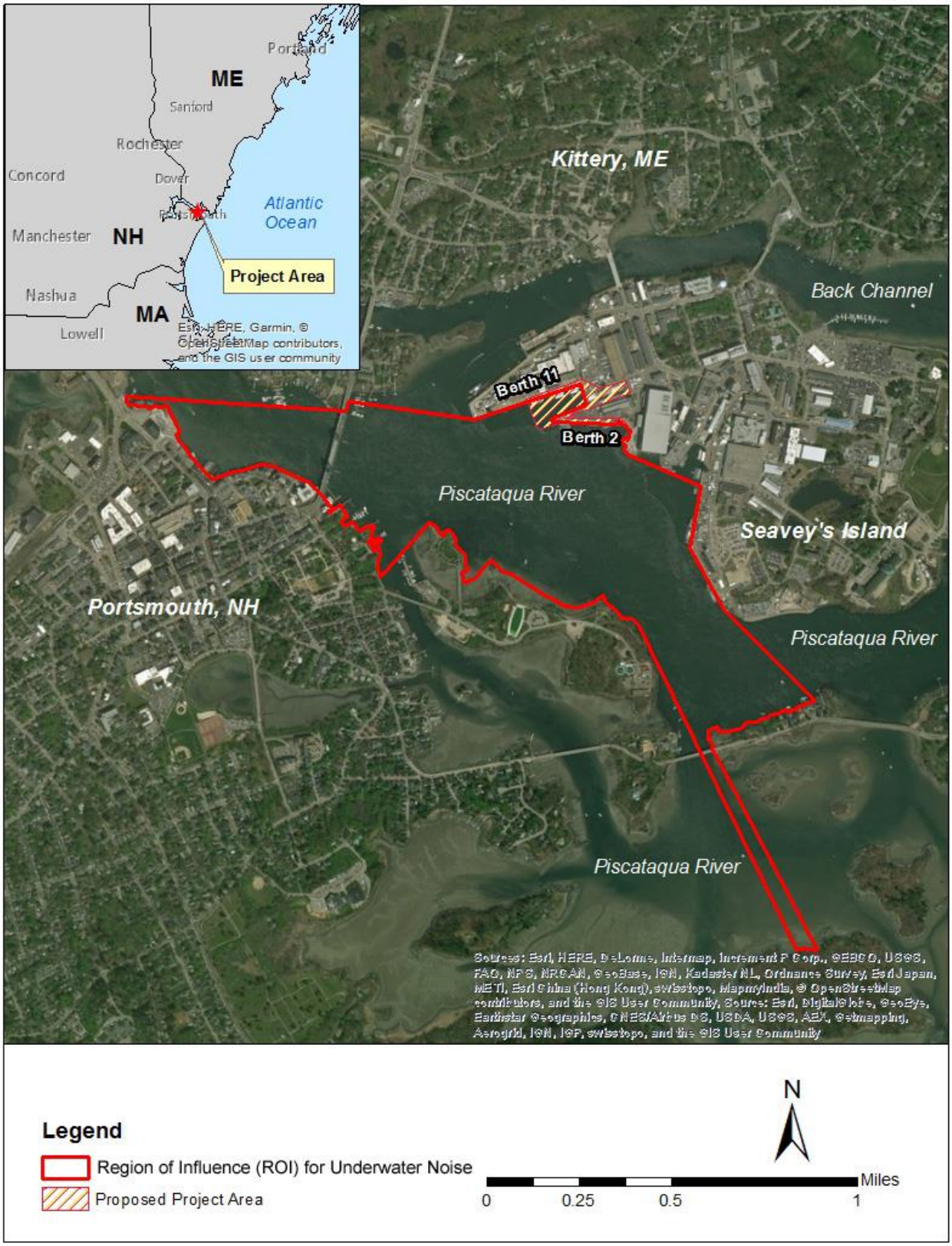


Figure 6-1. Region of Influence for Underwater Noise

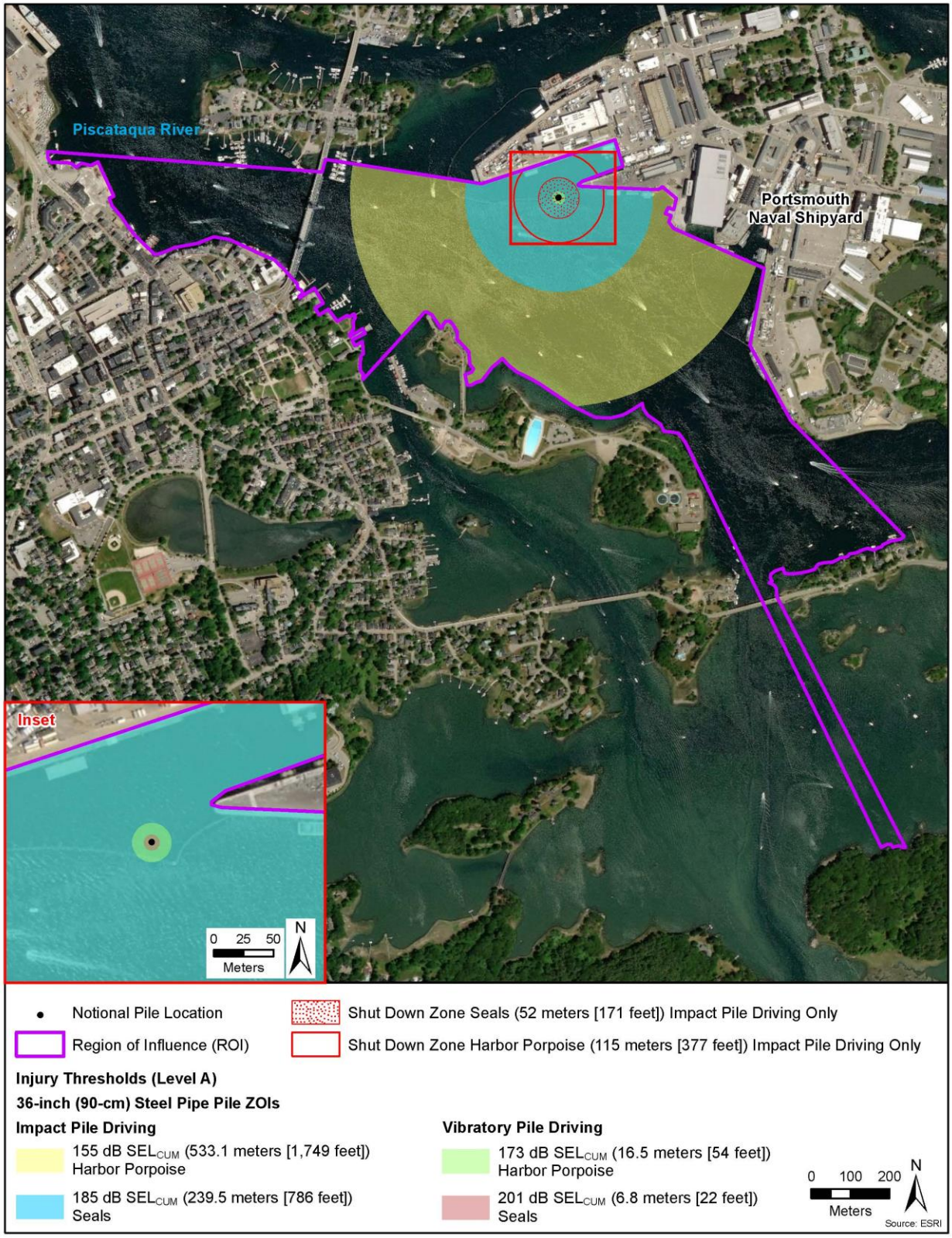


Figure 6-2. Representative ZOI for Level A Injury due to Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 36-inch Steel pipe piles

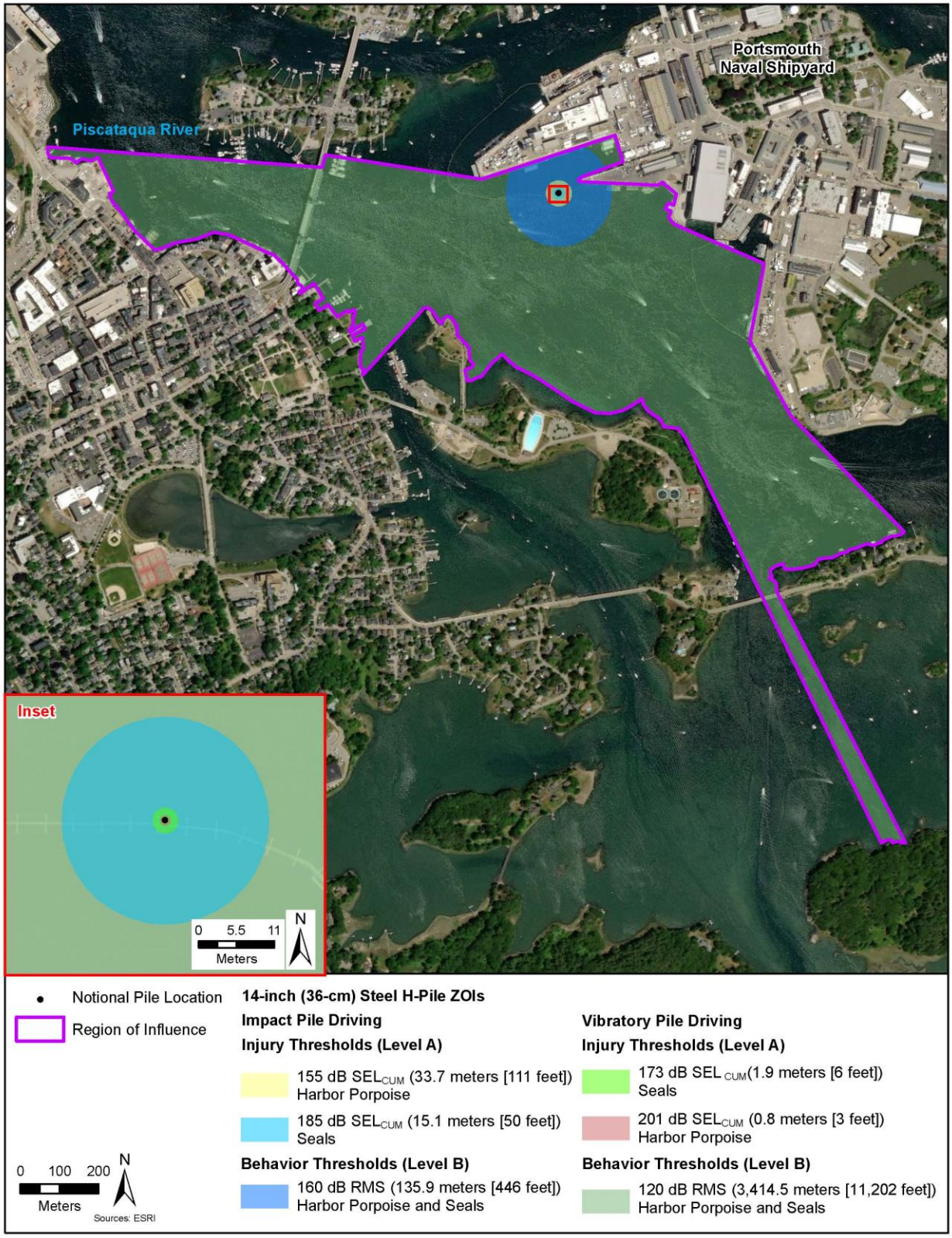


Figure 6-3. Representative ZOI for Level A Injury and Level B Behavioral Disturbance due to Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 14-inch Steel H-Piles

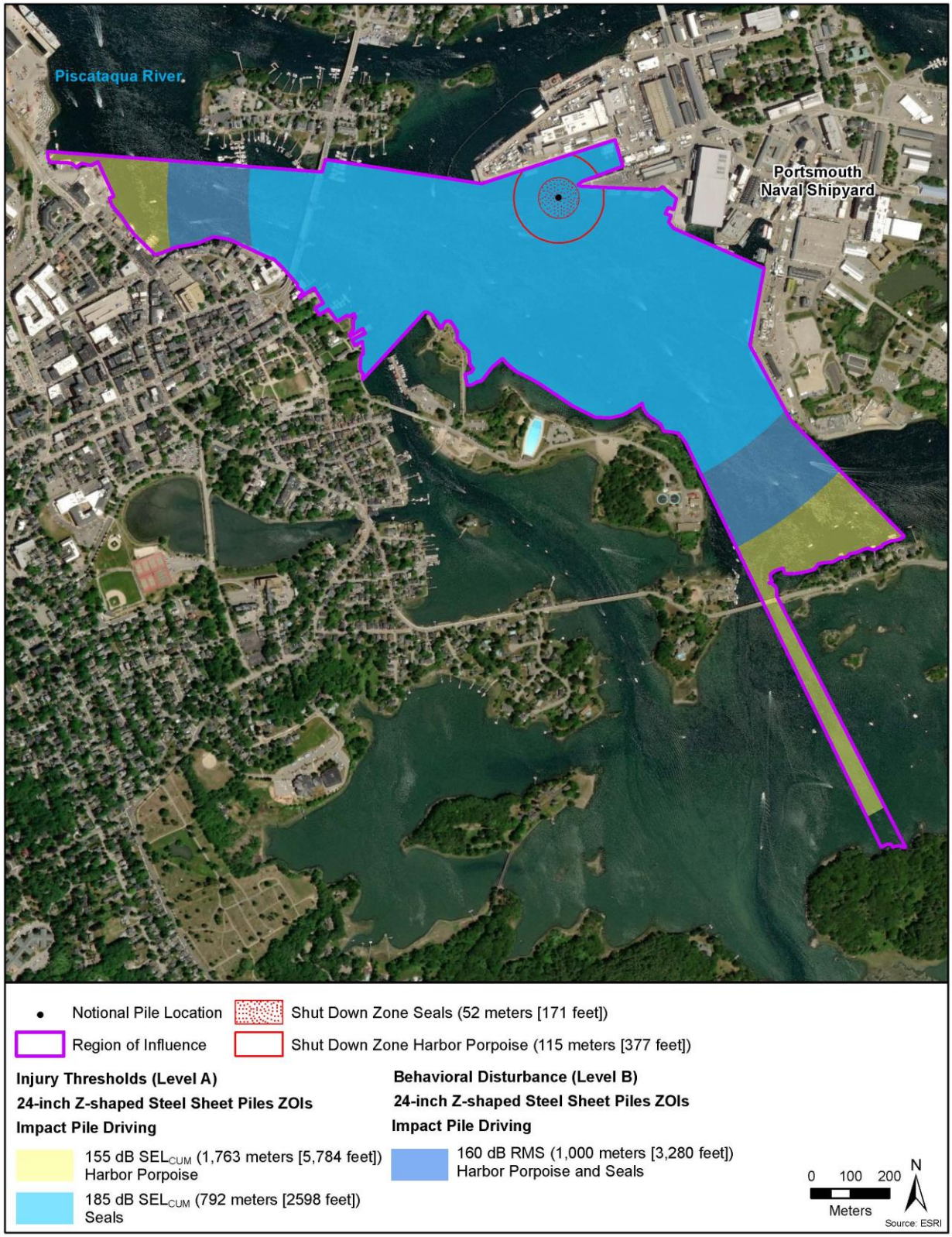


Figure 6-4. Representative ZOI for Level A Injury and Level B Behavioral Disturbance due to Underwater Pile Driving Noise during Impact Pile Driving 24-inch Z-shaped Sheet Piles

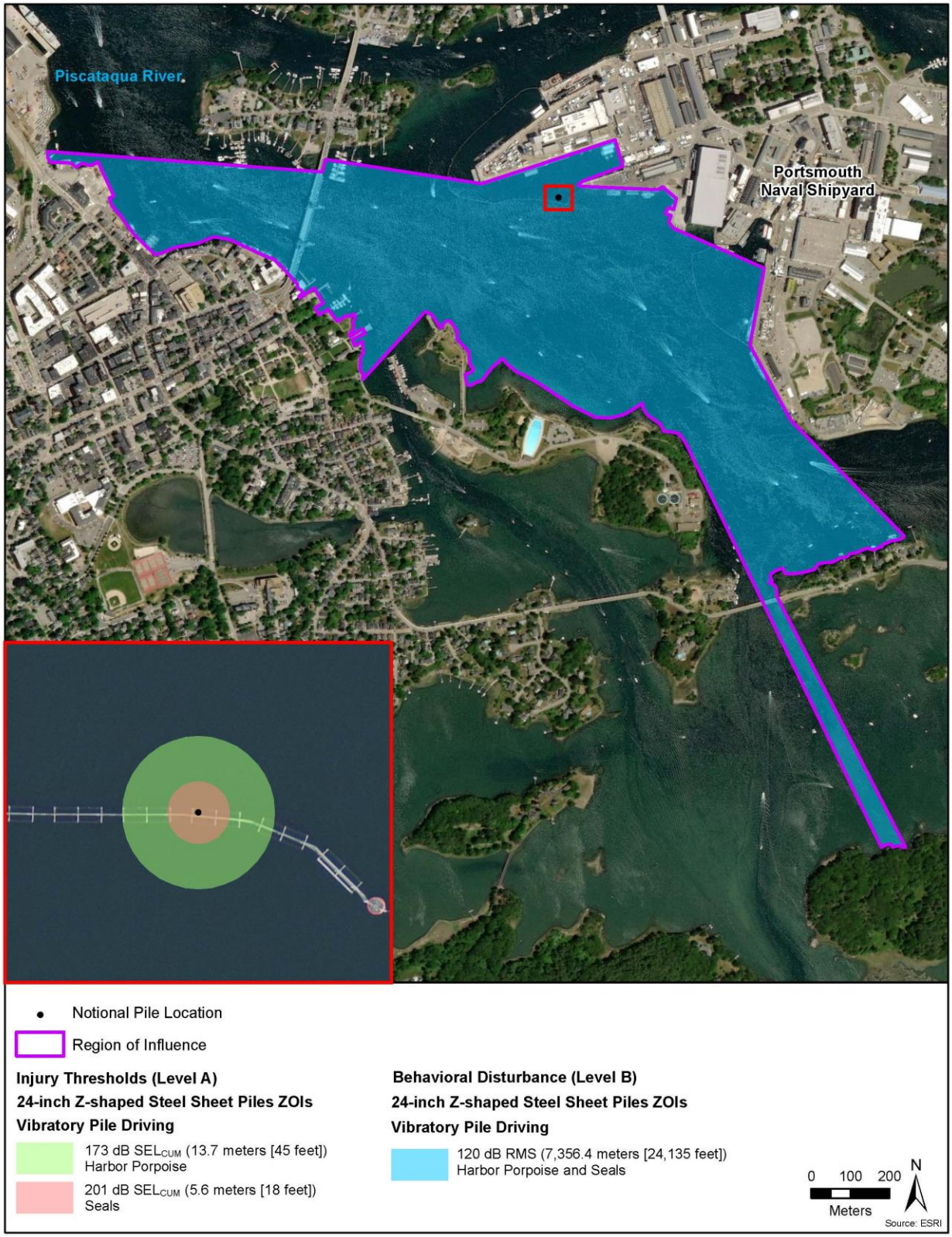


Figure 6-5. Representative ZOI for Level A Injury and Level B Disturbance due to Underwater Pile Driving Noise during Vibratory Pile Driving 24-inch Z-shaped Sheet Piles

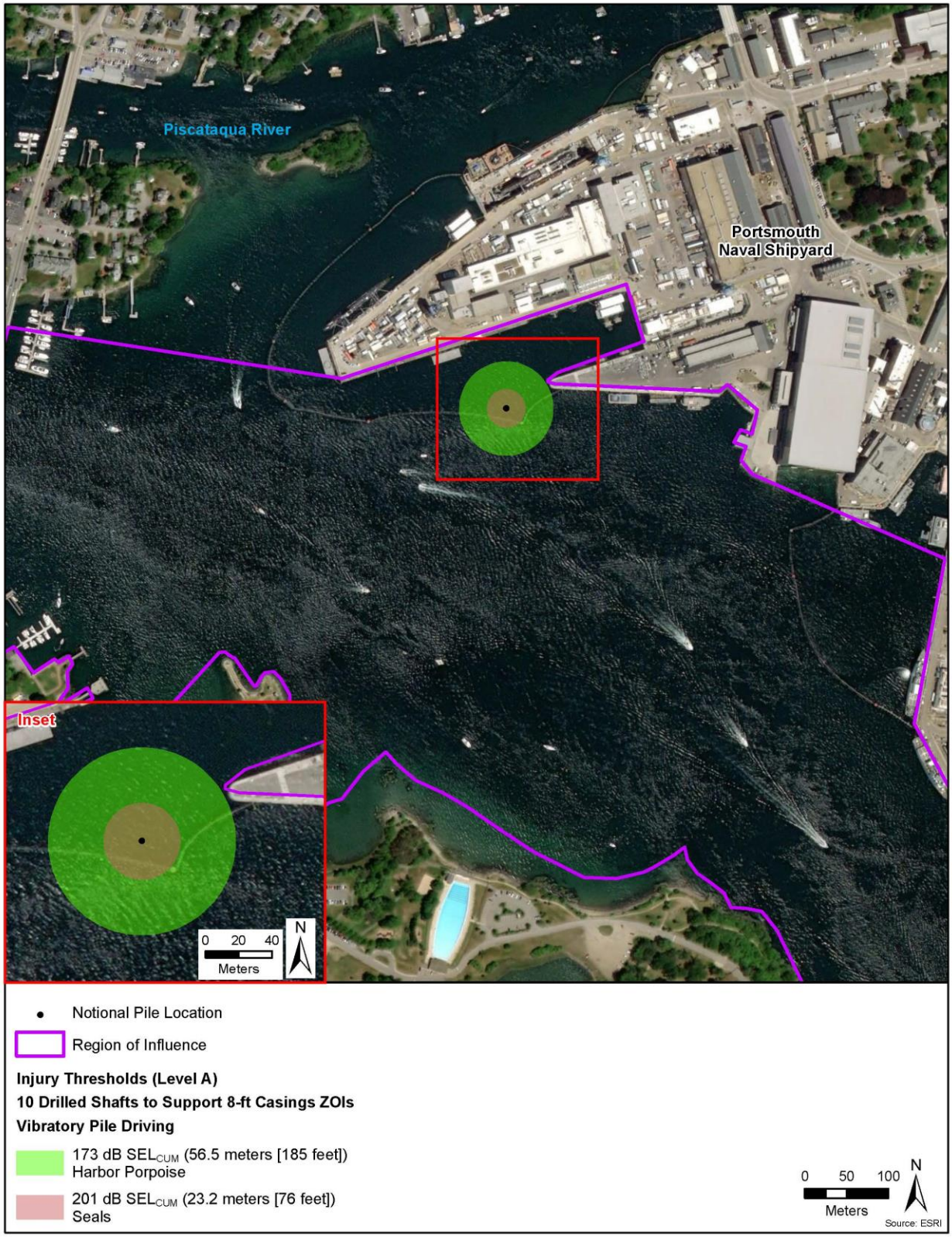


Figure 6-6. Representative ZOI for Level A Injury due to Underwater Drilling of Shafts for 8-ft Diameter Casings

