particulate matter with a diameter ≤ 2.5 microns
CO_2 = carbon dioxide
Neg. = negligible

TABLE 9.3-1

Summary of the Compressor Stations for the Proposed NEXUS Project

Facility Name	MP a/	Location (County, State, Etc.)	Summary of Compressor Station Equipment with Potential Noise Impact b/
Hanoverton Compressor Station	1.2	Columbiana County, OH Near Hanoverton, OH	New compressor station designed with two (2) Solar Model Titan 250 turbine-driven compressor units, each unit rated at 30,000 hp (ISO) and gas cooling.
Wadsworth Compressor Station	60.3	Medina County, OH Near Wadsworth, OH	New compressor station designed with one (1) Solar Model Titan 250 turbine-driven compressor unit rated at 30,000 hp (ISO) and gas cooling.
Clyde Compressor Station	129.5	Sandusky County, OH Near Clyde, OH	New compressor station designed with one (1) Solar Model Titan 250 turbine-driven compressor unit rated at 30,000 hp (ISO) and gas cooling.
Waterville Compressor Station	178.1	Lucas County, OH Near Waterville, OH	New compressor station designed with one (1) Solar Model Titan 250 turbine-driven compressor unit rated at 30,000 hp (ISO) and gas cooling.

a/ NEXUS mainline pipeline milepost rounded to the nearest tenth. All mileposts are approximate at this time.
b/ Each new compressor station will include: lube oil cooler(s), turbine exhaust system with exhaust stack for each compressor unit, turbine air intake system for each compressor unit, gas aftercooling, aboveground gas piping and a unit blowdown silencer for each compressor unit.

TABLE 9.3-2

Summary of the Planned M&R Stations for the Proposed NEXUS Project

Facility Name	MP	Location (County, State, Etc.)	Summary of M&R Station Equipment with Potential Noise Impact a/
NEXUS/TGP M&R Station	0.0 b/	Columbiana County, OH Near Kensington, OH	Two dual 16" (four total) ultrasonic metering skids and two dual 16" (four total) monitor regulating skids (?). Regulator skid/piping and metering skid will be covered with an enclosure.
NEXUS/Kensington M&R Station and NEXUS/Texas Eastern M&R Station	0.0 c/ and 0.9 b/	Columbiana County, OH Near Kensington, OH	Both M&Rs located within the same property; dual 16" and single 8" ultrasonic metering skids, triple 16" and single 8" monitor regulating skids, and dual 30" bi-directional skids (?). Regulator skid/piping and metering skid will be covered with an enclosure.
NEXUS/Willow Run M&R Station	249.0 c/	Washtenaw County, MI Ypsilanti Township, MI	Dual 16" ultrasonic metering skids, dual 16" monitor regulating skids, and dual 24" bi-directional skids (?). Regulator skid/piping and metering skid will be covered with an enclosure.

a/ Preliminary design/equipment anticipated at each M&R station for the Project.
b/ TGP Interconnecting Pipeline milepost rounded to the nearest tenth. All mileposts are approximate at this time.
c/ NEXUS Mainline Route milepost rounded to the nearest tenth. All mileposts are approximate at this time.

TABLE 9.3-3

Summary of the Planned Horizontal Directional Drill (HDD) Crossings for the Proposed NEXUS Project

HDD #	NAME (CROSSING AREA)	ENTRY MP a/	EXIT MP a/	Location (County, State)
1	Tuscarawas River HDD	45.8	46.2	Summit County, OH
2	East Branch of Black River HDD	83.1	83.5	Lorain County, OH
3	West Branch of Black River HDD	88.8	89.0	Lorain County, OH
4	Vermillion River HDD	100.1	100.6	Erie County, OH
5	Huron River HDD	112.7	113.2	Erie County, OH
6	Sandusky River HDD	141.1	141.6	Sandusky County, OH
7	Portage River HDD	157.3	157.6	Sandusky County, OH
8	Maumee River HDD	175.9	176.6	Wood & Lucas County, OH
9	Saline River HDD	231.7	232.0	Washtenaw County, MI
10	Hydro Park HDD	244.8	245.2	Washtenaw County, MI
11	Interstate 94 (I-94) HDD	245.6	245.9	Washtenaw County, MI

a/ Nexus Mainline Route milepost rounded to the nearest tenth. All mileposts are approximate at this time.

TABLE 9.3-4

Noise Quality Analysis for the Hanoverton Compressor Station

Closest NSA	Distance and Direction of NSA to Site Center	Ambient L_{dn} (dBA) a/	Est'd L_{dn} of the Station during Operation (dBA)	Station L_{dn} + Ambient L_{dn} (dBA)	Change in the Ambient Sound Level (dB)
NSA #1	1,040 ft. (SSE)	46.4	51.0	52.3	5.9
NSA #2	1,680 ft. (W)	45.5	45.9	48.7	3.2
NSA #3	1,800 ft. (NE)	41.1	45.2	46.6	5.5
NSA #4	1,740 ft. (S)	45.5	45.6	48.5	3.0
NSA #5	1,900 ft. (SW)	45.5	44.7	48.1	2.6

a/ Ambient sound level based on recent sound survey conducted at the site of each facility.

TABLE 9.3-5

Noise Quality Analysis for the Wadsworth Compressor Station

Closest NSA	Distance and Direction of NSA to Site Center	Ambient L_{dn} (dBA) a/	Est'd L_{dn} of the Station during Operation (dBA)	Station L_{dn} + Ambient L_{dn} (dBA)	Change in the Ambient Sound Level (dB)
NSA #1	1,800 ft. (W)	56.7	44.5	57.0	0.3
NSA #2	1,840 ft. (WNW)	46.9	44.2	48.8	1.9
NSA #3	2,490 ft. (NE)	48.5	40.7	49.2	0.7

a/ Ambient sound level based on recent sound survey conducted at the site of each facility.

TABLE 9.3-6

Noise Quality Analysis for the Clyde Compressor Station

Closest NSA	Distance and Direction of NSA to Site Center	Ambient L_{dn} (dBA) a/	Est'd L_{dn} of the Station during Operation (dBA)	Station L_{dn} + Ambient L_{dn} (dBA)	Change in the Ambient Sound Level (dB)
NSA #1	1,450 ft. (NNW)	63.2	46.4	63.3	0.1
NSA #2	810 ft. (SW)	51.8	52.7	55.3	3.5
NSA #3	1,160 ft. (SE)	53.4	48.9	54.7	1.3

a/ Ambient sound level based on recent sound survey conducted at the site of each facility.

TABLE 9.3-7

Noise Quality Analysis for the Waterville Compressor Station

Closest NSA	Distance and Direction of NSA to Site Center	Ambient L_{dn} (dBA) a/	Est'd L_{dn} of the Station during Operation (dBA)	Station L_{dn} + Ambient L_{dn} (dBA)	Change in the Ambient Sound Level (dB)
NSA #1	1,390 ft. (E)	60.6	48.0	60.8	0.2
NSA #2	1,990 ft. (N)	48.6	43.8	49.9	1.3
NSA #3	3,790 ft. (W)	41.5	36.0	42.6	1.1
NSA #4	1,660 ft. (SE)	60.6	46.0	60.7	0.1

a/ Ambient sound level based on recent sound survey conducted at the site of each facility.

TABLE 9.3-8

Noise Quality Analysis for the Project M&R Stations

Respective M&R Station	Distance and Direction of Closest NSA to the M&R Station	Ambient L_{dn} (dBA) a/	Est'd L_{dn} due to the M&R Station (dBA)	M&R Station L_{dn} + Ambient L_{dn} (dBA)	Change in the Ambient Sound Level (dB)
NEXUS/TGP M&R Station	850 ft. (W)	45.0	32.0	45.2	0.2
NEXUS/Kensington M&R Station & NEXUS/Texas Eastern M&R Station	700 ft. (NE)	60.0	35.5	60.0	0.0
NEXUS/Willow Run M&R Station	300 ft. (E)	54.2	42.9	54.5	0.3

a/ Ambient sound level based on recent sound survey conducted at the site of each facility.

TABLE 9.3-9

Noise Levels of Major Construction Equipment a/

Equipment Type	Sound Level at 50 Feet (dBA)
Trucks	85
Crane	85
Roller	85
Bulldozers	85
Pickup Trucks	55
Backhoes	80

a/ U.S. Department of Transportation, Federal Highway Administration. 2011. FHWA Highway Construction Noise Handbook. Available online at: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

TABLE 9.3-10

Noise Quality Analysis for HDDs with NSAs within ½ Mile of Entry and/or Exit Site (Assumes Standard Rig Employed)

HDD Segment (Entry or Exit Site)	Distance and Direction of the Closest NSA to HDD Site Center	Ambient L_{dn} (dBA) a/	Calculated L_{dn} of the HDD Operations (dBA)	L_{dn} of HDD Operations + Ambient L_{dn} (dBA)	Change in the Ambient Sound Level
HDD #1 (Entry)	450 ft. (NW)	42.6	66.9	67.0	24.4
HDD #1 (Exit)	830 ft. (NW)	43.3	49.4	50.4	7.1
HDD #2 (Entry)	1,480 ft. (SE)	40.2	53.1	53.3	13.1
HDD #2 (Exit)	770 ft. (W)	41.2	48.3	49.1	7.9
HDD #3 (Entry)	790 ft. (SW)	41.1	61.5	61.5	20.4
HDD #3 (Exit)	730 ft. (NW)	43.6	47.8	49.2	5.6
HDD #4 (Entry)	770 ft. (SW)	38.7	61.7	61.7	23.0
HDD #4 (Exit)	340 ft. (E)	41.2	59.6	59.7	18.5
HDD #5 (Entry)	410 ft. (NE)	55.8	65.5	66.0	10.2
HDD #5 (Exit)	750 ft. (E)	56.4	50.4	57.4	1.0
HDD #6 (Entry)	1,150 ft. (ESE)	63.8	53.7	64.2	0.4
HDD #6 (Exit)	660 ft. (SE)	56.0	51.7	57.4	1.4
HDD #7 (Entry)	600 ft. (NE)	42.3	64.2	64.2	21.9
HDD #7 (Exit)	450 ft. (NW)	44.1	53.5	53.9	9.8
HDD #8 (Entry)	980 ft. (SW)	45.3	59.3	59.5	14.2
HDD #8 (Exit)	1,020 ft. (S)	43.6	47.4	48.9	5.3
HDD #9 (Entry)	550 ft. (NW)	40.8	63.1	63.1	22.3
HDD #9 (Exit)	720 ft. (S)	46.3	50.8	52.1	5.8
HDD #10 (Entry)	1,420 ft. (NE)	49.0	53.5	54.8	5.8
HDD #10 (Exit)	1,040 ft. (NE)	53.1	45.3	53.8	0.7
HDD #11 (Entry)	220 ft. (NW)	51.1	75.1	75.1	24.0
HDD #11 (Exit)	250 ft. (W)	60.6	62.2	64.5	3.9

a/ Existing ambient sound level based on an ambient sound survey conducted at each HDD site.

TABLE 9.3-11

Noise Quality Analysis for HDDs that could Exceed the Sound Criterion at the Closest NSAs (Assumes Additional Noise Mitigation Measures Employed to Meet the Sound Criterion/Guideline)

HDD Segment (Entry or Exit Site)	Distance and Direction of the Closest NSA to HDD Site Center	Ambient L_{dn} (dBA) a/	Calculated L_{dn} of the HDD Operations (dBA)	L_{dn} of HDD Operations + Ambient L_{dn} (dBA)	Change in the Ambient Sound Level
HDD #1 (Entry)	450 ft. (NW)	42.6	54.1	54.4	11.8
HDD #3 (Entry)	790 ft. (SW)	41.1	49.5	50.1	9.0
HDD #4 (Entry)	770 ft. (SW)	38.7	49.8	50.1	11.4
HDD #4 (Exit)	340 ft. (E)	41.2	50.4	50.9	9.7
HDD #5 (Entry)	410 ft. (NE)	55.8	53.4	57.8	2.0
HDD #7 (Entry)	600 ft. (NE)	42.3	51.2	51.7	9.4
HDD #8 (Entry)	980 ft. (SW)	45.3	47.5	49.5	4.2
HDD #9 (Entry)	550 ft. (NW)	40.8	51.1	51.5	10.7
HDD #11 (Entry)	220 ft. (NW)	51.1	53.8	55.6	4.5
HDD #11 (Exit)	250 ft. (W)	60.6	52.0	61.2	0.6

a/ Existing ambient sound level based on ambient sound survey(s) conducted at the HDD sites.

APPENDIX 9A

Compressor Station Air Permit Applications and Emission Calculations

[*Not included in this Filing*]

APPENDIX 9B

General Conformity Applicability Analysis

[*Not included in this Filing*]

NEXUS
GAS TRANSMISSION

APPENDIX 9C

NEXUS Project Dust Control Plan

NEXUS GAS TRANSMISSION

NEXUS Gas Transmission, LLC

NEXUS Project

Docket No. PF15-10-000

DUST CONTROL PLAN

June 2015

Table of Contents

1.0 Introduction

NEXUS Gas Transmission, LLC ("NEXUS") is seeking a Certificate of Public Convenience and Necessity ("Certificate") from the Federal Energy Regulatory 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 billion cubic feet 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 ("Dawn"). Through interconnections with existing pipelines, shippers on 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 will traverse Pennsylvania, West Virginia, Ohio and Michigan, terminating at the 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 Dawn.

The purpose of this Dust Control Plan (Plan) is to inform the contractor and its subcontractors of required measures to reduce the impact of dust on the nearby community (i.e., off-site receptors including residences, businesses) and on-site workers as a result of construction and soil handling activities. Additionally, this plan helps prevent the off-site spread of dust that may result from Project construction activity. This Plan describes control measures to be implemented before, after, and while conducting any dust generating operation. The Plan requires monitoring, corrective actions to abate emission of dust and documentation of control measures taken.

2.0 Applicability

The Plan is applicable to any fugitive dust emissions associated with construction vehicle movement and with trenching, backfilling, and other earthmoving activities, including routine use of unpaved roads, soil excavation, and handling of any other dusty materials.

3.0 Dust Emissions and Control Measures

NEXUS' Construction Contractor (Contractor) will visually monitor the presence of airborne dust at the downwind boundary of the work site. If excessive airborne dust is detected at the boundary of the work site or if complaints are received, the Contractor should check for the presence of airborne dust on the upwind side of the construction area and implement dust control measures if construction activity is clearly the major contributing factor to increased dust emissions downwind. The Contractor will discontinue construction activities if generation of dust cannot be controlled to avoid soiling of structures or personal belongings on adjacent properties.

The Contractor will take measures to reduce dust generation and employ practices to prevent excessive fugitive dust emissions (e.g., visible dust clouds). No dust control measures are generally required during precipitation events. Dust control measures are required especially during warm dry weather and those days with strong winds. A source of clean, potable water, calcium chloride or other commercially-available dust control agents must be made available to wet down exposed soil surfaces. Dust control measures include but are not limited to:

Soil Excavation and Handling

- Load haul trucks such that the load is below the freeboard;
- Prevent spillage;
- Apply water, calcium chloride or other commercially-available dust control agents when needed prior to disturbance and during disturbance to prevent dust generation;
- Maintain existing ground coverings (e.g., existing pavement) until disturbance is required for construction and stabilize exposed soil with gravel or other stabilizing material, if dust generation is observed; and
- Discontinue construction activities if generation of dust cannot be controlled to avoid soiling of structures or personal belongings on adjacent properties.

Unpaved haul and access roads

- Apply water or other dust control agents when needed;
- Control and immediately remove any track-out;
- Cover loads, as appropriate;
- Maintain appropriate low vehicle speeds in unpaved areas; and
- Route vehicles and equipment to covered surfaces (e.g., paved or graveled) when possible.

4.0 Responsibility and Authority

The contractor Construction Superintendent, the Environmental Inspector, and the onsite NEXUS chief inspector will share the authority to determine if/when water needs to be reapplied for dust control and to determine if/when additional mitigation will be needed.

The Construction Contractor will furnish, operate and maintain equipment and employ methods to minimize the migration of dust beyond the boundaries of the work site. The Contractor also will provide a copy of the Dust Control Plan to all applicable site subcontractors. The Contractor Construction Superintendent will be responsible for implementing the Dust Control Plan. The Environmental Inspector has stop work authority for any non-compliance issues.

5.0 Recordkeeping and Monitoring

NEXUS' Contractor will document in their daily report the actual application or implementation of the control measures delineated in the Dust Control Plan or otherwise.

APPENDIX 9D

Screening Level Ambient Air Quality Analyses

[*Not included in this Filing*]

APPENDIX 9E

Construction Emissions Calculations

[*Not included in this Filing*]

APPENDIX 9F

Results of the Ambient Sound Survey and Acoustical Analysis for each Compressor Station Associated with the NEXUS Project

HANOVERTON COMPRESSOR STATION
(COLUMBIANA COUNTY, OHIO)

RESULTS OF AN AMBIENT SOUND SURVEY AND ACOUSTICAL ANALYSIS OF THE NATURAL GAS COMPRESSOR STATION ASSOCIATED WITH THE NEXUS GAS TRANSMISSION PROJECT

H&K Report No. 3224

H&K Job No. 4875

Date of Report: June 9, 2015

Submitted to: **Fluor Enterprises, Inc.** (Fluor)
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Sugar Land, TX 77478

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REPORT SUMMARY

This report provides the results of an acoustical analysis for the new **Hanoverton Compressor Station** (referred to as "Station" or "CS-1" in the report) associated with the proposed **NEXUS Gas Transmission Project** ("Project" or "NEXUS Project"). Also included are the results of the recent ambient sound survey at the proposed site of the Station. The intent of the acoustical analysis is to project the sound contribution of the Station during full load operation and determine noise control measures to insure that applicable sound criteria are not exceeded at the nearby noise-sensitive areas (NSAs). The purpose of the ambient sound survey was to identify and verify the nearby NSAs surrounding the Station and to quantify the current ambient sound environment at the nearby NSAs.

The following table summarizes the ambient sound level at the identified closest NSAs, the estimated sound level contribution of the Station at the closest NSAs if the Station was operated at full load and the total sound level contribution of the Station (i.e., sound level contribution of the Station plus the ambient noise level). The results provided in this table are referred to as the "Noise Quality Analysis" for the Station.

Noise Quality Analysis for Hanoverton Compressor Station associated with the NEXUS Project

Closest NSA(s) and Type of NSA	Distance and Direction of NSA to Station Site Center	Ambient Ldn (via Meas'd Ld & Est'd Ln)	Est'd Sound Level (Ldn) of the Station at Full Load	Est'd "Total" Ldn (Station Noise + Ambient Noise)	Potential Noise Increase
NSA #1 (Residences)	1,040 ft. (SSE)	46.4 dBA	51.0 dBA	52.3 dBA	5.9 dB
NSA #2 (Residence)	1,680 ft. (west)	45.5 dBA	45.9 dBA	48.7 dBA	3.2 dB
NSA #3 (Residence)	1,800 ft. (NE)	41.1 dBA	45.2 dBA	46.6 dBA	5.5 dB
NSA #4 (Residence)	1,740 ft. (south)	45.5 dBA	45.6 dBA	48.5 dBA	3.0 dB
NSA #5 (Residence)	1,900 ft. (SW)	45.5 dBA	44.7 dBA	48.1 dBA	2.6 dB

The results of the acoustical analysis indicates that if the anticipated and/or recommended noise control measures are implemented successfully, the sound contribution of the proposed Station should be equal to or lower than **55 dBA** (L_{dn}) at the nearby NSAs, which is the FERC sound level requirement for this type of facility. In addition, the acoustical analyses indicate that the noise of construction activities and noise resulting from a unit blowdown event at the Station should have limited noise impact on the surrounding environment. Also, since Station noise sources that could cause perceptible vibration (e.g., turbine exhaust noise) will be adequately mitigated, there should not be any perceptible increase in vibration at any NSA during Station operation.

TABLE OF CONTENTS

1.0 INTRODUCTION

In this report, **Hoover & Keith Inc.** (H&K) presents the results of an acoustical analysis for the new **Hanoverton Compressor Station** (referred to as "Station" or "CS-1" in the report) associated with the proposed **NEXUS Gas Transmission Project** ("Project" or "NEXUS Project"). Also included are the results of the recent ambient sound survey at the proposed site of the Station. The following summarizes the purpose of the ambient sound survey and Station acoustical analysis:

(1) Quantify the existing acoustic environment (i.e., measure the typical ambient sound levels) and verify the current noise-sensitive areas (NSAs) around the Station, such as residences, hospitals and schools;

(2) Estimate the sound level contribution of the Station at the nearby NSAs and estimate the "total" Station sound level contribution (i.e., Station noise plus the ambient sound level);

(3) Determine noise mitigation measures to insure that applicable sound level criteria are not exceeded after installation and full load operation of the Station; and

(4) Project the noise at the nearby NSAs resulting from construction activities at the Station, and estimate the noise contribution due to a unit blowdown event at the Station.

2.0 SOUND CRITERIA

Federal: It is anticipated that certificate conditions of the Office of Energy Projects (OEP) of the Federal Energy Regulatory Commission (FERC) will require that the sound level attributable to a new natural gas compressor station during full load operation not exceed a day-night average sound level (i.e., L_{dn}) of **55 dBA** at any nearby NSA. In addition, the operation of the Station should not result in a perceptible increase in vibration at any nearby NSA. The L_{dn} is an energy average of the measured daytime L_{eq} (L_d) and measured nighttime L_{eq} (L_n) plus **10 dB**. The **10-dB** adjustment to the L_n is intended to compensate for nighttime sensitivity. For a steady sound source that operates continuously over a 24-hour period and controls the environmental sound level, the L_{dn} is approximately **6.4 dB** above the measured L_{eq}. Consequently, an L_{dn} of **55 dBA** corresponds to a L_{eq} of **48.6 dBA**. If both the L_d and L_n are measured and/or estimated, then the L_{dn} is calculated using the following formula:

$$L_{\mathrm{dn}} = 10\log_{10}\left(\frac{15}{24}10^{L_{\mathrm{d}}/10} + \frac{9}{24}10^{(L_{\mathrm{n}}+10)/10}\right)$$

State of Ohio: The State of Ohio or the Ohio EPA does not have regulations related to acceptable noise levels. We understand that sometimes noise level regulations are covered under local ordinances or city codes (e.g., public nuisance and limit excessive noise between certain hours).

County/Township: Columbiana County Code of Ordinances includes “nuisance-type” of noise and vibration requirements for facilities in “Light Industrial Districts”. In summary, the code of ordinances states that facilities should not be offensive to the occupants of adjacent premises or the community at large by reason of noise/vibration disturbances. No applicable local/township noise regulations have been identified, although any local noise regulations, if required, will be addressed during the local permitting process.

3.0 SITE/FACILITY DESCRIPTION

Figure 1 (**Appendix**, p. 11) provides an area layout around the Station that shows the NSAs within 1 mile of the Station and other areas of interest. **Figure 2** (**Appendix**, p. 12) provides a layout around the Station that shows the identified closest NSAs, reported sound measurement positions near the identified closest NSAs and a conceptual layout of equipment and buildings at the Station. The Station will be located in Columbiana County, Ohio, approximately 1 mile south of Hanoverton, OH. There are a few NSAs (e.g., residences) located within 1 mile of the Station, and the closest NSAs are residences located 1,040 south-southeast (SSE) of the Station (along Railroad Street).

The proposed Station will consist of two (2) Solar Titan 250 gas turbine-driven centrifugal gas compressor units [i.e., 30,000 horsepower (HP) rating (ISO/each)]. We understand that the turbines and compressors for the compressor units will be installed inside an acoustically-insulated metal building (i.e., Compressor Building). The following describes the anticipated auxiliary equipment and other notable items associated with the Station compressor units:

- Outdoor lube oil cooler (“LO cooler”);
- Turbine exhaust system designed with an adequate muffler system;
- Turbine air intake filter system designed with in-duct silencer;
- Gas piping and associated piping components, and most gas piping will be buried;
- Gas aftercooler (i.e., air-cooled heat exchanger) that serves the compressor units; and
- Gas blowdown silencer associated with a unit blowdown.

There will also be two (2) types of gas blowdown events: (1) gas blowdown that occurs when a compressor is stopped and gas between the suction/discharge valves and compressor is vented to the atmosphere (“unit blowdown”) via a blowdown silencer, and (2) emergency shutdown (“ESD”) that will only occur at required Department of Transportation (DOT) test intervals or in an emergency situation (e.g., gas leak or fire). The unit blowdown will be a “maintenance” type of unit blowdown which can occur when the compressor unit is stopped and gas between the suction/discharge valves and compressor unit is vented to the atmosphere through a silencer. During the period of commissioning and testing, it is estimated that a unit blowdown could occur 2 to 4 times/day and typically only during the daytime. During normal operation of the Station (i.e., after the commissioning period), a unit blowdown event occurs infrequently (e.g., 1 to 3 times/month). In addition, a unit blowdown event only occurs for a short time frame (e.g., unit blowdown event would persist for approximately 1 to 5 minutes). There also can be an emergency shutdown ("ESD") that will only occur only during an emergency situation (e.g., gas leak or fire), which rarely occurs, noting that some natural gas facilities operate for years without having an ESD, and the gas blowdown related to an ESD may be vented via a blowdown silencer. Note that for required DOT test intervals of the ESD operations (e.g., once or twice a year), it is not necessary to vent/blowdown the pipeline gas to atmosphere.

4.0 MEASUREMENT METHODOLOGY, MEASUREMENT LOCATIONS AND CONDITIONS

Ambient sound levels were measured near three (3) of the identified closest NSAs (i.e., "NSA #1", "NSA #2" & "NSA #3"). The following provides a description of the identified closest surrounding NSAs and the reported sound measurement positions ("Pos."):

Pos. 1: Near NSA #1 (closest NSA): Residences located 1,040 feet south-southeast (SSE) of the Station site center (i.e., anticipated location of the Compressor Building);

Pos. 2: Near NSA #2: Residence located approximately 1,680 feet west of Station site center;

Pos. 3: Near NSA #3: Residence located 1,800 feet northeast (NE) of the Station site center,

NSA #4: Residence located approximately 1,740 feet south of the Station site center, and in our opinion, the ambient sound level measured at Meas. Pos. 2 is representative of the ambient sound level at NSA #4; and

NSA #5: Residence located approximately 1,900 feet southwest (SW) of the Station site center, and in our opinion, the ambient sound level measured at Meas. Pos. 2 is representative of the ambient sound level at NSA #5.

The sound survey was conducted by Garrett Porter of H&K during the daytime of Feb. 3, 2015. During the site ambient sound survey, the temperature was 27 degrees F, the wind was from the west and there were overcast sky conditions. At the reported sound measurement locations, the A-wt. equivalent sound levels (i.e., L_{eq}) and the unweighted octave-band (O.B.) sound pressure levels (SPLs) were measured at approximately 5 feet above ground. The sound measurements attempted to exclude "extraneous sound" such as the noise contribution of occasional vehicle passing by the measurement position and/or other intermittent sources. The acoustical measurement system consisted of a Rion NA-27 Sound Level Meter (a Type 1 SLM per ANSI S1.4 & S1.11) equipped with microphone, covered with a windscreen. The SLM was calibrated with a microphone calibrator (calibrated within 1 year of the test date).

5.0 MEASUREMENT RESULTS AND OBSERVATIONS

Table A (**Appendix**, p. 13) summarizes the measured daytime L_{eq} (L_d) and the estimated nighttime L_{eq} (L_n) at the NSA sound measurement locations along with the average of the measured L_d since several samples of the ambient sound level were measured. **Table A** also includes the resulting ambient L_{dn} as calculated from the measured L_d and estimated L_n. Meteorological conditions that occurred during the sound survey are summarized in **Table B** (**Appendix**, p. 13). The measured daytime sound levels (L_d) and related unweighted O.B. SPLs at the reported sound measurement positions are provided in **Table C** (**Appendix**, p. 13).

The following **Table 1** summarizes the measured ambient L_d and estimated ambient L_n at the closest NSAs along with the resulting ambient L_{dn} at the closest NSAs, as calculated from the measured ambient L_d and estimated L_n.

Meas. Pos.	Description of the Identified Closest NSAs, as related to the Sound Measurement Location	Meas'd Ambient Ld	Est'd Ambient Ln	Resulting Ambient Ldn
Pos. 1	NSA #1: Residences 1,040 ft. SSE of the Station	46.4 dBA	36.4 dBA	46.4 dBA
Pos. 2	NSA #2: Residence 1,680 ft. west of the Station; NSA #4 (1,740 ft. south of Station); NSA #5 (1,900 ft. SW of Station)	45.5 dBA	35.5 dBA	45.5 dBA
Pos. 3	NSA #3: Residence 1,800 ft. NE of the Station	40.2 dBA	32.2 dBA	41.1 dBA

Table 1: Summary of the Measured Ld, Estimated Ln and Resulting Ambient Ldn at the Closest NSAs

It is our opinion that the measured sound level data adequately quantifies the existing ambient sound level for the meteorological conditions that occurred during the sound survey. The ambient L_n were not measured but were estimated based on our site observations to provide a more accurate representation of the ambient L_{dn} (i.e., ambient nighttime levels could be lower than the measured daytime levels). At the reported sound measurement location near all of the identified NSAs, noise sources that contributed to the ambient A-wt. sound level included primarily the noise of distant vehicle traffic, sound of birds and at times, sound of wind blowing in trees.

6.0 ACOUSTICAL ANALYSIS (COMPRESSOR STATION)

6.1 Sound Level Contribution of the Station

The acoustical analysis considers the noise produced by equipment for the Station compressor units that could impact the sound contribution at any NSA. The predicted sound contribution of the Station were performed only for the closest NSAs (i.e., NSA #1, NSA #2, NSA #3, NSA #4 & NSA #5) since the Station sound contribution at other more distant NSAs should be equal to or less than the predicted Station sound level at these closest NSAs. A description of the acoustical analysis methodology and source of sound data for the analysis is provided in the **Appendix** (pp. 17–18). The following sound sources were considered significant and included in the Station acoustical analysis:

- Noise generated by the turbines/compressors that penetrates the Compressor Building;
- Noise of the turbine exhaust radiated from the turbine exhaust stack for each unit;
- Noise radiated from aboveground/outdoor gas piping and associated components;
- Noise of the outdoor LO coolers and associated outdoor piping;
- Noise generated by the turbine air intake systems, and
- Noise of the gas aftercooler(s) and associated aboveground piping.

Table D (**Appendix**, p. 14) shows the spreadsheet analysis of the estimated A-wt. sound level and unweighted O.B. SPLs at the closest NSA ("NSA #1") contributed by the Station compressor units during full load operation for standard day propagating conditions (i.e., no wind, 60 deg. F., 70% R.H.). Included in **Table D** is the estimated "total" sound level contribution of the Station at NSA #1 (i.e., sound level contribution of the Station plus the ambient sound level).

Table E (**Appendix**, p. 15) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the Station at NSA #2 based on the acoustical analysis at NSA #1, along with the estimated total sound level contribution of the Station at NSA #2 (i.e., sound level contribution of the Station plus the ambient sound level).

Table F (**Appendix**, p. 15) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the Station at NSA #3 based on the acoustical analysis at NSA #1, along with the estimated total sound level contribution of the Station at NSA #3 (i.e., sound level contribution of the Station plus the ambient sound level).

Table G (**Appendix**, p. 16) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the Station at NSA #4 based on the acoustical analysis at NSA #1, along with the estimated total sound level contribution of the Station at NSA #4 (i.e., sound level contribution of the Station plus the ambient sound level).

Table H (**Appendix**, p. 16) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the Station at NSA #5 based on the acoustical analysis at NSA #1, along with the estimated total sound level contribution of the Station at NSA #5 (i.e., sound level contribution of the Station plus the ambient sound level).

The following **Table 2** summarizes the calculated sound level contribution of the Station at the identified closest NSAs assuming full load operation of all equipment associated with the Station, noting that the estimated A-wt. sound level was used to calculate the representative L_{dn}.

Operating Condition and associated NSA	Est'd A-Wt. Sound Level of Station	Calc'd Ldn (via Est'd A-Wt. Level)
Est'd sound contribution of Station during full load operation at NSA #1	44.6 dBA	51.0 dBA
Est'd sound contribution of Station during full load operation at NSA #2	39.5 dBA	45.9 dBA
Est'd sound contribution of Station during full load operation at NSA #3	38.8 dBA	45.2 dBA
Est'd sound contribution of Station during full load operation at NSA #4	39.2 dBA	45.6 dBA
Est'd sound contribution of Station during full load operation at NSA #5	38.3 dBA	44.7 dBA

Table 2: Estimated Sound Contribution of the Station during Full Load Operation at the Closest NSAs

6.2 Sound Contribution of a Unit Blowdown Event at the Station

The noise level of the unit blowdown event via a blowdown silencer will be specified to meet an A-wt. sound level of **60 dBA** at a distance of 300 feet. If this sound requirement is achieved, the noise of a unit blowdown will be approximately **46 dBA** (i.e., L_{dn} of approximately **52 to 53 dBA**) at the closest NSA, located approximately 1,040 feet from the unit blowdown silencer, which would be lower than **55 dBA** (L_{dn}). Consequently, although the noise of a unit blowdown event could be slightly audible at the nearby NSAs, it is not expected to present a noise impact, noting also that a unit blowdown event occurs infrequently for a short time frame (e.g., 1 to 5 minute period). A description of the acoustical analysis methodology and source of sound data related to blowdown noise are provided in the **Appendix** (p. 18)

7.0 ACOUSTICAL ANALYSIS (SITE CONSTRUCTION ACTIVITIES)

The acoustical analysis of the construction-related activities at the site of the Station considers the noise produced by any significant sound sources associated with the primary construction equipment that could impact the sound contribution at the nearby NSAs. The predicted sound contribution of construction equipment/activities was performed only for the closest NSA (i.e., NSA #1). Construction of the Station will consist of earth work (e.g., site grading, clearing and grubbing) and construction of the Station buildings, and it is assumed that the highest level of construction noise would occur during site earth work (i.e., time frame when the largest amount of construction equipment would operate).

Table I (**Appendix**, p. 19) shows the calculation of the estimated maximum A-wt. sound level at the closest NSA contributed by the construction activities at the Station for standard day propagating conditions. A description of the methodology and source of sound data for the construction noise analysis are provided in the **Appendix** (p. 20). The analysis indicates that the maximum A-wt. noise level of construction activities at the closest NSA would be equal to or less than **53 dBA** (i.e., L_{dn} of approximately **51 dBA**, since nighttime construction activities are not anticipated).

8.0 NOISE CONTROL MEASURES (COMPRESSOR STATION)

The following section provides the recommended noise control measures and equipment sound level requirements along with other assumptions that may affect the noise of the Station.

8.1 Building enclosing the Turbines/Compressors

We understand that the turbines and compressors will be installed inside an acoustically-insulated metal building (i.e., Compressor Building). The following describes specific sound requirements and other items related to the components of the Compressor Building.

- As a minimum, walls/roof should be constructed with an exterior skin of 22–gauge metal. In addition, building interior surfaces should be covered with a minimum of 6–inch thick "high-density" mineral wool or fiberglass (i.e., 6.0–8.0 pcf uniform density) covered with a perforated liner. Note that "low-density" insulation (e.g., 0.6 to 0.75 pcf density) should **not** be substituted for the high-density material although low-density insulation could be employed in addition to the high-density insulation;

- No windows or louvers should be installed in the building walls; Personnel entry doors should be a **STC-36 sound rating**, even if glazing is employed, and should be self-closing and should seal well when closed; Large access doors ("roll-up doors") should seal well when closed and consist of an insulated-type door (e.g., 18-ga. exterior facing, 24-ga. backskin with insulation core);

- It is anticipated that the building air ventilation system will be designed with air supply fans mounted in the building walls along with roof-mounted air exhaust vents. Assuming this type of air ventilation system, the sound level for each wall air-supply fan should not exceed **50 dBA** at **50 feet**, which will require that each supply fan employ an exterior dissipative-type silencer (e.g., minimum 3-ft. length) and an acoustically-lined weatherhood.

8.2 Turbine Exhaust System

The turbine exhaust system for each compressor unit should include a silencer system that provides the following dynamic sound insertion loss ("DIL") values at rated operating conditions.

DIL Values for the Exhaust Silencer System in dB per Octave-Band (O.B.) Center Freq. (Hz)

31.5	63	125	250	500	1000	2000	4000	8000
5	16	25	35	45	45	45	35	30

To meet these recommended DIL values and minimize the impact of the turbine exhaust noise at surrounding residences, a "2–stage" exhaust silencer system should be implemented. One (1) of the 2-stage silencers should be employed horizontally in the exhaust ducting located inside the Compressor Building for the compressor unit (i.e., "1st stage silencer"), and the other silencer system could be integrated into the vertical outdoor exhaust stack (i.e., "2nd stage silencer") or in the horizontal exhaust ducting located outside the Compressor Building. If a CO converter is employed, which is anticipated, it is assumed that a CO converter system would be inserted upstream of the 1st stage silencer, inside the Compressor Building.

8.3 Outdoor Aboveground Gas Piping

The acoustical analysis indicates that noise control measures, such as acoustical pipe insulation, will be required for outdoor aboveground gas piping to meet applicable sound criteria. The following items associated with the gas piping and piping components should be addressed:

- Acoustical pipe insulation should be employed for aboveground suction and discharge gas piping. Acoustical pipe insulation should consist of a minimum 3-inch thick fiberglass or mineral wool (6.0-8.0 pcf density) that is covered with a mass-filled vinyl jacket (e.g., composite of 1.0 psf mass-filled vinyl laminated to 0.020-inch thick aluminum). All exposed pipe supports for the insulated gas piping should be covered with acoustical material;

- Outdoor valves should be covered with acoustical blanket material. Filter–separator(s) and associated aboveground gas piping should not have to be covered with acoustical material. It is also recommended that the suction pipe strainer for the compressor units be removed soon after the Station is placed in service, if feasible.

8.4 Lube Oil Cooler

The LO cooler should not exceed **60 dBA** at **50 feet** from the cooler perimeter at the full rated operating conditions (i.e., equivalent to a PWL of **92–93 dBA**). Note that a "standard" Solar LO cooler may not be capable of meeting this sound requirement, and consequently, a "special" or "custom" LO cooler will be required to meet the recommended sound requirement.

8.5 Turbine Air Intake System

The turbine air intake system for each compressor unit should be designed with at least one (1) in-duct silencer (e.g., 7-ft. length "special" silencer or combination of 2 Solar "standard" silencers), and at least one of the silencers (i.e., if 2 separate silencers are employed) should be installed in the intake ductwork located inside the Compressor Building. As a minimum, the air intake silencer system should provide the following DIL values at the rated operating conditions of the turbine-driven compressor units, noting that only one (1) "standard" Solar air intake silencer may not be capable of meeting these DIL values.

DIL Values in dB per O.B. Center Frequency for the Turbine Air Intake System

31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
4	10	20	35	45	55	60	60	55

8.6 Gas Aftercooler

The sound level generated by any multi-fan gas cooler that serves the compressor units should not exceed **62 dBA** at **50 feet** at the full rated operating conditions (i.e., all fans operating at maximum design speed). To meet this sound level requirement, the gas aftercooler will need to be designed with "low-noise" fans that operate at relatively low tip speeds (e.g., fans operating at below 7,200 fpm tip speeds). In addition, aboveground inlet pipe risers and inlet header (if above ground) for the gas cooler should be covered with acoustical pipe insulation.

8.7 Unit Blowdown Silencer

The unit blowdown silencer should attenuate the unsilenced blowdown noise to a noise level equal to or less than **60 dBA** at 300 feet from the outlet of the silencer, which includes the noise radiated from the shell of the silencer during the blowdown event.

9.0 SUMMARY AND FINAL COMMENT

The following **Table 3** summarizes the ambient sound level at the identified closest NSAs, the estimated sound level contribution of the Station at the closest NSAs during full load Station operation and the "total" sound level contribution of the Station (i.e., sound level contribution of Station during operation plus the ambient sound level). The results provided in this table are referred to as the "Noise Quality Analysis" for the Station.

Closest NSA(s) and Type of NSA	Distance and Direction of NSA to Station Site Center	Ambient Ldn (via Meas'd Ld & Est'd Ln)	Est'd Sound Level (Ldn) of the Station at Full Load	Est'd "Total" Ldn (Station Noise + Ambient Noise)	Potential Noise Increase
NSA #1 (Residences)	1,040 ft. (SSE)	46.4 dBA	51.0 dBA	52.3 dBA	5.9 dB
NSA #2 (Residence)	1,680 ft. (west)	45.5 dBA	45.9 dBA	48.7 dBA	3.2 dB
NSA #3 (Residence)	1,800 ft. (NE)	41.1 dBA	45.2 dBA	46.6 dBA	5.5 dB
NSA #4 (Residence)	1,740 ft. (south)	45.5 dBA	45.6 dBA	48.5 dBA	3.0 dB
NSA #5 (Residence)	1,900 ft. (SW)	45.5 dBA	44.7 dBA	48.1 dBA	2.6 dB

Table 3: Noise Quality Analysis for the Hanoverton Station associated with NEXUS Project

The results of the acoustical analysis indicates that if the noise control measures are employed successfully, the sound contribution of the Station should be equal to or lower than **55 dBA** (L_{dn}) at the nearby NSAs, which is the FERC sound level requirement for this type of facility. In addition, the acoustical analyses indicate that the noise of construction activities and noise resulting from a unit blowdown event at the Station should have limited noise impact on the surrounding environment. Also, since Station noise sources that could cause perceptible vibration (e.g., turbine exhaust noise) will be adequately mitigated, there should not be any perceptible increase in vibration at any NSA during Station operation.

APPENDIX

- **FIGURE 1: GENERAL AREA LAYOUT AROUND THE STATION SHOWING THE NSAs LOCATED WITHIN 1 MILE OF THE STATION AND OTHER AREAS OF INTEREST**
- **FIGURE 2: AREA LAYOUT SHOWING IDENTIFIED CLOSEST NSAs, REPORTED SOUND MEASUREMENT POSITIONS NEAR THE CLOSEST NSAs, AND CONCEPTUAL LAYOUT OF THE STATION SHOWING THE EQUIPMENT, BUILDINGS AND STATION FENCELINE**
- **SUMMARY OF THE MEASURED AMBIENT SOUND DATA**
- **ACOUSTICAL ANALYSIS (COMPRESSOR STATION)**
- **ANALYSIS METHODOLOGY (NOISE ATTRIBUTABLE TO THE STATION AND A BLOWDOWN EVENT) AND THE SOURCE OF SOUND DATA**
- **ACOUSTICAL ANALYSIS (CONSTRUCTION ACTIVITIES)**
- **DESCRIPTION OF THE ANALYSES METHODOLOGY (CONSTRUCTION ACTIVITIES) AND THE SOURCE OF SOUND DATA**

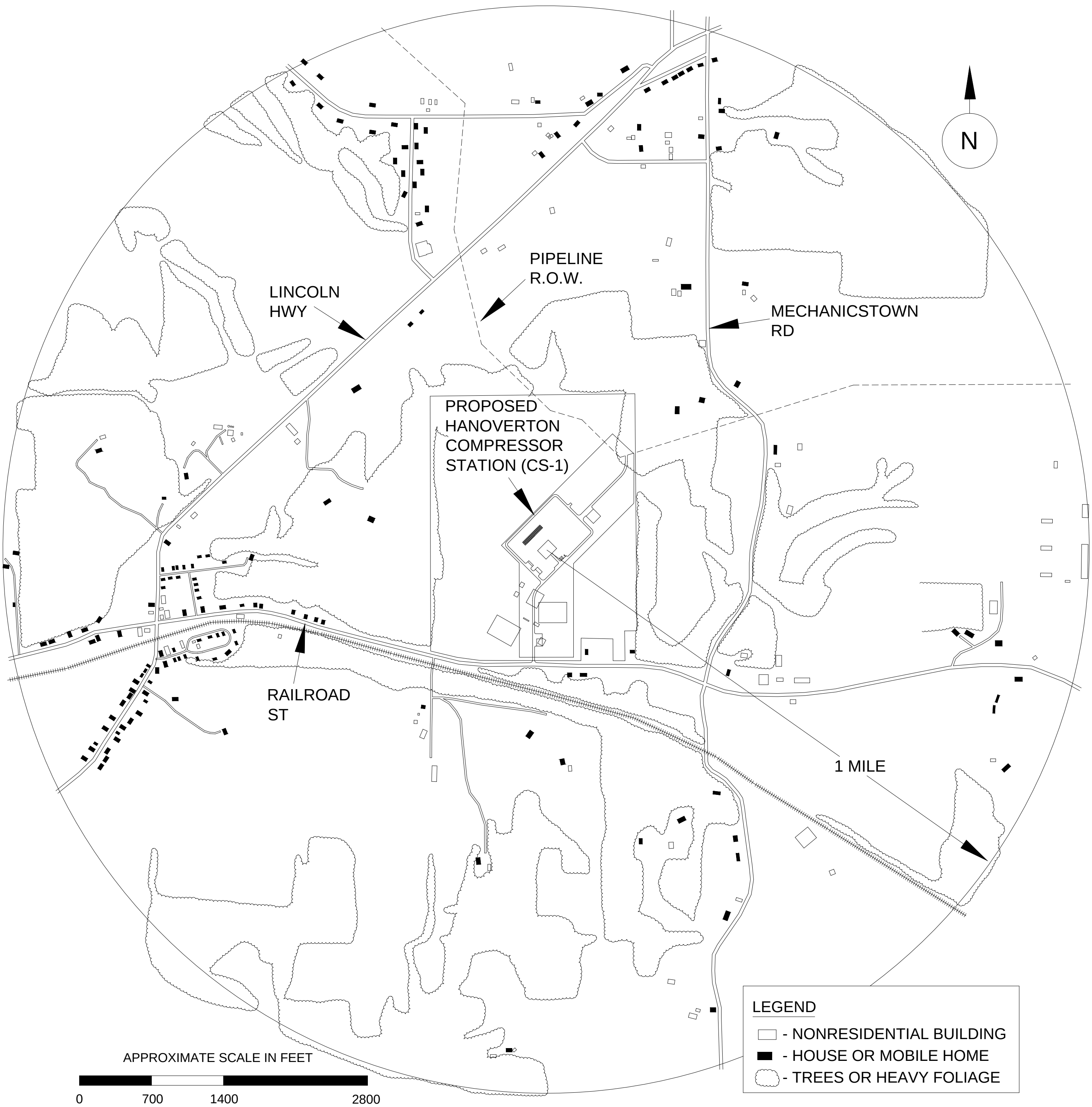

Figure 1: NEXUS Hanoverton Compressor Station (CS-1): General Area Layout showing the NSAs within 1 Mile of the Station Site and Other Areas of Interest.

