IN-AIR ACOUSTIC MODELING REPORT

Virginia Offshore Wind Technology Advancement Project

(VOWTAP)

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LIST OF ACRONYMS

Acronym	Definition
BITS	Block Island Transmission System
BIWF	Block Island Wind Farm
CNEL	Community noise equivalent level
dB	Decibel
dBA	A-weighted decibel
dBL	Linear decibel
Dominion	Virginia Electric and Power Company, a wholly-owned subsidiary of Dominion Resources, Inc.
EPA	Environmental Protection Agency
FHWA	Federal Highway Association
HDD	Horizontal directional drilling
HUD	Housing and Urban Development
IBGS	Inward Battered Guide Structure
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
kJ	kilojoule
kV	kilovolt
L_{dn}	Day-night sound level
L_{eq}	Equivalent sound level
m/s	meter per second
mph	mile per hour
MOE	Ministry of Environment
MVA	Megavolt ampere
MVAR	Megavolt ampere reactive
MW	megawatt
NEMA	National Electrical Manufacturers Association
NSR	Noise sensitive receptor
USGS	United States Geological Survey
VOWTAP	Virginia Offshore Wind Technology Advancement Project
WSDOT	Washington State Department of Transportation
WTG	wind turbine generator

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1 INTRODUCTION

Virginia Electric and Power Company, a wholly-owned subsidiary of Dominion Resources, Inc. (Dominion) is proposing the Virginia Offshore Wind Technology Advancement Project (VOWTAP or Project), a 12 megawatt (MW), two turbine offshore wind demonstration project located approximately 27 statute miles (mi) (24 nautical miles [nm], 43 kilometers [km]) offshore of Virginia Beach, Virginia (Figure 1). Other Project facilities include a 34.5 kilovolt (kV) Inter-Array Cable that will interconnect the two VOWTAP wind turbine generators (WTGs) and a 34.5 kV Export Cable that will convey electricity from the WTGs to a landfall site located in city of Virginia Beach, Virginia (Figure 1). The onshore components of VOWTAP will comprise the following facilities:

- A Switch Cabinet that will serve as the transition point were the Export Cable and associated fiber optic communications cable will be spliced with the Onshore Interconnection Cable and a separate Onshore Fiber Optic Cable.
- An underground Onshore Interconnection Cable;
- Onshore Fiber Optic Cable; and
- An Interconnection Station

Noise would be generated during Project construction and operation. Noise generated during construction would be associated with general construction activities needed to build both the onshore and offshore components and from the specialized construction activities associated with horizontal directional drilling (HDD) for installation of the Onshore Interconnection Cable; Onshore Fiber Optic Cable and the Export Cable landfall. Noise generated during operation would be associated with the wind turbine generators (WTGs) and Interconnection Station. Noise could potentially impact in-air noise sensitive receptors (NSRs). Unlike in the marine environment, in-air NSRs are all humans and do not include wildlife such as marine mammals. The following report focuses on in-air acoustic analysis and provides an overview of applicable acoustic criteria, a discussion of the acoustic analysis methodology and inputs and provides analysis results and conclusions.

2 EXISTING CONDITIONS

The onshore portions of the Project Area consist of undeveloped natural areas, developed lands ranging from low density to medium-high density in certain locations, and active military training areas. Camp Pendleton includes a training area for the Virginia Army National Guard as well as National Guard units from other states. The offshore portions of the Project Area consist of the open ocean; areas that are heavily trafficked by commercial, recreational and military vessels; and areas used for military practices.

Ambient sound measurements have not been conducted in the Project Area but in 2005 the U.S. Army Center for Health Promotion and Preventive Medicine Operational Noise Program published the "Virginia Army National Guard Statewide Operational Noise Management Plan", which provides a strategy for noise management and describes the acoustic environments for several training areas including Camp Pendleton. Camp Pendleton has a single small arms range that is used infrequently. When the small arms range is in use, Table 1 shows the peak decibel levels that can be expected by distance and angle from the firing point.

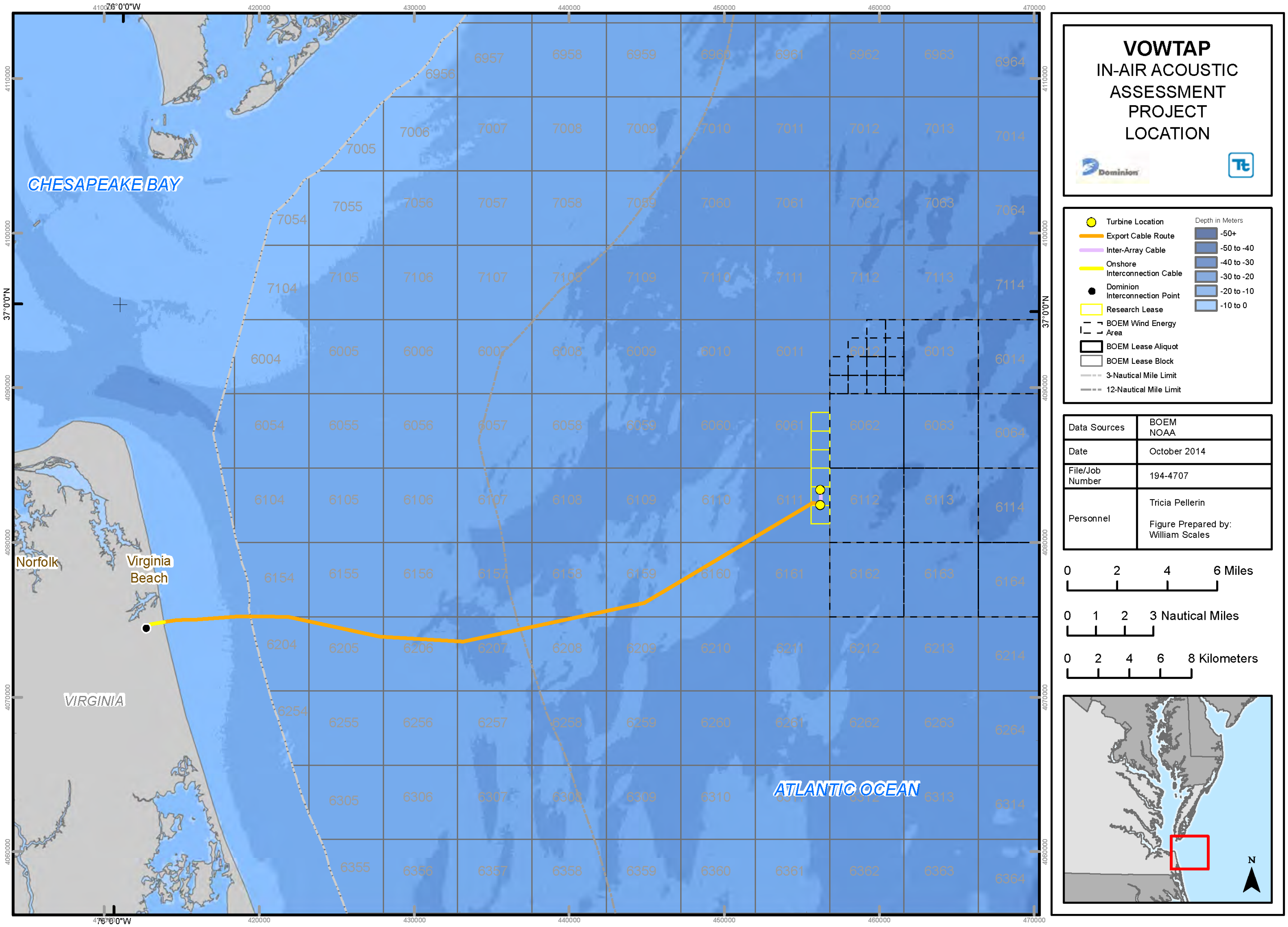

Figure 1. Overview of Project Study Area

Table 1. Camp Pendleton Predicted Peak Sound Levels for M-16 Live Fire

Distance (meters)	Predicted Sound Level (dBA)		
	0°	90°	180°
50	135-150	112-127	102-117
100	113-128	106-121	95-110
200	106-121	99-114	89-104
400	93-108	86-101	78-93
800	85-100	77-92	69-84
1,600	75-90	67-82	59-74

Noise complaints at Camp Pendleton are infrequent and there appears to be a general acceptance by the surrounding community of periodically elevated noise levels. In addition, some noise generated at the firing range is often masked by jet noise emanating from the Naval Air Station Oceana (VaANG 2005).

Overall, background sound levels in the Project Area both onshore and offshore will vary both spatially and temporally depending on a number of factors including proximity to other area sound sources such as local land and marine uses and activities, population densities, vehicle and nautical traffic, and proximity to existing recreational, commercial, and industrial sound sources, and time of day. Closer to the coastline, waves breaking on the seashore may also contribute to the soundscape. The VOWTAP is expected to contribute to the in-air acoustic environment during construction on a short-term basis as well as during operation. However, since the existing acoustic environment within the Project Area is susceptible to elevated noise levels from Camp Pendleton, it is expected that noise generated during Project operation would be minimal or comparable to that already occurring at Camp Pendleton.

3 ACOUSTIC CRITERIA

The criteria for the in-air acoustic assessment are thresholds established by guidelines or regulations at the federal, state, and/or local level. The following federal, state and local acoustic criteria may be applicable to the Project. For reference, a summary of acoustical terminology and typical metrics used to measure and regulate environmental noise is provided at the end of this report in Attachment A.

3.1 Federal

3.1.1 U.S. Environmental Protection Agency

In 1974, the U.S. Environmental Protection Agency (EPA) published *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (EPA 1974). This report represents the only published study that includes a large database of community reaction to noise to which a proposed project can be readily compared. The EPA has developed widely accepted recommendations for long term exposure to environmental noise with the goal of protecting public health and safety. The publication evaluates the effects of environmental noise with respect to health and safety, and provides information for state and local governments to use in developing their own ambient noise standards. For outdoor residential areas and other locations in which quiet is a basis for use, the recommended EPA guideline is a day-night sound level (L_{dn}) of 55 dBA. The EPA also suggests an $L_{eq}(24)$ of 70 dBA (24-hour) limit to avoid adverse effects on public health and safety at publicly accessible property lines or extents of work areas where extended periods of public exposure are possible. The EPA cause-and-effect criteria limits are summarized in Table 2.

Table 2. Summary of EPA Cause and Effect Noise Levels

Location	Level	Effect
All public accessible areas with prolonged exposure	70 dBA $L_{eq(24)}$	Safety
Outdoor at residential structure and other noise sensitive receptors where a large amount of time is spent	55 dBA L_{dn}	Protection against annoyance and activity interference
Outdoor areas where limited amounts of time are spent, e.g., park areas, school yards, golf courses, etc.	55 dBA $L_{eq(24)}$	
Indoor residential	45 dBA L_{dn}	
Indoor non-residential	55 dBA $L_{eq(24)}$	
Source: EPA 1974.		

