Appendix N

Acoustic Assessment

DEEPWATERWIND®

Appendix N-1

In-Air Acoustic Report

DEEPWATERWIND®

Block Island Wind Farm
and
Block Island Transmission System

In-Air Acoustic Report

Prepared for

Deepwater Wind Block Island, LLC

and

Deepwater Wind Block Island Transmission, LLC

DEEPWATERWIND®

CLEAN ENERGY IS JUST OVER THE HORIZON

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EXECUTIVE SUMMARY

Deepwater Wind Block Island, LLC, a wholly owned indirect subsidiary of Deepwater Wind Holdings, LLC, is proposing to develop the Block Island Wind Farm (BIWF), a 30 megawatt (MW) offshore wind farm located approximately 3 miles (mi) (4.8 kilometers [km]) southeast of Block Island, Rhode Island. The BIWF will consist of five (5), 6 MW wind turbine generators (WTGs), a submarine cable interconnecting the WTGs (Inter-Array Cable), and a 34.5-kV transmission cable from the northernmost WTG to an interconnection point on Block Island (Export Cable). In connection with the BIWF, Deepwater Wind Block Island Transmission, LLC, also a wholly owned indirect subsidiary of Deepwater Wind Holdings, LLC, is proposing to develop the Block Island Transmission System (BITS), a 34.5 kilovolt (kV) alternating current (AC) bi-directional submarine transmission cable that will run approximately 22 miles (35.4 kilometers) from Block Island to the Rhode Island mainland. For the purposes of this analysis, the two Deepwater Wind Holdings, LLC corporate entities associated with the development of the BIWF and BITS are collectively referred to as “Deepwater Wind.” Likewise, the BIWF and BITS are collectively referred to as “the Project.”

Tetra Tech EC, Inc. (Tetra Tech) has completed an acoustic assessment of in-air noise impacts related to the BIWF and BITS. The acoustic engineering analysis was completed to: (1) estimate site-specific sound propagation characteristics and incorporating terrain effects; (2) computer simulate Project construction and operational sound levels over a range of future Project operational and meteorological conditions using internationally accepted calculation standards; and (3) evaluate the feasibility of the Project to be in compliance with applicable noise requirements. Primary noise-generating activities during construction are horizontal directional drilling (HDD) and pile driving. Primary noise-generating activities during operation are the wind turbine generators (WTGs), switchyards, and the nautical hazard prevention device (i.e., foghorn). These Project activities were analyzed to determine potential noise impacts at noise sensitive receptors (NSRs; residential structures).

Sound propagation modeling was conducted using the Computer Aided Noise Abatement (CadnaA) software program (version 4.2.140), a comprehensive 3-dimensional acoustic modeling program specifically developed for the power generation industry with calculations made in accordance with International Organization for Standardization (ISO) Standard 9613-2 “Attenuation of Sound during Propagation Outdoors”. The industry standard CadnaA acoustic modeling software is widely used by sound engineers due to its adaptability to describe complex acoustic scenarios. 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. The results of the acoustic modeling results were compared to applicable noise requirements prescribed locally by the Towns of Narragansett and New Shoreham, Rhode Island.

Construction activity modeling results indicated that sound levels generated by the short- HDD option would be in compliance with the 65 dBA daytime Narragansett limit but not the nighttime limit. The long-HDD option would not be in compliance with either the daytime or the nighttime noise ordinance in the Town of Narragansett and neither short- nor long HDD option would comply with the nighttime noise ordinance in the Town of New Shoreham at nearby NSRs. To achieve compliance, Deepwater Wind has committed to the following mitigation measures:

1. Use of a temporary sound wall in Narragansett if necessary to comply with the Town of Narragansett noise ordinance;

2. Limiting HDD activities to daytime hours unless a situation arises where ceasing the HDD activity would compromise safety (both human health and environmental) and/or the integrity of the Project; and
3. Use of a temporary sound wall in New Shoreham for nighttime work, if it occurs.

For the HDD sites proposed on Block Island, no mitigation would be required to comply with the Town of New Shoreham 65 dBA daytime limit. Deepwater Wind will seek a variance of the Narragansett Noise Ordinance from the town council during vibratory pile driving needed for cofferdam construction if the long-HDD option is selected.

Results of the pile driving modeling analysis revealed no potential compliance issue with the Town of New Shoreham noise ordinance.

Operations activity modeling results of the three alternative locations (A, B, and C) for the Block Island Substation, which is comprised of the BIWF Generation Switchyard and BITS Island Switchyard, indicate that the Block Island Substation would comply with the Town of New Shoreham noise ordinance. Modeling results also indicate that the Narragansett Switchyard (BITS Alt 1) will comply will the Town of Narragansett noise ordinance. At times, sound generated at the Block Island Substation and Narragansett Switchyards could be audible offsite dependent on prevailing background levels.

The foghorn, which is expected to be mounted on the platform of the centrally located WTG, was analyzed under standard downwind propagation and anomalous meteorological conditions. Modeling results showed received sound levels onshore would remain low-level for both scenarios with received sound levels at NSR well below the applicable 55 dBA Town of New Shoreham limit. Wind turbine operation was also analyzed under standard downwind propagation and anomalous meteorological conditions in addition to expected long-term average meteorological conditions based on historical data of the Project Area collected in support of the RI Ocean SAMP. Under all scenarios, received sound levels at identified NSRs remained below 25 dBA, which is well below the New Shoreham 55 dBA nighttime limit.

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ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
BIPCO	Block Island Power Company
BITS	Block Island Transmission System
BIWF	Block Island Wind Farm
CFR	Code of Federal Regulations
CRMC	Rhode Island Coastal Resources Management Council
dBA	A-weighted decibel
dBL	linear decibel
Deepwater Wind	Deepwater Wind Rhode Island, LLC and Deepwater Wind Block Island Transmission, LLC
EPA	U.S. Environmental Protection Agency
GIS	geographic information system
HDD	horizontal directional drilling
HDPE	high-density polyethylene
Hz	hertz
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IEC	International Electrotechnical Commission
ISO	Organization for International Standardization
kHz	kilohertz
kJ	kilojoule
kVA	kilovolt ampere
L_{dn}	day-night sound level
L_{eq}	equivalent sound level
L_{max}	maximum sound level
L_{min}	minimum sound level
L_n	statistical sound level
MD	medium density
MVA	megavolt ampere
MSL	mean sea level
MW	megawatt
NEMA	National Electrical Manufacturers Association
nm	nautical mile
NRC	Noise Reduction Coefficient
NSR	noise sensitive receptor
Project	Block Island Wind Farm and Block Island Transmission System
RI Ocean SAMP	Rhode Island Ocean Special Area Management Plan
URI	University of Rhode Island
USGS	United States Geological Survey
WTG	wind turbine generator

1.0 INTRODUCTION

Deepwater Wind Block Island, LLC, a wholly owned indirect subsidiary of Deepwater Wind Holdings, LLC, proposes to develop the Block Island Wind Farm (BIWF), an approximately 30 megawatt (MW) offshore wind farm located approximately 3 miles (mi) (4.8 kilometers [km])[1] southeast of Block Island, Rhode Island. The BIWF will consist of five (5), 6 megawatt (MW) wind turbine generators (WTGs), a submarine cable interconnecting the WTGs (Inter-Array Cable), and a 34.5-kV transmission cable from the northernmost WTG to an interconnection point on Block Island (Export Cable). In connection with the BIWF, Deepwater Wind Block Island Transmission, LLC, also a wholly owned indirect subsidiary of Deepwater Wind Holdings, LLC, proposes to develop the Block Island Transmission System (BITS), a 34.5 kilovolt (kV) alternating current (AC) bi-directional submerged transmission cable that will run approximately 22 miles (35.4 kilometers) from Block Island to the Rhode Island mainland (collectively "Deepwater Wind" and "Project"). The BITS and BIWF Export Cable will be brought ashore using a horizontal direction drill (HDD) from points off of Block Island (Town of New Shoreham) and Narragansett, Rhode Island. The Project will also include construction of a new substation on Block Island, Rhode Island (Block Island Substation), comprised of the BIWF Generation Switchyard and the BITS Island Switchyard.

Noise will be generated during Project construction and operation and since BIWF is located offshore both potential in-air and underwater noise impacts are considered as a part of the permitting process. The evaluation of noise impacts is typically most critical at noise sensitive receptors (NSRs), which for the purposes of the in-air environment are structures such as residences, hospitals, schools, etc. and in the underwater environment are marine mammals, sea turtles, and fish. The following acoustic assessment deals specifically with potential noise impacts that may occur as a result of the Project within the in-air environment. The underwater acoustic assessment is provided under a separate cover.

Primary noise-generating activities during construction are HDD and pile driving. Primary noise-generating activities during operation are the WTGs, switchyards, and nautical hazard prevention device (i.e., foghorn). The overall objectives of this study were to: (1) estimate site-specific sound propagation characteristics and incorporating terrain effects; (2) computer simulate Project construction and operational sound levels over a range of future Project operational and meteorological conditions using internationally accepted calculation standards; and (3) evaluate the feasibility of the Project to be in compliance with applicable noise requirements. This acoustic report includes a description of in-air acoustic sound metrics and terminology, existing conditions, regulatory framework, methods employed, and the results and conclusions of the modeling analysis.

1.1 In-Air Acoustic Concepts and Terminology

In-air sound levels are presented on a logarithmic scale to account for the large range of acoustic pressures that the human ear is exposed to and are expressed in units of decibels (dB). A decibel is defined as the ratio between a measured value and a reference value usually corresponding to the lower threshold of human hearing defined as 20 micropascals (μPa). Broadband sound includes sound energy summed across the entire audible frequency spectrum. In addition to broadband sound pressure levels, analysis of the various frequency components of the sound spectrum can be completed to determine tonal

[1] Distances throughout the Acoustic Report are provided as statute miles (mi) or nautical miles (nm) as appropriate, with kilometers in parentheses. For reference, 1 mi equals approximately 0.87 nm.

characteristics. The unit of frequency is Hertz (Hz), measuring the cycles per second of the sound pressure waves, and typically the frequency analysis examines 11 octave (or 33 1/3 octave) bands ranging from 16 Hz (low) to 16,000 Hz (high). One third (1/3) octave bands take these ten octave bands and split them into three, giving a more higher resolution and a more detailed description of the frequency content of the sound. Since the human ear does not perceive every frequency with equal loudness, spectrally varying sounds are often adjusted with a weighting filter. The A-weighted filter is applied to compensate for the frequency response of the human auditory system and is represented in dBA.

An inherent property of the logarithmic decibel scale is that the sound pressure levels of two separate sources are not directly additive. For example, if a sound of 50 dBA is added to another sound of 50 dBA, the result is a 3-decibel increase (or 53 dBA), not an arithmetic doubling of 100 dBA. The human ear does not perceive changes in the sound pressure level as equal changes in loudness. Scientific research demonstrates that the following general relationships hold between sound level and human perception for two sound levels with the same or very similar frequency characteristics:

- 1 dBA is the practically achievable limit of the accuracy of sound measurement systems and corresponds to an approximate 10 percent variation in sound pressure. A 1 dBA increase or decrease is a non-perceptible change in sound.
- 3 dBA increase or decrease is a doubling (or halving) of acoustic energy and it corresponds to the threshold of perceptibility of change in a laboratory environment. In practice, the average person is not able to distinguish a 3 dBA difference in environmental sound outdoors.
- 5 dBA increase or decrease is described as a perceptible change in sound level and is a discernible change in an outdoor environment.
- 10 dBA increase or decrease is a tenfold increase or decrease in acoustic energy but is perceived as a doubling or halving in sound (i.e., the average person will judge a 10 dBA change in sound level to be twice or half as loud).

The analysis of acoustic data requires special consideration of sound levels that will generally fluctuate over time. To account for the time-varying nature of environmental noise, a single descriptor known as the equivalent sound level (L_{eq}) is often used. The L_{eq} value is the sound energy averaged over a complete measurement period. It is defined as the steady, continuous sound level over a specified time that has the same acoustic energy as the actual varying sound levels over the same time. The metrics commonly used for environmental sound studies, including the L_{eq}, are reported as dBA. The equivalent sound level has been shown to provide both an effective and uniform method for describing time-varying sound levels and is widely used in acoustic assessments of wind energy facilities. The day-night sound level (L_{dn}) measures the 24-hour average noise level at a given location. The L_{dn} is calculated by averaging the 24-hour hourly L_{eq} levels at a given location after adding 10 dB to the nighttime period (10:00 p.m.- 7:00 a.m.) to account for the increased sensitivity of people to noises that occur at night. Several other statistical descriptors can also be assessed to provide further understanding of the existing soundscapes. The statistical sound levels (L_n) provide the sound level exceeded for that percentage of time over the given measurement period. An L_{10} level is often referred to as the intrusive noise level and is the sound level that is exceeded for 10 percent of the time during a specified measurement period. The L_{90} level, which is the sound level that is exceeded for 90 percent of the time during the measurement time period, can be thought of as the quietest 10 percent of any time period and is often referred to as the residual sound level. The L_{90} can be an indicator of the potential of audibility for a new sound source. The

L_{max} is the maximum sound level during the measurement period and the L_{min} is the minimum sound levels during the measurement period. Estimates of noise sources and outdoor acoustic environments, and the comparison of relative loudness are presented in Table 1. Table 2 presents additional reference information on terminology used in the acoustic assessment.

Table 1 Sound Pressure Levels and Relative Loudness of Typical Noise Sources and Soundscapes

Noise Source or Activity	Sound Level (dBA)	Subjective Impression	Relative Loudness (Perception of Different Sound Levels)
Jet aircraft takeoff from carrier (50 ft)	140	Threshold of pain	64 times as loud
50-hp siren (100 ft)	130		32 times as loud
Loud rock concert near stage or Jet takeoff (200 ft)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 ft)	110		8 times as loud
Jet takeoff (2,000 ft)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 ft)	90		2 times as loud
Garbage disposal, food blender (2 ft), or Pneumatic drill (50 ft)	80	Loud	Reference loudness
Vacuum cleaner (10 ft)	70		1/2 as loud
Passenger car at 65 mph (25 ft)	65	Moderate	
Large store air-conditioning unit (20 ft)	60		1/4 as loud
Light auto traffic (100 ft)	50	Quiet	1/8 as loud
Quiet rural residential area with no activity	45		
Bedroom or quiet living room or Bird calls	40	Faint	1/16 as loud
Typical wilderness area	35		
Quiet library, soft whisper (15 ft)	30	Very quiet	1/32 as loud
Wilderness with no wind or animal activity	25	Extremely quiet	
High-quality recording studio	20		1/64 as loud
Acoustic test chamber	10	Just audible	
	0	Threshold of hearing	
Adapted from: Beranek (1988) and USEPA (1971)			

Table 2 Acoustic Terms and Definitions

Term	Definition
Noise	Typically it is unwanted sound. This word adds the response of humans to the physical phenomenon of sound. The descriptor is used only when negative effects on people are known to occur.
Sound Pressure Level (L_P)	Pressure fluctuations in a medium (air in this case). Sound pressure is measured in decibels referenced to 20 microPascals, the approximate threshold of human perception to sound at 1000 Hz.
Sound Power Level (L_W)	The total acoustic power of a noise source measured in decibels referenced to 10^{-12} watts. Sound power is independent of the environment The wind turbine manufacturer noise specification is provided in these terms since sound power is independent of environment.
A-Weighted Decibel (dBA)	Environmental sound is typically composed of acoustic energy across all frequencies (Hz). To compensate for the auditory frequency response of the human ear, an A-weighting filter is commonly used for describing environmental sound levels. Sound levels that are A-weighted are presented as dBA in this report.
Unweighted Decibels (dBL)	Unweighted sound levels are referred to as linear, or dBL. Linear decibels are used to determine a sound's tonality and to engineer solutions to reduce or control noise as techniques are different for low and high frequency noise. Sound levels that are linear are presented as dBL in this report.
Acoustic Modulation	Technical term describing the variation of sound pressure over time caused by aerodynamic noise as the wind turbine blade passes through the air and interaction with turbulence effects created by the tower structure, i.e. blade swish.