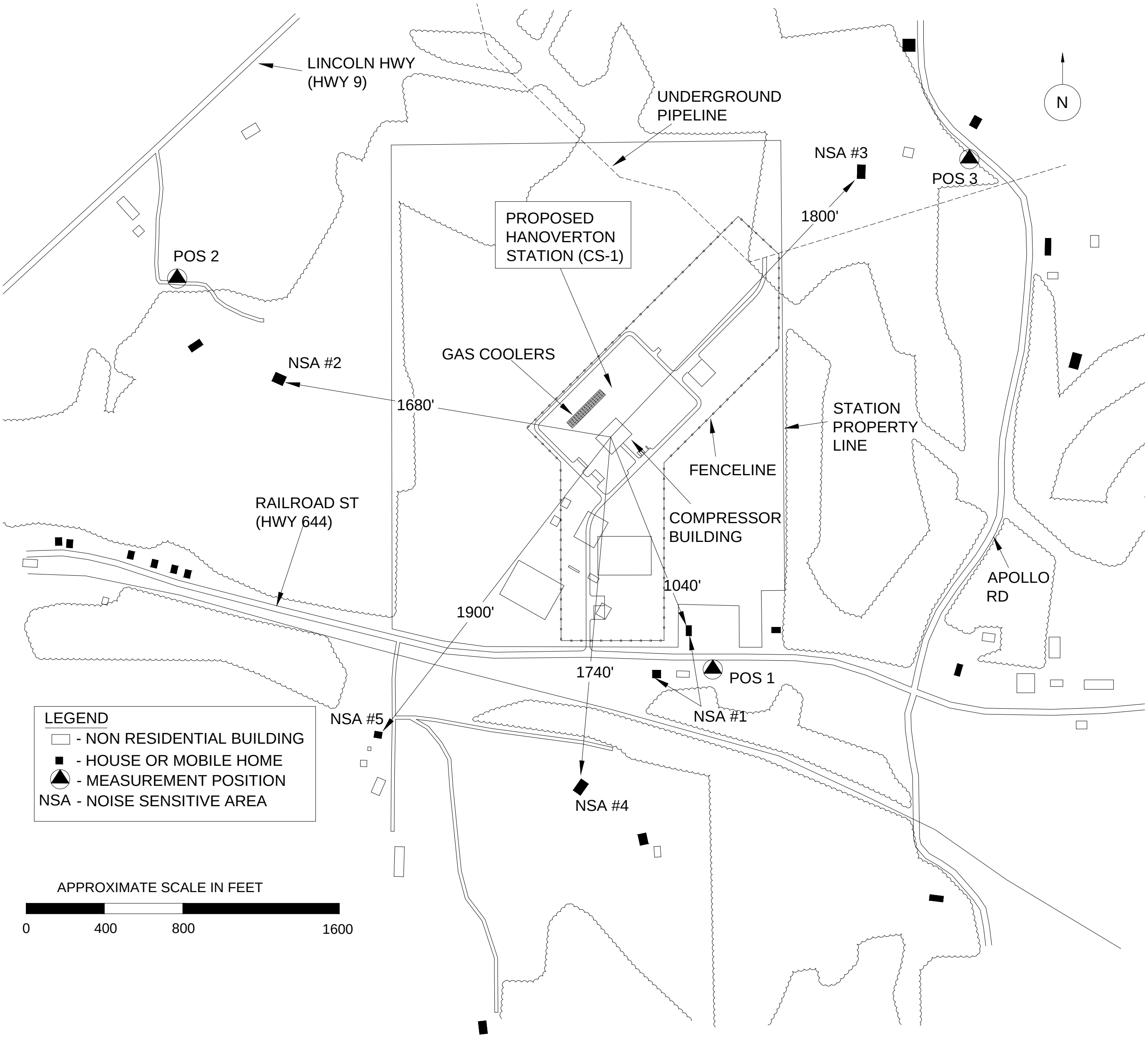

Figure 2: NEXUS Hanoverton Compressor Station (CS-1): Area Layout showing the Identified Closest NSAs, Chosen Sound Measurement Positions near the Closest NSAs and Conceptual Layout of Station Equipment and Buildings.

Measurement Set		Meas'd/Calc'd A-Wt. Levels (dBA)				
		Day-time	Avg'd of	Night time	Calc'd Ldn	
Meas. Pos. & NSA	Time/Date of Test	Leq(Ld)	Ld	Leq(Ln)	Note (2)	Notes/Observations
Pos. 1 (NSA #1) Residences approx. 1,040 ft. SSE of the Station Site Center	12:01 PM (2/3/15) 12:03 PM (2/3/15) 12:03 PM (2/3/15)	46.2 45.4 47.5	**46.4**	**36.4** Note (1)	**46.4** Note (2)	Primary noise during tests: Sound of birds, sound of wind blowing in trees, noise of distant vehicle traffic traveling along Hwy. 644 (Railroad Street).
Pos. 2 (NSA #2) Residence approx. 1,680 ft. west of the Station Site Center	12:12 PM (2/3/15) 12:13 PM (2/3/15) 12:14 PM (2/3/15)	43.0 48.1 45.3	**45.5**	**35.5** Note (1)	**45.5** Note (2)	Primary noise during tests: Noise of traffic along Lincoln Highway and sound of wind blowing in trees. Ambient levels at identified NSA #4 & NSA #5 should be similar to ambient levels at Pos. 2 (NSA #2).
Pos. 3 (NSA #3) Residence approx. 1,800 ft. NE of the Station Site Center	12:25 PM (2/3/15) 12:27 PM (2/3/15) 12:28 PM (2/3/15)	37.8 42.3 40.5	**40.2**	**32.2** Note (1)	**41.1** Note (2)	Primary noise during tests: Sound of wind in trees and noise of distant vehicle traffic.

Table A: **Hanoverton Compressor Station (CS-1): Summary of Ambient Daytime Sound Levels (Ld) at the Closest NSAs, as Meas'd on Feb. 3, 2015, Est'd Nighttime Levels (Ln) and Resulting Ldn.**

Note (1): Nightime sound levels (Ln) were not measured but since there should be less noise during night, the Ln was estimated to provide a representative ambient Ldn (e.g., 3 to 10 dB subtracted from the daytime levels).

Note (2): Ldn calculated by adding 6.4 dB to the measured Ld. If both the Ld and Ln are measured and/or estimated, the Ldn is calculated using the following formula:

$$L_{dn} = 10\log_{10}\left(\frac{15}{24}10^{L_d/10} + \frac{9}{24}10^{(L_n+10)/10}\right)$$

Measurement Set		Temp.	R.H.	Wind	Wind	Peak	
Meas. Pos.	Time Frame/Date of Tests	(°F)	(%)	Direction	Speed	Wind	Sky Conditions
Pos. 1 - 3	12:00 PM to 1:00 PM (2/3/15)	27	57	From the west	0-3 mph	4 mph	Overcast

Table B: **Hanoverton Compressor Station (CS-1): Summary of the Meteorological Conditions during the Ambient Sound Survey on Feb. 3, 2015.**

Measurement Set		Unweighted Sound Pressure Level (SPL) in dB per O.B. Frequency (in Hz)									A-Wt.
Meas. Pos. & NSA	Time/Date of Test	31.5	63	125	250	500	1000	2000	4000	8000	Level
Pos. 1 (NSA #1)	12:01 PM (2/3/15)	60.3	50.3	46.6	46.9	36.8	40.3	41.5	32.4	27.6	46.2
Residences approx.	12:03 PM (2/3/15)	59.3	48.8	41.6	36.5	36.1	41.3	40.6	33.7	30.5	45.4
1,040 ft. SSE of the	12:03 PM (2/3/15)	74.6	64.8	52.8	42.0	37.9	42.2	41.2	31.4	26.2	47.5
Station Site Center	**Avg. A-Wt. & SPL**	**64.7**	**54.6**	**47.0**	**41.8**	**36.9**	**41.3**	**41.1**	**32.5**	**28.1**	**46.4**
Pos. 2 (NSA #2)	12:12 PM (2/3/15)	66.8	46.7	41.5	39.4	38.8	39.9	34.6	27.0	22.3	43.0
Residence approx.	12:13 PM (2/3/15)	66.8	48.1	43.3	43.7	45.6	45.4	36.9	28.6	23.9	48.1
1,680 ft. west of the	12:14 PM (2/3/15)	66.3	47.1	42.5	38.9	41.8	42.1	36.7	31.5	26.4	45.3
Station Site Center	**Avg. A-Wt. & SPL**	**66.6**	**47.3**	**42.4**	**40.7**	**42.1**	**42.5**	**36.1**	**29.0**	**24.2**	**45.5**
Pos. 3 (NSA #3)	12:25 PM (2/3/15)	58.2	46.7	38.9	35.4	35.2	32.5	28.9	26.7	23.2	37.8
Residence approx.	12:27 PM (2/3/15)	53.3	42.6	40.5	38.6	39.3	39.3	30.6	29.0	26.2	42.3
1,800 ft. NE of the	12:28 PM (2/3/15)	52.1	45.0	40.0	35.2	35.0	38.1	31.5	26.6	23.5	40.5
Station Site Center	**Avg. A-Wt. & SPL**	**54.5**	**44.8**	**39.8**	**36.4**	**36.5**	**36.6**	**30.3**	**27.4**	**24.3**	**40.2**

Table C: **Hanoverton Compressor Station (CS-1): Measured Ambient Ld and Unweighted Octave-Band ("O.B.") SPLs at the Closest NSAs, as Measured on Feb. 3, 2015.**

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted PWL or SPL in dB per O.B. Center Frequency (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
1)	PWL of Turbines/Compressors inside Building	108	112	114	116	118	115	115	120	118	125	
	Atten. of Additional Noise Control (Building)	-6	-10	-18	-25	-30	-35	-40	-45	-45		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	-1	-1	-2		
1040	Hemispherical Radiation	-58	-58	-58	-58	-58	-58	-58	-58	-58		
1040	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-8	-14		
1040	Source Sound Level Contribution	44	44	38	33	29	20	13	8	0	30	
2)	PWL of Unsilenced Titan 250 Exhaust (2 Units)	129	133	131	134	138	133	125	115	105	138	
	Atten. Of Noise Control (Exhaust Muffler)	-5	-16	-25	-40	-45	-45	-45	-35	-25		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	0	0	0		
1040	Hemispherical Radiation	-58	-58	-58	-58	-58	-58	-58	-58	-58		
1040	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-8	-14		
1040	Source Sound Level Contribution	66	59	48	36	34	28	19	14	8	38	
3)	PWL of the LO Cooler (1 Unit)	105	98	92	90	88	86	85	82	75	92	
	PWL of All LO Coolers for 2 Units (+3 dB)	108	101	95	93	91	89	88	85	78	95	
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	-1	-1	-2		
1040	Hemispherical Radiation	-58	-58	-58	-58	-58	-58	-58	-58	-58		
1040	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	0	0	0		
1040	Source Sound Level Contribution	50	43	37	35	33	31	29	26	18	36	
4)	PWL of Outdoor Piping/Components	95	95	98	92	92	105	114	112	105	118	
	Atten. of Noise Control (Acoustical Insulation)	2	2	0	-2	-6	-10	-12	-15	-15		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	-1	-2	-4	-5	-5		
1040	Hemispherical Radiation	-58	-58	-58	-58	-58	-58	-58	-58	-58		
1040	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-2	-1	-2	-3	-8	-14		
1040	Source Sound Level Contribution	39	39	40	30	26	33	37	26	13	40	
5)	PWL of Unsilenced Titan 250 Intakes (2 Units)	119	122	131	132	133	135	138	177	169	178	
	Est'd Attenuation of Intake Silencer System	-2	-10	-15	-25	-30	-40	-50	-60	-50		
	Est'd Attenuation of Air Intake Filter	-1	-4	-6	-15	-20	-25	-28	-30	-30		
1040	Hemispherical Radiation	-58	-58	-58	-58	-58	-58	-58	-58	-58		
1040	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-8	-14		
1040	Source Sound Level Contribution	58	50	52	34	24	10	0	21	17	37	
6)	PWL of All Outdoor Gas Aftercooler(s)	115	108	95	94	92	90	86	84	82	95	
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	-1	-1	-2		
1150	Hemispherical Radiation	-59	-59	-59	-59	-59	-59	-59	-59	-59		
1150	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-9	-16		Calc'd
1150	Source Sound Level Contribution	56	49	36	35	32	29	23	15	5	34	Ldn
Est'd Total Sound Contribution of Sources at NSA #1		**67**	**60**	**54**	**42**	**39**	**37**	**38**	**30**	**21**	**44.6**	**51.0**

Ambient Sound Level (Ldn) at the NSA	**46.4**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	52.3
Potential Increase above Ambient Sound Level (dB)	**5.9**

Table D: Hanoverton Compressor Station (CS-1): Est'd Sound Contribution of Station at NSA #1 (i.e., Residences located approx. 1,040 Ft. SSE of the Site Center) assuming Operation of Two (2) Solar Titan 250 Turbine-Driven Compressor Units. In addition, Estimated Increase above the Ambient Sound Level.

NOTE: Muffler DIL & Equipment PWL values on this spreadsheet should <u>not</u> be used as the specified values. Refer to "Noise Control Measures" section in report or other company specifications for actual specified values.

Dist (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	Calc'd Ldn
	Est'd SPLs of Station at 1,040 Ft. (RE: Table D)	67	60	54	42	39	37	38	30	21	44.6	
1680	Hemisph Radiation [20*log(1680/1040)=4.2 dB]	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2		
1680	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-9		
Est'd Total Sound Contribution of Station at NSA #4		**63**	**56**	**50**	**37**	**34**	**32**	**32**	**21**	**8**	**39.5**	**45.9**

Ambient Sound Level (Ldn) at the NSA	**45.5**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	48.7
Potential Increase above Ambient Sound Level (dB)	**3.2**

Table E: Hanoverton Compressor Station (CS-1): Est'd Sound Contribution of Station at NSA #2 (i.e., Residence located approx. 1,680 Ft. West of the Site Center) assuming Operation of Two (2) Solar Titan 250 Turbine-Driven Compressor Units. In addition, Estimated Increase above the Ambient Sound Level.

Dist (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	Calc'd Ldn
	Est'd SPLs of Station at 1,040 Ft. (RE: Table D)	67	60	54	42	39	37	38	30	21	44.6	
1800	Hemisph Radiation [20*log(1800/1040)=4.8 dB]	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8		
1800	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-6	-10		
Est'd Total Sound Contribution of Station at NSA #2		**62**	**55**	**49**	**37**	**34**	**31**	**31**	**19**	**6**	**38.8**	**45.2**

Ambient Sound Level (Ldn) at the NSA	**41.1**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	46.6
Potential Increase above Ambient Sound Level (dB)	**5.5**

Table F: Hanoverton Compressor Station (CS-1): Est'd Sound Contribution of Station at NSA #3 (i.e., Residence located approx. 1,800 Ft. NE of the Site Center) assuming Operation of Two (2) Solar Titan 250 Turbine-Driven Compressor Units. In addition, Estimated Increase above the Ambient Sound Level.

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	
	Est'd SPLs of Station at 1,040 Ft. (RE: Table D)	67	60	54	42	39	37	38	30	21	44.6	
1740	Hemisph Radiation [20*log(1740/1040)=4.5 dB]	-4.5	-4.5	-4.5	-4.5	-4.5	-4.5	-4.5	-4.5	-4.5		Calc'd
1740	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-10		Ldn
Est'd Total Sound Contribution of Station at NSA #4		**62**	**55**	**49**	**37**	**34**	**32**	**31**	**20**	**7**	**39.2**	**45.6**

Ambient Sound Level (Ldn) at the NSA	**45.5**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	48.5
Potential Increase above Ambient Sound Level (dB)	**3.0**

Table G: Hanoverton Compressor Station (CS-1): Est'd Sound Contribution of Station at NSA #4 (i.e., Residence located approx. 1,740 Ft. South of the Site Center) assuming Operation of Two (2) Solar Titan 250 Turbine-Driven Compressor Units. In addition, Estimated Increase above the Ambient Sound Level.

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	
	Est'd SPLs of Station at 1,040 Ft. (RE: Table D)	67	60	54	42	39	37	38	30	21	44.6	
1900	Hemisph Radiation [20*log(1900/1040)=5.2 dB]	-5.2	-5.2	-5.2	-5.2	-5.2	-5.2	-5.2	-5.2	-5.2		Calc'd
1900	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-7	-12		Ldn
Est'd Total Sound Contribution of Station at NSA #5		**62**	**55**	**49**	**36**	**33**	**31**	**30**	**18**	**4**	**38.3**	**44.7**

Ambient Sound Level (Ldn) at the NSA	**45.5**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	48.1
Potential Increase above Ambient Sound Level (dB)	**2.6**

Table H: Hanoverton Compressor Station (CS-1): Est'd Sound Contribution of Station at NSA #5 (i.e., Residence located approx. 1,900 Ft. SW of the Site Center) assuming Operation of Two (2) Solar Titan 250 Turbine-Driven Compressor Units. In addition, Estimated Increase above the Ambient Sound Level.

DESCRIPTION OF THE ANALYSIS METHODOLOGY AND THE SOURCE OF SOUND DATA USED FOR THE ANALYSIS OF THE STATION COMPRESSOR UNITS

ANALYSIS METHODOLOGY

In general, the predicted sound level contributed by the Station compressor units was calculated as a function of frequency from estimated unweighted octave-band (O.B.) sound power levels (PWLs) for each significant sound source associated with the compressor unit(s). The following summarizes the analysis procedure for the analysis of the Station compressor unit(s):

- Initially, unweighted O.B. PWLs of the significant noise sources associated with the compressor unit(s) were determined from actual sound level measurements performed by H&K at similar type of gas compressor facilities and/or equipment manufacturer's sound data;

- Then, expected noise reduction (NR) or attenuation in dB per O.B. frequency due to any noise control measures, hemispherical sound propagation (discussed in more detail below*) and atmospheric sound absorption (discussed in more detail below**) were subtracted from the unweighted O.B. PWLs to obtain the unweighted O.B. SPLs of each noise source. Since sound shielding by buildings can influence the sound level contributed at the NSAs, we also included the sound shielding due to buildings, if appropriate. The sound attenuation effect due to vegetation or land contour were typically not considered in the analyses since there appears there could be limited amount of vegetation (e.g., trees) or hills between the site and the nearby NSAs;

- Finally, the resulting estimated O.B. SPLs for all noise sources associated with the compressor units (with noise control and other sound attenuation effects) were logarithmically summed, and the total O.B. SPLs for all noise sources were corrected for A-weighting to provide the estimated overall A-wt. sound level contributed by the compressor units at the closest NSA to the compressor units. The predicted sound contribution of the Station at the closest NSA was utilized to estimate the noise contribution of the Station at the other NSAs more distant that the closest NSA.

*Attenuation due to hemispherical sound propagation: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically (i.e., outward, over and above the surface) from the source. The following equation is the theoretical decrease of sound energy when determining the resulting SPLs of a noise source at a specific distance ("r") of a receiver from a source PWL values:

> Decrease in SPL ("hemispherical propagation") from a noise source = **20*log(r) – 2.3 dB**
> where "r" is distance of the receiver from the noise source.

Attenuation due to air absorption: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on the temperature and relative humidity (R.H.) of air and frequency of sound. For example, the attenuation due to air absorption for 1000 Hz O.B. SPL is approximately **1.5 dB per 1,000 feet for standard day conditions (i.e., no wind, 60 deg. F and 70% R.H.).

ANALYSIS METHODOLOGY (NOISE ATTRIBUTABLE TO A BLOWDOWN EVENT)

The noise resulting from a blowdown event was estimated by using the “inverse-square law” and included some attenuation due to atmospheric sound absorption. Consequently, the estimated noise of a blowdown event at the receptor (closest NSA) was calculated as follows:

SPL (receptor) = (Blowdown SPL at R1) – 20*log(R2/R1)– Atm. Atten.= **60 dBA** – 20*log (1,040/300)–3 dB = **46 dBA**

Where: R1 = Distance of Specified Blowdown Noise Level Requirement (i.e., 300 ft.)
R2 = Distance of the Receptor from the Blowdown Silencer (1,040 ft.)

SOURCE OF SOUND DATA

The following describes the source of sound data for estimating the source sound levels and source PWLs used in the acoustical analysis for the compressor units. Note that equipment noise levels utilized in the acoustical analysis (i.e., spreadsheet analysis) are generally higher than the sound level requirement for the equipment to insure that the design incorporates an acoustical “margin of safety.”

(1) PWL values of the specific equipment inside the building (i.e., noise of the turbine and compressor) was calculated from sound data measured by H&K on a very similar type of gas compressor installation.

(2) Turbine exhaust PWL values for the Solar turbine were calculated from sound data provided by Solar (i.e., Solar Noise Prediction Manual) and sound data recently measured in the field by H&K on a similar type of turbine installation.

(3) The noise radiated from aboveground gas piping is primarily a result the noise generated by the gas compressors. Consequently, measurement of both near field and far field sound data on gas piping is presumed to be an accurate method of quantifying the noise associated with the new gas piping, and the estimated PWL values for gas piping used in the analysis were determined from near field and far field sound data by H&K on a similar type of compressor to that of the proposed compressor units.

(4) PWL values for the turbine LO cooler(s) and gas aftercooler(s) were designated to meet the design noise goal. Note that the estimated PWL for the cooler(s) utilized in the acoustical analysis assumes some noise associated with piping associated with the coolers. The noise level for the LO cooler and gas aftercooler used in the acoustical analysis is generally higher than the sound level requirement in order that the noise design analysis incorporates an acoustical “margin of safety.” In addition, there can be other noise associated with the cooler that is not directly related to the operation of the cooler fans.

(5) PWL values for turbine air intake were calculated from sound data provided by Solar (i.e., Solar Noise Prediction Manual), although low-frequency SPLs were modified as a result of field acoustical tests by H&K.

Type of Equipment	Equipment Power Rating or Capacity	Est'd Number Required	Est'd A-Wt. Sound Level at 50 Ft.: Note (1)	Resulting A-Wt. PWL of Single Piece of Equip.	Assumed Max. No. Operating at One Time	Est'd Max. A-Wt. PWL or Sound Level of Equip.	
Diesel Generator	250 to 400 HP	1 to 2	65 - 70 dBA	102 dBA	1	102	
Bulldozer	250 to 700 HP	1 to 2	75 - 80 dBA	110 dBA	1	110	
Grader	450 to 600 HP	1 to 2	70 - 75 dBA	105 dBA	1	105	
Backhoe	130 to 210 HP	1 to 2	65 - 72 dBA	104 dBA	1	104	
Front End Loader	150 to 250 HP	1 to 2	65 - 70 dBA	102 dBA	1	102	
Truck Loaded	40 Ton	As needed	70 - 75 dBA	105 dBA	1	105	
	Est'd Total Maximum A-Wt. PWL (dBA) of All Construction Site Equipment					113	Calc'd
	Atten. (dB) due to Hemispherical Sound Propagation (1,040 Ft.): Note (2)					-58	Ldn
	Est'd Attenuation (in dB) due to Air Absorption and/or Foliage-Shielding: Note (3)					-2	Note (4)
	Est'd Sound Level (dBA) at Closest NSA (NSA #1) Considering a Maximum Number of Equipment Operating at One Time					53 dBA	51 dBA

Table I: **Hanoverton Compressor Station (CS-1): Est'd Sound Contribution at the Closest NSA (NSA #1, Residences approx. 1,040 Ft. SSE of Site Center) during Construction Activity at the Station. Sound Contribution assumes Operation of the "Loudest" Equipment during a Time Frame with the Largest Amount of Equipment Operating (e.g., Site Grading & Clearing/Grubbing)**

Note (1): Noise Emission Levels of construction equipment based on an EPA Report (meas'd sound data for a railroad construction project) and measured sound data in the field by H&K or other published sound data.

Note (2): <u>Noise attenuation due to hemispherical sound propagation</u>: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically from the source.

The following equation is the theoretical decrease of sound energy when determining the resulting SPL of a noise source at a specific distance ("r") of a receiver from a source sound power level (PWL):

Decrease in SPL ("hemispherical propagation") from a noise source = 20*log(r) – 2.3 dB, where "r" is distance of the receiver from the noise source. For example, if the distance "r" is 1,040 feet between the site and closest NSA, the "hemispherical propagation" = **20*log(1,040) – 2.3 dB = 58 dB**.

Note (3): <u>Noise attenuation due to air absorption & foliage</u>: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on temperature and relative humidity (R.H.) of the air and the frequency of sound. For standard day conditions (i.e., no wind, 60 deg. F. and 70% R.H.), the attenuation due to air absorption for the medium frequency" (i.e., 1000 Hz O.B. SPL) is approximately **1.5 dB** per 1,000 feet. In addition, foliage such as forest/trees between the Station site and nearby NSAs can have a sound attenuation effect depending on the amount/thickness of the foliage.

Note (4): Calc'd Ldn is approx. 2 dB lower than A-wt. sound level since construction activities will occur only during daytime.

ANALYSIS METHODOLOGY AND SOURCE OF SOUND DATA (CONSTRUCTION ACTIVITIES)

The predicted sound level contributed by the construction-related activity (i.e., construction of the compressor station) was calculated from estimated A-wt. PWL of noise sources (i.e., construction equipment noise) that typically operate during the specific construction activity. The following summarizes the acoustical analysis procedure utilized for the construction activity at the site:

- Initially, the A-wt. PWL of noise sources associated with the construction activity were determined from published sound data and/or actual sound level measurements by H&K, and the total PWL of each noise source (equipment) was based on the anticipated number of equipment operating;

- Next, A-wt. PWL of all sources were logarithmically summed to provide the overall A-wt. PWL contributed by construction activity. It is assumed that the highest level of construction noise would occur during site earth work (i.e., time frame when the largest amount of equipment would operate);

- Finally, the estimated A-wt. sound level of the construction activity at the specific distance was determined by compensating for sound attenuation due to propagation (hemispherical radiation), atmospheric sound absorption and sound attenuation effect of foliage/forest***.

The noise levels of construction equipment were based on an EPA Report (i.e., measured sound data from railroad construction equipment taken during the Northeast Corridor Improvement Project) that was summarized in a 1995 Report to the Federal Transit Administration as prepared by Harris Miller Miller & Hanson Inc. Also, construction equipment noise levels listed in an article in the Journal of Noise Control Engineering and sound data at a typical compressor station construction site, as measured by H&K, was utilized. The following list some references used by H&K to determine construction equipment noise emission levels:

(1) "Transit Noise and Vibration Impact Assessment", dated April 1995, prepared by Harris Miller Miller & Hanson Inc. for the Office of Planning of the Federal Transit Administration.
(2) Erich Thalheimer, "Construction Noise Control Program and Mitigation Strategy at the Central Artery/Tunnel Project", J of Noise Control Eng., 48 (5), pp. 157-165 (2000 Sep-Oct).
(3) "Noise Control for Building Manufacturing Plant Equipment and Products", course handout notes for a noise course given by Hoover & Keith Inc.

***Discussion of noise attenuation due to foliage: Since there will be a substantial amount of trees between the Station and NSAs, the sound attenuation effect of foliage was included. The potential attenuation of foliage, based on our experience and an ISO Standard[1], the "medium-frequency" attenuation (i.e., 1000 Hz) due to forest/trees greater than 500 feet thick is approximately **10 dB**. Consequently, for this Station (i.e., distance of 1,040 feet from closest NSA), the "medium-frequency" air absorption attenuation would be approximately **2 dB** (i.e., 1.5 dB x 1,040/1000 = 2 dB). Then, adding the attenuation due to foliage (approx. **0 dB**) to the air absorption attenuation, an overall attenuation of **2 dB** was utilized as the estimated attenuation due to air absorption and foliage.

End of Report

[1] ISO Standard 9613-1: 1993 (E), entitled "Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound by the atmosphere, and Part 2: General method of calculation"

WADSWORTH COMPRESSOR STATION
(MEDINA COUNTY, OHIO)

RESULTS OF AN AMBIENT SOUND SURVEY AND ACOUSTICAL ANALYSIS OF THE NATURAL GAS COMPRESSOR STATION (CS-2) ASSOCIATED WITH THE NEXUS GAS TRANSMISSION PROJECT

H&K Report No. 3225

H&K Job No. 4875

Date of Report: June 9, 2015

Submitted to: **Fluor Enterprises, Inc.** (Fluor)
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REPORT SUMMARY

This report provides the results of an acoustical analysis for the new **Wadsworth Compressor Station** (referred to as "Station" in the report) associated with the proposed **NEXUS Gas Transmission Project** ("Project" or "NEXUS Project"). Also included are the results of the recent ambient sound survey at the proposed site of the Station. The intent of the acoustical analysis is to project the sound contribution of the Station during full load operation and determine noise control measures to insure that applicable sound criteria are not exceeded at the nearby noise-sensitive areas (NSAs). The purpose of the ambient sound survey was to identify and verify the nearby NSAs surrounding the Station and to quantify the current ambient sound environment at the nearby NSAs.

The following table summarizes the ambient sound level at the identified closest NSAs, the estimated sound level contribution of the Station at the closest NSAs if the Station was operated at full load and the total sound level contribution of the Station (i.e., sound level contribution of the Station plus the ambient noise level). The results provided in this table are referred to as the "Noise Quality Analysis" for the Station.

Noise Quality Analysis for the Wadsworth Compressor Station associated with the NEXUS Project

Closest NSA(s) and Type of NSA	Distance and Direction of NSA to Station Site Center	Ambient Ldn (via Meas'd Ld & Est'd Ln)	Est'd Sound Level (Ldn) of the Station at Full Load	Est'd "Total" Ldn (Station Noise + Ambient Noise)	Potential Noise Increase
NSA #1 (Residences)	1,800 ft. (west)	56.7 dBA	44.5 dBA	57.0 dBA	0.3 dB
NSA #2 (Residences)	1,840 ft. (WNW)	46.9 dBA	44.2 dBA	48.8 dBA	1.9 dB
NSA #3 (Residences)	2,490 ft. (NE)	48.5 dBA	40.7 dBA	49.2 dBA	0.7 dB

The results of the acoustical analysis indicates that if the anticipated and/or recommended noise control measures are implemented successfully, the sound contribution of the proposed Station should be equal to or lower than **55 dBA** (L_{dn}) at the nearby NSAs, which is the FERC sound level requirement for this type of facility. In addition, the acoustical analyses indicate that the noise of construction activities and noise resulting from a unit blowdown event at the Station should have limited noise impact on the surrounding environment. Also, since Station noise sources that could cause perceptible vibration (e.g., turbine exhaust noise) will be adequately mitigated, there should not be any perceptible increase in vibration at any NSA during Station operation.

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1.0 INTRODUCTION

In this report, **Hoover & Keith Inc.** (H&K) presents the results of an acoustical analysis for the new **Wadsworth Compressor Station** (referred to as "Station" in the report) associated with the proposed **NEXUS Gas Transmission Project** ("Project" or "NEXUS Project"). Also included are the results of the recent ambient sound survey at the proposed site of the Station. The following summarizes the purpose of the ambient sound survey and Station acoustical analysis:

(1) Quantify the existing acoustic environment (i.e., measure the typical ambient sound levels) and verify the current noise-sensitive areas (NSAs) around the Station, such as residences, hospitals and schools;

(2) Estimate the sound level contribution of the Station at the nearby NSAs and estimate the "total" Station sound level contribution (i.e., Station noise plus the ambient sound level);

(3) Determine noise mitigation measures to insure that applicable sound level criteria are not exceeded after installation and full load operation of the Station; and

(4) Project the noise at the nearby NSAs resulting from construction activities at the Station, and estimate the noise contribution due to a unit blowdown event at the Station.

2.0 SOUND CRITERIA

Federal: It is anticipated that certificate conditions of the Office of Energy Projects (OEP) of the Federal Energy Regulatory Commission (FERC) will require that the sound level attributable to a new natural gas compressor station during full load operation not exceed a day-night average sound level (i.e., L_{dn}) of **55 dBA** at any nearby NSA. In addition, the operation of the Station should not result in a perceptible increase in vibration at any nearby NSA. The L_{dn} is an energy average of the measured daytime L_{eq} (L_d) and measured nighttime L_{eq} (L_n) plus **10 dB**. The **10-dB** adjustment to the L_n is intended to compensate for nighttime sensitivity. For a steady sound source that operates continuously over a 24-hour period and controls the environmental sound level, the L_{dn} is approximately **6.4 dB** above the measured L_{eq}. Consequently, an L_{dn} of **55 dBA** corresponds to a L_{eq} of **48.6 dBA**. If both the L_d and L_n are measured and/or estimated, then the L_{dn} is calculated using the following formula:

$$L_{\mathrm{dn}} = 10\log_{10}\left(\frac{15}{24}10^{L_{\mathrm{d}}/10} + \frac{9}{24}10^{(L_{\mathrm{n}}+10)/10}\right)$$

State of Ohio: The State of Ohio or the Ohio EPA does not have regulations related to acceptable noise levels. We understand that sometimes noise level regulations are covered under local ordinances or city codes (e.g., public nuisance and limit excessive noise between certain hours).

County/Township: No applicable county or township noise regulations have been identified, although any local noise regulations, if required, will be addressed during the local permitting process.

3.0 SITE/FACILITY DESCRIPTION

Figure 1 (**Appendix**, p. 11) provides an area layout around the Station that shows the NSAs within 1 mile of the Station and other areas of interest. **Figure 2** (**Appendix**, p. 12) provides a layout around the Station that shows the identified closest NSAs, reported sound measurement positions near the identified closest NSAs and a conceptual layout of equipment and buildings at the Station. The Station will be located in Medina County, Ohio, approximately 6 miles west of Wadsworth, OH and approximately 7 miles south of Medina, OH. There are a few NSAs (e.g., primarily residences) located within 1 mile of the Station, and the closest NSAs are residences located approximately 1,800 feet west of the Station site (along Guilford Road). The Station site is surrounding by some foliage that could provide additional attenuation of the Station noise.

The proposed Station will consist of one (1) Solar Titan 250 gas turbine-driven centrifugal gas compressor unit [i.e., 30,000 horsepower (HP) rating (ISO)]. We understand that the turbine and compressor for the compressor unit will be installed inside an acoustically-insulated metal building (i.e., Compressor Building). The following describes the anticipated auxiliary equipment and other notable items associated with the Station compressor unit:

- Outdoor lube oil cooler ("LO cooler");
- Turbine exhaust system designed with an adequate muffler system;
- Turbine air intake filter system designed with in-duct silencer;
- Gas piping and associated piping components, and most gas piping will be buried;
- Gas aftercooler (i.e., air-cooled heat exchanger) that serves the compressor unit; and
- Gas blowdown silencer associated with a unit blowdown.

There will also be two (2) types of gas blowdown events: (1) gas blowdown that occurs when a compressor is stopped and gas between the suction/discharge valves and compressor is vented to the atmosphere ("unit blowdown") via a blowdown silencer, and (2) emergency shutdown ("ESD") that will only occur at required Department of Transportation (DOT) test intervals or in an emergency situation (e.g., gas leak or fire). The unit blowdown will be a "maintenance" type of unit blowdown which can occur when the compressor unit is stopped and gas between the suction/discharge valves and compressor unit is vented to the atmosphere through a silencer. During the period of commissioning and testing, it is estimated that a unit blowdown could occur 2 to 4 times/day and typically only during the daytime. During normal operation of the Station (i.e., after the commissioning period), a unit blowdown event occurs infrequently (e.g., 1 to 3 times/month). In addition, a unit blowdown event only occurs for a short time frame (e.g., unit blowdown event would persist for approximately 1 to 5 minutes). There also can be an emergency shutdown ("ESD") that will only occur only during an emergency situation (e.g., gas leak or fire), which rarely occurs, noting that some natural gas facilities operate for years without having an ESD, and the gas blowdown related to an ESD may be vented via a blowdown silencer. Note that for required DOT test intervals of the ESD operations (e.g., once or twice a year), it is not necessary to vent/blowdown the pipeline gas to atmosphere.

4.0 MEASUREMENT METHODOLOGY, MEASUREMENT LOCATIONS AND CONDITIONS

Ambient sound levels were measured near three (3) of the identified surrounding NSAs (i.e., “NSA #1”, “NSA #2” & “NSA #3”). The following provides a description of the identified NSAs and the reported sound measurement positions (“Pos.”):

Pos. 1: Near NSA #1 (closest NSA): Residences located 1,800 feet west of the Station site center (i.e., anticipated location of the Compressor Building);
Pos. 2: Near NSA #2: Residences located 1,840 feet west-northwest (WNW) of the Station site center; and
Pos. 3: Near NSA #3: Residences located 2,490 feet northeast (NE) of the Station site center.

The sound survey was conducted by Garrett Porter of H&K during the daytime of Feb. 3, 2015. During the site ambient sound survey, the temperature was 33 degrees F, the wind was from the south and there were overcast sky conditions. At the reported sound measurement locations, the A-wt. equivalent sound levels (i.e., L_{eq}) and the unweighted octave-band (O.B.) sound pressure levels (SPLs) were measured at approximately 5 feet above ground. The sound measurements attempted to exclude "extraneous sound" such as the noise contribution of occasional vehicle passing by the measurement position and/or other intermittent sources. The acoustical measurement system consisted of a Rion NA-27 Sound Level Meter (a Type 1 SLM per ANSI S1.4 & S1.11) equipped with microphone, covered with a windscreen. The SLM was calibrated with a microphone calibrator (calibrated within 1 year of the test date).

5.0 MEASUREMENT RESULTS AND OBSERVATIONS

Table A (**Appendix**, p. 13) summarizes the measured daytime L_{eq} (L_d) and the estimated nighttime L_{eq} (L_n) at the NSA sound measurement locations along with the average of the measured L_d since several samples of the ambient sound level were measured. **Table A** also includes the resulting ambient L_{dn} as calculated from the measured L_d and estimated L_n. Meteorological conditions that occurred during the sound survey are summarized in **Table B** (**Appendix**, p. 13). The measured daytime sound levels (L_d) and related unweighted O.B. SPLs at the reported sound measurement positions are provided in **Table C** (**Appendix**, p. 13).

The following **Table 1** summarizes the measured ambient L_d and estimated ambient L_n at the closest NSAs along with the resulting ambient L_{dn} at the closest NSAs, as calculated from the measured ambient L_d and estimated L_n.

Meas. Pos.	Description of the Identified Closest NSAs, as related to the Sound Measurement Location	Meas'd Ambient Ld	Est'd Ambient Ln	Resulting Ambient Ldn
Pos. 1	NSA #1: Residences 1,800 feet west of the Station site	56.7 dBA	46.7 dBA	56.7 dBA
Pos. 2	NSA #2: Residences 1,840 feet WNW of the Station site	43.0 dBA	40.0 dBA	46.9 dBA
Pos. 3	NSA #3: Residences 2,490 feet NE of the Station site	47.6 dBA	39.6 dBA	48.5 dBA

Table 1: Summary of the Measured Ld, Estimated Ln and Resulting Ambient Ldn at the Identified NSAs

It is our opinion that the measured sound level data adequately quantifies the existing ambient sound level for the meteorological conditions that occurred during the sound survey. The ambient L_n were not measured but were estimated based on our site observations to provide a more accurate representation of the ambient L_{dn} (i.e., ambient nighttime levels could be lower than the measured daytime levels). At the reported sound measurement location near all of the identified NSAs, noise sources that contributed to the ambient A-wt. sound level included the sound of birds, the noise of distant vehicle traffic along Interstate 76 ("I-76"), and occasionally, the sound of wind blowing in the nearby foliage/trees.

6.0 ACOUSTICAL ANALYSIS (COMPRESSOR STATION)

6.1 Sound Level Contribution of the Station

The acoustical analysis considers the noise produced by equipment for the Station compressor unit that could impact the sound contribution at any NSA. The predicted sound contribution of the Station were performed only for the closest NSAs (i.e., NSA #1, NSA #2 & NSA #3) since the Station sound contribution at other nearby NSAs should be equal to or less than the Station sound level at these closest NSAs. A description of the acoustical analysis methodology and source of sound data for the analysis is provided in the **Appendix** (pp. 16–17). The following sound sources were considered significant and included in the Station acoustical analysis:

- Noise generated by the turbine/compressor that penetrates the Compressor Building;
- Noise of the turbine exhaust radiated from the turbine exhaust stack;
- Noise radiated from aboveground/outdoor gas piping and associated components;
- Noise of the outdoor LO cooler and associated outdoor piping;
- Noise generated by the turbine air intake system, and
- Noise of the gas aftercooler and associated aboveground piping.

Table D (**Appendix**, p. 14) shows the spreadsheet analysis of the estimated A-wt. sound level and unweighted O.B. SPLs at the closest NSA ("NSA #1") contributed by the Station compressor unit during full load operation for standard day propagating conditions (i.e., no wind, 60 deg. F., 70% R.H.). Included in **Table D** is the estimated "total" sound level contribution of the Station at NSA #1 (i.e., sound level contribution of the Station plus the ambient sound level).

Table E (**Appendix**, p. 15) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the Station at NSA #2 based on the acoustical analysis at NSA #1, along with the estimated total sound level contribution of the Station at NSA #2 (i.e., sound level contribution of the Station plus the ambient sound level).

Table F (**Appendix**, p. 15) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the Station at NSA #3 based on the acoustical analysis at NSA #1, along with the estimated total sound level contribution of the Station at NSA #3 (i.e., sound level contribution of the Station plus the ambient sound level).

The following **Table 2** summarizes the calculated sound level contribution of the Station at the closest NSAs assuming full load operation of all equipment associated with the Station, noting that the estimated A-wt. sound level was used to calculate the representative L_{dn}.

Operating Condition and associated NSA	Est'd A-Wt. Sound Level of Station	Calc'd Ldn (via Est'd A-Wt. Level)
Est'd sound contribution of Station during full load operation at NSA #1	38.1 dBA	44.5 dBA
Est'd sound contribution of Station during full load operation at NSA #2	37.8 dBA	44.2 dBA
Est'd sound contribution of Station during full load operation at NSA #3	34.3 dBA	40.7 dBA

Table 2: Estimated Sound Contribution of the Station during Full Load Operation at the Closest NSAs

6.2 Sound Contribution of a Unit Blowdown Event at the Station

The noise level of the unit blowdown event via a blowdown silencer will be specified to meet an A-wt. sound level of **60 dBA** at a distance of 300 feet. If this sound requirement is achieved, the noise of a unit blowdown will be approximately **42 dBA** (i.e., L_{dn} of approximately **48 to 49 dBA**) at the closest NSA, located approximately 1,800 feet from the unit blowdown silencer, which would be lower than **55 dBA** (L_{dn}). Consequently, although the noise of a unit blowdown event could be slightly audible at the nearby NSAs, it is not expected to present a noise impact, noting also that a unit blowdown event occurs infrequently for a short time frame (e.g., 1 to 5 minute period). A description of the acoustical analysis methodology and source of sound data related to blowdown noise are provided in the **Appendix** (p. 17)

7.0 ACOUSTICAL ANALYSIS (SITE CONSTRUCTION ACTIVITIES)

The acoustical analysis of the construction-related activities at the site of the Station considers the noise produced by any significant sound sources associated with the primary construction equipment that could impact the sound contribution at the nearby NSAs. The predicted sound contribution of construction equipment/activities was performed only for the closest NSA (i.e., NSA #1). Construction of the Station will consist of earth work (e.g., site grading, clearing and grubbing) and construction of the Station buildings, and it is assumed that the highest level of construction noise would occur during site earth work (i.e., time frame when the largest amount of construction equipment would operate).

Table G (**Appendix**, p. 18) shows the calculation of the estimated maximum A-wt. sound level at the closest NSA contributed by the construction activities at the Station for standard day propagating conditions. A description of the methodology and source of sound data for the construction noise analysis are provided in the **Appendix** (p. 19). The acoustical analysis indicates that the maximum A-wt. noise level of construction activities at the closest NSA would be equal to or less than **45 dBA** (i.e., L_{dn} of approximately **43 dBA**, since nighttime construction activities are not anticipated).

8.0 NOISE CONTROL MEASURES (COMPRESSOR STATION)

The following section provides the recommended noise control measures and equipment sound level requirements along with other assumptions that may affect the noise of the Station.

8.1 Building enclosing the Turbine/Compressor

We understand that the turbine and compressor will be installed inside an acoustically-insulated metal building (i.e., Compressor Building). The following describes specific sound requirements and other items related to the components of the Compressor Building.