The application of the EPA noise guidelines is a common compliance approach to help ensure adequate protection of human health and welfare. The EPA sound level guidelines state that the levels identified are low enough to be protective with an adequate margin of safety. The EPA sound level guidelines do not impose federal decisions about the appropriateness of noise environments upon any level of government, nor are they a source of instructions for solving local noise problems, but they are best viewed as a technical aid for local decision makers who seek to balance scientific information about effects of noise on people, and to reconcile local economic and political realities such as cost and technical feasibility. While the EPA criteria limits cannot be used to infer audibility thresholds, designing to adequately meet EPA guidelines would likely result in the reduced probability of dissatisfaction from NSRs and below which there is no evidence that the general population would be at risk to EPA identified health effects. The EPA limit is not a regulatory limit but is intentionally conservative to protect the most sensitive portion of the population with an additional margin of safety.

3.1.2 U.S. Department of Housing and Urban Development

The Department of Housing and Urban Development (HUD), in its efforts to provide decent housing and a suitable living environment, is concerned with noise as a major source of environmental pollution and issued Sub-part B on Noise Abatement and Control to Part 51 of Title 24 of the Code of Federal Regulations. As stated in 24 CFR 51, Subpart B, the HUD's objectives are to make the assessment of the suitability of the noise environment at a site: (1) easy to perform; (2) uniformly applicable to different noise sources; and (3) as consistent as possible with the assessment policies of other Federal departments and agencies.

HUD has identified noise standards for new housing construction, which are given in Table 3. As indicated in Table 3, sites with sound levels of 65 community noise equivalent level (CNEL) or L_{dn} and below are considered "acceptable."

Similar to the EPA guidelines, the HUD standards are not regulatory limits but they have been used previously to assess noise on military installations. Considering many of the onshore Project activities will occur within Camp Pendleton the HUD standards were included for consideration when analyzing the potential for Project noise impacts.

Table 3. HUD Site Acceptability Standards

Approval [a/]	L_{dn} or CNEL (dBA) [b/]	Requirements
Acceptable	≤ 65 [c/]	None
Normally Acceptable	65 – 75	Special Approvals [d/] Environmental [e/] Attenuation [f/]
Unacceptable	> 75	Special Approvals [d/] Environmental [e/] Attenuation [g/]

Notes:
a/ The noise environment inside a building is considered acceptable if: (i) The noise environment external to the building complies with these standards, and (ii) the building is constructed in a manner common to the area or, if of uncommon construction, has at least the equivalent noise attenuation characteristics.
b/ Where the building location is determined, the standards shall apply at a location 6.5 feet from the building housing noise sensitive activities in the direction of the predominant noise source. Where the building location is undetermined, the standards shall apply 6.5 feet from the building setback line nearest to the predominant noise source. However, where quiet outdoor space is desired at a site, distances should be measured from important noise sources to the outdoor area in question. (It is assumed that quiet outdoor space includes single-family private yards and multi-family patios or balconies that are greater than six feet in depth).
c/ Acceptable threshold may be shifted to 70 dBA in special circumstances pursuant to Section 51.105 (a).
d/ See Section 51.104(b) (Special Requirements) for requirements.
e/ See Section 51.104(b) (Special Requirements) for requirements.
f/ Five (5.0) dBA additional attenuation required for sites above 65 dB but not exceeding 70 dBA, and 10 dBA additional attenuation required for sites above 70 dBA but not exceeding 75 dB; see Section 51.104(a).
g/ Attenuation measures can be submitted to the Assistant Secretary for CPD for approval on a case-by-case basis.

3.2 State

There are no statewide noise standards; however, Virginia legislation enables local counties and municipalities to establish planning commissions to develop and carry out comprehensive plans for the coordination of physical development and future needs of those municipalities and counties. These plans may include local noise standards. The governing authority of each municipality may then adopt, amend, and enforce the planning commission's recommendations. In situations where provisions of local ordinances conflict with other standards, the stricter provisions govern.

3.3 Local

3.3.1 City of Virginia Beach

Section 23-69 of the City of Virginia Beach Code of Ordinances prescribes daytime and nighttime sound limits applicable at residences:

> *Daytime. No person shall permit, operate or cause any source of sound to create a sound level in another person's residential dwelling during the hours between 7:00 a.m. and 10:00 p.m. in excess of 65 dBA when measured inside the residence at least four (4) feet from the wall nearest the source, with doors and windows to the receiving area closed.*
>
> *Nighttime. No person shall permit, operate or cause any source of sound to create a sound level that can be heard in another person's residential dwelling during the hours between 10:00 p.m. and 7:00 a.m. in excess of 55 dBA when measured inside the residence at least four (4) feet from the wall nearest the source, with doors and windows to the receiving area closed.*

In addition, construction activities are exempt from daytime regulations but operation of such equipment between the hours of 9:00 pm and 7:00 am is prohibited unless otherwise authorized as described in the ordinance. It should be noted, however, that all onshore construction activities will be occurring exclusively on, over, and under property owned and controlled by the Commonwealth of Virginia and to which the City of Virginia Beach ordinances do not apply.[1]

4 METHODS

Acoustic modeling was conducted to predict the received sound levels at NSRs from the primary-noise generating activities occurring during Project construction and operation. NSRs are locations where people reside or where the presence of unwanted sound could adversely affect the use of land. Examples of NSRs include residences, schools, hospitals, churches, and nursing homes. A total of 991 NSRs were included in the modeling analysis, which are located within Camp Pendleton and the City of Virginia Beach and were identified within an approximate distance of 0.5 mi (0.8 km) from onshore construction and operations activities. The following subsections discuss the acoustic modeling scenarios, sound source levels and other details and inputs related to the acoustic modeling program.

4.1 Acoustic Modeling Scenarios

In this study, acoustic modeling analyses were conducted for the Project activities that are expected to generate in-air sound levels, which could affect NSRs. The following five modeling scenarios were considered in the current study:

- Scenario 1: Onshore construction activities
- Scenario 2: HDD installation activities including the HDD for the Export Cable landfall, Onshore Interconnection Cable, and Onshore Fiber Optic Cable
- Scenario 3: Pile driving of the Inward Battered Guide Structure (IBGS) foundations
- Scenario 4: Interconnection Station operation
- Scenario 5: WTG operation

4.2 Sound Source Levels

4.2.1 Onshore Construction

Noise generated during construction would be associated with general construction activities needed to build both onshore and offshore components and specialized construction activities needed for cable

[1] Precedent for exemption to local ordinances for offshore wind project activities occurring on, over, and under state-owned property has recently been set by the Deepwater Wind Block Island Wind Farm (BIWF) and Block Island Transmission System (BITS) Project off the coast of Rhode Island. In its permit applications Deepwater Wind asserted this exemption to local ordinances. The Deepwater Wind BIWF and BITS were provided with the authorization to proceed with the construction and operation of the Project by the state (the Coastal Resources Management Council) and lead federal (USACE) permitting agencies on June 13, 2014, and September 4, 2014, respectively.

installation. Onshore construction activities would take place between February and June of 2017. These activities include installation of conduit for offshore Export Cable, installation of Onshore Interconnection Cable and Fiber Optic Cable, and construction of the Interconnection Station.

Tables 4 and 5 present the representative construction equipment sources and associated sound levels at a 50 foot reference distance expected during the shore transition (Table 4), and the Interconnection Station (Table 5) phases of construction. Sound source levels were obtained from the Federal Highway Association (FHWA) Construction Noise Handbook" (FHWA 2006) and from Dominion. Usage factors were derived by taking the number of hours per day that, according to the construction schedule, a given piece of equipment would be utilized and dividing that by the number of hours in a day. Additionally, the usage factors assumed for the construction noise assessment match those used in the construction air quality emissions analysis. Some of the equipment on this list is unlikely to be used (e.g., a mounted impact hammer). This equipment is included to represent a worst case sound source.

Table 4. Shore Transition Construction Equipment Sound Source Levels at Reference Distance

Construction Equipment [a/]	Equipment Quantity	Sound Source Level (L_{max} at 50 ft)	Usage Factor (%)
Mounted Impact Hammer (Hoe Ram)	1	90	17
Dump Truck	1	84	17
Flatbed Truck (Material Supply)	1	84	17
Tracked Excavator	1	85	50
Air Compressor	1	80	50
Water Pump	1	77	50
Mud Pump	2	77	50
Generator	2	82	50
Slurry Plant	1	78	50
Desilter	1	85	50
Shale Shaker	1	85	50
a/ Excludes HDD.			

Table 5. Interconnection Station Construction Equipment Sound Source Levels at Reference Distance

Construction Equipment	Equipment Quantity	Sound Source Level (Lmax at 50 ft)	Usage Factor (%)
Concrete Saw	1	90	17
Mounted Impact Hammer (Hoe Ram)	1	90	17
Dump Truck	1	84	50
Concrete Truck	1	85	17
Flatbed Truck (Material Supply)	1	84	17
Crane	1	85	17
Paver	1	85	17
Earth Compactor	1	80	17
Tracked Excavator	1	85	50
Air Compressor	1	80	50
15 Ton Picker	1	85	50
Generator	1	82	50

4.2.2 Horizontal Directional Drilling

The Export Cable will make landfall through a conduit installed using HDD. This process will allow the cable to pass beneath the sensitive dune areas, the beach, and high energy intertidal zone. Mobilization to the site and equipment set up will begin in March with installation of conduit for the Export Cable complete in May. HDD for the Project is expected to last a total of 11 weeks at the Camp Pendleton Beach Parking Area, with the construction crew working approximately 8 hours per day.

The on-site equipment at the Camp Pendleton Parking Area would consist of an HDD drilling rig and auxiliary support equipment including items such as a water pump, slurry mixing tank, crane, loader, generator and portable light sets. Of these, the HDD drill rig is expected to be the dominant sound source. Table 6 presents typical sound pressure level data for equipment required for HDD operations.

Table 6. Estimated Typical HDD Equipment Sound Pressure Level Data

HDD Equipment	Maximum Sound Pressure Level at 50 feet (dBA)
HDD Drill Rig	92
Control Cab Power Unit	81
Water Pump	76
Slurry Mixing Tank	78
Cuttings Separation Unit	80
Cuttings Pit w/ Pump	76
Slurry Pump	76
Generator	81
Backhoe/Crane	83
Bobcat Loader	80

Table 7 presents the estimated noise emission source levels for the HDD at the Camp Pendleton Parking Area using a composite construction noise spectrum by octave band center frequency.

Table 7. HDD Composite Sound Spectrum at a Reference Distance of 50 feet

Activity	Octave Band Sound Power Data (dBL)									Broadband (dBA)
	31	63	125	250	500	1000	2000	4000	8000	
HDD Operations	98	99	95	89	87	86	83	82	81	92

A smaller guided drill (such as the Ditch Witch JT3020) will be employed to install the Onshore Interconnection Cable and Fiber Optic Cable. This sound source has an estimated sound pressure level of 69 dBA at 50 ft (15.2 m). Drilling will take place at up to 12 locations a maximum of 500 ft (152 m) apart. Installation is expected to take a total of 6 weeks.

4.2.3 Pile Driving

Foundation installation will require the use of pile driving, which can generate high noise levels; however, all pile driving will occur offshore and will be of short term duration (approximately 7 days per WTG). The VOWTAP WTG foundations are referred to as an IBGS, which will be comprised of the 10.2-ft (3.1-m) diameter central caisson, structural jacket, and three 5.9-ft (1.8-m) inward battered piles. The caisson will be driven into the seafloor using a hydraulic hammer with maximum blow energy of

1000 kilojoules (kJ). The structural jacket will then be lowered onto the caisson and the piles will be driven into its sleeves using maximum blow energy of 600 kJ.