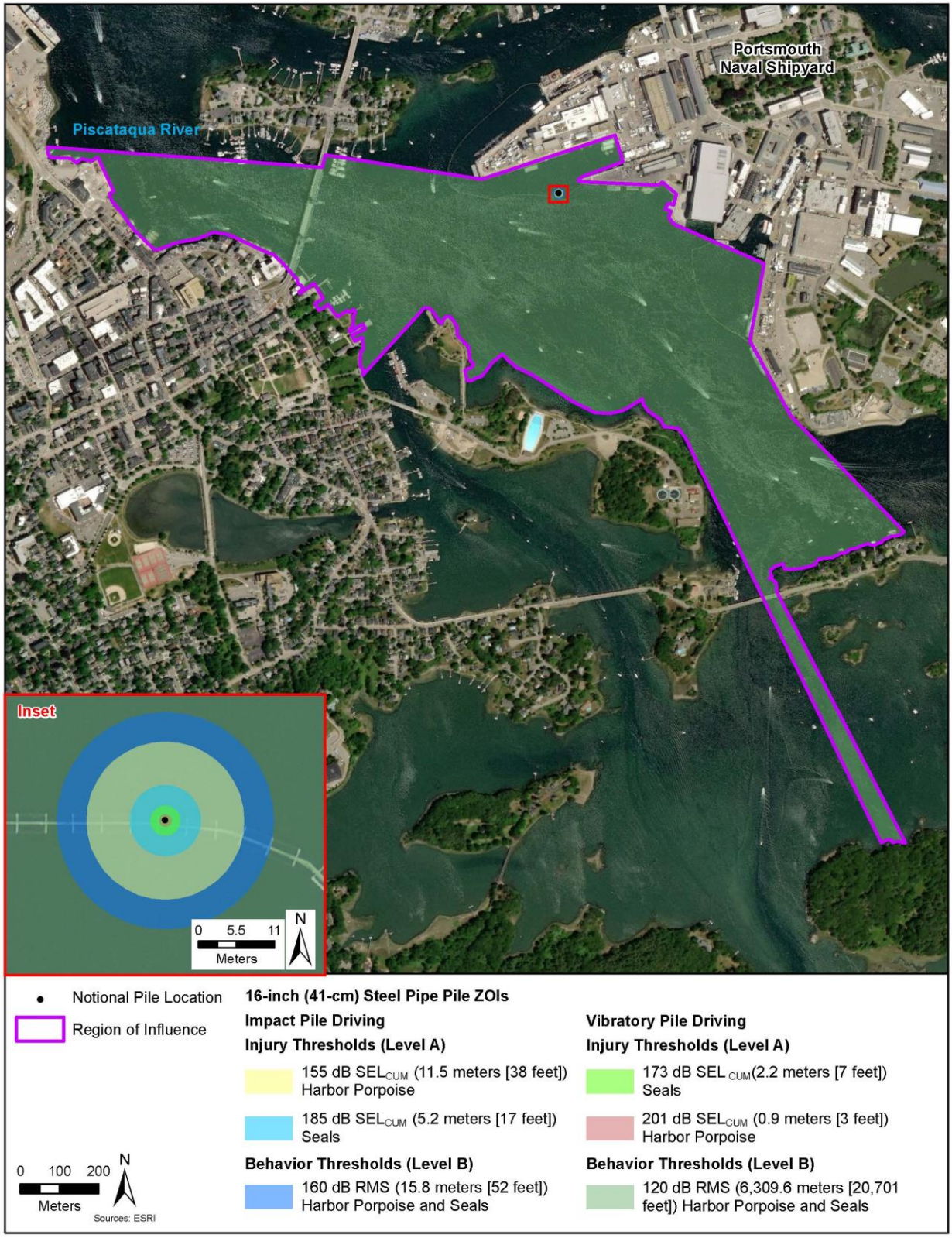


Figure 6-7. Representative ZOI for Level A Injury and Level B Behavioral Disturbance due to Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 16-inch Steel Pipe Piles

Figure 6-8. Representative ZOI for Behavioral Disturbance due to Airborne Pile driving Noise

Project Name:	PNSY - Super Flood	PSO:	Alex VanEtten	Page:	of
PSO Location:	NewCastle Causeway	Lead PSO Info:	(207) 614-4240	Date:	11-24-20

Weather AM	Partial Clouds	Wind Spd/Dir	8mph/W	Temp (F)	33	Cld Cover (%)	60%	BSS	1	Visibility	Good
PM	Partly Cloudy	Wind Spd/Dir	12mph/NW	Temp (F)	40	Cld Cover (%)	50%	BSS	1	Visibility	Good

Construction Activity Info					Marine Mammal Observation*					
Event Info (circle all applicable)	Pile Material Used (circle all applicable)	Time of Event (start and end if applicable)	PSO Name	Tidal State	Species (use code)	Distance and Bearing from PSO (m and degrees)	# Animals & Sex (min/max/best est) # of calves	Movement Relative to Noise	Behavior Code Note Any Change In Behavior	Take Types / Number
Start of Day, End of Day Vibratory, Impact, Drilling Sighting, Delay, Shutdown	18" Sheet 24" Sheet 16" Pipe 36" Pipe 14" H-Pile 96" Casing	6 :40 :	ave	Flow		___ m ___ o	/ / / ___ M ___ F ___ calves	Towards, Away, Parallel		Level A: ___ indvs Level B: ___ indvs
Start of Day, End of Day Vibratory, Impact, Drilling Sighting, Delay, Shutdown	18" Sheet 24" Sheet 16" Pipe 36" Pipe 14" H-Pile 96" Casing	8 :10 8 :12	ave	Ebb	HBSE	205 m 298 °	1 / 1 / 1 / – M – F – calves	Towards, Away, Parallel	1 swimming	Level A: ___ indvs Level B: ___ indvs
Start of Day, End of Day Vibratory, Impact, Drilling Sighting, Delay, Shutdown	18" Sheet 24" Sheet 16" Pipe 36" Pipe 14" H-Pile 96" Casing	9 :19 9 :22	ave	Ebb	HBSE	110 m 19 °	1 / 1 / 1 / – M – F – calves	Towards, Away, Parallel	1 milling	Level A: ___ indvs Level B: ___ indvs
Start of Day, End of Day Vibratory, Impact, Drilling Sighting, Delay, Shutdown	18" Sheet 24" Sheet 16" Pipe 36" Pipe 14" H-Pile 96" Casing	12 :47 12 :49	ave	Ebb	HBSE	321 m 346 °	1 / 1 / 1 / – M – F – calves	Towards, Away, Parallel	1 swimming	Level A: ___ indvs Level B: ___ indvs
Start of Day, End of Day Vibratory, Impact, Drilling Sighting, Delay, Shutdown	18" Sheet 24" Sheet 16" Pipe 36" Pipe 14" H-Pile 96" Casing	13 :25 :	ave	Flow		___ m ___ o	/ / / ___ M ___ F ___ calves	Towards, Away, Parallel		Level A: ___ indvs Level B: ___ indvs
Start of Day, End of Day Vibratory, Impact, Drilling Sighting, Delay, Shutdown	18" Sheet 24" Sheet 16" Pipe 36" Pipe 14" H-Pile 96" Casing	: :				___ m ___ o	/ / / ___ M ___ F ___ calves	Towards, Away, Parallel		Level A: ___ indvs Level B: ___ indvs
Start of Day, End of Day Vibratory, Impact, Drilling Sighting, Delay, Shutdown	18" Sheet 24" Sheet 16" Pipe 36" Pipe 14" H-Pile 96" Casing	: :				___ m ___ o	/ / / ___ M ___ F ___ calves	Towards, Away, Parallel		Level A: ___ indvs Level B: ___ indvs
Start of Day, End of Day Vibratory, Impact, Drilling Sighting, Delay, Shutdown	18" Sheet 24" Sheet 16" Pipe 36" Pipe 14" H-Pile 96" Casing	: :				___ m ___ o	/ / / ___ M ___ F ___ calves	Towards, Away, Parallel		Level A: ___ indvs Level B: ___ indvs
Start of Day, End of Day Vibratory, Impact, Drilling Sighting, Delay, Shutdown	18" Sheet 24" Sheet 16" Pipe 36" Pipe 14" H-Pile 96" Casing	: :				___ m ___ o	/ / / ___ M ___ F ___ calves	Towards, Away, Parallel		Level A: ___ indvs Level B: ___ indvs

* For all species observations entered, note physical location on attached map with species code, date, and time.

Species Codes: HBPP (Harbor porpoise); HBSE (Harbor seal); GRSE (Gray seal); HDSE (Hooded seal); HPSE (Harp seal); OTHR (Other species; list name)

Behavioral Codes: 1) no response, 2) head alert (looks towards disturbance), 3) approaches in water, or 4) retreat or flush (leaves the area or flushes from haul-out site).

Other Monitoring Notes:

PSNY POC: Ian Trefry at ian.trefry@navy.mil or 207.438.4362

NAVFAC MIDLANT POC: Jessica Bassi at jessica.bassi@navy.mil or 757.341.0493

Form Revised: January 21, 2020

Scanned by TapScanner

Submittal 52B.3 Hydroacoustic Monitoring Plan

Specification Section 01 57 19.00 22

SD-01 Preconstruction Submittal

P 310 DD1 Super Flood Basin and P1074 Portal Crane Rail Extension

April 23, 2020

Presented To:

PNSY Public Works Department

Portsmouth Naval Shipyard

Kittery, Maine 03904

By:

Cianbro Corporation

Pittsfield, Maine 04967

TABLE OF CONTENTS

A. Introduction 3

B. Requirements 4

C. Equipment and Procedures 17

D. Reporting 19

APPENDICES

Appendix A – Equipment Data Sheets 21

Appendix B – Acoustic Model ZOI 35

Appendix C – Anticipated Piles to be Driven 42

FIGURES

Figure 1. Region of Influence for Underwater Noise 4

Figure 2. Plan View of Project Site 5

Figure 3. Representative Map Version of Distance between Point and Federal Navigation Channel 6

Figure 4. Representative Map Version of Distance between Source Pile and 20x Depth at Pile 6

Figure 5. Representative Monitoring Locations for Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 36-Inch Steel Pipe Piles 8

Figure 6. Representative Monitoring Locations for Underwater Pile Driving Noise during Impact Pile Driving 24-Inch Z-shaped Sheet Piles 9

Figure 7. Representative Monitoring Locations for Underwater Pile Driving Noise during Vibratory Pile Driving 24-Inch Z-shaped Sheet Piles 10

Figure 8. Representative Monitoring Locations for Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 16-Inch Steel Pipe Piles 11

Figure 9. Representative Monitoring Locations for Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 14-Inch Steel H-Piles 12

Figure 10. Representative Monitoring Locations for Underwater Drilling of Shafts for 8-ft Diameter Casings 13

Figure 11. Representative ZOI for Level A Injury due to Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 36-Inch Steel Pipe Pile 36

Figure 12. Representative ZOI for Level A Injury and Level B Behavioral Disturbance due to Underwater Pile Driving Noise during Impact Pile Driving 24-Inch Z-shaped Sheet Piles 37

Figure 13. Representative ZOI for Level A Injury and Level B Behavioral Disturbance due to Underwater Pile Driving Noise during Vibratory Pile Driving 24-Inch Z-shaped Sheet Piles 38

Figure 14. Representative ZOI for Level A Injury and Level B Behavioral Disturbance due to Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 16-Inch Steel Pipe Piles 39

Figure 15. Representative ZOI for Level A Injury due to Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 14-Inch Steel H-Piles 40

Figure 16. Representative ZOI for Level A Injury due to Underwater Drilling of Shafts for 8-ft Diameter Casings 41

LIST OF TABLES

Table 1. Marine Mammal Hearing Groups 20

Table 2. Shutdown Distances For Various Pile Driving Activities 42

Table 3. Marine Mammal Level A and Level B Harassment Zones For Monitoring 42

Table 4. Marine Mammal Shutdown Distances with Monitoring Locations Distances 43

A. Introduction

The following is the hydroacoustic monitoring plan for Portsmouth Naval Shipyard (PNSY) DD1 Super Flood Basin and Portal Crane Rail Extension project. Over the course of this project, in-water pile driving/excavating work will be necessary to complete the super flood basin. This work will produce a variety of high intensity sound within the project area, propagating out to portions of the Piscataqua River. These high levels of sound pressure have the potential to harass and possibly injure marine mammals that can be found living in the Piscataqua River.

Sound is one of the main methods marine mammals use to communicate, navigate, and forage for food. The impacts to marine mammals by introducing temporary threshold shifts (TTS) and permanent threshold shifts (PTS) are still being researched as more data is collected. However, it is known that the impact of high pressure levels have the potential to affect an animal's physical condition.

The main course of action is to collect acoustical data from various pile driving equipment to determine the source level produced those piles. The zones (TTS and PTS) were established based on isopleth shifts estimated for each pile type that will be installed the duration of this authorization.

Monitoring of the zones will not affect Level A or Level B zones during the first year of construction. Depending on the results of year one monitoring, NMFS will be consulted on adjustments to Level A and Level B zones for construction years 2 through 6.

The level B harassment zone is defined as the area where sound intensity could potentially harass, but not harm, a protected species while driving/excavating activity is taking place will be recorded as a "take." Information will then be compared and shared in collaboration with marine mammal observations, ensuring cetacean and pinniped safety from permanent harassment and injury while work is being completed. The disturbance zone will include all areas where the underwater or airborne SPLs are anticipated to equal or exceed the Level B (disturbance) criteria for marine mammals during all noise generating activities.

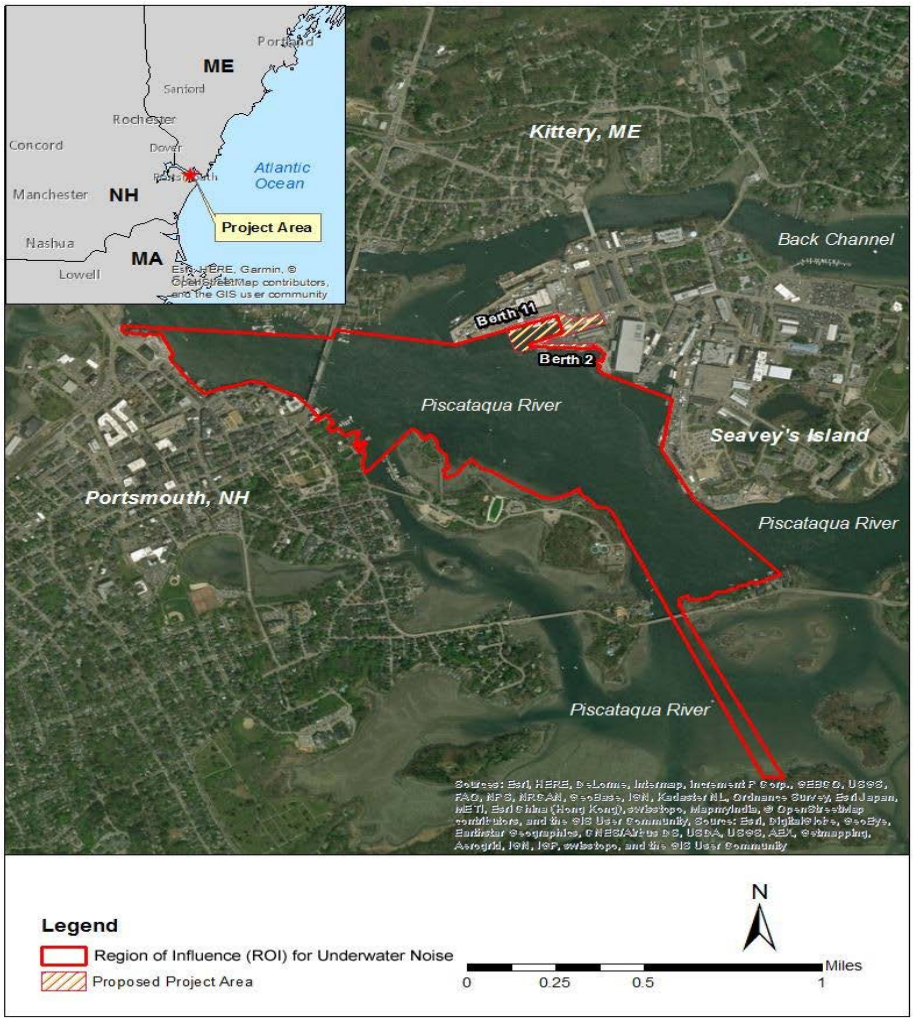
All NAVFAC and NMFS approved zones can also be found in Appendix B – Acoustic Model ZOI.

The numbers of piles to be monitored for pile driving per the issued IHA are:

- 10 AZ sheet piles and 10 flat web sheet piles under both impact and vibratory driving
- 4 16-inch steel piles for impact and vibratory driving
- 5 36-inch steel piles for impact and vibratory driving
- 5 14-inch H-piles for impact and vibratory driving
- 4 8-foot diameter shafts for down-the-hole drilling

Due to the dynamic nature of this construction project, the number of piles and pile types have changed since the submission of the IHA application. Appendix C denotes the current list of pile types and count with the difference from the totals within the issued IHA identified. The table confirms a representative number of piles from each type will be monitored. Any additional changes will be brought to the attention of the Navy and NMFS to discuss and adjust monitoring as needed.

Figure 1 shows region of influence by underwater noise based on transmission loss models.



Source: NOAA Fisheries. IHA Application. 2020.

Figure 1. Region of Influence for Underwater Noise

B. Requirements

Hydroacoustic monitoring will comply with the ***Final Request for Incidental Harassment Authorization for Modification, Expansion, and Future Operations of Dry Dock 1 at Portsmouth Naval Ship Yard*** and the issued Incidental Harassment Authorization dated December 2019.

For the piles that will be monitored, 100% of the data will be analyzed and reported (including "soft starts" of impact hammers). Monitoring is necessary as specified in the issued IHA, section 5(c). Monitoring will occur 33' (10m) from the source pile and at remote locations have been chosen to comply with NMFS data collection guidance while ensuring the equipment does not interfere with the navigable channel of the river. In addition to determining the area where 120 dB and 160 dB RMS exists, further hydrophone measurements will be taken at various distances appropriate to accurately confirm transmission loss and estimated ZOI locations for each pile type.

There will always be a static hydrophone deployed at 10m regardless of pile type/activity. Locations for remote hydrophone deployment have been chosen based on NMFS data collection guidance; however, where the distance criteria cannot be met due to proximity to the navigable channel, the equipment will be placed as far as practicable and will be noted in the reporting. This can be seen in Figure 5 through 10.

The approximate distance was found with consulting Project specification plans (Figure 2) to find the best possible location to monitor. Location will reflect strategical deployment as to avoid flat surfaces, fixed structures, or other obstructions (concrete batch plant, barges, etc.) that may reflect frequencies and further obscure data. The distance closest to the navigable channel of the river is approximately 458 feet (139.6m) from the Point between Berth 1 and Berth 2.

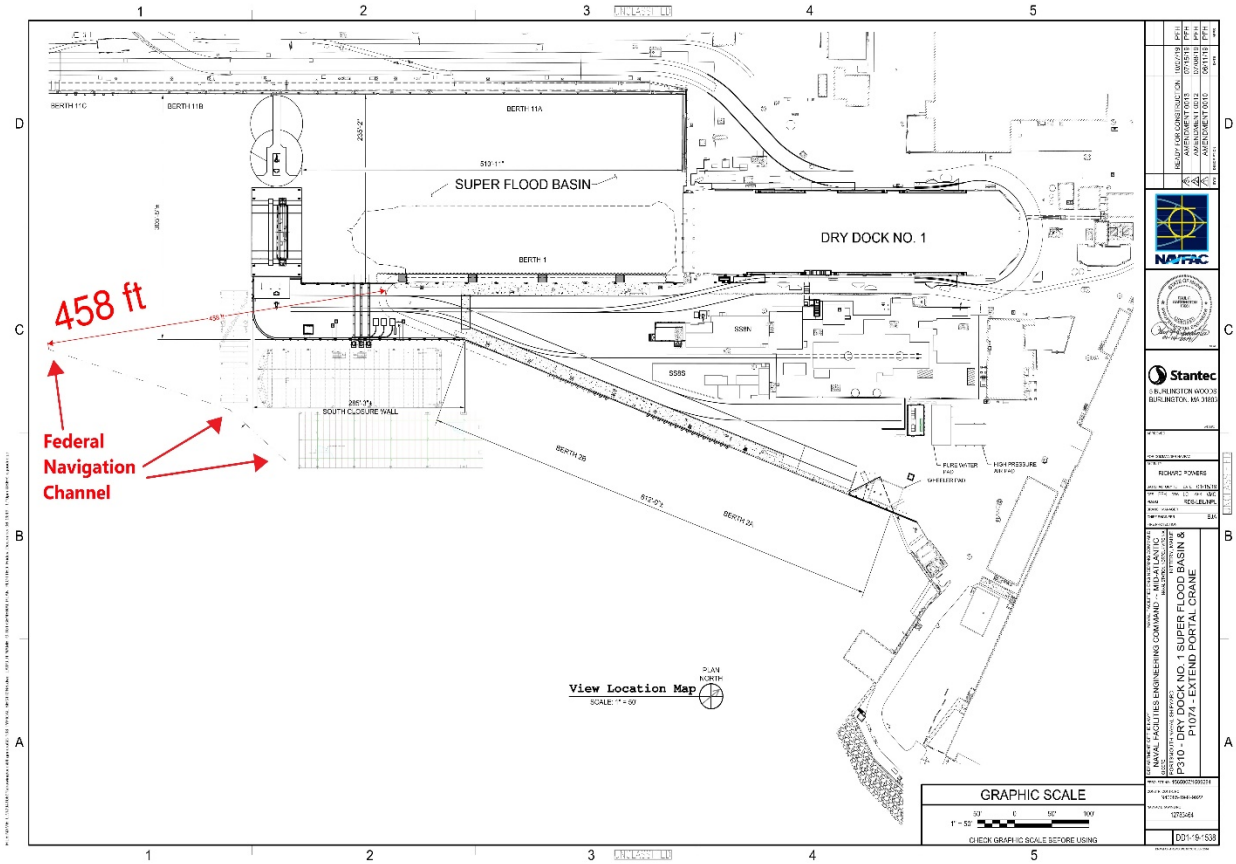


Figure 2. Plan View of Project Site.