- As a minimum, walls/roof should be constructed with an exterior skin of 22–gauge metal, and building interior surfaces should be covered with 6–inch thick "high-density" mineral wool (i.e., 6.0-8.0 pcf uniform density) covered with a perforated liner; Note that "low-density" insulation (e.g., 0.6 to 0.75 pcf density) should **not** be substituted for the high-density material although low-density insulation could be employed in addition to the high-density insulation;

- No windows or louvers should be installed in the building walls although a minimum number of skylights could be installed in the building roof although not anticipated;

- Each large access door system (i.e., "roll-up door") should consist of an insulated-type door (e.g., 18-ga. exterior facing, 24-ga. backskin with insulation core); Personnel entry doors should be a **STC-36 sound rating**, even if glazing is employed and should be self-closing and should seal well when closed;

- It is anticipated that the building air ventilation system will be designed with air supply fans mounted in the building walls along with roof-mounted air exhaust vents or a roof ridge vent to exhaust the air (i.e., wall louvers should not be employed). Assuming this type of air ventilation system, the sound level for each wall air-supply fan should not exceed **50 dBA** at **50 feet**, which will require that each fan employ an exterior dissipative-type silencer (e.g., 3-ft. length) and an acoustically-lined weatherhood.

8.2 Turbine Exhaust System

The turbine exhaust system for the turbine-driven compressor unit should include a silencer system that provides the following dynamic sound insertion loss ("DIL") values at the rated turbine operating conditions.

DIL Values for the Exhaust Silencer System in dB per Octave-Band (O.B.) Center Freq. (Hz)

31.5	63	125	250	500	1000	2000	4000	8000
5	16	25	35	45	45	45	35	30

To meet these recommended DIL values and minimize the impact of the turbine exhaust noise at surrounding residences, a "2–stage" exhaust silencer system should be implemented. One (1) of the 2-stage silencers should be employed horizontally in the exhaust ducting located inside the Compressor Building for the compressor unit (i.e., "1st stage silencer"), and the other silencer system could be integrated into the vertical outdoor exhaust stack (i.e., "2nd stage silencer") or in the horizontal exhaust ducting located outside the Compressor Building. If a CO converter is employed, which is anticipated, it is assumed that a CO converter system would be inserted upstream of the 1st stage silencer, inside the Compressor Building.

8.3 Outdoor Aboveground Gas Piping

The analysis indicates that noise control measures, such as acoustical pipe insulation, will be required for outdoor aboveground gas piping to meet applicable sound criteria. The following items associated with the gas piping and piping components should be addressed:

- Acoustical pipe insulation should be employed for aboveground suction and discharge gas piping. Acoustical pipe insulation should consist of a minimum 3-inch thick fiberglass or mineral wool (6.0-8.0 pcf density) that is covered with a mass-filled vinyl jacket (e.g., composite of 1.0 psf mass-filled vinyl laminated to 0.020-inch thick aluminum). All exposed pipe supports for the insulated gas piping should be covered with acoustical insulation;

- Outdoor valves should not have to be covered with acoustical blanket material. Filter–separator(s) and associated aboveground gas piping should not have to be covered with any type of acoustical material. It is also recommended that the suction pipe strainer for the compressor units be removed soon after the Station is placed in service, if feasible.

8.4 Lube Oil Cooler

Lube oil cooler ("LO cooler") should not exceed **60 dBA** at **50 feet** from the cooler perimeter at the full rated operating conditions (i.e., equivalent to a PWL of **92–93 dBA**), and a "custom" Solar LO cooler may be required to meet the recommended sound level requirement.

8.5 Turbine Air Intake System

The turbine air intake system for the compressor unit should be designed with at least one (1) in-duct silencer (e.g., 7-ft. length "special" silencer or combination of 2 Solar "standard" silencers), and at least one of the silencers (i.e., if 2 separate silencers are employed) should be installed in the intake ductwork located inside the Compressor Building. As a minimum, the air intake silencer system should provide the following DIL values at the rated operating conditions of the turbine-driven compressor unit, noting that only one (1) "standard" Solar air intake silencer may not be capable of meeting these DIL values although the use of two (2) "standard" Solar air intake silencers (per Solar's "Noise Prediction Guidelines") should be capable of meeting the DIL values.

DIL Values in dB per O.B. Center Frequency for the Turbine Air Intake System

31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
3	8	18	30	45	55	60	60	55

8.6 Gas Aftercooler

The sound level generated by the multi-fan gas cooler that serves the compressor unit should not exceed **62 dBA** at **50 feet** at the full rated operating conditions (i.e., all fans operating at maximum design speed). To meet this sound level requirement, the gas aftercooler will need to be designed with "low-noise" fans that operate at relatively low tip speeds (e.g., fans operating at below 7,200 fpm tip speeds). In addition, aboveground inlet pipe risers and inlet header for the gas cooler should be covered with acoustical pipe insulation but the outlet pipe risers should not have to be covered with acoustical pipe insulation.

8.7 Unit Blowdown Silencer

The unit blowdown silencer should attenuate the unsilenced blowdown noise to a noise level equal to or less than **60 dBA** at 300 feet from the outlet of the silencer, which includes the noise radiated from the shell of the silencer during the blowdown event.

9.0 SUMMARY AND FINAL COMMENT

The following **Table 3** summarizes the ambient sound level at the closest NSAs, the estimated sound level contribution of the Station at the closest NSAs during full load Station operation and the "total" sound level contribution of the Station (i.e., sound level contribution of Station during operation plus the ambient sound level). The results provided in this table are referred to as the "Noise Quality Analysis" for the Station.

Closest NSA(s) and Type of NSA	Distance and Direction of NSA to Station Site Center	Ambient Ldn (via Meas'd Ld & Est'd Ln)	Est'd Sound Level (Ldn) of the Station at Full Load	Est'd "Total" Ldn (Station Noise + Ambient Noise)	Potential Noise Increase
NSA #1 (Residences)	1,800 ft. (west)	56.7 dBA	44.5 dBA	57.0 dBA	0.3 dB
NSA #2 (Residences)	1,840 ft. (WNW)	46.9 dBA	44.2 dBA	48.8 dBA	1.9 dB
NSA #3 (Residences)	2,490 ft. (NE)	48.5 dBA	40.7 dBA	49.2 dBA	0.7 dB

Table 3: Noise Quality Analysis for the Wadsworth Compressor Station associated with NEXUS Project

The results of the acoustical analysis indicates that if the noise control measures are employed successfully, the sound contribution of the Station should be equal to or lower than **55 dBA** (L_{dn}) at the nearby NSAs, which is the FERC sound level requirement for this type of facility. In addition, the acoustical analyses indicate that the noise of construction activities and noise resulting from a unit blowdown event at the Station should have limited noise impact on the surrounding environment. Also, since Station noise sources that could cause perceptible vibration (e.g., turbine exhaust noise) will be adequately mitigated, there should not be any perceptible increase in vibration at any NSA during Station operation.

APPENDIX

- **FIGURE 1: GENERAL AREA LAYOUT AROUND THE STATION SHOWING THE NSAs LOCATED WITHIN 1 MILE OF THE STATION AND OTHER AREAS OF INTEREST**
- **FIGURE 2: AREA LAYOUT SHOWING IDENTIFIED CLOSEST NSAs, REPORTED SOUND MEASUREMENT POSITIONS NEAR THE CLOSEST NSAs, AND CONCEPTUAL LAYOUT OF THE STATION SHOWING THE EQUIPMENT, BUILDINGS AND STATION FENCELINE**
- **SUMMARY OF THE MEASURED AMBIENT SOUND DATA**
- **ACOUSTICAL ANALYSIS (COMPRESSOR STATION)**
- **ANALYSIS METHODOLOGY (NOISE ATTRIBUTABLE TO THE STATION AND A BLOWDOWN EVENT) AND THE SOURCE OF SOUND DATA**
- **ACOUSTICAL ANALYSIS (CONSTRUCTION ACTIVITIES)**
- **DESCRIPTION OF THE ANALYSES METHODOLOGY (CONSTRUCTION ACTIVITIES) AND THE SOURCE OF SOUND DATA**

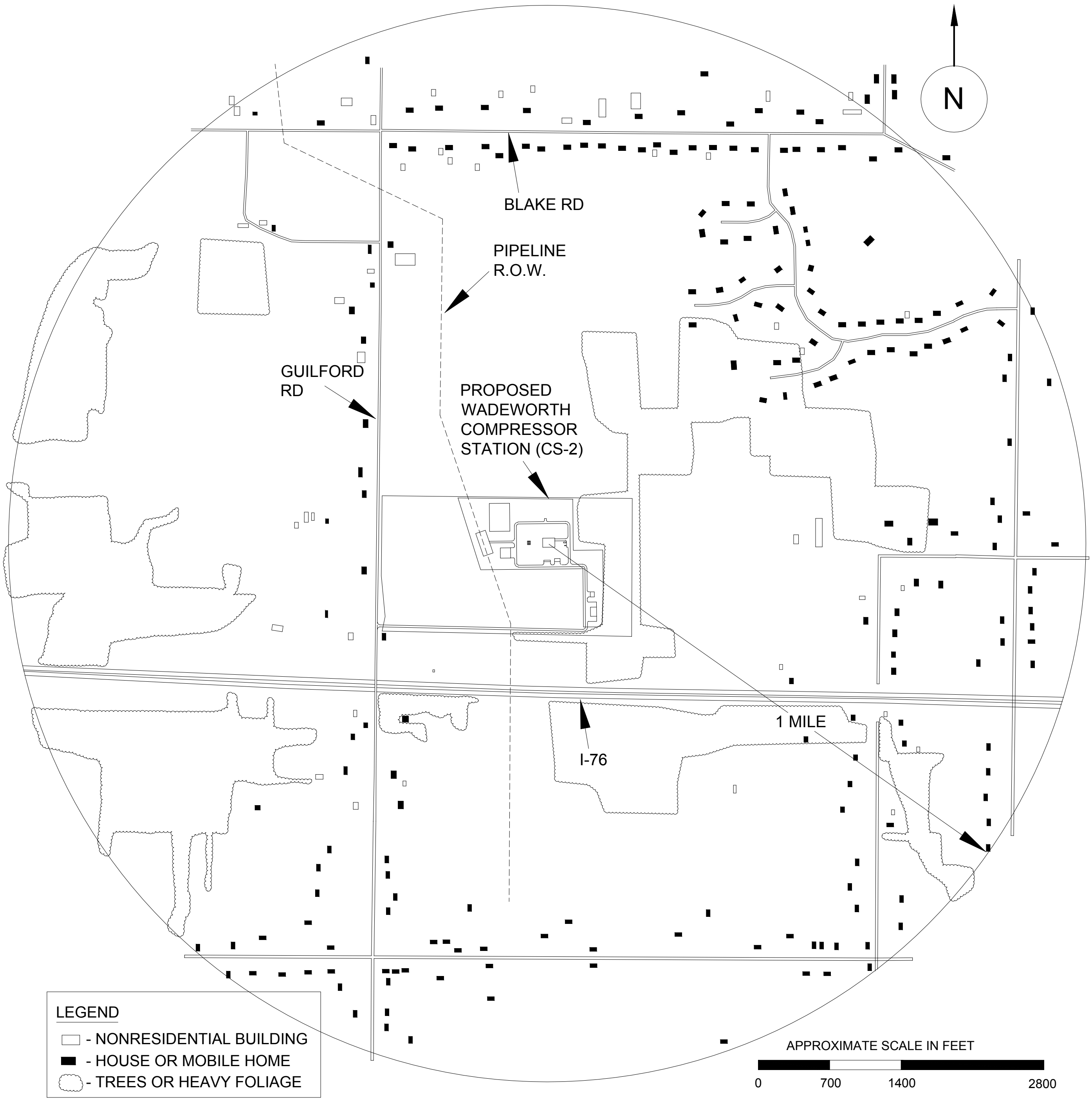

Figure 1: NEXUS Wadsworth Compressor Station (CS-2): General Area Layout showing the NSAs within 1 Mile of the Station Site and Other Areas of Interest.

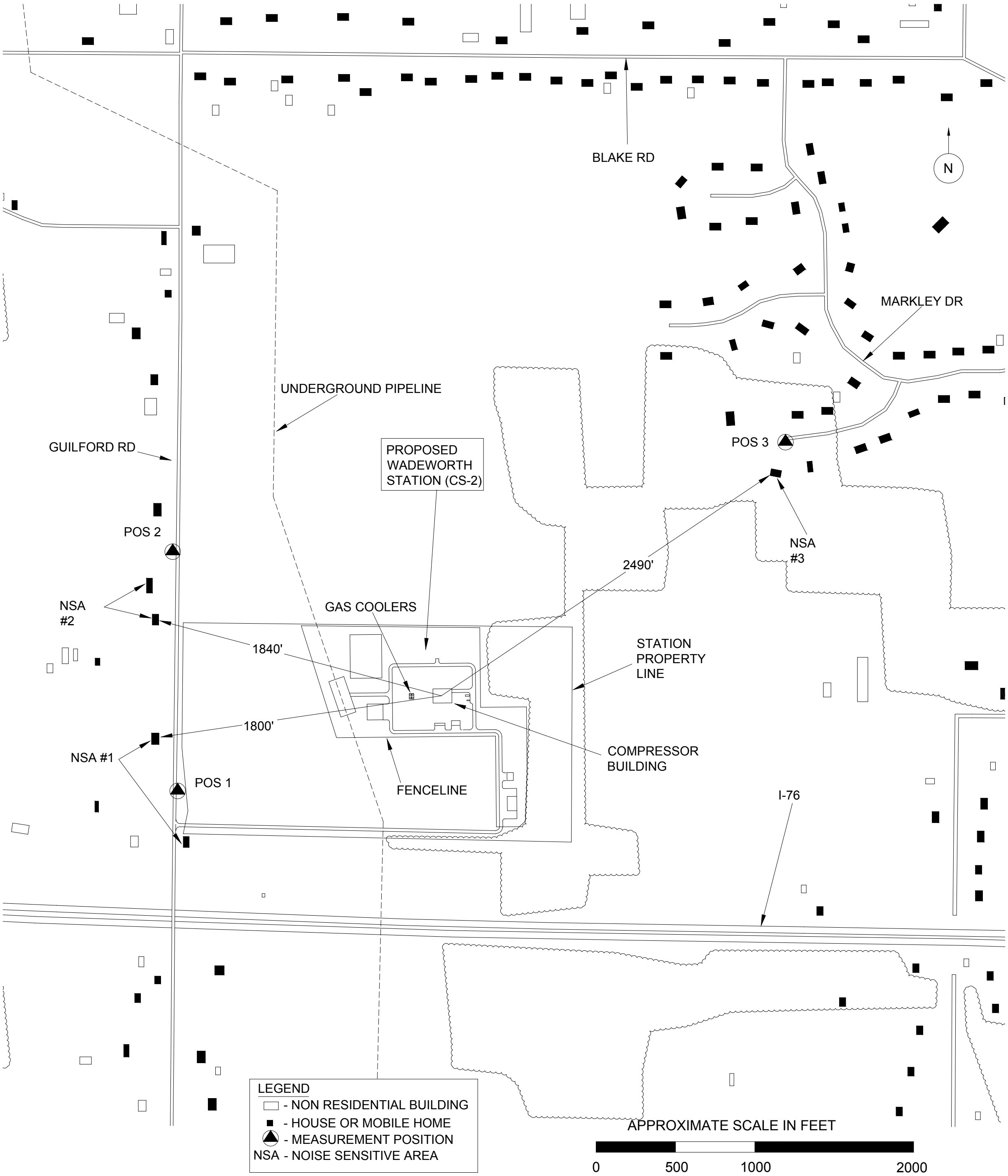

Figure 2: NEXUS Wadsworth Compressor Station (CS-2): Layout showing the Identified Closest NSAs, Chosen Sound Measurement Positions near the Closest NSAs and Conceptual Layout of Station Equipment and Buildings.

Measurement Set		Meas'd/Calc'd A-Wt. Levels (dBA)				
Meas. Pos. & NSA	Time/Date of Test	Day-time Leq(Ld)	Avg'd of Ld	Night time Leq(Ln)	Calc'd Ldn Note (2)	Notes/Observations
Pos. 1 (NSA #1) Residences approx. 1,800 ft. west of the Station Site Center	9:36 AM (2/3/15)	56.3	**56.7**	**46.7** Note (1)	**56.7** Note (2)	Primary noise during tests: Noise of traffic on I-76 and the sound of birds.
	9:38 AM (2/3/15)	58.2				
	9:40 AM (2/3/15)	55.8				
Pos. 2 (NSA #2) Residences approx. 1,840 ft. WNW of the Station Site Center	9:47 AM (2/3/15)	43.4	**43.0**	**40.0** Note (1)	**46.9** Note (2)	Primary noise during tests: Noise of traffic on I-76; sound of wind blowing in trees and sound of birds.
	9:51 AM (2/3/15)	43.4				
	9:52 AM (2/3/15)	42.1				
Pos. 3 (NSA #3) Residences approx. 2,490 ft. NE of the Station Site Center	9:59 AM (2/3/15)	48.3	**47.6**	**39.6** Note (1)	**48.5** Note (2)	Primary noise during tests: Noise of traffic on I-76 and the sound of wind blowing in trees.
	10:00 AM (2/3/15)	46.9				
	10:01 AM (2/3/15)	47.7				

Table A: **Wadsworth Compressor Station (CS-2): Summary of Ambient Daytime Sound Levels (Ld) at the Closest NSAs, as Meas'd on Feb. 3, 2015, Est'd Nighttime Levels (Ln) and Resulting Ldn.**

Note (1): Nightime sound levels (Ln) were not measured but since there should be less noise during night, the Ln was estimated to provide a representative ambient Ldn (e.g., 3 to 10 dB subtracted from the daytime levels).

Note (2): Ldn calculated by adding 6.4 dB to the measured Ld. If both the Ld and Ln are measured and/or estimated, the Ldn is calculated using the following formula:

$$L_{dn} = 10\log_{10}\left(\frac{15}{24}10^{L_d/10} + \frac{9}{24}10^{(L_n+10)/10}\right)$$

Measurement Set		Temp.	R.H.	Wind	Wind	Peak	
Meas. Pos.	Time Frame/Date of Tests	(°F)	(%)	Direction	Speed	Wind	Sky Conditions
Pos. 1 - 3	9:00 AM to 11:00 AM (2/3/15)	33	57	From the south	1-3 mph	3 mph	Overcast

Table B: **Wadsworth Compressor Station (CS-2): Summary of the Meteorological Conditions during Ambient Sound Survey on Feb. 3, 2015.**

Measurement Set		Unweighted Sound Pressure Level (SPL) in dB per O.B. Frequency (in Hz)									A-Wt.
Meas. Pos. & NSA	Time/Date of Test	31.5	63	125	250	500	1000	2000	4000	8000	Level
Pos. 1 (NSA #1)	9:36 AM (2/3/15)	58.3	54.3	52.6	49.8	51.2	54.3	47.2	33.8	27.1	56.3
Residences approx.	9:38 AM (2/3/15)	58.3	52.3	51.3	47.9	53.1	56.4	49.1	34.9	26.3	58.2
1,800 ft. west of the	9:40 AM (2/3/15)	59.2	53.7	53.0	47.2	51.3	53.5	47.6	34.0	27.7	55.8
Station Site Center	**Avg. A-Wt. & SPL**	**58.6**	**53.4**	**52.3**	**48.3**	**51.9**	**54.7**	**48.0**	**34.2**	**27.0**	**56.7**
Pos. 2 (NSA #2)	9:47 AM (2/3/15)	48.4	45.6	42.6	41.1	41.9	39.4	33.1	24.8	20.3	43.4
Residences approx.	9:51 AM (2/3/15)	51.9	47.7	44.0	40.2	42.8	37.7	28.3	34.0	25.7	43.4
1,840 ft. WNW of the	9:52 AM (2/3/15)	56.9	49.4	45.1	40.8	41.6	36.2	28.4	29.2	26.0	42.1
Station Site Center	**Avg. A-Wt. & SPL**	**52.4**	**47.6**	**43.9**	**40.7**	**42.1**	**37.8**	**29.9**	**29.3**	**24.0**	**43.0**
Pos. 3 (NSA #3)	9:59 AM (2/3/15)	52.5	51.2	54.2	45.8	47.0	44.4	32.2	24.6	21.3	48.3
Residences approx.	10:00 AM (2/3/15)	50.2	51.1	48.8	47.2	45.7	42.8	31.8	22.5	18.9	46.9
2,490 ft. NE of the	10:01 AM (2/3/15)	50.1	51.6	49.6	47.2	47.3	43.2	29.8	21.5	18.8	47.7
Station Site Center	**Avg. A-Wt. & SPL**	**50.9**	**51.3**	**50.9**	**46.7**	**46.7**	**43.5**	**31.3**	**22.9**	**19.7**	**47.6**

Table C: **Wadsworth Compressor Station (CS-2): Measured Ambient Ld and Unweighted Octave-Band ("O.B.") SPLs at the Closest NSAs, as Measured on Feb. 3, 2015.**

Source No.	Noise Sources and Other Conditions/Factors	Unweighted PWL or SPL in dB per O.B. Center Frequency (Hz)									A-Wt.	
& Dist (Ft)	associated with Acoustical Analysis	31.5	63	125	250	500	1000	2000	4000	8000	Level	
1)	PWL of Turbine/Compressor inside Building	108	112	114	116	118	115	115	120	118	125	
	Atten. of Additional Noise Control (Building)	-6	-10	-18	-25	-30	-35	-40	-45	-45		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	-1	-2	-3	-3		
1800	Hemispherical Radiation	-63	-63	-63	-63	-63	-63	-63	-63	-63		
1800	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-5	-14	-25		
1800	Source Sound Level Contribution	39	39	33	27	24	13	5	0	0	25	
2)	PWL of Unsilenced Titan 250 Exhaust (1 Unit)	126	130	128	131	135	130	122	112	102	135	
	Atten. Of Noise Control (Exhaust Muffler)	-5	-16	-25	-40	-45	-45	-45	-35	-25		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	0	0	0		
1800	Hemispherical Radiation	-63	-63	-63	-63	-63	-63	-63	-63	-63		
1800	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-5	-14	-25		
1800	Source Sound Level Contribution	58	51	40	27	26	19	9	1	0	30	
3)	PWL of the LO Cooler (1 Unit)	105	98	92	90	88	86	85	82	75	92	
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	-1	-2	-3	-3		
1800	Hemispherical Radiation	-63	-63	-63	-63	-63	-63	-63	-63	-63		
1800	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-5	-14	-25		
1800	Source Sound Level Contribution	42	35	29	26	24	19	15	3	0	25	
4)	PWL of Outdoor Piping/Components	95	95	98	92	92	105	114	112	105	118	
	Atten. of Noise Control (Acoustical Insulation)	2	2	0	-2	-6	-10	-12	-15	-15		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	-1	-2	-3	-3		
1800	Hemispherical Radiation	-63	-63	-63	-63	-63	-63	-63	-63	-63		
1800	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-2	-1	-3	-5	-14	-25		
1800	Source Sound Level Contribution	34	34	35	25	22	28	32	18	0	35	
5)	PWL of Unsilenced Titan 250 Intake (1 Unit)	116	120	128	129	130	132	135	174	166	175	
	Est'd Attenuation of Intake Silencer System	-2	-6	-15	-20	-25	-30	-40	-60	-50		
	Est'd Attenuation of Air Intake Filter	-1	-4	-6	-15	-20	-25	-28	-30	-30		
1800	Hemispherical Radiation	-63	-63	-63	-63	-63	-63	-63	-63	-63		
1800	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-5	-14	-25		
1800	Source Sound Level Contribution	50	47	44	30	21	11	0	8	0	30	
6)	PWL of All Outdoor Gas Aftercooler	115	108	96	94	90	90	88	85	82	95	
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	-1	-2	-3	-3		
1700	Hemispherical Radiation	-62	-62	-62	-62	-62	-62	-62	-62	-62		
1700	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-5	-13	-23		Calc'd
1700	Source Sound Level Contribution	53	46	33	31	27	24	19	7	0	30	Ldn
Est'd Total Sound Contribution of Sources at NSA #1		**60**	**54**	**46**	**36**	**32**	**31**	**32**	**18**	**0**	**38.1**	**44.5**

Ambient Sound Level (Ldn) at the NSA	**56.7**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	57.0
Potential Increase above Ambient Sound Level (dB)	**0.3**

Table D: Wadsworth Compressor Station (CS-2): Est'd Sound Contribution of Station at NSA #1 (i.e., Residences located approx. 1,800 Ft. West of the Site Center) assuming Operation of One (1) Solar Titan 250 Turbine-Driven Compressor Unit. In addition, Estimated Increase above the Ambient Sound Level.

NOTE: Muffler DIL & Equipment PWL values on this spreadsheet should <u>not</u> be used as the specified values. Refer to "Noise Control Measures" section in report or other company specifications for actual specified values.

Dist (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt.	
		31.5	63	125	250	500	1000	2000	4000	8000	Level	
	Est'd SPLs of Station at 1,800 Ft. (RE: Table D)	60	54	46	36	32	31	32	18	0	38.1	
1840	Hemisph Radiation [20*log(1840/1800)=0.2 dB]	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2		Calc'd
1840	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	0	0	-1		Ldn
Est'd Total Sound Contribution of Station at NSA #2		**60**	**53**	**46**	**36**	**32**	**30**	**32**	**18**	**0**	**37.8**	**44.2**

Ambient Sound Level (Ldn) at the NSA	**46.9**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	48.8
Potential Increase above Ambient Sound Level (dB)	**1.9**

Table E: Wadsworth Compressor Station (CS-2): Est'd Sound Contribution of Station at NSA #2 (i.e., Residences located approx. 1,840 Ft. WNW of the Site Center) assuming Operation of One (1) Solar Titan 250 Turbine-Driven Compressor Unit. In addition, Estimated Increase above the Ambient Sound Level.

Dist (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt.	
		31.5	63	125	250	500	1000	2000	4000	8000	Level	
	Est'd SPLs of Station at 1,800 Ft. (RE: Table D)	60	54	46	36	32	31	32	18	0	38.1	
2490	Hemisph Radiation [20*log(2490/1800)=2.8 dB]	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8		Calc'd
2490	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-9		Ldn
Est'd Total Sound Contribution of Station at NSA #3		**57**	**51**	**43**	**33**	**29**	**27**	**27**	**10**	**0**	**34.3**	**40.7**

Ambient Sound Level (Ldn) at the NSA	**48.5**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	49.2
Potential Increase above Ambient Sound Level (dB)	**0.7**

Table F: Wadsworth Compressor Station (CS-2): Est'd Sound Contribution of Station at NSA #3 (i.e., Residences located approx. 2,490 Ft. NE of the Site Center) assuming Operation of One (1) Solar Titan 250 Turbine-Driven Compressor Unit. In addition, Estimated Increase above the Ambient Sound Level.

DESCRIPTION OF THE ANALYSIS METHODOLOGY AND THE SOURCE OF SOUND DATA USED FOR THE ANALYSIS OF THE STATION COMPRESSOR UNIT

ANALYSIS METHODOLOGY

In general, the predicted sound level contributed by the Station compressor unit was calculated as a function of frequency from estimated unweighted octave-band (O.B.) sound power levels (PWLs) for each significant sound source associated with the compressor unit(s). The following summarizes the analysis procedure for the analysis of the Station compressor unit(s):

- Initially, unweighted O.B. PWLs of the significant noise sources associated with the compressor unit(s) were determined from actual sound level measurements performed by H&K at similar type of gas compressor facilities and/or equipment manufacturer's sound data;

- Then, expected noise reduction (NR) or attenuation in dB per O.B. frequency due to any noise control measures, hemispherical sound propagation (discussed in more detail below*) and atmospheric sound absorption (discussed in more detail below**) were subtracted from the unweighted O.B. PWLs to obtain the unweighted O.B. SPLs of each noise source. Since sound shielding by buildings can influence the sound level contributed at the NSAs, we also included the sound shielding due to buildings, if appropriate. The sound attenuation effect due to vegetation or land contour were typically not considered in the analyses since there appears there could be limited amount of vegetation (e.g., trees) or hills between the site and the nearby NSAs;

- Finally, the resulting estimated O.B. SPLs for all noise sources associated with the compressor units (with noise control and other sound attenuation effects) were logarithmically summed, and the total O.B. SPLs for all noise sources were corrected for A-weighting to provide the estimated overall A-wt. sound level contributed by the compressor unit at the closest NSA to the compressor unit. The predicted sound contribution of the Station at the closest NSA was utilized to estimate the noise contribution of the Station at the other NSAs more distant that the closest NSA.

*Attenuation due to hemispherical sound propagation: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically (i.e., outward, over and above the surface) from the source. The following equation is the theoretical decrease of sound energy when determining the resulting SPLs of a noise source at a specific distance ("r") of a receiver from a source PWL values:

> Decrease in SPL ("hemispherical propagation") from a noise source = **20*log(r) – 2.3 dB**
> where "r" is distance of the receiver from the noise source.

Attenuation due to air absorption: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on the temperature and relative humidity (R.H.) of air and frequency of sound. For example, the attenuation due to air absorption for 1000 Hz O.B. SPL is approximately **1.5 dB per 1,000 feet for standard day conditions (i.e., no wind, 60 deg. F and 70% R.H.).

ANALYSIS METHODOLOGY (NOISE ATTRIBUTABLE TO A BLOWDOWN EVENT)

The noise resulting from a blowdown event was estimated by using the "inverse-square law" and included some attenuation due to atmospheric sound absorption. Consequently, the estimated noise of a blowdown event at the receptor (closest NSA) was calculated as follows:

SPL (receptor) = (Blowdown SPL at R1) – 20*log(R2/R1)– Atm. Atten.= **60 dBA** – 20*log (1800/300)–2 dB = **42 dBA**

Where: R1 = Distance of Specified Blowdown Noise Level Requirement (i.e., 300 ft.)
R2 = Distance of the Receptor from the Blowdown Silencer (1,800 ft.)

SOURCE OF SOUND DATA

The following describes the source of sound data for estimating the source sound levels and source PWLs used in the acoustical analysis for the compressor unit. Note that equipment noise levels utilized in the acoustical analysis (i.e., spreadsheet analysis) are generally higher than the sound level requirement for the equipment to insure that the design incorporates an acoustical "margin of safety."

(1) PWL values of the specific equipment inside the building (i.e., noise of the turbine and compressor) was calculated from sound data measured by H&K on a very similar type of gas compressor installation.

(2) Turbine exhaust PWL values for the Solar turbine were calculated from sound data provided by Solar (i.e., Solar Noise Prediction Manual) and sound data recently measured in the field by H&K on a similar type of turbine installation.

(3) The noise radiated from aboveground gas piping is primarily a result the noise generated by the gas compressors. Consequently, measurement of both near field and far field sound data on gas piping is presumed to be an accurate method of quantifying the noise associated with the new gas piping, and the estimated PWL values for gas piping used in the analysis were determined from near field and far field sound data by H&K on a similar type of compressor to that of the proposed compressor units.

(4) PWL values for the turbine LO cooler(s) and gas aftercooler(s) were designated to meet the design noise goal. Note that the estimated PWL for the cooler(s) utilized in the acoustical analysis assumes some noise associated with piping associated with the coolers. The noise level for the LO cooler and gas aftercooler used in the acoustical analysis is generally higher than the sound level requirement in order that the noise design analysis incorporates an acoustical "margin of safety." In addition, there can be other noise associated with the cooler that is not directly related to the operation of the cooler fans.

(5) PWL values for turbine air intake were calculated from sound data provided by Solar (i.e., Solar Noise Prediction Manual), although low-frequency SPLs were modified as a result of field acoustical tests by H&K.

Type of Equipment	Equipment Power Rating or Capacity	Est'd Number Required	Est'd A-Wt. Sound Level at 50 Ft.: Note (1)	Resulting A-Wt. PWL of Single Piece of Equip.	Assumed Max. No. Operating at One Time	Est'd Max. A-Wt. PWL or Sound Level of Equip.	
Diesel Generator	250 to 400 HP	1 to 2	65 - 70 dBA	102 dBA	1	102	
Bulldozer	250 to 700 HP	1 to 2	75 - 80 dBA	110 dBA	1	110	
Grader	450 to 600 HP	1 to 2	70 - 75 dBA	105 dBA	1	105	
Backhoe	130 to 210 HP	1 to 2	65 - 72 dBA	104 dBA	1	104	
Front End Loader	150 to 250 HP	1 to 2	65 - 70 dBA	102 dBA	1	102	
Truck Loaded	40 Ton	As needed	70 - 75 dBA	105 dBA	1	105	
	Est'd Total Maximum A-Wt. PWL (dBA) of All Construction Site Equipment					113	Calc'd
	Atten. (dB) due to Hemispherical Sound Propagation (1,800 Ft.): Note (2)					-63	Ldn
	Est'd Attenuation (in dB) due to Air Absorption and/or Foliage-Shielding: Note (3)					-5	Note (4)
	Est'd Sound Level (dBA) at Closest NSA (NSA #1) Considering a Maximum Number of Equipment Operating at One Time					45 dBA	43 dBA

Table G: **Wadsworth Compressor Station (CS-2): Est'd Sound Contribution at the Closest NSA (NSA #1, Residences approx. 1,800 Ft. West of Site Center) during Construction Activity at the Station. Sound Contribution assumes Operation of the "Loudest" Equipment during a Time Frame with the Largest Amount of Equipment Operating (e.g., Site Grading & Clearing/Grubbing)**

Note (1): Noise Emission Levels of construction equipment based on an EPA Report (meas'd sound data for a railroad construction project) and measured sound data in the field by H&K or other published sound data.

Note (2): Noise attenuation due to hemispherical sound propagation: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically from the source.

The following equation is the theoretical decrease of sound energy when determining the resulting SPL of a noise source at a specific distance ("r") of a receiver from a source sound power level (PWL):

Decrease in SPL ("hemispherical propagation") from a noise source = 20*log(r) – 2.3 dB, where "r" is distance of the receiver from the noise source. For example, if the distance "r" is 1,800 feet between the site and closest NSA, the "hemispherical propagation" = **20*log(1,800) – 2.3 dB = 63 dB**.

Note (3): Noise attenuation due to air absorption & foliage: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on temperature and relative humidity (R.H.) of the air and the frequency of sound. For standard day conditions (i.e., no wind, 60 deg. F. and 70% R.H.), the attenuation due to air absorption for the medium frequency" (i.e., 1000 Hz O.B. SPL) is approximately **1.5 dB** per 1,000 feet. In addition, foliage such as forest/trees between the Station site and nearby NSAs can have a sound attenuation effect depending on the amount/thickness of the foliage.

Note (4): Calc'd Ldn is approx. 2 dB lower than A-wt. sound level since construction activities will occur only during daytime.

ANALYSIS METHODOLOGY AND SOURCE OF SOUND DATA (CONSTRUCTION ACTIVITIES)

The predicted sound level contributed by the construction-related activity (i.e., construction of the compressor station) was calculated from estimated A-wt. PWL of noise sources (i.e., construction equipment noise) that typically operate during the specific construction activity. The following summarizes the acoustical analysis procedure utilized for the construction activity at the site:

- Initially, the A-wt. PWL of noise sources associated with the construction activity were determined from published sound data and/or actual sound level measurements by H&K, and the total PWL of each noise source (equipment) was based on the anticipated number of equipment operating;

- Next, A-wt. PWL of all sources were logarithmically summed to provide the overall A-wt. PWL contributed by construction activity. It is assumed that the highest level of construction noise would occur during site earth work (i.e., time frame when the largest amount of equipment would operate);

- Finally, the estimated A-wt. sound level of the construction activity at the specific distance was determined by compensating for sound attenuation due to propagation (hemispherical radiation), atmospheric sound absorption and sound attenuation effect of foliage/forest***.

  The noise levels of construction equipment were based on an EPA Report (i.e., measured sound data from railroad construction equipment taken during the Northeast Corridor Improvement Project) that was summarized in a 1995 Report to the Federal Transit Administration as prepared by Harris Miller Miller & Hanson Inc. Also, construction equipment noise levels listed in an article in the Journal of Noise Control Engineering and sound data at a typical compressor station construction site, as measured by H&K, was utilized. The following list some references used by H&K to determine construction equipment noise emission levels:

  (1) "Transit Noise and Vibration Impact Assessment", dated April 1995, prepared by Harris Miller Miller & Hanson Inc. for the Office of Planning of the Federal Transit Administration.
  (2) Erich Thalheimer, "Construction Noise Control Program and Mitigation Strategy at the Central Artery/Tunnel Project", J of Noise Control Eng., 48 (5), pp. 157-165 (2000 Sep-Oct).
  (3) "Noise Control for Building Manufacturing Plant Equipment and Products", course handout notes for a noise course given by Hoover & Keith Inc.

  ***Discussion of noise attenuation due to foliage: Since there will be a substantial amount of trees between the Station and NSAs, the sound attenuation effect of foliage was included. The potential attenuation of foliage, based on our experience and an ISO Standard[1], the "medium-frequency" attenuation (i.e., 1000 Hz) due to forest/trees greater than 500 feet thick is approximately **10 dB**. Consequently, for this Station (i.e., distance of 1,800 feet from closest NSA), the "medium-frequency" air absorption attenuation would be approximately **3 dB**, (i.e., 1.5 dB x 1,800/1000 = 3 dB). Then, adding the attenuation due to foliage (approx. **2 dB**) to the air absorption attenuation, an overall attenuation of **5 dB** was utilized as the estimated attenuation due to air absorption and foliage.

End of Report

[1] ISO Standard 9613-1: 1993 (E), entitled "Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound by the atmosphere, and Part 2: General method of calculation"

CLYDE COMPRESSOR STATION
(SANDUSKY COUNTY, OHIO)

RESULTS OF AN AMBIENT SOUND SURVEY AND ACOUSTICAL ANALYSIS OF THE NATURAL GAS COMPRESSOR STATION (CS-3) ASSOCIATED WITH THE NEXUS GAS TRANSMISSION PROJECT

H&K Report No. 3226

H&K Job No. 4875

Date of Report: June 9, 2015

Submitted to: **Fluor Enterprises, Inc.** (Fluor)
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Sugar Land, TX 77478

Project Applicant: **NEXUS Gas Transmission, LLC** (“NEXUS”)

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REPORT SUMMARY

This report provides the results of an acoustical analysis for the new **Clyde Compressor Station** (referred to as "Station" or "CS-3" in the report) associated with the proposed **NEXUS Gas Transmission Project** ("Project" or "NEXUS Project"). Also included are the results of the recent ambient sound survey at the proposed site of the Station. The intent of the acoustical analysis is to project the sound contribution of the Station during full load operation and determine noise control measures to insure that applicable sound criteria are not exceeded at the nearby noise-sensitive areas (NSAs). The purpose of the ambient sound survey was to identify and verify the nearby NSAs surrounding the Station and to quantify the current ambient sound environment at the nearby NSAs.

The following table summarizes the ambient sound level at the identified closest NSAs, the estimated sound level contribution of the Station at the closest NSAs if the Station was operated at full load and the total sound level contribution of the Station (i.e., sound level contribution of the Station plus the ambient noise level). The results provided in this table are referred to as the "Noise Quality Analysis" for the Station.

Noise Quality Analysis for the Clyde Compressor Station associated with the NEXUS Project

Closest NSA(s) and Type of NSA	Distance and Direction of NSA to Station Site Center	Ambient Ldn (via Meas'd Ld & Est'd Ln)	Est'd Sound Level (Ldn) of the Station at Full Load	Est'd "Total" Ldn (Station Noise + Ambient Noise)	Potential Noise Increase
NSA #1 (Residences)	1,450 ft. (NNW)	63.2 dBA	46.4 dBA	63.3 dBA	0.1 dB
NSA #2 (Residences)	810 ft. (SW)	51.8 dBA	52.7 dBA	55.3 dBA	3.5 dB
NSA #3 (Residence)	1,160 ft. (SE)	53.4 dBA	48.9 dBA	54.7 dBA	1.3 dB

The results of the acoustical analysis indicates that if the anticipated and/or recommended noise control measures are implemented successfully, the sound contribution of the proposed Station should be equal to or lower than **55 dBA** (L_{dn}) at the nearby NSAs, which is the FERC sound level requirement for this type of facility. In addition, the acoustical analyses indicate that the noise of construction activities and noise resulting from a unit blowdown event at the Station should have limited noise impact on the surrounding environment. Also, since Station noise sources that could cause perceptible vibration (e.g., turbine exhaust noise) will be adequately mitigated, there should not be any perceptible increase in vibration at any NSA during Station operation.

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1.0 INTRODUCTION

In this report, **Hoover & Keith Inc.** (H&K) presents the results of an acoustical analysis for the new **Clyde Compressor Station** (referred to as “Station” or “CS-3” in the report) associated with the proposed **NEXUS Gas Transmission Project** (“Project” or “NEXUS Project”). Also included are the results of the recent ambient sound survey at the proposed site of the Station. The following summarizes the purpose of the ambient sound survey and Station acoustical analysis:

(1) Quantify the existing acoustic environment (i.e., measure the typical ambient sound levels) and verify the current noise-sensitive areas (NSAs) around the Station, such as residences, hospitals and schools;

(2) Estimate the sound level contribution of the Station at the nearby NSAs and estimate the “total” Station sound level contribution (i.e., Station noise plus the ambient sound level);

(3) Determine noise mitigation measures to insure that applicable sound level criteria are not exceeded after installation and full load operation of the Station; and

(4) Project the noise at the nearby NSAs resulting from construction activities at the Station, and estimate the noise contribution due to a unit blowdown event at the Station.

2.0 SOUND CRITERIA

Federal: It is anticipated that certificate conditions of the Office of Energy Projects (OEP) of the Federal Energy Regulatory Commission (FERC) will require that the sound level attributable to a new natural gas compressor station during full load operation not exceed a day-night average sound level (i.e., L_{dn}) of **55 dBA** at any nearby NSA. In addition, the operation of the Station should not result in a perceptible increase in vibration at any nearby NSA. The L_{dn} is an energy average of the measured daytime L_{eq} (L_d) and measured nighttime L_{eq} (L_n) plus **10 dB**. The **10-dB** adjustment to the L_n is intended to compensate for nighttime sensitivity. For a steady sound source that operates continuously over a 24-hour period and controls the environmental sound level, the L_{dn} is approximately **6.4 dB** above the measured L_{eq}. Consequently, an L_{dn} of **55 dBA** corresponds to a L_{eq} of **48.6 dBA**. If both the L_d and L_n are measured and/or estimated, then the L_{dn} is calculated using the following formula:

$$L_{dn} = 10\log_{10}\left(\frac{15}{24}10^{L_d/10} + \frac{9}{24}10^{(L_n+10)/10}\right)$$

State of Ohio: The State of Ohio or the Ohio EPA does not have regulations related to acceptable noise levels. We understand that sometimes noise level regulations are covered under local ordinances or city codes (e.g., public nuisance and limit excessive noise between certain hours).

County/Township: No applicable county or township noise regulations have been identified, although local noise regulations, if required, will be addressed during the permitting process.

3.0 SITE/FACILITY DESCRIPTION

Figure 1 (**Appendix**, p. 10) provides an area layout around the Station that shows the NSAs within 1 mile of the Station and other areas of interest. **Figure 2** (**Appendix**, p. 11) provides an area layout around the Station that shows the identified closest NSAs around the Station, reported sound measurement positions near the identified closest NSAs and a conceptual layout of equipment/buildings at the Station. The Station will be located in Sandusky County, Ohio, approximately 5 miles northeast of Clyde, OH, and Interstate 80 (also referred to as "Interstate 90") is located relatively close to the Station. There are a few NSAs (e.g., primarily residences) located within 1 mile of the Station, and the closest NSAs are residences located approximately 810 feet southwest (SW) of the Station site (along Pickle Street).

The proposed Station will consist of one (1) Solar Titan 250 gas turbine-driven centrifugal gas compressor unit [i.e., 30,000 horsepower (HP) rating (ISO)]. We understand that the turbine and compressor for the compressor unit will be installed inside an insulated metal building (i.e., Compressor Building). The following describes the anticipated auxiliary equipment and other notable items associated with the Station compressor unit:

- Outdoor lube oil cooler ("LO cooler");
- Turbine exhaust system designed with an adequate muffler system;
- Turbine air intake filter system designed with in-duct silencer;
- Gas piping and associated piping components, and most gas piping will be buried;
- Gas aftercooler (i.e., air-cooled heat exchanger) that serves the compressor unit; and
- Gas blowdown silencer associated with a unit blowdown.

There will also be two (2) types of gas blowdown events: (1) gas blowdown that occurs when a compressor is stopped and gas between the suction/discharge valves and compressor is vented to the atmosphere ("unit blowdown") via a blowdown silencer, and (2) emergency shutdown ("ESD") that will only occur at required Department of Transportation (DOT) test intervals or in an emergency situation (e.g., gas leak or fire). The unit blowdown will be a "maintenance" type of unit blowdown which can occur when the compressor unit is stopped and gas between the suction/discharge valves and compressor unit is vented to the atmosphere through a silencer. During the period of commissioning and testing, it is estimated that a unit blowdown could occur 2 to 4 times/day and typically only during the daytime. During normal operation of the Station (i.e., after the commissioning period), a unit blowdown event occurs infrequently (e.g., 1 to 3 times/month). In addition, a unit blowdown event only occurs for a short time frame (e.g., unit blowdown event would persist for approximately 1 to 5 minutes). There also can be an emergency shutdown ("ESD") that will only occur only during an emergency situation (e.g., gas leak or fire), which rarely occurs, noting that some natural gas facilities operate for years without having an ESD, and the gas blowdown related to an ESD may be vented via a blowdown silencer. Note that for required DOT test intervals of the ESD operations (e.g., once or twice a year), it is not necessary to vent/blowdown the pipeline gas to atmosphere.

4.0 MEASUREMENT METHODOLOGY, MEASUREMENT LOCATIONS AND CONDITIONS

Current ambient sound levels were measured near three (3) of the identified surrounding closest NSAs (i.e., "NSA #1", "NSA #2" & "NSA #3"). The following provides a description of the identified NSAs and the reported sound measurement positions ("Pos."):

Pos. 1: Near NSA #1: Residences located 1,450 feet north-northwest (NNW) of the Station site center (i.e., anticipated location of the Compressor Building);
Pos. 2: Near NSA #2 (closest NSA): Residences located 810 feet SW of the Station site center;
Pos. 3: Near NSA #3: Residence located 1,160 feet southeast (SE) of the Station site center.