Term	Definition
Propagation/Attenuation	The decrease in amplitude of an acoustic signal due to geometric spreading losses with increased distance from the source. Other factors that can effect attenuation include air absorption, terrain effects, ground absorption, diffraction around objects and topographical features, trees, and meteorological conditions including wind velocity, temperature, humidity and non-homogenous atmospheric conditions.
Octave Bands	The audible range of humans spans from 20 to 20,000 Hertz and is typically divided into center frequencies (Hz) ranging from 31 to 8,000 Hz.
Masking	Interference in the perception of one sound by the presence of another sound. At elevated wind speeds, wind generated noise and leaf rustle will mask wind turbine sound levels which remain relatively constant.
Broadband	Containing sound energy at all frequencies across the entire audible spectra.
Frequency (Hz)	The rate of oscillation of a sound, measured in units of Hertz (Hz) or kilohertz (kHz). One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate. For comparative purposes, the lowest note on a full range piano is approximately 32 Hz and middle C is 261 Hz.
Directivity	Directivity accounts for the variation in sound intensity with orientation relative to the noise source. The Directivity correction is often denoted as DI.
Wavelength	The distance between peaks of a propagating wave with a well-defined frequency. It is related to the frequency through the following equation $\lambda = c/f$ where c is the sound speed and f is the frequency in Hz. It has the dimensions of length.
Notes: Compiled by from multiple technical and engineering sources	

1.2 Existing Conditions

The existing acoustic environment within the Project study area is dependent upon a number of localized coastal area factors that affect the in-air ambient sound levels both spatially and temporally depending on season and time of day. Such factors may include natural sounds such as wind, surf conditions, and animal vocalizations, or environmental sounds related local land uses and activities, population densities, vehicle and nautical traffic, and proximity to existing recreational, commercial, and industrial sound sources.

The BIWF and BITS is expected to contribute to the acoustic environment on a short-term basis during construction as well as during operation. The Project study area consists of undeveloped natural areas, some commercial land use and mixed residential land use ranging from low density to medium high density in certain locations. Block Island is a popular tourist destination and therefore population density would be expected to vary based on the season. Actual ambient measurements have not be conducted to document the existing acoustic environment; however, ambient sound levels are expected to be low, although may be sporadically elevated in localized areas due to aircraft, roadway noise or periods of human activity. Background sound levels will vary both spatially and temporally depending on proximity to area sound sources, roadways and natural sounds. Diurnal effects result in sound levels that are typically quieter during the night than during the daytime, except during periods when evening and nighttime insect noise may dominate the soundscape. Closer to the coastline, waves breaking on the seashore may also contribute to the overall existing soundscape.

2.0 REGULATORY FRAMEWORK

The criteria for the in-air acoustic assessment are thresholds established by guidelines or regulations at the federal, state, or local level.

2.1 Federal

In 1974, the U.S. 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 an 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 public exposure is possible. The EPA cause-and-effect criteria limits are summarized in Table 3.

Table 3 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 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 intentionally conservative to protect the most sensitive portion of the population with an additional margin of safety.

2.2 State

The State of Rhode Island does not have environmental noise regulations with numerical decibel limits directly or indirectly applicable to the Project. Rhode Island leaves it up to each individual community to establish noise regulations through community by-laws; however, the Rhode Island Coastal Resources Management Council (CRMC), the state's coastal management agency, developed the Rhode Island

Ocean Special Area Management Plan (RI Ocean SAMP). The major driver for the development of the Ocean SAMP was the determination by the Rhode Island Office of Energy Resources in 2007 that investment in offshore wind farms would be necessary to achieve Governor Donald Carcieri's mandate that offshore wind resources provide 15 percent of the state's electrical power by 2020. In response, the CRMC proposed the creation of the RI Ocean SAMP as a mechanism to develop a comprehensive management and regulatory tool that would proactively engage the public and provide policies and recommendations for appropriate siting of offshore renewable energy. The RI Ocean SAMP provides recommendations to guide the CRMC in promoting a balance and comprehensive ecosystem-based management approach for the development and protection of Rhode Island's ocean-based resources within the RI Ocean SAMP study area. In Chapter 11 of the RI Ocean SAMP the following policy is given for offshore renewable energy and other offshore development with respect to noise:

- A goal for the wind farm applicant and operator is to have operational noise from wind turbines average less than or equal to 100 dB re 1 μPa2 in any 1/3 octave band at a range of 100 meters at full power production.
- The applicant and manufacturer should endeavor to minimize the radiated airborne noise from the wind turbines.
- A monitoring system including acoustical, optical and other sensors should be established near these facilities to quantify the effects.

As stated in the RI Ocean SAMP, the goals presented above are just that. They should not be considered standards, and may not even be realistic given current knowledge and technology but should remain targets proponents should strive for in the pursuit of possibly alleviating potential adverse noise impacts associated with offshore wind turbine operation.

2.3 Local

Local noise requirements have been identified on Block Island (Town of New Shoreham) as well as on the mainland towns of Narragansett and South Kingstown as described in the following subsections.

2.3.1 Town of New Shoreham Noise Ordinance

Chapter 12-1 of the Town of New Shoreham Code of Ordinance pertains to noise with the objective of establishing standards for control of noise pollution in the town by setting maximum permissible sound levels for various activities to protect health, safety and general welfare. The following maximum permissible sound levels are allowed at or within the real property boundary of a receiving land (Table 4). When determining Project compliance at NSRs the most stringent Category I sound limits were used, which apply to all residential use zones and also happen to be identical to sound limits provided for Category III.

In addition, for any source of sound that emits a pure tone, the maximum sound level limits in Table 4 are reduced by 5 dBA. In terms of construction, the ordinance states that a noise disturbance cannot be created across a residential property boundary or within a noise sensitive area. Lastly, guidance is provided on the measurement of sound in Section 12-4 of the ordinance.

Table 4 New Shoreham Maximum Permissible Sound Levels by Receiving Land Use

Location of Receiving Land	Time	Sound Limit (dBA)
Category I: Residential A Zone Residential B Zone Residential C Zone Residential C/Mixed Use Zone	7:00 am to 9:00 pm	65 dBA
	9:00 pm to 7:00 am	55 dBA
Category II: New Harbor Commercial Zone Old Harbor Commercial Zone Mixed Use Zone Service Commercial Zone	7:00 am to 12:00 am	70 dBA
	12:00 am to 7:00 am	65 dBA
Category III: Beaches Public Waters	7:00 am to 9:00 pm	65 dBA
	9:00 pm to 7:00 am	55 dBA
Category IV: Special Event	Daytime special events shall be exempt from the sound limits (dBA) until December 31, 2005.	

2.3.2 Narragansett Noise Ordinance

The Narragansett Code of Ordinances identifies maximum permissible sound levels by receiving land use (Part II, Chapter 22 [Environment], Article III, Section 22-47). Table 5 presents these limits in terms of broadband levels that are allowed at or within the real property boundary of a receiving land use. In addition, the regulation states that for any source emitting a narrow band sound, the maximum sound level limits presented below will be reduced by 5 dBA. Construction is restricted to avoiding the creation of a noise disturbance across a residential real property boundary unless a variance is obtained from the town council. When determining Project compliance at NSRs the Residential maximum permissible limits shown in Table 5 were used.

Table 5 Narragansett Maximum Permissible Sound Levels by Receiving Land Use

Location of Receiving Land Use	Time	Sound Limit (dBA)
Zoning District: Residential	7:00 a.m. to 10:00 p.m.	65 dBA
	10:00 p.m. to 7:00 a.m.	55 dBA
Zoning District: Business Zones BA, BB, BC	1:00 a.m. to 7:00 a.m.	55 dBA
	All other times	75 dBA
Zoning District: Industrial Zones IA and IB	1:00 a.m. to 7:00 a.m.	55 dBA
	All other times	75 dBA

3.0 ACOUSTIC ANALYSIS METHODOLOGY

The proposed acoustic analysis for assessing potential noise impacts associated with Project construction and operation included the following steps:

1. Preliminary research was conducted to identify noise requirements that would be applicable to the Project. These requirements are described in Section 2.0 of this report;
2. A study was completed by geographic information system (GIS) analysts to identify potential NSRs within a ½ mile buffer distance of proposed Project activities;
3. Primary noise-generating Project activities were identified as warranting inclusion in the acoustic analysis. Relevant details pertaining to these activities including location, duration, dimensions and sound characteristics were obtained. Wherever possible, actual measurement data or manufacturer design specifications were used to describe sound sources;
4. The acoustic model was selected and used to carry out prediction simulations of the primary noise-generating activities; and
5. Comparison of the results attained from the model with the noise requirements applicable to the Project.

The calculation model can also provide useful information in regards to mitigation, if necessary, in order to reduce noise resulting from the Project.

3.1 Sound Propagation Model

This section summarizes the acoustic modeling software employed, sound source characteristics, model input parameters, and Project-specific modeling considerations. The in-air acoustic modeling analysis employed the DataKustik's Cadna/A software (version 4.2.140). CadnaA is a comprehensive 3-dimensional acoustic software model that conforms to the Organization for International 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 receiver 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. The following subsections discuss how CadnaA incorporates site-specific aspects including sound source characteristics, topography and ground effects, and meteorology.

3.1.1 Sound Source Characteristics

CadnaA allows for three basic types of sound sources to be introduced into the model: point, line, and areas sources. Point sources can be used for small sources or for larger sources with proportioned dimensions that are located away from the relevant receptors. Line sources are used for linear-shaped sources such as pipelines or transmission lines. Finally, area sources can be vertical, such as openings in a building or noise-radiating façade, or horizontal such as a roof, or a number of fixed or moving sources distributed on the ground. The Project-specific sounds sources will be included in the model as a combination of point (WTG, foghorn, jet plow) and area (switchyard, HDD) sources.

For point sources, sound levels will attenuate with increased distance from the source in accordance with the “inverse square law” due to geometric divergence that occurs as the sound energy is spread across a sphere of greater dimensions. The equivalent continuous downwind octave band sound pressure level at a receiver location is calculated for each point source and its image sources on both a broadband and frequency dependent basis from 31 Hz to 8 kHz. Geometrical divergence accounts for spherical spreading in the free field from a point sound source according to the equation below:

$$L_{fT}(DW) = L_W + D_C - A \text{ in dBA}$$

Where:

D_C directivity index correction that describes the extent by which the equivalent continuous sound pressure level from the point sound source deviates in a specified direction from the level of an omnidirectional point source producing sound power level (L_w) (dB)

A octave-band attenuation that occurs during propagation from the point sound source to the receiver (dB)

For line or area sources, the sound power level is distributed uniformly over the dimensions of the specified area or line. Octave band sound power data from the equipment manufacturer will be used as inputs to the model wherever possible. In the absence of manufacturer data, reasonable and appropriate assumptions will be derived from engineering guidelines and literature.

3.1.2 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 travel over land or water. Topographical information will be 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 study area. For the acoustic modeling analysis, sound attenuation through foliage and diffraction around and over existing anthropogenic structures such as buildings will be ignored so results will be representative of defoliate winter time conditions.

3.1.3 Meteorology

When calculating an annual average sound level, variations in the sound level during varying meteorological situations are important. 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 will be considered.

4.0 PROJECT SOUND SOURCES

The Project sound sources analyzed within the in-air acoustic model included the WTGs, switchyards, the foghorn and HDD. The following subsections provide details, including sound power level data, for each of these sources.

4.1 Horizontal Directional Drilling

The Project is considering the use of HDD to install the underground cable in two different ways, in the form of a long-distance HDD and in the form of a short-distance HDD. HDD is required for installing the underground cable from shore, which will be housed within a 12-inch steel or High-density polyethylene (HDPE) conduit. Installation of a conduit by HDD is generally accomplished in three stages. The first stage consists of directionally drilling a small-diameter pilot hole along a pre-determined path. The second stage enlarges this pilot hole to a diameter that will accommodate the conduit. The third stage involves pulling the conduit through the enlarged hole.

During the drilling of the pilot hole, directional control is achieved by using a non-rotating drill string with an asymmetrical leading edge. The asymmetry of the leading edge creates a steering bias, which allows the operator to control the direction of the drill bit. The actual path of the pilot hole is monitored during drilling by taking periodic readings of the inclination and azimuth. These readings are used to calculate the horizontal and vertical coordinates along the pilot holes relative to the initial entry point on the surface. Once the pilot hole is complete, it is enlarged using reaming tools that are often custom-made for a particular diameter pipe or type of soil. The reamers are typically attached to the drill string at the exit point and are rotated and drawn to the drilling rig, thus enlarging the pilot hole with each pass. Once the drilled hole is enlarged, the cable can be pulled through. For this Project the cable will be either floated on the water or will be on the drilling barge and readied for pulling. A reamer is attached to the drill string from shore and connected to the cable pullhead via a swivel. The swivel prevents any translation of the reamer's rotation into the cable allowing for a smooth pull into the drilled hole. The drilling rig then begins the pullback operation, rotating and pulling on the cable and once again circulating high volumes of drilling slurry. The pullback continues until the reamer and cable break ground at the drilling rig onshore. Long-distance HDD will be conducted at the Block Island Town Beach and on the Rhode Island mainland in the Narragansett Town Beach (BITS Alt 1). The long-distance HDD will be initiated from the manholes on land and will terminate at the temporary offshore cofferdams.

Short-distance HDD is proposed at two locations, one in the parking lot of the Block Island Town Beach and one on Rhode Island mainland on the Narragansett Town Beach. As the name suggested, short-distance HDD does not require drilling as far as long-distance HDD and correspondingly does not require as large a drill. The short-distance HDD will be used in combination with a jet plow that installs the cables below the seabed at each landing location. To accomplish the necessary burial, the jet plow will be positioned over the trench at the mean low water mark and pulled from shore by the cable installation vessel. Once the vessel reaches a water depth of 20 ft (6.1 m), the plow lead lines would be detached from the vessel and transferred to a winch located with the temporary HDD work areas onshore. The winch will then be used to pull the jet plow the remaining distance up onto the beach and into the excavated trench.

4.1.1 HDD Sound Source Levels

Each HDD is expected to take 3 to 12 weeks. Deepwater Wind anticipates completing the HDD during the winter, or possibly spring or fall, to avoid disturbance during the peak summer recreational season. Construction activities will occur 12 hours per day during typical daytime hours unless a situation arises where ceasing the HDD activity would compromise safety (both human health and environmental) and/or the integrity of the Project. The equipment would consist of a HDD drilling rig and auxiliary support equipment including electric mud pumps, portable generators, mud mixing and cleaning equipment, forklifts, loaders, trucks, and portable light sets. Of these, the HDD drill rig is expected to be the dominant sound source. The total sound pressure level for the long-distance HDD equipment is 92 dBA at 50 feet (based on maximum estimate provided by the contractor). Table 6 presents typical sound pressure level data for equipment required for HDD operations.

Table 6 Estimated HDD Operation Equipment Sound Pressure Level Data

HDD Equipment/Machinery	Maximum Sound Pressure Levels at 50 feet (dBA)
HDD Drill Rig	92
Mud Pumps	81
Generator	82
Slurry Plant	77
Desilter	60
Backhoe	80
Boom Truck	84
Loader	80
Crane	85
Pickup Truck	55

Table 7 presents the estimated noise emission source levels for the long-distance HDD using a composite construction noise spectrum by octave band center frequencies for use in the mitigation analysis, if necessary, and to accurately calculate offsite sound propagation paths.

Table 7 HDD Composite Sound Spectrum Levels at a Reference Distance of 50 Feet

	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

For the short-distance HDD equipment sound pressure level data and octave band spectra are similar to what is presented in Tables 6 and 7, respectively with the exception of the HDD drill rig, which has a maximum sound pressure level of 70 dBA at 50 feet.

4.2 Pile Driving

Two types of pile driving will be required during Project construction, impact and vibratory pile driving. Impact pile driving will be used to seat the WTG foundations and vibratory pile driving will be required to construct the temporary cofferdams for the long-distance HDD.

Vibratory pile drivers install piling into the ground by applying a rapidly alternating force to the pile. This is generally accomplished by rotating eccentric weights about shafts. Each rotating eccentric produces a force acting in a single plane and directed toward the centerline of the shaft. The weights are set off-center of the axis of rotation by the eccentric arm. If only one eccentric is used, in one revolution a force will be exerted in all directions, giving the system a good deal of lateral whip. To avoid this problem the eccentrics are paired so the lateral forces cancel each other, leaving only axial force for the pile. Impact piling is performed using hammers which drive the pile by first inducing downward velocity in a metal ram. Upon impact with the pile accessory, the ram creates a force far larger than its weight, which moves the pile an increment into the ground.