Pile drivers are impact devices and produce elevated levels of noise generated during hammer strikes. The noise produced from pile driving techniques can be estimated based on the expected hammer blow energy and pile driving source levels from similar offshore wind energy developments and major infrastructure projects such as those conducted by the Washington State Department of Transportation (WSDOT). Using such references and assuming the maximum blow energy of 1000 kJ, the following representative octave band spectrum (in linear decibels; dBL) and broadband sound power level (dBA) were employed for the in-air acoustic modeling analysis (Table 8)

Table 8. Pile Driving Sound Power Level Data

Activity	Octave Band Sound Power Data (dBL)									Broadband (dBA)
	31	63	125	250	500	1000	2000	4000	8000	
Pile Driving	88	91	102	107	114	131	103	95	85	131

4.2.4 Interconnection Station Operation

Onshore facilities will include an Interconnection Station, which will generate noise during operation mostly attributed to the onsite transformer and shunt reactor. The transformer will have one 12.5 megavolt ampere (MVA) transformer and one 4.3 megavolt ampere reactive (MVAR) shunt reactor.

There are three main sound sources associated with a transformer: core noise, load noise and noise generated by the operation of the cooling equipment. The core is the principal noise source, dominating in the intermediate frequency range between 100 and 600 Hz. The relative magnitudes of the noise at these different frequency levels are dependent on the design of the transformer (i.e., core material, core geometry); however, the noise generated is largely independent of the transformer load. The load noise is primarily caused by the load current in the transformer's conducting coils (or windings), and the main frequency of this sound is twice the supply frequency; 100 Hz for 50 Hz transformers and 120 Hz for 60 Hz transformers. The cooling equipment (fans and pumps) noise typically dominates the very low and very high frequency ends of the sound spectrum; however, cooling equipment sound is comparatively lower and considered secondary to the sound produced by the core and load. Shunt reactors contain components similar to power transformers but noise generated is primarily from vibrational forces resulting from magnetic "pull" effects at iron-air interfaces. Also, unlike transformers, operation of shunt reactors is typically intermittent, operating when voltage stabilization is needed during load variation.

Transformers are designed and catalogued by kilovolt ampere (kVA) or MVA ratings. Just as horsepower ratings designate the power capacity of an electric motor, a transformer's kVA rating indicates its maximum power output capacity. The transformer industry uses the National Electrical Manufacturers Association (NEMA) published NEMA Standards TR1-1993 (R2000). These standards establish noise ratings to designate maximum sound emitted from transformers, voltage regulators, and shunt reactors based on the equipment's method of cooling, its dielectric fluid (air-cooled versus oil-cooled) and the electric power rating. It is reasonable to expect that any transformer installed as part of the Project will conform to all relevant NEMA standards. The sound power radiated is a function of the NEMA rating and the total surface area of the transformer. Transformer and shunt reactor sound source levels were estimated based on dimensions and MVA (or MVAR) rating information provided by Dominion and are presented by octave band frequency in Table 9.

Table 9. Interconnection Station Sound Power Level Data

	Unweighted Octave Band Sound Power Data (dBL)								
	31.5	63	125	250	500	1000	2000	4000	8000
Transformer (12.5 MVA)	90	96	98	93	93	87	82	77	70
Shunt Reactor (4.3 MVAR)	30	40	76	71	57	43	38	39	38

4.2.5 Wind Turbine Operation

Proposed offshore facilities include two 6 MW Alstom Haliade 150 WTGs. It is currently anticipated that the turbines will be sited approximately 3,445 ft (1,050 m) apart. Sound generated by an operating WTG is comprised of both aerodynamic and mechanical sound with the dominant sound component from utility scale WTGs being largely aerodynamic. Aerodynamic sound refers to the sound produced from air flow and the interaction with the WTG tower structure and moving rotor blades. Mechanical sound is generated at the gearbox, generator, and cooling fan, and is radiated from the surfaces of the nacelle and machinery enclosure and by openings in the nacelle casing; however, mechanical noise has been minimized in most modern upwind WTGs.

Wind farms, in comparison to conventional energy projects, are somewhat unique in that the sound generated by each individual WTG will increase as the wind speed across the site increases. WTG sound is negligible when the rotor is at rest, increases as the rotor tip speed increases, and is generally constant once rated power output and maximum rotational speed are achieved. Under maximum rotational wind speed the assumed maximum sound power level will be reached, generally occurring at approximately 16 miles per hour (mph) to 20 mph (7 meters per second [m/s] to 9 m/s) depending on WTG type and according to manufacturer specifications. It is important to recognize that as wind speeds increase, the background ambient sound level will likely increase as well, resulting in acoustic masking effects. The net result is that during periods of elevated wind when higher WTG sound emissions occur, the sound produced from a WTG operating at maximum rotational speed may well be largely or fully masked due to wind generated sound in foliage or increased noise related to waves crashing on the shoreline. In practical terms, this means a nearby receptor may hear these other sound sources (i.e., foliage, ocean waves) rather than WTG noise.

In terms of sound source levels for the Haliade 150 WTGs, Alstom has provided specifications indicating that each WTG will operate with noise levels between 111.2 dBA and 112.3 dBA depending on the prevailing wind speed with the highest noise levels reached around rated wind speed. WTG manufacturers declare acoustic emission performance using a consistent methodology described per International Standard IEC 61400-11:2006 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques. These data are inclusive of both mechanical and aerodynamic source components. WTGs can be somewhat directional, radiating more sound in some directions than others. The IEC test measurement protocol requires that sound measurements are made for the maximum downwind directional location when reporting apparent sound power levels. Thus, worst-case WTG directivity and sound generating efficiencies are reported in the sound source data and therefore also assumed in the development of the acoustic model. Sound power data by octave band frequency were not available at the time of the analysis; therefore, representative spectra were used in the model. In addition, a 2 dBA k-factor (or uncertainty band) was included to account for the inherent uncertainty associated with the sound measurements as described in IEC/TS 61400-14: Declaration of apparent sound power level and tonality values.

4.3 Sound Propagation Model

The Project in-air acoustic modeling analysis employed DataKustik's Cadna/A software (version 4.3.143). CadnaA is a comprehensive 3-dimensional acoustic software model that conforms to the International Organization for Standardization (ISO) standard ISO 9613-2 "Attenuation of Sound During Propagation Outdoors." This standard evaluates A-weighted sound pressure levels under meteorological conditions favorable to propagation from sources of known sound emission. The calculation of sound propagation from source to receptor locations consists of full octave band algorithms that incorporate the following physical effects:

- Geometric spreading wave divergence
- Reflection from surfaces
- Atmospheric absorption
- Screening by topography and obstacles
- Terrain complexity and ground effects
- Frequency dependent propagation
- Source directivity factors
- Multiple noise sources, and source type (point, area, and/or line)
- Height of both sources and receptors
- Seasonal foliage effects
- Averaging predicted sound levels over a given time period
- Site-specific, long-term meteorological conditions

CadnaA has been shown to be a highly accurate and effective acoustic modeling tool for a wide variety of sound sources including wind energy projects when appropriate adjustments, site-specific terrain and topographical features are considered.

4.4 Acoustic Environment

The following subsections discuss how CadnaA incorporates site-specific characteristics including topography, ground effects, and meteorology into the acoustic analysis. In addition, specialized conditions that can occur with an offshore installation are discussed, which influence sound propagation and attenuation, are discussed.

4.4.1 Topography and Ground Effects

Terrain conditions, vegetation type, ground cover, the density and height of foliage, and sea state conditions can also influence the absorption that takes place when sound travels over land or water.

Topographical information was imported into the acoustic model using the official United States Geological Survey (USGS) digital elevation dataset to accurately represent terrain in three dimensions. In addition, the ISO 9613-2 standard accounts for ground absorption by assigning a numerical coefficient of G=0 for acoustically hard, reflective surfaces and G=1 for absorptive surfaces and soft ground. If the ground is hard-packed dirt, typically found in industrial complexes, pavement, bare rock or for sound traveling over bodies of water, the absorption coefficient is defined as G=0 to account for reduced sound attenuation. In contrast, ground covered in vegetation, including suburban lawns, will be acoustically absorptive and aid in sound attenuation, i.e., G=1.0. Ground absorption coefficients will vary throughout the Project Area with water being represented as perfectly reflective. For the acoustic modeling analysis, sound attenuation through foliage and diffraction around and over existing anthropogenic structures such as buildings was ignored so results are representative of defoliate winter time conditions.

4.4.2 Meteorology

The ISO 9613-2 standard calculates received sound pressure levels for meteorological conditions favorable to propagation, i.e., downwind sound propagation or what might occur typically during a moderate atmospheric ground level inversion, which is typically assumed to be regulatory worst case. At large distances from a sound source, influences of wind or temperature gradients may cause fluctuations in received sound levels at distant downwind receivers. The fluctuation of wind and temperature at a specific location during the propagation of sound can cause a variation in the speed and curve of sound waves. A higher atmospheric temperature will generally result in a faster sound speed; however, since the temperature of the atmosphere is not uniform there are local variations in the sound speed. When the atmospheric temperature is higher at the surface the temperature decreases with height and sound waves are refracted upwards. This results in a shadow zone formation where sound does not penetrate. This situation is more typical during the nighttime hours. On the other hand, if the atmospheric temperature is lower at the surface and the air warmer, the temperature increases with height and the sound waves are refracted downwards. Sound waves may also refract upwards or downwards depending on the wind direction. When conducting the in-air acoustic modeling analysis site-specific meteorology and its effect on sound propagation was considered.

4.4.3 Shoreline Effect

The ground effect depends on the height of a source or the receiver relative to the ground. As sound waves reach the coast line, a modification of the ground boundary occurs and this sudden change produces additional sound attenuation due to the partial reflection of sound waves. At the shoreline the wind and temperature gradients are also modified as the sea and the land are not always at the same temperature, thus generating friction at the ground surface. These effects result in a variation in the speed and curve of the sound waves. Few studies have been conducted regarding the shoreline effect and how it influences sound propagation, however, an average attenuation for low frequencies has been documented at 3 dB (Johansson 2003) at distances up to 3,281 ft (1,000 m) from the sound source, and then increasing with greater distances. The Danish Ministry of Environment (MOE) documented calculations of ground effect of sound propagating from a WTG with a hub height of 328 ft (100 m), which corresponds to the approximate size of WTGs for this Project. The results indicated that ground effect of multiple reflections does not occur until at very large distances (above 13,123 ft [4,000 m]) under a wind speed of 18 mph

(8 m/s). The conclusion was that multiple reflections were not significant within the area extending from the WTG to a distance of 13,123 ft (4,000 m) and the effect does not begin until greater than approximately 3.1 mi (5 km) for WTGs with a hub height of about 328 ft (100 m).