The sound survey was conducted by Garrett Porter of H&K during the daytime of Feb. 4, 2015. During the site ambient sound survey, the temperature was 36 degrees F, the wind was from the west and there were overcast sky conditions. At the reported sound measurement locations, the A-wt. equivalent sound levels (i.e., L_{eq}) and the unweighted octave-band (O.B.) sound pressure levels (SPLs) were measured at approximately 5 feet above ground. The sound measurements attempted to exclude "extraneous sound" such as the noise contribution of occasional vehicle passing by the measurement position and/or other intermittent sources. The acoustical measurement system consisted of a Rion NA-27 Sound Level Meter (a Type 1 SLM per ANSI S1.4 & S1.11) equipped with microphone, covered with a windscreen. The SLM was calibrated with a microphone calibrator (calibrated within 1 year of the test date).

5.0 MEASUREMENT RESULTS AND OBSERVATIONS

Table A (**Appendix**, p. 12) summarizes the measured daytime L_{eq} (L_d) and the estimated nighttime L_{eq} (L_n) at the NSA sound measurement locations along with the average of the measured L_d since several samples of the ambient sound level were measured. **Table A** also includes the resulting ambient L_{dn} as calculated from the measured L_d and estimated L_n. Meteorological conditions that occurred during the sound survey are summarized in **Table B** (**Appendix**, p. 12). The measured daytime sound levels (L_d) and related unweighted O.B. SPLs at the reported sound measurement positions are provided in **Table C** (**Appendix**, p. 12).

The following **Table 1** summarizes the measured ambient L_d and estimated ambient L_n at the closest NSAs along with the resulting ambient L_{dn} at the closest NSAs, as calculated from the measured ambient L_d and estimated L_n.

Meas. Pos.	Description of the Identified Closest NSAs, as related to the Sound Measurement Location	Meas'd Ambient Ld	Est'd Ambient Ln	Resulting Ambient Ldn
Pos. 1	NSA #1: Residences 1,450 feet NNW of the Station site	62.4 dBA	54.4 dBA	63.2 dBA
Pos. 2	NSA #2: Residences 810 feet SW of the Station site	49.2 dBA	44.2 dBA	51.8 dBA
Pos. 3	NSA #3: Residences 1,160 feet SE of the Station site	52.5 dBA	44.5 dBA	53.4 dBA

Table 1: Summary of the Measured Ld, Estimated Ln and Resulting Ambient Ldn at the Identified NSAs

It is our opinion that the measured sound level data adequately quantifies the existing ambient sound level for the meteorological conditions that occurred during the sound survey. At the reported sound measurement positions near the closest NSAs, the ambient A-wt. sound level was primarily a result of the noise of distant vehicle traffic along Interstate 80/90 ("I-80/90"). The ambient L_n were not measured but were estimated based on our site observations to provide a more accurate representation of the ambient L_{dn} (i.e., ambient nighttime levels could be lower than the measured daytime levels since there should be less traffic noise along I-80/90).

6.0 ACOUSTICAL ANALYSIS (COMPRESSOR STATION)

6.1 Sound Level Contribution of the Station

The acoustical analysis considers the noise produced by equipment for the Station compressor unit that could impact the sound contribution at any NSA. The predicted sound contribution of the Station were performed only for the closest NSAs (i.e., NSA #1, NSA #2 & NSA #3) since the Station sound contribution at other nearby NSAs should be equal to or less than the Station sound level at these closest NSAs. A description of the acoustical analysis methodology and source of sound data for the analysis is provided in the **Appendix** (pp. 15–16). The following sound sources were considered significant and included in the Station acoustical analysis:

- Noise generated by the turbine/compressor that penetrates the Compressor Building;
- Noise of the turbine exhaust radiated from the turbine exhaust stack;
- Noise radiated from aboveground/outdoor gas piping and associated components;
- Noise of the outdoor LO cooler and associated outdoor piping;
- Noise generated by the turbine air intake system, and
- Noise of the gas aftercooler and associated aboveground piping.

Table D (**Appendix**, p. 13) shows the spreadsheet analysis of the estimated A-wt. sound level and unweighted O.B. SPLs at the closest NSA (i.e., NSA #2) contributed by the Station compressor unit during full load operation for standard day propagating conditions (i.e., no wind, 60 deg. F., 70% R.H.). Included in **Table D** is the estimated "total" sound level contribution of the Station at NSA #1 (i.e., sound level contribution of the Station plus the ambient sound level).

Table E (**Appendix**, p. 14) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the Station at the next closest NSA ("NSA #3") based on the acoustical analysis at NSA #2, along with the estimated total sound level contribution of the Station at NSA #3 (i.e., sound level contribution of the Station plus the ambient sound level).

Table F (**Appendix**, p. 14) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the Station at NSA #1 based on the acoustical analysis at NSA #2, along with the estimated total sound level contribution of the Station at NSA #3 (i.e., sound level contribution of the Station plus the ambient sound level).

The following **Table 2** summarizes the calculated sound level contribution of the Station at the closest NSAs assuming full load operation of all equipment associated with the Station, noting that the estimated A-wt. sound level was used to calculate the representative L_{dn}.

Operating Condition and associated NSA	Est'd A-Wt. Sound Level of Station	Calc'd Ldn (via Est'd A-Wt. Level)
Est'd sound contribution of Station during full load operation at NSA #1	40.0 dBA	46.4 dBA
Est'd sound contribution of Station during full load operation at NSA #2	46.3 dBA	52.7 dBA
Est'd sound contribution of Station during full load operation at NSA #3	42.5 dBA	48.9 dBA

Table 2: Estimated Sound Contribution of the Station during Full Load Operation at the Closest NSAs

6.2 Sound Contribution of a Unit Blowdown Event at the Station

The noise level of the unit blowdown event via a blowdown silencer will be specified to meet an A-wt. sound level of **60 dBA** at a distance of 300 feet. If this sound requirement is achieved, the noise of a unit blowdown will be approximately **47 dBA** (i.e., L_{dn} of approximately **53 to 54 dBA**) at the closest NSA, located approximately 900 feet from the unit blowdown silencer, which would be lower than **55 dBA** (L_{dn}). Consequently, although the noise of a unit blowdown event could be slightly audible at the nearby NSAs, it is not expected to present a noise impact, noting also that a unit blowdown event occurs infrequently for a short time frame (e.g., 1 to 5 minute period). A description of the acoustical analysis methodology and source of sound data related to blowdown noise are provided in the **Appendix** (p. 16)

7.0 ACOUSTICAL ANALYSIS (SITE CONSTRUCTION ACTIVITIES)

The acoustical analysis of the construction-related activities at the site of the Station considers the noise produced by any significant sound sources associated with the primary construction equipment that could impact the sound contribution at the nearby NSAs. The predicted sound contribution of construction equipment/activities was performed only for the closest NSA (i.e., NSA #2). Construction of the Station will consist of earth work (e.g., site grading, clearing and grubbing) and construction of the Station buildings, and it is assumed that the highest level of construction noise would occur during site earth work (i.e., time frame when the largest amount of construction equipment would operate).

Table G (**Appendix**, p. 17) shows the calculation of the estimated maximum A-wt. sound level at the closest NSA contributed by the construction activities at the Station for standard day propagating conditions. A description of the methodology and source of sound data for the construction noise analysis are provided in the **Appendix** (p. 18). The analysis indicates that the maximum A-wt. noise level of construction activities at the closest NSA would be equal to or less than **54 dBA** (i.e., L_{dn} of **52 dBA**, since nighttime construction activities are not anticipated).

8.0 NOISE CONTROL MEASURES (COMPRESSOR STATION)

The following section provides the recommended noise control measures and equipment sound level requirements along with other assumptions that may affect the noise of the Station.

8.1 Building enclosing the Turbine/Compressor

We understand that the turbine and compressor will be installed inside an acoustically-insulated metal building (i.e., Compressor Building). The following describes specific sound requirements and other items related to the components of the Compressor Building.

- As a minimum, walls/roof should be constructed with an exterior skin of 22–gauge metal, and building interior surfaces should be covered with 6–inch thick "high-density" mineral wool (i.e., 6.0-8.0 pcf uniform density) covered with a perforated liner; Note that "low-density" insulation (e.g., 0.6 to 0.75 pcf density) should **not** be substituted for the high-density material although low-density insulation could be employed in addition to the high-density insulation;

- No windows or louvers should be installed in the building walls although a minimum number of skylights could be installed in the building roof although not anticipated;

- Each large access door system (i.e., "roll-up door") should consist of an insulated-type door (e.g., 18-ga. exterior facing, 24-ga. backskin with insulation core); personnel entry doors should be a **STC-36 sound rating**, even if glazing is employed and should be self-closing and should seal well when closed;

- It is anticipated that the building air ventilation system will be designed with air supply fans mounted in the building walls along with roof-mounted air exhaust vents or a roof ridge vent to exhaust the air (i.e., wall louvers should not be employed). Assuming this type of air ventilation system, the sound level for each wall air-supply fan should not exceed **50 dBA** at **50 feet**, which will require that each fan employ an exterior dissipative-type silencer (e.g., 3-ft. length) and an acoustically-lined weatherhood.

8.2 Turbine Exhaust System

The turbine exhaust system for compressor unit should include a silencer system that provides the following dynamic sound insertion loss ("DIL") values at the rated turbine operating conditions.

DIL Values for the Exhaust Silencer System in dB per Octave-Band (O.B.) Center Freq. (Hz)

31.5	63	125	250	500	1000	2000	4000	8000
5	16	25	35	45	45	45	35	30

To meet these recommended DIL values and minimize the impact of the turbine exhaust noise at surrounding residences, a "2–stage" exhaust silencer system should be implemented. One (1) of the 2-stage silencers should be employed horizontally in the exhaust ducting located inside the Compressor Building for the compressor unit (i.e., "1st stage silencer"), and the other silencer system could be integrated into the vertical outdoor exhaust stack (i.e., "2nd stage silencer") or in the horizontal exhaust ducting located outside the Compressor Building. If a CO converter is employed, which is anticipated, it is assumed that a CO converter system would be inserted upstream of the 1st stage silencer, inside the Compressor Building.

8.3 Outdoor Aboveground Gas Piping

The analysis indicates that noise control measures, such as acoustical pipe insulation, will be required for outdoor aboveground gas piping to meet applicable sound criteria. The following items associated with the gas piping and piping components should be addressed:

- Acoustical pipe insulation should be employed for aboveground suction and discharge gas piping. Acoustical pipe insulation should consist of a minimum 3-inch thick fiberglass or mineral wool (6.0-8.0 pcf density) that is covered with a mass-filled vinyl jacket (e.g., composite of 1.0 psf mass-filled vinyl laminated to 0.020-inch thick aluminum). All exposed pipe supports for the insulated gas piping should be covered with acoustical insulation;

- Outdoor valves should be covered with acoustical blanket material. Filter–separator(s) and associated aboveground gas piping should not have to be covered with any type of acoustical material. It is also recommended that the suction pipe strainer for the compressor units be removed soon after the Station is placed in service, if feasible.

8.4 Lube Oil Cooler

Lube oil cooler ("LO cooler") should not exceed **60 dBA** at **50 feet** from the cooler perimeter at the full rated operating conditions (i.e., equivalent to a PWL of **92–93 dBA**), and a "custom" Solar LO cooler may be required to meet the recommended sound level requirement.

8.5 Turbine Air Intake System

The turbine air intake system for the compressor unit should be designed with at least one (1) in-duct silencer (e.g., 7-ft. length "special" silencer or combination of 2 Solar "standard" silencers), and at least one of the silencers (i.e., if 2 separate silencers are employed) should be installed in the intake ductwork located inside the Compressor Building. As a minimum, the air intake silencer system should provide the following DIL values at the rated operating conditions of the turbine-driven compressor unit.

DIL Values in dB per O.B. Center Frequency for the Turbine Air Intake System

31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
4	10	20	35	45	55	60	60	55

8.6 Gas Aftercooler

The sound level generated by the multi-fan gas cooler that serves the compressor unit should not exceed **62 dBA** at **50 feet** at the full rated operating conditions (i.e., all fans operating at maximum design speed). To meet this sound level requirement, the gas aftercooler will need to be designed with "low-noise" fans that operate at relatively low tip speeds (e.g., fans operating at below 7,200 fpm tip speeds). In addition, aboveground inlet pipe risers and inlet header for the gas cooler should be covered with acoustical pipe insulation but the outlet pipe risers should not have to be covered with acoustical pipe insulation.

8.7 Unit Blowdown Silencer

The unit blowdown silencer should attenuate the unsilenced blowdown noise to a noise level equal to or less than **60 dBA** at 300 feet from the outlet of the silencer, which includes the noise radiated from the shell of the silencer during the blowdown event.

9.0 SUMMARY AND FINAL COMMENT

The following **Table 3** summarizes the ambient sound level at the closest NSAs, the estimated sound level contribution of the Station at the closest NSAs during full load Station operation and the "total" sound level contribution of the Station (i.e., sound level contribution of Station during operation plus the ambient sound level). The results provided in this table are referred to as the "Noise Quality Analysis" for the Station.

Closest NSA(s) and Type of NSA	Distance and Direction of NSA to Station Site Center	Ambient Ldn (via Meas'd Ld & Est'd Ln)	Est'd Sound Level (Ldn) of the Station at Full Load	Est'd "Total" Ldn (Station Noise + Ambient Noise)	Potential Noise Increase
NSA #1 (Residences)	1,450 ft. (NNW)	63.2 dBA	46.4 dBA	63.3 dBA	0.1 dB
NSA #2 (Residences)	810 ft. (SW)	51.8 dBA	52.7 dBA	55.3 dBA	3.5 dB
NSA #3 (Residence)	1,160 ft. (SE)	53.4 dBA	48.9 dBA	54.7 dBA	1.3 dB

Table 3: Noise Quality Analysis for the Clyde Compressor Station associated with NEXUS Project

The results of the acoustical analysis indicates that if the noise control measures are employed successfully, the sound contribution of the Station should be equal to or lower than **55 dBA** (L_{dn}) at the nearby NSAs, which is the FERC sound level requirement for this type of facility. In addition, the acoustical analyses indicate that the noise of construction activities and noise resulting from a unit blowdown event at the Station should have limited noise impact on the surrounding environment. Also, since Station noise sources that could cause perceptible vibration (e.g., turbine exhaust noise) will be adequately mitigated, there should not be any perceptible increase in vibration at any NSA during Station operation.

APPENDIX

- **FIGURE 1: GENERAL AREA LAYOUT AROUND THE STATION SHOWING THE NSAs LOCATED WITHIN 1 MILE OF THE STATION AND OTHER AREAS OF INTEREST**
- **FIGURE 2: AREA LAYOUT SHOWING IDENTIFIED CLOSEST NSAs, REPORTED SOUND MEASUREMENT POSITIONS NEAR THE CLOSEST NSAs, AND CONCEPTUAL LAYOUT OF THE STATION SHOWING THE EQUIPMENT, BUILDINGS AND STATION FENCELINE**
- **SUMMARY OF THE MEASURED AMBIENT SOUND DATA**
- **ACOUSTICAL ANALYSIS (COMPRESSOR STATION)**
- **ANALYSIS METHODOLOGY (NOISE ATTRIBUTABLE TO THE STATION AND A BLOWDOWN EVENT) AND THE SOURCE OF SOUND DATA**
- **ACOUSTICAL ANALYSIS (CONSTRUCTION ACTIVITIES)**
- **DESCRIPTION OF THE ANALYSES METHODOLOGY (CONSTRUCTION ACTIVITIES) AND THE SOURCE OF SOUND DATA**

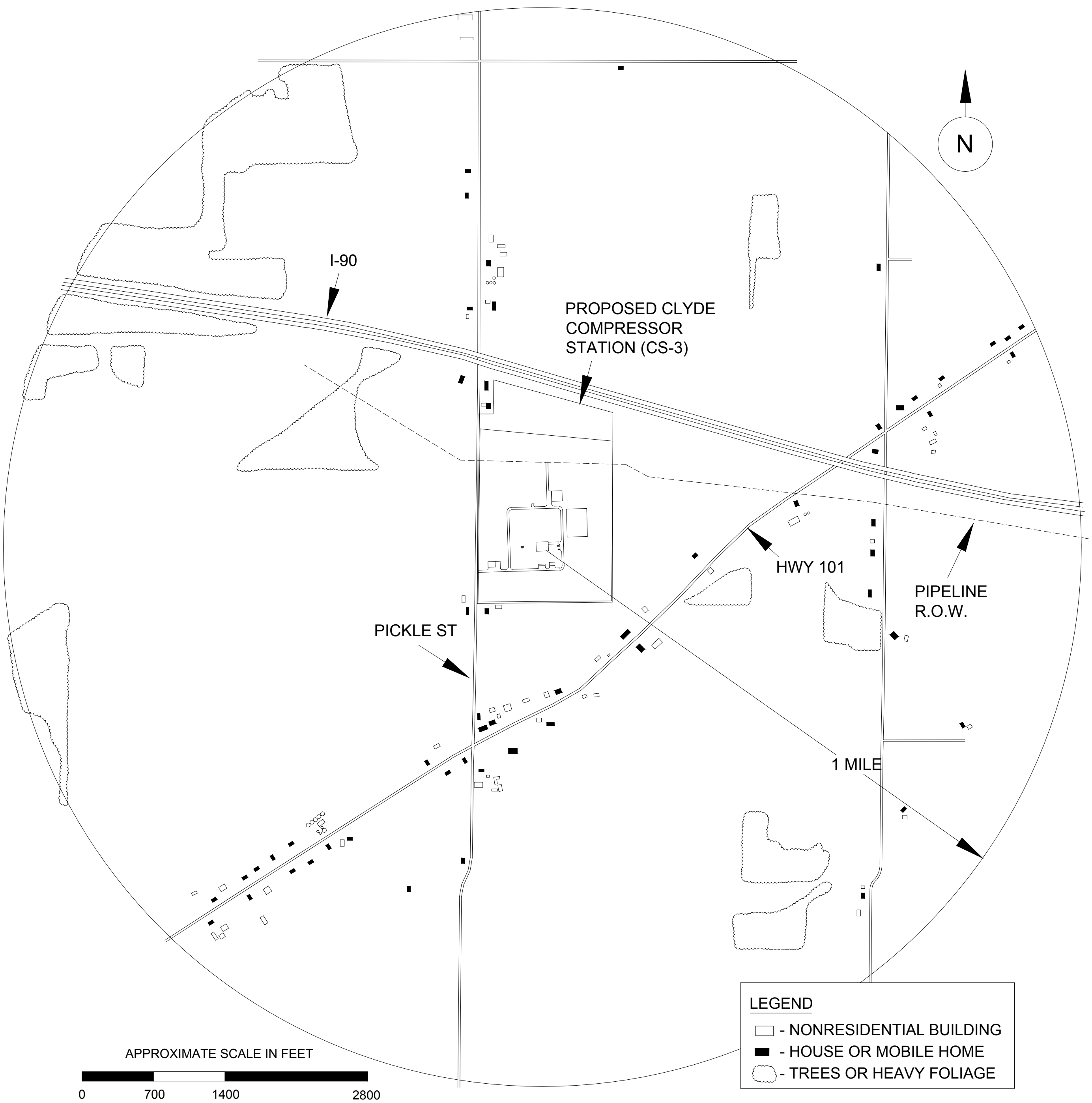

Figure 1: NEXUS Clyde Compressor Station (CS-3): General Area Layout showing the NSAs within 1 Mile of the Station Site and Other Areas of Interest.

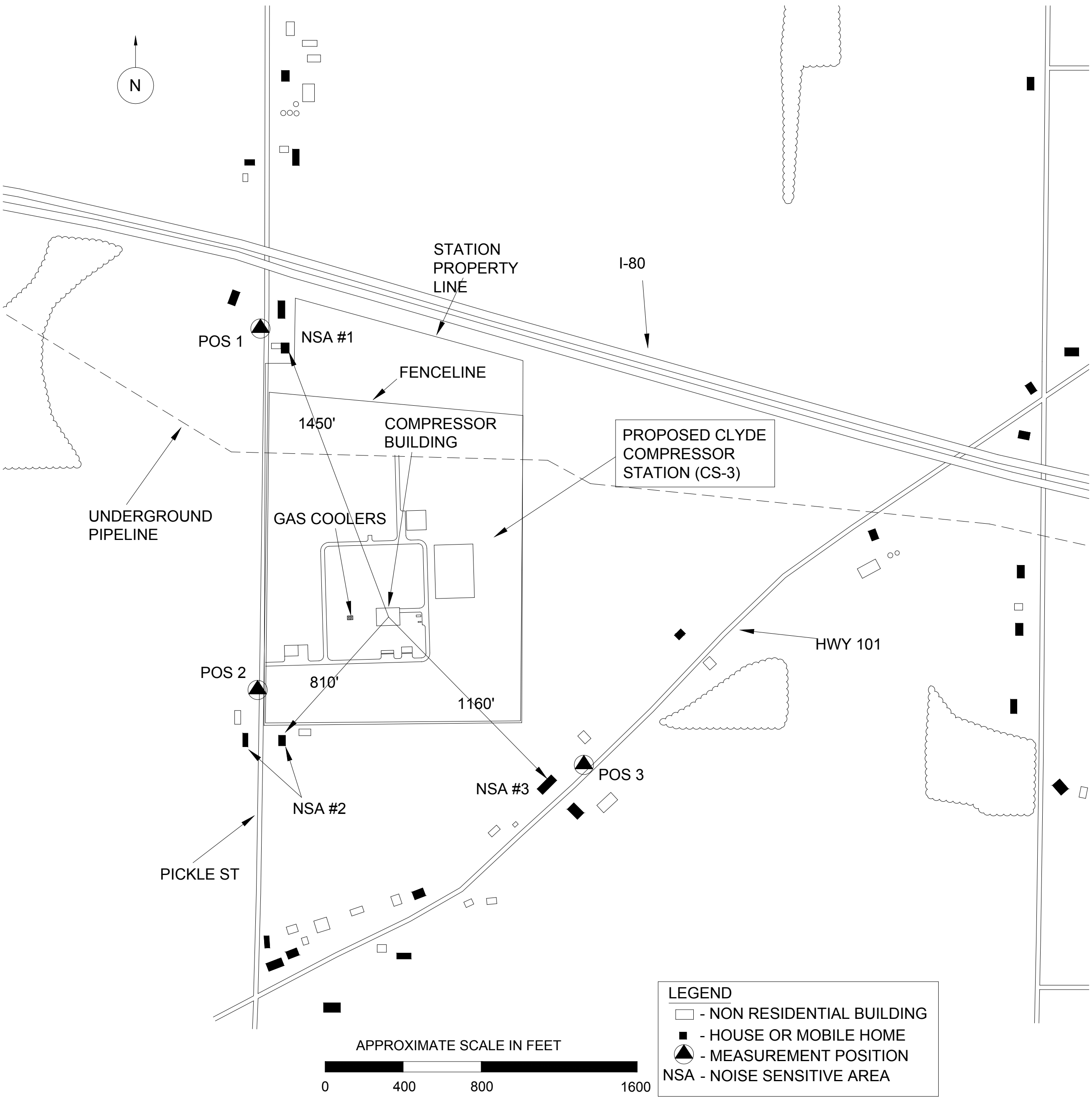

Figure 2: NEXUS Clyde Compressor Station (CS-3): Layout showing the Surrounding NSAs, Chosen Sound Measurement Positions near the Closest NSAs and Conceptual Layout of Station Equipment and Buildings.

Measurement Set		Meas'd/Calc'd A-Wt. Levels (dBA)				
Meas. Pos. & NSA	Time/Date of Test	Day-time Leq(Ld)	Avg'd of Ld	Night time Leq(Ln)	Calc'd Ldn Note (2)	Notes/Observations
Pos. 1 (NSA #1) Residences approx. 1,450 ft. NNW of the Station Site Center	1:14 PM (2/4/15) 1:15 PM (2/4/15) 1:16 PM (2/4/15)	64.4 60.7 62.0	**62.4**	**54.4** Note (1)	**63.2** Note (2)	Primary noise during tests: Noise of vehicle traffic along Interstate 80 ("I-80").
Pos. 2 (NSA #2) Residences approx. 810 ft. SW of the Station Site Center	1:24 PM (2/4/15) 1:25 PM (2/4/15) 1:27 PM (2/4/15)	49.2 48.5 49.8	**49.2**	**44.2** Note (1)	**51.8** Note (2)	Primary noise during tests: Noise of vehicle traffic along I-80.
Pos. 3 (NSA #3) Residence approx. 1,160 ft. SE of the Station Site Center	1:33 PM (2/4/15) 1:34 PM (2/4/15) 1:35 PM (2/4/15)	52.8 52.3 52.5	**52.5**	**44.5** Note (1)	**53.4** Note (2)	Primary noise during tests: Noise of vehicle traffic along I-80 and Hwy. 101.

Table A: **Clyde Compressor Station (CS-3): Summary of Ambient Daytime Sound Levels (i.e., Ld) at the Closest NSAs, as Meas'd on Feb. 4, 2015, Est'd Nighttime Levels (Ln) and Resulting Ldn.**

Note (1): Nightime sound levels (Ln) were not measured but since there should be less noise during night, the Ln was estimated to provide a representative ambient Ldn (e.g., 3 to 8 dB subtracted from the daytime levels).

Note (2): Ldn calculated by adding 6.4 dB to the measured Ld. If both the Ld and Ln are measured and/or estimated, the Ldn is calculated using the following formula:

$$L_{\mathrm{dn}} = 10\log_{10}\left(\frac{15}{24}10^{L_{\mathrm{d}}/10} + \frac{9}{24}10^{(L_{\mathrm{n}}+10)/10}\right)$$

Measurement Set		Temp.	R.H.	Wind	Wind	Peak	
Meas. Pos.	Time Frame/Date of Tests	(°F)	(%)	Direction	Speed	Wind	Sky Conditions
Pos. 1 - 3	1:00 PM to 2:30 PM (2/4/15)	36	74	From the west	2-5 mph	5 mph	Overcast

Table B: **Clyde Compressor Station (CS-3): Summary of the Meteorological Conditions during Ambient Sound Survey on Feb. 4, 2015.**

Measurement Set		Unweighted Sound Pressure Level (SPL) in dB per O.B. Frequency (in Hz)									A-Wt.
Meas. Pos. & NSA	Time/Date of Test	31.5	63	125	250	500	1000	2000	4000	8000	Level
Pos. 1 (NSA #1)	1:14 PM (2/4/15)	69.4	64.8	59.3	59.3	62.6	61.1	54.4	45.2	32.1	64.4
Residences approx.	1:15 PM (2/4/15)	70.5	62.9	56.6	55.8	58.4	57.6	51.4	42.5	30.3	60.7
1,450 ft. NNW of the	1:16 PM (2/4/15)	72.3	64.4	57.9	57.8	60.5	58.7	51.4	41.7	29.8	62.0
Station Site Center	**Avg. A-Wt. & SPL**	**70.7**	**64.0**	**57.9**	**57.6**	**60.5**	**59.1**	**52.4**	**43.1**	**30.7**	**62.4**
Pos. 2 (NSA #2)	1:24 PM (2/4/15)	68.9	58.1	47.9	44.8	47.5	46.1	36.7	27.8	25.2	49.2
Residences approx.	1:25 PM (2/4/15)	70.1	58.6	49.4	44.9	47.4	44.8	34.5	25.1	23.0	48.5
810 ft. SW of the	1:27 PM (2/4/15)	70.7	60.1	49.8	44.5	48.0	46.7	36.5	31.1	27.3	49.8
Station Site Center	**Avg. A-Wt. & SPL**	**69.9**	**58.9**	**49.0**	**44.7**	**47.6**	**45.9**	**35.9**	**28.0**	**25.2**	**49.2**
Pos. 3 (NSA #3)	1:33 PM (2/4/15)	61.8	51.3	47.1	45.5	51.7	49.9	39.3	27.0	25.6	52.8
Residence approx.	1:34 PM (2/4/15)	61.2	49.8	46.3	44.5	50.0	50.2	38.1	25.7	22.9	52.3
1,160 ft. SE of the	1:35 PM (2/4/15)	58.9	49.6	47.9	46.7	50.9	49.5	41.7	28.0	24.1	52.5
Station Site Center	**Avg. A-Wt. & SPL**	**60.6**	**50.2**	**47.1**	**45.6**	**50.9**	**49.9**	**39.7**	**26.9**	**24.2**	**52.5**

Table C: **Clyde Compressor Station (CS-3): Measured Ambient Ld and Unweighted Octave-Band ("O.B.") SPLs at the Closest NSAs, as Measured on Feb. 4, 2015.**

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted PWL or SPL in dB per O.B. Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	
1)	PWL of Turbine/Compressor inside Building	108	112	114	116	118	115	115	120	118	125	
	Atten. of Additional Noise Control (Building)	-6	-10	-18	-25	-30	-35	-40	-45	-45		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	-1	-2	-3		
810	Hemispherical Radiation	-56	-56	-56	-56	-56	-56	-56	-56	-56		
810	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-6	-11		
810	Source Sound Level Contribution	46	46	40	35	32	23	16	11	3	32	
2)	PWL of Unsilenced Titan 250 Exhaust (1 Unit)	126	130	128	131	135	130	122	112	102	135	
	Atten. Of Noise Control (Exhaust Muffler)	-5	-16	-25	-40	-45	-45	-45	-35	-25		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	0	0	0		
810	Hemispherical Radiation	-56	-56	-56	-56	-56	-56	-56	-56	-56		
810	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-6	-11		
810	Source Sound Level Contribution	65	58	47	35	34	28	19	15	10	37	
3)	PWL of the LO Cooler (1 Unit)	105	98	92	90	88	86	85	82	75	92	
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	-1	-2	-3		
810	Hemispherical Radiation	-56	-56	-56	-56	-56	-56	-56	-56	-56		
810	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-6	-11		
810	Source Sound Level Contribution	49	42	36	34	32	29	26	18	5	34	
4)	PWL of Outdoor Piping/Components	95	95	98	92	92	105	114	112	105	118	
	Atten. of Noise Control (Acoustical Insulation)	2	2	0	-2	-8	-10	-14	-15	-15		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	-1	-2	-3		
810	Hemispherical Radiation	-56	-56	-56	-56	-56	-56	-56	-56	-56		
810	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-2	-1	-1	-2	-6	-11		
810	Source Sound Level Contribution	41	41	42	32	28	38	41	33	20	44	
5)	PWL of Unsilenced Titan 250 Intake (1 Unit)	116	120	128	129	130	132	135	174	166	175	
	Est'd Attenuation of Intake Silencer System	-2	-6	-15	-20	-25	-30	-40	-60	-50		
	Est'd Attenuation of Air Intake Filter	-1	-4	-6	-15	-20	-25	-28	-30	-30		
810	Hemispherical Radiation	-56	-56	-56	-56	-56	-56	-56	-56	-56		
810	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-6	-11		
810	Source Sound Level Contribution	57	54	51	38	29	20	9	22	19	37	
6)	PWL of Outdoor Gas Aftercooler(s)	115	108	95	92	88	85	82	80	78	92	
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	-1	-2	-3		
750	Hemispherical Radiation	-55	-55	-55	-55	-55	-55	-55	-55	-55		
750	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-2	-6	-10		Calc'd
750	Source Sound Level Contribution	60	53	40	36	32	29	24	17	10	35	Ldn
Est'd Total Sound Contribution of Sources at NSA #2		**67**	**61**	**53**	**43**	**39**	**39**	**41**	**34**	**23**	**46.3**	**52.7**

Ambient Sound Level (Ldn) at the NSA	**51.8**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	55.3
Potential Increase above Ambient Sound Level (dB)	**3.5**

Table D: Clyde Compressor Station (CS-3): Est'd Sound Contribution of the Station at NSA #2 (i.e., Residences located approx. 810 Ft. SW of the Site Center) assuming Operation of One (1) Solar Titan 250 Turbine-Driven Compressor Unit. In addition, Estimated Increase above the Ambient Sound Level.

NOTE: Muffler DIL & Equipment PWL values on this spreadsheet should not be used as the specified values. Refer to "Noise Control Measures" section in report or other company specifications for actual specified values.

Dist (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt.	
		31.5	63	125	250	500	1000	2000	4000	8000	Level	
	Est'd SPLs of Station at 810 Ft. (RE: Table D)	67	61	53	43	39	39	41	34	23	46.3	
1160	Hemisph Radiation [20*log(1160/810)=3.1 dB]	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1		Calc'd
1160	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-3	-5		Ldn
Est'd Total Sound Contribution of Station at NSA #3		**64**	**57**	**50**	**40**	**36**	**36**	**37**	**28**	**15**	**42.5**	**48.9**

Ambient Sound Level (Ldn) at the NSA	**53.4**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	54.7
Potential Increase above Ambient Sound Level (dB)	**1.3**

Table E: Clyde Compressor Station (CS-3): Est'd Sound Contribution of the Station at NSA #3 (i.e., Residence located approx. 1,160 Ft. SE of the Site Center) assuming Operation of One (1) Solar Titan 250 Turbine-Driven Compressor Unit. In addition, Estimated Increase above the Ambient Sound Level.

Dist (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt.	
		31.5	63	125	250	500	1000	2000	4000	8000	Level	
	Est'd SPLs of Station at 810 Ft. (RE: Table D)	67	61	53	43	39	39	41	34	23	46.3	
1450	Hemisph Radiation [20*log(1450/810)=5.1 dB]	-5.1	-5.1	-5.1	-5.1	-5.1	-5.1	-5.1	-5.1	-5.1		Calc'd
1450	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-9		Ldn
Est'd Total Sound Contribution of Station at NSA #1		**62**	**55**	**48**	**38**	**34**	**33**	**34**	**24**	**9**	**40.0**	**46.4**

Ambient Sound Level (Ldn) at the NSA	**63.2**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	63.3
Potential Increase above Ambient Sound Level (dB)	**0.1**

Table F: Clyde Compressor Station (CS-3): Est'd Sound Contribution of the Station at NSA #1 (i.e., Residences located approx. 1,450 Ft. NNW of the Site Center) assuming Operation of One (1) Solar Titan 250 Turbine-Driven Compressor Unit. In addition, Estimated Increase above the Ambient Sound Level.

DESCRIPTION OF THE ANALYSIS METHODOLOGY AND THE SOURCE OF SOUND DATA USED FOR THE ANALYSIS OF THE STATION COMPRESSOR UNIT

ANALYSIS METHODOLOGY

In general, the predicted sound level contributed by the Station compressor unit was calculated as a function of frequency from estimated unweighted octave-band (O.B.) sound power levels (PWLs) for each significant sound source associated with the compressor unit(s). The following summarizes the analysis procedure for the analysis of the Station compressor unit(s):

- Initially, unweighted O.B. PWLs of the significant noise sources associated with the compressor unit(s) were determined from actual sound level measurements performed by H&K at similar type of gas compressor facilities and/or equipment manufacturer's sound data;

- Then, expected noise reduction (NR) or attenuation in dB per O.B. frequency due to any noise control measures, hemispherical sound propagation (discussed in more detail below*) and atmospheric sound absorption (discussed in more detail below**) were subtracted from the unweighted O.B. PWLs to obtain the unweighted O.B. SPLs of each noise source. Since sound shielding by buildings can influence the sound level contributed at the NSAs, we also included the sound shielding due to buildings, if appropriate. The sound attenuation effect due to vegetation or land contour were typically not considered in the analyses since there appears there could be limited amount of vegetation (e.g., trees) or hills between the site and the nearby NSAs;

- Finally, the resulting estimated O.B. SPLs for all noise sources associated with the compressor units (with noise control and other sound attenuation effects) were logarithmically summed, and the total O.B. SPLs for all noise sources were corrected for A-weighting to provide the estimated overall A-wt. sound level contributed by the compressor unit at the closest NSA to the compressor unit. The predicted sound contribution of the Station at the closest NSA was utilized to estimate the noise contribution of the Station at the other NSAs more distant that the closest NSA.

*Attenuation due to hemispherical sound propagation: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically (i.e., outward, over and above the surface) from the source. The following equation is the theoretical decrease of sound energy when determining the resulting SPLs of a noise source at a specific distance ("r") of a receiver from a source PWL values:

Decrease in SPL ("hemispherical propagation") from a noise source = **20*log(r) – 2.3 dB**
where "r" is distance of the receiver from the noise source.

Attenuation due to air absorption: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on the temperature and relative humidity (R.H.) of air and frequency of sound. For example, the attenuation due to air absorption for 1000 Hz O.B. SPL is approximately **1.5 dB per 1,000 feet for standard day conditions (i.e., no wind, 60 deg. F. and 70% or 50% R.H.).

ANALYSIS METHODOLOGY (NOISE ATTRIBUTABLE TO A BLOWDOWN EVENT)

The noise resulting from a blowdown event was estimated by using the “inverse-square law” and included some attenuation due to atmospheric sound absorption. Consequently, the estimated noise of a blowdown event at the receptor (closest NSA) was calculated as follows:

SPL (receptor) = (Blowdown SPL at R1) – 20*log(R2/R1)– Atm. Atten.= **60 dBA** – 20*log (900/300)–3 dB = **47 dBA**

Where: R1 = Distance of Specified Blowdown Noise Level Requirement (i.e., 300 ft.)

R2 = Distance of the Receptor from the Blowdown Silencer (900 ft.)

SOURCE OF SOUND DATA

The following describes the source of sound data for estimating the source sound levels and source PWLs used in the acoustical analysis for the compressor unit. Note that equipment noise levels utilized in the acoustical analysis (i.e., spreadsheet analysis) are generally higher than the sound level requirement for the equipment to insure that the design incorporates an acoustical “margin of safety.”

(1) PWL values of the specific equipment inside the building (i.e., noise of the turbine and compressor) was calculated from sound data measured by H&K on a very similar type of gas compressor installation.

(2) Turbine exhaust PWL values for the Solar turbine were calculated from sound data provided by Solar (i.e., Solar Noise Prediction Manual) and sound data recently measured in the field by H&K on a similar type of turbine installation.

(3) The noise radiated from aboveground gas piping is primarily a result the noise generated by the gas compressors. Consequently, measurement of both near field and far field sound data on gas piping is presumed to be an accurate method of quantifying the noise associated with the new gas piping, and the estimated PWL values for gas piping used in the analysis were determined from near field and far field sound data by H&K on a similar type of compressor to that of the proposed compressor units.

(4) PWL values for the turbine LO cooler(s) and gas aftercooler(s) were designated to meet the design noise goal. Note that the estimated PWL for the cooler(s) utilized in the acoustical analysis assumes some noise associated with piping associated with the coolers. The noise level for the LO cooler and gas aftercooler used in the acoustical analysis is generally higher than the sound level requirement in order that the noise design analysis incorporates an acoustical “margin of safety.” In addition, there can be other noise associated with the cooler that is not directly related to the operation of the cooler fans.

(5) PWL values for turbine air intake were calculated from sound data provided by Solar (i.e., Solar Noise Prediction Manual), although low-frequency SPLs were modified as a result of field acoustical tests by H&K.

Type of Equipment	Equipment Power Rating or Capacity	Est'd Number Required	Est'd A-Wt. Sound Level at 50 Ft.: Note (1)	Resulting A-Wt. PWL of Single Piece of Equip.	Assumed Max. No. Operating at One Time	Est'd Max. A-Wt. PWL or Sound Level of Equip.	
Diesel Generator	250 to 400 HP	1 to 2	65 - 70 dBA	102 dBA	1	102	
Bulldozer	250 to 700 HP	1 to 2	75 - 80 dBA	110 dBA	1	110	
Grader	450 to 600 HP	1 to 2	70 - 75 dBA	105 dBA	1	105	
Backhoe	130 to 210 HP	1 to 2	65 - 72 dBA	104 dBA	1	104	
Front End Loader	150 to 250 HP	1 to 2	65 - 70 dBA	102 dBA	1	102	
Truck Loaded	40 Ton	As needed	70 - 75 dBA	105 dBA	1	105	
	Est'd Total Maximum A-Wt. PWL (dBA) of All Construction Site Equipment					113	Calc'd
	Atten. (dB) due to Hemispherical Sound Propagation (810 Ft.): Note (2)					-56	Ldn
	Est'd Attenuation (in dB) due to Air Absorption and/or Foliage-Shielding: Note (3)					-3	Note (4)
	Est'd Sound Level (dBA) at Closest NSA (NSA #1) Considering a Maximum Number of Equipment Operating at One Time					54 dBA	52 dBA

Table G: **Clyde Compressor Station (CS-3): Est'd Sound Contribution at the Closest NSA (NSA #2, Residence approx. 810 Ft. SW of Site Center) during Construction Activity at the Station. Sound Contribution assumes Operation of the "Loudest" Equipment during a Time Frame with the Largest Amount of Equipment Operating (e.g., Site Grading & Clearing/Grubbing)**

Note (1): Noise Emission Levels of construction equipment based on an EPA Report (meas'd sound data for a railroad construction project) and measured sound data in the field by H&K or other published sound data.

Note (2): Noise attenuation due to hemispherical sound propagation: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically from the source.

The following equation is the theoretical decrease of sound energy when determining the resulting SPL of a noise source at a specific distance ("r") of a receiver from a source sound power level (PWL):

Decrease in SPL ("hemispherical propagation") from a noise source = 20*log(r) – 2.3 dB, where "r" is distance of the receiver from the noise source. For example, if the distance "r" is 810 feet between the site and closest NSA, the "hemispherical propagation" = **20*log(810) – 2.3 dB = 56 dB**.

Note (3): Noise attenuation due to air absorption & foliage: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on temperature and relative humidity (R.H.) of the air and the frequency of sound. For standard day conditions (i.e., no wind, 60 deg. F. and 70% R.H.), the attenuation due to air absorption for the medium frequency" (i.e., 1000 Hz O.B. SPL) is approximately **1.5 dB** per 1,000 feet. In addition, foliage such as forest/trees between the Station site and nearby NSAs can have a sound attenuation effect depending on the amount/thickness of the foliage.

Note (4): Calc'd Ldn is approx. 2 dB lower than A-wt. sound level since construction activities will occur only during daytime.

ANALYSIS METHODOLOGY AND SOURCE OF SOUND DATA (CONSTRUCTION ACTIVITIES)

The predicted sound level contributed by the construction-related activity (i.e., construction of the compressor station) was calculated from estimated A-wt. PWL of noise sources (i.e., construction equipment noise) that typically operate during the specific construction activity. The following summarizes the acoustical analysis procedure utilized for the construction activity at the site:

- Initially, the A-wt. PWL of noise sources associated with the construction activity were determined from published sound data and/or actual sound level measurements by H&K, and the total PWL of each noise source (equipment) was based on the anticipated number of equipment operating;

- Next, A-wt. PWL of all sources were logarithmically summed to provide the overall A-wt. PWL contributed by construction activity. It is assumed that the highest level of construction noise would occur during site earth work (i.e., time frame when the largest amount of equipment would operate);

- Finally, the estimated A-wt. sound level of the construction activity at the specific distance was determined by compensating for sound attenuation due to propagation (hemispherical radiation), atmospheric sound absorption and sound attenuation effect of foliage/forest***.

  The noise levels of construction equipment were based on an EPA Report (i.e., measured sound data from railroad construction equipment taken during the Northeast Corridor Improvement Project) that was summarized in a 1995 Report to the Federal Transit Administration as prepared by Harris Miller Miller & Hanson Inc. Also, construction equipment noise levels listed in an article in the Journal of Noise Control Engineering and sound data at a typical compressor station construction site, as measured by H&K, was utilized. The following list some references used by H&K to determine construction equipment noise emission levels:

  (1) "Transit Noise and Vibration Impact Assessment", dated April 1995, prepared by Harris Miller Miller & Hanson Inc. for the Office of Planning of the Federal Transit Administration.
  (2) Erich Thalheimer, "Construction Noise Control Program and Mitigation Strategy at the Central Artery/Tunnel Project", J of Noise Control Eng., 48 (5), pp. 157-165 (2000 Sep-Oct).
  (3) "Noise Control for Building Manufacturing Plant Equipment and Products", course handout notes for a noise course given by Hoover & Keith Inc.

  ***Discussion of noise attenuation due to foliage: Since there will be a substantial amount of trees between the Station and NSAs, the sound attenuation effect of foliage was included. The potential attenuation of foliage, based on our experience and an ISO Standard[1], the "medium-frequency" attenuation (i.e., 1000 Hz) due to forest/trees greater than 500 feet thick is approximately **10 dB**. Consequently, for this Station (i.e., distance of 810 feet from closest NSA), the "medium-frequency" air absorption attenuation would be approximately **1 dB**, (i.e., 1.5 dB x 810/1000 = 1 dB). Then, adding the attenuation due to foliage (approx. **2 dB**) to the air absorption attenuation, an overall attenuation of **3 dB** was utilized as the estimated attenuation due to air absorption and foliage.

End of Report

[1] ISO Standard 9613-1: 1993 (E), entitled "Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound by the atmosphere, and Part 2: General method of calculation"

WATERVILLE COMPRESSOR STATION
(LUCAS COUNTY, OHIO)

RESULTS OF AN AMBIENT SOUND SURVEY AND ACOUSTICAL ANALYSIS OF THE NATURAL GAS COMPRESSOR STATION (CS-4) ASSOCIATED WITH THE NEXUS GAS TRANSMISSION PROJECT

H&K Report No. 3227

H&K Job No. 4875

Date of Report: June 9, 2015

Submitted to: **Fluor Enterprises, Inc.** (Fluor)
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Sugar Land, TX 77478

Project Applicant: **NEXUS Gas Transmission, LLC** ("NEXUS")

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REPORT SUMMARY

This report provides the results of an acoustical analysis for the new **Waterville Compressor Station** (referred to as "Station" or "CS-4" in the report) associated with the proposed **NEXUS Gas Transmission Project** ("Project" or "NEXUS Project"). Also included are the results of the recent ambient sound survey at the proposed site of the Station. The intent of the acoustical analysis is to project the sound contribution of the Station during full load operation and determine noise control measures to insure that applicable sound criteria are not exceeded at the nearby noise-sensitive areas ("NSAs"). The purpose of the ambient sound survey was to identify and verify the nearby NSAs surrounding the Station and to quantify the current ambient sound environment at the nearby NSAs.