Original Figure Sourced from Project Specifications. 2020.
Modified by Cianbro to show proposed locations for pile driving monitoring.

Figure 3. Representative Map Version of Distance between Point and Federal Navigation Channel

Original Figure Sourced Google Maps. 2020.
Modified by Cianbro to show proposed locations for pile driving monitoring.

The furthest source pile will be seated approximately 200 feet from the Point between Berth 1 and Berth 2. The depth at this pile will be 65 feet (19.812m) between the water surface and river floor bed. Following NMFS guidance of 20 x 19.812 (the depth of the pile), this leaves the monitoring location 396.24m (1300 feet) from the source pile. This can be seen in Figure 4.

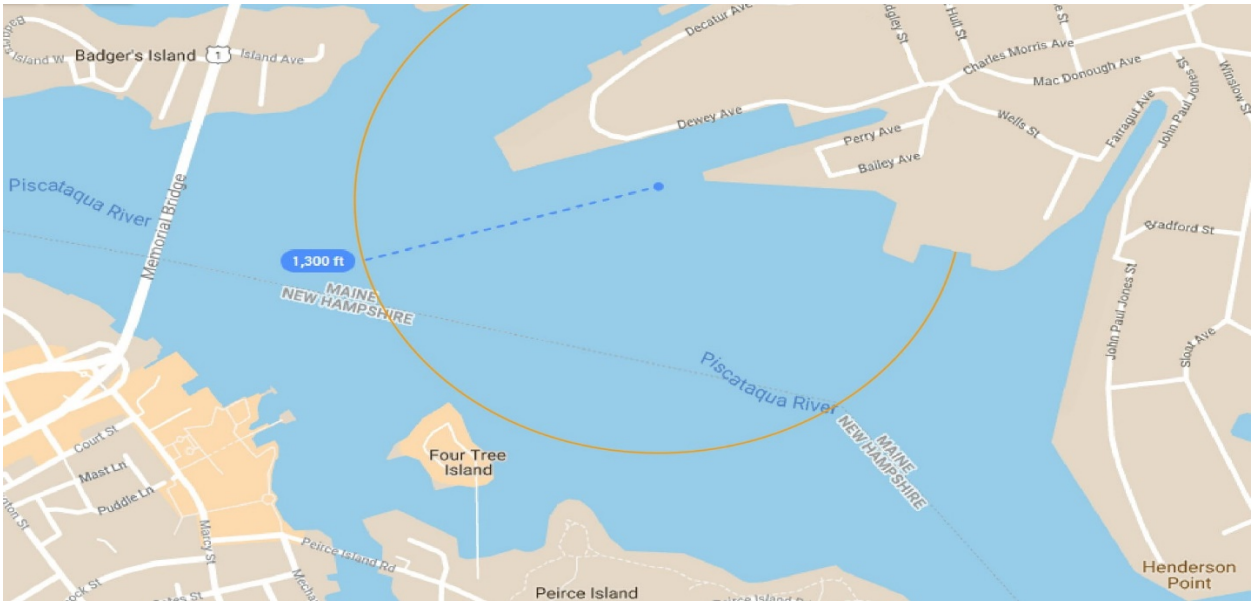


Figure 4. Representative Map Version of Distance between Source Pile and 20x Depth at Pile

Original Figure Sourced Google Maps. 2020.
Modified by Cianbro to show proposed locations for pile driving monitoring.

Direct communication between the pile driving crew, observers and hydroacoustic monitors is critical. There will always be a direct line of communication between the operations crew and marine mammal monitoring team to ensure no pile driving activity occurs before the hydrophone(s) is appropriately set and operational. Should activity type change, work will cease and the hydrophone will be repositioned, recording the new location with a GPS to confirm the correct distance for the next respective pile type/activity as required by the IHA.

If there is concurrent noise (i.e. drilling and vibratory hammer), the most conservative location will be utilized for remote monitoring.

Figures 5 through 10 are proposed locations for deployment of a remote hydrophone in each respective location as close to the Federal Navigation Channel as possible without unsafely intruding. More details can be found in Appendix B - Table 4. Marine Mammal Shutdown Distances with Monitoring Locations Distances. Exact locations will be determined by activity location within the project area.

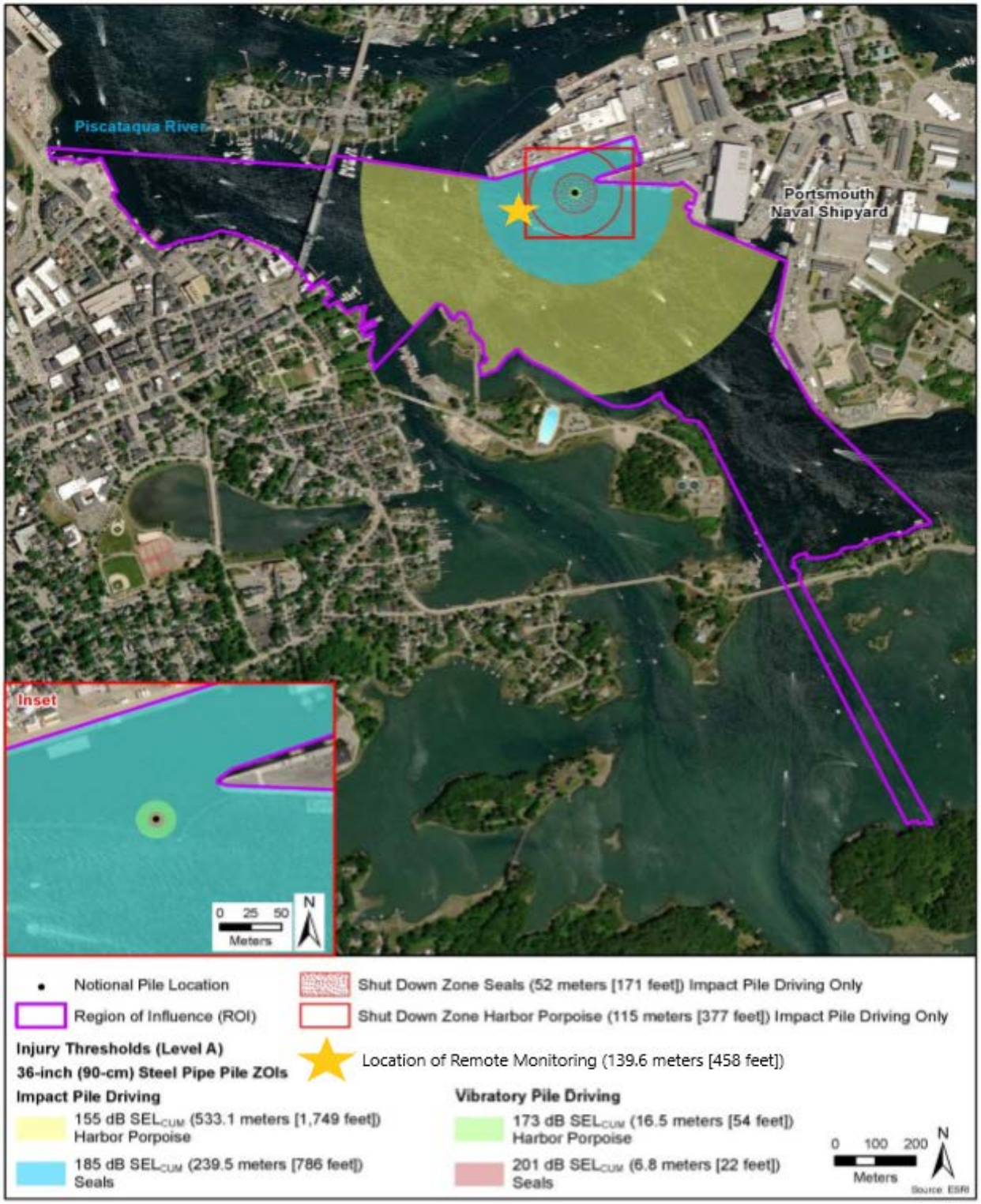


Figure 5. Representative Remote Monitoring Locations for Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 36-Inch Steel Pipe Piles*

Original Figure Sourced from NOAA Fisheries. IHA Application. 2020.
Modified by Cianbro to show proposed locations for pile driving monitoring.
*Location may be adjusted based on proximity to the navigable channel

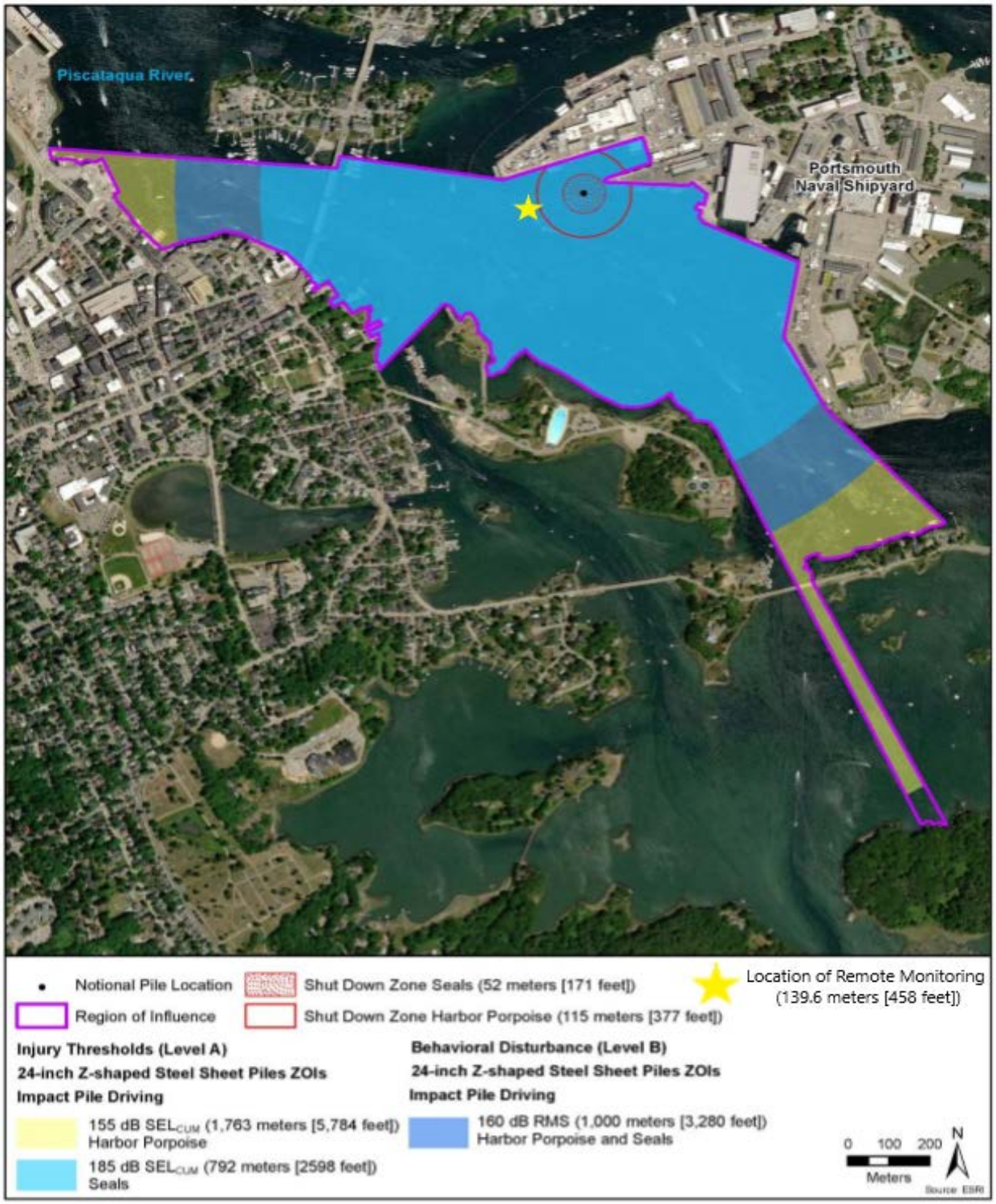


Figure 6. Representative Remote Monitoring Locations for Underwater Pile Driving Noise during Impact Pile Driving 24-Inch Z-shaped Sheet Piles

Original Figure Sourced from NOAA Fisheries. IHA Application. 2020.
Modified by Cianbro to show proposed locations for pile driving monitoring.
*Location may be adjusted based on proximity to the navigable channel

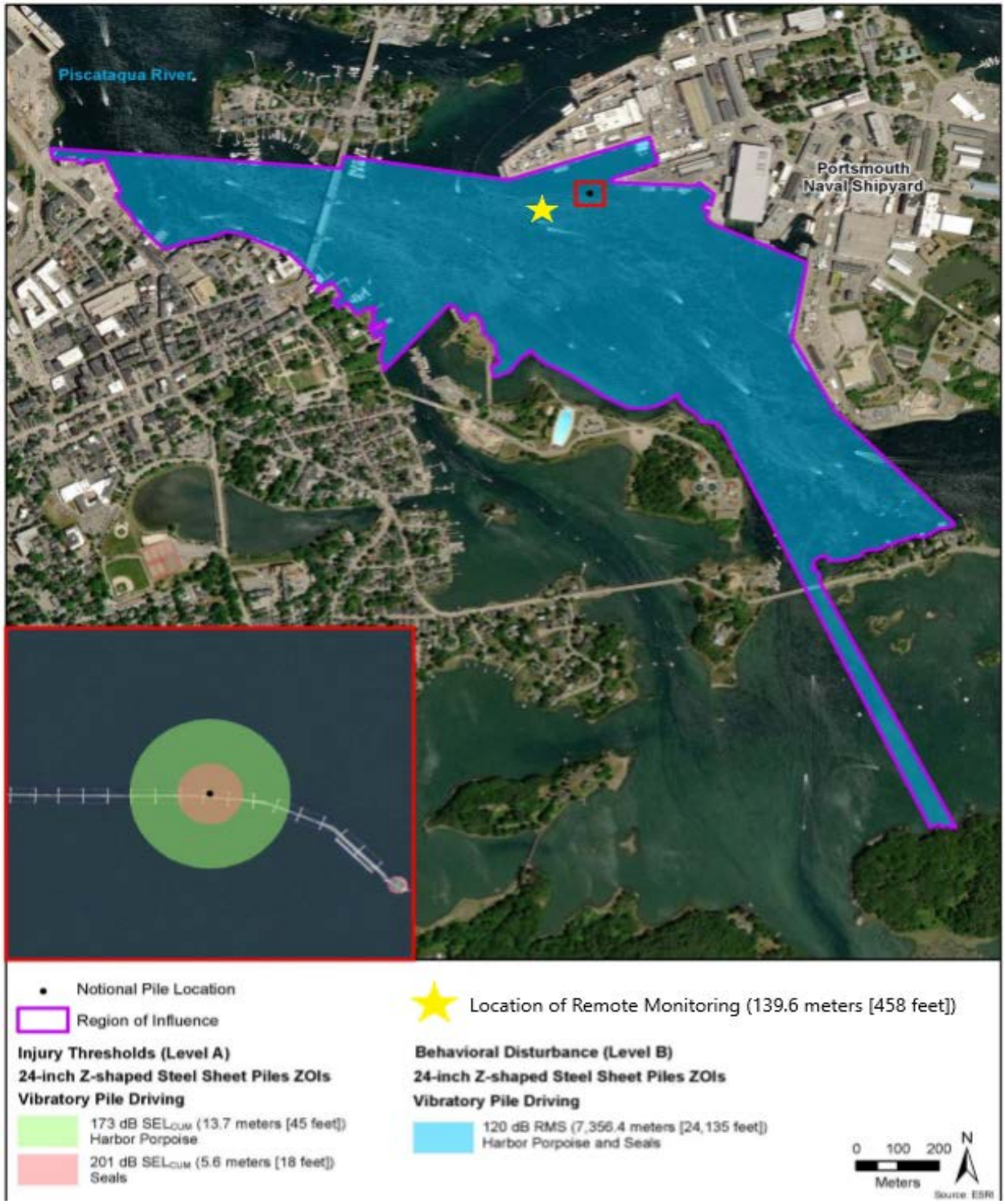


Figure 7. Representative Remote Monitoring Locations for Underwater Pile Driving Noise during Vibratory Pile Driving 24-Inch Z-shaped Sheet Piles*

Original Figure Sourced from NOAA Fisheries. IHA Application. 2020.
Modified by Cianbro to show proposed locations for pile driving monitoring.
*Location may be adjusted based on proximity to the navigable channel

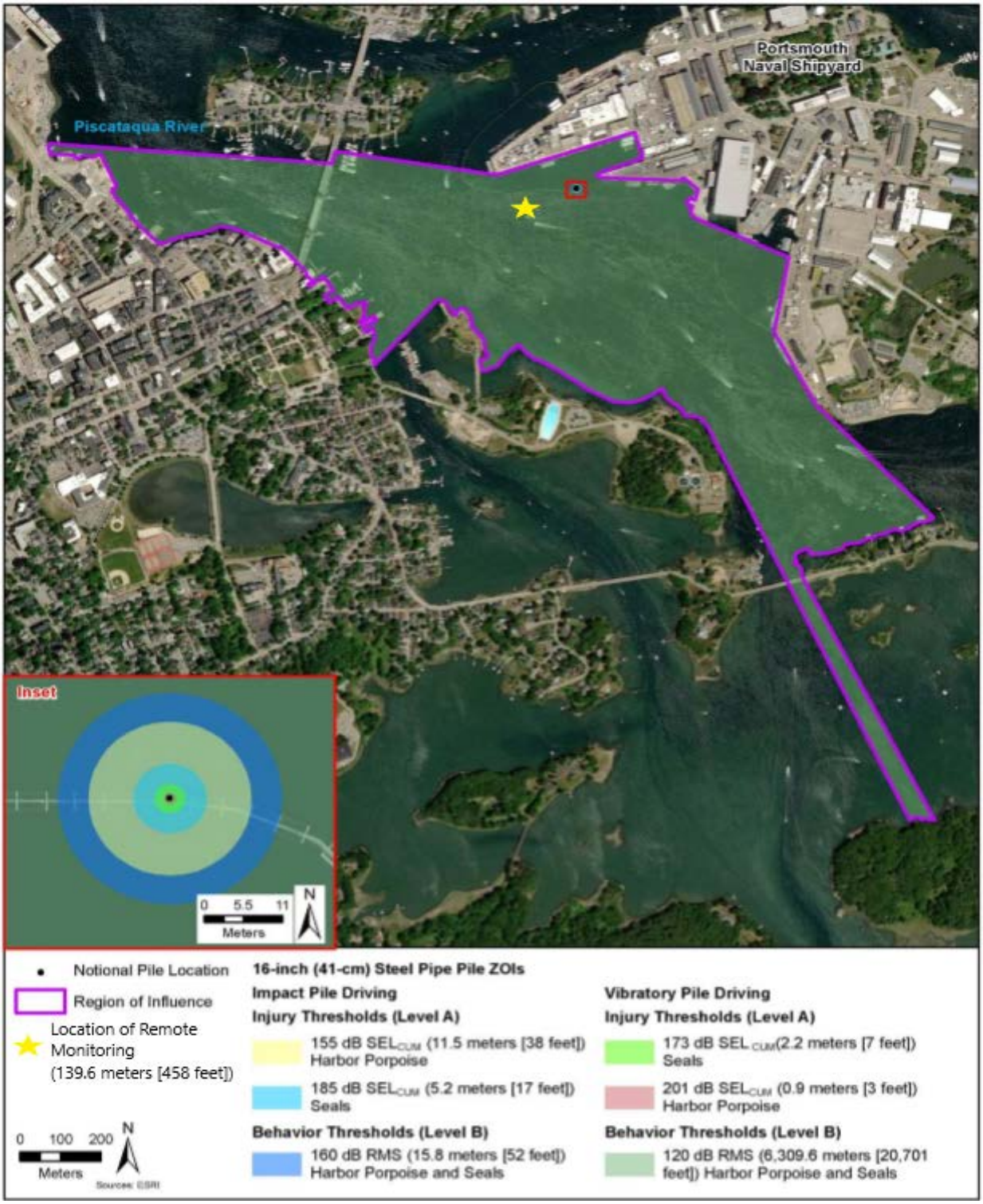


Figure 8. Representative Remote Monitoring Locations for Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 16-Inch Steel Pipe Piles

Original Figure Sourced from NOAA Fisheries. IHA Application. 2020.
Modified by Cianbro to show proposed locations for pile driving monitoring.
*Location may be adjusted based on proximity to the navigable channel