4.4.4 Propagation Over Water

Sound propagating from offshore WTGs behaves differently than propagation from land-based WTGs and this is largely attributed to the water acting as a completely reflective surface. The effect water has on sound propagation increases as the distance between the source and receiver increases. The influence of the reflecting water on the received sound level may be just as strong as the direct contribution from the sound source. In addition, downwind refractive effects result in a cylindrical wave spreading to form a reflecting layer in the atmosphere at a specified height. Strong reflection may occur during certain periods of the year with higher gradients in wind speed and direction at relatively low heights. This cylindrical spreading of sound energy due to multiple reflections from the sea surface is correlated with a slower rate of reduction than sound propagating over land, similar to the effect created by atmospheric temperature and wind gradients. Therefore, sound propagation over water is variable and dependent on a number of factors including:

- The distance over water from the sound source to the receiver;
- The height of the sound source above the completely reflective water surface;
- The height of the atmospheric inversion layer trapping the sound waves below the height of the source, thus creating the cylindrical wave;
- The atmospheric absorption coefficient due to the shoreline effect; and
- The attenuation due to the ground damping and the damping of sound.

Due to the above factors that are unique to offshore WTG sources, transmission loss that occurs between the sound source and receiver may vary considerably.

5 MODELING RESULTS

Acoustic modeling was performed to predict the received sound levels at the identified NSRs under each of the scenarios as described in Section 4.1. The results of these analyses are presented in the subsequent subsections.

5.1 Onshore Construction

Construction noise, although temporary, can be a source of concern for NSRs. Construction of the Project will require the use of heavy equipment that may be periodically audible at offsite locations. Received sound levels will fluctuate, depending on the construction activity, equipment type, and distance between source and receiver. Sound from construction equipment will vary depending on the construction phase and the number and class of equipment at a location at any given time.

Construction sound will attenuate with increased distance from the sound sources. Other factors, such as vegetation, terrain and obstacles, such as buildings, will act to limit the impact of construction noise levels, but were not considered in the evaluation. Consequently, model results likely overstate actual noise levels. For the purpose of this analysis, composite received sound levels from the VOWTAP onshore construction activities at various reference distances were calculated at the proposed HDD Work Areas located at the Camp Pendleton Beach or Croatian Beach parking areas and at the site of the proposed Interconnection Station (Table 10). Section 2.3 provides source levels and usage factors for each phase.

Table 10. Onshore Construction Equipment Sound Attenuation at Reference Distances

Construction Phase	Composite Sound Levels (dBA L_{eq})					
	50 feet	100 feet	200 feet	500 feet	1000 feet	2000 feet
HDD Work Area [a/]	92	86	80	72	66	60
Interconnection Station	92	86	80	72	66	60
a/ Excludes HDD.						

Criteria applicable within Camp Pendleton are not clearly defined; however, it is reasonable to assume that if construction is limited to daytime hours disturbance to NSRs will be minimized.

5.2 Horizontal Directional Drilling

Potential noise impacts associated with HDD required for landing the Export Cable at either the Camp Pendleton Beach or Croatian Beach parking areas were modeled in CadnaA. Calculations were completed under meteorological conditions corresponding to downwind propagation, or equivalently, propagation under a well-developed moderate ground-based temperature inversion. This scenario represents standard day sound propagation conditions which is consistent with the ISO 9613-2 standard that CadnaA employs in its simulation calculations and is typically considered “regulatory worst case”.

At the Croatan Beach Parking Area the most impacted NSR showed a predicted received sound level of 69 dBA. That NSR was located on Lockheed Avenue in the City of Virginia Beach; however, the Croatan Beach Parking Area is no longer being considered for landing the Export Cable. The most impacted NSR from HDD occurring at the Camp Pendleton Beach Parking Area showed a predicted received sound level of 63 dBA. HDD sound contours are provided for the Croatan Beach Parking Area (See Figure C-1) and Camp Pendleton Beach Parking Area (See Figure C-2). In addition, tabulated results showing received sound levels at the top fifty most impacted NSRs are given in Tables B-1 and B-2 of Attachment B for Croatan Beach parking area and Camp Pendleton Beach parking area, respectively.

As described in Section 3.3.1, operation of construction equipment will be occurring exclusively on, over, and under property owned and controlled by the Commonwealth of Virginia and to which the City of Virginia Beach ordinances do not apply.

In addition to the assessment of Export Cable landfall activities, received sound levels were also evaluated for the HDD of the Onshore Interconnection Cable and Onshore Fiber Optic Cable to the proposed Interconnection Station. Onshore cable HDD activities were modelled at three separate locations along the proposed Onshore Interconnection and Fiber Optic Cable installation routes. Modeling results indicate that the most impacted NSR, located within Oceana military housing area, showed a predicted received sound level of 54 dBA. Sound from Onshore Interconnection and Fiber Optic Cable installation activities are displayed in Figure C-3 and tabulated results showing received sound levels at the top fifty most impacted NSRs are given in Table B-3 of Attachment B.

5.3 Pile Driving

Potential noise impacts associated with pile driving needed for the installation of the IBGS foundations were modeled in CadnaA. Calculations were completed for two different meteorological conditions:

1. Operation under meteorological conditions corresponding to downwind propagation, or equivalently, propagation under a well-developed moderate ground-based temperature inversion. As described in Section 5.2, this scenario is typically considered “regulatory worst case”.
2. Operation under anomalous meteorological conditions that may occur periodically, which will aid in long range propagation of sound. These anomalous meteorological conditions may include stable air masses resulting in pronounced temperature inversions and/or the presence of wind gradients combined with a pronounced low level jet stream which can bend sound waves downwards during propagation over long distances. Such anomalous conditions may occur with offshore applications due to frictional convergence at coastlines.

Results of the above two modeling scenarios are presented in Figures C-4 and C-5. Received sound levels are reduced to an equivalent sound level (L_{eq}) of 48.6 dBA, with directly corresponds to the EPA L_{dn} guideline of 55 dBA, at a distance of approximately 3.3 kilometers from the two WTGs. Modeling results show that, while pile driving noise would likely be inaudible onshore, audibility could occur under certain meteorological conditions.

5.4 Interconnection Station

The Interconnection Station design layout has not yet been finalized, consequently, the locations of the onsite transformer and shunt reactor were approximated with their sound emissions characterized as described in Section 4.2.4. Modeling assumed simultaneous operation of the transformer and shunt reactor under normal operating conditions. Modeling results showed that highest predicted received sound level as a result of Interconnection Station operation was 41 dBA, which occurred at the Oceana military housing. This received sound level shows compliance with all criteria presented in Section 3.0 including the City of Virginia Beach Noise Ordinance, HUD noise standards and EPA noise 55 L_{dn} noise guideline, which equates to an L_{eq} of 48.6 dBA. Sound contours corresponding to Interconnection Station operation are displayed in Figure C-6 and tabulated results showing received sound levels at the top fifty most impacted NSRs are given in Table B-4 of Attachment B.

5.5 Wind Turbine Operation

Acoustic modeling was conducted assuming both WTGs at the preferred locations are operating continuously and concurrently at the maximum rated sound power level of 112.3 dBA as provided by Alstom. In addition, the k-factor of 2 dBA was added to this sound power as indicated in Section 4.2.1. Sound propagation calculations assumed the water surrounding the WTGs was perfectly reflective. In addition, though propagation in the atmosphere is not strongly dependent on temperature and humidity, parameters selected for temperature (50°F [10°C]) and relative humidity (70 percent) are representative of favorable sound propagation conditions.

Modeling was completed for the same two meteorological conditions used to analyze pile driving, as described in Section 5.3. Modeling results are presented as sound contours in Figures C-7 and C-8.

Received sound levels are reduced to an equivalent sound level (L_{eq}) of 48.6 dBA, with directly corresponds to the EPA L_{dn} guideline of 55 dBA, at a distance of approximately 2,543 ft (775 m) from the two WTGs. Due to the significant distance to the shore it is expected any sound generated by WTG operation would be inaudible at onshore NSRs.

6 CONCLUSIONS AND RECOMMENDATIONS

Modeling results show that both pile driving and WTG operation will occur at a sufficient distance from shore to prevent any potential adverse noise impacts at NSRs. Operation of the Interconnection Station showed predicted sound levels at nearby Oceana military housing of 41 dBA and below, which complies with all criteria considered in this acoustic assessment.

Onshore construction noise may be audible at NSRs. Received sound levels at NSRs from construction will depend on the type of equipment used, the mode of equipment operation, the length of time the equipment is in use, the amount of equipment used simultaneously, and the distance between the sound source and NSR. All of these factors are expected to vary regularly throughout the construction period making the calculation of a specific received sound-level value at each NSR location difficult. The following mitigation measures will be considered in order to reduce the level of disturbance associated with Project construction:

- Construction operations will not occur between 7:00 pm and 7:00 am on weekdays or Saturday, or at any time on Sunday;
- Construction site and access road speed limits will be established and enforced during the construction period;
- Electrically-powered equipment will be used instead of pneumatic or internal combustion powered equipment, where feasible;
- Material stockpiles and mobile equipment staging, parking, and maintenance areas will be located as far as practicable from NSRs;
- The use of noise-producing signals, including horns, whistles, alarms, and bells, will be for safety warning purposes only;
- No Project-related public address or music system will be audible at any adjacent receptor; and
- All noise-producing construction equipment and vehicles using internal combustion engines will be equipped with mufflers, air-inlet silencers where appropriate, and any other shrouds, shields, or other noise-reducing features in good operating condition that meet or exceed original factory specification. Mobile or fixed "package" equipment (e.g., arc-welders, air compressors) will be equipped with shrouds and noise control features that are readily available for that type of equipment.

7 REFERENCES

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Attachment A – Acoustic Terminology

Summary of Typical Metrics for Regulating Environmental Noise & Acoustical Terminology Discussed in the Report:

A-Weighted Sound Level (dBA): The A-wt. sound level is a single-figure sound rating, expressed in decibels, 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.

Background or Ambient Noise: The total noise produced by all other sources associated with a given environment in the vicinity of a specific sound source of interest, and includes any residual noise.

Community Noise Equivalent Level (CNEL): A 24-hour equivalent continuous level in dBA where 5 dBA is added to evening noise levels from 7:00 p.m. to 10:00 p.m. and 10 dBA is added to nighttime noise levels from 10:00 p.m. to 7:00 a.m.

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 35dB is 38 dB.

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.).

Day-Night 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 approx. 6.4 dB above the measured L_{eq}.

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.

Octave Band 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 SPL frequency ranges. Then, the relative loudness of two sounds can be compared frequency range by frequency range. As an illustration, two noise sources can have the same dBA rating and yet sound completely different. For example, a high-pitched sound concentrated at a frequency of 2000 Hz could have the same dBA rating as a much louder low-frequency sound concentrated at 50 Hz.

Sound Pressure Level (L_p or SPL): Ten times the common logarithm to the base 10 of the ratio of the mean square sound pressure to the square of a reference pressure. Therefore, the sound pressure level is equal to 20 times the common logarithm of the ratio of the sound pressure to a reference pressure (20 micropascals or 0.0002 microbar).