The following table summarizes the ambient sound level at the identified closest NSAs, the estimated sound level contribution of the Station at the closest NSAs if the Station was operated at full load and the total sound level contribution of the Station (i.e., sound level contribution of the Station plus the ambient noise level). The results provided in this table are referred to as the "Noise Quality Analysis" for the Station.

Noise Quality Analysis for the Waterville Compressor Station associated with the NEXUS Project

Closest NSA(s) and Type of NSA	Distance and Direction of NSA to Station Site Center	Ambient Ldn (via Meas'd Ld & Est'd Ln)	Est'd Sound Level (Ldn) of the Station at Full Load	Est'd "Total" Ldn (Station Noise + Ambient Noise)	Potential Noise Increase
NSA #1 (Residence)	1,390 ft. (east)	60.6 dBA	48.0 dBA	60.8 dBA	0.2 dB
NSA #2 (Residence)	1,990 ft. (north)	48.6 dBA	43.8 dBA	49.9 dBA	1.3 dB
NSA #3 (Residence)	3,790 ft. (west)	41.5 dBA	36.0 dBA	42.6 dBA	1.1 dB
NSA #4 (Residence)	1,660 ft. (SE)	60.6 dBA	46.0 dBA	60.7 dBA	0.1 dB

The results of the acoustical analysis indicates that if the anticipated and/or recommended noise control measures are implemented successfully, the sound contribution of the proposed Station should be equal to or lower than **55 dBA** (L_{dn}) at the nearby NSAs, which is the FERC sound level requirement for this type of facility. In addition, the acoustical analyses indicate that the noise of construction activities and noise resulting from a unit blowdown event at the Station should have limited noise impact on the surrounding environment. Also, since Station noise sources that could cause perceptible vibration (e.g., turbine exhaust noise) will be adequately mitigated, there should not be any perceptible increase in vibration at any NSA during Station operation.

TABLE OF CONTENTS

1.0 INTRODUCTION

In this report, **Hoover & Keith Inc.** (H&K) presents the results of an acoustical analysis for the new **Waterville Compressor Station** (referred to as "Station" or "CS-4") associated with the proposed **NEXUS Gas Transmission Project** ("Project" or "NEXUS Project"). Also included are the results of the recent ambient sound survey at the proposed site of the Station. The following summarizes the purpose of the ambient sound survey and Station acoustical analysis:

(1) Quantify the existing acoustic environment (i.e., measure the typical ambient sound levels) and verify the current noise-sensitive areas (NSAs) around the Station, such as residences, hospitals and schools;

(2) Estimate the sound level contribution of the Station at the nearby NSAs and estimate the "total" Station sound level contribution (i.e., Station noise plus the ambient sound level);

(3) Determine noise mitigation measures to insure that applicable sound level criteria are not exceeded after installation and full load operation of the Station; and

(4) Project the noise at the nearby NSAs resulting from construction activities at the Station, and estimate the noise contribution due to a unit blowdown event at the Station.

2.0 SOUND CRITERIA

Federal: It is anticipated that certificate conditions of the Office of Energy Projects (OEP) of the Federal Energy Regulatory Commission (FERC) will require that the sound level attributable to a new natural gas compressor station during full load operation not exceed a day-night average sound level (i.e., L_{dn}) of **55 dBA** at any nearby NSA. In addition, the operation of the Station should not result in a perceptible increase in vibration at any nearby NSA. The L_{dn} is an energy average of the measured daytime L_{eq} (L_d) and measured nighttime L_{eq} (L_n) plus **10 dB**. The **10-dB** adjustment to the L_n is intended to compensate for nighttime sensitivity. For a steady sound source that operates continuously over a 24-hour period and controls the environmental sound level, the L_{dn} is approximately **6.4 dB** above the measured L_{eq}. Consequently, an L_{dn} of **55 dBA** corresponds to a L_{eq} of **48.6 dBA**. If both the L_d and L_n are measured and/or estimated, then the L_{dn} is calculated using the following formula:

$$L_{dn} = 10\log_{10}\left(\frac{15}{24}10^{L_d/10} + \frac{9}{24}10^{(L_n+10)/10}\right)$$

State of Ohio: The State of Ohio or the Ohio EPA does not have regulations related to acceptable noise levels. We understand that sometimes noise level regulations are covered under local ordinances or city codes (e.g., public nuisance and limit excessive noise between certain hours).

County/Township: No applicable county or township noise regulations have been identified, although any local noise regulations, if required, will be addressed during the permitting process.

3.0 SITE/FACILITY DESCRIPTION

Figure 1 (**Appendix**, p. 11) provides an area layout around the Station that shows the NSAs within 1 mile of the Station and other areas of interest. **Figure 2** (**Appendix**, p. 12) provides an area layout around the Station that shows the identified NSAs around the Station, reported sound measurement positions near the identified closest NSAs and a conceptual layout of equipment and buildings at the Station. The Station will be located in Lucas County, Ohio, near Waterville, OH and 2.5 miles southeast of Whitehouse, OH. There are a few NSAs (e.g., primarily residences) located within 1 mile of the Station, and the closest NSA is a residence located 1,390 feet east of the Station site (along Noward Road).

The proposed Station will consist of one (1) Solar Titan 250 gas turbine-driven centrifugal gas compressor unit [i.e., 30,000 horsepower (HP) rating (ISO)]. We understand that the turbine and compressor for the compressor unit will be installed inside an insulated metal building (i.e., Compressor Building). The following describes the anticipated auxiliary equipment and other notable items associated with the Station compressor unit:

- Outdoor lube oil cooler ("LO cooler");
- Turbine exhaust system designed with an adequate muffler system;
- Turbine air intake filter system designed with in-duct silencer;
- Gas piping and associated piping components, and most gas piping will be buried;
- Gas aftercooler (i.e., air-cooled heat exchanger) that serves the compressor unit; and
- Gas blowdown silencer associated with a unit blowdown.

There will also be two (2) types of gas blowdown events: (1) gas blowdown that occurs when a compressor is stopped and gas between the suction/discharge valves and compressor is vented to the atmosphere ("unit blowdown") via a blowdown silencer, and (2) emergency shutdown ("ESD") that will only occur at required Department of Transportation (DOT) test intervals or in an emergency situation (e.g., gas leak or fire). The unit blowdown will be a "maintenance" type of unit blowdown which can occur when the compressor unit is stopped and gas between the suction/discharge valves and compressor unit is vented to the atmosphere through a silencer. During the period of commissioning and testing, it is estimated that a unit blowdown could occur 2 to 4 times/day and typically only during the daytime. During normal operation of the Station (i.e., after the commissioning period), a unit blowdown event occurs infrequently (e.g., 1 to 3 times/month). In addition, a unit blowdown event only occurs for a short time frame (e.g., unit blowdown event would persist for approximately 1 to 5 minutes). There also can be an emergency shutdown ("ESD") that will only occur only during an emergency situation (e.g., gas leak or fire), which rarely occurs, noting that some natural gas facilities operate for years without having an ESD, and the gas blowdown related to an ESD may be vented via a blowdown silencer. Note that for required DOT test intervals of the ESD operations (e.g., once or twice a year), it is not necessary to vent/blowdown the pipeline gas to atmosphere.

4.0 MEASUREMENT METHODOLOGY, MEASUREMENT LOCATIONS AND CONDITIONS

Current ambient sound levels were measured near three (3) of the identified surrounding closest NSAs (i.e., "NSA #1", "NSA #2" & "NSA #3"). The following provides a description of the identified NSAs and the reported sound measurement positions ("Pos."):

Pos. 1: Near NSA #1 (closest NSA): Residence located 1,390 feet east of the Station site center (i.e., anticipated location of the Compressor Building);
Pos. 2: Near NSA #2: Residence located 1,990 feet north of the Station site center;
Pos. 3: Near NSA #3: Residence located 3,790 feet west of the Station site center; and
NSA #4: Residence located 1,660 feet southeast (SE) of the Station site, and in our opinion, the ambient sound level measured at Meas. Pos. 1 is representative of the ambient sound level at NSA #4.

The sound survey was conducted by Garrett Porter of H&K during the daytime of Feb. 5, 2015. During the site ambient sound survey, the temperature was 6 degrees F, the wind was from the south and there were clear sky conditions. At the reported sound measurement locations, the A-wt. equivalent sound levels (i.e., L_{eq}) and the unweighted octave-band (O.B.) sound pressure levels (SPLs) were measured at approximately 5 feet above ground. The sound measurements attempted to exclude "extraneous sound" such as the noise contribution of occasional vehicle passing by the measurement position and/or other intermittent sources. The acoustical measurement system consisted of a Rion NA-27 Sound Level Meter (a Type 1 SLM per ANSI S1.4 & S1.11) equipped with microphone, covered with a windscreen. The SLM was calibrated with a microphone calibrator (calibrated within 1 year of the test date).

5.0 MEASUREMENT RESULTS AND OBSERVATIONS

Table A (**Appendix**, p. 13) summarizes the measured daytime L_{eq} (L_d) and the estimated nighttime L_{eq} (L_n) at the NSA sound measurement locations along with the average of the measured L_d since several samples of the ambient sound level were measured. **Table A** also includes the resulting ambient L_{dn} as calculated from the measured L_d and estimated L_n. Meteorological conditions that occurred during the sound survey are summarized in **Table B** (**Appendix**, p. 13). The measured daytime sound levels (L_d) and related unweighted O.B. SPLs at the reported sound measurement positions are provided in **Table C** (**Appendix**, p. 13).

The following **Table 1** summarizes the measured ambient L_d and estimated ambient L_n at the closest NSAs along with the resulting ambient L_{dn} at the closest NSAs, as calculated from the measured ambient L_d and estimated L_n.

Meas. Pos.	Description of the Identified Closest NSAs, as related to the Sound Measurement Location	Meas'd Ambient Ld	Est'd Ambient Ln	Resulting Ambient Ldn
Pos. 1	NSA #1: Residences 1,390 feet east of the Station site; NSA #4 (1,660 ft. SE of the Station)	59.7 dBA	51.7 dBA	60.6 dBA
Pos. 2	NSA #2: Residences 1,990 feet north of the Station site	44.7 dBA	41.7 dBA	48.6 dBA
Pos. 3	NSA #3: Residences 3,790 feet west of the Station site	37.5 dBA	34.5 dBA	41.5 dBA

Table 1: Summary of the Measured Ld, Estimated Ln and Resulting Ambient Ldn at the Identified NSAs

It is our opinion that the measured sound level data adequately quantifies the existing ambient sound level for the meteorological conditions that occurred during the sound survey. The ambient L_n were not measured but were estimated based on our site observations to provide a more accurate representation of the ambient L_{dn} (i.e., ambient nighttime levels could be lower than the measured daytime levels). At the reported sound measurement location near all of the identified NSAs, noise sources that contributed to the ambient A-wt. sound level included primarily the noise of distant vehicle traffic along Highway 24.

6.0 ACOUSTICAL ANALYSIS (COMPRESSOR STATION)

6.1 Sound Level Contribution of the Station

The acoustical analysis considers the noise produced by equipment for the Station compressor unit that could impact the sound contribution at any NSA. The predicted sound contribution of the Station were performed only for the closest NSAs (i.e., NSA #1, NSA #2, NSA #3 & NSA #4) since the Station sound contribution at other nearby NSAs should be equal to or less than the Station sound level at these closest NSAs. A description of the acoustical analysis methodology and source of sound data for the analysis is provided in the **Appendix** (pp. 16–17). The following sound sources were considered significant and included in the Station acoustical analysis:

- Noise generated by the turbine/compressor that penetrates the Compressor Building;
- Noise of the turbine exhaust radiated from the turbine exhaust stack;
- Noise radiated from aboveground/outdoor gas piping and associated components;
- Noise of the outdoor LO cooler and associated outdoor piping;
- Noise generated by the turbine air intake system, and
- Noise of the gas aftercooler and associated aboveground piping.

Table D (**Appendix**, p. 14) shows the spreadsheet analysis of the estimated A-wt. sound level and unweighted O.B. SPLs at the closest NSA (i.e., NSA #1) contributed by the Station compressor unit during full load operation for standard day propagating conditions (i.e., no wind, 60 deg. F., 70% R.H.). Included in **Table D** is the estimated "total" sound level contribution of the Station at NSA #1 (i.e., sound level contribution of the Station plus the ambient sound level).

Table E (**Appendix**, p. 15) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the Station at NSA #2 based on the acoustical analysis at NSA #1, along with the estimated total sound level contribution of the Station at NSA #2 (i.e., sound level contribution of the Station plus the ambient sound level).

Table F (**Appendix**, p. 15) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the Station at NSA #3 based on the acoustical analysis at NSA #1, along with the estimated total sound level contribution of the Station at NSA #3 (i.e., sound level contribution of the Station plus the ambient sound level).

Table G (**Appendix**, p. 15) provides the estimated A-wt. sound level and unweighted O.B. SPLs of the Station at NSA #4 based on the acoustical analysis at NSA #1, along with the estimated total sound level contribution of the Station at NSA #4 (i.e., sound level contribution of the Station plus the ambient sound level).

The following **Table 2** summarizes the calculated sound level contribution of the Station at the closest NSAs assuming full load operation of all equipment associated with the Station, noting that the estimated A-wt. sound level was used to calculate the representative L_{dn}.

Operating Condition and associated NSA	Est'd A-Wt. Sound Level of Station	Calc'd Ldn (via Est'd A-Wt. Level)
Est'd sound contribution of Station during full load operation at NSA #1	41.6 dBA	48.0 dBA
Est'd sound contribution of Station during full load operation at NSA #2	37.4 dBA	43.8 dBA
Est'd sound contribution of Station during full load operation at NSA #3	29.6 dBA	36.0 dBA
Est'd sound contribution of Station during full load operation at NSA #4	39.6 dBA	46.0 dBA

Table 2: Estimated Sound Contribution of the Station during Full Load Operation at the Closest NSAs

6.2 Sound Contribution of a Unit Blowdown Event at the Station

The noise level of the unit blowdown event via a blowdown silencer will be specified to meet an A-wt. sound level of **60 dBA** at a distance of 300 feet. If this sound requirement is achieved, the noise of a unit blowdown will be approximately **43 dBA** (i.e., L_{dn} of approximately **49 to 50 dBA**) at the closest NSA, located approximately 1,390 feet from the unit blowdown silencer, which would be lower than **55 dBA** (L_{dn}). Consequently, although the noise of a unit blowdown event could be slightly audible at the nearby NSAs, it is not expected to present a noise impact, noting also that a unit blowdown event occurs infrequently for a short time frame (e.g., 1 to 5 minute period). A description of the acoustical analysis methodology and source of sound data related to blowdown noise are provided in the **Appendix** (p. 17)

7.0 ACOUSTICAL ANALYSIS (SITE CONSTRUCTION ACTIVITIES)

The acoustical analysis of the construction-related activities at the site of the Station considers the noise produced by any significant sound sources associated with the primary construction equipment that could impact the sound contribution at the nearby NSAs. The predicted sound contribution of construction equipment/activities was performed only for the closest NSA (i.e., NSA #1). Construction of the Station will consist of earth work (e.g., site grading, clearing and grubbing) and construction of the Station buildings, and it is assumed that the highest level of construction noise would occur during site earth work (i.e., time frame when the largest amount of construction equipment would operate).

Table H (**Appendix**, p. 18) shows the calculation of the estimated maximum A-wt. sound level at the closest NSA contributed by the construction activities at the Station for standard day propagating conditions. A description of the methodology and source of sound data for the construction noise analysis are provided in the **Appendix** (p. 19). The analysis indicates that the maximum A-wt. noise level of construction activities at the closest NSA would be equal to or less than **47 dBA** (i.e., L_{dn} of approximately **45 dBA**, since nighttime construction activities are not anticipated).

8.0 NOISE CONTROL MEASURES (COMPRESSOR STATION)

The following section provides the recommended noise control measures and equipment sound level requirements along with other assumptions that may affect the noise of the Station.

8.1 Building enclosing the Turbine/Compressor

We understand that the turbine and compressor will be installed inside an acoustically-insulated metal building (i.e., Compressor Building). The following describes specific sound requirements and other items related to the components of the Compressor Building.

- As a minimum, walls/roof should be constructed with an exterior skin of 22–gauge metal, and building interior surfaces should be covered with 6–inch thick “high-density” mineral wool (i.e., 6.0-8.0 pcf uniform density) covered with a perforated liner; Note that “low-density” insulation (e.g., 0.6 to 0.75 pcf density) should **not** be substituted for the high-density material although low-density insulation could be employed in addition to the high-density insulation;

- No windows or louvers should be installed in the building walls although a minimum number of skylights could be installed in the building roof although not anticipated;

- Each large access door system (i.e., “roll-up door”) should consist of an insulated-type door (e.g., 18-ga. exterior facing, 24-ga. backskin with insulation core); personnel entry doors should be a **STC-36 sound rating**, even if glazing is employed and should be self-closing and should seal well when closed;

- It is anticipated that the building air ventilation system will be designed with air supply fans mounted in the building walls along with roof-mounted air exhaust vents or a roof ridge vent to exhaust the air (i.e., wall louvers should not be employed). Assuming this type of air ventilation system, the sound level for each wall air-supply fan should not exceed **50 dBA** at **50 feet**, which will require that each fan employ an exterior dissipative-type silencer (e.g., 3-ft. length) and an acoustically-lined weatherhood.

8.2 Turbine Exhaust System

The turbine exhaust system for each turbine-driven compressor unit should include a silencer system that provides the following dynamic sound insertion loss ("DIL") values at the rated turbine operating conditions.

DIL Values for the Exhaust Silencer System in dB per Octave-Band (O.B.) Center Freq. (Hz)

31.5	63	125	250	500	1000	2000	4000	8000
5	16	25	35	45	45	45	35	30

To meet these recommended DIL values and minimize the impact of the turbine exhaust noise at surrounding residences, a "2–stage" exhaust silencer system should be implemented. One (1) of the 2-stage silencers should be employed horizontally in the exhaust ducting located inside the Compressor Building for the compressor unit (i.e., "1st stage silencer"), and the other silencer system could be integrated into the vertical outdoor exhaust stack (i.e., "2nd stage silencer") or in the horizontal exhaust ducting located outside the Compressor Building. If a CO converter is employed, which is anticipated, it is assumed that a CO converter system would be inserted upstream of the 1st stage silencer, inside the Compressor Building.

8.3 Outdoor Aboveground Gas Piping

The analysis indicates that noise control measures, such as acoustical pipe insulation, will be required for outdoor aboveground gas piping to meet applicable sound criteria. The following items associated with the gas piping and piping components should be addressed:

- Acoustical pipe insulation should be employed for aboveground suction and discharge gas piping. Acoustical pipe insulation should consist of a minimum 3-inch thick fiberglass or mineral wool (6.0-8.0 pcf density) that is covered with a mass-filled vinyl jacket (e.g., composite of 1.0 psf mass-filled vinyl laminated to 0.020-inch thick aluminum). All exposed pipe supports for the insulated gas piping should be covered with acoustical insulation;

- Outdoor valves should not have to be covered with acoustical blanket material. Filter–separator(s) and associated aboveground gas piping should not have to be covered with any type of acoustical material. It is also recommended that the suction pipe strainer for the compressor units be removed soon after the Station is placed in service, if feasible.

8.4 Lube Oil Cooler

Lube oil cooler ("LO cooler") should not exceed **60 dBA** at **50 feet** from the cooler perimeter at the full rated operating conditions (i.e., equivalent to a PWL of **92–93 dBA**), and a "custom" Solar LO cooler may be required to meet the recommended sound level requirement.

8.5 Turbine Air Intake System

The turbine air intake system for the compressor unit should be designed with at least one (1) in-duct silencer (e.g., 7-ft. length "special" silencer or combination of 2 Solar "standard" silencers), and at least one of the silencers (i.e., if 2 separate silencers are employed) should be installed in the intake ductwork located inside the Compressor Building. As a minimum, the air intake silencer system should provide the following DIL values at the rated operating conditions of the turbine-driven compressor unit, noting that only one (1) "standard" Solar air intake silencer may not be capable of meeting these DIL values although the use of two (2) "standard" Solar air intake silencers (per Solar's "Noise Prediction Guidelines") should be capable of meeting the DIL values.

DIL Values in dB per O.B. Center Frequency for the Turbine Air Intake System

31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
3	8	18	30	45	55	60	60	55

8.6 Gas Aftercooler

The sound level generated by the multi-fan gas cooler that serves the compressor unit should not exceed **62 dBA** at **50 feet** at the full rated operating conditions (i.e., all fans operating at maximum design speed). To meet this sound level requirement, the gas aftercooler will need to be designed with "low-noise" fans that operate at relatively low tip speeds (e.g., fans operating at below 7,200 fpm tip speeds). In addition, aboveground inlet pipe risers and inlet header for the gas cooler should be covered with acoustical pipe insulation but the outlet pipe risers should not have to be covered with acoustical pipe insulation.

8.7 Unit Blowdown Silencer

The unit blowdown silencer should attenuate the unsilenced blowdown noise to a noise level equal to or less than **60 dBA** at 300 feet from the outlet of the silencer, which includes the noise radiated from the shell of the silencer during the blowdown event.

9.0 SUMMARY AND FINAL COMMENT

The following **Table 3** summarizes the ambient sound level at the closest NSAs, the estimated sound level contribution of the Station at the closest NSAs during full load Station operation and the "total" sound level contribution of the Station (i.e., sound level contribution of Station during operation plus the ambient sound level). The results provided in this table are referred to as the "Noise Quality Analysis" for the Station.

Closest NSA(s) and Type of NSA	Distance and Direction of NSA to Station Site Center	Ambient Ldn (via Meas'd Ld & Est'd Ln)	Est'd Sound Level (Ldn) of the Station at Full Load	Est'd "Total" Ldn (Station Noise + Ambient Noise)	Potential Noise Increase
NSA #1 (Residence)	1,390 ft. (east)	60.6 dBA	48.0 dBA	60.8 dBA	0.2 dB
NSA #2 (Residence)	1,990 ft. (north)	48.6 dBA	43.8 dBA	49.9 dBA	1.3 dB
NSA #3 (Residence)	3,790 ft. (west)	41.5 dBA	36.0 dBA	42.6 dBA	1.1 dB
NSA #4 (Residence)	1,660 ft. (SE)	60.6 dBA	46.0 dBA	60.7 dBA	0.1 dB

Table 3: Noise Quality Analysis for the Waterville Compressor Station associated with NEXUS Project

The results of the acoustical analysis indicates that if the noise control measures are employed successfully, the sound contribution of the Station should be equal to or lower than **55 dBA** (L_{dn}) at the nearby NSAs, which is the FERC sound level requirement for this type of facility. In addition, the acoustical analyses indicate that the noise of construction activities and noise resulting from a unit blowdown event at the Station should have limited noise impact on the surrounding environment. Also, since Station noise sources that could cause perceptible vibration (e.g., turbine exhaust noise) will be adequately mitigated, there should not be any perceptible increase in vibration at any NSA during Station operation.

APPENDIX

- **FIGURE 1: GENERAL AREA LAYOUT AROUND THE STATION SHOWING THE NSAs LOCATED WITHIN 1 MILE OF THE STATION AND OTHER AREAS OF INTEREST**
- **FIGURE 2: LAYOUT SHOWING IDENTIFIED CLOSEST NSAs SURROUNDING THE STATION, REPORTED SOUND MEASUREMENT POSITIONS NEAR THE CLOSEST NSAs, AND CONCEPTUAL LAYOUT OF STATION EQUIPMENT AND BUILDINGS**
- **SUMMARY OF THE MEASURED AMBIENT SOUND DATA**
- **ACOUSTICAL ANALYSIS (COMPRESSOR STATION)**
- **ANALYSIS METHODOLOGY (NOISE ATTRIBUTABLE TO THE STATION AND A BLOWDOWN EVENT) AND THE SOURCE OF SOUND DATA**
- **ACOUSTICAL ANALYSIS (CONSTRUCTION ACTIVITIES)**
- **DESCRIPTION OF THE ANALYSES METHODOLOGY (CONSTRUCTION ACTIVITIES) AND THE SOURCE OF SOUND DATA**

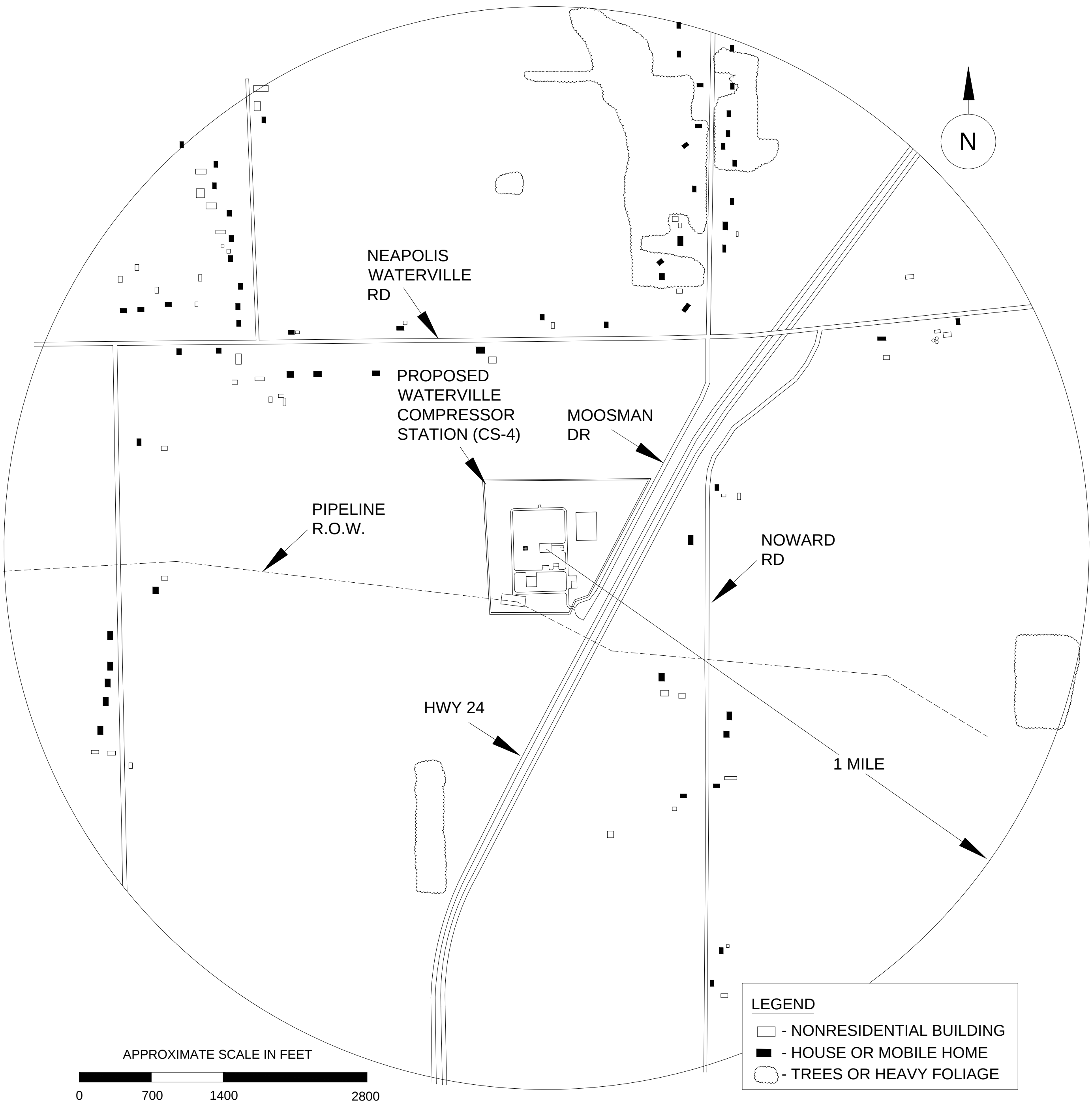

Figure 1: NEXUS Waterville Compressor Station (CS-4): General Area Layout showing the NSAs within 1 Mile of the Station Site and Other Areas of Interest.

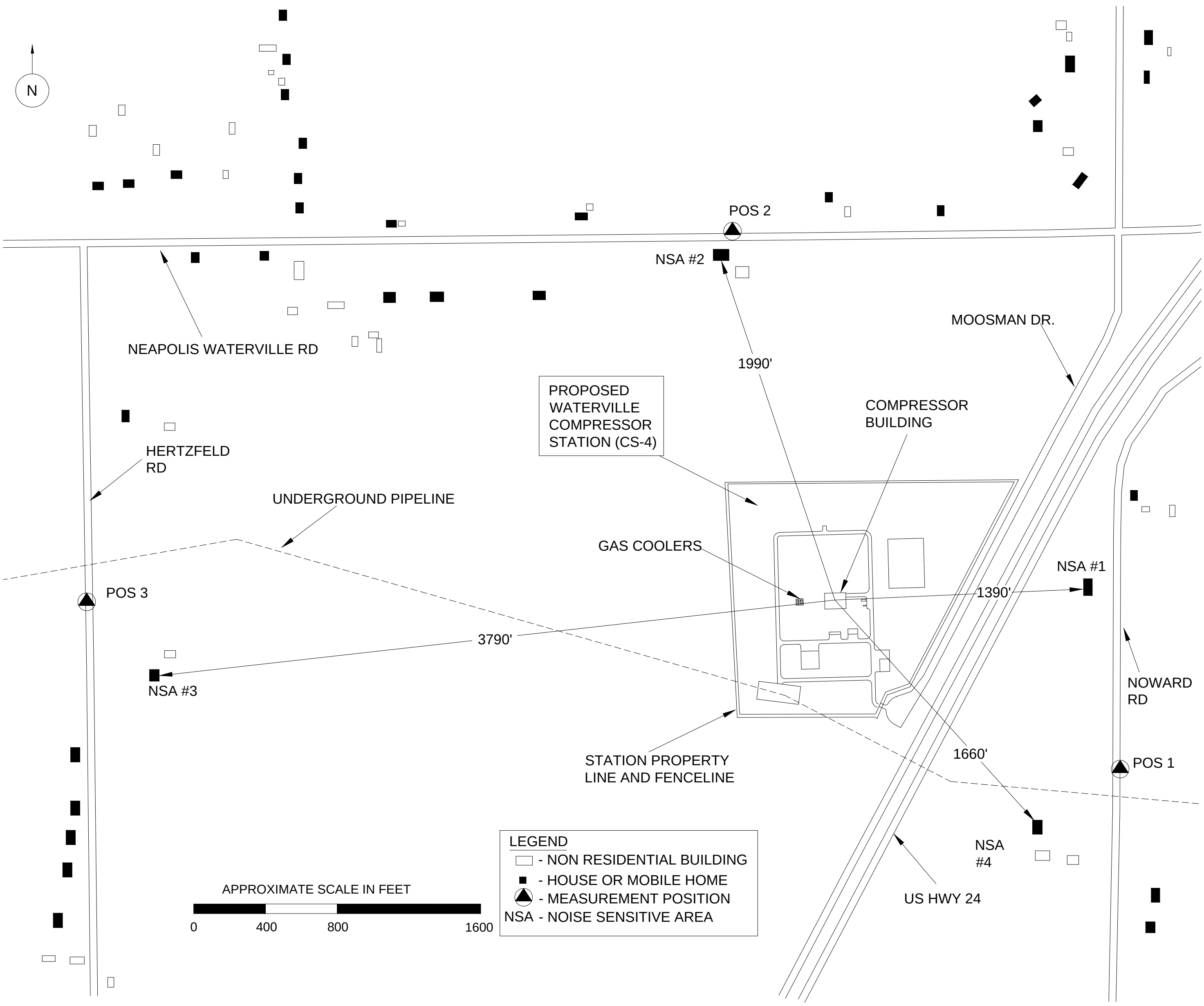

Figure 2: NEXUS Waterville Compressor Station (CS-4): Area Layout showing the Surrounding Closest NSAs, Chosen Sound Measurement Positions near the Closest NSAs and Conceptual Layout of Station Equipment and Buildings.

Measurement Set		Meas'd/Calc'd A-Wt. Levels (dBA)				
Meas. Pos. & NSA	**Time/Date of Test**	Day-time Leq(Ld)	Avg'd of Ld	Night time Leq(Ln)	Calc'd Ldn Note (2)	**Notes/Observations**
Pos. 1 (NSA #1) Residence approx. 1,390 ft. east of the Station Site Center	10:32 AM (2/5/15)	59.6	**59.7**	**51.7** Note (1)	**60.6** Note (2)	Primary noise during tests: noise of vehicle traffic along US Hwy. 24. Ambient levels at identified NSA #4 should be similar to the ambient levels at Pos. 1 (NSA #1).
	10:33 AM (2/5/15)	61.1				
	10:34 AM (2/5/15)	58.4				
Pos. 2 (NSA #2) Residence approx. 1,990 ft. north of the Station Site Center	10:42 AM (2/5/15)	46.4	**44.7**	**41.7** Note (1)	**48.6** Note (2)	Primary noise during tests: noise of vehicle traffic along US Hwy. 24.
	10:45 AM (2/5/15)	44.9				
	10:46 AM (2/5/15)	42.6				
Pos. 3 (NSA #3) Residence approx. 3,790 ft. west of the Station Site Center	10:52 AM (2/5/15)	39.6	**37.5**	**34.5** Note (1)	**41.5** Note (2)	Primary noise during tests: noise of vehicle traffic along US Hwy. 24 and at times, the sound of birds.
	10:53 AM (2/5/15)	36.6				
	10:54 AM (2/5/15)	36.4				

Table A: **Waterville Compressor Station (CS-4): Summary of Ambient Daytime Sound Levels (Ld) at the Closest NSAs, as Meas'd on Feb. 5, 2015, Est'd Nighttime Levels (Ln) and Resulting Ldn.**

Note (1): Nightime sound levels (Ln) were not measured but since there should be less noise during night, the Ln was estimated to provide a representative ambient Ldn (e.g., 3 to 8 dB subtracted from the daytime levels).

Note (2): Ldn calculated by adding 6.4 dB to the measured Ld. If both the Ld and Ln are measured and/or estimated, the Ldn is calculated using the following formula:

$$L_{\mathrm{dn}} = 10\log_{10}\left(\frac{15}{24}10^{L_{\mathrm{d}}/10} + \frac{9}{24}10^{(L_{\mathrm{n}}+10)/10}\right)$$

Measurement Set		Temp.	R.H.	Wind	Wind	Peak	
Meas. Pos.	**Time Frame/Date of Tests**	**(°F)**	**(%)**	**Direction**	**Speed**	**Wind**	**Sky Conditions**
Pos. 1 - 3	10:00 AM to 11:30 AM (2/5/15)	6	58	From the south	0 mph	1 mph	Clear Skies

Table B: **Waterville Compressor Station (CS-4): Summary of the Meteorological Conditions during Ambient Sound Survey on Feb. 5, 2015.**

Measurement Set		Unweighted Sound Pressure Level (SPL) in dB per O.B. Frequency (in Hz)									A-Wt.
Meas. Pos. & NSA	**Time/Date of Test**	31.5	63	125	250	500	1000	2000	4000	8000	**Level**
Pos. 1 (NSA #1)	10:32 AM (2/5/15)	65.3	50.7	47.4	49.1	57.4	57.5	45.9	35.3	27.6	59.6
Residence approx.	10:33 AM (2/5/15)	64.4	49.6	46.2	48.2	58.1	59.4	48.1	35.8	26.6	61.1
1,390 ft. east of the	10:34 AM (2/5/15)	63.2	49.9	52.4	49.0	54.9	56.8	45.4	34.5	26.6	58.4
Station Site Center	**Avg. A-Wt. & SPL**	**64.3**	**50.1**	**48.7**	**48.8**	**56.8**	**57.9**	**46.5**	**35.2**	**26.9**	**59.7**
Pos. 2 (NSA #2)	10:42 AM (2/5/15)	55.9	44.8	43.3	45.0	42.8	43.2	37.2	31.8	26.0	46.4
Residence approx.	10:45 AM (2/5/15)	54.4	46.0	47.3	44.2	44.9	39.9	27.7	21.8	19.8	44.9
1,990 ft. north of the	10:46 AM (2/5/15)	54.4	45.5	45.3	41.6	43.2	36.5	24.8	21.4	19.8	42.6
Station Site Center	**Avg. A-Wt. & SPL**	**54.9**	**45.4**	**45.3**	**43.6**	**43.6**	**39.9**	**29.9**	**25.0**	**21.9**	**44.7**
Pos. 3 (NSA #3)	10:52 AM (2/5/15)	51.2	47.7	47.6	42.7	37.8	31.8	24.5	20.9	19.0	39.6
Residence approx.	10:53 AM (2/5/15)	51.7	46.7	45.3	39.0	33.6	30.2	23.3	18.4	16.5	36.6
3,790 ft. west of the	10:54 AM (2/5/15)	52.2	47.4	45.8	38.9	33.7	28.4	22.6	19.8	17.2	36.4
Station Site Center	**Avg. A-Wt. & SPL**	**51.7**	**47.3**	**46.2**	**40.2**	**35.0**	**30.1**	**23.5**	**19.7**	**17.6**	**37.5**

Table C: **Waterville Compressor Station (CS-4): Measured Ambient Ld and Unweighted Octave-Band ("O.B.") SPLs at the Closest NSAs, as Measured on Feb. 5, 2015.**

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted PWL or SPL in dB per O.B. Center Frequency (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	Calc'd Ldn
1)	PWL of Turbine/Compressor inside Building	108	112	114	116	118	115	115	120	118	125	
	Atten. of Additional Noise Control (Building)	-6	-10	-18	-25	-30	-35	-40	-45	-45		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	-1	-2	-3		
1390	Hemispherical Radiation	-61	-61	-61	-61	-61	-61	-61	-61	-61		
1390	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-11	-19		
1390	Source Sound Level Contribution	41	41	35	30	26	17	9	2	0	27	
2)	PWL of Unsilenced Titan 250 Exhaust (1 Unit)	126	130	128	131	135	130	122	112	102	135	
	Atten. Of Noise Control (Exhaust Muffler)	-5	-16	-25	-40	-45	-45	-45	-35	-25		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	0	0	0		
1390	Hemispherical Radiation	-61	-61	-61	-61	-61	-61	-61	-61	-61		
7	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	0	0	0		
1390	Source Sound Level Contribution	60	53	42	30	29	24	16	16	16	33	
3)	PWL of the LO Cooler (1 Unit)	105	98	92	90	88	86	85	82	75	92	
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	-1	-2	-3		
1390	Hemispherical Radiation	-61	-61	-61	-61	-61	-61	-61	-61	-61		
1390	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-11	-19		
1390	Source Sound Level Contribution	44	37	31	29	26	23	19	9	0	28	
4)	PWL of Outdoor Piping/Components	95	95	98	92	92	105	114	112	105	118	
	Atten. of Noise Control (Acoustical Insulation)	2	2	0	-2	-8	-10	-12	-15	-15		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	-1	-2	-3		
1390	Hemispherical Radiation	-61	-61	-61	-61	-61	-61	-61	-61	-61		
1390	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-2	-1	-2	-4	-11	-19		
1390	Source Sound Level Contribution	36	36	37	27	22	32	37	24	7	39	
5)	PWL of Unsilenced Titan 250 Intake (1 Unit)	116	120	128	129	130	132	135	174	166	175	
	Est'd Attenuation of Intake Silencer System	-2	-6	-15	-20	-25	-30	-40	-60	-50		
	Est'd Attenuation of Air Intake Filter	-1	-4	-6	-15	-20	-25	-28	-30	-30		
1390	Hemispherical Radiation	-61	-61	-61	-61	-61	-61	-61	-61	-61		
1390	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-11	-19		
1390	Source Sound Level Contribution	52	49	46	33	23	14	2	13	6	32	
6)	PWL of Outdoor Gas Aftercooler	115	108	96	94	90	90	88	85	82	95	
	Atten. of Additional Noise Control	0	0	0	0	0	0	0	0	0		
	Misc. Atten. (Foliage, Shielding, Ground Effect)	0	0	0	0	0	0	-1	-2	-3		
1500	Hemispherical Radiation	-61	-61	-61	-61	-61	-61	-61	-61	-61		
1500	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-11	-21		
1500	Source Sound Level Contribution	54	47	34	32	28	27	21	10	0	31	
Est'd Total Sound Contribution of Sources at NSA #1		**62**	**56**	**49**	**38**	**34**	**34**	**37**	**25**	**17**	**41.6**	**48.0**

Ambient Sound Level (Ldn) at the NSA	**60.6**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	60.8
Potential Increase above Ambient Sound Level (dB)	**0.2**

Table D: Waterville Compressor Station (CS-4): Est'd Sound Contribution of the Station at NSA #1 (i.e., Residence located approx. 1,390 Ft. East of the Site Center) assuming Operation of One (1) Solar Titan 250 Turbine-Driven Compressor Unit. In addition, Estimated Increase above the Ambient Sound Level.

NOTE: Muffler DIL & Equipment PWL values on this spreadsheet should <u>not</u> be used as the specified values. Refer to "Noise Control Measures" section in report or other company specifications for actual specified values.

Dist (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt.	
		31.5	63	125	250	500	1000	2000	4000	8000	Level	
	Est'd SPLs of Station at 1,390 Ft. (RE: Table D)	62	56	49	38	34	34	37	25	17	41.6	
1990	Hemisph Radiation [20*log(1990/1390)=3.1 dB]	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1	-3.1		Calc'd
1990	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-8		Ldn
Est'd Total Sound Contribution of Station at NSA #3		**59**	**53**	**45**	**35**	**31**	**30**	**32**	**17**	**6**	**37.4**	**43.8**

Ambient Sound Level (Ldn) at the NSA	**48.6**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	49.9
Potential Increase above Ambient Sound Level (dB)	**1.3**

Table E: Waterville Compressor Station (CS-4): Est'd Sound Contribution of the Station at NSA #2 (i.e., Residence located approx. 1,990 Ft. North of the Site Center) assuming Operation of One (1) Solar Titan 250 Turbine-Driven Compressor Unit. In addition, Estimated Increase above the Ambient Sound Level.

Dist (Ft.)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt.	
		31.5	63	125	250	500	1000	2000	4000	8000	Level	
	Est'd SPLs of Station at 1,390 Ft. (RE: Table D)	62	56	49	38	34	34	37	25	17	41.6	
3790	Hemisph Radiation [20*log(3790/1390)=8.7 dB]	-8.7	-8.7	-8.7	-8.7	-8.7	-8.7	-8.7	-8.7	-8.7		Calc'd
3790	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-2	-4	-7	-18	-33		Ldn
Est'd Total Sound Contribution of Station at NSA #3		**53**	**47**	**39**	**29**	**24**	**22**	**21**	**0**	**0**	**29.6**	**36.0**

Ambient Sound Level (Ldn) at the NSA	**41.5**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	42.6
Potential Increase above Ambient Sound Level (dB)	**1.1**

Table F: Waterville Compressor Station (CS-4): Est'd Sound Contribution of the Station at NSA #3 (i.e., Residence located approx. 3,790 Ft. West of the Site Center) assuming Operation of One (1) Solar Titan 250 Turbine-Driven Compressor Unit. In addition, Estimated Increase above the Ambient Sound Level.

Source No. & Dist (Ft)	Noise Sources and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL in dB per O.B. Center Frequency (Hz)									A-Wt.	
		31.5	63	125	250	500	1000	2000	4000	8000	Level	
	Est'd SPLs of Station at 1,390 Ft. (RE: Table D)	62	56	49	38	34	34	37	25	17	41.6	
1660	Hemisph Radiation [20*log(1660/1390)=1.5 dB]	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5		Calc'd
1660	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-2	-4		Ldn
Est'd Total Sound Contribution of Station at NSA #4		**60**	**54**	**47**	**37**	**33**	**32**	**35**	**22**	**12**	**39.6**	**46.0**

Ambient Sound Level (Ldn) at the NSA	**60.6**
Sound Contribution of Station (Ldn) plus Ambient Sound Level (Ldn)	60.7
Potential Increase above Ambient Sound Level (dB)	**0.1**

Table G: Waterville Compressor Station (CS-4): Est'd Sound Contribution of the Station at NSA #4 (i.e., Residence located approx. 1,660 Ft. SE of the Site Center) assuming Operation of One (1) Solar Titan 250 Turbine-Driven Compressor Unit. In addition, Estimated Increase above the Ambient Sound Level.

DESCRIPTION OF THE ANALYSIS METHODOLOGY AND THE SOURCE OF SOUND DATA USED FOR THE ANALYSIS OF THE STATION COMPRESSOR UNIT

ANALYSIS METHODOLOGY

In general, the predicted sound level contributed by the Station compressor unit was calculated as a function of frequency from estimated unweighted octave-band (O.B.) sound power levels (PWLs) for each significant sound source associated with the compressor unit(s). The following summarizes the analysis procedure for the analysis of the Station compressor unit(s):

- Initially, unweighted O.B. PWLs of the significant noise sources associated with the compressor unit(s) were determined from actual sound level measurements performed by H&K at similar type of gas compressor facilities and/or equipment manufacturer's sound data;

- Then, expected noise reduction (NR) or attenuation in dB per O.B. frequency due to any noise control measures, hemispherical sound propagation (discussed in more detail below*) and atmospheric sound absorption (discussed in more detail below**) were subtracted from the unweighted O.B. PWLs to obtain the unweighted O.B. SPLs of each noise source. Since sound shielding by buildings can influence the sound level contributed at the NSAs, we also included the sound shielding due to buildings, if appropriate. The sound attenuation effect due to vegetation or land contour were typically not considered in the analyses since there appears there could be limited amount of vegetation (e.g., trees) or hills between the site and the nearby NSAs;

- Finally, the resulting estimated O.B. SPLs for all noise sources associated with the compressor units (with noise control and other sound attenuation effects) were logarithmically summed, and the total O.B. SPLs for all noise sources were corrected for A-weighting to provide the estimated overall A-wt. sound level contributed by the compressor unit at the closest NSA to the compressor unit. The predicted sound contribution of the Station at the closest NSA was utilized to estimate the noise contribution of the Station at the other NSAs more distant that the closest NSA.