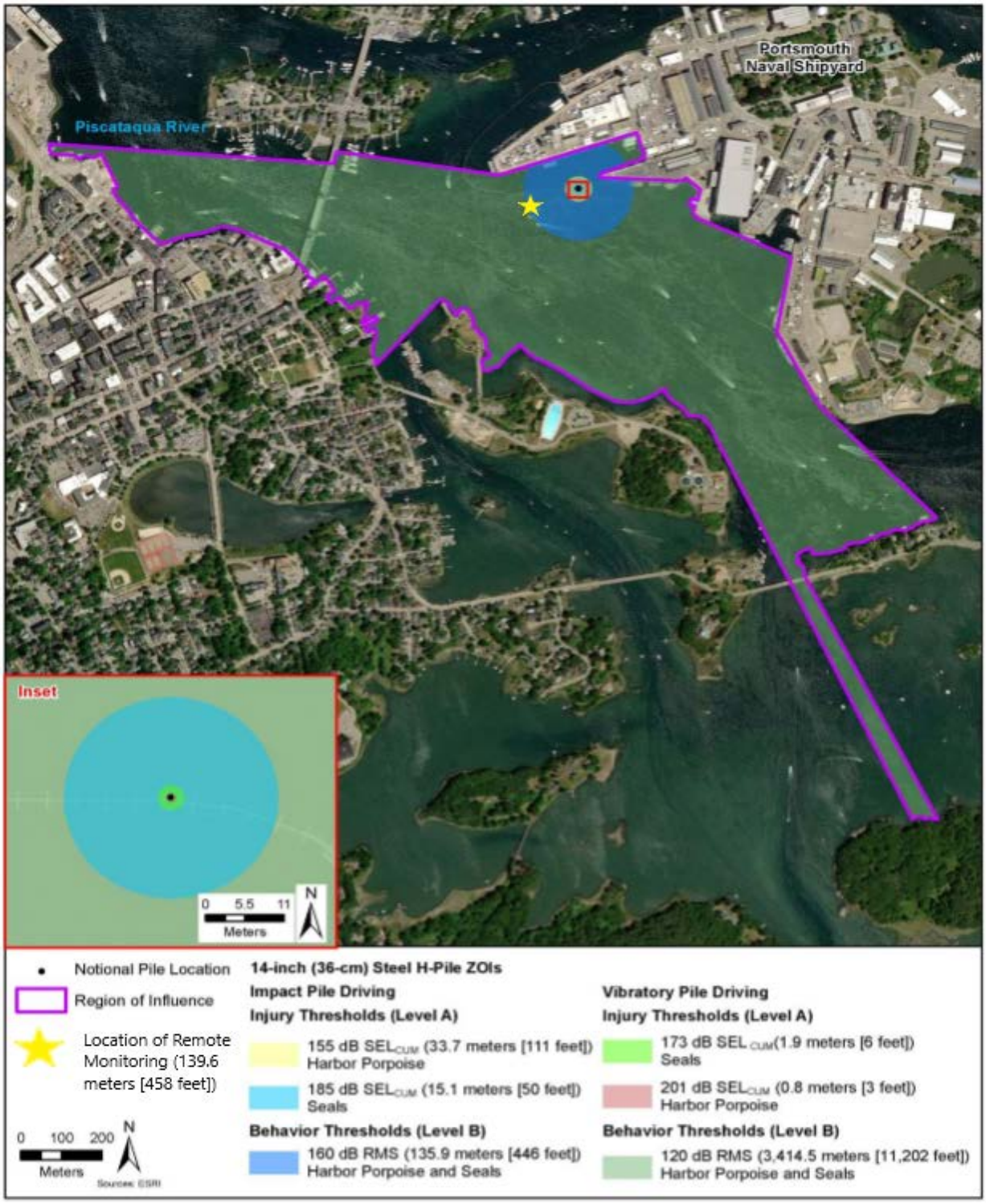


Figure 9. Representative Remote Monitoring Locations for Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 14-Inch Steel H-Piles

Original Figure Sourced from NOAA Fisheries. IHA Application. 2020.
Modified by Cianbro to show proposed locations for pile driving monitoring.
*Location may be adjusted based on proximity to the navigable channel

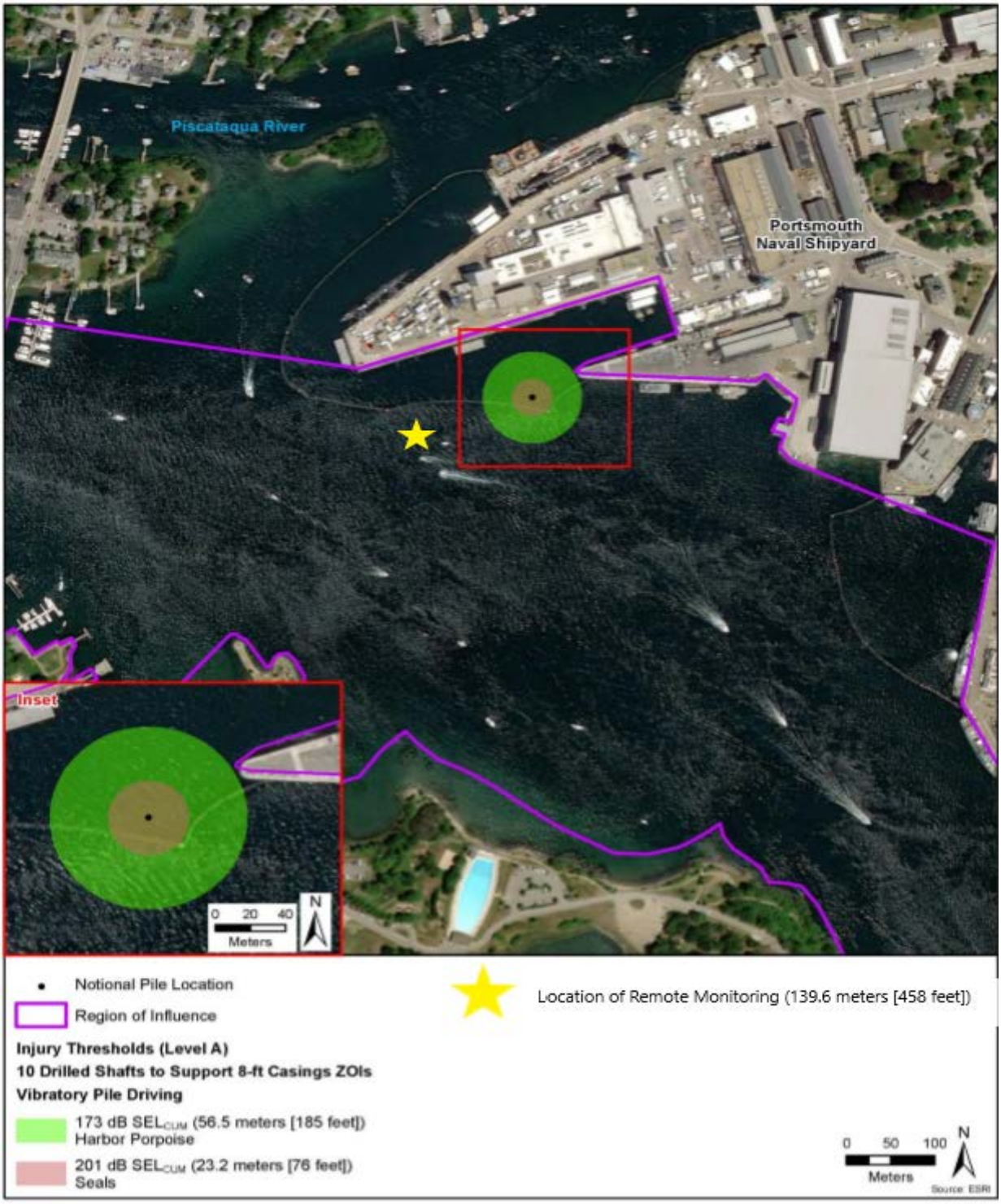


Figure 10. Representative Remote Monitoring Locations for Underwater Drilling of Shafts for 8-ft Diameter Casings

Original Figure Sourced from NOAA Fisheries. IHA Application. 2020.
Modified by Cianbro to show proposed locations for pile driving monitoring.
*Location may be adjusted based on proximity to the navigable channel

Monitoring for Vibratory Hammer Use:

Vibratory hammers are used to install piles when allowed by the sediment type. This style of hammer produces a significantly lower source level of sound pressure when compared to the impact hammer. For this reason, vibratory hammers will be the primary method of steel pile installation. These hammers lack the rapid rise in amplitude but have longer durations of an event. Vibratory hammers are considered a non-impulsive source as the hammer uses counterweights that spin to create a vibration. The vibration of the hammer will "liquefy" the soil allowing the pile to move into or out of the sediment.

Measuring Vibratory Pile Driving/Extracting

- Maximum Peak Pressure: The highest instantaneous level of pressure during a single strike. This is expressed in units of dB re 1 µPa.
- Mean (Leq): Equivalent continuous sound level in decibels, equivalent to the total sound energy measured over a stated period of time and also known as the time-average sound level. This is expressed in units of dB re 1 µPa.
    - *Method*: Convert raw data collected in voltage to sound pressure. Convert the sound pressure to dB values.
- Median: Middle number taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the middlemost number in the set.
- Minimum: The lowest pressure data (SPL) taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the smallest number in the set.
- Maximum: The highest pressure data (SPL) taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the largest number in the set.
- cSEL, SELcum: Cumulative sound exposure level an animal is exposed to during a specified duration of time. This is expressed in units of dB re 1 μPa^2 x sec.
- Duration: The length of time for how long something lasts, from one set interval to another. This is expressed in units of milliseconds (ms), seconds, and/or minutes.
    - *Method:* Calculate length of total *active* hammer time (only when the hammer is running).
- Power Spectral Density: The average power in a sound during a certain time range and in a certain frequency range. This will be able to give a visualization for which frequency variations are strong and which are weak. This is expressed in units of dB re μPa^2 per Hz.
    - *Method*: Computed from the fast-Fourier transform of the signal multiplied by its complex conjugate, the resulting quantity is divided by the frequency bin-width of each FFT result and the square root taken of the result.
    - For vibratory drilling, the power spectral density will be computed over the entire duration of the total active hammer. This will exclude periods of hammer shut-down to ensure results computed only include duration of total active hammer time.

Monitoring for Drilling Use:

Drilling to remove overburden sediments and rock within steel casing is anticipated to occur and recent studies show that source characters consist of both non-impulsive and impulsive components. A rock drill will be used in the case of any bedrock present. Any form of driving/drilling could have an increased duration from the initial transient sound due to reverberation. Post processing of drilling use will be analyzed with components of a non-impulsive source as well as components of an impulsive source.

For impulsive components of drilling, the level B ZOI will be all portions of the project area where marine mammals are exposed to impulsive underwater sounds greater than 160 dB SPL. This information is computed over a time interval between the first 5% and last 5% of the accumulated energy of each strike (RMS 90%).

Measuring Drilling

- Maximum Peak Pressure: The highest instantaneous level of pressure during a single strike. This is expressed in units of dB re 1 µPa.
- Mean (Leq): Equivalent continuous sound level in decibels, equivalent to the total sound energy measured over a stated period of time and also known as the time-average sound level. This is expressed in units of dB re 1 µPa.
    - *Method*: Convert raw data collected in voltage to sound pressure. Convert the sound pressure to dB values.
- Median: Middle number taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the middlemost number in the set.
- Minimum: The lowest pressure data (SPL) taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the smallest number in the set.
- Maximum: The highest pressure data (SPL) taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the largest number in the set.
- cSEL, SELcum: Cumulative sound exposure level an animal is exposed to during a specified duration of time. This is expressed in units of dB re 1 μPa^2 x sec.
- Duration: The length of time for how long something lasts, from one set interval to another. This is expressed in units of milliseconds (ms), seconds, and/or minutes.
    - *Method:* Calculate length of total *active* hammer time (only when the hammer is running).
- Power Spectral Density: The average power in a sound during a certain time range and in a certain frequency range. This will be able to give a visualization for which frequency variations are strong and which are weak. This is expressed in units of dB re μPa^2 per Hz.
    - *Method*: Computed from the fast-Fourier transform of the signal multiplied by its complex conjugate, the resulting quantity is divided by the frequency bin-width of each FFT result and the square root taken of the result.

    - For drilling, the power spectral density will be computed over the entire duration of the total active hammer. This will exclude periods of hammer shut-down to ensure results computed only include duration of total active hammer time.
- Number of hammer strikes (only used for impulsive components of drilling).
- Mean duration of a pile strike. This will be based on the RMS SPL 90% energy window criterion.
    - RMS 90% energy window: Measure of the average or effective pressure over the duration of post-processed data. This method omits the first and last 5% of the post-processed data taken from the RMS SPL. This is expressed in units of dB re 1 µPa.

Monitoring for Impact Hammer Use:

Impact hammers are typically used to install pile to approved stability ("seat" the pile). Impact hammers are also utilized to install pile through coarse or difficult substrates, such as cobbled or fractured rock. It is not anticipated that the impact hammer will be utilized significantly on this project beyond seating pile to appropriate depth/stability. The majority of pile work will utilize a vibratory hammer. Impact hammers produces a greater level of sound pressure compared to the vibratory hammer. Impact hammers use pistons that are lifted by a variety of ways such as ignition, hydraulics, or steam; once the piston is lifted to a desired height, it is released and will drop against the head of the pile to drive it into the sediment. This method is considered an impulsive noise source. Impact hammers on this project will by controlled by hydraulics.

For impact pile driving, the level B ZOI will be all portions of the project area where marine mammals are exposed to impulsive underwater sounds greater than 160 dB SPL. This information is computed over a time interval between the first 5% and last 5% of the accumulated energy of each strike (RMS 90%). The piles being driven for this project will be initially placed with a vibratory hammer, and then driven to refusal with an impact hammer.

Pile-driving days are not consecutive and certain activities may occur simultaneously.

Measuring Impact Pile Driving

- Maximum Peak Pressure: The highest instantaneous level of pressure during a single strike. This is expressed in units of dB re 1 µPa.
    - Maximum value will be given from the phase of pile driving during which hammer energy is producing at maximum (referred to as Level 4).
- From all the strikes associated with each pile occurring during the Level 4 phase these additional measures will be made:
    - Mean, median, minimum and maximum RMS pressure level. This is expressed in units of dB re 1 µPa.
    - Mean duration of a pile strike. This will be based on the RMS SPL 90% energy window criterion.
        - RMS 90% energy window: Measure of the average or effective pressure over the duration of post-processed data. This method omits the first and last 5% of the post-processed data taken from the RMS SPL. This is expressed in units of dB re 1 µPa.
    - Number of hammer strikes.

    - Mean, median, minimum, and maximum single strike SEL. This is expressed in dB re 1 μPa^2 x sec
        - ssSEL single-strike: Impact hammer blow is determined by double integral of the sound pressure signal over the duration of the strike. This is expressed in units of dB re 1 μPa^2 x sec.
- Cumulative SEL as defined by the mean single strike SEL + 10*log (# of hammer strikes). This is expressed in dB re 1 μPa^2 x sec.
- Median integration time used to calculate SPL RMS.
    - Duration: The length of time for how long something lasts, from one set interval to another. The time given will be the median integration time used to calculate 90% SPL RMS. This is expressed in units of milliseconds (ms), seconds, and/or minutes.
- cSEL, SELcum: Cumulative sound exposure level an animal is exposed to during a specified duration of time. This will be computed from all the strikes associated with each pile occurring during all phases, i.e., soft start, Level 1 to Level 4. This is expressed in dB re 1 μPa^2 x sec
    - Logarithmic sum of all individual ssSEL's for all blows to the pile. The sum is taken of the antilog, with $\log_{10}$ taken of results.
- Power Spectral Density: The average power in a sound during a certain time range and in a certain frequency range. This will be able to give a visualization for which frequency variations are strong and which are weak. This is expressed in units of dB re μPa^2 per Hz.
    - *Method*: Computed from the fast-Fourier transform of the signal multiplied by its complex conjugate, the resulting quantity is divided by the frequency bin-width of each FFT result and the square root taken of the result.
    - For impact driving, the power spectral density will be computed based on the average of up to eight successive strikes with a similar sound. The FFT of each hammer strike will be computed for the portion of the signal within each 90% energy window strike duration and then averaged.

cSEL/SEL_{cum} and ssSEL are both energy or power measurements expressed in decibel (dB) as power quantity measurements.

- 10dB is a tenfold increase in sonic energy.
- 3dB increase in sonic energy is a doubling of energy.

Any data such as voltage and pressure data are field quantity measurements. The measurement and reference value are squared from power.

- 20dB in SPL is a tenfold increase in sound pressure.
- 6dB increase is a doubling of sound pressure.

C. Equipment and Procedures

The hydrophones to be used on this project are Cetacean Research CR3 omnidirectional piezoelectric element hydrophones. These hydrophones have a receiving sensitivity of -210

dB re 1uV/Pa and a linear frequency response from 25Hz – 92kHz (usable from 10Hz – 93kHz). Hydrophones will be deployed roughly mid-depth in the water column and weighted with an anchor. Hydrophones will be strategically deployed as to avoid flat surfaces, fixed structures, or other obstructions that may reflect frequencies and further obscure data. Depth will be confirmed by weighted tape measure and/or depth sounder.

Data acquired from the hydrophones will be via a 30m coaxial cable to a SpectraDAQ-200. The length of cable will be adequate to reach the shallowest depth of the river (15 ft) and the deepest depths of the river (69 ft). The DAQ is a custom designed precision data acquisition sound card that allows for real time, recording/playback and post processing of up to two channels. The data acquired from the SpectraDAQ-200 will be processed at a sample rate of 192kHz per channel with a resolution of 24 bits. This will allow for 144 dB of headroom in the recording. The overall system will be able to handle up to 230 dB before overloading. Use of a higher bit depth will reduce the risk of clipping without increasing quantization errors.

The input channels of the SpectraDAQ-200 provide 4 fixed gain steps (+/-10V, +/-2.5, +/-625mV, +/-156mV). This allows SpectraPLUS-SC to be calibrated directly to volts, millivolts or to the transducer sensitivity providing quick and accurate calibration for hydrophones. Maximum input voltage for the A/D converters can be set in any of the 4 fixed gain steps. If the input range is changed, the calibration will automatically apply the correct gain to the measurement. The input range is applied to both channels.

Information captured from the hydrophone and transmitted through the DAQ will be recorded into a 2 TB external LaCie hard drive. The hard drive will remain in the Cianbro Operation's Trailer "Trailer 2" within the CIA. NAVFAC will develop a security plan that Cianbro will be required to follow regarding the safeguard of recorded data.

RMS SPL, peak SPL, frequency content, and cSEL computed from the hydrophone data will be displayed in real time, monitored and inspected frequently during all measurements.

Monitoring will not take place if any kind of vessel in the surrounding area is creating enough noise to affect the recordings. No monitoring may occur when a submarine is moving anywhere near the Shipyard, both via tug or under its own power. No monitoring may occur when a submarine is within line of sight of the hydrophone. The hydrophone will be removed from the water prior to a submarine moving to a berth within line of sight of noise creating activities. NAVFAC will provide 7 days' notice before any submarine movements. Three days prior to a submarine moving near the Shipyard, Cianbro will submit recorded data to Shipyard security for review before being removed from the Shipyard or stored on non-Government devices. It is not anticipated that there will be acoustic monitoring of pile installation work while submarines are at berth or in transit. If monitoring is allowed when a submarine is at berth on the Shipyard, Cianbro will coordinate with NAVFAC and Shipyard security on best practices for submitting all recordings for review before the data is removed from the Shipyard or stored on non-Government devices.

The GPS position of hydrophone locations will be recorded with a Garmin eTrex 20x, handheld GPS navigator. Information from GPS will be directly linked with acoustic data ensure synchronization between the two. The location reported for each measurement will be

the average position during the time of recording. Distances to piles will be verified with a laser rangefinder when possible.

Calibration on both the hydrophones and data acquisition system will be performed at the start of each day. Calibration will be performed with a Cetacean intelligent pistonphone with electronic temperature and pressure compensation. It produces 10 Pa (114 dB re 20 µPa air) (140 dB re 1 µPa water) @ 250Hz. This pistonphone will be custom made with a coupler that will create an airtight locking seal to the CR3 hydrophone.

All data will be monitored, recorded, and post-processed in SpectraPLUS-SC software as well as Aquatic Acoustic Metric Interface software.

Equipment data sheets are included in Appendix A – Equipment Data Sheets of this document.

D. Reporting

The draft report on all monitoring conducted under the IHA will be submitted within ninety calendar days of the completion of the project or sixty days prior to the issuance of any subsequent IHA for this project, whichever comes first. (For internal review purposes the Contractor will submit the draft documents to the Navy twenty days prior to submittal to NMFS and the final documents to the Navy fifteen days prior to submittal to NMFS). Daily reports will include a description of the pile driving work observed, the location (latitude and longitude), number of measurements made, preliminary RMS SPL and cSEL results, as well as any problems encountered.

A final report will be prepared and submitted within thirty days following the resolution of comments on the draft report from NMFS. This report will include all data required from the project specifications including statistics on RMS SPL, strike characteristics, SEL intensities, and the frequency composition of impact driving sound. Full accounts of all monitoring equipment, procedures, and analysis of procedures will be included with the environmental conditions (Beaufort Sea State) for each set of respective measurements.

If any results of monitoring are analyzed and weighted by respective marine mammal functional hearing groups to report on sound attenuation or distances, Cianbro will follow the guidance as defined by NMFS. The two groups being monitored in the Piscataqua River are; phocid pinnipeds (PW) and high frequency (HF) cetaceans. The hearing range of these two groups are as followed:

Table 1. Marine Mammal Hearing Groups

Hearing Group	Generalized Hearing Range*
High-frequency (HF) cetaceans	275 Hz to 160 kHz
Phocid pinnipeds (PW) underwater	50 Hz to 86 kHz
* Represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall et al. 2007) and PW pinniped (approximation).	

Source: NOAA Fisheries. Marine Mammal Acoustic Technical Guidance. 2020.

Auditory weighting and exposure parameters have been set by NOAA by respective hearing groups. Applying auditory weighting functions is necessary as it gives a more accurate representation of how animals will perceive the loudness of various frequencies. The weighted functions take into account sensitivity to a range of frequencies in the respective hearing group. These functions often result in smaller isopleths as certain frequencies are attenuated.