Attachment B – Received Sound Levels at NSRs

Table B-1 Received Sound Levels – HDD, Croatan Beach Parking Area

NSR ID	NSR Description	UTM Coordinates		Received Sound Level (dBA)
		Easting (m)	Northing (m)	
R-615	Residential	413662	4075175	69
R-617	Residential	413628	4075170	69
R-613	Residential	413713	4075184	68
R-608	Residential	413652	4075206	67
R-618	Residential	413569	4075160	67
R-609	Residential	413625	4075203	67
R-601	Residential	413652	4075221	66
R-603	Residential	413708	4075216	66
R-605	Residential	413620	4075215	66
R-620	Residential	413542	4075156	66
R-595	Residential	413648	4075236	65
R-611	Residential	413567	4075190	65
R-598	Residential	413618	4075230	65
R-596	Residential	413706	4075233	65
R-588	Residential	413646	4075253	65
R-607	Residential	413564	4075206	65
R-591	Residential	413703	4075247	64
R-592	Residential	413614	4075246	64
R-612	Residential	413536	4075186	64
R-578	Residential	413644	4075268	64
R-583	Residential	413611	4075260	64
R-568	Residential	413641	4075281	64
R-610	Residential	413533	4075201	64
R-602	Residential	413562	4075221	64
R-582	Residential	413702	4075261	63
R-574	Residential	413696	4075275	63
R-576	Residential	413612	4075275	63
R-557	Residential	413639	4075297	63
R-594	Residential	413559	4075236	63
R-604	Residential	413530	4075216	63
R-621	Residential	413490	4075153	63
R-561	Residential	413691	4075291	63
R-563	Residential	413609	4075290	63
R-551	Residential	413633	4075312	62
R-589	Residential	413558	4075251	62
R-556	Residential	413606	4075303	62
R-614	Residential	413488	4075179	62

Table B-1 Received Sound Levels – HDD, Croatan Beach Parking Area

NSR ID	NSR Description	UTM Coordinates		Received Sound Level (dBA)
		Easting (m)	Northing (m)	
R-543	Residential	413634	4075327	62
R-622	Residential	413465	4075146	62
R-599	Residential	413528	4075230	62
R-554	Residential	413690	4075306	62
R-579	Residential	413554	4075267	62
R-533	Residential	413630	4075340	62
R-546	Residential	413606	4075321	62
R-593	Residential	413525	4075245	61
R-545	Residential	413687	4075321	61
R-539	Residential	413606	4075335	61
R-569	Residential	413550	4075281	61
R-516	Residential	413625	4075373	61
R-538	Residential	413683	4075336	61

Table B-2 Received Sound Levels – HDD, Camp Pendleton Parking Area

NSR ID	NSR Description	UTM Coordinates		Received Sound Level (dBA)
		Easting (m)	Northing (m)	
R-615	Residential	413662	4075175	63
R-618	Residential	413569	4075160	63
R-620	Residential	413542	4075156	62
R-617	Residential	413628	4075170	62
R-621	Residential	413490	4075153	62
R-613	Residential	413713	4075184	62
R-608	Residential	413652	4075206	62
R-611	Residential	413567	4075190	62
R-622	Residential	413465	4075146	62
R-612	Residential	413536	4075186	62
R-601	Residential	413652	4075221	61
R-609	Residential	413625	4075203	61
R-595	Residential	413648	4075236	61
R-610	Residential	413533	4075201	61
R-603	Residential	413708	4075216	61
R-605	Residential	413620	4075215	61
R-607	Residential	413564	4075206	61
R-614	Residential	413488	4075179	61
R-588	Residential	413646	4075253	61
R-596	Residential	413706	4075233	60

Table B-2 Received Sound Levels – HDD, Camp Pendleton Parking Area

NSR ID	NSR Description	UTM Coordinates		Received Sound Level (dBA)
		Easting (m)	Northing (m)	
R-598	Residential	413618	4075230	60
R-602	Residential	413562	4075221	60
R-604	Residential	413530	4075216	60
R-591	Residential	413703	4075247	60
R-619	Residential	413418	4075159	60
R-592	Residential	413614	4075246	60
R-594	Residential	413559	4075236	60
R-578	Residential	413644	4075268	60
R-599	Residential	413528	4075230	60
R-582	Residential	413702	4075261	60
R-583	Residential	413611	4075260	60
R-589	Residential	413558	4075251	60
R-593	Residential	413525	4075245	60
R-574	Residential	413696	4075275	59
R-597	Residential	413479	4075232	59
R-568	Residential	413641	4075281	59
R-576	Residential	413612	4075275	59
R-579	Residential	413554	4075267	59
R-584	Residential	413520	4075260	59
R-606	Residential	413419	4075209	59
R-561	Residential	413691	4075291	59
R-557	Residential	413639	4075297	59
R-563	Residential	413609	4075290	59
R-569	Residential	413550	4075281	59
R-575	Residential	413520	4075275	59
R-586	Residential	413474	4075256	59
R-556	Residential	413606	4075303	59
R-551	Residential	413633	4075312	59
R-559	Residential	413547	4075296	59
R-562	Residential	413517	4075290	59

Table B-3 Received Sound Levels – Cable Splicing Activities

NSR ID	NSR Description	UTM Coordinates		Received Sound Level (dBA)
		Easting (m)	Northing (m)	
MH-1	Oceana Military Housing - Multi-Family	412723	4074370	54
MH-5	Oceana Military Housing - Multi-Family	412692	4074338	50
MH-8	Oceana Military Housing - Multi-Family	412734	4074317	49

Table B-3 Received Sound Levels – Cable Splicing Activities

NSR ID	NSR Description	UTM Coordinates		Received Sound Level (dBA)
		Easting (m)	Northing (m)	
MH-6	Oceana Military Housing - Multi-Family	412655	4074330	48
MH-2	Oceana Military Housing - Multi-Family	412615	4074367	47
MH-13	Oceana Military Housing - Multi-Family	412694	4074277	46
R-622	Residential	413465	4075146	46
R-619	Residential	413418	4075159	46
R-621	Residential	413490	4075153	45
MH-12	Oceana Military Housing - Multi-Family	412617	4074282	45
MH-4	Oceana Military Housing - Multi-Family	412569	4074343	45
R-614	Residential	413488	4075179	44
MH-17	Oceana Military Housing - Multi-Family	412631	4074244	44
MH-19	Oceana Military Housing - Multi-Family	412687	4074218	44
R-620	Residential	413542	4075156	44
MH-10	Oceana Military Housing - Multi-Family	412562	4074290	43
R-612	Residential	413536	4075186	43
R-618	Residential	413569	4075160	43
R-616	Residential	413359	4075170	43
MH-24	Oceana Military Housing - Multi-Family	412651	4074191	43
R-610	Residential	413533	4075201	43
MB-45	Military Barracks	412673	4074714	43
MH-16	Oceana Military Housing - Multi-Family	412566	4074245	43
R-597	Residential	413479	4075232	43
R-611	Residential	413567	4075190	43
MH-23	Oceana Military Housing - Multi-Family	412612	4074194	42
MH-27	Oceana Military Housing - Multi-Family	412688	4074161	42
R-604	Residential	413530	4075216	42
R-606	Residential	413419	4075209	42
R-607	Residential	413564	4075206	42
R-599	Residential	413528	4075230	42
MH-9	Oceana Military Housing - Multi-Family	412498	4074315	42
R-586	Residential	413474	4075256	42
R-602	Residential	413562	4075221	42
R-593	Residential	413525	4075245	42
R-617	Residential	413628	4075170	42
R-594	Residential	413559	4075236	42
R-600	Residential	413415	4075228	42
R-584	Residential	413520	4075260	41
R-570	Residential	413472	4075278	41
R-589	Residential	413558	4075251	41

Table B-3 Received Sound Levels – Cable Splicing Activities

NSR ID	NSR Description	UTM Coordinates		Received Sound Level (dBA)
		Easting (m)	Northing (m)	
R-609	Residential	413625	4075203	41
MH-22	Oceana Military Housing - Multi-Family	412523	4074195	41
R-575	Residential	413520	4075275	41
MH-30	Oceana Military Housing - Multi-Family	412624	4074124	41
MH-28	Oceana Military Housing - Multi-Family	412575	4074153	41
R-605	Residential	413620	4075215	41
R-579	Residential	413554	4075267	41
R-615	Residential	413662	4075175	41
R-587	Residential	413409	4075254	41

Table B-4 Received Sound Levels – Interconnection Station

NSR ID	NSR Description	UTM Coordinates		Received Sound Level (dBA)
		Easting (m)	Northing (m)	
MH-1	Oceana Military Housing - Multi-Family	412723	4074370	41
MH-5	Oceana Military Housing - Multi-Family	412692	4074338	37
MH-8	Oceana Military Housing - Multi-Family	412734	4074317	37
MH-6	Oceana Military Housing - Multi-Family	412655	4074330	35
MH-2	Oceana Military Housing - Multi-Family	412615	4074367	34
MH-13	Oceana Military Housing - Multi-Family	412694	4074277	34
MH-12	Oceana Military Housing - Multi-Family	412617	4074282	32
MH-4	Oceana Military Housing - Multi-Family	412569	4074343	32
MH-17	Oceana Military Housing - Multi-Family	412631	4074244	31
MH-19	Oceana Military Housing - Multi-Family	412687	4074218	31
MH-10	Oceana Military Housing - Multi-Family	412562	4074290	30
MH-24	Oceana Military Housing - Multi-Family	412651	4074191	30
MH-16	Oceana Military Housing - Multi-Family	412566	4074245	30
MB-45	Military Barracks	412673	4074714	29
MH-23	Oceana Military Housing - Multi-Family	412612	4074194	29
MH-27	Oceana Military Housing - Multi-Family	412688	4074161	29
MH-9	Oceana Military Housing - Multi-Family	412498	4074315	29
MH-3	Oceana Military Housing - Multi-Family	412477	4074349	29
MB-40	Military Barracks	412638	4074745	28
MH-7	Oceana Military Housing - Multi-Family	412444	4074318	28
MH-22	Oceana Military Housing - Multi-Family	412523	4074195	27
MH-28	Oceana Military Housing - Multi-Family	412575	4074153	27
MH-30	Oceana Military Housing - Multi-Family	412624	4074124	27
MH-35	Oceana Military Housing - Multi-Family	412659	4074098	27

Table B-4 Received Sound Levels – Interconnection Station

NSR ID	NSR Description	UTM Coordinates		Received Sound Level (dBA)
		Easting (m)	Northing (m)	
MH-15	Oceana Military Housing - Multi-Family	412451	4074249	27
MH-29	Oceana Military Housing - Multi-Family	412525	4074149	27
MH-31	Oceana Military Housing - Multi-Family	412561	4074120	26
MH-11	Oceana Military Housing - Multi-Family	412396	4074287	26
MH-38	Oceana Military Housing - Multi-Family	412623	4074062	26
MH-33	Oceana Military Housing - Multi-Family	412510	4074118	26
MH-26	Oceana Military Housing - Multi-Family	412450	4074167	26
MH-18	Oceana Military Housing - Multi-Family	412396	4074234	25
MH-21	Oceana Military Housing - Multi-Family	412414	4074205	25
MH-37	Oceana Military Housing - Multi-Family	412522	4074082	25
MH-41	Oceana Military Housing - Multi-Family	412557	4074058	25
MH-14	Oceana Military Housing - Multi-Family	412362	4074273	25
MB-34	Military Barracks	412510	4074783	25
MH-43	Oceana Military Housing - Multi-Family	412609	4074032	25
MH-36	Oceana Military Housing - Multi-Family	412450	4074098	25
MH-20	Oceana Military Housing - Multi-Family	412360	4074216	25
MB-31	Military Barracks	412465	4074802	24
MH-48	Oceana Military Housing - Multi-Family	412633	4073979	24
MH-34	Oceana Military Housing - Multi-Family	412406	4074105	24
MH-49	Oceana Military Housing - Multi-Family	412574	4073978	24
MH-39	Oceana Military Housing - Multi-Family	412428	4074061	24
MH-45	Oceana Military Housing - Multi-Family	412469	4074019	24
MH-25	Oceana Military Housing - Multi-Family	412330	4074175	24
MH-32	Oceana Military Housing - Multi-Family	412353	4074120	23
MB-27	Military Barracks	412420	4074814	23
MB-17	Military Barracks	412464	4074853	23