4.2.1 Pile Driving Sound Source Levels

Pile driving can generate high noise levels but all Project pile driving will occur offshore and will be of short term duration. Duration of pile driving is anticipated to consist of 4 days per jacket. Pile driving activities will occur during daylight hours starting approximately 30 minutes after dawn and 30 minutes prior to dusk unless a situation arises where ceasing the pile driving activity would compromise safety (both human health and environmental) and/or the integrity of the Project. Each jacket will require 7 days to complete the installation. Jackets will be installed one at a time at each WTG location for a total of 5 weeks of jacket installation assuming no delays due to weather or other circumstances. Should the long-HDD option be selected, vibratory pile driving will occur for a period of two days during cofferdam installation and two days during cofferdam removal.

Acoustic modeling was conducted for noise produced from impact pile driving of a single support pile for the WTG jacket foundation at the centrally located WTG. The octave band spectrum data used for the modeling analysis were derived from a published study of pile driving noise measured during the San Francisco – Oakland Bay Bridge East Span Seismic Safety Project (Thorson and Reyff, 2004). This reference presented airborne noise measurements collected at 100 meter range from 2.4 m diameter steel pile that was driven using a hydraulic impact hammer with approximately 1000 kJ of hammer energy. The measured sound power was adjusted for the lower 600 kJ hammer energy expected for Project use and back propagated to a range of 1 meter from the source. Table 8 presents the octave band and overall broadband A-weighted sound power level used to model impact pile driving.

Table 8 Impact Pile Driving Sound Power Level Information

	Octave Band Sound Power Data (dBL)									Broadband (dBA)
	31	63	125	250	500	1000	2000	4000	8000	
Impact Hammer (600 kJ)	85	88	99	104	111	128	100	92	82	129

According to the Federal Highway Administration Construction Noise Handbook in-air sound levels for impact and vibratory pile driving are comparable. Acoustic modeling was conducted for noise produced from vibratory pile driving at both proposed cofferdam locations (Block Island and Narragansett). For a worst case analysis it was assumed that the vibratory pile driver was positioned within the cofferdam area at the point closest to onshore potential noise sensitive receptors. The octave band spectrum data used for the modeling analysis were taken from a study of vibratory pile driving noise measured during the Vashon Ferry Terminal Test Pile Project conducted for the Washington State Department of Transportation. Table 9 presents the octave band and overall broadband A-weighted sound power level used to model vibratory pile driving.

Table 9 Vibratory Pile Driving Sound Power Level Information

	Octave Band Sound Power Data (dBL)									Broadband (dBA)
	31	63	125	250	500	1000	2000	4000	8000	
Vibratory Hammer	74	88	102	97	112	114	122	121	120	126

4.3 Substation and Switchyards

The Project will include the construction and operation of a new substation on Block Island (Block Island Substation) and expansion of existing Block Island Power Company (BIPCO) Property. The BIPCO Property houses the diesel-powered energy generation facilities currently producing power for Block Island. Existing facilities within the BIPCO property include office buildings, storage buildings, generator buildings, substation, cell phone tower buildings, cooling pond, a garage, and a temporary housing residential building.

The new Block Island Substation, which is comprised of the BIWF Generation Switchyard and the BITS Island Switchyard, will serve as the point of interconnection on Block Island for both the BIWF and the BITS. The Block Island Substation will consist of a metal-clad 34.5 kV switchgear, an isolation transformer, and an O&M building located inside a new fenced substation area, covered with crushed stone surface material. Details pertaining to on-site sound sources, including dimensions and megavolt ampere (MVA) rating are:

- QTY 1- 33kV-34.5kV, 21/28/35 MVA Transformer (Dimensions: 22'5” x 17'11”, height: 14'2") and 35 MVA rating.
- QTY 1- 34.5kV-2400V, 4.5/6/7.5 MVA Transformer (Dimensions: 16'9” x 15'8”, height: 10'5”) and 7.5 MVA rating.
- QTY 2 - Shunt reactors 1.5MVAR, iron core (Dimensions: 13'5” x 6'6, height: 14'2”).

To accommodate the connection to the new Block Island Substation, the existing BIPCO substation facilities will be expanded to include a new overhead breaker bay. Currently there are three options being considered for the Block Island Substation, Alternatives A, B and C, all of which were analyzed in this assessment. There will be an additional switchyard associated with the Project on mainland Rhode Island in Narragansett near an existing DPW building (Narragansett Switchyard) (BITS Alt 1) . This switchyard will have equipment including 34.5 kV metal clad switchgear and two shunt reactors, similar to the shunt reactors referenced above. This equipment will be located within a fenced substation area, covered with crushed stone surface material. The metal clad switchgear will be mounted inside a switchgear building set atop a concrete pad.

4.3.1 Substation and Switchyard Sound Source Levels

Switchyards (or substations) have switching, protection and control equipment and one or more transformers, which generate the sound generally described as a low humming. 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. Both transformers and shunt reactors were included in the acoustic modeling analysis for the Block Island Substation, as identified in the site plans. Circuit-breaker operations may also cause audible noise, particularly the operation of air-blast breakers, which is characterized as an impulsive sound event of very short duration, and expected to occur no more than a few times throughout the year. Because of its short duration and infrequent occurrence, circuit breaker noise was not considered in this screening level analysis.

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 NEMA methodology for measuring noise involves A-weighted sound measurements using microphones positioned 1 foot (0.3 meters) from a tautly drawn string that encircles the device at a height that is one-half the overall height of the device. The device's noise signal is the average of all measurements taken around the perimeter of the device, allowing for unique noise sources such as cooling fans to contribute to the overall rating without having disproportional influence on that sound rating. The sound power radiated is a function of the NEMA rating and the total surface area of the four side walls. The switchyards designed for the Project will conform to all relevant NEMA standards. Transformer and shunt reactor sound source levels were estimated based on their dimensions and MVA rating information provided by Deepwater Wind and are presented by octave band frequency in Table 10.

Table 10 Switchyard Sound Power Level Information

	Unweighted Octave Band Sound Power Data (dBL)								
	31.5	63	125	250	500	1000	2000	4000	8000
Transformer (35 MVA)	92	96	92	92	91	85	81	75	67
Transformer (7.5 MVA)	82	86	82	82	81	75	71	65	57
Shunt reactor	20	30	66	61	47	33	28	29	28

Few complaints from nearby residents are expected regarding switchyards with transformers less than 10 MVA capacities, except in urban areas with little or no buffer distance attenuation between the source and receiver locations. Complaints are more likely at switchyards with transformer sizes of 10 to 150 MVA with separation distances of 500 to 600 feet or less. In very quiet rural areas where the nighttime ambient acoustic environment can reach levels of 20 to 25 dBA under calm or low level wind conditions, the sound generated from the transformers of this size may be periodically audible at distances of half a mile.

As mentioned above, the existing BIPCO property will be expanded to include a new overhead breaker bay to accommodate the Block Island Substation. The diesel-powered generators currently used at the BIPCO site may no longer be required or may only be operated on an as needed basis. NSRs in the vicinity of the existing BIPCO site would have grown habituated to sound produced from generators and the BIPCO site in general, and while the diesel generators were not analyzed in this study, sound levels experienced by NSRs may decrease to some degree in the event that the generators are taken out of service or used less frequently.

4.4 Wind Turbines Generators

Sound generated by an operating WTG is comprised of both aerodynamic and mechanical sound with the dominant sound component from utility scale wind turbines being largely aerodynamic. Aerodynamic sound refers to the sound produced from air flow and the interaction with the wind turbine 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. Due to the improved design of WTG mechanical components and the use of improved noise damping materials within the nacelle, including elastomeric elements supporting the generator and gearbox, mechanical noise emissions have been minimized.

Wind farms, in comparison to conventional energy projects, are somewhat unique in that the sound generated by each individual wind turbine will increase as the wind speed across the site increases. Wind turbine 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 7 to 9 meters per second [m/s] depending on wind turbine type and according to manufacturer specifications. It is important to recognize, 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 NSR may hear these other sound sources (i.e., foliage, ocean waves) rather than wind turbine noise.

Wind farm operation in the offshore environment is unique due to effects related to the sound reflective nature of the surrounding water and the impact of the shoreline on sound attenuation. The following subsections briefly discuss these phenomena.

4.4.1 Shoreline Effect

The ground effect depends on the height of a source or the receiver relative the ground. The effect of ground reflections (or mirror source) varies at the source and receiver positions. As sound waves reach the coast line, a modification of the ground boundary occurs and this sudden change produces a supplementary sound attenuation due to the partial reflection of sound waves. In addition, the wind and temperature gradients (as described in Section 3.1.3) are 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 made of the shoreline effect and its effect on acoustical propagation, however, an average attenuation for low frequencies has been documented at 3 dB (Johansson, 2003) up to 1000 meters, and then increasing with distance onward. The Danish Ministry of Environment (MOE) documented calculations of ground effect of sound propagating from a WTG with a hub height of 100 meters, which corresponds to the approximate size of WTGs for this Project. The results indicated that ground effect of multiple reflections does not occur until very large distances are reached (above 4000 meters) under a wind speed of 8 m/s. The conclusion was that multiple reflections were without importance for an area of distance under 4000 meters and the effect does not begin until greater than approximately 5 km for WTGs with a hub height of about 100 meters.

4.4.2 Sound Propagation over Water at Large Distances

Noise propagation from offshore WTGs is different than propagation from land based WTGs. Sound propagation over water at large distances (generally above 2000-3000 meters) involves a completely reflective surface and is dependent on the distance between the receiver and the sound source. As this distance increases, the effect of water reflection also 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. Due to this reflecting layer, the sound from a source may be enclosed and form spherical waves that appear at certain distances as a cylindrical wave. This cylindrical spreading of sound energy due to multiple reflections from the sea surface generates a reduced sound at large distances 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.

As a result the transmission loss between the received sound pressure at the receiver point and at the sound source may vary considerably due to these noted factors that are unique to offshore sound sources such as offshore WTGs.

4.4.3 Model Input Parameters

The operational acoustic assessment was performed using the updated Project design layout dated October 19, 2011 consisting of 5 Siemens SWT-6.0-120 WTGs or comparable model. For the purposes of analysis in this report, the proposed WTG will have a rotor diameter of 165 meters (541 feet) and a hub height of 100 meters (320 feet) above mean low water. A summary of the setup parameters included in CadnaA for the WTG operational modeling analysis are shown in Table 11.

Table 11 CadnaA Acoustic Modeling Setup Parameters

Model Input	Parameter Value
Wind turbine model	Siemens SWT-6.0-120
Number of wind turbines	5 WTGs
Ground absorption	(over water, reflective) 0.5 (over land, semi-reflective)
Source height	Point sources at 100 meters (320 feet)
Receiver height	1.52 meters (5 feet)
Temperature	10^{o} C (50^{o} F)
Relative humidity	70%

Sound propagation in the atmosphere is not strongly dependent on temperature and humidity, and the 70 percent relative humidity parameter value is representative of favorable sound propagation conditions. Calculations were completed for three different meteorological conditions:

1. Operation 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”.

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 the presence of wind gradients combined with a defined 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.

3. Operation using historic meteorological data. Long-term wind rose data (1980-1999) reported in the RI Ocean SAMP was used to evaluate received sound levels over typical meteorological conditions that can be expected for the area.

Results of the above WTG operation scenarios are reported in Section 5.0 of this report.

4.4.4 WTG Sound Source Levels

In order to assist project developers and acoustical engineers, wind turbine manufacturers report WTG sound power data at integer wind speeds referenced to the effective hub height, ranging from cut-in to full rated power per International Standard IEC 61400-11:2006 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques. This internationally accepted International Electrotechnical Commission (IEC) standard was developed to ensure consistent and comparable sound emission data of utility-scale WTGs between manufacturers. These data are inclusive of both mechanical and aerodynamic source components. Wind turbines 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 acoustic model.

A summary of sound power data for the SWT-6.0-120 WTG correlated by wind speed at hub height are presented in Table 12. Full octave band frequency levels corresponding to the maximum sound power level of 111 dBA at a wind speed of 8 m/s are presented in Table 13, which is inclusive of the 1.5 dBA k-factor or uncertainty factor reported by Siemens. It is expected that the SWT-6.0-120 WTG version installed will have similar sound data to that used in the acoustic modeling analysis; however, it is possible that the final manufacturer warranty data could vary slightly.

Table 12 Broadband Sound Power Levels (dBA) Correlated with Wind Speed

	WTG L_{max} Sound Power Level (L_W) at Reference Wind Speed					
Wind Speed at hub height	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s
SWT-6.0-120	95.4	100.9	107.8	110.4	111	111

Table 13 SWT-6.0-120 Sound Power Level by Octave Band Center Frequency

Frequency (Hz)	Octave Band Sound Power Level (dBL)								Broadband (dBA)
	63	125	250	500	1000	2000	4000	8000	
SWT-6.0-120	115.3	110.7	110.1	108.8	106.8	101.2	96.6	89.3	111.0
Note: 1/1 octave band spectra provided by equipment manufacturers for informational purposes only.									

The acoustic model assumes that all WTGs are operating continuously and concurrently at the maximum manufacturer-rated sound level at the given operational condition. The combination of the modeling parameters used and the inclusion of the statistical k uncertainty factor and engineering safety factors are expected to result in a reasonable and conservative assessment of Project WTG sound levels.

4.5 Nautical Hazard Prevention Device

The platform of the centrally located WTG (WTG #3) will be equipped with a nautical hazard prevention device, or a foghorn. Requirements as detailed in 33 Code of Federal Regulations (CFR) 67, which calls for a foghorn to be installed less than 150 feet above mean sea level (MSL) with a sound signal audible to 0.5 nm. 33 CFR 67 also requires the foghorn emit a tone of 119.8 dB at a frequency of 822 Hz that will sound for a period of 2 seconds during a 20 second cycle (18 seconds silence).

The recommended unit produced by Pharos Marine Automatic Power is the DA-2 foghorn. The unit will be placed atop of the transition deck approximately 61 feet above MSL and will operate continuously unless fitted with a fog detection device, the need for which is still being assessed. The DA-2 is a proven, reliable sound emitter for use on offshore platforms. The horn is designed at an optimum frequency to maximize its range rating for both U. S. Coast Guard and International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) criteria. Two emitters are stacked in a vertical array on a marine grade aluminum support structure. The tower base includes a hinge to facilitate lowering of the tower. The emitter housings are molded rigid polyurethane and the acoustical driver elements are sealed by non-corrodible diaphragms. Each emitter is enclosed in a patented diffraction ring to concentrate the acoustical energy in the horizontal plane. The power supply operates at over 80 percent efficiency over a wide range of input voltage. Dual channels provide protection against a complete power supply failure. The coding timer is controlled by a replaceable "PROM" to allow field alteration of coding rhythm. Dual codes (2 sec on, 18 sec off) to meet U. S. and (Morse "U" 30 sec period) for international requirements are standard. Foghorn noise was analyzed under two meteorological conditions including standard day downwind propagation conditions and anomalous conditions, similar to what is being considered for the WTG operational assessment.

5.0 COMPLIANCE ASSESSMENT AND MITIGATION

In-air acoustic modeling was conducted for the Project in order to assess the potential noise impacts associated with construction and operation. The modeling analysis was conducted using the parameters and methodology described in Sections 3.0 and 4.0 of this report. Results are displayed in the form of sound contour plots with Project received sound levels as color-coded isopleths in 5 dBA increments, which are all contained within Appendix A. The resultant sound contour plots are independent of the existing acoustic environment (i.e., the plots and tabulated results represent Project-generated sound levels only). Received sound levels at discrete NSR locations are also tabulated in Appendix B. Project compliance was assessed at noise sensitive structures and not their associated property lines.

Figures A-1 and A-2 show received sound levels associated with short-distance HDD and jet plow construction activity at Narragansett Town Beach (BITS Alt 1) and Block Island, respectively. Figures A-3 and A-4 present received sound levels associated with long-distance HDD construction activity in Narragansett at the Town Beach parking lot (BITS Alt 1) and on Block Island at the Town Beach parking lot. Results of the acoustic modeling analysis indicated that the short-distance HDD option would be in compliance with the 65 dBA daytime Narragansett limit but not the nighttime limit. The long-HDD option would not be in compliance with either the daytime or the nighttime noise ordinance in the Town of Narragansett and neither short- nor long HDD option would comply with the nighttime noise ordinance in the Town of New Shoreham at nearby NSRs. To achieve compliance, Deepwater Wind has committed to mitigation measures that are described in Section 5.1. Tables B-1 through B-4 contain received sound levels at NSRs for each HDD site.