These weightings take into account a variety of factors based on studies of each respective hearing group. Filters with various weightings (A, B, C, D, and Z weighted) attempted to correspond to loudness as perceived by respective hearing group. This example can be found in humans as the typically hearing range is 20 Hz – 20 kHz. Although this is a spectrum of frequencies, A-weighting is commonly used as it has been found to be the most accurate at representing the average perceived loudness of the human ear.

Weighted functions will not be applied until post processing. This is recommended as it leaves the total spectrum of frequencies captured to be fully analyzed. This is important as one could potentially find a source beyond the frequencies of interest that is producing a frequency that in turn, is producing harmonics/subharmonics that fall into the interested frequency range. Attempts to attenuate the source could then be made to ensure harmonics/subharmonics in the interested frequency range are also attenuated to more acceptable levels.

Both received level and duration of exposure are taken into account when factoring the weighted SEL_{cum} metric. This metric is recommended to apply to individual activities/sources, not multiple activities occurring within the same area. The SEL_{cum} metric is used to determine the TTS and PTS ZOI for marine mammals.

For each species group, a low frequency cutoff (f_{low}) and high frequency cutoff (f_{high}) is applied to filter out data below the range of functional hearing for that group. For high frequency cetaceans f_{low} is 200 Hz and for pinnipeds f_{low} is 75 Hz. For all hearing groups, f_{high} is 20 kHz, the frequency above which minimal sound energy is typically produced by pile driving activities.

If any weighting is applied in post processing, reports will include both weighted and non-weighted analytics.

Appendix A – Equipment Data Sheet

7511 Greenwood Avenue N #615 - Seattle, Washington 98103 USA
Telephone: 206-650-8676 E-mail: crtinfo@cetrestec.com

Cetacean Research Technology

Website: www.cetrestec.com Hydrophone Specifications — March 2019

HYDROPHONE SPECIFICATIONS

Model Number	CR1A	CR2	CR3
Linear Frequency Range (±3dB) [kHz]	0.00016† – 48	0.0019† – 28	0.0004† – 180
Useable Frequency Range (+3/-12dB) [kHz]	0.00005† – 68	0.0005† – 60	0.0001† – 240
Sensitivity [dB, re 1V/µPa]	-199‡	-214	-207‡
SPL Equiv. Noise at 1kHz [dB, re 1µPa/√Hz]	38 (< *Sea State Zero*)	68	54
Maximum Operating Depth [m]	500	370	980
Operating Temperature Range [ºC]	-25 to 60‡	-40 to 70	-40 to 90‡
Capacitance [nF]	12	0.82	6.7
Dimensions [mm]	85L x 32 dia.	56L x 14 dia.	50L x 18 dia.
Coaxial Cable Length [m]	15	10	15
Directionality	Omni below 10kHz	Omni below 10kHz	Omnidirectional

† Requires a preamplifier with 100MΩ input impedance, such as VP1000. If a preamplifier with 330kΩ input impedance is used, such as the USB Dual Pre, then the low frequency -3dB point will be increased by a factor of 300 (e.g. 48Hz instead of 0.16Hz for the CR1A). ‡ Hydrophone is spot calibrated at the factory; calibration is guaranteed between -5C and 30C. Calibrated frequency response measurements can be performed for an additional fee.

Hydrophones not in stock will ship within 8 weeks of the receipt of payment. Add 4 weeks to delivery time for custom orders. Acceptable payment includes: check or money order made out in US funds and drawn on a US bank; VISA, MasterCard, Discover or American Express cards; or money wire transfers. There is an added fee for foreign wire transfers. Qualifying nonprofit organizations may receive discounts.

All hydrophones carry a 90-day limited warranty. Extended warranties are available. Units will either be repaired or replaced at the discretion of Cetacean Research Technology. Misuse or damage to the connectors or cable voids the warranty. Prices are for *advance payment only* and subject to change without notice. **All sales are final**.

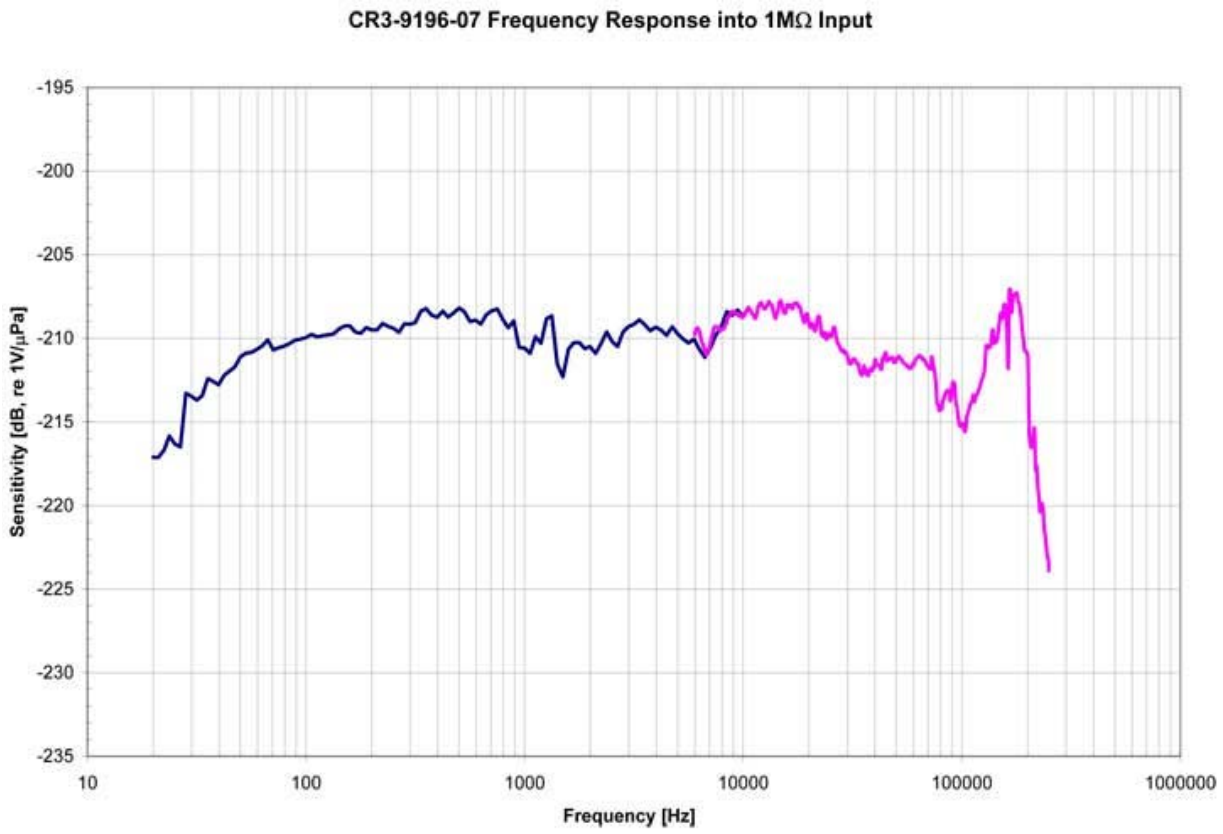
7511 Greenwood Avenue N #615 - Seattle, Washington 98103 USA
Telephone: 206-650-8676 E-mail: crtinfo@cetrestec.com

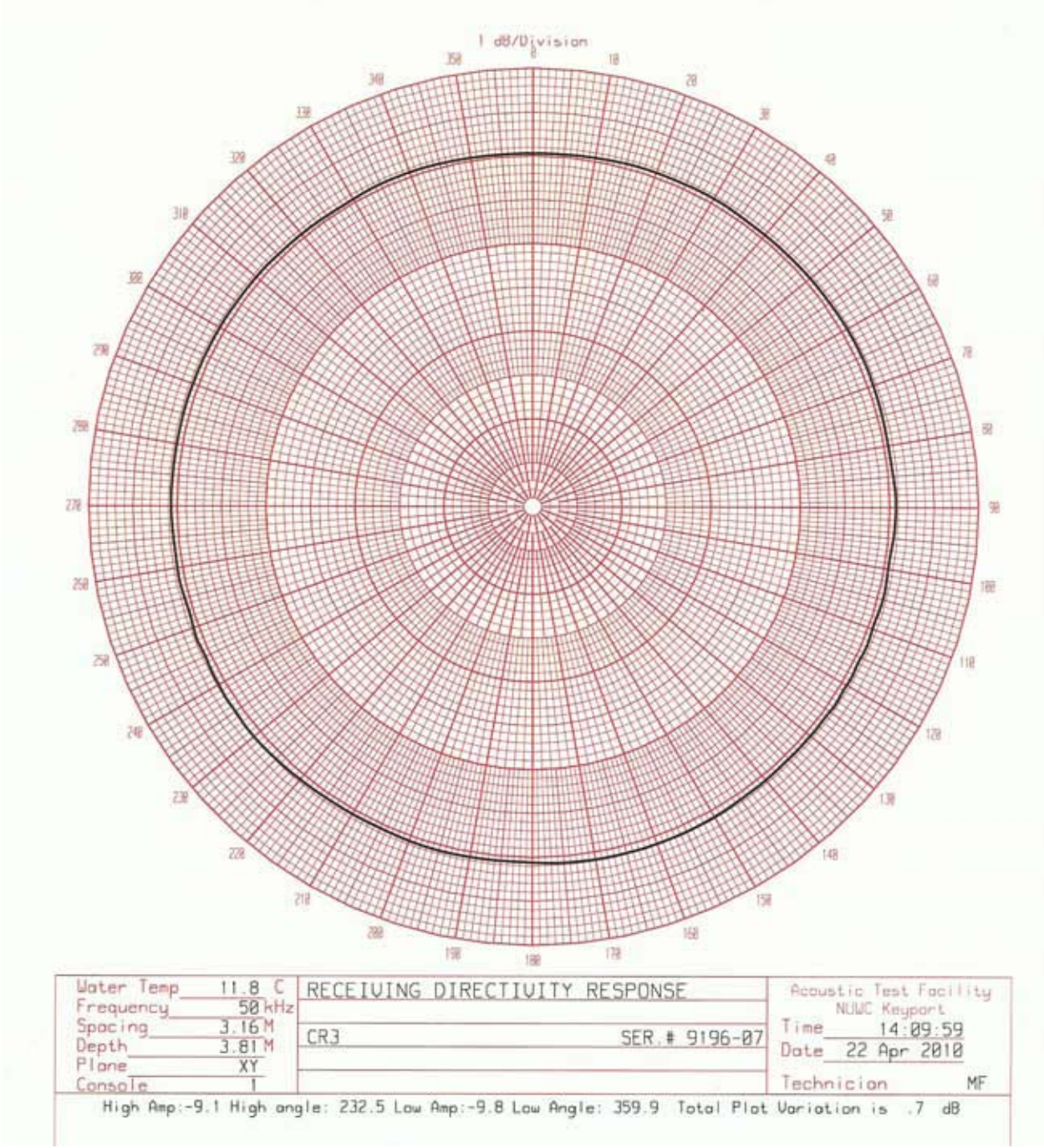
Website: www.cetrestec.com Hydrophone Specifications — March 2019

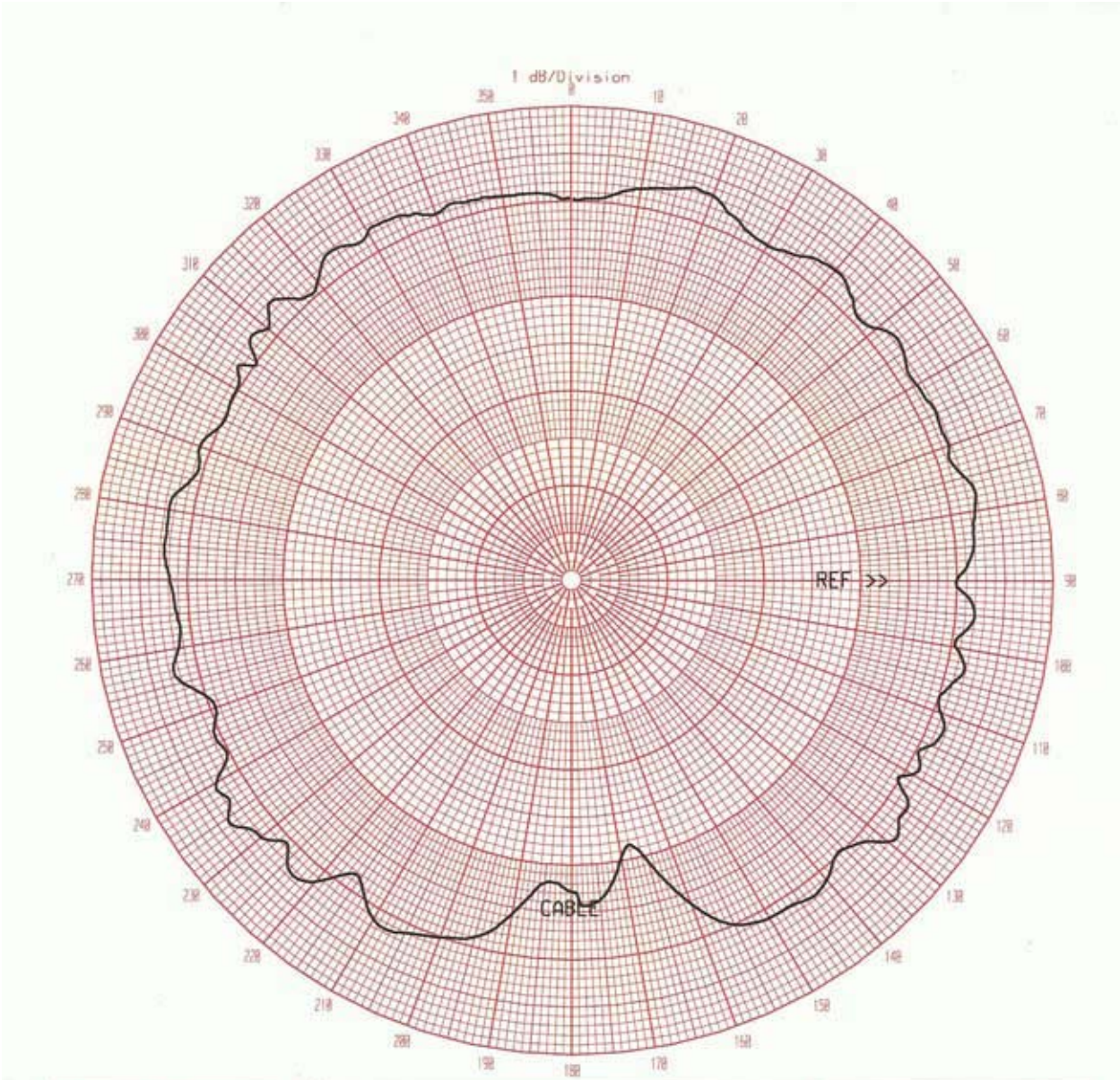
CR3 Hydrophone specifications

Linear Frequency Range (±3dB) [kHz]	0.0004† to 180
Usable Frequency Range (+3/-12dB) [kHz]	0.0001† to 240
Transducer Sensitivity [dB, re 1V/µPa]	-207‡
Preamplifier Gain [dB]	N/A
SPL Equiv. Self Noise at 1kHz [dB, re 1µPa/√Hz]	54
Power Requirement [Vdc]	N/A
RMS Overload Acoustic Pressure [dB, re 1µPa]	N/A
Maximum Operating Depth [m]	980
Operating Temperature Range [°C]	-40 to 90‡
Capacitance [nF]	6.7
Dimensions [mm]	50 L x 18 dia
Coaxial Cable Length [m]	15 Cable terminated with male BNC connector (longer cable optional)

Directionality	omnidirectional
Battery / Connector box	power not required




1 dB/Division
Water Temp 11.8 C
Frequency 50 kHz
Spacing 3.16 M
Depth 3.81 M
Plane XY
Console 1
RECEIVING DIRECTIVITY RESPONSE
CR3
SER. # 9196-07
Acoustic Test Facility
NUWC Keyport
Time 14:09:59
Date 22 Apr 2010
Technician MF
High Amp:-9.1 High angle: 232.5 Low Amp:-9.8 Low Angle: 359.9 Total Plot Variation is .7 dB



Water Temp 11.7 C Frequency 50 kHz Spacing 3.16 M Depth 3.81 M Plane XZ Console 1	RECEIVING DIRECTIVITY RESPONSE CR3 SER # 9196-07	Acoustic Test Facility NUWC Keyport Time 13:52:53 Date 22 Apr 2010 Technician MF

SPECTRADAQ-200

SpectraDAQ-200 is a precision data acquisition sound card optimized for test and measurement applications. Designed specifically for use with SpectraPLUS it features fixed gain steps for easy calibration to the transducer sensitivity, IEPE power for accelerometers or microphones, and standard BNC connectors. It is housed in a rugged steel case and powered by USB 3.0.

Excellent Performance

The A/D and D/A converters are state of the art and provide incredible dynamic range and extremely low distortion.

Direct Calibration

The input channels provide 4 fixed gain steps. This allows SpectraPLUS to be calibrated directly to volts, millivolts or to the transducer sensitivity providing quick and accurate calibration for microphones, accelerometers and other sensors.

IEPE Power

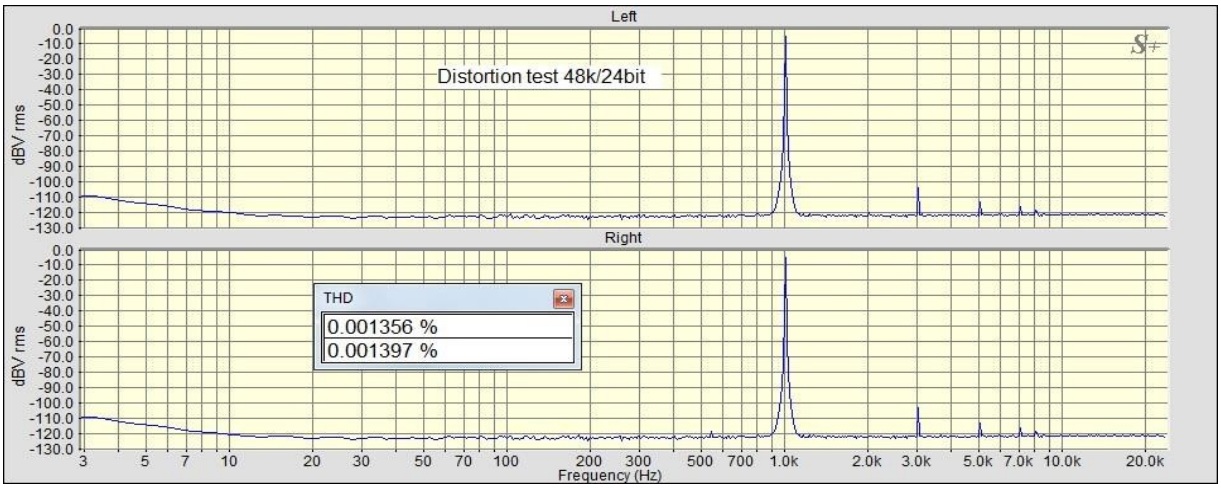
Accelerometers, microphones and hydrophones often use IEPE powered sensors; IEPE power is a 4ma constant current supply that is built-in to the input circuitry of the module. It is enabled via the SpectraPLUS software. IEPE is also known as ICP (trademarked by PCB electronics).