Attachment C – Figures

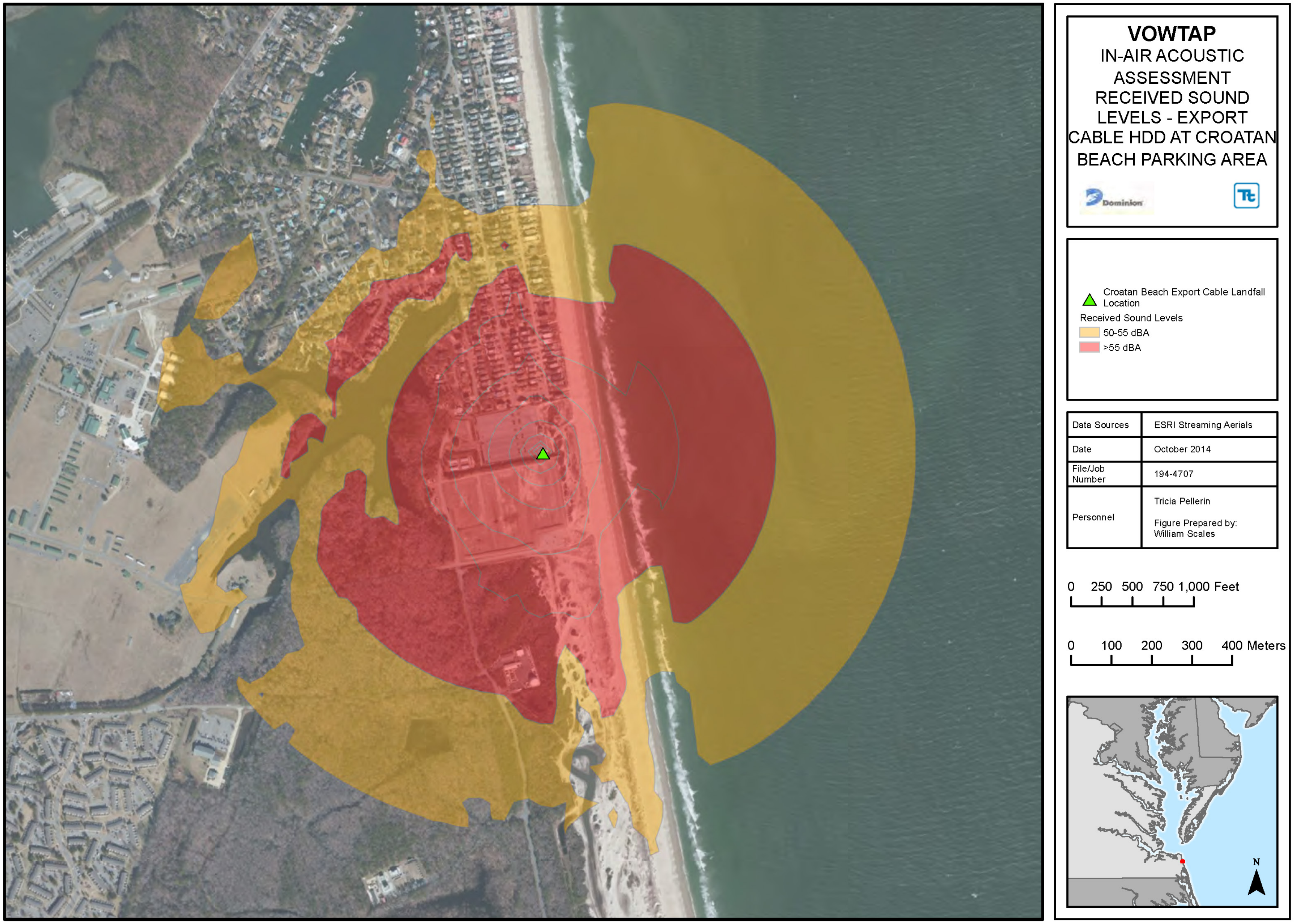


Figure C-1. Received Sound Levels, HDD at Croatan Beach Parking Area

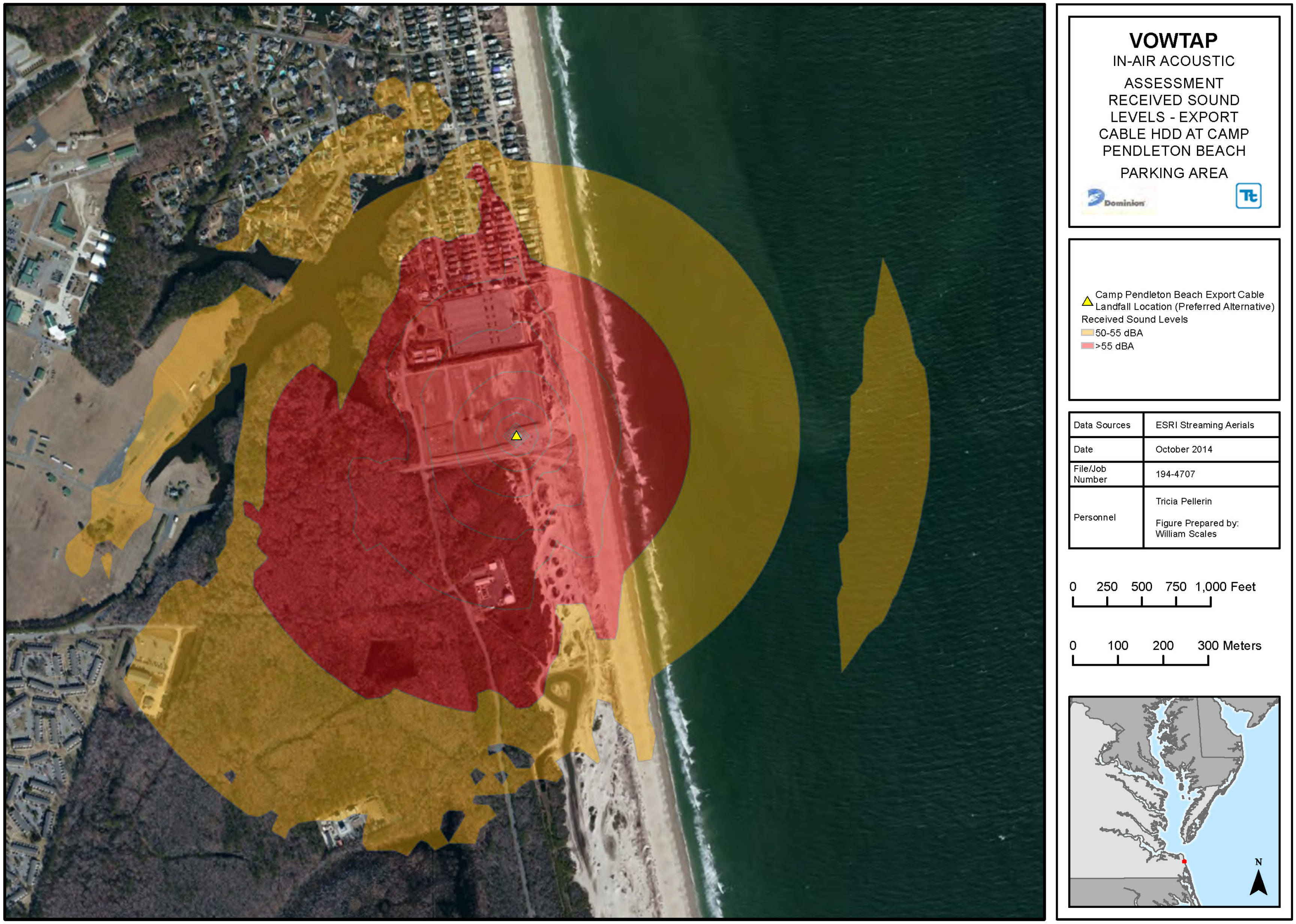


Figure C-2. Received Sound Levels, HDD at Camp Pendleton Beach Parking Area

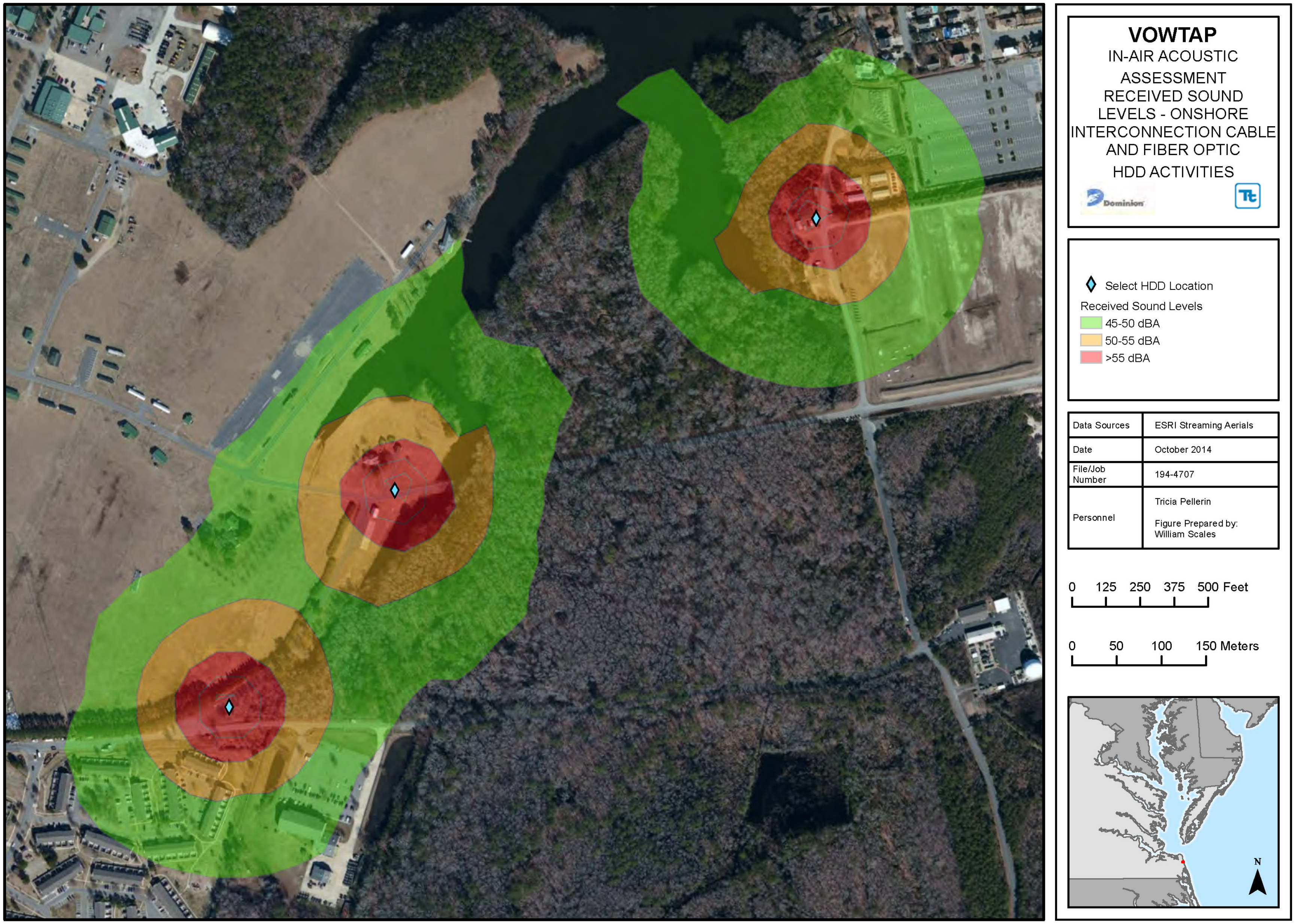
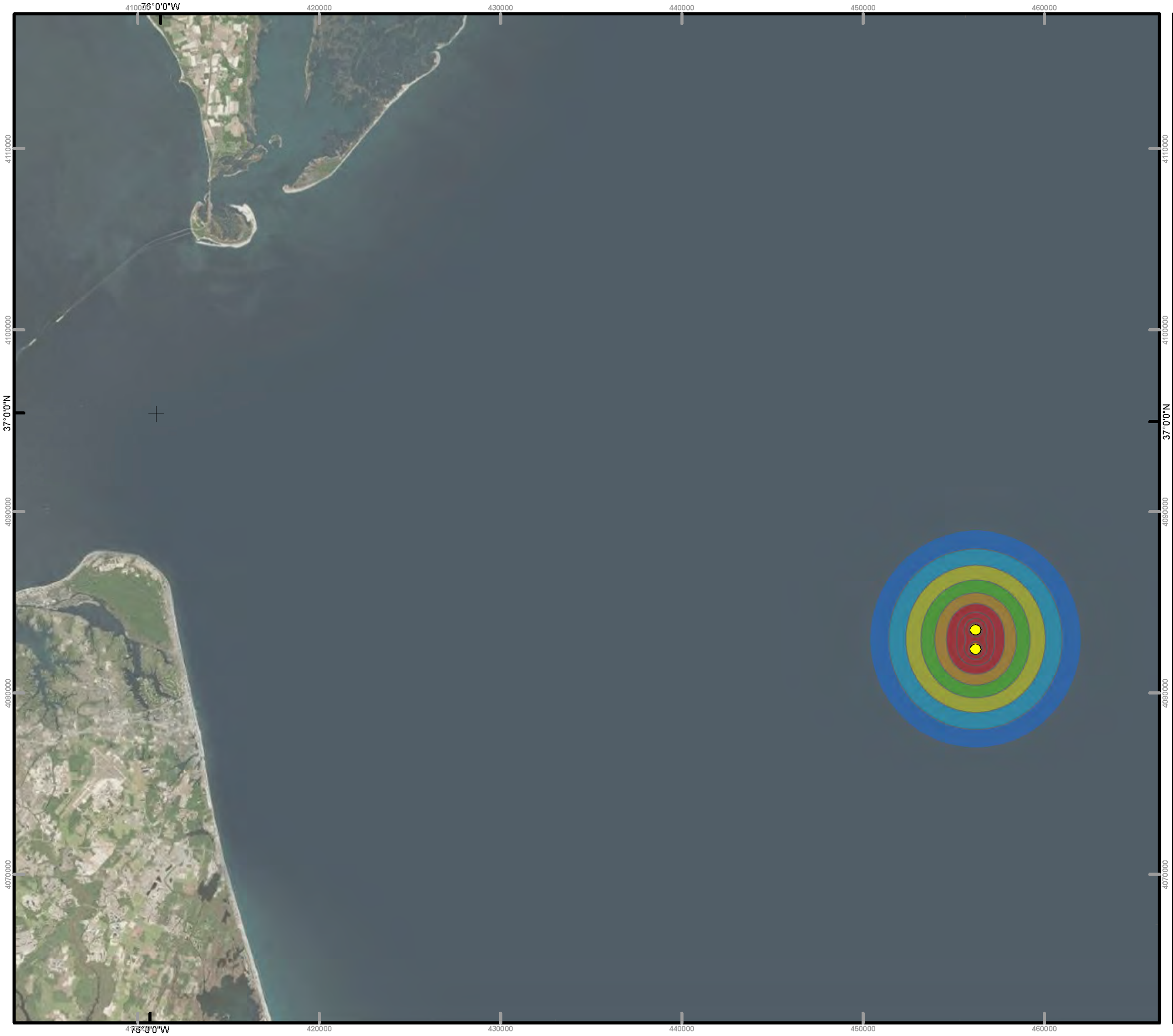