Received sound levels generated from impact pile driving during WTG foundation installation are shown in Figure A-5. The highest predicted received sound level at an NSR as a result of impact pile driving was 31 dBA, which is well below the applicable New Shoreham 55 dBA maximum permissible nighttime noise limit for residential land uses. Received sound levels generated from vibratory pile driving during cofferdam construction at the Block Island and Narragansett Town Beach (BITS Alt 1) are provided in Figures A-6 and A-7. Results from the vibratory pile driving acoustic modeling analysis show compliance issues with applicable daytime and nighttime limits at Block Island and only nighttime limits at Narragansett Town Beach (see Tables B-5 and B-6). To avoid nighttime noise impacts at NSRs vibratory pile driving activities will occur only during daylight hours starting approximately 30 minutes after dawn and 30 minute prior to dusk. As mentioned in Section 4.2.1, for a worst case analysis it was assumed that the vibratory pile driver was positioned within the cofferdam area at the point closest to onshore potential NSRs. Mitigation measures are limited for offshore vibratory pile driving but Deepwater Wind will consult with the contractor in order to determine whether there are any effective vibratory pile driving mitigation techniques. If necessary, Deepwater Wind will obtain a variance of the noise ordinances from the Narragansett and New Shoreham town councils for the period when vibratory pile driving is being conducted.

Noise related to operation of the Block Island Substation was also analyzed and predicted received sound levels are given in Figures A-8, A-9 and A-10 for alternatives A, B, and C, respectively. The results for the Block Island Substation Alternatives show compliance with the Town of New Shoreham 55 dBA nighttime limit at all identified NSRs for all three switchyard alternatives (see Table B-9) though sound may be periodically audible offsite, depending on prevailing background noise levels, which have not been determined, though sound levels are expected to be generally low in this area. Figure A-11 shows received sound levels generated by the Narragansett Switchyard (BITS Alt 1). Modeling results show that the low level sound generated from the two shunt reactors being installed at the Narragansett Switchyard will be well below the applicable 65 dBA daytime and 55 dBA nighttime Narragansett maximum permissible sound limits (see Table B-8). Currently, Project substation design is preliminary; therefore, results may change as a result of adjustments to equipment components used in modeling assumptions.

Figures A-12 and A-13 show received sound levels associated with the foghorn mounted on the platform of the WTG 3 under standard downwind propagation conditions and anomalous meteorological conditions, respectively. Modeling results show that under standard downwind propagation conditions received sound levels generated by the foghorn are expected to attenuate to less than 25 dBA offshore and under anomalous meteorological conditions received sound levels onshore will remain below 30 dBA, which the highest predicted sound level of 26 dBA occurring at NSR ID 1.

As described in Section 4.3.3, wind turbine operation noise was analyzed under standard downwind propagation conditions (Figure A-14), anomalous meteorological conditions (Figure A-15), and under expected long-term average meteorological conditions (Figure A-16) based on historical data of the Project area collected in support of the RI Ocean SAMP. Under all modeled scenarios, received sound levels at identified NSRs remained below 25 dBA, which is well below the New Shoreham 55 dBA nighttime limit.

5.1 Mitigation Assessment

As discussed in Section 5.0, construction activity modeling results indicated that sound levels generated by long-distance and short-distance HDD construction activity would not be in compliance with the daytime and nighttime noise ordinance in the Town of Narragansett or with the nighttime noise ordinance in the Town of New Shoreham at nearby NSRs. To achieve compliance, Deepwater Wind has committed to the following mitigation measures:

- **Work hours:** Limiting HDD activities to daytime hours unless a situation arises where ceasing the HDD activity would compromise safety (both human health and environmental) and/or the integrity of the Project; and

- **Noise Abatement Plan:** For the HDD sites proposed on Block Island, no mitigation would be required to comply with the Town of New Shoreham 65 dBA daytime limit. For the Narragansett HDD sites and Block Island HDD site during nighttime hours the following mitigation is proposed:

    1. Use of a temporary sound wall in Narragansett if necessary to comply with the Town of Narragansett noise ordinance; and

    2. Use of a temporary sound wall in New Shoreham for nighttime work, if it occurs.

Deepwater Wind commits to a noise abatement plan including minimizing noise from the HDD drill rigs and support equipment with combustible engines with retrofitted “critical mufflers”. Critical mufflers are the best available technology currently being used for exhaust noise reduction. In addition to the new mufflers, the engine compartments have been modified with 1-1/2” acoustic board insulation to further reduce noise generated by mechanical means.

Deepwater Wind will also monitor sound levels in the vicinity of the HDD work area and if sound levels are elevated noise mitigation measures will be adjusted appropriately. In order to reduce received sound levels at nearby NSRs a temporary sound wall, which blocks the line of sight between the HDD drill rig and the closest residences is recommended in some cases. A temporary sound wall is a sound barrier that is a non-retractable temporary wall that is typically constructed of ¾ inch Medium Density Overlay (MD) plywood, or other material of equivalent utility and appearance having a surface weight of 2 pounds per square foot or greater. The temporary noise barriers should have a Sound Transmission Class of STC-30, or greater, per American Society for Testing and Materials (ASTM) Test Method E90. The temporary barriers should be lined on one side with glass fiber, mineral wool, or other similar type noise-absorbing material at least 2-inches thick and have a Noise Reduction Coefficient rating of NRC-0.85, or greater, as per ASTM Test Method C423. The materials used for temporary barriers should be sufficient to last through the duration of the construction work, and shall be maintained in good repair. Alternatively, prefabricated acoustic barriers are available from acoustical equipment vendors. Barrier panels will be mounted on ‘jersey’ concrete bases and attached to support frames designed to withstand 80-mph wind loads plus a 30 percent gust factor. The barriers will be installed such that sound-absorptive surfaces face the noise source. When the barrier units are joined together, the mating surfaces of the barrier sides shall be flush with each other. Gaps between barrier units and between the bottom edges of the barrier panels and the ground would be closed with material that will completely fill the gaps and be of sufficient density to attenuate sound.

As mentioned previously, Deepwater Wind will limit HDD construction activities to daytime hours. For the BITS Alt 1 long-distance HDD, a four-sided sound wall with a total height of 15 feet would be sufficient to attain compliance with the applicable 65 dBA daytime limit at the closest NSR. For the short-distance HDD a three-sided sound wall 20 feet high will be required to adhere to the Narragansett nighttime limit and may be used during daytime, if determined to be necessary to comply with the daytime limit. If compliance cannot be achieved with the Town of Narragansett nighttime limits, Deepwater Wind will obtain a variance of the Narragansett Noise Ordinance from the town council for the period when HDD is being conducted.

For the long-distance and short-distance HDD sites on Block Island, no mitigation would be required to comply with the Town of New Shoreham 65 dBA daytime limit. To comply with the applicable 55 dBA Town of New Shoreham nighttime limit, a two-sided sound wall with a height of at least 12 feet would be required for the long-distance HDD scenario and a south-facing one-sided 15-foot wall would be required for compliance during short-distance HDD. Tables B-1 through B-5 contain received sound levels at NSRs for each HDD site excluding and including temporary sound wall mitigation.

6.0 REFERENCES

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Washington State Department of Transportation. 2010. Vashon Ferry Terminal Test Pile Project – Vibratory Pile Monitoring Technical Memorandum.

APPENDIX A

Figures

Deepwater Wind
Figure A-1: Received Sound Levels BITS Alternative 1 Short HDD and Jet Plow

May 2012

- Short HDD Location
- BITS Alternative 1
- HDD Staging Area

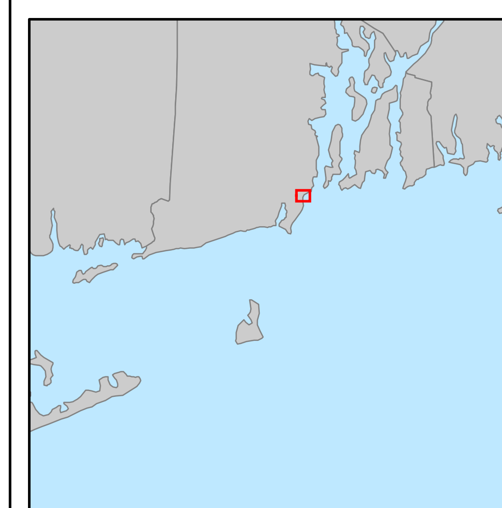
Sound Level Contour Ranges (dBA)

- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

0 250 500 750 1,000 Feet

0 100 200 300 400 Meters

N



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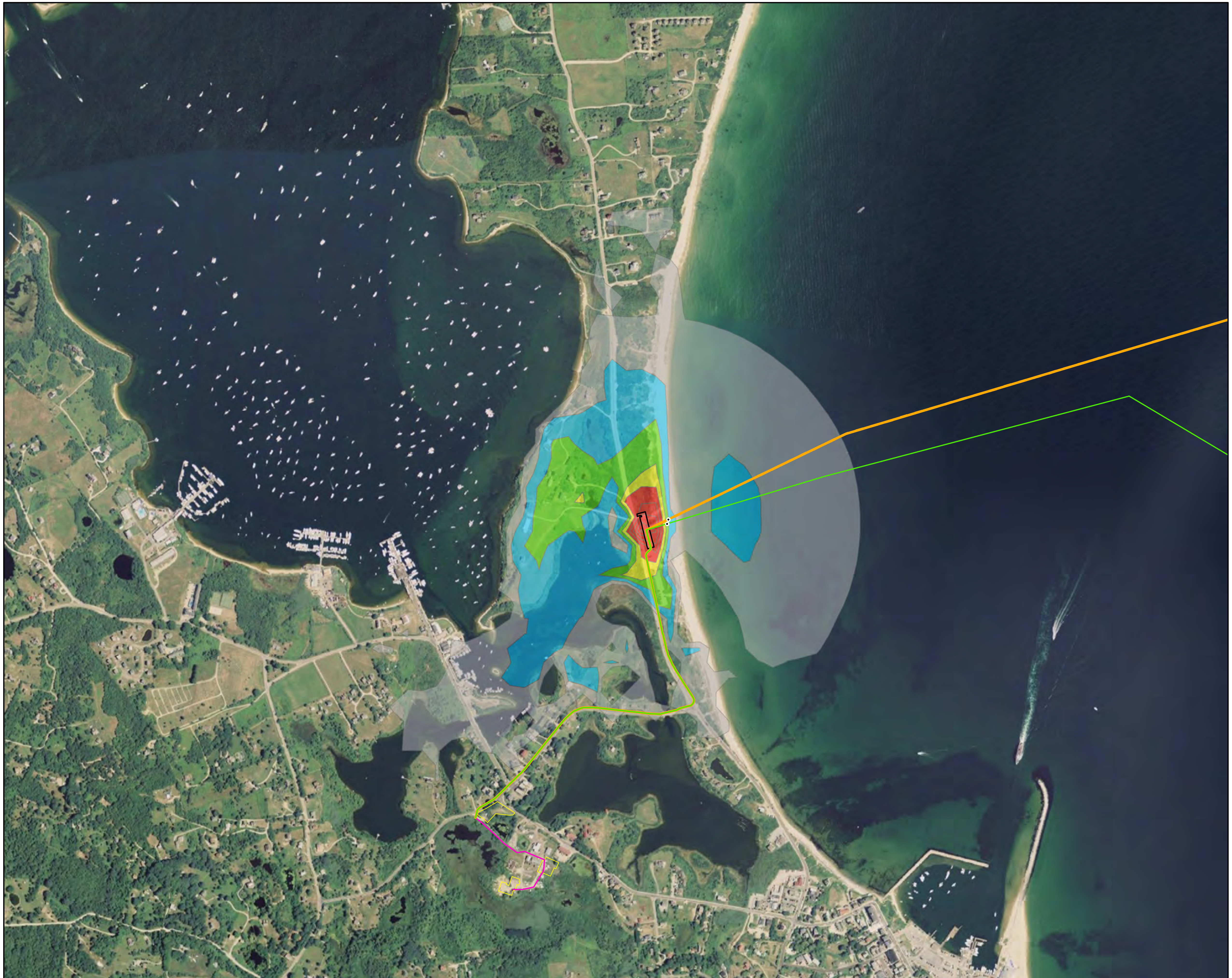


Deepwater Wind
Figure A-2:
Received Sound Levels
Block Island
Short HDD and Jet Plow

May 2012

- Short HDD Location
- BITS Alternative 1
- Export Cable
- Proposed Overhead Line
- HDD Staging Area
- Substation Alternatives

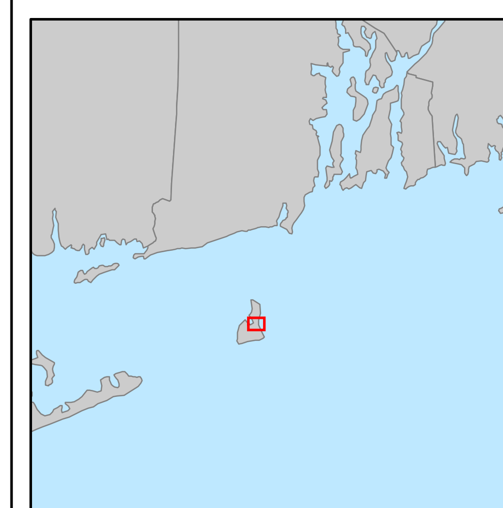
Sound Level Contour Ranges (dBA)

- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

0 250 500 750 1,000 Feet

0 100 200 300 400 Meters

N



DEEPWATERWIND

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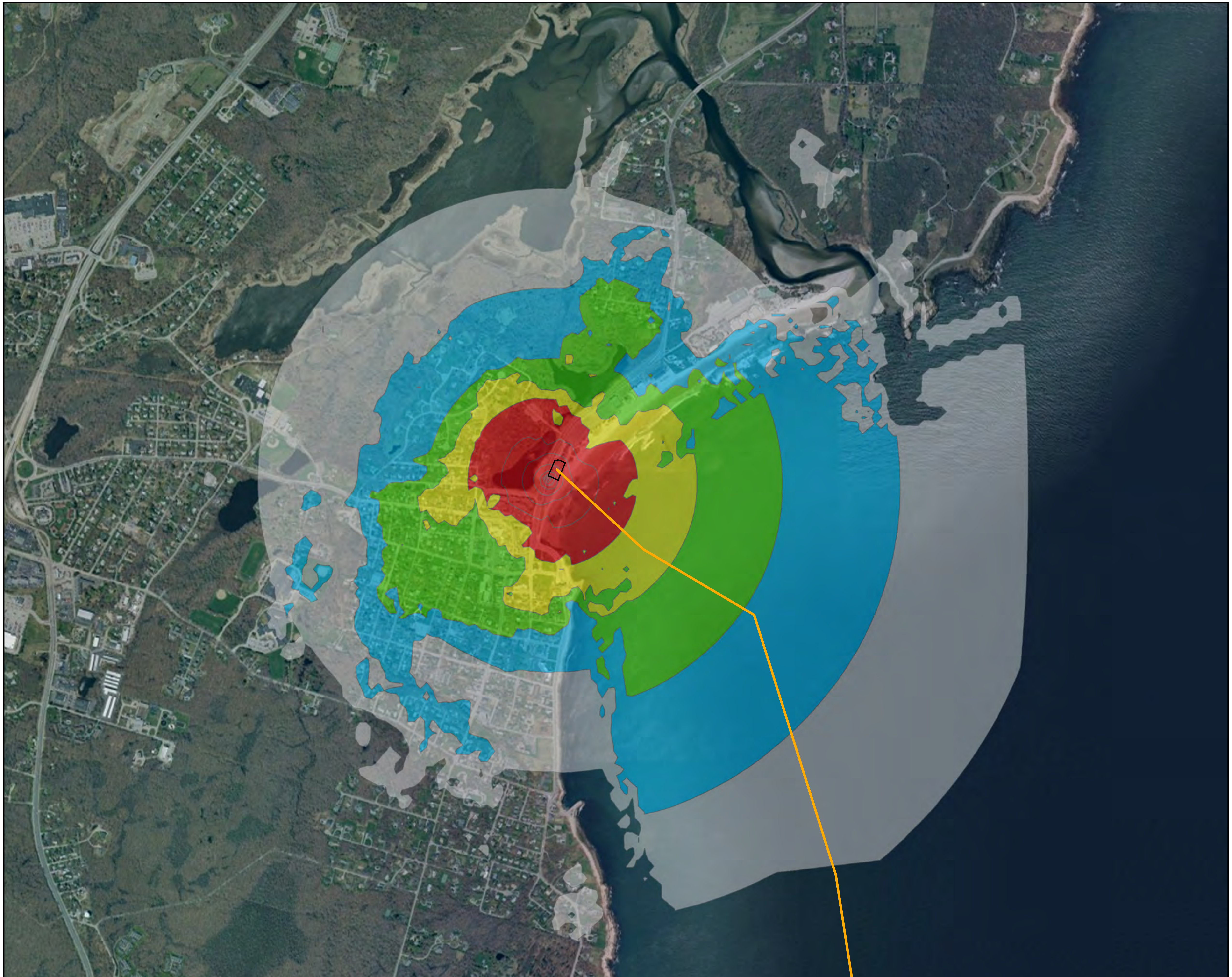