*Attenuation due to hemispherical sound propagation: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically (i.e., outward, over and above the surface) from the source. The following equation is the theoretical decrease of sound energy when determining the resulting SPLs of a noise source at a specific distance ("r") of a receiver from a source PWL values:

> Decrease in SPL ("hemispherical propagation") from a noise source = **20*log(r) – 2.3 dB**
> where "r" is distance of the receiver from the noise source.

Attenuation due to air absorption: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on the temperature and relative humidity (R.H.) of air and frequency of sound. For example, the attenuation due to air absorption for 1000 Hz O.B. SPL is approximately **1.5 dB per 1,000 feet for standard day conditions (i.e., no wind, 60 deg. F and 70% R.H.).

ANALYSIS METHODOLOGY (NOISE ATTRIBUTABLE TO A BLOWDOWN EVENT)

The noise resulting from a blowdown event was estimated by using the "inverse-square law" and included some attenuation due to atmospheric sound absorption. Consequently, the estimated noise of a blowdown event at the receptor (closest NSA) was calculated as follows:

SPL (receptor) = (Blowdown SPL at R1) – 20*log(R2/R1)– Atm. Atten.= **60 dBA** – 20*log (1390/300)–4 dB = **43 dBA**

Where: R1 = Distance of Specified Blowdown Noise Level Requirement (i.e., 300 ft.)
R2 = Distance of the Receptor from the Blowdown Silencer (1,390 ft.)

SOURCE OF SOUND DATA

The following describes the source of sound data for estimating the source sound levels and source PWLs used in the acoustical analysis for the compressor unit. Note that equipment noise levels utilized in the acoustical analysis (i.e., spreadsheet analysis) are generally higher than the sound level requirement for the equipment to insure that the design incorporates an acoustical "margin of safety."

(1) PWL values of the specific equipment inside the building (i.e., noise of the turbine and compressor) was calculated from sound data measured by H&K on a very similar type of gas compressor installation.

(2) Turbine exhaust PWL values for the Solar turbine were calculated from sound data provided by Solar (i.e., Solar Noise Prediction Manual) and sound data recently measured in the field by H&K on a similar type of turbine installation.

(3) The noise radiated from aboveground gas piping is primarily a result the noise generated by the gas compressors. Consequently, measurement of both near field and far field sound data on gas piping is presumed to be an accurate method of quantifying the noise associated with the new gas piping, and the estimated PWL values for gas piping used in the analysis were determined from near field and far field sound data by H&K on a similar type of compressor to that of the proposed compressor units.

(4) PWL values for the turbine LO cooler(s) and gas aftercooler(s) were designated to meet the design noise goal. Note that the estimated PWL for the cooler(s) utilized in the acoustical analysis assumes some noise associated with piping associated with the coolers. The noise level for the LO cooler and gas aftercooler used in the acoustical analysis is generally higher than the sound level requirement in order that the noise design analysis incorporates an acoustical "margin of safety." In addition, there can be other noise associated with the cooler that is not directly related to the operation of the cooler fans.

(5) PWL values for turbine air intake were calculated from sound data provided by Solar (i.e., Solar Noise Prediction Manual), although low-frequency SPLs were modified as a result of field acoustical tests by H&K.

Type of Equipment	Equipment Power Rating or Capacity	Est'd Number Required	Est'd A-Wt. Sound Level at 50 Ft.: Note (1)	Resulting A-Wt. PWL of Single Piece of Equip.	Assumed Max. No. Operating at One Time	Est'd Max. A-Wt. PWL or Sound Level of Equip.	
Diesel Generator	250 to 400 HP	1 to 2	65 - 70 dBA	102 dBA	1	102	
Bulldozer	250 to 700 HP	1 to 2	75 - 80 dBA	110 dBA	1	110	
Grader	450 to 600 HP	1 to 2	70 - 75 dBA	105 dBA	1	105	
Backhoe	130 to 210 HP	1 to 2	65 - 72 dBA	104 dBA	1	104	
Front End Loader	150 to 250 HP	1 to 2	65 - 70 dBA	102 dBA	1	102	
Truck Loaded	40 Ton	As needed	70 - 75 dBA	105 dBA	1	105	
	Est'd Total Maximum A-Wt. PWL (dBA) of All Construction Site Equipment					113	Calc'd
	Atten. (dB) due to Hemispherical Sound Propagation (1,390 Ft.): Note (2)					-61	Ldn
	Est'd Attenuation (in dB) due to Air Absorption and/or Foliage-Shielding: Note (3)					-5	Note (4)
	Est'd Sound Level (dBA) at Closest NSA (NSA #1) Considering a Maximum Number of Equipment Operating at One Time					47 dBA	45 dBA

Table H: **Waterville Compressor Station (CS-4): Est'd Sound Contribution at the Closest NSA (NSA #1, Residences approx. 1,390 Ft. East of Site Center) during Construction Activity at the Station. Sound Contribution assumes Operation of the "Loudest" Equipment during a Time Frame with the Largest Amount of Equipment Operating (e.g., Site Grading & Clearing/Grubbing)**

Note (1): Noise Emission Levels of construction equipment based on an EPA Report (meas'd sound data for a railroad construction project) and measured sound data in the field by H&K or other published sound data.

Note (2): Noise attenuation due to hemispherical sound propagation: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically from the source.

The following equation is the theoretical decrease of sound energy when determining the resulting SPL of a noise source at a specific distance ("r") of a receiver from a source sound power level (PWL):

Decrease in SPL ("hemispherical propagation") from a noise source = 20*log(r) – 2.3 dB, where "r" is distance of the receiver from the noise source. For example, if the distance "r" is 1,390 feet between the site and closest NSA, the "hemispherical propagation" = **20*log(1,390) – 2.3 dB = 61 dB**.

Note (3): Noise attenuation due to air absorption & foliage: Air absorbs sound energy, and the amount of absorption ("attenuation") is dependent on temperature and relative humidity (R.H.) of the air and the frequency of sound. For standard day conditions (i.e., no wind, 60 deg. F. and 70% R.H.), the attenuation due to air absorption for the medium frequency" (i.e., 1000 Hz O.B. SPL) is approximately **1.5 dB** per 1,000 feet. In addition, foliage such as forest/trees between the Station site and nearby NSAs can have a sound attenuation effect depending on the amount/thickness of the foliage.

Note (4): Calc'd Ldn is approx. 2 dB lower than A-wt. sound level since construction activities will occur only during daytime.

ANALYSIS METHODOLOGY AND SOURCE OF SOUND DATA (CONSTRUCTION ACTIVITIES)

The predicted sound level contributed by the construction-related activity (i.e., construction of the compressor station) was calculated from estimated A-wt. PWL of noise sources (i.e., construction equipment noise) that typically operate during the specific construction activity. The following summarizes the acoustical analysis procedure utilized for the construction activity at the site:

- Initially, the A-wt. PWL of noise sources associated with the construction activity were determined from published sound data and/or actual sound level measurements by H&K, and the total PWL of each noise source (equipment) was based on the anticipated number of equipment operating;

- Next, A-wt. PWL of all sources were logarithmically summed to provide the overall A-wt. PWL contributed by construction activity. It is assumed that the highest level of construction noise would occur during site earth work (i.e., time frame when the largest amount of equipment would operate);

- Finally, the estimated A-wt. sound level of the construction activity at the specific distance was determined by compensating for sound attenuation due to propagation (hemispherical radiation), atmospheric sound absorption and sound attenuation effect of foliage/forest***.

  The noise levels of construction equipment were based on an EPA Report (i.e., measured sound data from railroad construction equipment taken during the Northeast Corridor Improvement Project) that was summarized in a 1995 Report to the Federal Transit Administration as prepared by Harris Miller Miller & Hanson Inc. Also, construction equipment noise levels listed in an article in the Journal of Noise Control Engineering and sound data at a typical compressor station construction site, as measured by H&K, was utilized. The following list some references used by H&K to determine construction equipment noise emission levels:

  (1) "Transit Noise and Vibration Impact Assessment", dated April 1995, prepared by Harris Miller Miller & Hanson Inc. for the Office of Planning of the Federal Transit Administration.
  (2) Erich Thalheimer, "Construction Noise Control Program and Mitigation Strategy at the Central Artery/Tunnel Project", J of Noise Control Eng., 48 (5), pp. 157-165 (2000 Sep-Oct).
  (3) "Noise Control for Building Manufacturing Plant Equipment and Products", course handout notes for a noise course given by Hoover & Keith Inc.

  ***Discussion of noise attenuation due to foliage: Since there will be a substantial amount of trees between the Station and NSAs, the sound attenuation effect of foliage was included. The potential attenuation of foliage, based on our experience and an ISO Standard[1], the "medium-frequency" attenuation (i.e., 1000 Hz) due to forest/trees greater than 500 feet thick is approximately **10 dB**. Consequently, for this Station (i.e., distance of 1,390 feet from closest NSA), the "medium-frequency" air absorption attenuation would be approximately **2 dB**, (i.e., 1.5 dB x 1,390/1000 = 2 dB). Then, adding the attenuation due to foliage (approx. **3 dB**) to the air absorption attenuation, an overall attenuation of **5 dB** was utilized as the estimated attenuation due to air absorption and foliage.

End of Report

[1] ISO Standard 9613-1: 1993 (E), entitled "Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound by the atmosphere, and Part 2: General method of calculation"

APPENDIX 9G

Acoustical Assessment of the M&R Stations Associated with the NEXUS Project

Subject: **Acoustical Assessment of the Meter/Regulator Stations ("M&R Stations") associated with the Proposed NEXUS Gas Transmission Project [Columbiana County (Ohio) and Washtenaw County (Michigan)]**

Prepared for: **Fluor Enterprises, Inc.** (Fluor)
1 Fluor Daniel Drive
Sugar Land, TX 77478

Project Applicant: **NEXUS Gas Transmission, LLC** ("NEXUS")

H&K Report No. 3228
Date of Report: May 29, 2015
Submitted by: Paul D. Kiteck, P.E.**, Hoover & Keith Inc.** (H&K)

1.0 INTRODUCTION

The following report provides the results of an acoustical assessment (i.e., noise impact analysis) of the natural gas meter/regulator stations ("M&R stations") associated with the proposed **NEXUS Gas Transmission Project** ("Project" or "NEXUS Project"). The purpose of the acoustical assessment is to estimate the sound contribution of each Project M&R station at the nearby noise-sensitive areas (NSAs), such as residences, hospitals or schools, and if necessary, provide noise control measures to meet applicable sound level criteria. In addition, ambient sound surveys were conducted to document the noise environment around the Project M&R station sites and verify nearby NSAs around the site of each Project M&R station.

2.0 DESCRIPTION OF THE M&R STATIONS

There are four (4) planned meter/regulator stations ("M&R stations") associated with the Project. For the acoustical assessment in the report, a noise impact analysis was conducted for all M&R stations since all M&R stations have NSAs within ½ mile of the M&R station. The M&R stations will be installed to measure and regulate the gas flow and pressure to and/or from the respective natural gas transmission pipelines. Each M&R station will consist of meter runs with gas flow meters (i.e., metering skid), "regulator runs" designed with flow-control valves ("FCVs") employed for gas flow-control and gas pressure regulation (i.e., regulator skid), isolation block valves and associated instrumentation. The following **Table A** summarizes the M&R stations associated with the Project, general location (i.e., state, county and closest town), observed closest NSA(s) to each M&R station, and distance and direction of the closest NSA. **Table A** also includes the referenced drawing (i.e., "Figure") for each M&R station.

Project M&R Stations	County/State and Other Related Location Information	Brief Description of M&R Station Design, Equipment and Purpose	Closest NSA and Type of NSA	Distance & Direction of Closest NSA	Reference Drawing (Figure)
NEXUS/Tennessee Gas Pipeline ("TGP") M&R Station (MR01)	Columbiana County, OH Near Kensington, OH	Regulator skid and metering skid; receives natural gas from TGP	Residences	850 ft. (west)	Figure 1 (p. 6)
NEXUS/Kensington M&R Station (MR02) and NEXUS/Texas Eastern M&R Station (MR03)	Columbiana County, OH Near Kensington, OH	Two (2) M&Rs at this location; both M&Rs include a regulator skid and a metering skid; receives natural gas from KPP and from TX Eastern Pipeline	Residences	700 ft. (NE)	Figure 2 (p. 7)
NEXUS/Willow Run M&R Station (MR04)	Washtenaw County, MI; Ypsilanti Township, MI	Regulator skid and metering skid; delivers gas to specific customers	Residences	300 ft. (east)	Figure 3 (p. 8)

Table A: Summary of the Project M&R Stations along with Distance/Direction of the Closest NSA(s) to each M&R Station and Ambient Sound Level (per recent Sound Surveys).

3.0 SOUND CRITERIA/GUIDELINES, TYPICAL METRICS AND TERMINOLOGY

For the reader's information, a summary of applicable acoustical terminology and description of metrics used to measure/regulate environmental noise is provided at the end of report (p. 12).

Federal (FERC) Sound Level Guideline/Criterion: The Office of Energy Projects (OEP) of the Federal Energy Regulatory Commission (FERC) require that the sound level attributable to the natural gas compressor station should not exceed a day-night average A-weighted (A-wt.) sound level (expressed as "dBA") of **55 dBA** (i.e., Ldn) at any nearby NSA. The FERC may impose a sound guideline/requirement for an M&R station, and a sound level contribution of **55 dBA** (Ldn) at any nearby NSA is typically used as a "benchmark sound guideline/criterion" for assessing the noise contributed by an M&R station. For an essentially steady sound source that operates continuously over a 24-hour period and controls the environmental sound level, the Ldn is approximately **6.4 dB** above the measured Leq. Consequently, an Ldn of **55 dBA** corresponds to a Leq (e.g., Ld) of **48.6 dBA**. If both the Ld and Ln are measured and/or estimated, then the Ldn is calculated using the following formula:

$$L_{\mathrm{dn}} = 10\log_{10}\left(\frac{15}{24}10^{L_{\mathrm{d}}/10} + \frac{9}{24}10^{(L_{\mathrm{n}}+10)/10}\right)$$

State of Ohio: The State of Ohio or the Ohio EPA does not have regulations related to acceptable noise levels. We understand that sometimes noise level regulations are covered under local ordinances or city codes (e.g., public nuisance and limit excessive noise between certain hours).

Columbiana County and Townships in the County: Columbiana County Code of Ordinances includes "nuisance-type" of noise and vibration requirements for facilities in "Light Industrial Districts", and in summary, states that facilities should not be offensive to the occupants of adjacent premises or the community at large by reason of noise/vibration disturbances. No applicable local/township noise regulations have been identified, although any local noise regulations, if required, will be addressed during the local permitting process.

State of Michigan: Under the State of Michigan Public Service Commission (MPSC) requirements, the noise attributable to an oil or gas surface facility is regulated under Michigan's Oil and Gas Regulations, Rule 324.1015 *Nuisance noise* and Rule 324.1016 *Construction standards for noise abatement at compressors associated with surface facilities*. Note that that MPSC regulations may not be applicable to an interstate natural gas pipeline project. In summary, Rule 324.1015 *Nuisance noise* stipulates that:

- A person shall not cause a *nuisance noise* in the production, handling, or use of oil, gas, or brine or in the handling of any product associated with the production or use of oil, gas or brine. As stipulated in the rule, *"nuisance noise"* means any noise from a well or its associated surface facilities that causes injurious effects to human health or safety or the unreasonable interference with the comfortable enjoyment of life or property;

- Noise attributable to a surface facility must not exceed **45 dBA** at a distance of 1,320 feet;

- The State of Michigan *Supervisor of Wells* is authorized to use administrative controls to require that the surface facility *permittee* measure sound levels at nearby *noise-sensitive areas* and at a distance of 1,320 feet, if the *Supervisor of Wells* receives 1 or more complaints of noise. The State of Michigan *Supervisor of Wells* is authorized to require appropriate noise control measures for a surface facility *permittee* after all applicable information is considered. The State of Michigan *Supervisor of Wells* is authorized to require appropriate noise control measures even if the **45 dBA** noise level at 1,320 feet from the facility is not exceeded (clarification from the MI Dept. of Environmental Quality);

- Rule 324.1016, in summary, stipulates minimum construction standards for noise abatement at surface facilities.

In summary, the State of Michigan requirements stipulate that the noise due to *compressors associated with surface facilities* must not exceed **45 dBA** at 1,320 feet. However, the State regulations also stipulate that appropriate noise control measures can be authorized even if the **45 dBA** noise level at 1,320 feet from the facility is not exceeded. A practical interpretation of this additional stipulation is that if a noise impact is assumed to exist by the State, that they can request additional noise control measures

Ypsilanti (MI) Charter Township Noise Ordinance: The Ypsilanti Charter Township ordinance requirements at the property line (75 decibels daytime/70 decibels nighttime) are specific for land zoned as industrial; however, the existing zoning of the new Willow Run M&R Station may not be zoned industrial. If the land is not zoned industrial, it appears that the property line requirements are reduced to 60 decibels. Please note that we are assuming that decibels imply "dBA".

4.0 AMBIENT SOUND DATA AND MEASUREMENT METHODOLOGY

Ambient sound measurements and verification of NSAs at the M&R station sites were performed by Garrett Porter of H&K during site sound surveys in February, 2015. Ambient sound levels were measured near the closest NSA(s) within ½ mile of each M&R station with NSAs within ½ mile of each M&R station, noting that each Project M&R station has NSAs within ½ mile of the M&R station site. The daytime A-weighted (A-wt.) equivalent sound level ("Leq") and unweighted octave-band (O.B.) sound pressure levels (SPLs) were measured. Sound measurements attempted to exclude extraneous sound such as a vehicle passing immediately by the sound measurement position. The acoustical measurement system consisted of a Rion Model NA-27 Sound Level Meter (a Type 1 "SLM" per ANSI S1.4 & S1.11) equipped with a Rion Model UC-53A microphone with a windscreen. The resulting/reported ambient Ldn is calculated from the measured daytime Leq (i.e., Ld) and estimated nighttime Leq (i.e., Ln), noting that the ambient Ln were not measured but was estimated based on site observations to provide a more accurate representation of the ambient Ldn (i.e., ambient nighttime levels could be lower than the measured daytime levels).

5.0 ACOUSTICAL ASSESSMENT

5.1 General Description of the Acoustical Assessment

In general, the noise generated by an M&R station is typically related to the noise generated by the FCVs (i.e., valve-generated noise) that is radiated from the aboveground gas piping, and the level of piping noise is directly related to the pressure drop ("PD") and gas flow across the FCVs for the regulator runs. In addition, there could be some noise generated by other site equipment (e.g., metering piping). For the assessment of the potential noise emitted by each Project M&R station, we have evaluated the operating condition that could generate the highest amount of noise (i.e., so-called "worst case" condition). The predicted sound contribution was performed only for the closest NSA(s) since the sound contribution at other more distant NSAs should be less than the sound contribution at the closest NSA(s). A description of the acoustical analysis methodology and source of sound data is provided at the end of the report (pp. 11–12).

5.2 Calculation of the Sound Contribution of each Respective M&R Station

The calculation (i.e., spreadsheet analysis) of the A-wt. sound level contribution and unweighted O.B. SPLs of each respective M&R station at the closest NSA is provided on **Table 1** (p. 9), **Table 2** (p. 10) and **Table 3** (p. 10), assuming "worst case" operating conditions (i.e., maximum gas flow and PD across the FCVs), and the analysis assumed that the gas piping run(s) employ a FCV designed to meet **90 dBA** at 1 meter for the "worst-case" operating conditions and other noise control measures (i.e., enclosure covering the regulator skid and covering the metering skid). To reduce computation, it is assumed that if the noise of the M&R station at more distant NSAs will be equal to or less than the resulting M&R station noise at the closest NSA(s).

The following **Table B** summarizes the estimated sound level contribution (i.e., Ldn; as calculated from the estimated A-wt. sound level) for each M&R station at the closest NSA(s) assuming "worst-case" operating conditions and ambient sound level [i.e., ambient Ldn calculated from the measured daytime Leq (i.e., Ld) and estimated nighttime Leq (i.e., Ln)]. The presented results in **Table B** assume the operating conditions that could generate the maximum amount of noise. In addition, the spreadsheet analysis for each respective M&R station is referenced in **Table B**.

Project M&R Stations	Closest NSA and Type of NSA	Distance & Direction of Closest NSA	Ambient Ldn	Calc'd Ldn of M&R Station (via Est'd A-Wt. Level)	Level (Ldn) of M&R Station plus Ambient Level (Ldn)	Increase Above Ambient	Reference Table
NEXUS/TGP M&R Station	Residences	850 ft. (west)	45.0 dBA	32.0 dBA	45.2 dBA	0.2 dB	Table 1 (p. 8)
NEXUS/Kensington M&R and NEXUS/Texas Eastern M&R	Residences	700 ft. (NE)	60.0 dBA	35.5 dBA	60.0 dBA	0.0 dB	Table 2 (p. 8)
NEXUS/Willow Run M&R Station	Residences	300 ft. (east)	54.2 dBA	42.9 dBA	54.5 dBA	0.3 dB	Table 3 (p. 9)

Table B: Summary of the Estimated Sound Level of the M&R Stations at the Closest NSA(s) during "Worst Case" Operation (i.e., Operating Conditions that Generate Maximum Noise).

It is assumed that valve-generated noise will not be notably higher than predicted by the valve manufacturers (e.g., within +/- **5 dB** of the estimated noise levels by the valve manufacturer).

6.0 EQUIPMENT SOUND REQUIREMENTS AND FINAL COMMENT

It is recommended and assumed that the FCVs associated with each M&R station be designed to achieve a maximum **90 dBA** for the full range of operating conditions (i.e., A-wt. sound level generated at 3 feet from the gas piping; downstream of the FCV). In addition, to reduce pipe/valve–radiated noise, we understand that the regulator skid and metering skid will be covered with an enclosure, and it is recommended that the enclosure be an "off-skid" type of acoustically-designed building.

The results of the acoustical assessment indicate that the noise attributable to each respective M&R station associated with the **NEXUS Project** should be lower than an L_{dn} of **55 dBA** at the nearby NSAs if the anticipated noise control measures are employed successfully (i.e., low-noise FCVs and enclosure for the regulator skid and metering skid). It is also expected that the M&R station noise levels will meet any applicable state, county and/or local noise requirements.

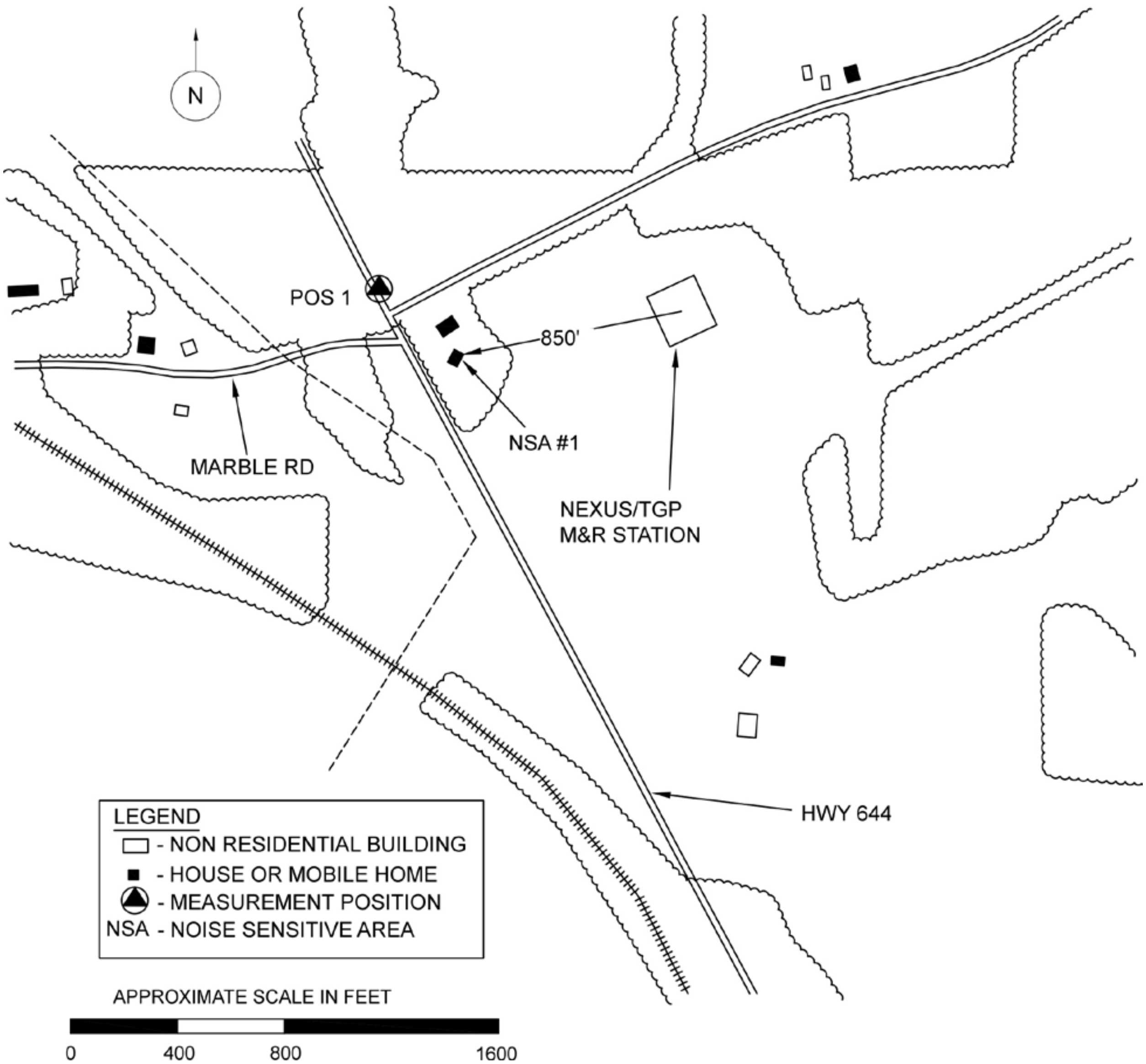

Figure 1: NEXUS Project (NEXUS/TGP M&R Station): Area Layout showing Location of the Nearby NSAs and NSA Sound Measurement Position(s) near the Closest NSA(s).

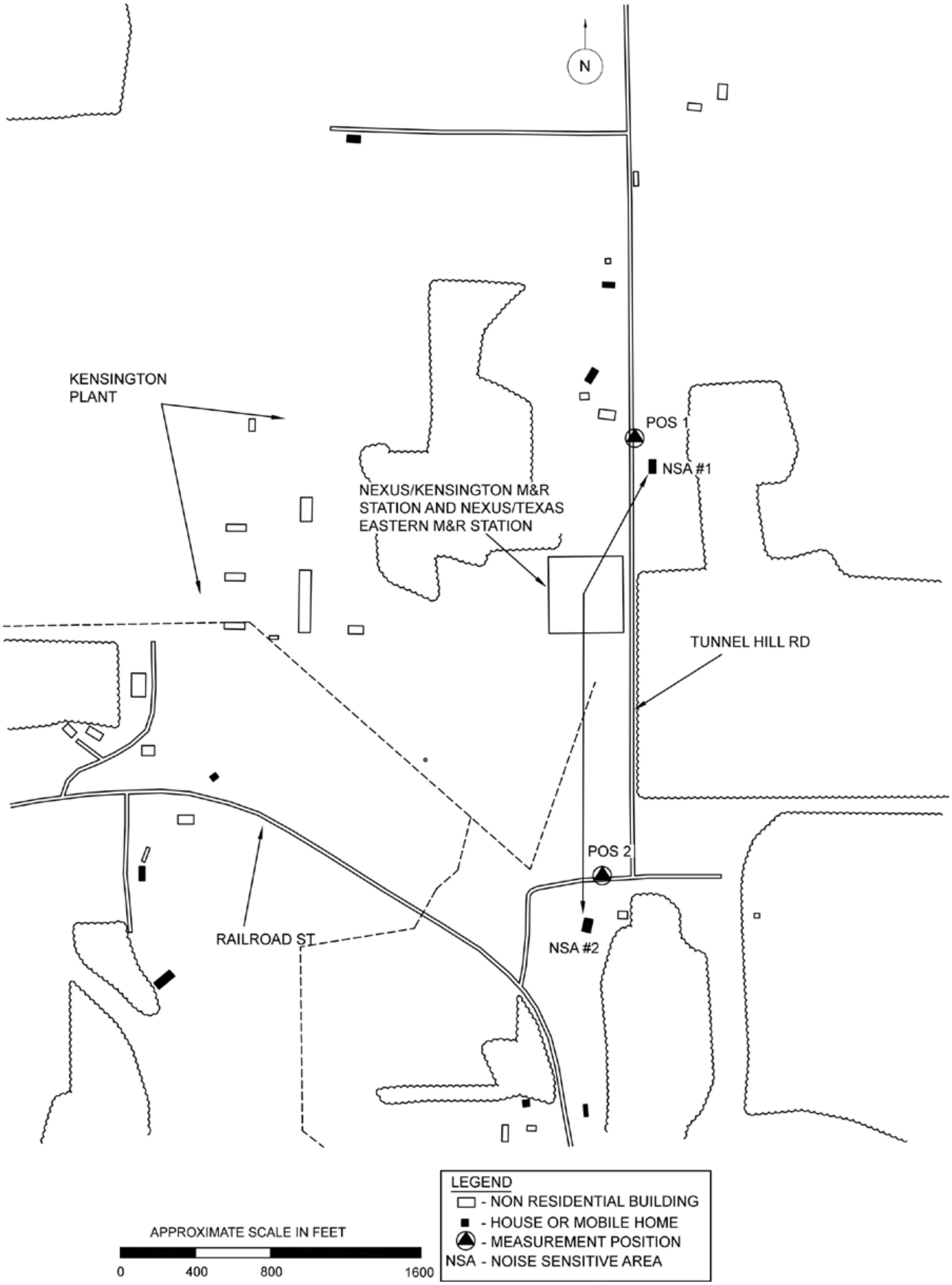

Figure 2: NEXUS Project (NEXUS/Kensington M&R Station and NEXUS/Texas Eastern M&R Station): Area Layout showing Location of the nearby NSAs and Sound Measurement Positions near Closest NSA(s).

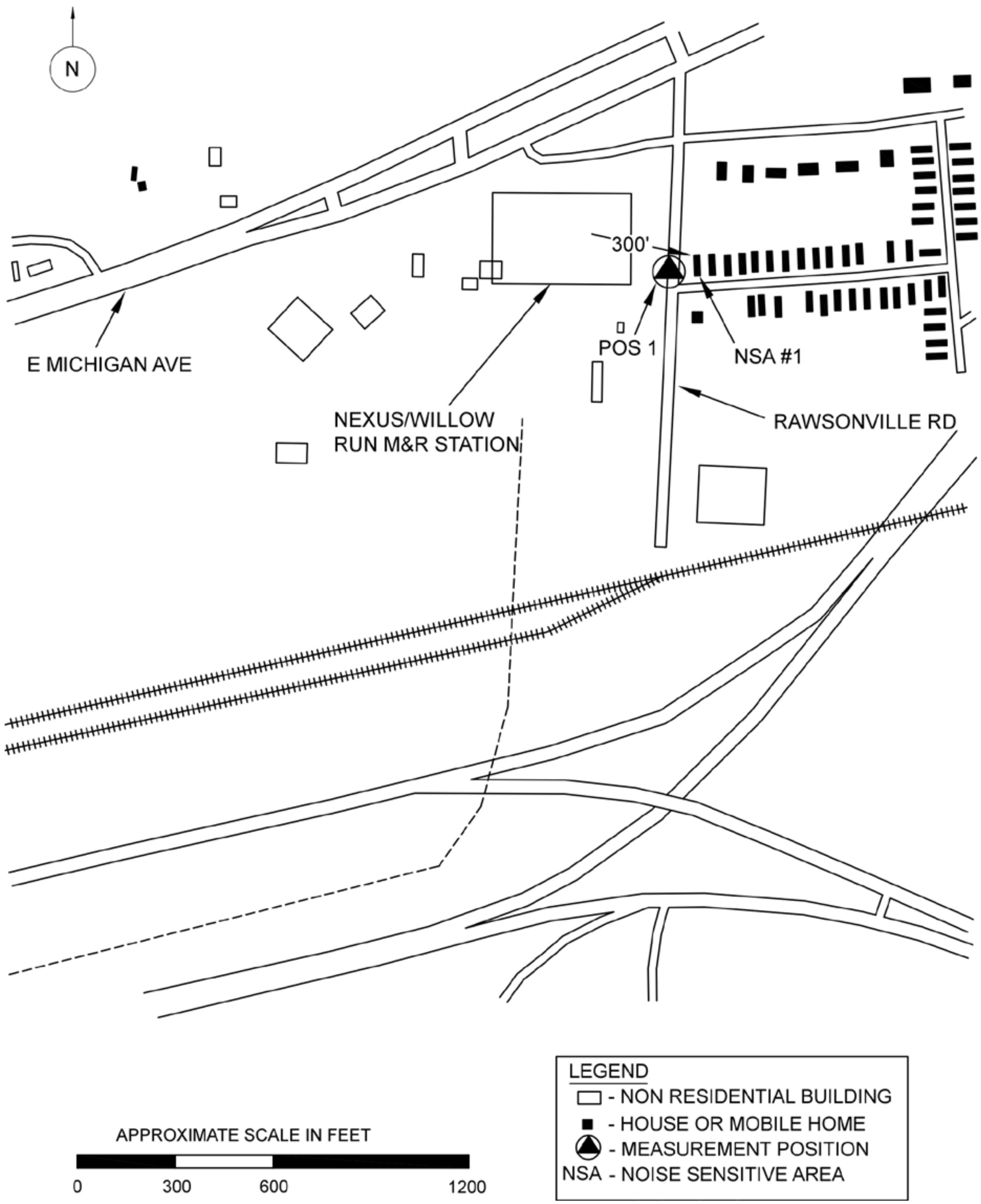

Figure 3: NEXUS Project (NEXUS/Willow Run M&R Station): Area Layout showing Location of the Nearby NSAs and NSA Sound Measurement Position(s) near the Closest NSA(s).

Source PWL and SPL and Other Factors related to the Sound Level Contribution of the Facility during Operation		Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	
Source 1	PWL for Regulator Run(s) on Flow Control Skid	84	81	81	84	94	101	101	96	91	106	
Source 2	PWL of Misc. Equipment/Piping & Metering Skid	80	80	82	84	87	92	92	88	85	97	
	Total PWL of Facility Sources (Sources 1 & 2)	**102**	**98**	**85**	**87**	**95**	**102**	**102**	**97**	**92**	**106**	
	Atten. Of Noise Control (Enclosure for Each Skid)	-2	-6	-10	-12	-16	-20	-22	-25	-25		
	Misc. Atten. (Foliage, Land Contour, Obstructions)	0	0	0	0	0	-1	-2	-3	-3		Calc'd
850	Hemispherical Radiation: Note (1)	-56	-56	-56	-56	-56	-56	-56	-56	-56		Ldn
850	Attn. Due to Atm. Absorption (60 Deg, 70% RH)	0	0	0	0	-1	-2	-3	-7	-12		Note (4)
Est'd Sound Contribution at Closest NSA: Note (2)		**44**	**36**	**18**	**18**	**22**	**23**	**18**	**6**	**0**	**25.6**	**32.0**

Ambient Sound Level (dBA): Note (3)	**45.0**
Est'd Total Sound Level during Operation of M&R Station	**45.2**
Potential Increase above the Ambient Level (dB)	**0.2**

Table 1: NEXUS Gas Transmission Project (NEXUS/TGP M&R Station): Est'd Sound Level Contribution due to the M&R Station at the Closest NSA (i.e., Residences approx. 850 ft. West of the M&R Station Site) assuming Operating Conditions that could generate the "Maximum" Noise Contribution (Maximum Flow Conditions).

Notes: (1) Hemispherical Sound Radiation = 20*log(r) - 2.3 dB (where "r"=distance to source in ft.);
(2) SPL = PWL - (Hemispherical Sound Radiation) - (Atten. Due to Noise Control) - (Atm. Absorption) - (Misc. Attenuation);
(3) Ambient sound level measured by H&K during a 2015 ambient sound survey;
(4) Ldn calculated by adding 6.4 dB to the estimated A-wt. sound level (Leq).

Source PWL and SPL and Other Factors related to the Sound Level Contribution of the Facility during Operation		Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	
Source 1	PWL: Regulator Runs on 2 Flow Control Skids	87	84	84	87	97	104	104	99	94	109	
Source 2	PWL of Misc. Equipment/Piping & Metering Skid	80	80	82	84	87	92	92	88	85	97	
	Total PWL of Facility Sources (Sources 1 & 2)	**88**	**85**	**86**	**89**	**97**	**104**	**104**	**99**	**95**	**109**	
	Atten. Of Noise Control (Enclosure for Each Skid)	-2	-6	-10	-12	-16	-20	-22	-25	-25		
	Misc. Atten. (Foliage, Land Contour, Obstructions)	0	0	0	0	-1	-2	-3	-4	-4		Calc'd
700	Hemispherical Radiation: Note (1)	-55	-55	-55	-55	-55	-55	-55	-55	-55		Ldn
700	Attn. Due to Atm. Absorption (60 Deg, 70% RH)	0	0	0	0	-1	-1	-3	-6	-10		Note (4)
Est'd Sound Contribution at Closest NSA: Note (2)		**31**	**25**	**21**	**22**	**25**	**26**	**22**	**10**	**1**	**29.1**	**35.5**

Ambient Sound Level (dBA): Note (3)	**60.0**
Est'd Total Sound Level during Operation of M&R Station	**60.0**
Potential Increase above the Ambient Level (dB)	**0.0**

Table 2: NEXUS Gas Transmission Project (NEXUS/Kensington M&R Station; NEXUS/Texas Eastern M&R Station): Est'd Sound Level Contribution due to the M&R Stations at Closest NSA (i.e., Residence 700 ft. NE of M&R Stations) during Operating Conditions that could generate "Maximum" Noise Contribution (Maximum Flow Conditions).

Source PWL and SPL and Other Factors related to the Sound Level Contribution of the Facility during Operation		Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	
Source 1	PWL for Regulator Run(s) on Flow Control Skid	84	81	81	84	94	101	101	96	91	106	
Source 2	PWL of Misc. Equipment/Piping & Metering Skid	80	80	82	84	87	92	92	88	85	97	
	Total PWL of Facility Sources (Sources 1 & 2)	**85**	**84**	**85**	**87**	**95**	**102**	**102**	**97**	**92**	**106**	
	Atten. Of Noise Control (Enclosure for Each Skid)	-2	-6	-10	-12	-16	-20	-22	-25	-25		
	Misc. Atten. (Foliage, Land Contour, Obstructions)	0	0	0	0	0	0	-1	-2	-3		Calc'd
300	Hemispherical Radiation: Note (1)	-47	-47	-47	-47	-47	-47	-47	-47	-47		Ldn
300	Attn. Due to Atm. Absorption (60 Deg, 70% RH)	0	0	0	0	0	-1	-1	-2	-4		Note (4)
Est'd Sound Contribution at Closest NSA: Note (2)		**36**	**30**	**27**	**28**	**31**	**34**	**30**	**20**	**13**	**36.5**	**42.9**

Ambient Sound Level (dBA): Note (3)	**54.2**
Est'd Total Sound Level during Operation of M&R Station	**54.5**
Potential Increase above the Ambient Level (dB)	**0.3**

Table 3: NEXUS Gas Transmission Project (NEXUS/Willow Run M&R Station): Est'd Sound Level Contribution due to the M&R Station at the Closest NSA (i.e., Residences approx. 300 ft. East of the M&R Station Site) assuming Operating Conditions that could generate the "Maximum" Noise Contribution (Maximum Flow Conditions).

Description of Acoustical Assessment Methodology and Source of Sound Data

In general, the predicted sound level contributed by a new M&R station was calculated as a function of frequency from estimated unweighted octave-band (O.B.) sound power levels (PWLs) for the M&R station, in which the PWL values were designated to meet the design noise goal (i.e., source of sound data). The following summarizes the acoustical analysis procedure:

- Initially, unweighted O.B. PWL values of the significant noise sources were determined from equipment manufacturer’s sound data and/or actual sound measurements performed by H&K at similar type of natural gas compressor facilities (i.e., M&R station);

- Then, expected noise reduction (NR) or attenuation in dB per O.B. frequency due to any noise control measures, hemispherical sound propagation (discussed in more detail below*) and atmospheric sound absorption (discussed in more detail below**) were subtracted from the unweighted O.B. PWLs to obtain the unweighted O.B. SPLs of each noise source. Since sound shielding by buildings can influence the sound level contributed at the NSAs, we also included the sound shielding due to buildings, if appropriate. Sound attenuation effect due to foliage/trees was also considered in the analysis since there probably will be some sound attenuation due to foliage/trees;

- Finally, the resulting estimated unweighted O.B. SPLs for all noise sources associated with the new M&R station (with any noise control and other sound attenuation effects) were logarithmically summed, and the total O.B. SPLs for all noise sources were corrected for A-weighting to provide the estimated overall A-wt. sound level contributed by the M&R stations at the closest NSA. If necessary, the predicted sound contribution of the new M&R stations at the closest NSA was utilized to estimate the noise contribution at the other nearby NSAs that are more distant that the closest NSA.

*Attenuation due to hemispherical sound propagation: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically (i.e., outward, over and above the surface) from the sound source. The following equation is the theoretical decrease of sound energy when determining the resulting SPL values of a noise source at a specific distance (“r”) of a receiver from the estimated PWL values:

> Decrease in SPL (“hemispherical propagation”) from a noise source = **20*log(r) – 2.3 dB**
> where “r” is distance of the receiver from the noise source.

Attenuation due to air absorption: Air absorbs sound energy, and the amount of absorption (“attenuation”) is dependent on the temperature and relative humidity (R.H.) of air and frequency of sound. For example, the attenuation due to air absorption for 1000 Hz O.B. SPL is approximately **1.5 dB per 1,000 feet for standard day conditions (i.e., no wind, 60 deg. F. and 70% R.H.).

Source of Sound Data

In general, the sound data for estimating the source sound levels and O.B. PWL values utilized in the acoustical analyses are based primarily on measured sound data by H&K at similar installations. For a gas pipeline facilities used solely to regulate gas flow and control gas pressure, the primary source of noise can be valve-generated noise radiated from gas piping, and the level of piping noise is directly related to the pressure drop across the flow-control/regulator valve(s). In addition, if necessary, we utilized the Fisher Sizing Computer Program to substantiate the calculation of valve/piping noise since the primary noise contributor at a typical M&R station is valve-generated noise. Note that the predicted noise level for an M&R station is generally higher than the sound level requirement for the station equipment and components to insure that the design incorporates an acoustical “margin of safety.”

Summary of Typical Metrics and Acoustical Terminology

(1) Daytime Sound Level (L_d) & Nighttime Sound Level (L_n): L_d is the equivalent A-weighted sound level, in decibels, for a 15 hour time period, between 07:00 to 22:00 Hours (7:00 a.m. to 10:00 p.m.). L_n is the equivalent A-weighted sound level, in decibels, for a 9 hour time period, between 22:00 to 07:00 Hours (10:00 p.m. to 7:00 a.m.).

(2) Equivalent Sound Level (L_{eq}): The equivalent sound level (L_{eq}) can be considered an average sound level measured during a period of time, including any fluctuating sound levels during that period. In this report, the L_{eq} is equal to the level of a steady (in time) A-weighted sound level that would be equivalent to the sampled A-weighted sound level on an energy basis for a specified measurement interval. The concept of the measuring L_{eq} has been used broadly to relate individual and community reaction to aircraft and other environmental noises.

(3) Day-Night Average Sound Level (L_{dn}): The L_{dn} is an energy average of the measured daytime L_{eq} (L_d) and the measured nighttime L_{eq} (L_n) plus **10 dB**. The **10-dB** adjustment to the L_n is intended to compensate for nighttime sensitivity. As such, the L_{dn} is not a true measure of the sound level but represents a skewed average that correlates generally with past sound surveys which attempted to relate environmental sound levels with physiological reaction and physiological effects. For a steady sound source that operates continuously over a 24-hour period and controls the environmental sound level, an L_{dn} is approximately **6.4 dB** above the measured L_{eq}. Consequently, an L_{dn} of **55 dBA** corresponds to a L_{eq} of **48.6 dBA**. If both the L_d and L_n are measured, then the L_{dn} is calculated using the following formula:

$$L_{\mathrm{dn}} = 10\log_{10}\left(\frac{15}{24}10^{L_{\mathrm{d}}/10} + \frac{9}{24}10^{(L_{\mathrm{n}}+10)/10}\right)$$

(4) Sound Power Level (L_W or PWL): Ten times the common logarithm of the ratio of the total acoustic power radiated by a sound source to a reference power. A reference power of a picowatt or 10^{-12} watt is conventionally used.