Figure C-3. Received Sound Levels, Cable Splicing Activities



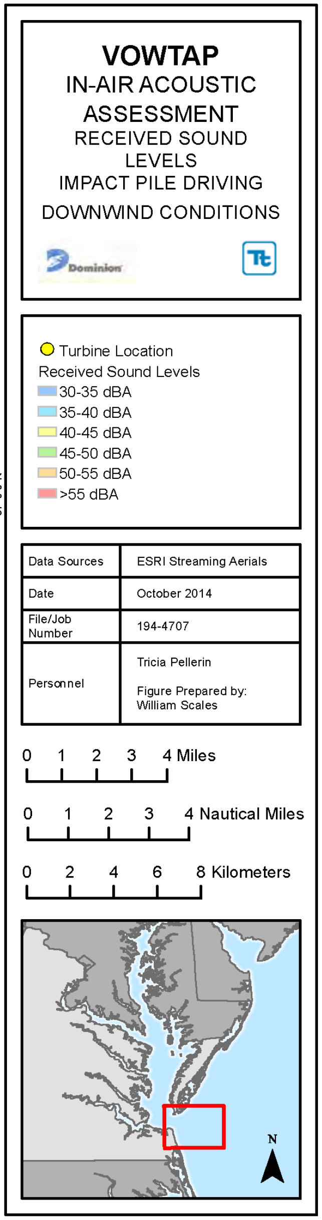


Figure C-4. Received Sound Levels, Impact Pile Driving, Downwind Conditions

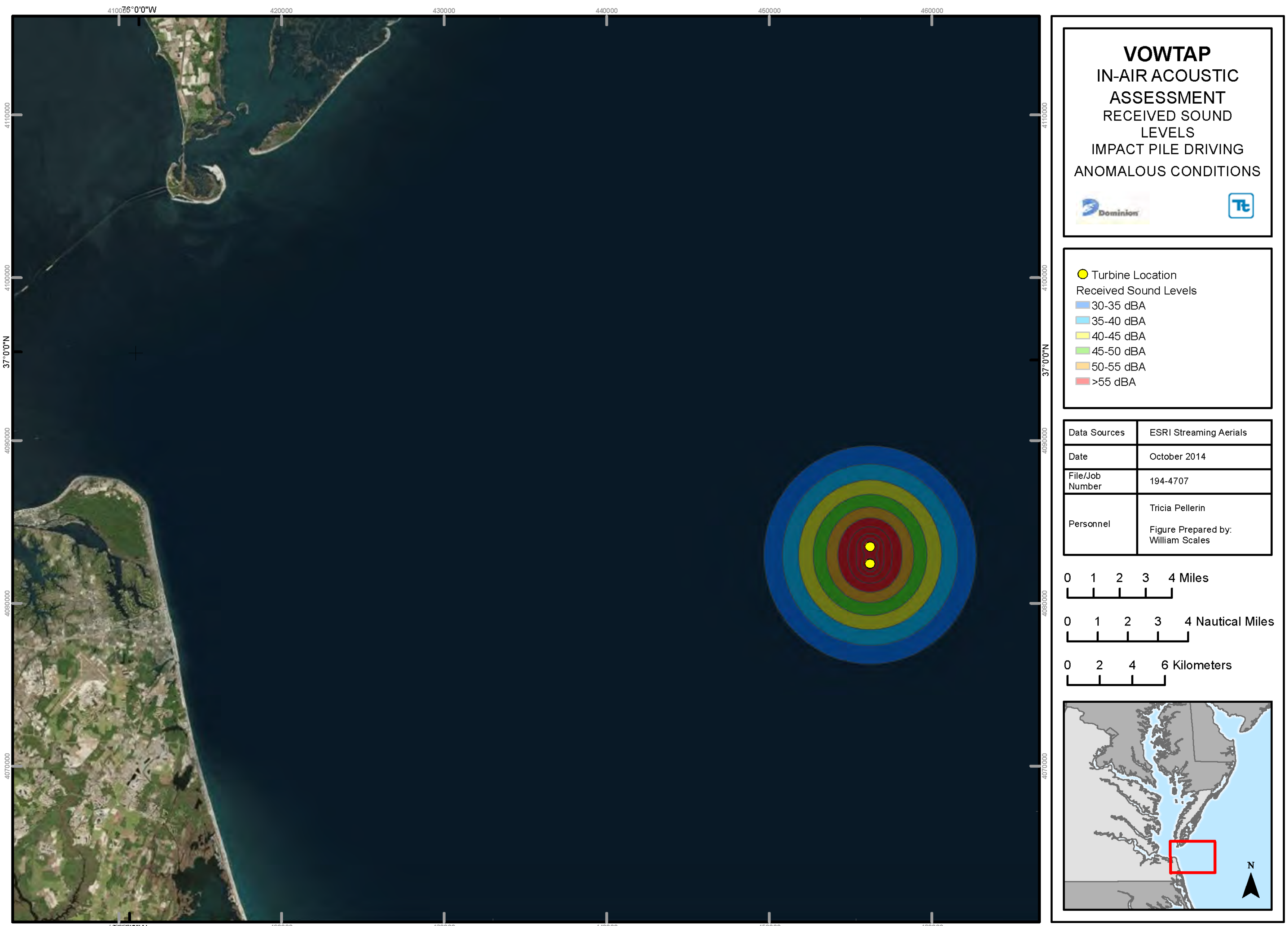


Figure C-5. Received Sound Levels, Impact Pile Driving, Anomalous Conditions

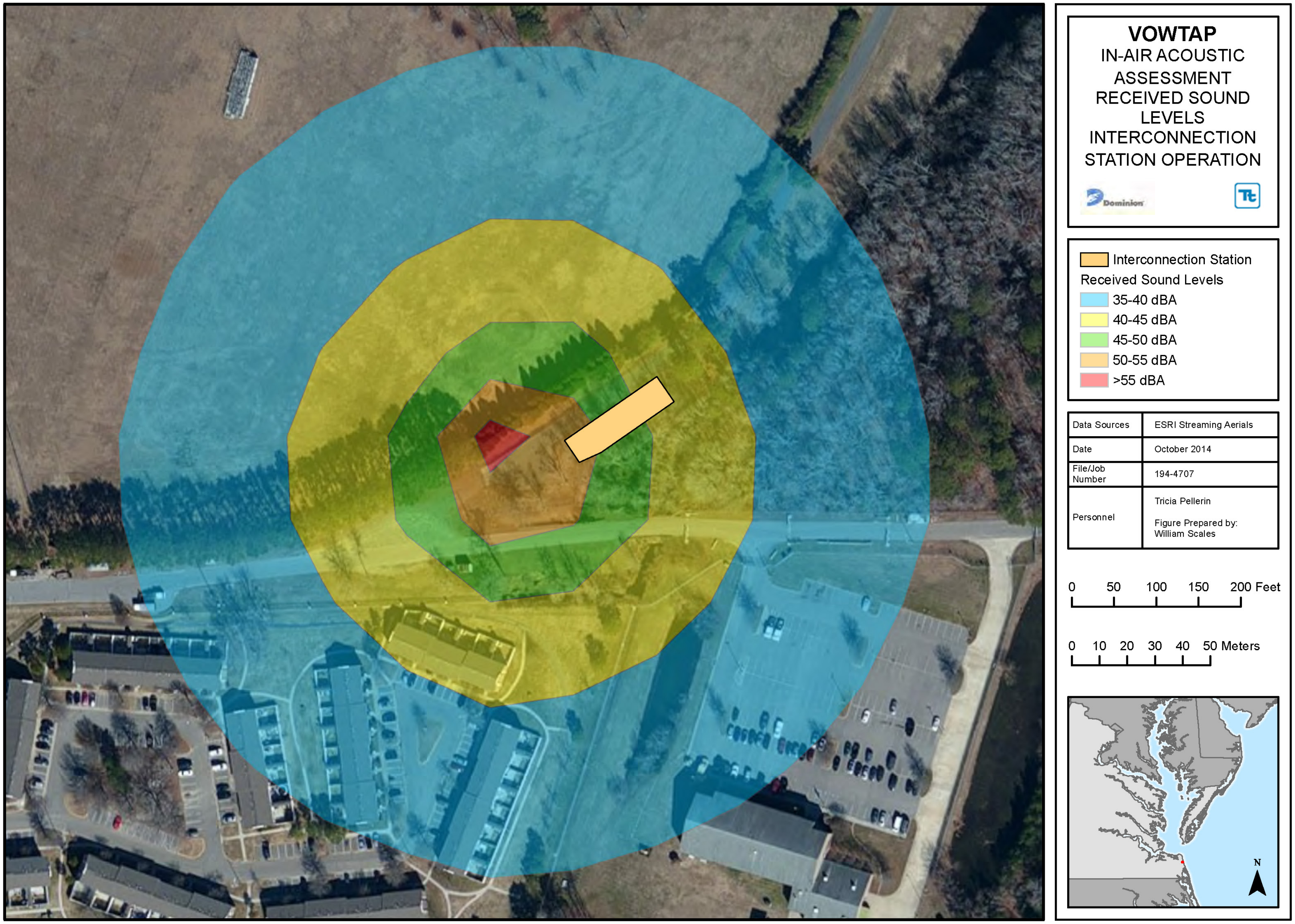