Deepwater Wind
Figure A-3: Received Sound Levels BITS Alternative 1 Long HDD

May 2012

BITS Alternative 1

HDD Staging Area

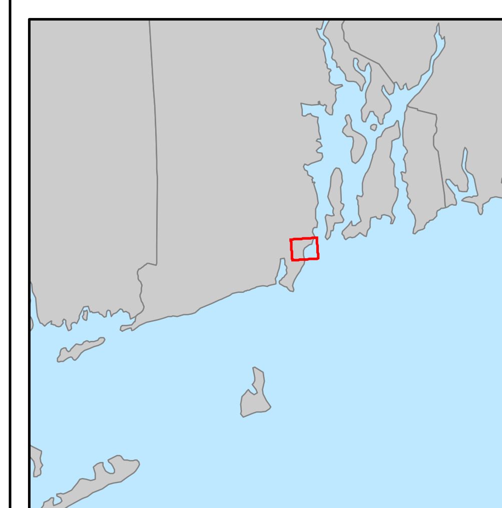
Sound Level Contour Ranges (dBA)

- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

0 500 1,000 1,500 2,000 Feet

0 125 250 375 500 Meters

N



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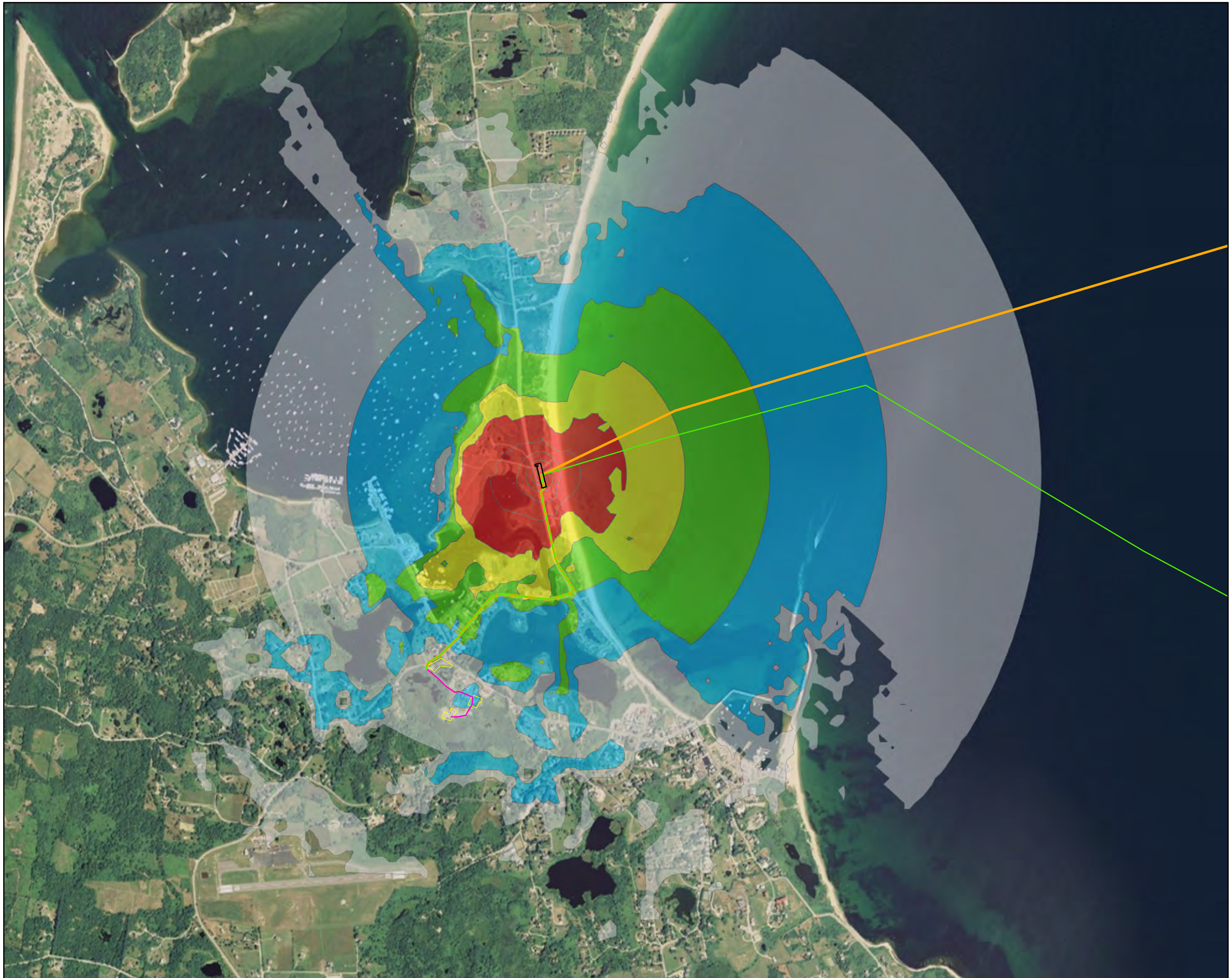
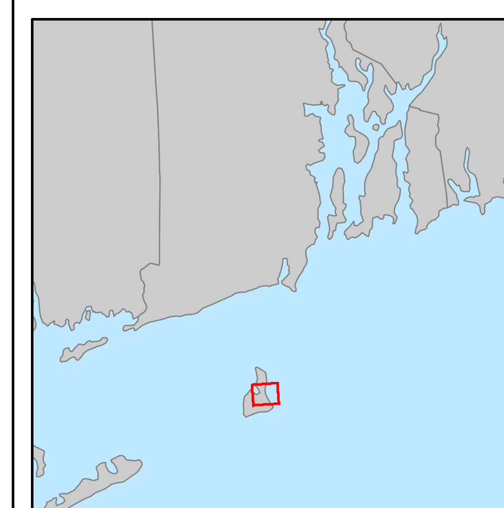
Deepwater Wind
Figure A-4: Received Sound Levels Block Island Long HDD

May 2012





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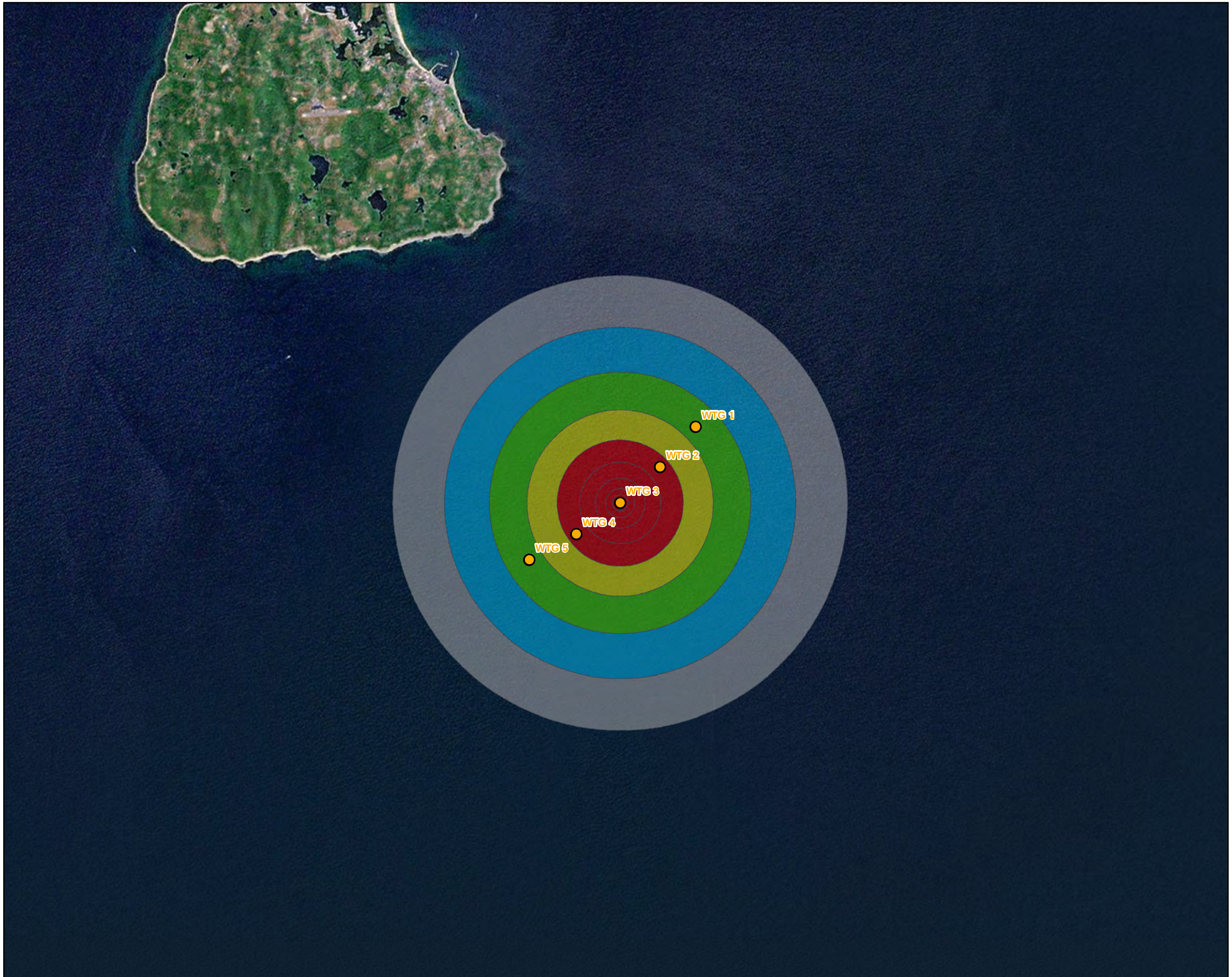


Deepwater Wind
Figure A-5: Received Sound Levels Impact Pile Driving Wind Turbine Construction

May 2012

Wind Turbine Generator (Project layout dated 12/7/2012)

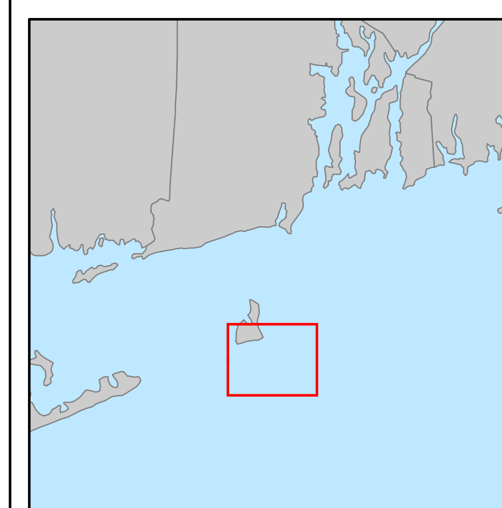
Sound Level Contour Ranges (dBA)

- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

0 0.5 1 1.5 2 Miles

0 0.25 0.5 0.75 1 Nautical Miles

N



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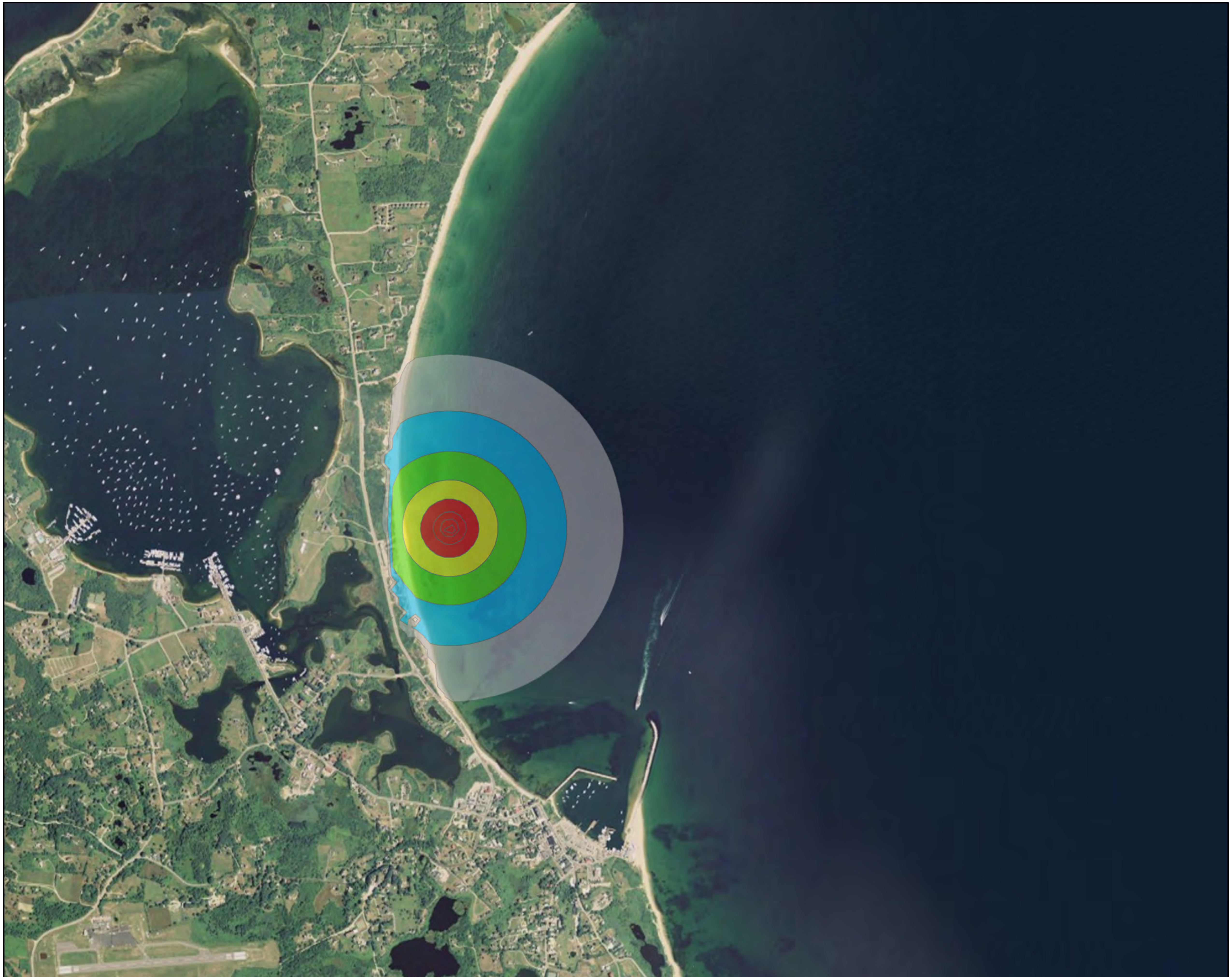


Deepwater Wind
Figure A-6:
Received Sound Levels
Vibratory Pile Driving
Block Island Long HDD