End of Report

APPENDIX 9H

Acoustical Assessment of the Planned HDDs for the Natural Gas Pipeline Systems Associated with the NEXUS Project

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H&K Job No. 4875

Subject: **Acoustical Assessment of the Potential HDDs (Ohio and Michigan) for the new Natural Gas Pipeline System associated with the NEXUS Project**

Prepared for: **Fluor Enterprises, Inc.** (Fluor)
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Sugar Land, TX 77478-3899

Project Applicant: **NEXUS Gas Transmission, LLC** (NEXUS)

H&K Report No. 3229
Date of Report: May 29, 2015
Submitted by: Paul D. Kiteck, P.E.**, Hoover & Keith Inc.** (H&K)

1.0 INTRODUCTION

The following report by **Hoover & Keith Inc.** (H&K) provides the results of an acoustical assessment of the planned horizontal directional drilling (HDD) sites related to the construction of a new natural gas pipeline associated with the **NEXUS Gas Transmission Project** ("Project" or "NEXUS Project") for **NEXUS Gas Transmission, LLC**. The HDD construction technique (i.e., a "trenchless crossing" method) is an alternative to traditional open cut construction and is itself an environmental mitigative measure for avoiding foreign pipelines, utilities and water bodies. As an alternative method to an HDD trenchless crossing method, a direct pipe ("DP") trenchless crossing method can also be employed, which is similar to an HDD except that the pipe is tunneled/thrusted with a "microtunnel boring machine (MTBM)". For the reader's information, a summary of applicable acoustical terminology and typical metrics used to measure and regulate environmental noise is provided at the end of the report (pp. 27–28).

The purpose of the acoustical assessment is to estimate the sound contribution at nearby noise-sensitive areas (NSAs), such as residences, schools or hospitals, resulting from drilling operations at the HDD or DP sites with NSAs within 0.5 mile and present noise mitigation measures to minimize the noise impact of HDD activities if the acoustical assessment indicates that the noise attributable to HDD operations could exceed an equivalent day-night sound level (L_{dn}) of **55 dBA**. Consequently, **55 dBA** (L_{dn}) is considered as the sound criterion for Project HDD operations normally utilized by the Federal Energy Regulatory Commission (FERC), and this sound criterion assumes that HDD operations could be employed for a 24-hour workday.

2.0 DESCRIPTION OF THE HDD SITES

Currently, there are potentially eleven (11) areas associated with the pipeline associated with the Project that will require either an HDD or DP type of pipe crossing although it appears that DP trenchless crossings will not be employed. Based on recent site visits to the area of the potential HDDs by H&K, there are NSAs within 0.5 mile of the entry and exit site for all of the potential HDD crossings. Consequently, a noise impact assessment of the HDD operations are provided for all HDD entry and HDD exit sites that have NSAs. For reference, **Figures 1–11** (pp. 7–17) provides an area layout around the respective HDD crossings, and these drawings show the NSAs within 0.5 mile of the HDD entry and/or exit site of each HDD crossing.

The following **Table A** summarizes the currently planned/potential HDD sites (i.e., HDD segment) along the Project pipeline route. **Table A** also includes the observed nearby NSAs to the HDD entry/exit site along with the distance/direction of the nearby (closest) NSAs and observed obstructions, such as foliage/trees, between the HDD site and the respective NSA that could provide additional attenuation of the HDD noise during HDD activities.

Ref. No.	Identification & Brief Description/Location of HDD or DP Crossing	Entry Exit Site	MP	Approx. Length of HDD	Closest NSA and Type of NSA	Distance & Direction of Closest NSA	Obstructions & Foliage between NSA & HDD Site	Reference Figure in Report
#1	Tuscarawas River HDD	Entry	45.8	2508 ft.	Residence	450 ft. (NW)	Some foliage	Fig. 1 (p. 7)
	Summit County, OH	Exit	46.2		Residence	830 ft. (NW)	Some foliage	Fig. 1 (p. 7)
#2	East Branch Black River HDD	Entry	83.1	1878 ft.	Residence	1,480 ft. (SE)	Significant foliage	Fig. 2 (p. 8)
	Lorain County, OH	Exit	83.5		Residence	770 ft. (W)	Limited foliage	Fig. 2 (p. 8)
#3	West Branch Black River HDD	Entry	88.8	1765 ft.	Residence	790 ft. (SW)	Significant foliage	Fig. 3 (p. 9)
	Lorain County, OH	Exit	89.0		Residence	730 ft. (NW)	Significant foliage	Fig. 3 (p. 9)
#4	Vermillion River HDD	Entry	100.1	2640 ft.	Residences	770 ft. (SW)	Some foliage	Fig. 4 (p. 10)
	Erie County, OH	Exit	100.6		Residence	340 ft. (E)	Significant foliage	Fig. 4 (p. 10)
#5	Huron River HDD	Entry	112.7	2996 ft.	Residence	410 ft. (NE)	Some foliage	Fig. 5 (p. 11)
	Erie County, OH	Exit	113.2		Residence	750 ft. (E)	Significant foliage	Fig. 5 (p. 11)
#6	Sandusky River HDD	Entry	141.1	3225 ft.	Residences	1,150 ft. (ESE)	Limited foliage	Fig. 6 (p. 12)
	Sandusky County, OH	Exit	141.6		Residence	660 ft. (SE)	Foliage & highway	Fig. 6 (p. 12)
#7	Portage River HDD	Entry	157.3	1835 ft.	Residences	600 ft. (NE)	Some foliage	Fig. 7 (p. 13)
	Sandusky County, OH	Exit	157.6		Residence	450 ft. (NW)	Some foliage	Fig. 7 (p. 13)
#8	Maumee River HDD	Entry	175.9	4166 ft.	Residences	980 ft. (SW)	Some foliage	Fig. 8 (p. 14)
	Wood & Lucas County, OH	Exit	176.6		Residence	1,020 ft. (S)	Some foliage	Fig. 8 (p. 14)
#9	Saline River HDD	Entry	231.7	1829 ft.	Residence	550 ft. (NW)	Some foliage	Fig. 9 (p. 15)
	Washtenaw County, MI	Exit	232.0		Residence	720 ft. (S)	Significant foliage	Fig. 9 (p. 15)
#10	Hydro Park HDD	Entry	244.8	2106 ft.	Residences	1,420 ft. (NE)	Foliage & highway	Fig. 10 (p. 16)
	Washtenaw County, MI	Exit	245.2		Residence	1,040 ft. (NE)	Significant foliage	Fig. 10 (p. 16)
#11	Interstate 94 (I-94) HDD	Entry	245.6	1661 ft.	Residence	220 ft. (NW)	Some foliage	Fig. 11 (p. 17)
	Washtenaw County, MI	Exit	245.9		Residences	250 ft. (W)	Some foliage	Fig. 11 (p. 17)

Table A: Summary of the HDD Crossings for new Pipeline Sections associated with the Project along with the Distance/Direction of the Closest NSA(s) to the Respective HDD Entry or Exit Site

3.0 AMBIENT SOUND SURVEYS AND SOUND MEASUREMENT METHODOLOGY

The measurement of the ambient sound levels and verification of NSAs around the potential HDD sites was performed by Garrett Porter of H&K in March, 2015. Ambient daytime sound levels (Ld) were measured at the closest NSA(s) to each potential HDD site. The ambient nighttime levels (Ln) were not measured but were estimated based on site observations to provide a more accurate representation of the ambient Ldn i.e., Ln could be lower than the measured Ld). At each measurement location, the A-weighted (A-wt.) equivalent sound level (Leq) and related unweighted octave-band (O.B.) sound pressure levels (SPLs) were measured. The acoustical measurement system consisted of a Rion Model NA-27 Sound Level Meter (a Type 1 "SLM" per ANSI S1.4 & S1.11) equipped with a Rion Model UC-53A microphone with a windscreen. The SLM was calibrated with a microphone calibrator (calibrated within 1 year of the test date).

4.0 HDD EQUIPMENT AND ACOUSTICAL ASSESSMENT OF PROJECT HDDs

The spreadsheet analyses (i.e., acoustical calculations) of the estimated A-wt. sound level contributed by the HDD operations during peak operating conditions associated with the planned HDD sites at the closest NSA to either the HDD entry or HDD exit site are provided in **Tables 1–22** (pp. 18–25), and it is assumed that the HDD operations could be employed for a 24-hour workday. For reference, a description of the acoustical analysis methodology and the source of sound data are provided at the end of the report (pp. 26–27) along with a brief summary of acoustical metrics and terminology associated with this acoustical assessment.

The following denotes the typical equipment at the HDD entry site and most of the listed equipment are considered noise sources associated with the HDD operations:

- Drilling rig and associated engine-driven hydraulic power unit (i.e., significant noise source);
- Engine-driven mud pump(s) and engine-driven generator set(s);
- Mud mixing/cleaning equipment and associated fluid systems shale shakers;
- Crane, backhoe, frontloader, forklift and/or truck(s); and
- Frac tanks (i.e., water & drilling mud storage); engine-driven light plants (nighttime operation).

The following denotes the typical equipment at the HDD exit site and most of the listed equipment are considered noise sources, noting that the noise generated at the HDD exit site is significantly lower than the noise generated at the HDD entry site:

- Backhoe, sideboom, backhoe and/or trucks;
- Possibly one (1) engine-driven generator set; possibly "small" engine-driven pump; and
- Engine-driven light plants (used for nighttime operation).

The following **Table B** summarizes the estimated sound level (Ldn) of drilling operations, as calculated from estimated A-wt. sound level, at the closest NSA(s) to each respective HDD site with NSAs within 0.5 mile of either the HDD entry or HDD exit site. In addition, **Table B** denotes those sites in which the sound level criterion could be exceeded during the HDD operations.

Ref. No.	HDD or DP Crossing	Entry or Exit Site	Closest NSA	Distance & Direction of NSA	Exceed Noise Criterion	Ambient Ldn (dBA)	Sound Level (Ldn) of HDD (dBA)	Ldn of HDD + Ambient (dBA)	Increase Above Ambient (dB)	Reference Noise Analysis Table
#1	Tuscarawas River	Entry	Residence	450 ft. (NW)	**Yes**	42.6	66.9	67.0	24.4	Table 1 (p. 18)
	HDD	Exit	Residence	830 ft. (NW)	**No**	43.3	49.4	50.4	7.1	Table 2 (p. 18)
#2	East Branch Black	Entry	Residence	1,480 ft. (SE)	**No**	40.2	53.1	53.3	13.1	Table 3 (p. 18)
	River HDD	Exit	Residence	770 ft. (W)	**No**	41.2	48.3	49.1	7.9	Table 4 (p. 19)
#3	West Branch Black	Entry	Residence	790 ft. (SW)	**Yes**	41.1	61.5	61.5	20.4	Table 5 (p. 19)
	River HDD	Exit	Residence	730 ft. (NW)	**No**	43.6	47.8	49.2	5.6	Table 6 (p. 19)
#4	Vermillion River	Entry	Residence	770 ft. (SW)	**Yes**	38.7	61.7	61.7	23.0	Table 7 (p. 20)
	HDD	Exit	Residence	340 ft. (E)	**Yes**	41.2	59.6	59.7	18.5	Table 8 (p. 20)
#5	Huron River HDD	Entry	Residence	410 ft. (NE)	**Yes**	55.8	65.5	66.0	10.2	Table 9 (p. 21)
		Exit	Residence	750 ft. (E)	**No**	56.4	50.4	57.4	1.0	Table 10 (p. 21)
#6	Sandusky River	Entry	Residence	1,150 ft. (ESE)	**No**	63.8	53.7	64.2	0.4	Table 11 (p. 21)
	HDD	Exit	Residence	660 ft. (SE)	**No**	56.0	51.7	57.4	1.4	Table 12 (p. 22)
#7	Portage River HDD	Entry	Residence	600 ft. (NE)	**Yes**	42.3	64.2	64.2	21.9	Table 13 (p. 22)
		Exit	Residence	450 ft. (NW)	**No**	44.1	53.5	53.9	9.8	Table 14 (p. 22)
#8	Maumee River HDD	Entry	Residence	980 ft. (SW)	**Yes**	45.3	59.3	59.5	14.2	Table 15 (p. 23)
		Exit	Residences	1,020 ft. (S)	**No**	43.6	47.4	48.9	5.3	Table 16 (p. 23)
#9	Saline River HDD	Entry	Residence	550 ft. (NW)	**Yes**	40.8	63.1	63.1	22.3	Table 17 (p. 23)
		Exit	Residence	720 ft. (S)	**No**	46.3	50.8	52.1	5.8	Table 18 (p. 24)
#10	Hydro Park HDD	Entry	Residence	1,420 ft. (NE)	**No**	49.0	53.5	54.8	5.8	Table 19 (p. 24)
		Exit	Residences	1,040 ft. (NE)	**No**	53.1	45.3	53.8	0.7	Table 20 (p. 24)
#11	I-94 HDD	Entry	Residence	220 ft. (NW)	**Yes**	51.1	75.1	75.1	24.0	Table 21 (p. 25)
		Exit	Residence	250 ft. (W)	**Yes**	60.6	62.2	64.5	3.9	Table 22 (p. 25)

Table B: Summary of the Estimated Sound Level Contribution of the Planned HDD Sites and assuming that No Additional Noise Mitigation Measures ("Standard HDD Rig/Equipment" Employed).

In summary, the acoustical assessment indicates that the noise of HDD operations at several of the HDD entry and/or HDD exit sites for the planned HDD crossings could exceed the sound level criterion at the closest NSAs if no additional noise mitigation measures are employed.

5.0 NOISE MITIGATION MEASURES/OPTIONS FOR HDDs THAT COULD EXCEED CRITERION

Since the sound criterion could be exceeded if no additional mitigation measures are employed at the Project HDD entry sites, it is necessary to develop a noise mitigation plan to reduce the noise of the HDD stationary equipment operations. Reducing the noise of mobile equipment is more difficult since mobile equipment may work outside the general HDD workspace. The following summarizes noise mitigation options that could be employed primarily at the HDD entry site, noting that employing full temporary on-site enclosures for primary equipment (e.g., hydraulic power unit) may not be feasible due to equipment cooling requirements and associated costs.

- Employ a temporary noise barrier (for example, 16 ft. height) around the entry site workspace constructed of 0.75 inch thick plywood panels or constructed of a sound-absorptive/barrier material designed with a septum mass layer with a minimum STC 20–31 rating;

- As an alternative to a workspace barrier, the entry side workspace could be covered with a large acoustically-lined tent (identified as a "noise-reducing tent") designed with sound-absorptive/barrier liner material with a minimum STC 20–31 rating;
- Employ residential–grade exhaust silencers on all engines in conjunction with any of the site HDD equipment (e.g., generators, pumps and hydraulic power unit);
- Partial noise barrier or enclosure around the hydraulic power unit and engine-driven pumps by covering the sides of the equipment with an acoustically-lined plywood barrier system or sound-absorptive/barrier material with a minimum STC 20–31 rating (employing a full enclosure can be difficult and expensive due to equipment cooling requirements);
- Employ a partial noise barrier around any engine jacket-water coolers;
- Install a partial barrier or partial enclosure around the mud mixing/cleaning system;
- Relocate specific equipment (e.g., remotely relocate mud rig);
- Employ low-noise generators, which are designed with a factory-installed enclosure;
- As an alternative to noise mitigation at NSA(s) that are relatively close to the HDD sites, sometimes temporary housing or equivalent monetary compensation could be discussed and/or offered to the affected landowners.

- For an HDD exit site in which the sound criterion could be exceeded, the most practical noise mitigation method is to employ a temporary noise barrier at the workspace (between site equipment and closest NSAs), since an exit site includes mostly mobile equipment;

For the HDD sites in which the sound criterion could be exceeded with no additional noise mitigation, the following **Table C** summarizes the projected sound level of HDD operations at the closest NSAs for the HDD sites in which additional noise mitigation measures are assumed to be employed to meet the sound criterion. The additional noise mitigation measures that were assumed for the HDD operations are summarized in the respective noise analysis tables, as referenced in **Table C**.

Ref. No.	HDD or DP Crossing	Entry or Exit Site	Closest NSA	Distance & Direction of NSA	Ambient Ldn (dBA)	Sound Level (Ldn) of HDD (dBA)	Ldn of HDD + Ambient (dBA)	Increase Above Ambient (dB)	Reference Noise Analysis Table
#1	Tuscarawas River HDD	Entry	Residence	450 ft. (NW)	42.6	54.1	54.4	11.8	Table 3 (p. 18)
#3	W. Branch Black River HDD	Entry	Residence	790 ft. (SW)	41.1	49.5	50.1	9.0	Table 5 (p. 19)
#4	Vermillion River HDD	Entry	Residence	770 ft. (SW)	38.7	49.8	50.1	11.4	Table 7 (p. 20)
#4	Vermillion River HDD	Exit	Residence	340 ft. (E)	41.2	50.4	50.9	9.7	Table 8 (p. 20)
#5	Huron River HDD	Entry	Residence	410 ft. (NE)	55.8	53.4	57.8	2.0	Table 9 (p. 21)
#7	Portage River HDD	Entry	Residence	600 ft. (NE)	42.3	51.2	51.7	9.4	Table 13 (p. 22)
#8	Maumee River HDD	Entry	Residence	980 ft. (SW)	45.3	47.5	49.5	4.2	Table 15 (p. 23)
#9	Saline River HDD	Entry	Residence	550 ft. (NW)	40.8	51.1	51.5	10.7	Table 17 (p. 23)
#11	I-94 HDD	Entry	Residence	220 ft. (NW)	51.1	53.8	55.6	4.5	Table 21 (p. 25)
#11	I-94 HDD	Exit	Residence	250 ft. (W)	60.6	52.0	61.2	0.6	Table 22 (p. 25)

Table C: Summary of the Estimated Sound Contribution of HDD Operations at the Closest NSA(s) assuming that Noise Mitigation Measures are employed to meet the Sound Criterion.

In addition to additional noise mitigation measures, nearby NSAs will be notified in advance of planned nighttime construction activities, advising them that noise-generating equipment may be operated during nighttime hours. Since mitigated noise levels attributable to HDD are anticipated to be below the FERC sound criterion at any NSAs, overnight construction, if necessary, is not expected to create significant impacts on surrounding NSAs. If the noise levels cannot be reduced to target levels, then temporary housing could be offered to the occupants of affected NSAs in the Project area until the construction activities are completed.

6.0 SUMMARY AND FINAL COMMENT

The acoustical assessment indicates that the noise attributable to the HDD operations at some of the HDD entry and exit sites associated with the pipeline construction for the **NEXUS Project** could exceed the sound level guideline of **55 dBA** (Ldn) at the closest NSAs. As a result, feasible noise mitigation measures/options are discussed which could be implemented during drilling activity to reduce the noise at the nearby NSAs associated with the HDD operations. Consequently, if adequate noise mitigations are successfully employed, the sound level due to HDD operations at the HDD construction sites should not exceed **55 dBA** (Ldn) at the NSAs, which is the FERC sound level guideline for project HDD operations. After the final pipeline route has been established and the actual required HDD sites have been selected, it is anticipated that specific noise mitigation measures that will be implemented for those HDD sites that could exceed the sound criterion will be evaluated and confirmed.

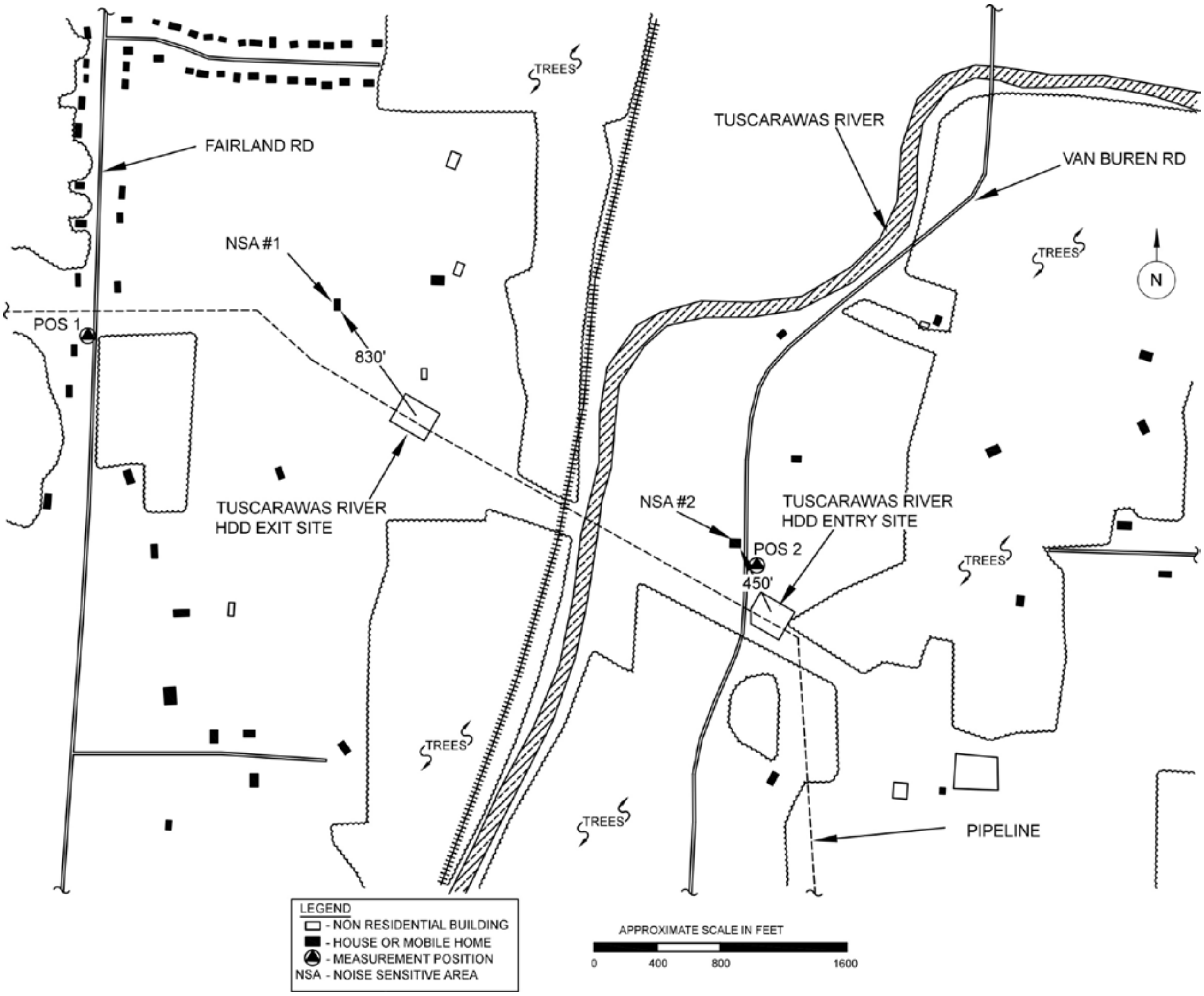

Figure 1: NEXUS Project [HDD #1 (Tuscarawas River HDD Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Locations and nearby NSA(s).

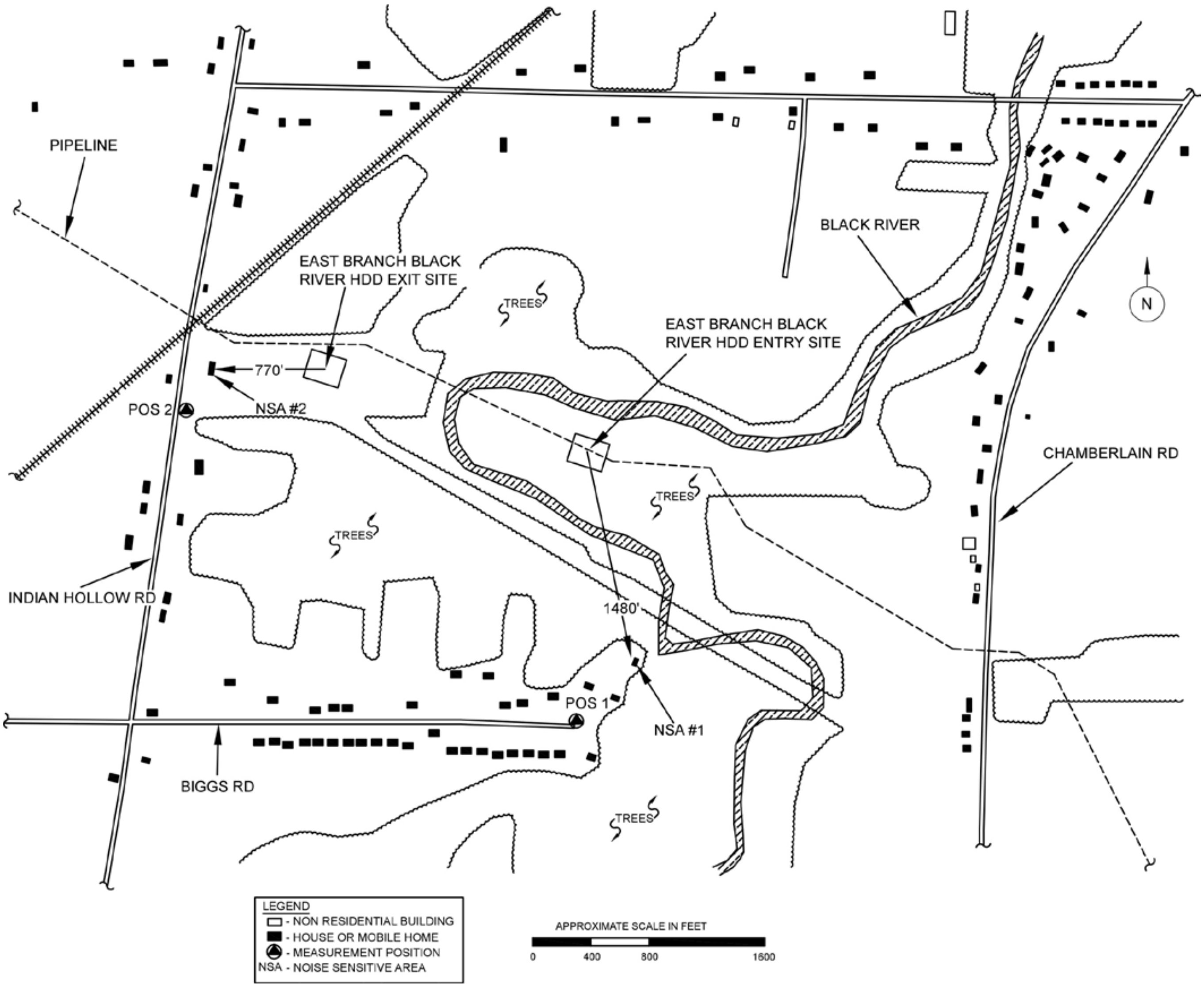

Figure 2: NEXUS Project [HDD #2 (East Branch Black River HDD Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Locations and nearby NSA(s).

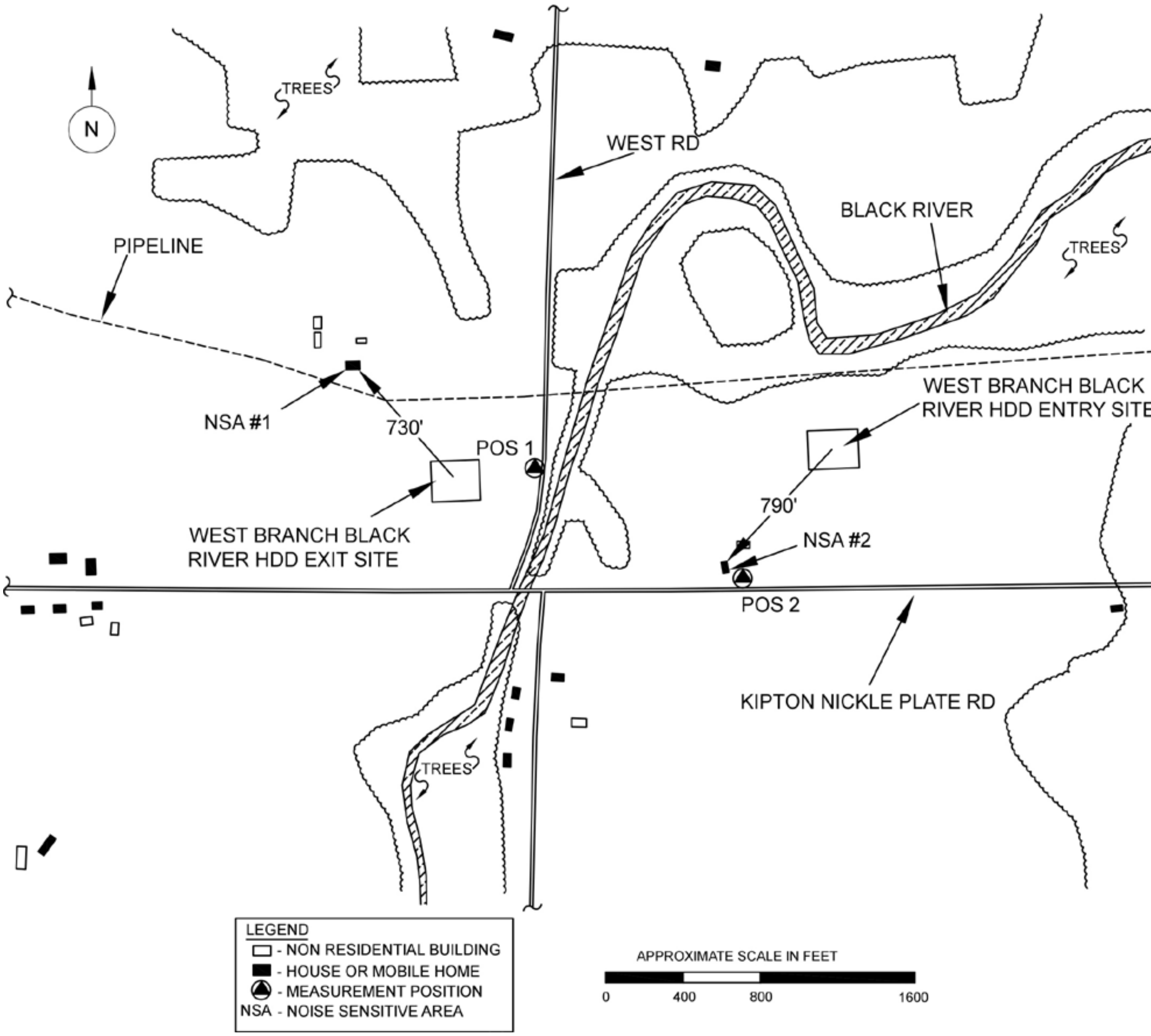

Figure 3: NEXUS Project (HDD #3 (West Branch Black River HDD Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Locations and nearby NSA(s).

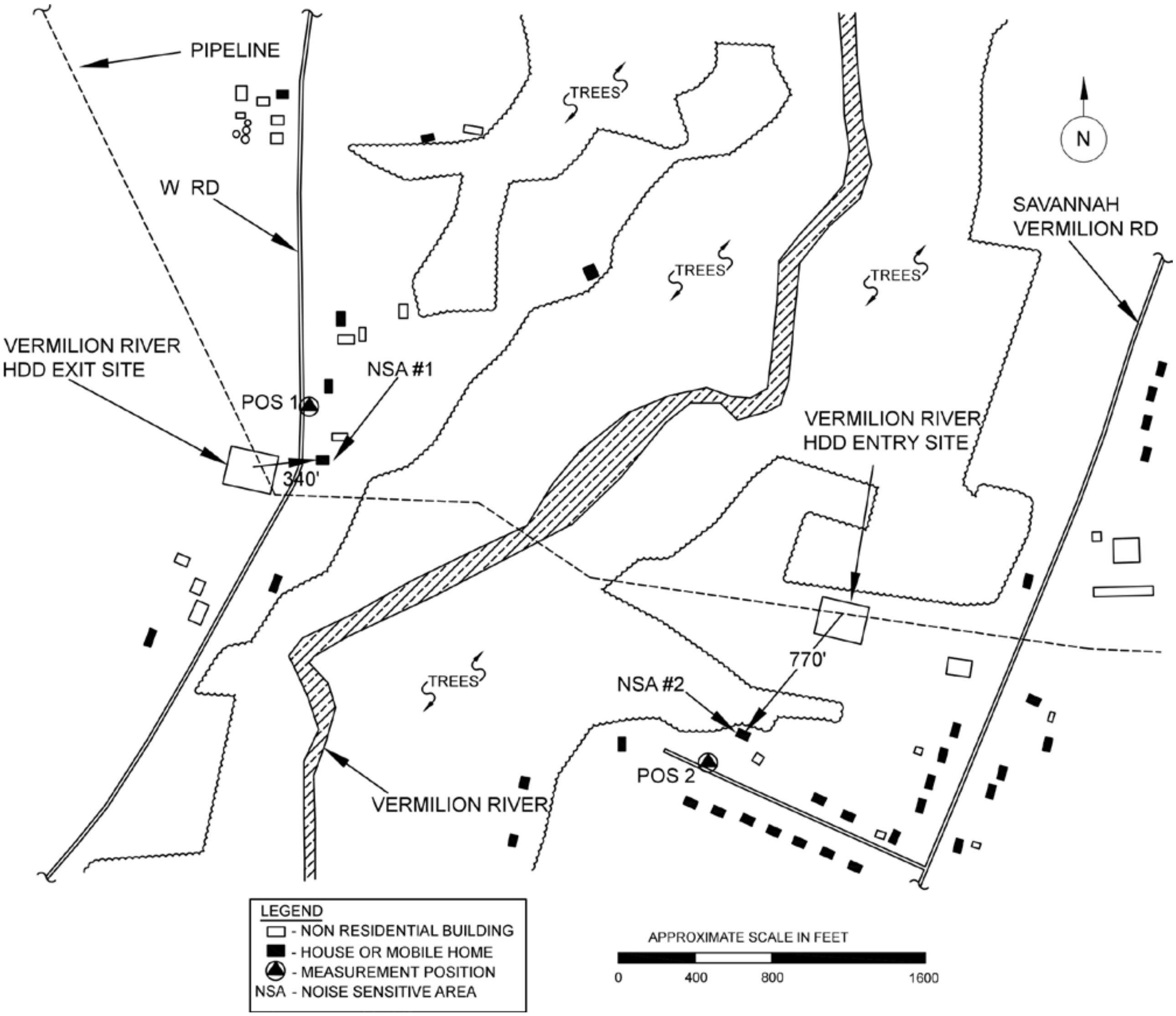

Figure 4: NEXUS Project [HDD #4 (Vermillion River HDD Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Locations and nearby NSA(s).

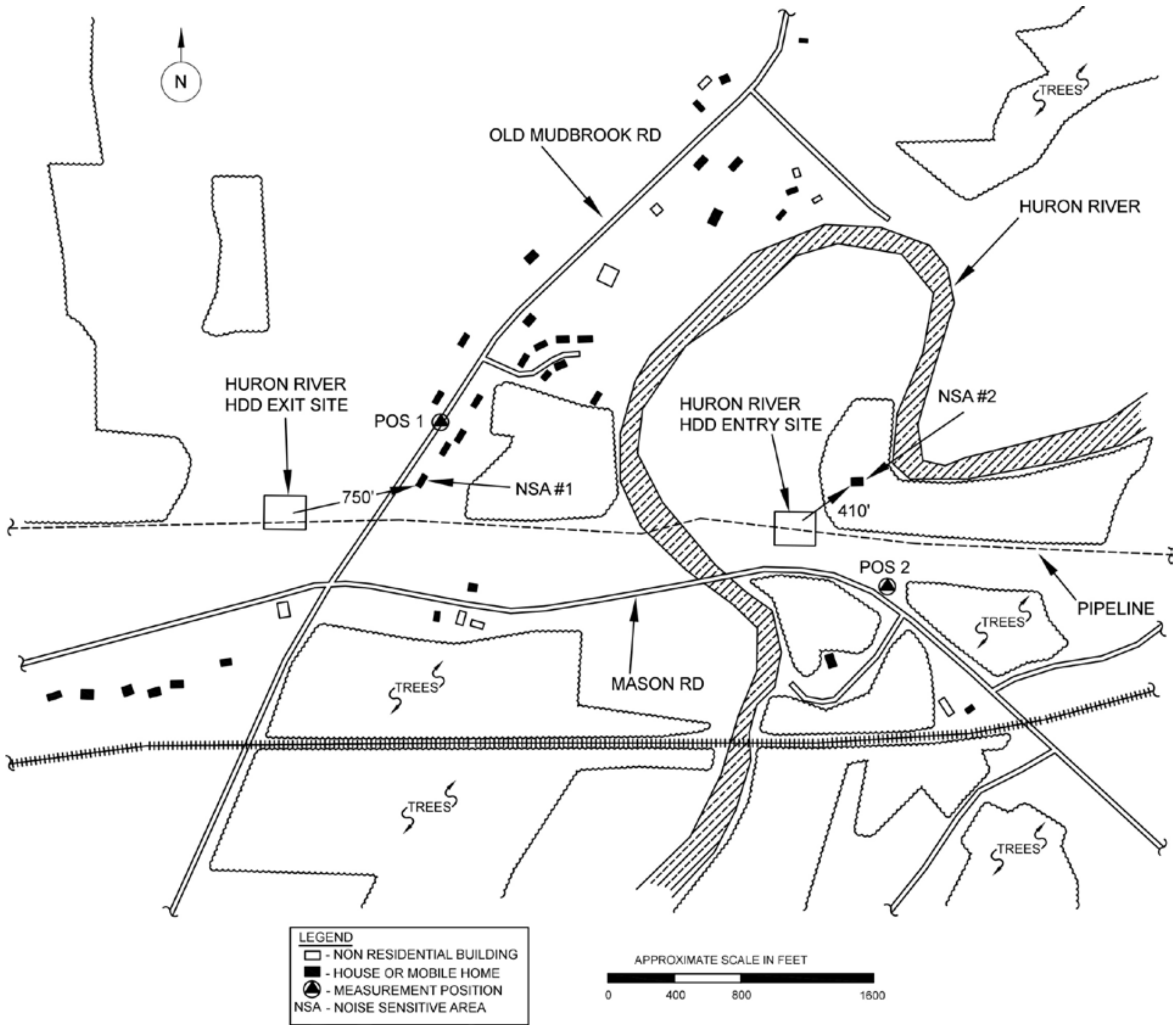

Figure 5: NEXUS Project [HDD #5 (Huron River HDD Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Locations and nearby NSA(s).

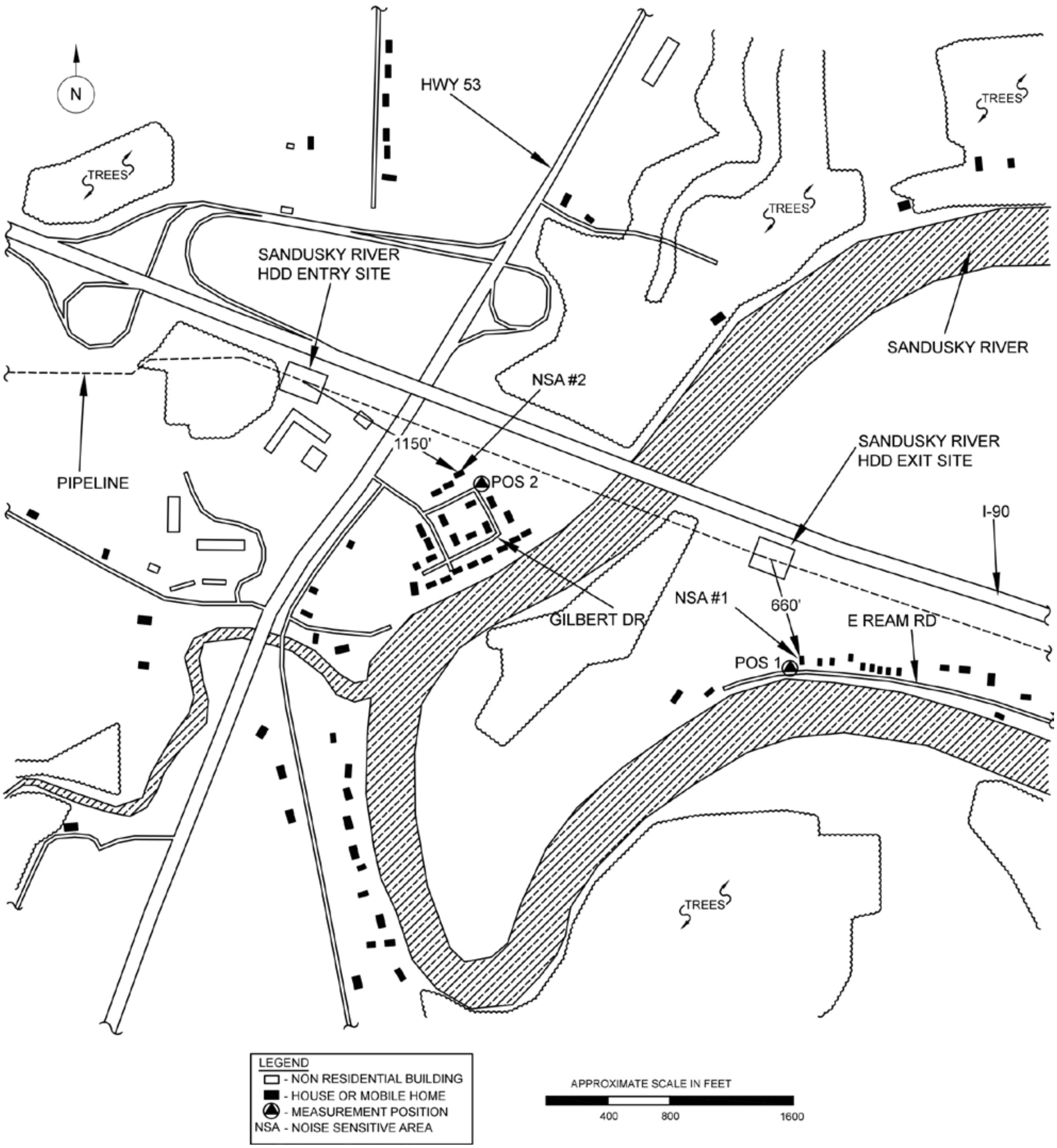

Figure 6: NEXUS Project [HDD #6 (Sandusky River HDD Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Locations and nearby NSA(s).

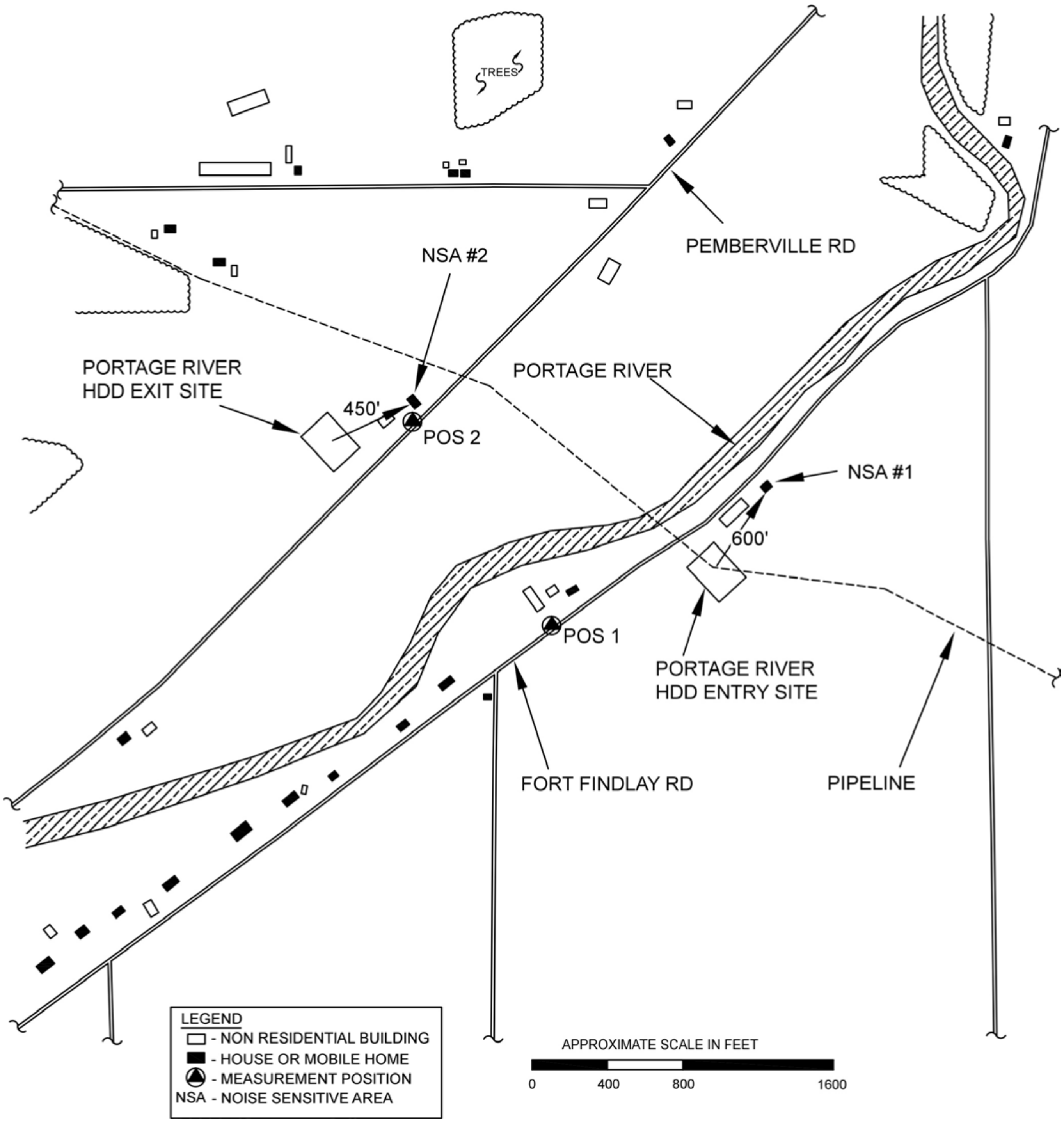

Figure 7: NEXUS Project [HDD #7 (Portage River HDD Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Locations and nearby NSA(s).