Input Voltage Ranges (software selectable)	+/-10V, +/-2.5, +/-625mV, +/-156mV
Sampling Rate	Up to 192kHz
Sampling Precision	24 bit
Input Channels	2
Input Impedance	0.5 Meg Ohm
IEPE power (software selectable)	4ma constant current
Frequency Response	4 Hz to 92 kHz (-1dB)
Low Frequency cutoff	2 Hz (-3dB)
Total Harmonic Distortion (THD)	< 0.002% (0.5 Vrms signal level, 2.5 V gain)
Spurious Free Dynamic Range	> 95 dB
Noise Floor (terminated inputs)	< -130 dBVrms
Channel Separation	> 90 dB
Input Connectors	2 BNC (single ended)
Output Voltage	+/-1.4 V (1 Vrms)
Output Channels	2

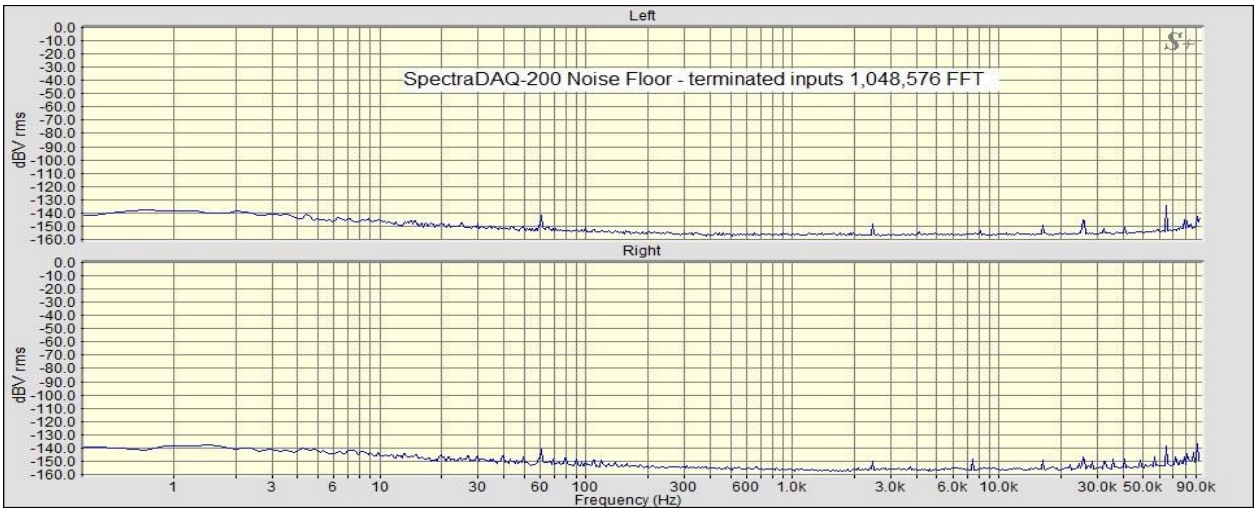
Output Connectors	1 BNC, 3.5 mm stereo
Digital I/O	3 Input, 3 Output (RJ45 connectors)
Drivers (Vista/Win7/8/10, x32 and x64)	MME (Windows Multimedia Extensions) ASIO (Steinberg Audio Stream Input/Output)
PC Interface	USB 3.0 (cable included)
Operating Temperature range	0 to 50 C
Dimensions	5.5 x 3 x 1 in (140 x 77 x 26 mm)
Weight	9 oz (250 grams)
Warranty	I year

Pricing, availability and specifications are subject to change without notice

Distortion measurement with the output looped back to the inputs



Noise floor measured with terminated inputs



Cetacean Research Technology
4728 12th Avenue NE Seattle, Washington 98105-4402 (206) 297-1310
crtinfo@cetrestec.com www.cetrestec.com

SpectraPLUS Features and Specifications

Key Feature	SpectraPLUSRT	SpectraPLUS-SC	SpectraPLUS-DT
Hardware Supported	Multimedia Sound Cards	Multimedia Sound Cards	Data Translation DT9800 Industrial A/D modules
Maximum Sampling Rate	200 kHz*	200 kHz*	2.0 MHz*
Maximum Channels	2	2	16
Maximum Sampling Precision	24 bit*	24 bit*	24 bit*
Composite Channels (Transfer Function, Multichannel average, etc)	0	1	16
Supported Modes	Real Time	Real Time, Record/Playback, Post Process	Real Time, Record/Playback, Post Process
Available Displays	Spectrum	Time Series, Spectrum, Phase, Spectrogram, 3-D Surface	Time Series, Spectrum, Phase, Spectrogram, 3-D Surface
Frequency Resolution	Fixed FFT size, 1/1 Octave, 1/3 Octave	Selectable FFT size, 1/1 through 1/96 Octave	Selectable FFT size, 1/1 through 1/96 Octave
Input Gain	Variable* (4 fixed steps#)	Variable* (4 fixed steps#)	Fixed Steps*
Calibrated Inputs	Uncalibrated (Volts or Millivolts#)	Uncalibrated (Volts or Millivolts#)	Volts or Millivolts
Calibration to Transducer	Use external reference signal (use transducer sensitivity#)	Use external reference signal (use transducer sensitivity#)	Use actual transducer sensitivity or external reference signal
Transducer Power	Phantom* (IEPE#)	Phantom* (IEPE#)	IEPE*
Triggering	No	Analog Input	Analog or TTL with User Accept/Reject option
Tachometer channel support	No	No	Yes
Order Analysis	No	No	Yes
Automation Support	No	Yes	Yes

** Hardware dependent* *#When SpectraDAQ-200 is used*			

Cetacean Research Technology

4728 12th Avenue NE Seattle, Washington 98105-4402 (206) 297-1310
crtinfo@cetrestec.com www.cetrestec.com

SpectraPLUS-SC Options

SpectraPLUS-SC consists of a base analyzer plus a set of 10 additional options so you can purchase only the features you need. Additional options can be purchased at anytime and activated with a simple phone call. The downloaded software includes all options for the 30 day evaluation period.

Base Analyzer		**Features include Single Channel Operation, Real Time Mode, Spectrum, Time Series, and Phase displays, Narrowband FFT sizes through 32,768 points, 1/1, and 1/3 Octave Analysis, Triggering, Markers, Overlays, Averaging, Peak Hold, Decimation, Mic Compensation, A, B, C Spectral Weighting**
Option /01	Dual Channel Processing	Dual Channel Operations - Real and Complex Transfer Functions, Coherence, Average, Cross Spectrum and cross channel delay compensation
Option /02	Recording and Post Processing Modes	Recorder and Post Processing modes - allows direct hard disk recording and playback. Post Processing mode provides comprehensive analysis from WAV files. Includes Digital Filtering capability
Option /03	Signal Generator Utility	Advanced Signal Generation - Pink/White noise, Noise Burst, Frequency Sweep, Frequency Step, Level Sweep, 1 kHz tone, Multiple Tones, Saw, Square, Pulse, IMD test tones and User Defined WAV source. Can generate different signals in each channel
Option /04	Color Spectrogram Display	Spectrogram View - displays the spectrum versus time in greyscale or color format for advanced joint time-frequency analysis.
Option /05	3-D Surface Display	3-D Surface View - displays the spectrum versus time in a 3-Dimensional perspective format
Option /06	Distortion Analysis Utilities	Distortion Analysis - measurement utilities for THD, THD+N, IMD, SNR, NF, SINAD. Each measurement is displayed in real time in a separate resizeable window. Also includes a dedicated THD+N versus Frequency utility that quickly and conveniently measures the distortion characteristics of your device over a range of frequencies.

Option /07	High Resolution Analysis	Adds 24 bit sampling precision and sampling rates above 48kHz (sound card dependent). Adds FFT sizes up to 1,048,576 points, and Octave scaling to 1/96
Option /08	Advanced Scaling and Calibration	Adds independent channel calibration and scaling for left and right channels with separate views for each. Useful for applications requiring separate channel scaling and calibration such as simultaneous sound and vibration measurements. This option also includes calibration conversions from Acceleration to Velocity or Displacement; also adds Power Specral Density scaling option for accurate noise measurements
Option /09	Acoustic Tools	Reverberation Time (RT60) utility features bar graph of reverberation time versus frequency band, 3-D Surface plot of the decay versus frequency and individual decay plots versus time. Delay Finder measures delay between two channels in milliseconds, feet or meters. Speed of sound - converts the delay value between milliseconds, feet or meters. Equivalent Noise (Leq) utility provides comprehensive noise level calculations for LeqT, Leq, Lpk , Lsel, Lmax, Lmin, L10, L50, L90. Stereo Phase Scope for real-time monitoring and analysis of signal phase. Phase scope mode displays a standard oscilloscope X- Y orientation (lissajous pattern) for analysis of phase, polarity, missing channel detection and stereo separation monitoring
Option /10	Automation Tools	Macro Command Processor utility allows you to easily automate measurements, record SPL and spectral data at user specified intervals/duration with time/date stamp, save files with user-defined names using a script-based programming language. It uses the underlying DDE syntax for an automation solution without requiring a third party program. Automation interface API allows the capability for an external program to control and read results from the analyzer in real time. Works with any program that supports COM such as C++, VB, Excel, and others. Dynamic Data Exchange (DDE) allows the capability for an external program to control and read results from the analyzer in real time. Works with any program that supports DDE such as C++, VB, Excel, Access and others. Data Logging utility produces an output text file containing selected spectral parameters + time-stamp for dynamic signal tracking and unattended event monitoring.

Garmin eTrex 20

Our Most Popular Handheld GPS Made Even Better

- Worldwide basemap
- 2.2" 65K color, sunlight-readable display
- GPS and GLONASS satellites for faster positioning
- Paperless geocaching
- 25-hour battery life with 2 AA batteries

eTrex 20 takes one of the most popular and reliable GPS handhelds and makes it better. Redesigned ergonomics, an easier-to-use interface, paperless geocaching and expanded mapping capabilities add up to serious improvements for an already legendary GPS handheld.

See the Way

eTrex 20 has an enhanced 2.2", 65K color, sunlight-readable display. Durable and water resistant, eTrex 20 is built to withstand the elements. It has an upgraded interface yet retains its legendary toughness to withstand dust, dirt, humidity or water.

Go Anywhere

With an array of compatible mounts, eTrex 20 is designed for use on ATVs, bicycles, in boats, as a handheld or in your car. Use the auto mount capability and City Navigator NT® maps for turn-by-turn driving directions, or the rugged mount for your motorcycle or ATV. Wherever you think you might take eTrex, it has the mapping and mounts to get you there.

Go Global

The new eTrex series is the first-ever consumer-grade receivers that can track both GPS and GLONASS satellites simultaneously. GLONASS is a system developed by the Russian Federation

that will be fully operational in 2012. When using GLONASS satellites, the time it takes for the receiver to “lock on” to a position is (on average) approximately 20 percent faster than using GPS. And when using both GPS and GLONASS, the receiver has the ability to lock on to 24 more satellites than using GPS alone.

Add Maps

With its microSD™ card slot and 1.7 GB of internal memory, eTrex 20 lets you load TOPO 24K maps and hit the trail, plug in BlueChart® g2 preloaded cards for a great day on the water or City Navigator NT map data for turn-by-turn routing on roads (see maps tab for compatible maps). eTrex 20 also supports BirdsEye Satellite Imagery (subscription required), that lets you download satellite images to your device and integrate them with your maps.

Keep Your Fix

With its high-sensitivity, WAAS-enabled GPS receiver and HotFix® satellite prediction, eTrex locates your position quickly and precisely and maintains its GPS location even in heavy cover and deep canyons.

Find Fun

eTrex 20 supports geocaching GPX files for downloading geocaches and details straight to your unit. Visit Geocaching.com to start your geocaching adventure. By going paperless, you're not only helping the environment but also improving efficiency. eTrex 20 stores and displays key information, including location, terrain, difficulty, hints and descriptions, which means no more manually entering coordinates and paper printouts. Simply upload the GPX file to your unit and start hunting for caches.

Plan Your Next Trip

Take charge of your next adventure with BaseCamp™, software that lets you view and organize maps, waypoints, routes, and tracks. This free trip-planning software even allows you to create Garmin Adventures that you can share with friends, family or fellow explorers. BaseCamp displays topographic map data in 2-D or 3-D on your computer screen, including contour lines and elevation profiles. It also can transfer an unlimited amount of satellite images to your device when paired with a BirdsEye Satellite Imagery subscription.

General

PHYSICAL DIMENSIONS	2.1" x 4.0" x 1.3" (5.4 x 10.3 x 3.3 cm)
DISPLAY SIZE	1.4" x 1.7" (3.5 x 4.4 cm); 2.2" diag (5.6 cm)
DISPLAY RESOLUTION	176 x 220 pixels
DISPLAY TYPE	transflective, 65-K color TFT
WEIGHT	5 oz (141.7 g) with batteries
BATTERY	2 AA batteries (not included); NiMH or Lithium recommended

BATTERY LIFE	25 hours
WATER RATING	IPX7
MEMORY/HISTORY	1.7GB
HIGH-SENSITIVITY RECEIVER	YES
INTERFACE	USB

Maps & Memory

ABILITY TO ADD MAPS	YES
BASEMAP	YES
MEMORY STORAGE AND POWER CAPACITY	microSD™ card (not included)
WAYPOINTS/FAVORITES/LOCATIONS	2000
ROUTES	200
TRACK LOG	10,000 points, 200 saved tracks

Outdoor Recreation Features

AREA CALCULATION	YES
AUTOMATIC ROUTING (TURN BY TURN ROUTING ON ROADS)	Yes (with optional mapping for detailed roads)
GEOCACHING-FRIENDLY	Yes (Paperless)
CUSTOM MAPS COMPATIBLE	YES
SUN AND MOON INFORMATION	YES
PICTURE VIEWER	YES

Appendix B – Acoustic Model ZOI

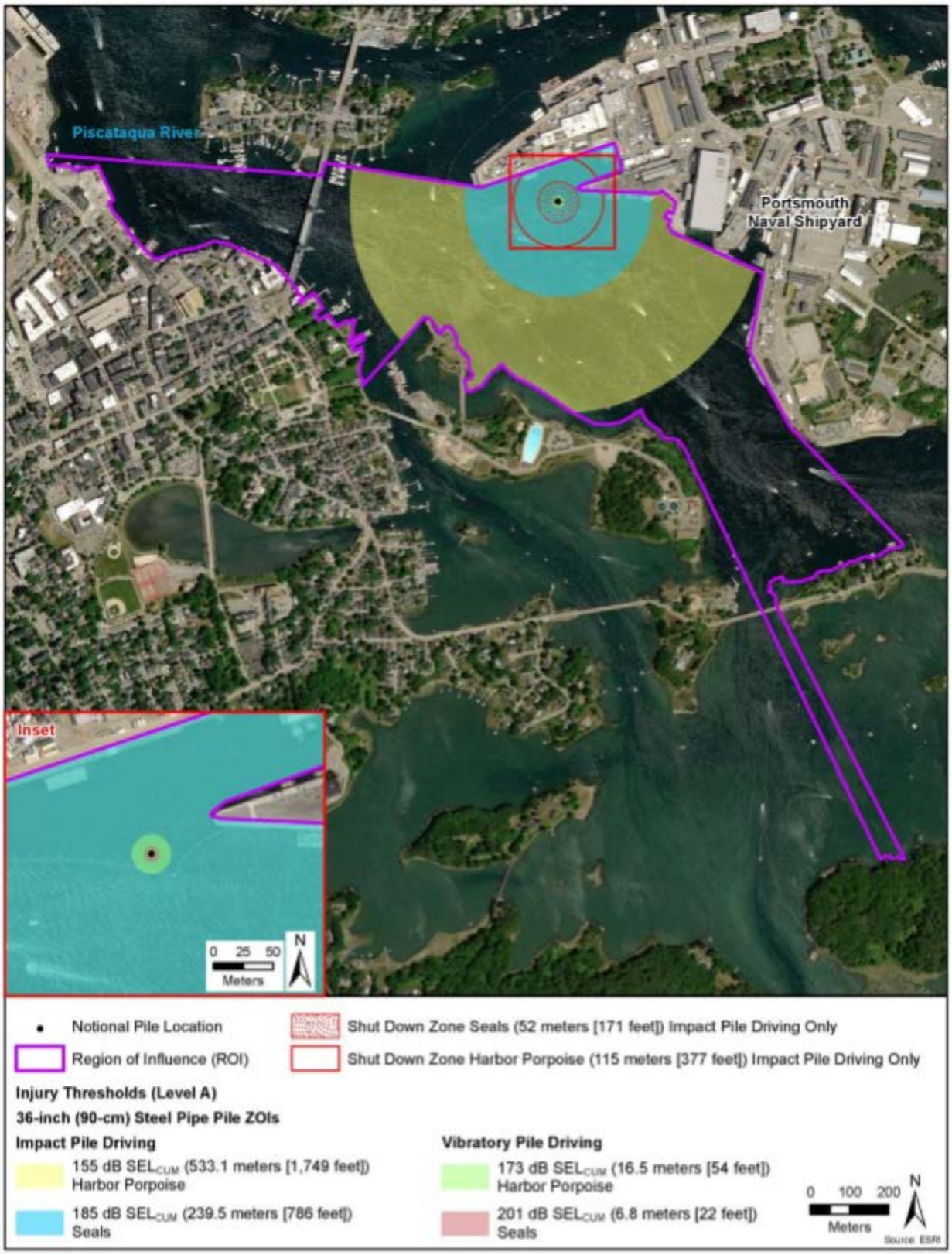


Figure 11. Representative ZOI for Level A Injury due to Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 36-Inch Steel Pipe Piles

Source: NOAA Fisheries. IHA Application. 2020.

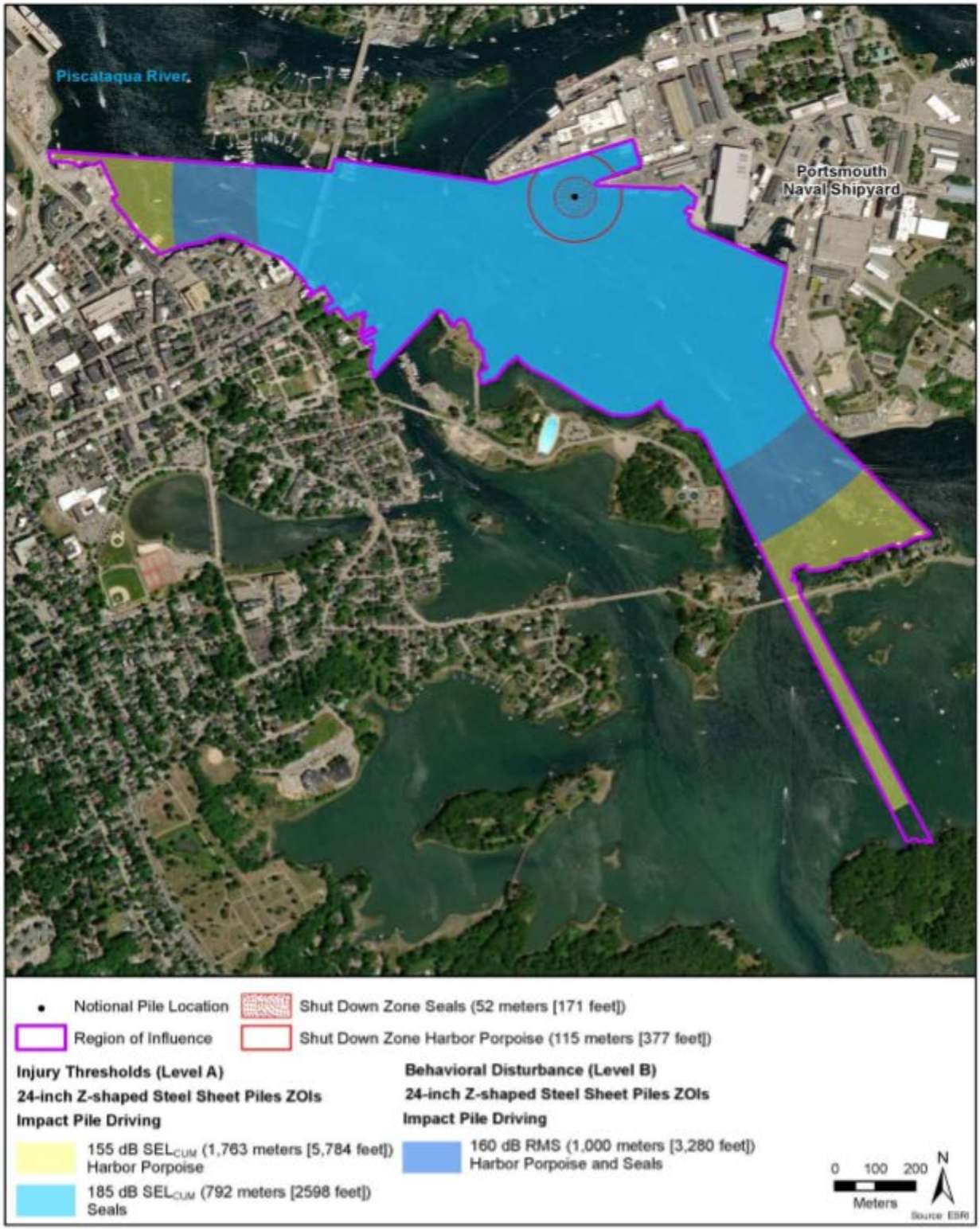


Figure 12. Representative ZOI for Level A Injury and Level B Behavioral Disturbance due to Underwater Pile Driving Noise during Impact Pile Driving 24-Inch Z-shaped Sheet Piles

Source: NOAA Fisheries. IHA Application. 2020.

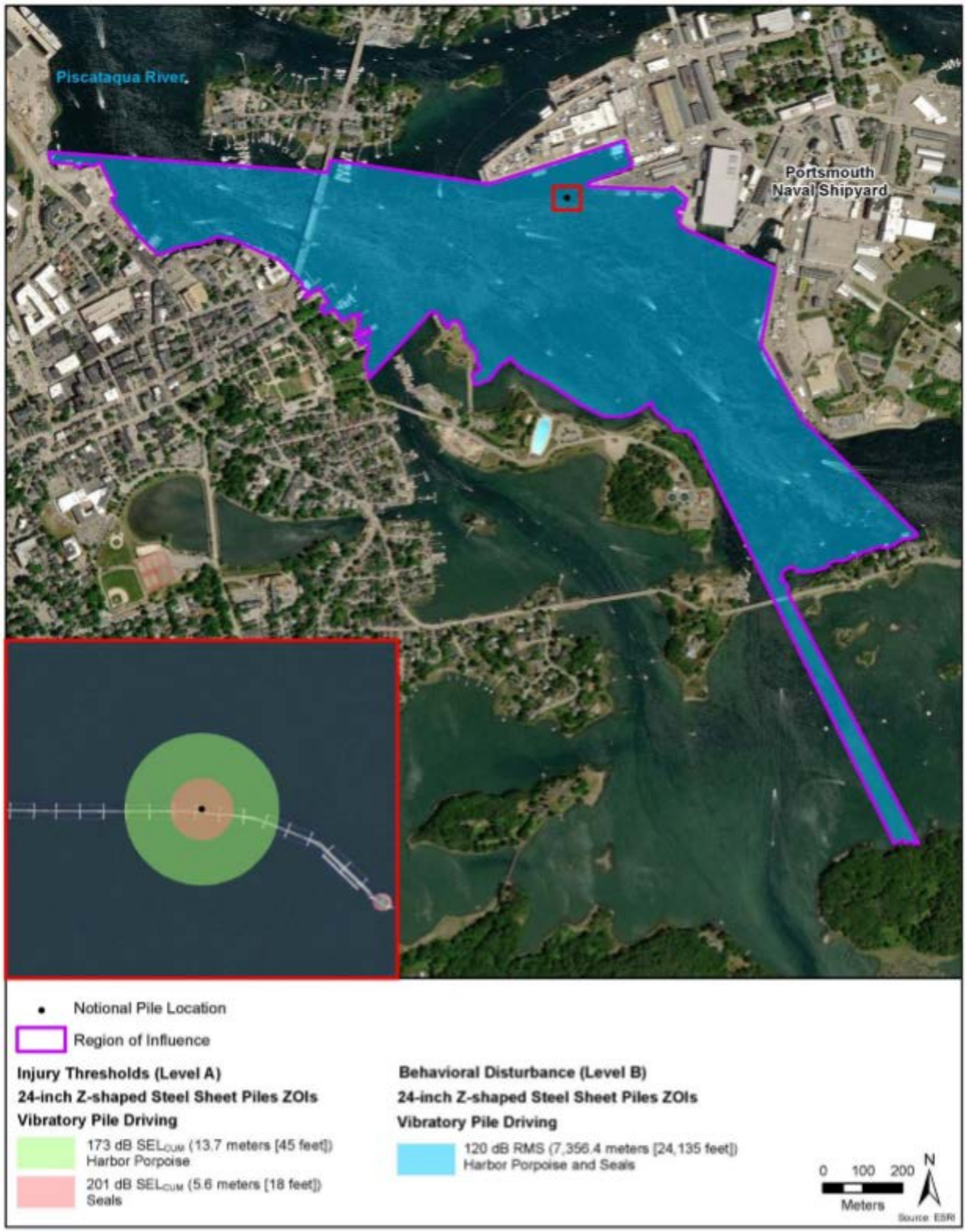


Figure 13. Representative ZOI for Level A Injury due to Underwater Pile Driving Noise during Vibratory Pile Driving 24-Inch Z-shaped Steel pipe piles

Source: NOAA Fisheries. IHA Application. 2020.