Figure C-6. Received Sound Levels, Interconnection Station Operation

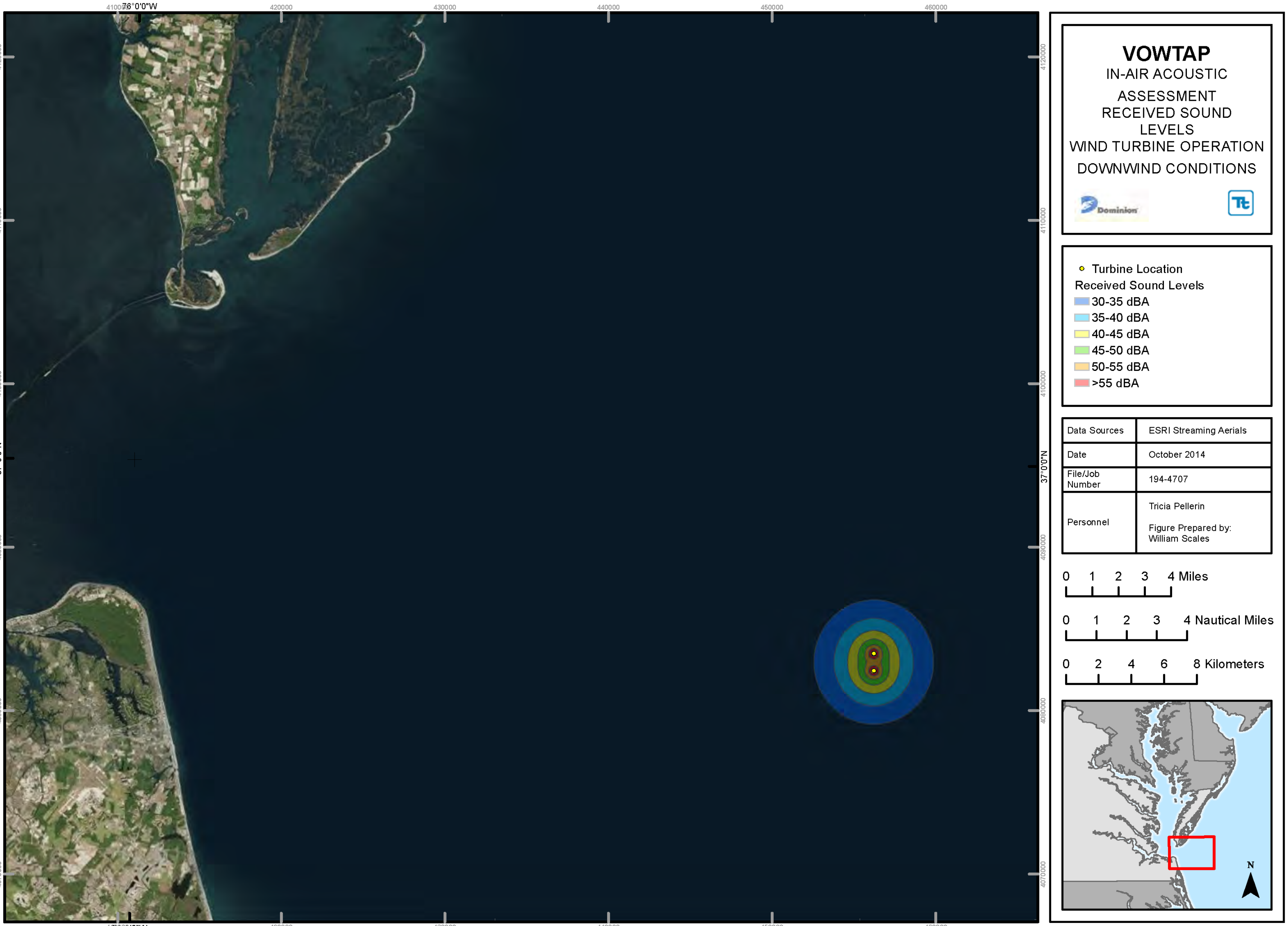


Figure C-7. Received Sound Levels, Wind Turbine Operation, Downwind Conditions

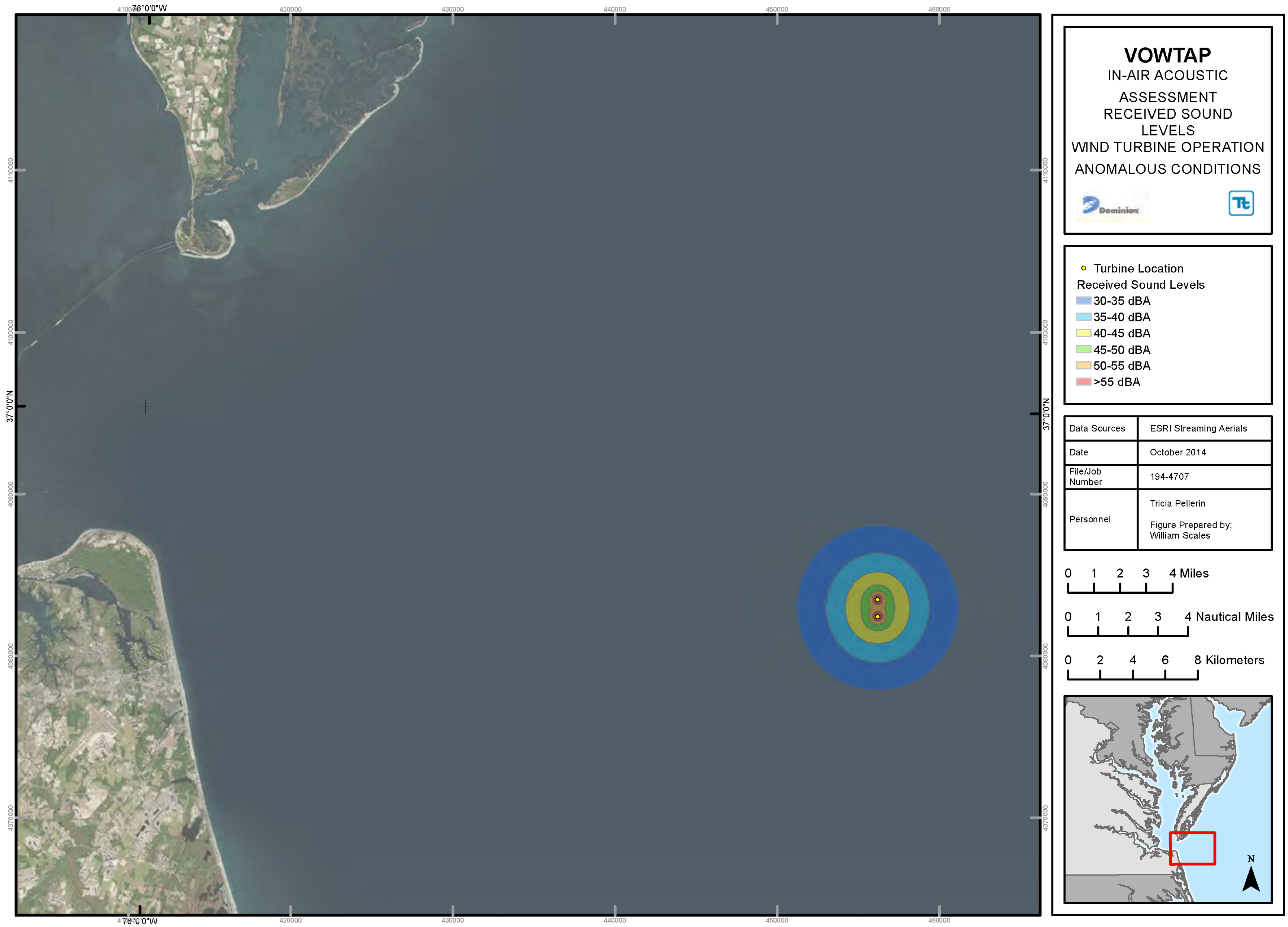


Figure C-8. Received Sound Levels, Wind Turbine Operation, Anomalous Conditions