May 2012

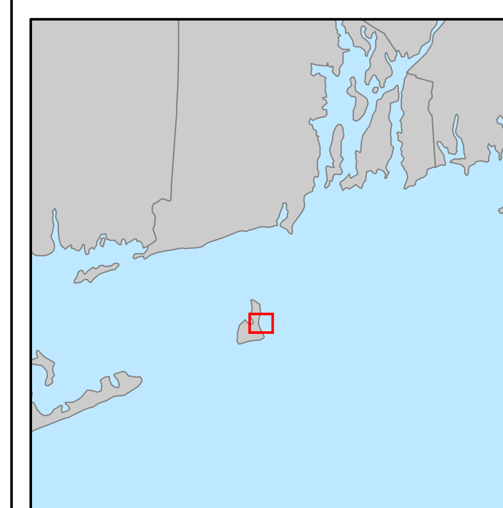
Sound Level Contour Ranges (dBA)

- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

0 0.1 0.2 0.3 0.4 Miles

0 0.1 0.2 Nautical Miles

N



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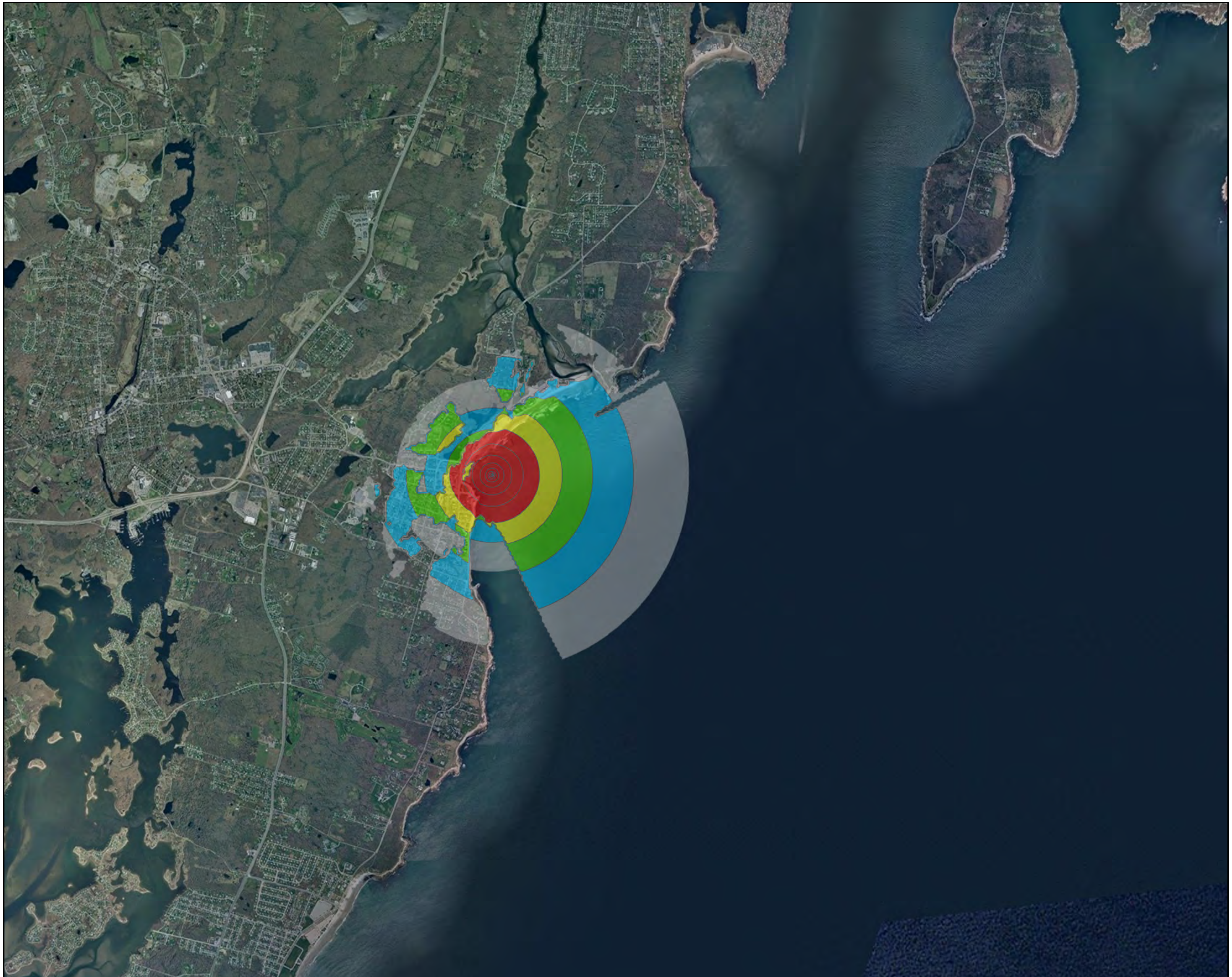
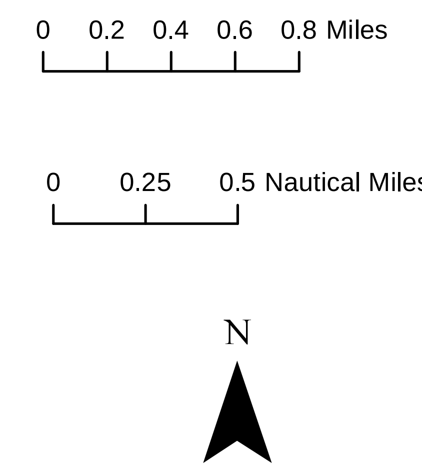


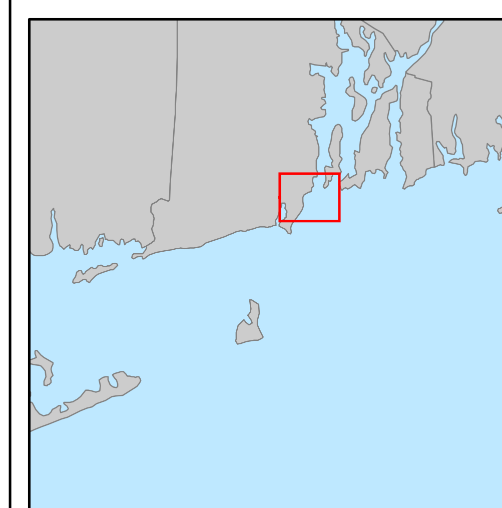
Deepwater Wind
Figure A-7:
Received Sound Levels
Vibratory Pile Driving
BITS Alternative 1
Long HDD Cofferdam

May 2012

Sound Level Contour Ranges (dBA)

- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA





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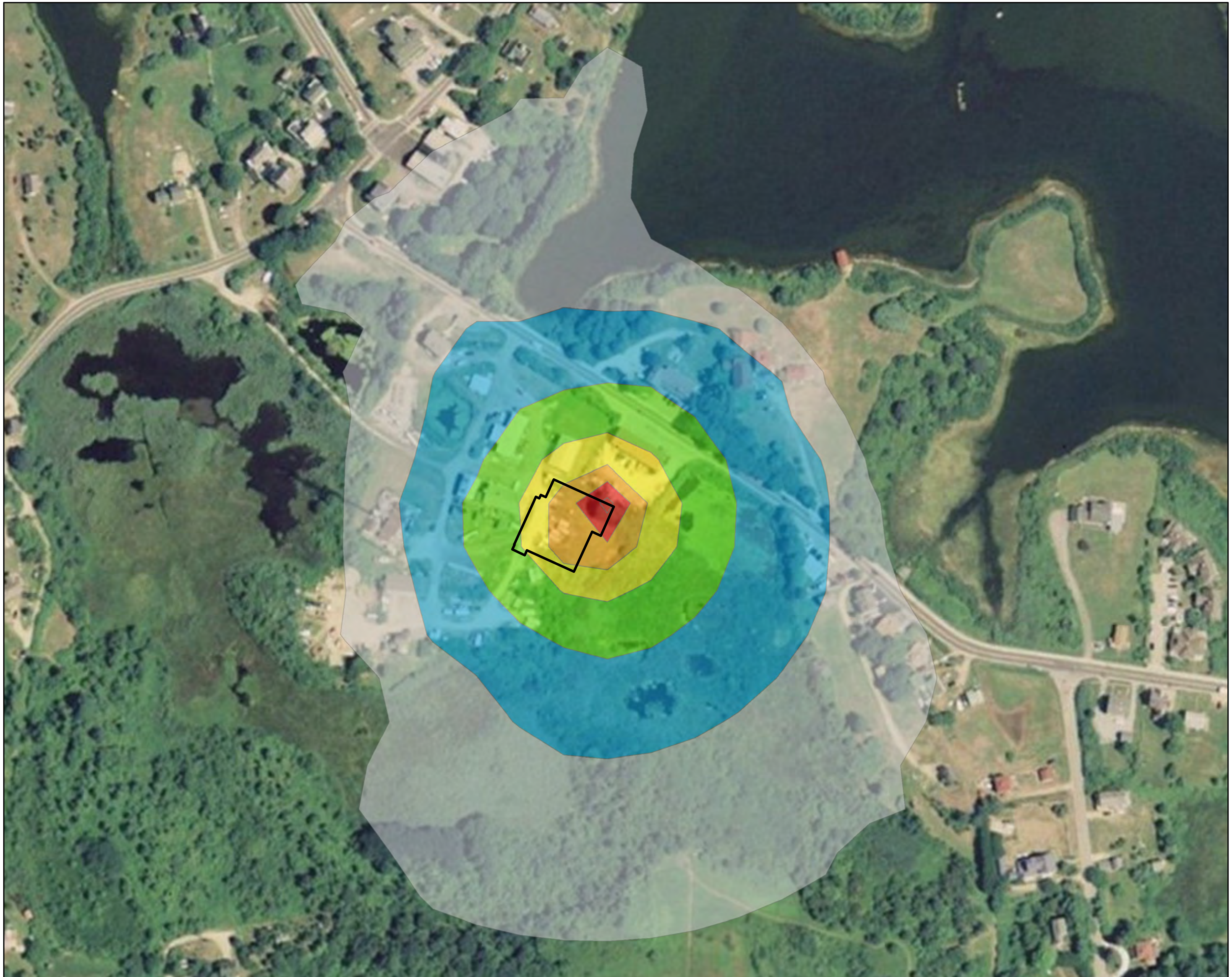


Deepwater Wind
Figure A-8:
Received Sound Levels
Block Island Switchyard
Alternative A

May 2012

BIPCO Alt A

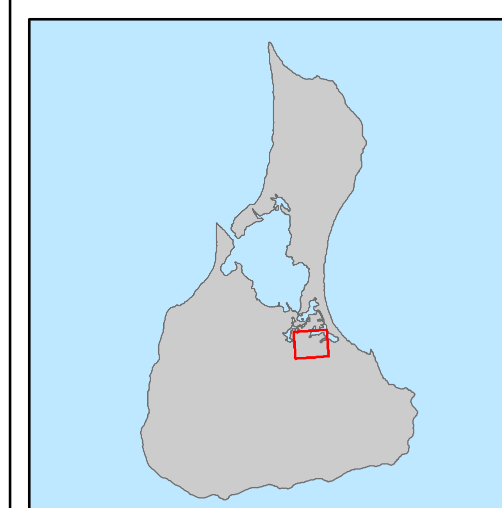
Sound Level Contour Ranges (dBA)

- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

0 75 150 225 300 Feet

0 30 60 90 Meters

N



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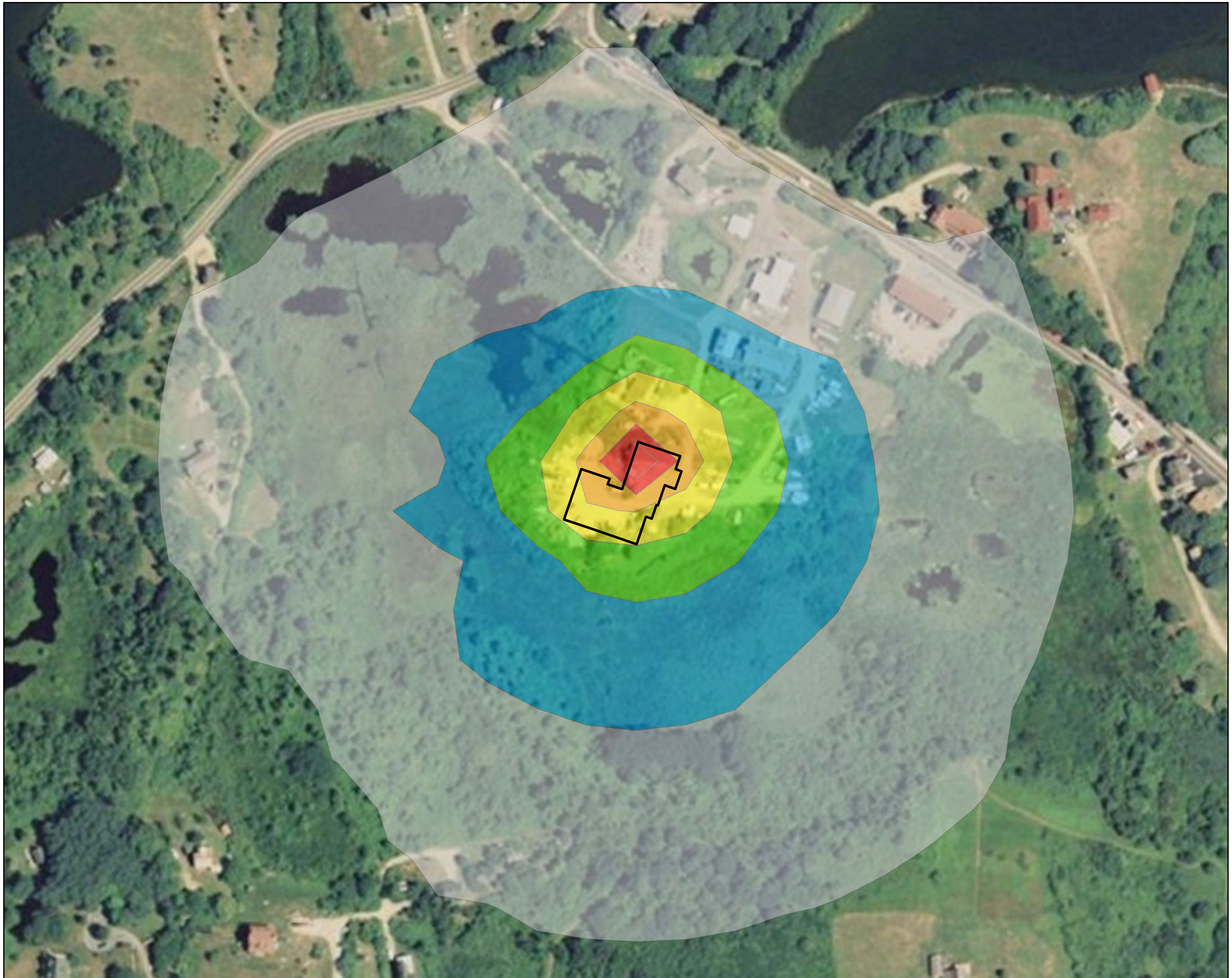
Deepwater Wind
Figure A-9: Received Sound Levels Block Island Switchyard Alternative B

May 2012



BIPCO Alt B

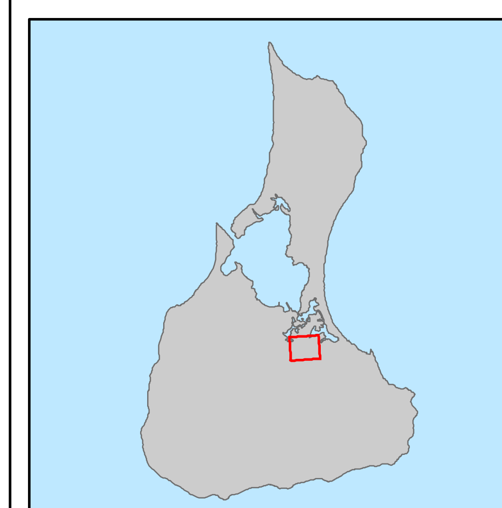
Sound Level Contour Ranges (dBA)

- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

0 75 150 225 300 Feet

0 30 60 90 Meters

N



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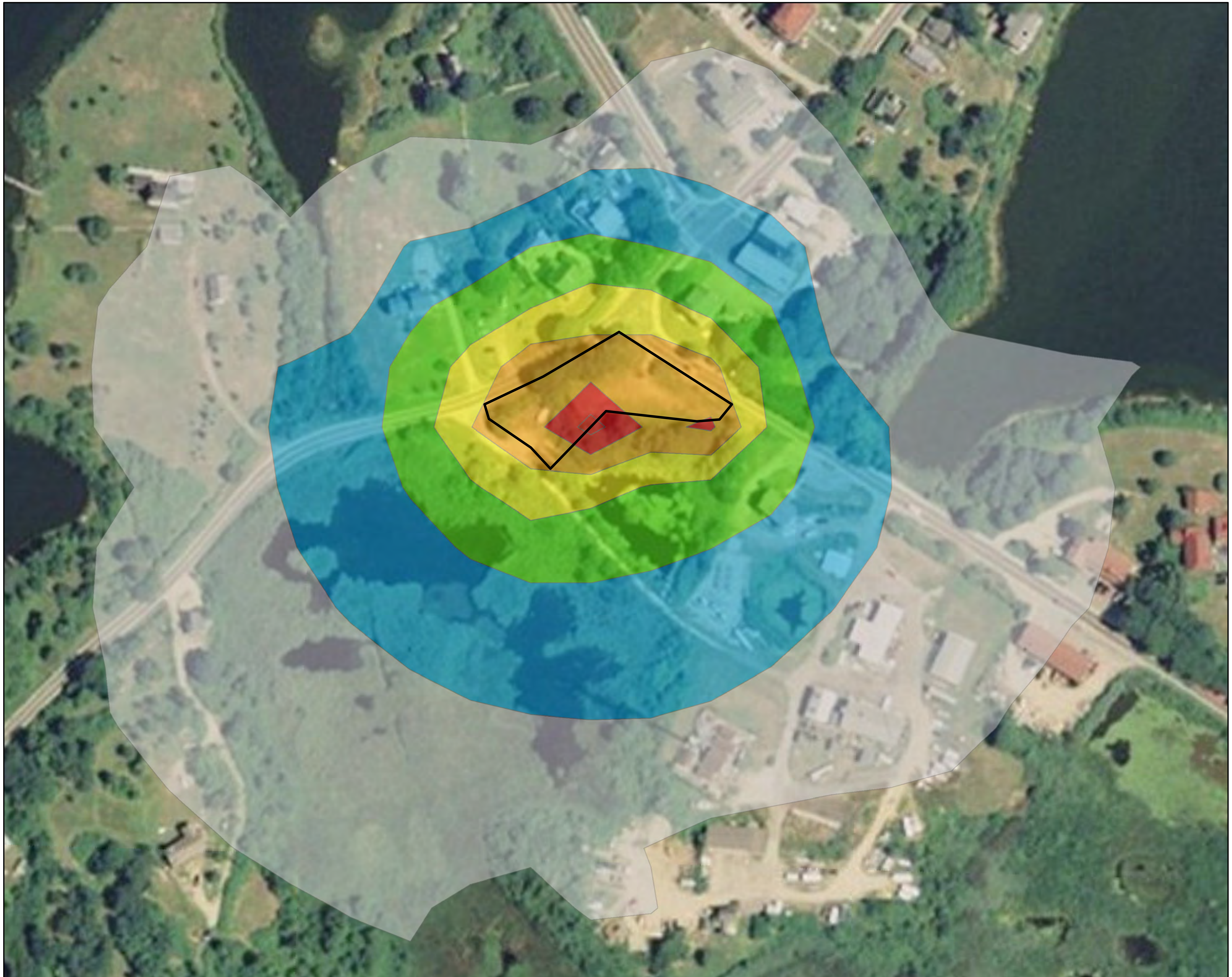


Deepwater Wind
Figure A-10: Received Sound Levels Block Island Switchyard Alternative C

May 2012

BIPCO Alt C

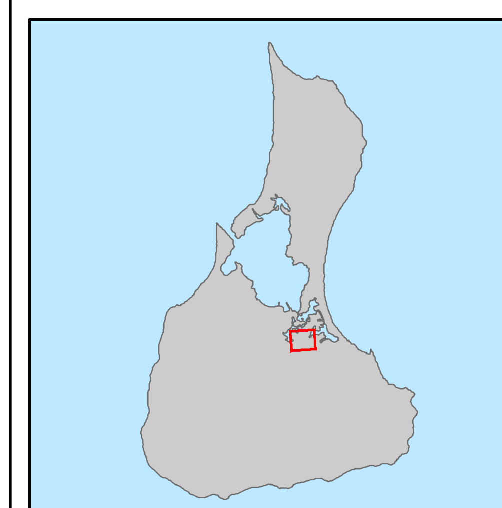
Sound Level Contour Ranges (dBA)

- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- 50 - 55 dBA
- 55 - 60 dBA
- > 60 dBA

0 50 100 150 200 Feet

0 25 50 75 Meters

N



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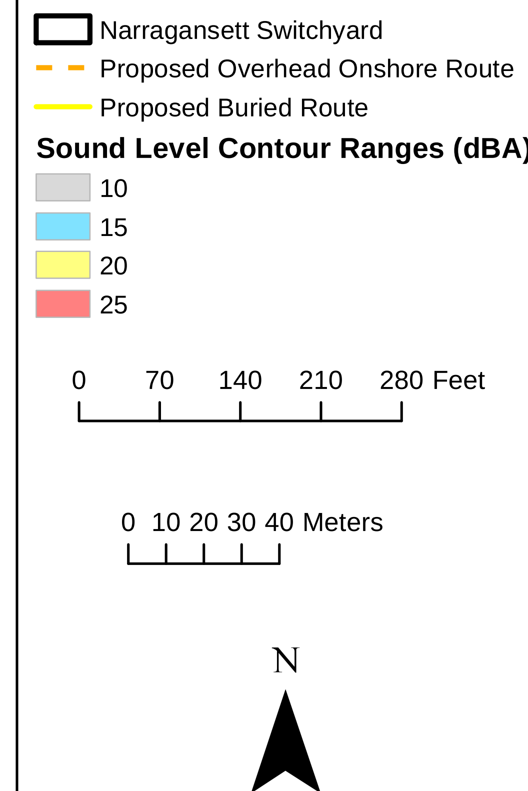
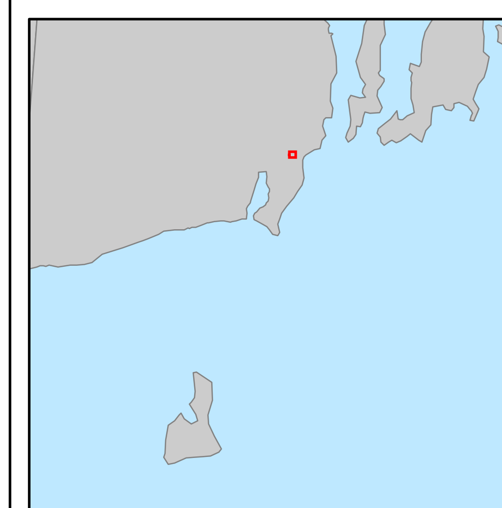
Deepwater Wind Figure A-11: Received Sound Levels Narragansett Switchyard

May 2012





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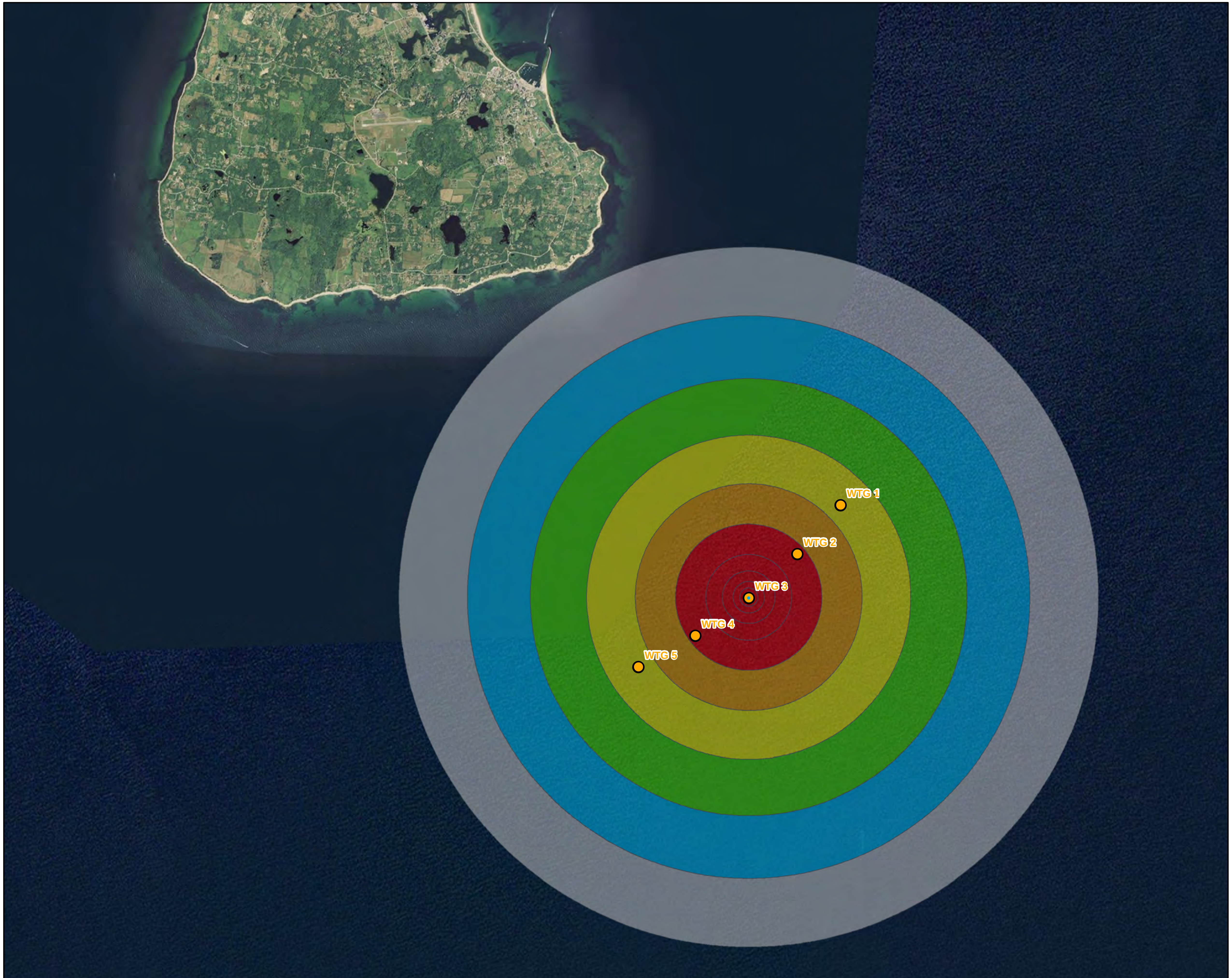


Deepwater Wind
Figure A-12:
Received Sound Levels
Fog Horn
Moderate Downwind
Conditions

May 2012

Foghorn
Wind Turbine Generator

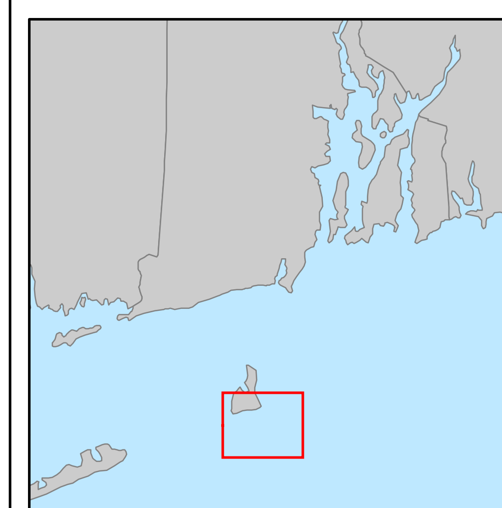
Sound Level Contour Ranges (dBA)

25 - 30 dBA
30 - 35 dBA
35 - 40 dBA
40 - 45 dBA
45 - 50 dBA
> 50 dBA

0 1,500 3,000 4,500 6,000 Feet

0 500 1,000 1,500 Meters

N



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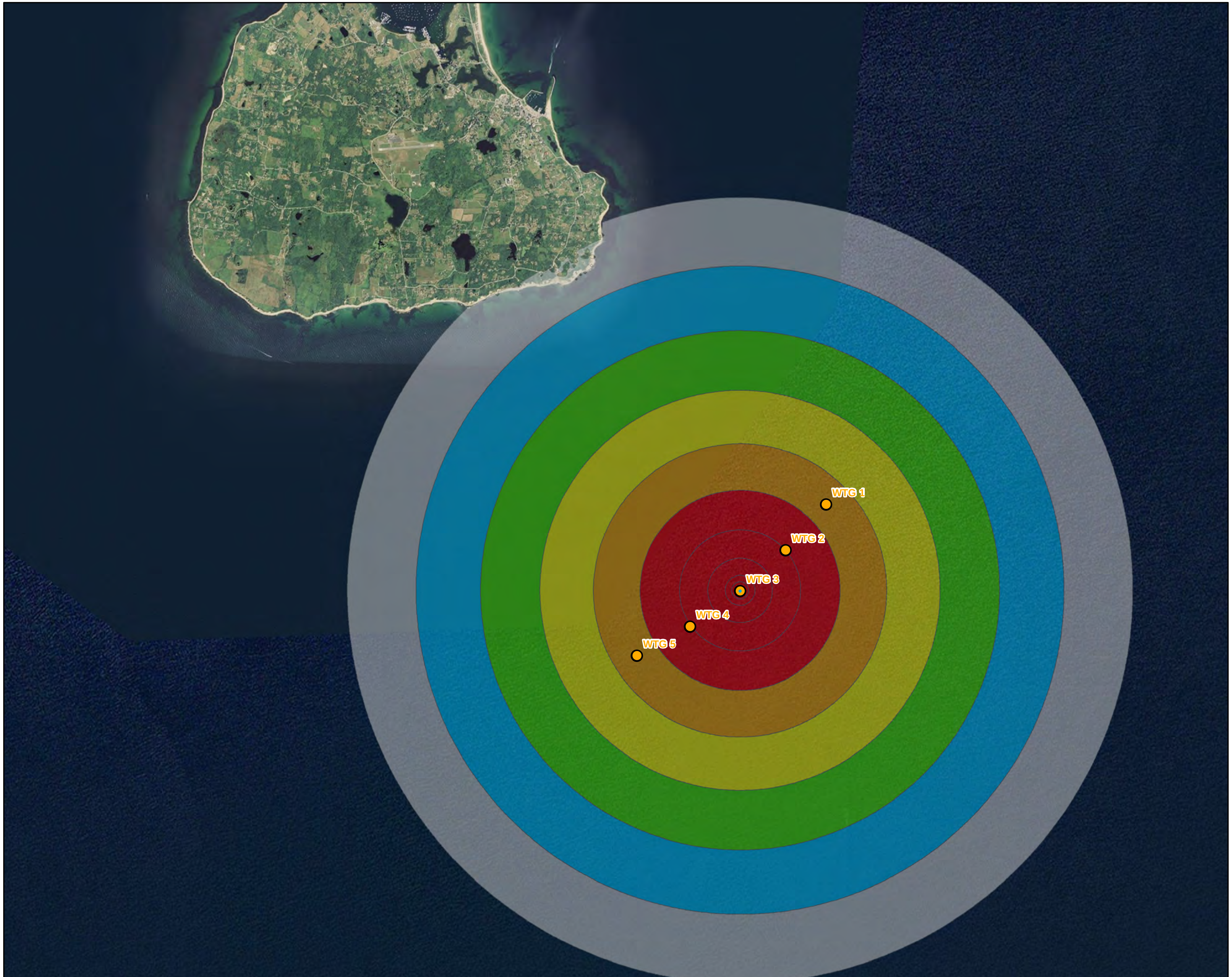


Deepwater Wind
Figure A-13: Received Sound Levels Fog Horn Anomalous Conditions

May 2012

Foghorn

Wind Turbine Generator

Sound Level Contour Ranges (dBA)