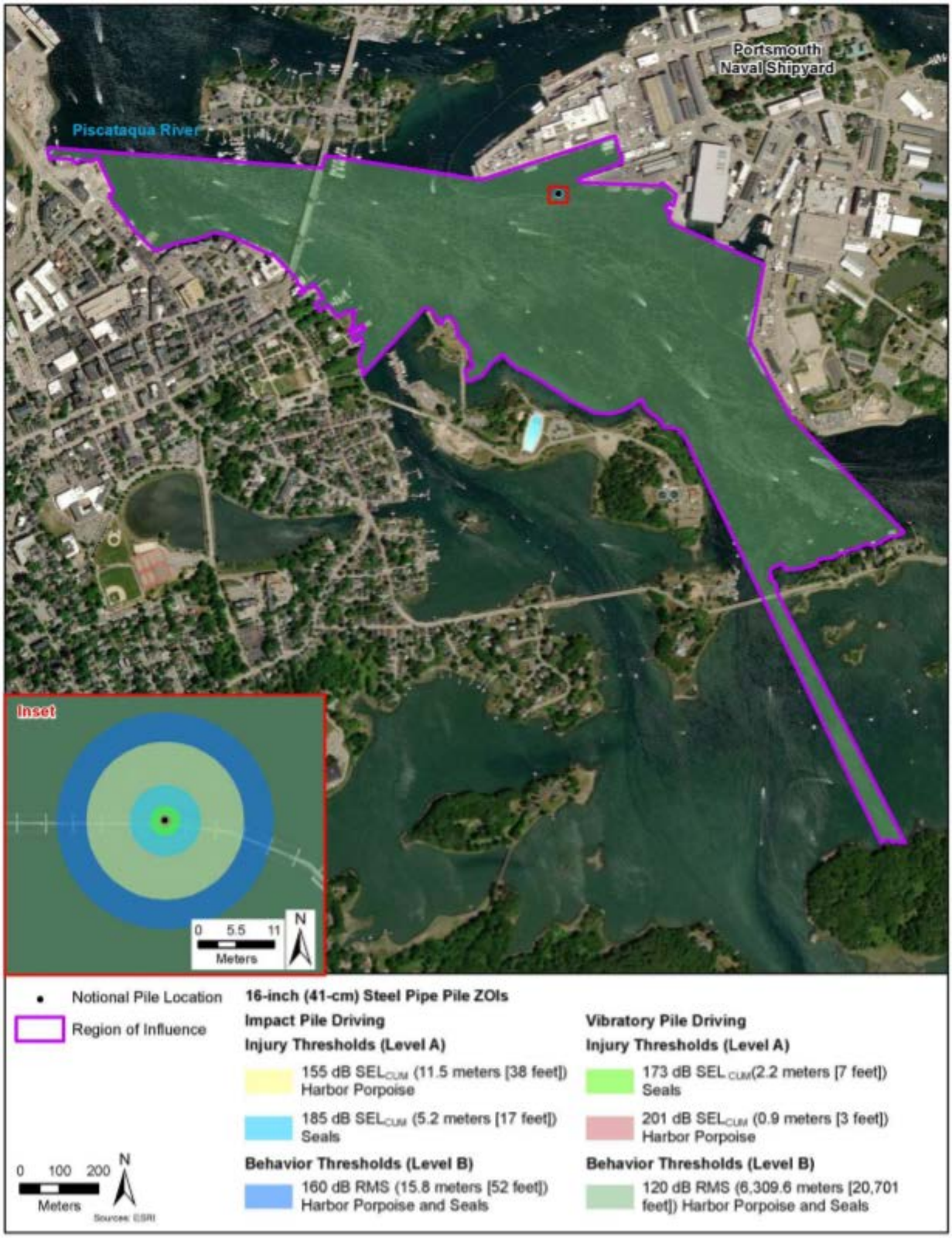


Figure 14. Representative ZOI for Level A Injury due to Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 16-Inch Steel Pipe Piles

Source: NOAA Fisheries. IHA Application. 2020.

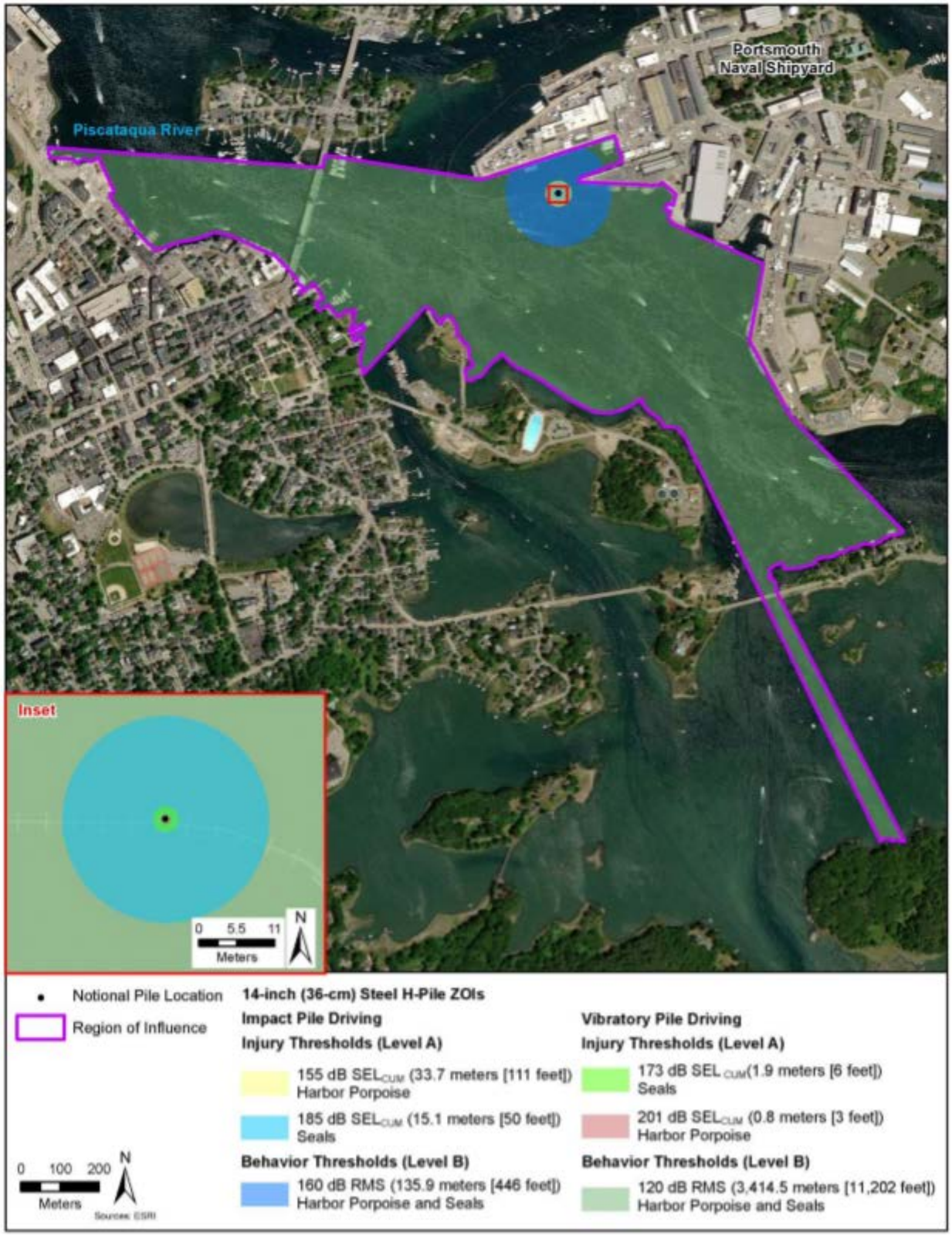


Figure 15. Representative ZOI for Level A Injury due to Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 14-Inch Steel H-Piles

Source: NOAA Fisheries. IHA Application. 2020.

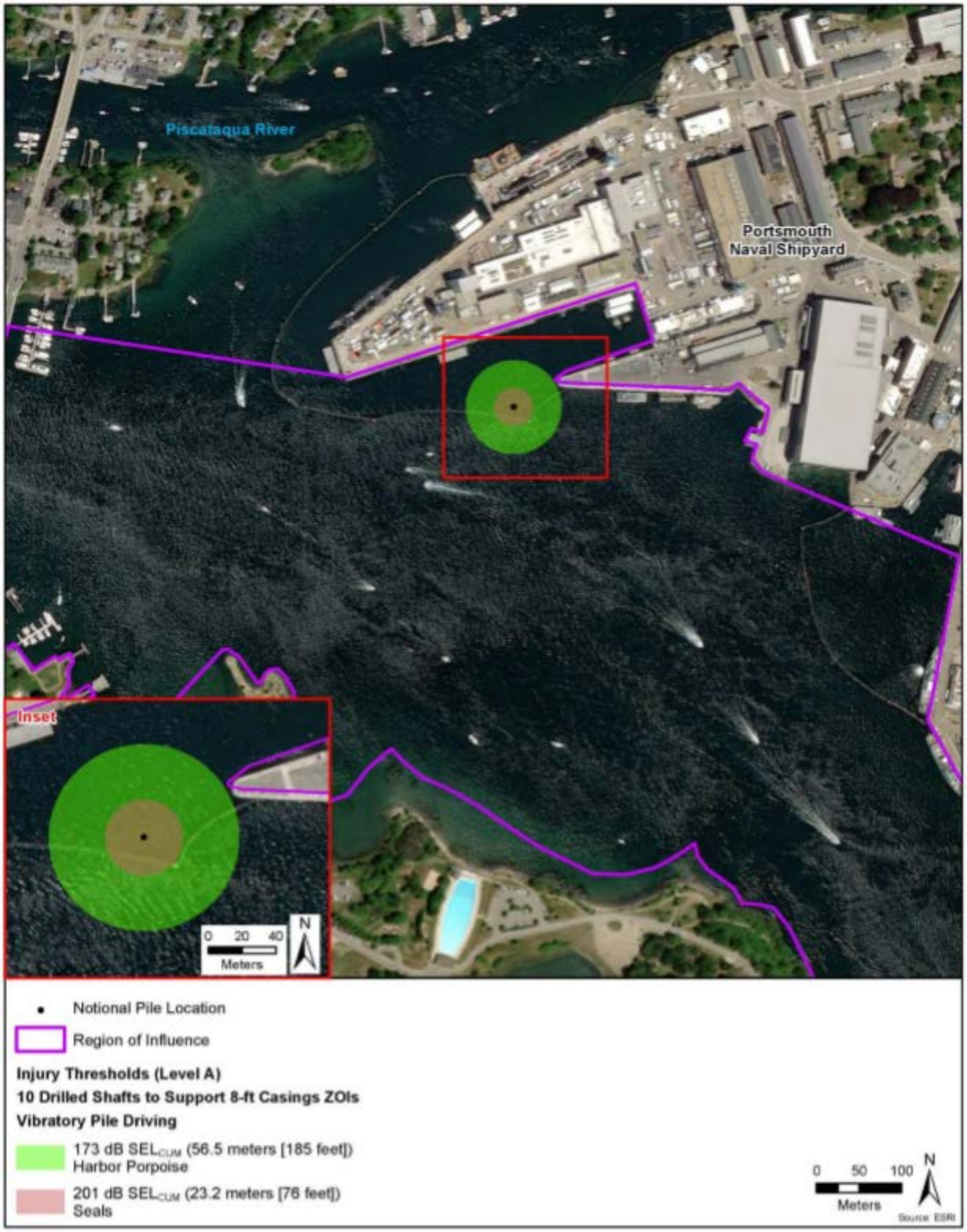


Figure 16. Representative ZOI for Level A Injury due to Underwater Drilling of Shafts for 8-ft Diameter Casings

Source: NOAA Fisheries. IHA Application. 2020.

Table 2. Shutdown distances for various pile driving activities

Pile type, size & driving method	Shutdown Distance (m)	
	Porpoise	Seal
Vibratory drive 14” H-pile (2 pile/day)	10	10
Impact drive 14” H-pile (2 pile/day)	35	20
Vibratory drive 24” sheet pile (12 pile/day)	20	10
Impact drive 18” & 24” sheet pile (12 pile/day)	110	50
Vibratory removal 14” H-pile (8 pile/day)	10	10
Vibratory drive 14” H-pile (1 pile/day)	10	10
Impact drive 14” H-pile (1 pile/day)	25	10
Down-hole drive 96” steel casing (0.5 pile/day)	60	25
Vibratory drive 36” steel pipe pile (1 pile/day)	20	10
Impact drive 36” steel pipe pile (1 pile/day)	110	50
Vibratory drive 16” steel pipe pile (1 pile/day)	10	10
Impact drive 16” steel pipe pile (1 pile/day)	15	10

Source: NOAA Fisheries. IHA. 2020.

Table 3. Marine mammal Level A and Level B harassment zones for monitoring

Pile type, size & driving method	Level A harassment		Level B harassment
	HF cetacean	Phocid	
	Dist. (m)	Dist. (m)	Dist (m.)
Vibratory drive 14” H-pile (2 pile/day)	1.9	0.8	3414.5
Impact drive 14” H-pile (2 pile/day)	33.7	15.1	135.9
Vibratory drive 24” sheet pile (12 pile/day)	13.7	5.6	7356.4
Impact drive 18” & 24” sheet pile (12 pile/day)	1763	792	1000
Vibratory removal 14” H-pile (8 pile/day)	4.9	2	3414
Vibratory drive 14” H-pile (1 pile/day)	1.2	0.5	3414
Impact drive 14” H-pile (1 pile/day)	21.2	9.5	135.9
Down-hole drive 96” steel casing (0.5 pile/day)	56.5	23.2	10000
Vibratory drive 36” steel pipe pile (1 pile/day)	16.5	6.8	10000
Impact drive 36” steel pipe pile (1 pile/day)	533.1	239.5	3414.5
Vibratory drive 16” steel pipe pile (1 pile/day)	2.2	0.9	6310
Impact drive 16” steel pipe pile (1 pile/day)	11.5	5.2	15.8

Source: NOAA Fisheries. IHA. 2020.

Table 4. Marine Mammal shutdown distances with monitoring location distances

Pile type, size & driving method	Shutdown Distance (m)		Hydrophone Location (m)	
	Porpoise	Seal	Static	Mobile
Vibratory drive 14” H-pile (2 pile/day)	10	10	10	139.6
Impact drive 14” H-pile (2 pile/day)	35	20	10	139.6
Vibratory drive 24” sheet pile (12 pile/day)	20	10	10	139.6
Impact drive 18” & 24” sheet pile (12 pile/day)	110	50	10	139.6
Vibratory removal 14” H-pile (8 pile/day)	10	10	10	139.6
Vibratory drive 14” H-pile (1 pile/day)	10	10	10	139.6
Impact drive 14” H-pile (1 pile/day)	25	10	10	139.6
Down-hole drive 96” steel casing (0.5 pile/day)	60	25	10	139.6
Vibratory drive 36” steel pipe pile (1 pile/day)	20	10	10	139.6
Impact drive 36” steel pipe pile (1 pile/day)	110	50	10	139.6
Vibratory drive 16” steel pipe pile (1 pile/day)	10	10	10	139.6
Impact drive 16” steel pipe pile (1 pile/day)	15	10	10	139.6

Original Figure Sourced from NOAA Fisheries. IHA Application. 2020.
Modified by Cianbro to show proposed locations for pile driving monitoring.

Appendix C – Anticipated Piles to be Driven

Piles to be driven From Cianbro Review of 2020 work planned

SECTION	SIZE (in)	PCS
SOUTH CLOSURE WALL CELLS		
PS31 SINGLE SHEETS (flat web)	19.69	
Total	→	136
WEST CLOSURE SHEET PILE - RE DESIGN		
PS31 SINGLE SHEETS (flat web)	19.69	
Total	→	264
Total Single Sheets		400
From IHA		310
Difference		90
ENTRANCE CUT-OFF WALL		
NZ26 DOUBLES SHEETS	27.57	
Total	→	6
BERTH 1 KNEE WALL		
NZ26 DOUBLES SHEETS	27.57	
Total	→	153
COMBI-WALL SHEET PILING		
NZ14 DOUBLES SHEETS	30.31	
Total	→	67
TEMPORARY COMBI WALL @ QUAY WALL		
NZ19 DOUBLES SHEETS	27.56	
Total	→	18
COMBI-WALL INTERFACE DIVIDER WALL - ADD		
NZ26 DOUBLES SHEETS	27.56	
Total	→	17
Total Double Sheets all		255
From IHA		652
Difference		-397
PILES TO MAKE MASTER PILE FOR DRIVING FLAT SHEETS		
HP14X89	14	
Total	→	6
H-PILE FOR TEMPORARY TEMPLATE		
12-14" H-PILE	12-14	
Total	→	6
Total	→	12
Total 14" H Pile From IHA		49
Difference		-37
COMBI-WALL FABRICATED WIDE FLANGE		
W40X199 H pile - Indludes singles needed for interlocks	40	
Total	→	12
COMBI-WALL FABRICATED WIDE FLANGE		
W24X176 H Pile - Indludes singles needed for interlocks	24	
Total	→	36
Total		12
From IHA		12
Difference		0
MICROPILE MATERIAL QUANTITIES		
24"X 1/2"WALL PIPE PILE	24	
Total	→	8
TEMPORARY SUPPORT PILE		
30" PIPE PILE	30	
Total	→	24
PIPE PILE		
16" PIPE PILE	16	
Total	→	8
Total	→	8
From IHA		
Difference		0

ALL PILE TYPES AND AMOUNTS ARE SUBJECT TO CHANGE AS DESIGNS CHANGE.

Submittal 1359.2 Hydroacoustic Monitoring Daily Reports

Specification Section 01 57 19.00 22

SD-06 Daily Reports

Covers Submittal #1359.2

P310 DD1 Super Flood Basin and P1074 Portal Crane Rail Extension

January 5, 2021

Presented To:

PNSY Public Works Department

Portsmouth Naval Shipyard

Kittery, Maine 03904

By:

Cianbro Corporation

Pittsfield, Maine 04967

1

List of Attachments

A. Daily Report – May 13, 2020 through June 11, 2020

Monitoring for Vibratory Hammer Use:

Vibratory hammers are used to install piles when allowed by the sediment type. This style of hammer produces a significantly lower source level of sound pressure when compared to the impact hammer. For this reason, vibratory hammers will be the primary method of steel pile installation. These hammers lack the rapid rise in amplitude but have longer durations of an event. Vibratory hammers are considered a non-impulsive source as the hammer uses counterweights that spin to create a vibration. The vibration of the hammer will "liquefy" the soil allowing the pile to move into or out of the sediment.

Measuring Vibratory Pile Driving/Extracting

- Maximum Peak Pressure: The highest instantaneous level of pressure during a single strike. This is expressed in units of dB re 1 µPa.
- Mean (Leq): Equivalent continuous sound level in decibels, equivalent to the total sound energy measured over a stated period of time and also known as the time-average sound level. This is expressed in units of dB re 1 µPa.
    - *Method*: Convert raw data collected in voltage to sound pressure. Convert the sound pressure to dB values.
- Median: Middle number taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the middlemost number in the set.
- Minimum: The lowest pressure data (SPL) taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the smallest number in the set.
- Maximum: The highest pressure data (SPL) taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the largest number in the set.
- cSEL, SELcum: Cumulative sound exposure level an animal is exposed to during a specified duration of time. This is expressed in units of dB re 1 μPa^2 x sec.
- Duration: The length of time for how long something lasts, from one set interval to another. This is expressed in units of milliseconds (ms), seconds, and/or minutes.
    - *Method:* Calculate length of total *active* hammer time (only when the hammer is running).
- Power Spectral Density: The average power in a sound during a certain time range and in a certain frequency range. This will be able to give a visualization for which frequency variations are strong and which are weak. This is expressed in units of dB re μPa^2 per Hz.
    - *Method*: Computed from the fast-Fourier transform of the signal multiplied by its complex conjugate, the resulting quantity is divided by the frequency bin-width of each FFT result and the square root taken of the result.
    - For vibratory drilling, the power spectral density will be computed over the entire duration of the total active hammer. This will exclude periods of hammer shut-down to ensure results computed only include duration of total active hammer time.

Only three power spectral density spectrums (Figures 1-12) for each pile type have been added to reduce the length of the report, however, all PSD spectrums can be provided if requested.