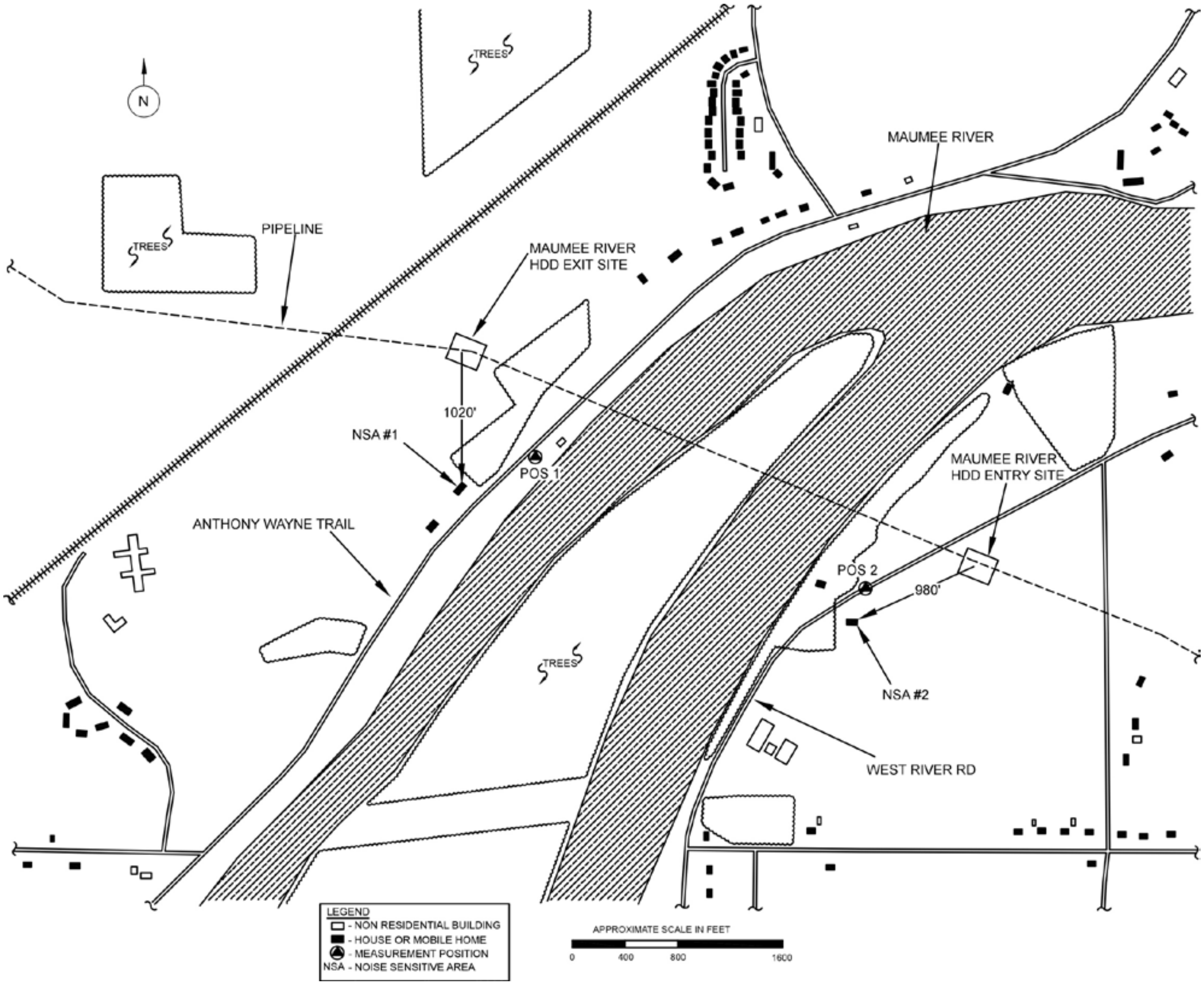

Figure 8: NEXUS Project [HDD #8 (Maumee River HDD Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Locations and nearby NSA(s).

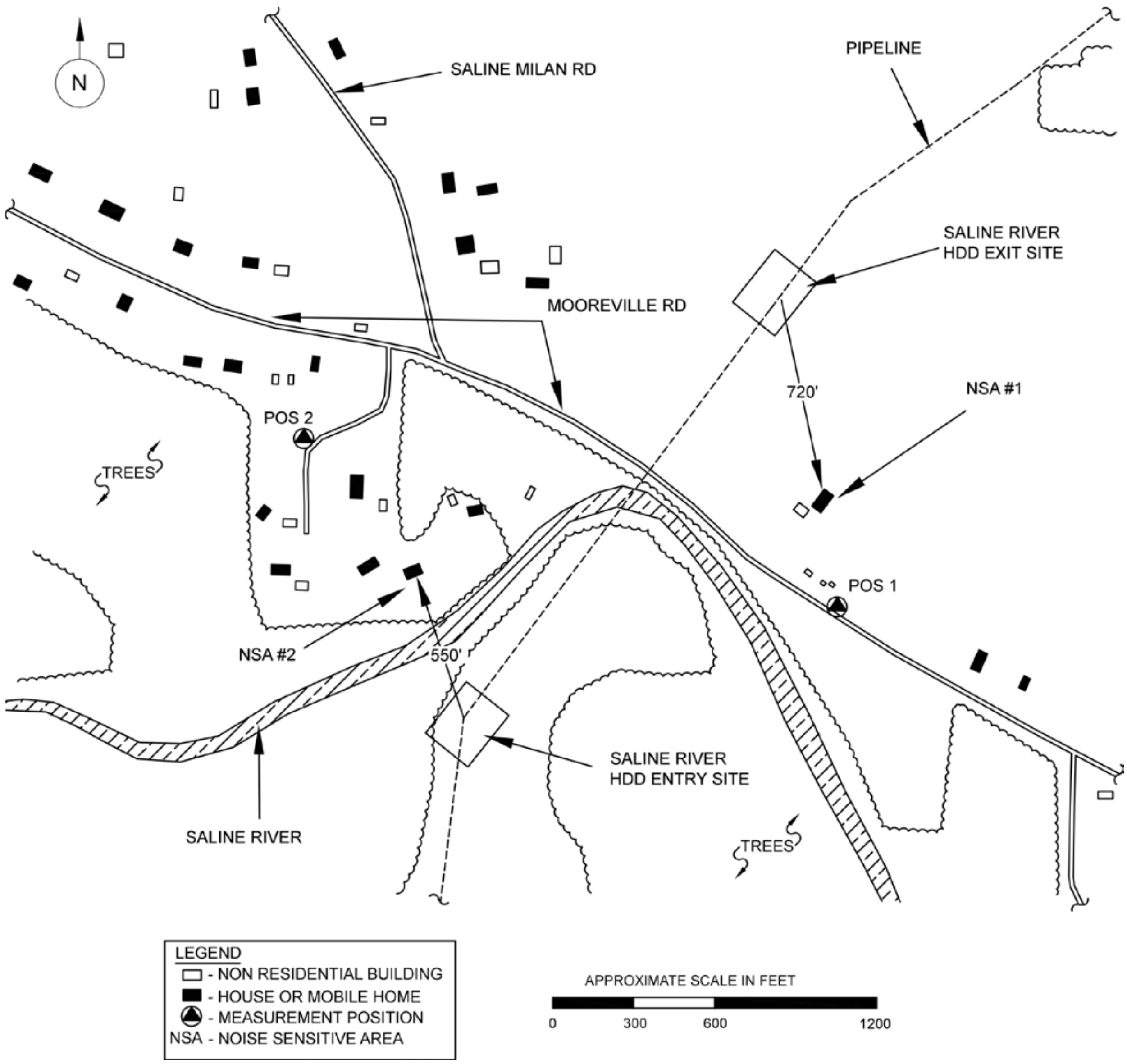

Figure 9: NEXUS Project [HDD #9 (Saline River HDD Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Locations and nearby NSA(s).

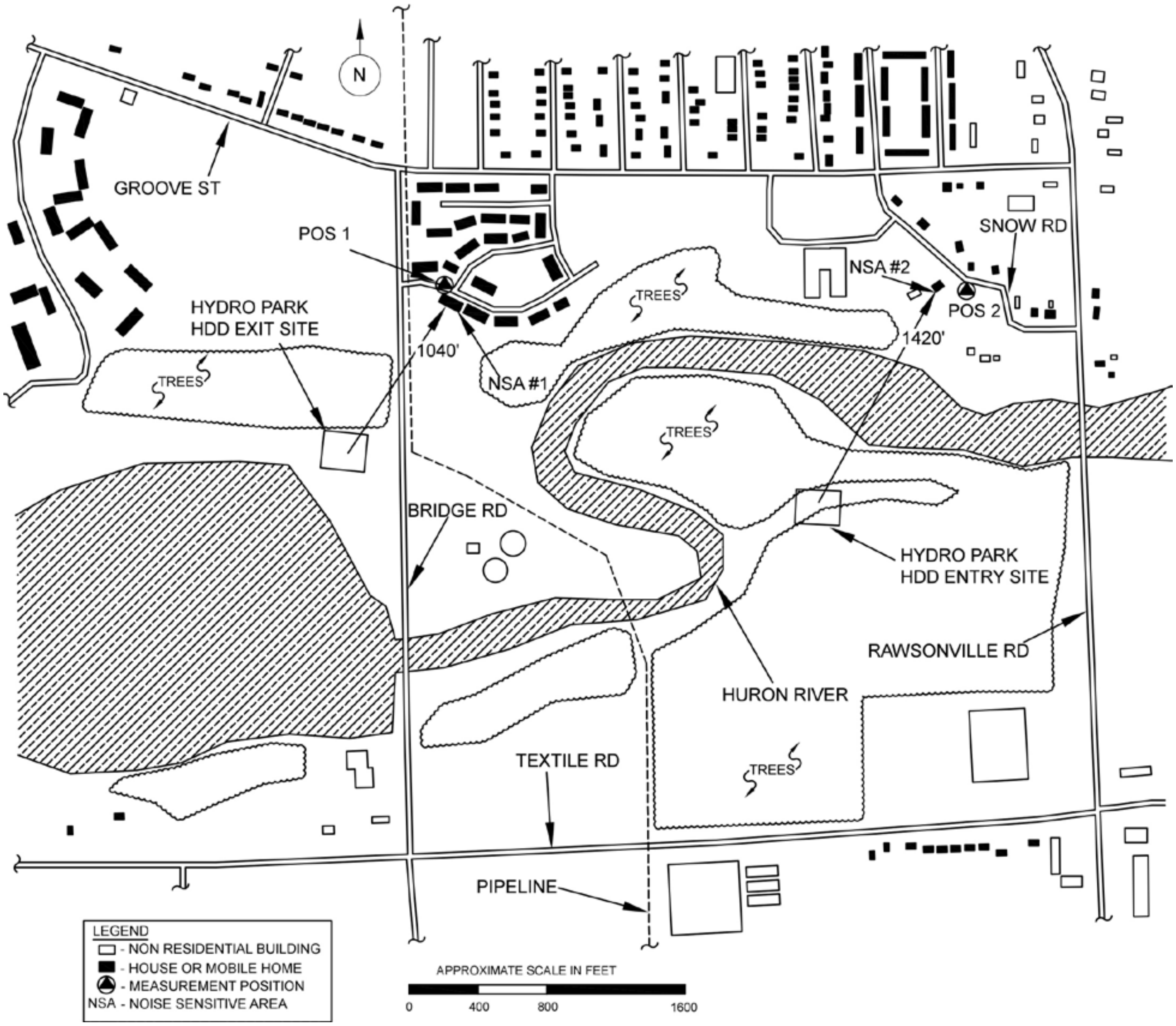

Figure 10: NEXUS Project [HDD #10 (Hydro Park HDD Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Locations and nearby NSA(s).

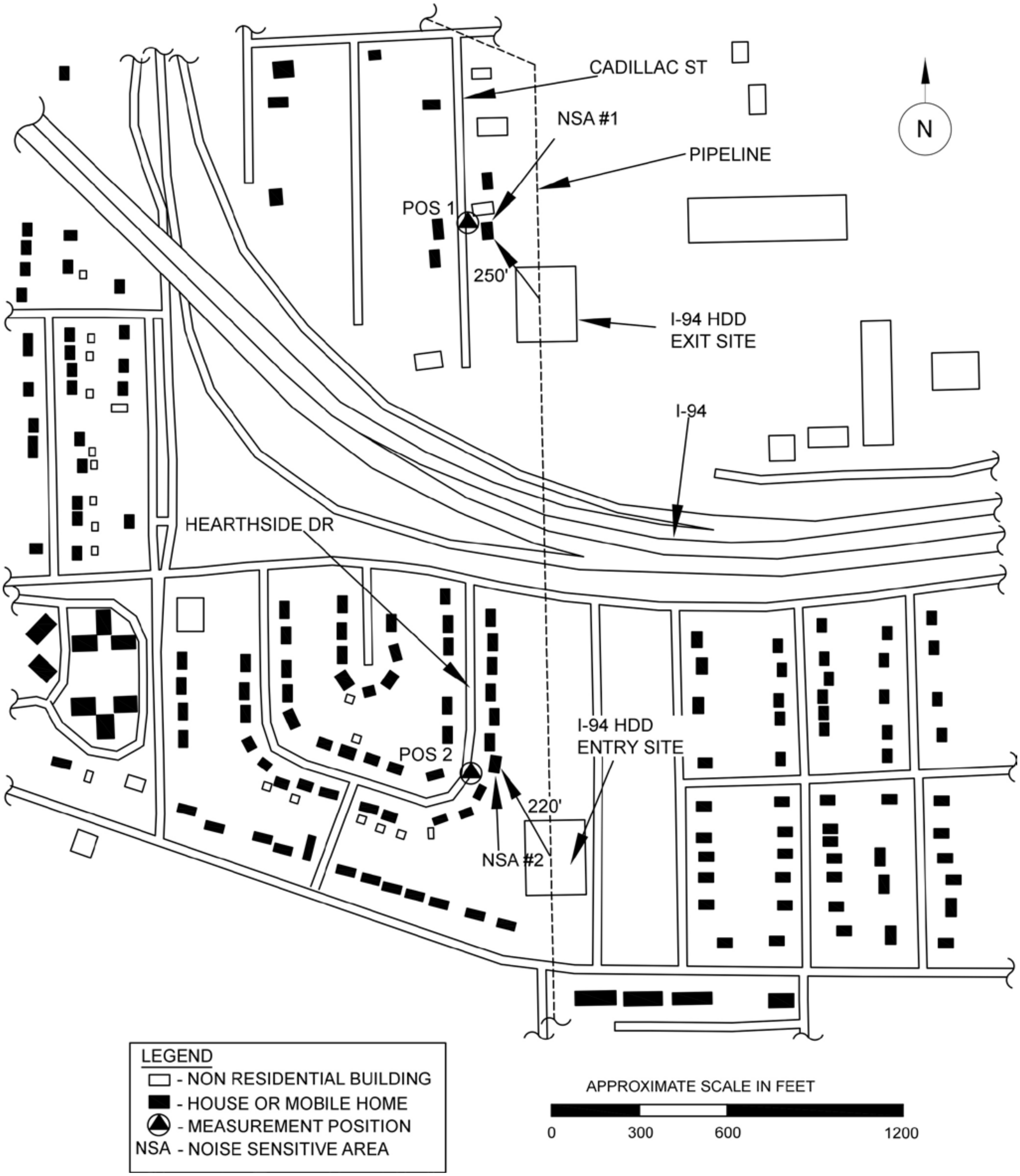

Figure 11: NEXUS Project [HDD #11 (I-94 HDD Crossing)]: Area Layout showing the HDD Crossing, HDD Entry/Exit Locations and nearby NSA(s).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	
	Peak PWL of HDD Operation at an Entry Point	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
450	Hemispherical Radiation	-51	-51	-51	-51	-51	-51	-51	-51	-51		Calc'd
450	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-4	-6		Ldn
	Est'd Total Sound Contribution with No Additional NC	**67**	**64**	**61**	**62**	**59**	**54**	**51**	**47**	**36**	**60.5**	**66.9**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											42.6
	Sound Contribution of HDD plus Ambient Level (dBA)											67.0
	Potential Increase above the Ambient Level (dB)											24.4
	Attenuation due to Added Noise Mitigation Measures	-3	-6	-9	-11	-13	-14	-15	-16	-16		
	Est'd Sound Level of HDD + Added Mitigation Measures	64	58	52	51	46	40	36	31	20	**47.7**	**54.1**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											42.6
	Sound Contribution of HDD plus Ambient Level (dBA)											54.4
	Potential Increase above the Ambient Level (dB)											11.8

Table 1: NEXUS Gas Transmission Project [HDD #1 (Tuscarawas River HDD) Entry Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 450 Ft. NW of the Entry Site). Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as a Temporary Noise Barrier for Hydraulic Power Unit and Engine-Driven Equipment, and "Low-Noise" Generators.

Notes: Est'd sound power level ("PWL") of HDD operation based on field tests by H&K on similar type of HDD rigs anticipated for this pipeline system. Est'd PWL at HDD exit site should be typically 12 to 14 dB lower than PWL at HDD entry site.

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	
	Peak PWL of HDD Operation at an Exit Point	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
830	Hemispherical Radiation	-56	-56	-56	-56	-56	-56	-56	-56	-56		Calc'd
830	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-7	-12		Ldn
	Est'd Total Sound Contribution with No Additional NC	**54**	**52**	**49**	**45**	**41**	**37**	**32**	**24**	**15**	**43.0**	**49.4**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											43.3
	Sound Contribution of HDD plus Ambient Level (dBA)											50.4
	Potential Increase above the Ambient Level (dB)											7.1

Table 2: NEXUS Gas Transmission Project [HDD #1 (Tuscarawas River HDD) Exit Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 830 Ft. NW of the Exit Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	
	Peak PWL of HDD Operation at an Entry Point	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Obstructions and/or Land Contour	0	0	-1	-3	-4	-5	-6	-7	-7		
1480	Hemispherical Radiation	-61	-61	-61	-61	-61	-61	-61	-61	-61		Calc'd
1480	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-6	-12	-21		Ldn
	Est'd Total Sound Contribution with No Additional NC	**57**	**54**	**50**	**49**	**46**	**40**	**35**	**26**	**9**	**46.7**	**53.1**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											40.2
	Sound Contribution of HDD plus Ambient Level (dBA)											53.3
	Potential Increase above the Ambient Level (dB)											13.1

Table 3: NEXUS Gas Transmission Project [HDD #2 (East Branch Black River HDD) Entry Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 1,480 Ft. SE of the Entry Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		Calc'd Ldn
	Peak PWL of HDD Operation at an Exit Point	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Obstructions and/or Land Contour	0	0	-1	-3	-4	-5	-6	-7	-7		
770	Hemispherical Radiation	-55	-55	-55	-55	-55	-55	-55	-55	-55		
770	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-6	-11		
Est'd Total Sound Contribution with No Additional NC		**55**	**52**	**48**	**43**	**40**	**36**	**30**	**23**	**15**	**41.9**	**48.3**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											41.2
	Sound Contribution of HDD plus Ambient Level (dBA)											49.1
	Potential Increase above the Ambient Level (dB)											7.9

Table 4: **NEXUS Gas Transmission Project [HDD #2 (East Branch Black River HDD) <u>Exit Site</u>]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 770 Ft. West of the Exit Site).**

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		Calc'd Ldn
	Peak PWL of HDD Operation at an Entry Point	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
790	Hemispherical Radiation	-56	-56	-56	-56	-56	-56	-56	-56	-56		
790	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-6	-11		
Est'd Total Sound Contribution with No Additional NC		**62**	**59**	**56**	**57**	**54**	**49**	**45**	**39**	**26**	**55.1**	**61.5**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											41.1
	Sound Contribution of HDD plus Ambient Level (dBA)											61.5
	Potential Increase above the Ambient Level (dB)											20.4
Attenuation due to Added Noise Mitigation Measures		-3	-6	-8	-10	-12	-14	-15	-16	-16		
Est'd Sound Level of HDD + Added Mitigation Measures		59	53	48	47	42	35	30	23	10	**43.1**	**49.5**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											41.1
	Sound Contribution of HDD plus Ambient Level (dBA)											50.1
	Potential Increase above the Ambient Level (dB)											9.0

Table 5: **NEXUS Gas Transmission Project [HDD #3 (West Branch Black River HDD) <u>Entry Site</u>]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 790 Ft. SW of the Entry Site). Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as a Temporary Noise Barrier for Hydraulic Power Unit and Engine-Driven Equipment, and "Low-Noise" Generators.**

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		Calc'd Ldn
	Peak PWL of HDD Operation at an Exit Point	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Obstructions and/or Land Contour	0	-1	-2	-4	-5	-6	-7	-8	-8		
730	Hemispherical Radiation	-55	-55	-55	-55	-55	-55	-55	-55	-55		
730	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-6	-10		
Est'd Total Sound Contribution with No Additional NC		**55**	**52**	**48**	**43**	**39**	**36**	**30**	**23**	**15**	**41.4**	**47.8**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											43.6
	Sound Contribution of HDD plus Ambient Level (dBA)											49.2
	Potential Increase above the Ambient Level (dB)											5.6

Table 6: **NEXUS Gas Transmission Project [HDD #3 (West Branch Black River HDD) <u>Exit Site</u>]: Est'd Sound HDD Operations at the Closest NSA (i.e., Residence approx. 730 Ft. NW of the Exit Site).**

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt.	
		31.5	63	125	250	500	1000	2000	4000	8000	Level	
	Peak PWL of HDD Operation at an Entry Point	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
770	Hemispherical Radiation	-55	-55	-55	-55	-55	-55	-55	-55	-55		Calc'd
770	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-6	-11		Ldn
Est'd Total Sound Contribution with No Additional NC		**63**	**59**	**56**	**57**	**54**	**49**	**45**	**39**	**27**	**55.3**	**61.7**
			Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA									38.7
			Sound Contribution of HDD plus Ambient Level (dBA)									61.7
				Potential Increase above the Ambient Level (dB)								23.0
Attenuation due to Added Noise Mitigation Measures		-3	-6	-8	-10	-12	-14	-15	-16	-16		
Est'd Sound Level of HDD + Added Mitigation Measures		60	53	48	47	42	35	30	23	11	**43.4**	**49.8**
			Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA									38.7
			Sound Contribution of HDD plus Ambient Level (dBA)									50.1
				Potential Increase above the Ambient Level (dB)								11.4

Table 7: **NEXUS Gas Transmission Project [HDD #4 (Vermillion River HDD) Entry Site]: Est'd Sound Contribution of of HDD Operations at the Closest NSA (i.e., Residence approx. 770 Ft. SW of the Entry Site). Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as a Temporary Noise Barrier for Hydraulic Power Unit and Engine-Driven Equipment, and "Low-Noise" Generators.**

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt.	
		31.5	63	125	250	500	1000	2000	4000	8000	Level	
	Peak PWL of HDD Operation at an Exit Point	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Obstructions and/or Land Contour	0	0	0	0	0	-1	-2	-3	-3		
340	Hemispherical Radiation	-48	-48	-48	-48	-48	-48	-48	-48	-48		Calc'd
340	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-3	-5		Ldn
Est'd Total Sound Contribution with No Additional NC		**62**	**60**	**57**	**54**	**51**	**48**	**43**	**38**	**32**	**53.2**	**59.6**
			Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA									41.2
			Sound Contribution of HDD plus Ambient Level (dBA)									59.7
				Potential Increase above the Ambient Level (dB)								18.5
Attenuation due to Added Noise Mitigation Measures		-2	-4	-6	-8	-9	-10	-12	-15	-15		
Est'd Sound Level of HDD + Added Mitigation Measures		60	56	51	46	42	38	31	23	17	**44.0**	**50.4**
			Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA									41.2
			Sound Contribution of HDD plus Ambient Level (dBA)									50.9
				Potential Increase above the Ambient Level (dB)								9.7

Table 8: **NEXUS Gas Transmission Project [HDD #4 (Vermillion River HDD) Exit Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 340 Ft. East of the Exit Site). Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as a Temporary Barrier between the HDD Workspace and Closest NSAs.**

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Entry Point	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Obstructions and/or Land Contour	0	-1	-2	-3	-5	-5	-6	-7	-7		
410	Hemispherical Radiation	-50	-50	-50	-50	-50	-50	-50	-50	-50		Calc'd
410	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-3	-6		Ldn
Est'd Total Sound Contribution with No Additional NC		**68**	**64**	**60**	**61**	**57**	**53**	**50**	**46**	**35**	**59.1**	**65.5**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											55.8
	Sound Contribution of HDD plus Ambient Level (dBA)											66.0
	Potential Increase above the Ambient Level (dB)											10.2
Attenuation due to Added Noise Mitigation Measures		-3	-6	-8	-10	-12	-14	-15	-16	-16		
Est'd Sound Level of HDD + Added Mitigation Measures		65	58	52	51	45	39	35	30	19	**47.0**	**53.4**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											55.8
	Sound Contribution of HDD plus Ambient Level (dBA)											57.8
	Potential Increase above the Ambient Level (dB)											2.0

Table 9: NEXUS Gas Transmission Project [HDD #5 (Huron River HDD) Entry Site]: Est'd Sound Contribution of of HDD Operations at the Closest NSA (i.e., Residence approx. 410 Ft. NE of the Entry Site). Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as a Temporary Noise Barrier for Hydraulic Power Unit and Engine-Driven Equipment, and "Low-Noise" Generators.

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Exit Point	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
750	Hemispherical Radiation	-55	-55	-55	-55	-55	-55	-55	-55	-55		Calc'd
750	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-3	-6	-11		Ldn
Est'd Total Sound Contribution with No Additional NC		**55**	**53**	**50**	**45**	**42**	**38**	**33**	**26**	**17**	**44.0**	**50.4**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											56.4
	Sound Contribution of HDD plus Ambient Level (dBA)											57.4
	Potential Increase above the Ambient Level (dB)											1.0

Table 10: NEXUS Gas Transmission Project [HDD #5 (Huron River HDD) Exit Site]: Est'd Sound Contribution of of HDD Operations at the Closest NSA (i.e., Residence approx. 750 Ft. East of the Exit Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Entry Point	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Obstructions and/or Land Contour	0	-1	-3	-5	-6	-7	-8	-8	-8		
1150	Hemispherical Radiation	-59	-59	-59	-59	-59	-59	-59	-59	-59		Calc'd
1150	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-5	-9	-16		Ldn
Est'd Total Sound Contribution with No Additional NC		**59**	**55**	**50**	**50**	**46**	**41**	**36**	**30**	**15**	**47.3**	**53.7**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											63.8
	Sound Contribution of HDD plus Ambient Level (dBA)											64.2
	Potential Increase above the Ambient Level (dB)											0.4

Table 11: NEXUS Gas Transmission Project [HDD #6 (Sandusky River HDD) Entry Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 1,150 Ft. ESE of the Entry Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Exit Point	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
660	Hemispherical Radiation	-54	-54	-54	-54	-54	-54	-54	-54	-54		Calc'd
660	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-5	-9		Ldn
Est'd Total Sound Contribution with No Additional NC		**56**	**54**	**51**	**47**	**43**	**40**	**34**	**28**	**20**	**45.3**	**51.7**
			Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA									56.0
			Sound Contribution of HDD plus Ambient Level (dBA)									57.4
				Potential Increase above the Ambient Level (dB)								1.4

Table 12: NEXUS Gas Transmission Project [HDD #6 (Sandusky River HDD) Exit Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 660 Ft. SE of the Exit Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Entry Point	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
600	Hemispherical Radiation	-53	-53	-53	-53	-53	-53	-53	-53	-53		Calc'd
600	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-5	-8		Ldn
Est'd Total Sound Contribution with No Additional NC		**65**	**62**	**59**	**59**	**56**	**52**	**48**	**43**	**31**	**57.8**	**64.2**
			Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA									42.3
			Sound Contribution of HDD plus Ambient Level (dBA)									64.2
				Potential Increase above the Ambient Level (dB)								21.9
Attenuation due to Added Noise Mitigation Measures		-3	-6	-9	-12	-13	-14	-15	-16	-16		
Est'd Sound Level of HDD + Added Mitigation Measures		62	56	50	47	43	38	33	27	15	**44.8**	**51.2**
			Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA									42.3
			Sound Contribution of HDD plus Ambient Level (dBA)									51.7
				Potential Increase above the Ambient Level (dB)								9.4

Table 13: NEXUS Gas Transmission Project [HDD #7 (Portage River HDD) Entry Site]: Est'd Sound Contribution of of HDD Operations at the Closest NSA (i.e., Residence approx. 600 Ft. NE of the Entry Site). Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as a Temporary Noise Barrier for Hydraulic Power Unit and Engine-Driven Equipment, and "Low-Noise" Generators.

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Exit Point	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Obstructions and/or Land Contour	0	0	-1	-3	-4	-5	-6	-7	-7		
450	Hemispherical Radiation	-51	-51	-51	-51	-51	-51	-51	-51	-51		Calc'd
450	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-4	-6		Ldn
Est'd Total Sound Contribution with No Additional NC		**59**	**57**	**53**	**48**	**45**	**41**	**36**	**31**	**24**	**47.1**	**53.5**
			Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA									44.1
			Sound Contribution of HDD plus Ambient Level (dBA)									53.9
				Potential Increase above the Ambient Level (dB)								9.8

Table 14: NEXUS Gas Transmission Project [HDD #7 (Portage River HDD) Exit Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 450 Ft. NW of the Exit Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	Calc'd Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Entry Point	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
980	Hemispherical Radiation	-58	-58	-58	-58	-58	-58	-58	-58	-58		
980	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-2	-4	-8	-14		
Est'd Total Sound Contribution with No Additional NC		**60**	**57**	**54**	**55**	**52**	**47**	**43**	**36**	**22**	**52.9**	**59.3**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											45.3
	Sound Contribution of HDD plus Ambient Level (dBA)											59.5
	Potential Increase above the Ambient Level (dB)											14.2
Attenuation due to Added Noise Mitigation Measures		-3	-6	-8	-10	-12	-14	-15	-16	-16		
Est'd Sound Level of HDD + Added Mitigation Measures		57	51	46	45	40	33	28	20	6	**41.1**	**47.5**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											45.3
	Sound Contribution of HDD plus Ambient Level (dBA)											49.5
	Potential Increase above the Ambient Level (dB)											4.2

Table 15: NEXUS Gas Transmission Project [HDD #8 (Maumee River HDD) Entry Site]: Est'd Sound Contribution of of HDD Operations at the Closest NSA (i.e., Residence approx. 980 Ft. SW of the Entry Site). Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as a Temporary Noise Barrier for Hydraulic Power Unit and Engine-Driven Equipment, and "Low-Noise" Generators.

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	Calc'd Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Exit Point	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
1020	Hemispherical Radiation	-58	-58	-58	-58	-58	-58	-58	-58	-58		
1020	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-8	-14		
Est'd Total Sound Contribution with No Additional NC		**52**	**50**	**47**	**43**	**39**	**35**	**29**	**21**	**11**	**41.0**	**47.4**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											43.6
	Sound Contribution of HDD plus Ambient Level (dBA)											48.9
	Potential Increase above the Ambient Level (dB)											5.3

Table 16: NEXUS Gas Transmission Project [HDD #8 (Maumee River HDD) Exit Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residences approx. 1,020 Ft. South of the Exit Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	Calc'd Ldn
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Entry Point	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Obstructions and/or Land Contour	0	0	-1	-3	-4	-5	-6	-7	-7		
550	Hemispherical Radiation	-53	-53	-53	-53	-53	-53	-53	-53	-53		
550	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-2	-4	-8		
Est'd Total Sound Contribution with No Additional NC		**65**	**62**	**58**	**58**	**55**	**50**	**47**	**42**	**31**	**56.7**	**63.1**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											40.8
	Sound Contribution of HDD plus Ambient Level (dBA)											63.1
	Potential Increase above the Ambient Level (dB)											22.3
Attenuation due to Added Noise Mitigation Measures		-3	-6	-8	-10	-12	-14	-15	-16	-16		
Est'd Sound Level of HDD + Added Mitigation Measures		62	56	50	48	43	36	32	26	15	**44.7**	**51.1**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											40.8
	Sound Contribution of HDD plus Ambient Level (dBA)											51.5
	Potential Increase above the Ambient Level (dB)											10.7

Table 17: NEXUS Gas Transmission Project [HDD #9 (Saline River HDD) Entry Site]: Est'd Sound Contribution of of HDD Operations at the Closest NSA (i.e., Residence approx. 550 Ft. NW of the Entry Site). Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as a Temporary Noise Barrier for Hydraulic Power Unit and Engine-Driven Equipment, and "Low-Noise" Generators.

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	Calc'd Ldn
	Peak PWL of HDD Operation at an Exit Point	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Obstructions and/or Land Contour	0	0	0	-1	-2	-3	-4	-5	-5		
720	Hemispherical Radiation	-55	-55	-55	-55	-55	-55	-55	-55	-55		
720	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	-1	-1	-3	-6	-10		
Est'd Total Sound Contribution with No Additional NC		**55**	**53**	**50**	**46**	**43**	**39**	**33**	**26**	**18**	**44.4**	**50.8**
			Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA									46.3
			Sound Contribution of HDD plus Ambient Level (dBA)									52.1
				Potential Increase above the Ambient Level (dB)								5.8

Table 18: NEXUS Gas Transmission Project [HDD #9 (Saline River HDD) Exit Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 720 Ft. South of the Exit Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	Calc'd Ldn
	Peak PWL of HDD Operation at an Entry Point	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Obstructions and/or Land Contour	0	0	-1	-3	-4	-5	-6	-7	-7		
1420	Hemispherical Radiation	-61	-61	-61	-61	-61	-61	-61	-61	-61		
1420	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-3	-6	-11	-20		
Est'd Total Sound Contribution with No Additional NC		**57**	**54**	**50**	**50**	**46**	**40**	**36**	**27**	**10**	**47.1**	**53.5**
			Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA									49.0
			Sound Contribution of HDD plus Ambient Level (dBA)									54.8
				Potential Increase above the Ambient Level (dB)								5.8

Table 19: NEXUS Gas Transmission Project [HDD #10 (Hydro Park HDD) Entry Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 1,420 Ft. NE of the Entry Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz) 31.5	63	125	250	500	1000	2000	4000	8000	A-Wt. Level	Calc'd Ldn
	Peak PWL of HDD Operation at an Exit Point	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Obstructions and/or Land Contour	0	0	-1	-3	-4	-5	-6	-7	-7		
1040	Hemispherical Radiation	-58	-58	-58	-58	-58	-58	-58	-58	-58		
1040	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	-1	-1	-2	-4	-8	-15		
Est'd Total Sound Contribution with No Additional NC		**52**	**50**	**46**	**40**	**37**	**33**	**27**	**19**	**8**	**38.9**	**45.3**
			Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA									53.1
			Sound Contribution of HDD plus Ambient Level (dBA)									53.8
				Potential Increase above the Ambient Level (dB)								0.7

Table 20: NEXUS Gas Transmission Project [HDD #10 (Hydro Park HDD) Exit Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residences approx. 1,040 Ft. NE of the Exit Site).

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Entry Point	118	115	112	114	112	109	108	106	98	115	
	Attenuation by Obstructions and/or Land Contour	0	0	0	0	-1	-1	-2	-3	-3		
220	Hemispherical Radiation	-45	-45	-45	-45	-45	-45	-45	-45	-45		Calc'd
220	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	0	-1	-2	-3		Ldn
Est'd Total Sound Contribution with No Additional NC		**73**	**70**	**67**	**69**	**66**	**63**	**61**	**57**	**47**	**68.7**	**75.1**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											51.1
	Sound Contribution of HDD plus Ambient Level (dBA)											75.1
	Potential Increase above the Ambient Level (dB)											24.0
Attenuation due to Added Noise Mitigation Measures		-5	-11	-16	-20	-21	-22	-24	-25	-25		
Est'd Sound Level of HDD + Added Mitigation Measures		68	59	51	49	45	41	37	32	22	**47.4**	**53.8**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											51.1
	Sound Contribution of HDD plus Ambient Level (dBA)											55.6
	Potential Increase above the Ambient Level (dB)											4.5

Table 21: NEXUS Gas Transmission Project [HDD #11 (Interstate 91 HDD) Entry Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 220 Ft. NW of the Entry Site). Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as a Temporary Noise Barrier for Hydraulic Power Unit, "Low-Noise" Generators and Workspace Noise-Reducing Tent.

Dist (Ft) or Calculation	Noise Source and Other Conditions/Factors associated with Acoustical Analysis	Unweighted SPL or PWL in dB per O.B. Center Freq. (Hz)									A-Wt. Level	
		31.5	63	125	250	500	1000	2000	4000	8000		
	Peak PWL of HDD Operation at an Exit Point	110	108	105	102	100	98	95	92	88	103	
	Attenuation by Obstructions and/or Land Contour	0	0	0	0	-1	-1	-2	-3	-3		
250	Hemispherical Radiation	-46	-46	-46	-46	-46	-46	-46	-46	-46		Calc'd
250	Atm. Absorption (70% R.H., 60 deg F)	0	0	0	0	0	-1	-1	-2	-4		Ldn
Est'd Total Sound Contribution with No Additional NC		**64**	**62**	**59**	**56**	**53**	**51**	**46**	**41**	**36**	**55.8**	**62.2**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											60.6
	Sound Contribution of HDD plus Ambient Level (dBA)											64.5
	Potential Increase above the Ambient Level (dB)											3.9
Attenuation due to Added Noise Mitigation Measures		-2	-4	-6	-8	-10	-12	-14	-15	-15		
Est'd Sound Level of HDD + Added Mitigation Measures		62	58	53	48	43	39	32	26	21	**45.6**	**52.0**
	Ambient Sound Level (Est'd Ldn via Meas'd Ld) in dBA											60.6
	Sound Contribution of HDD plus Ambient Level (dBA)											61.2
	Potential Increase above the Ambient Level (dB)											0.6

Table 22: NEXUS Gas Transmission Project [HDD #11 (Interstate 91 HDD) Exit Site]: Est'd Sound Contribution of HDD Operations at the Closest NSA (i.e., Residence approx. 250 Ft. West of the Exit Site). Includes the Est'd Sound Level if Additional Mitigation Measures are Employed such as a Temporary Barrier between the HDD Workspace and Closest NSAs.

Description of Acoustical Assessment Methodology and Source of Sound Data

In general, the predicted A-wt. sound level contributed by HDD operations was calculated as a function of frequency from estimated unweighted octave-band (O.B.) sound power levels (PWLs) during "peak" operations of HDD stationary equipment associated with Project HDDs. This prediction procedure was discussed in a 2009 technical paper[1]. The following summarizes the acoustical analysis procedure:

- Initially, unweighted O.B. PWL and A-wt. PWL values of HDD operations were determined from actual sound level measurements by H&K on similar type of HDD operations and equipment expected for this Project pipeline. Estimated PWL values of the HDD operations were calculated from sound measurements at different distances/directions from HDD operations (e.g., sound level measurements at 150 feet, 200 feet and 400 feet from HDD equipment operations);*****

- Then, expected attenuation in dB per O.B. frequency due to hemispherical sound propagation (discussed in more detail below******), atmospheric sound absorption (discussed in more detail below*******) and other factors (e.g., attenuation due to foliage and topography*******) were subtracted from the unweighted O.B. PWLs to obtain unweighted O.B. SPLs of HDD operations;

- Finally, the resulting estimated total unweighted O.B. SPLs for the HDD operations for each HDD, including sound attenuation effects, were logarithmically summed and corrected for A-weighting to provide the estimated overall A-wt. sound level contributed by the drilling operations at the specified distance(s).

*****It should be noted that the estimated PWL values of HDD operations utilized in the H&K acoustical analyses were based on measured sound level data at different distances from actual HDD construction sites, and therefore, the PWL values, for the most part, includes the effect of ground effect (e.g., ground absorption). Consequently, in our opinion, it would <u>not</u> be appropriate to strictly follow international–based standards, such as ISO 9613-2[2], when calculating the estimated A-wt. sound level at a respective receptor (i.e., NSA) via the PWL values utilized in the H&K acoustical analysis methodology.

******<u>Attenuation due to hemispherical sound propagation</u>: Sound propagates outwards in all directions (i.e., length, width, height) from a point source, and the sound energy of a noise source decreases with increasing distance from the source. In the case of hemispherical sound propagation, the source is located on a flat continuous plane/surface (e.g., ground), and the sound radiates hemispherically (i.e., outward, over and above the surface) from the source. The following equation is the theoretical decrease of sound energy when determining the resulting O.B. SPLs of a noise source at a specific distance ("r") of a receiver from a source O.B. PWL values:

> Decrease in SPL ("hemispherical propagation") from a noise source = **20*log(r) – 2.3 dB**
> where "r" is distance of the receiver from the noise source.

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[1]*Methods for Predicting and evaluating Noise from Horizontal Directional Drilling (HDD) Equipment*; by Paul Burge (URS Corp) and Paul D. Kiteck (Hoover & Keith Inc.); Inter-Noise 2009 (2009 August 23-26; Ottawa, Canada)

[2]International Standard Organization (ISO) 9613-2, Dec. 15, 1996 (Publication Date): *Acoustics - Attenuation of Sound During Propagation Outdoors - Part 2: General Method of Calculation*

***Attenuation due to air absorption, foliage and topography: Air absorbs sound energy, and the amount of absorption ("sound attenuation") is dependent on the temperature and relative humidity (R.H.) of air and frequency of sound. For example, the attenuation due to air absorption for 1000 Hz O.B. SPL is approximately **1.5 dB** per 1,000 feet for standard day conditions. Potential attenuation of foliage, based on our experience and an ISO Standard[3], the "medium-frequency" attenuation (i.e., 1000 Hz) due to forest/trees greater than 500 feet thick is approximately **10 dB**. Also, forested areas with plantings more than 100 feet deep can provide some attenuation of ground level noise sources, and the topography (i.e., land contour, such as a hill or ridge) between the HDD site and the NSA(s) can provide some additional attenuation of the HDD noise contribution at the respective NSA(s).

Summary of Typical Metrics and Acoustical Terminology

(1) Decibel (dB): A unit for expressing the relative power level difference between acoustical or electrical signals. It is ten times the common logarithm of the ratio of two related quantities that are proportional to power. When adding dB or dBA values, the values must be added logarithmically. For example, the logarithmic addition of **35 dB** plus **35 dB** is **38 dB**.

(2) A-Weighted Sound Level (dBA): The A-wt. sound level is a single-figure sound rating, expressed in decibels (Re 20 μPa), which correlates to the human perception of the loudness of sound. The dBA level is commonly used to measure industrial and environmental noise since it is easy to measure and provides a reasonable indication of the human annoyance value of the noise. The dBA measurement is not a good descriptor of a noise consisting of strong low-frequency components or for a noise with tonal components. The A-weighted curve approximates the response of the average ear at sound levels of 20 to 50 decibels.

(3) Background or Ambient Noise: The total noise produced by all other sources of a given environment in the vicinity of a specific source of interest, and includes any Residual Noise.

(4) Daytime Sound Level (L_d) & Nighttime Sound Level (L_n): L_d is the equivalent A-weighted sound level, in decibels, for a 15 hour time period, between 07:00 to 22:00 Hours (7:00 a.m. to 10:00 p.m.). L_n is the equivalent A-weighted sound level, in decibels, for a 9 hour time period, between 22:00 to 07:00 Hours (10:00 p.m. to 7:00 a.m.).

(5) Equivalent Sound Level (L_{eq}): The equivalent sound level (L_{eq}) can be considered an average sound level measured during a period of time, including any fluctuating sound levels during that period. In this report, the L_{eq} is equal to the level of a steady (in time) A-weighted sound level that would be equivalent to the sampled A-weighted sound level on an energy basis for a specified measurement interval. The concept of the measuring L_{eq} has been used broadly to relate individual and community reaction to aircraft and other environmental noises.

[3]ISO Standard 9613-1: 1993 (E); *Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the Absorption of Sound by the Atmosphere, and Part 2: General method of calculation*

(6) Day-Night Average Sound Level (L_{dn}): The L_{dn} is an energy average of the measured daytime L_{eq} (L_d) and the measured nighttime L_{eq} (L_n) plus **10 dB**. The **10-dB** adjustment to the L_n is intended to compensate for nighttime sensitivity. As such, the L_{dn} is not a true measure of the sound level but represents a skewed average that correlates generally with past sound surveys which attempted to relate environmental sound levels with physiological reaction and physiological effects. For a steady sound source that operates continuously over a 24-hour period and controls the environmental sound level, an L_{dn} is approximately **6.4 dB** above the measured L_{eq}. Consequently, an L_{dn} of **55 dBA** corresponds to a L_{eq} of **48.6 dBA**. If both the L_d and L_n are measured, then the L_{dn} is calculated using the following formula:

$$L_{\text{dn}} = 10\log_{10}\left(\frac{15}{24}10^{L_{\text{d}}/10} + \frac{9}{24}10^{(L_{\text{n}}+10)/10}\right)$$

(7) Octave Band (O.B.) Sound Pressure Level (SPL): Sound is typically measured in frequency ranges (e.g., high-pitched sound, low-pitched sound, etc.) that provides more meaningful sound data regarding the sound character of the noise. When measuring two noise sources for comparison, it is better to measure the spectrum of each noise, such as in octave band (O.B.) SPL frequency ranges. Then, the relative loudness of two sounds can be compared frequency range by frequency range. As an illustration, 2 noise sources can have the same dBA rating and yet sound completely different. For example, a high-pitched sound at a frequency of 2000 Hz could have the same dBA rating as a much louder low-frequency sound at 50 Hz.

(8) Sound Power Level (L_W or PWL): Ten times the common logarithm of the ratio of the total acoustic power radiated by a sound source to a reference power. A reference power of a picowatt or 10^{-12} watt is conventionally used.

End of Report