25 - 30 dBA

30 - 35 dBA

35 - 40 dBA

40 - 45 dBA

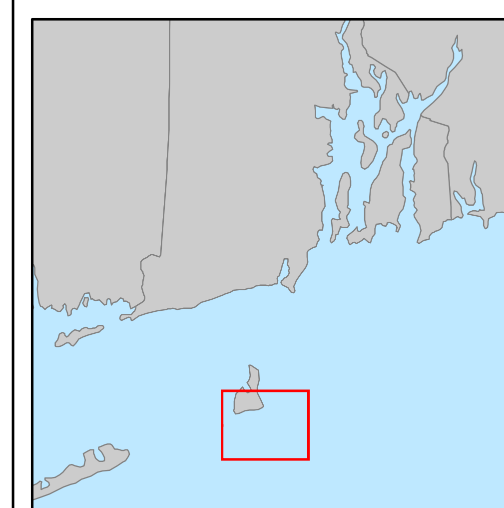
45 - 50 dBA

> 50 dBA

0 2,000 4,000 6,000 8,000 Feet

0 500 1,000 1,500 2,000 Meters

N



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Coordinate System: NAD 1983 UTM Zone 19N

Deepwater Wind
Figure A-14:
Received Sound Levels
WTG Operation
Maximum Rotational
Wind Speed, Moderate
Downwind Conditions

May 2012

Wind Turbine Generator

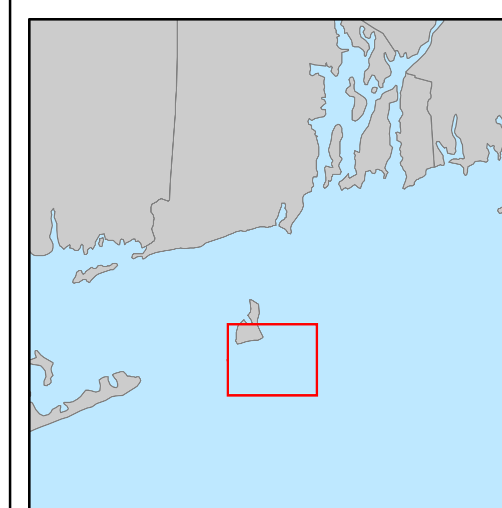
Sound Level Contour Ranges (dBA)

- 25 - 30 dBA
- 30 -35 dBA
- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- > 50 dBA

0 0.5 1 1.5 2 Miles

0 0.25 0.5 0.75 1 Nautical Miles

N



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Deepwater Wind
Figure A-15:
Received Sound Levels
Wind Turbine Operation
Maximum Rotational
Wind Speed, Anomalous
Conditions

May 2012

Wind Turbine Generator

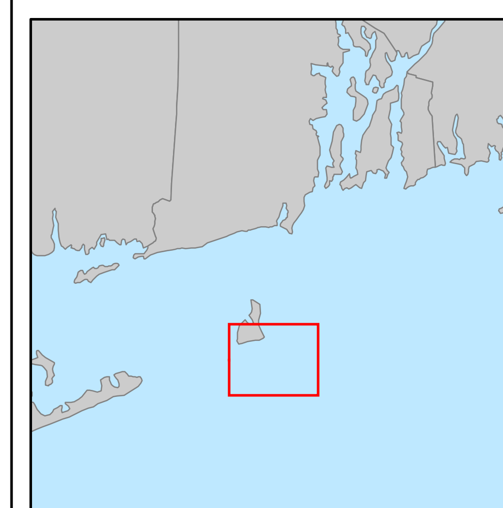
Sound Level Contour Ranges (dBA)

25 - 30 dBA
30 -35 dBA
35 - 40 dBA
40 - 45 dBA
45 - 50 dBA
> 50 dBA

0 0.5 1 1.5 2 Miles

0 0.25 0.5 0.75 1 Nautical Miles

N



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Deepwater Wind
Figure A-16:
Received Sound Levels
WTG Operation
Maximum Rotational
Wind Speed, Long-term
Average Conditions

May 2012

Wind Turbine Generator

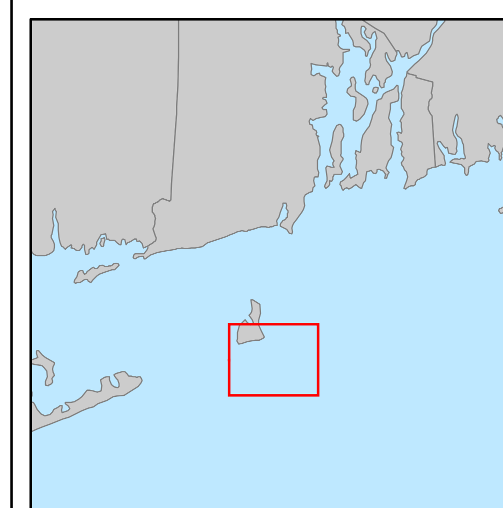
Sound Level Contour Ranges (dBA)

- 25 - 30 dBA
- 30 -35 dBA
- 35 - 40 dBA
- 40 - 45 dBA
- 45 - 50 dBA
- > 50 dBA

0 0.5 1 1.5 2 Miles

0 0.25 0.5 0.75 1 Nautical Miles

N



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APPENDIX B

Tables

Table B-1 Acoustic Model Output at NSRs (dBA) – Short-Distance HDD, BITS Alt 1, Narragansett Town Beach

NSR ID	UTM Coordinates (m)		Block Island	
	Easting	Northing	Unmitigated	Mitigated
1787	294824	4590007	65	48
1926	294608	4589817	57	39
1936	294661	4589810	58	41
1937	294630	4589793	57	40
1938	294658	4589777	56	41
1939	294668	4589743	55	41
1940	294680	4589795	58	42
Note: Receptors with received sound levels >= 55 dBA Narragansett nighttime limit shown				

Table B-2 Acoustic Model Output at NSRs (dBA) – Short-Distance HDD, Block Island

NSR ID	UTM Coordinates (m)		Block Island	
	Easting	Northing	Unmitigated	Mitigated
4297	284735	4562216	64	53
Note: Receptors with received sound levels >= 55 dBA New Shoreham nighttime limit shown				

Table B-3 Acoustic Model Output at NSRs (dBA) – Long-Distance HDD, BITS Alt 1 – Narragansett Town Beach Parking Lot

NSR ID	UTM Coordinates (m)		Narragansett Beach Parking Lot	
	Easting	Northing	Unmitigated	Mitigated
1787	294824	4590007	68	51
1808	294597	4590307	57	43
1809	294574	4590274	58	44
1810	294544	4590235	58	45
1811	294546	4590183	60	46
1812	294456	4590168	57	46
1813	294441	4590117	59	46
1815	294470	4590271	55	45
1824	294384	4590085	55	46
1845	294357	4589927	57	51
1846	294394	4589929	59	52
1847	294429	4589927	60	53
1848	294433	4589895	58	54
1849	294485	4589880	62	55
1850	294479	4589928	62	54
1851	294489	4589975	62	51
1852	294483	4590000	61	50
1853	294444	4590021	60	48
1854	294449	4589966	61	51
1855	294427	4589968	60	51
1856	294401	4589970	59	50
1857	294376	4589978	59	49
1858	294382	4590017	57	48

NSR ID	UTM Coordinates (m)		Narragansett Beach Parking Lot	
	Easting	Northing	Unmitigated	Mitigated
1859	294360	4589975	58	49
1860	294360	4589989	58	49
1861	294338	4589978	56	49
1862	294320	4589976	57	48
1880	294333	4589901	56	51
1881	294373	4589901	58	52
1882	294364	4589863	58	51
1883	294352	4589859	58	51
1884	294329	4589856	58	51
1885	294302	4589859	56	50
1886	294271	4589860	56	49
1900	294190	4589808	55	48
1901	294213	4589803	55	49
1902	294247	4589798	56	53
1903	294235	4589817	55	49
1904	294263	4589797	56	49
1905	294264	4589814	56	50
1906	294283	4589797	56	50
1907	294289	4589811	57	54
1908	294315	4589810	57	54
1909	294302	4589794	57	50
1910	294323	4589791	57	50
1911	294338	4589787	58	50
1912	294341	4589817	58	55
1913	294354	4589817	58	55
1914	294387	4589822	59	52
1915	294402	4589814	59	52
1916	294426	4589812	58	52
1917	294423	4589777	57	49
1918	294401	4589781	58	49
1919	294382	4589781	58	49
1920	294354	4589784	58	50
1921	294388	4589865	59	52
1922	294425	4589857	60	53
1924	294375	4590069	55	46
1925	294548	4589825	58	54
1926	294608	4589817	67	53
1927	294598	4589779	64	51
1928	294580	4589761	62	49
1929	294571	4589787	63	51
1930	294561	4589800	61	51
1931	294529	4589801	58	51
1932	294513	4589788	61	50
1933	294524	4589764	61	49

NSR ID	UTM Coordinates (m)		Narragansett Beach Parking Lot	
	Easting	Northing	Unmitigated	Mitigated
1934	294490	4589761	58	48
1935	294494	4589800	57	51
1936	294661	4589810	69	54
1937	294630	4589793	67	52
1938	294658	4589777	66	52
1939	294668	4589743	65	51
1940	294680	4589795	69	54
1941	294636	4589712	60	49
1943	294570	4589675	59	46
1956	294634	4589455	57	44
1958	294700	4589535	58	45
1959	294808	4589457	57	43
1960	294847	4589439	55	43
1961	294657	4589635	61	49
1962	294648	4589684	58	49
1963	294618	4589667	57	48
1964	294634	4589619	59	48
1965	294582	4589637	56	46
1966	294566	4589612	55	45
1968	294245	4589761	55	48
1970	294280	4589751	56	47
1971	294242	4589735	55	46
1972	294247	4589717	55	45
1973	294241	4589700	55	45
1974	294258	4589696	55	44
1975	294276	4589694	55	44
1976	294306	4589749	56	47
1977	294283	4589733	56	46
1981	294335	4589686	55	44
1982	294350	4589740	57	47
1983	294372	4589737	57	47
1984	294395	4589735	56	47
2008	294238	4589670	55	43
2009	294241	4589642	55	43
2018	294215	4589756	55	47
2019	294212	4589735	55	46
2068	294550	4589434	55	43
2072	294583	4589372	55	42
2074	294583	4589353	55	42
2075	294619	4589368	55	42
2086	294699	4589354	55	41
2087	294695	4589385	56	42
2088	294709	4589420	57	42
2089	294724	4589379	56	41

NSR ID	UTM Coordinates (m)		Narragansett Beach Parking Lot	
	Easting	Northing	Unmitigated	Mitigated
2090	294759	4589393	56	42
2094	294772	4589350	55	41
2096	294729	4589329	55	41
2100	294585	4589394	55	43
2101	294596	4589412	55	43
2102	294658	4589391	56	42
2103	294655	4589410	56	42
Note: Receptors with received sound levels >= 55 dBA Narragansett nighttime limit shown				

Table B-4 Acoustic Model Output at NSRs (dBA) – Long-Distance HDD, Block Island

NSR ID	UTM Coordinates (m)		Block Island	
	Easting	Northing	Unmitigated	Mitigated
4286	284359	4562301	57	51
4287	284348	4562201	60	50
4288	284366	4562348	59	51
4289	284416	4562434	58	52
4292	284474	4562605	56	51
4293	284526	4562654	55	51
4294	284477	4562424	63	53
4295	284421	4562416	59	52
4296	284458	4562374	63	53
4297	284735	4562216	73	73
4328	284478	4561862	57	52
4329	284504	4561847	57	53
4330	284688	4561787	56	55
4332	284590	4561822	56	54
Note: Receptors with received sound levels >= 55 dBA New Shoreham nighttime limit shown				

Table B-5 Acoustic Model Output at NSRs (dBA) – Vibratory Pile Driving for Long HDD Cofferdam, Block Island

NSR ID	UTM Coordinates (m)		Received Sound Level (dBA)
	Easting	Northing	
4278	284794	4563260	51
4284	284752	4563092	53
4297	284735	4562216	66
Note: Receptors with received sound levels >= 55 dBA New Shoreham nighttime limit shown			

Table B-6 Acoustic Model Output at NSRs (dBA) – Vibratory Pile Driving for Long HDD Cofferdam - BITS Alt 1, Narragansett

NSR ID	UTM Coordinates (m)		Received Sound Level (dBA)
	Easting	Northing	
1787	294824	4590007	62
1789	295078	4590225	58

NSR ID	UTM Coordinates (m)		Received Sound Level (dBA)
	Easting	Northing	
1790	295100	4590241	57
1791	295099	4590270	57
1792	295127	4590292	56
1847	294429	4589927	55
1851	294489	4589975	56
1852	294483	4590000	55
1854	294449	4589966	55
1855	294427	4589968	55
1927	294598	4589779	60
1928	294580	4589761	60
1929	294571	4589787	60
1937	294630	4589793	61
1938	294658	4589777	62
1939	294668	4589743	63
1940	294680	4589795	63
1941	294636	4589712	62
1943	294570	4589675	60
1947	294495	4589490	57
1949	294436	4589476	55
1950	294480	4589458	56
1951	294542	4589487	58
1952	294553	4589470	58
1953	294551	4589460	58
1954	294550	4589448	57
1955	294596	4589473	59
1956	294634	4589455	59
1957	294614	4589556	60
1958	294700	4589535	63
1959	294808	4589457	64
1960	294847	4589439	64
1961	294657	4589635	62
1962	294648	4589684	62
1963	294618	4589667	61
1964	294634	4589619	62
1965	294582	4589637	60
1966	294566	4589612	59
1967	294581	4589578	60
2066	294495	4589415	56
2067	294549	4589424	57
2068	294550	4589434	57
2069	294547	4589409	57
2070	294543	4589397	57
2071	294542	4589373	56
2072	294583	4589372	57

NSR ID	UTM Coordinates (m)		Received Sound Level (dBA)
	Easting	Northing	
2073	294540	4589357	56
2074	294583	4589353	57
2075	294619	4589368	58
2076	294660	4589332	58
2077	294627	4589319	57
2078	294571	4589317	56
2079	294583	4589280	56
2081	294698	4589273	57
2082	294701	4589251	57
2083	294736	4589247	57
2084	294713	4589293	58
2085	294699	4589332	59
2086	294699	4589354	59
2087	294695	4589385	60
2088	294709	4589420	61
2089	294724	4589379	60
2090	294759	4589393	61
2091	294771	4589371	61
2092	294791	4589409	62
2093	294792	4589334	60
2094	294772	4589350	60
2095	294760	4589322	59
2096	294729	4589329	59
2097	294752	4589274	58
2098	294763	4589245	58
2099	294787	4589244	58
2100	294585	4589394	57
2101	294596	4589412	58
2102	294658	4589391	59
2103	294655	4589410	59
2104	294539	4589296	55
2105	294505	4589308	55
2106	294488	4589326	55
2108	294467	4589362	55
2109	294490	4589352	55
2110	294505	4589444	56
2124	294739	4589112	55
2144	294739	4589189	56
2145	294685	4589173	55
2273	294428	4589438	55
Note: Receptors with received sound levels >= 55 dBA Narragansett nighttime limit shown			

Table B-7 Acoustic Model Output at NSRs (dBA) – Block Island Substation

NSR ID	UTM Coordinates (m)		Block Island Switchyard		
	Easting	Northing	Alternative A	Alternative B	Alternative C
4338	284356	4561581	32	30	38
4339	284345	4561568	32	31	40
4340	284317	4561545	32	31	48
4341	284392	4561410	43	36	36
4342	284469	4561406	48	33	32
4343	284424	4561402	48	35	34
4344	284383	4561372	44	40	34
4345	284324	4561365	36	48	36
4346	284352	4561465	37	33	42
4347	284488	4561444	41	32	32
4348	284525	4561450	38	31	31
4349	284528	4561469	36	31	31
4350	284539	4561457	37	31	30
4351	284555	4561448	36	30	29
4401	284572	4561338	37	31	28
4541	284201	4561551	26	29	41
4545	284265	4561563	27	31	46
4546	284281	4561587	27	30	42
4547	284280	4561612	26	26	35
Note: Receptors with received sound levels >= 35 dBA corresponding to extents of sound contours					

Table B-8 Acoustic Model Output at NSRs (dBA) – Narragansett Substation

NSR ID	UTM Coordinates (m)		Received Sound Level (dBA)
	Easting	Northing	
2796	293705	4590040	13
2795	293673	4590109	10
Note: Receptors with received sound levels >= 10 dBA corresponding to extents of sound contours			