Date	Pile Type	Record Start Time	Record Stop Time	Active Duration (Sec)	Distance (meters)	Mean (dB)	Median (dB)	Maximum (dB)	Minimum (dB)	cSEL (dB)
May 13, 2020	30” Pipe Pile	10:19	10:20	90	10	153.8	156.15	173.76	151.71	168.23
					94	141.1	151.03	163.75	147.88	158.18
May 13, 2020	30” Pipe Pile	10:31	10:33	29	10	165.2	161.36	180.57	153.37	177.24
					100	161.8	150.82	169.71	140.93	168.20
May 14, 2020	14” H-Pile	11:33	11:37	295	10	143.5	155.60	173.32	152.20	170.84
					140	132.8	141.38	152.32	135.87	156.64
May 14, 2020	14” H-pile	14:26	14:30	215	10	145.1	157.23	171.56	152.63	169.85
					71	134.6	144.12	158.31	134.57	157.77
May 14, 2020	14” H-Pile	15:57	16:00	234	10	150.9	147.95	160.38	150.14	171.42
					71	140.2	158.92	167.02	134.78	160.10
May 15, 2020	14” H-Pile	10:30	10:30	13	10	159.0	169.84	191.02	152.59	176.94
					140	151.9	164.86	168.02	147.74	162.81
May 15, 2020	14” H-Pile	11:07	11:07	12	10	158.8	172.13	187.13	151.06	175.44
					140	150.4	164.20	167.20	150.94	161.66
May 15, 2020	14” H-Pile	14:47	14:52	119	10	161.8	159.85	174.64	148.74	174.95
					140	139.8	146.85	166.85	138.18	158.84
May 20, 2020	14” H-Pile	14:43	14:44	68	10	159.7	158.24	175.33	151.30	164.91
					140	138.1	147.82	166.36	142.88	155.62
May 20, 2020	14” H-Pile	14:45	14:46	63	10	160.4	158.55	163.87	150.96	165.69
					140	135.8	152.03	158.86	146.40	158.80
May 20, 2020	14” H-Pile	14:51	14:53	240	10	162.6	164.75	182.26	151.65	175.53
					140	139.8	153.39	171.44	144.80	164.61
May 20, 2020	14” H-Pile	14:58	15:00	160	10	160.4	168.15	187.89	155.49	176.16
					140	142.3	156.21	167.28	136.66	165.79
May 20, 2020	14” H-Pile	15:05	15:07	96	10	158.6	165.40	179.05	153.71	178.24
					140	144.1	158.32	165.29	152.34	164.05
May 21, 2020	14” H-Pile	11:30	11:32	41	10	158.3	175.40	184.70	170.44	176.15
May 21, 2020	14” H-Pile	11:35	11:39	219	10	161.7	170.17	180.65	162.41	180.49

Date	Pile Type	Record Start Time	Record Stop Time	Active Duration (Sec)	Distance (meters)	Mean (dB)	Median (dB)	Maximum (dB)	Minimum (dB)	cSEL (dB)
May 21, 2020	14” H-Pile	11:48	11:48	6	10	164.2	175.85	178.54	165.05	170.96
May 21, 2020	NZ Sheet	11:49	11:56	257	10	162.8	179.20	188.32	156.25	188.93
May 21, 2020	NZ Sheet	14:34	14:34	9	10	165.03	172.45	174.66	155.40	167.48
					140	150.6	165.24	168.74	152.92	162.52
May 21, 2020	NZ Sheet	14:51	14:55	221	10	162.5	175.91	180.40	164.88	180.01
					140	153.5	167.84	172.57	162.92	177.98
May 21, 2020	NZ Sheet	15:39	15:40	80	10	163.9	171.26	182.46	159.64	181.46
					140	152.5	165.81	170.90	156.97	171.77
May 21, 2020	NZ Sheet	15:56	15:56	19	10	164.7	172.54	180.55	164.52	178.94
					140	153.8	166.37	170.10	163.64	166.02
May 21, 2020	NZ Sheet	16:02	16:03	30	10	168.4	171.86	179.24	161.30	177.26
					140	153.1	166.62	169.95	163.49	168.30
May 21, 2020	NZ Sheet	16:54	16:58	250	10	175.6	189.51	194.81	154.71	199.31
					140	152.9	165.64	172.48	151.11	176.42
May 28, 2020	30” Pipe Pile	13:13	13:17	216	80	145.3	147.28	156.96	136.38	161.44
May 28, 2020	30” Pipe Pile	13:23	13:26	147	90	143.9	147.09	163.48	135.40	160.15
May 28, 2020	30” Pipe Pile	13:29	13:34	326	90	141.3	144.21	167.40	136.24	160.19
June 10, 2020	30” Pipe Pile	10:06	10:06	12	20	171.3	186.98	194.29	164.66	180.27
					192	153.3	170.34	173.15	167.67	164.17
June 10, 2020	30” Pipe Pile	10:08	10:09	80	20	169.7	186.47	192.95	156.81	189.17
					192	154.6	170.58	175.80	159.08	175.76
June 10, 2020	30” Pipe Pile	10:10	10:11	71	20	174.4	191.91	202.09	179.20	193.53
					192	158.8	173.40	180.47	166.11	177.58
June 10, 2020	30” Pipe Pile	11:14	11:17	144	20	170.3	187.01	202.07	169.90	193.97

Date	Pile Type	Record Start Time	Record Stop Time	Active Duration (Sec)	Distance (meters)	Mean (dB)	Median (dB)	Maximum (dB)	Minimum (dB)	cSEL (dB)
June 11, 2020	Flat Web	13:58	14:00	19	20	135.7	158.73	167.99	149.38	165.26
					106	133.2	147.27	164.88	142.46	150.21
June 11, 2020	Flat Web	14:11	14:13	66	20	141.7	151.82	170.08	149.23	158.89
					106	138.5	144.45	157.16	137.79	155.61
June 11, 2020	Flat Web	14:15	14:16	26	20	151.3	157.32	167.58	149.33	161.01
					106	134.6	148.69	165.66	139.49	150.57
June 11, 2020	Flat Web	14:18	14:18	15	20	146.2	156.52	165.26	148.49	158.58
					106	133.0	147.13	150.13	137.23	146.40
June 11, 2020	Flat Web	14:23	14:23	20	20	153.9	161.89	167.63	155.24	165.04
					106	140.1	153.97	146.94	157.23	153.27
June 11, 2020	Flat Web	14:29	14:29	19	20	154.2	165.45	170.53	151.23	166.83
					106	142.6	157.39	160.84	152.30	156.61
June 11, 2020	Flat Web	14:57	14:58	59	20	158.6	166.50	177.96	161.01	173.27
					106	148.9	156.77	167.37	151.79	162.83
June 11, 2020	Flat Web	15:15	15:15	41	20	157.3	167.73	170.82	160.33	175.91
					106	145.7	158.43	161.33	136.31	172.58
June 11, 2020	Flat Web	15:22	15:24	84	20	147.1	161.25	167.56	149.45	167.62
					106	134.4	152.01	158.71	144.86	162.89
June 11, 2020	Flat Web	15:45	15:45	23	20	160.0	169.26	174.56	150.22	173.32
					106	147.1	159.18	161.22	143.39	160.96
June 11, 2020	Flat Web	15:47	15:48	35	20	148.0	158.73	162.08	150.08	162.66
					106	134.5	147.68	151.33	141.02	150.31
June 11, 2020	Flat Web	15:56	15:56	39	20	150.4	160.58	165.54	151.89	165.39
					106	140.4	151.41	156.26	136.12	155.20
June 11, 2020	Flat Web	15:58	15:59	30	20	149.2	160.63	166.38	154.71	164.16
					106	138.1	150.88	153.96	143.51	153.48

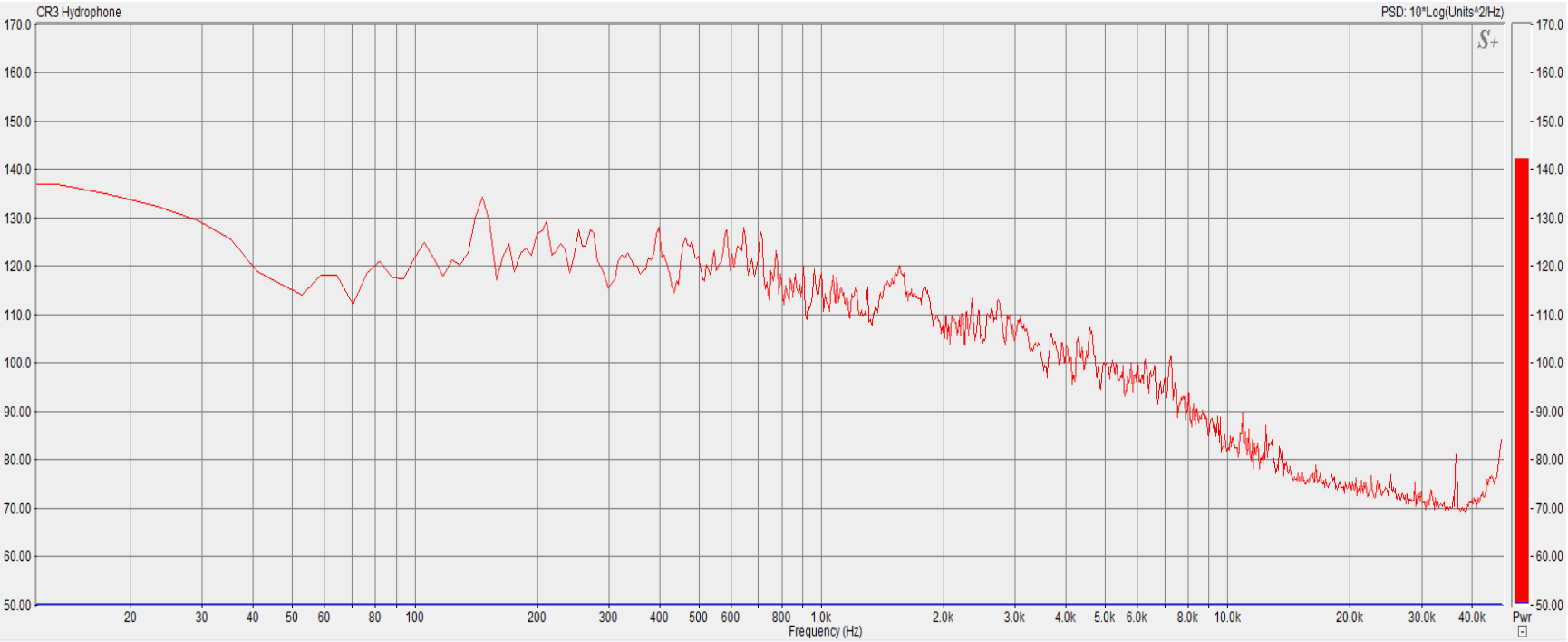


Figure 1. PSD 30” Pipe Pile May 13, 2020

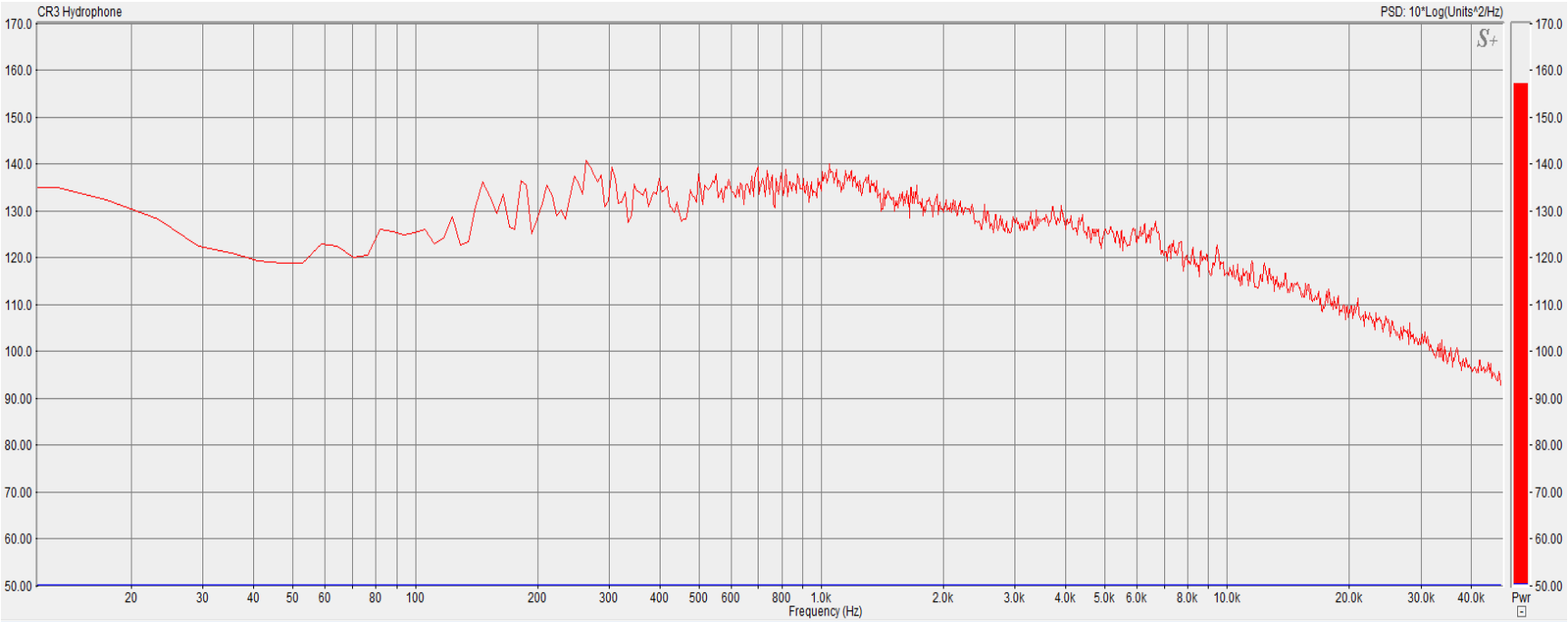


Figure 2. PSD 30” Pipe Pile May 13, 2020

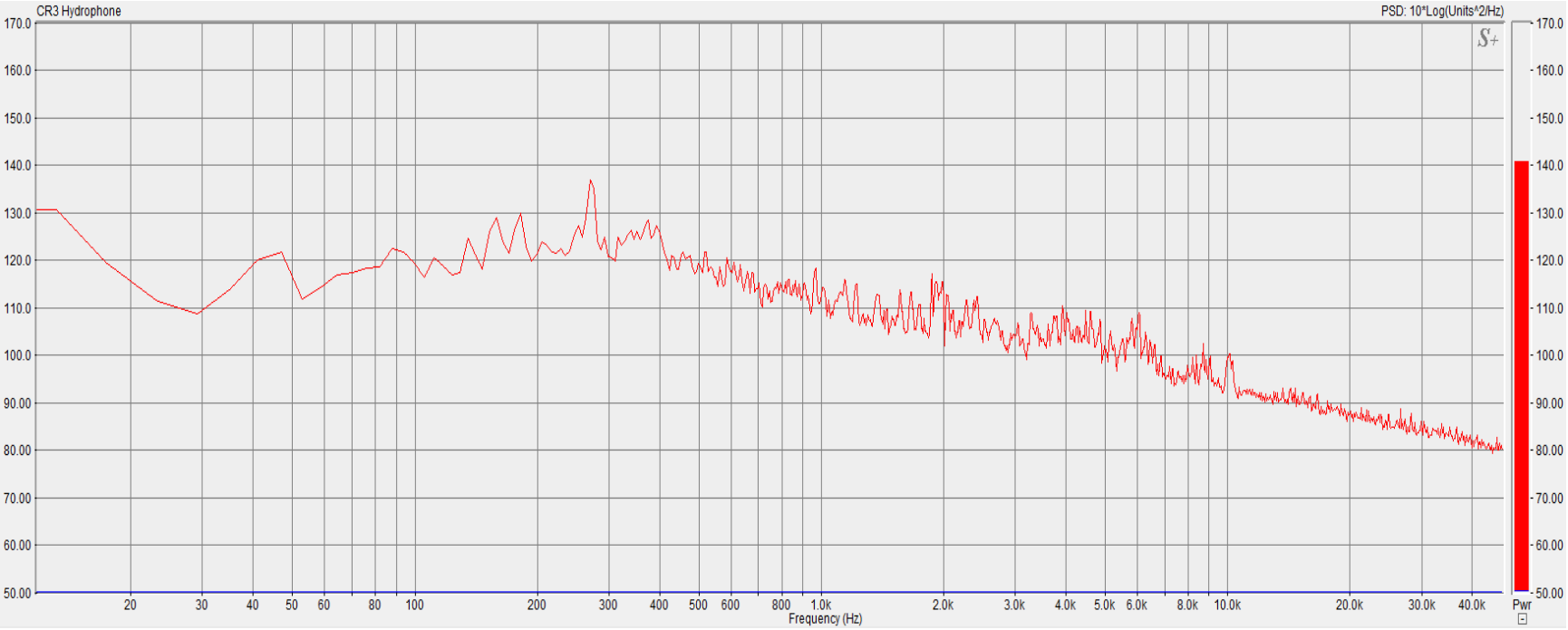


Figure 3. PSD 30” Pipe Pile May 28, 2020

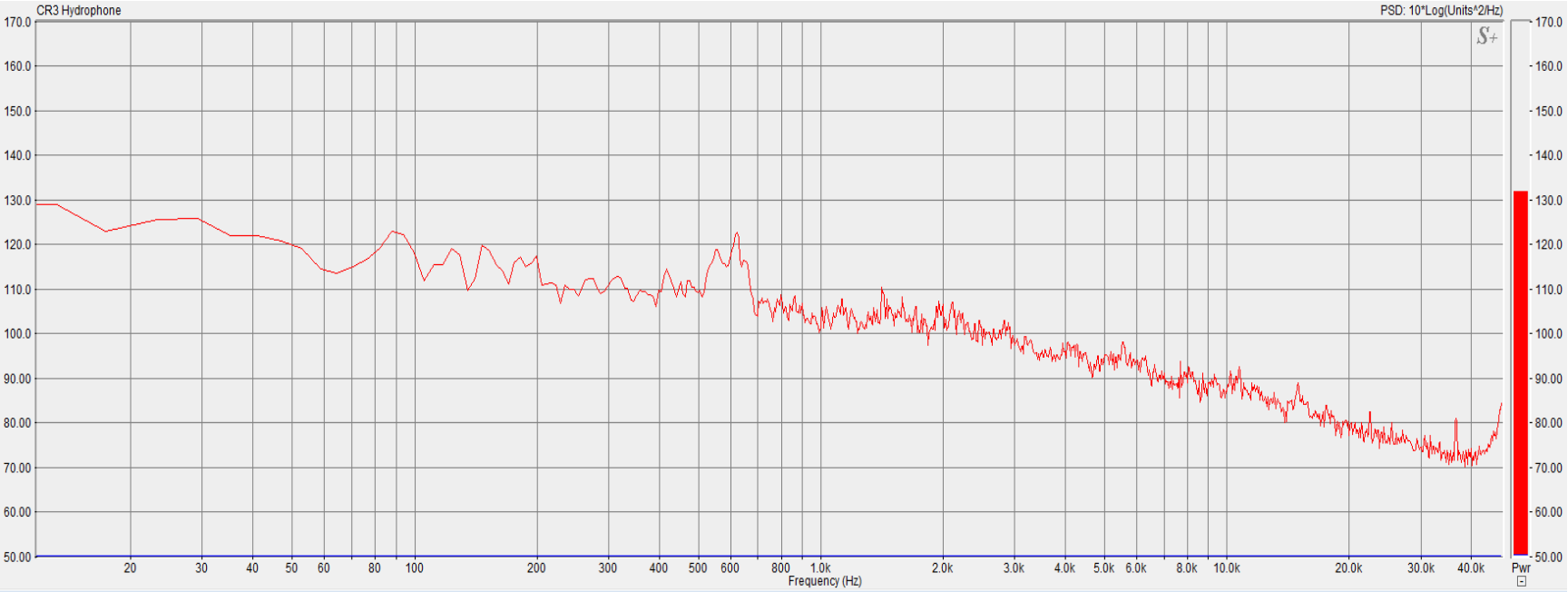


Figure 4. PSD 14” H-Pile May 14, 2020

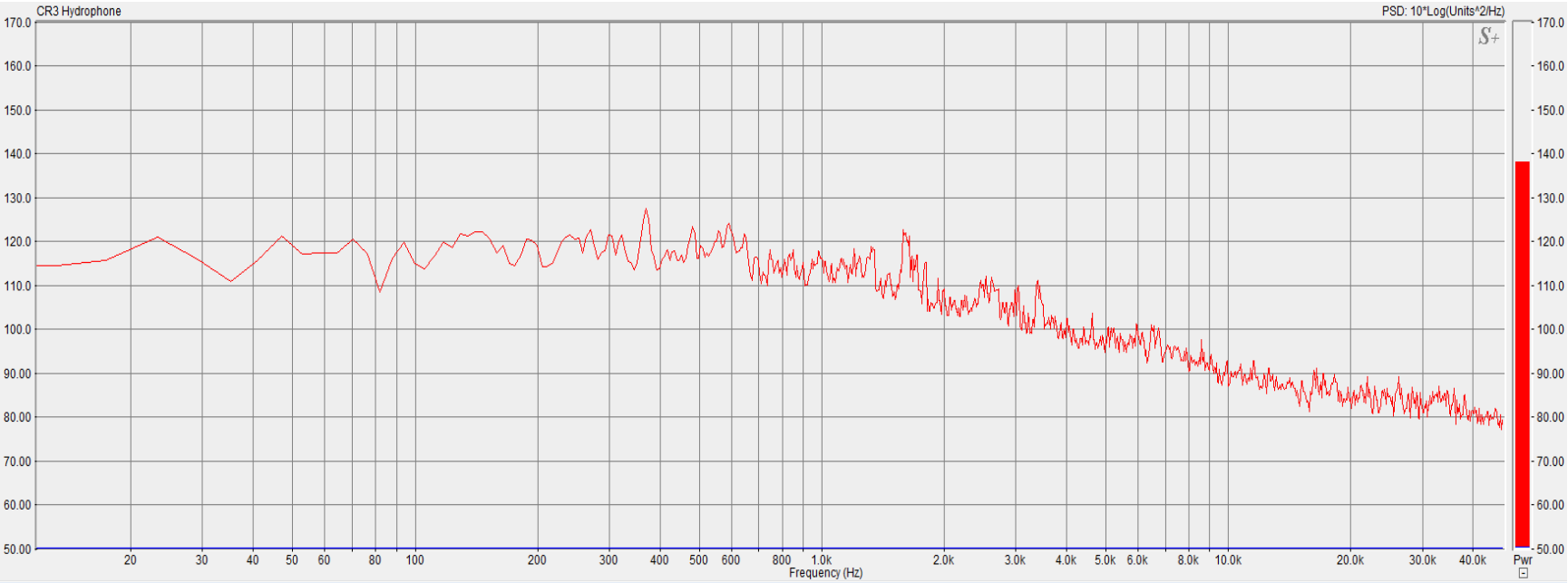


Figure 5. 14” H-Pile May 14, 2020

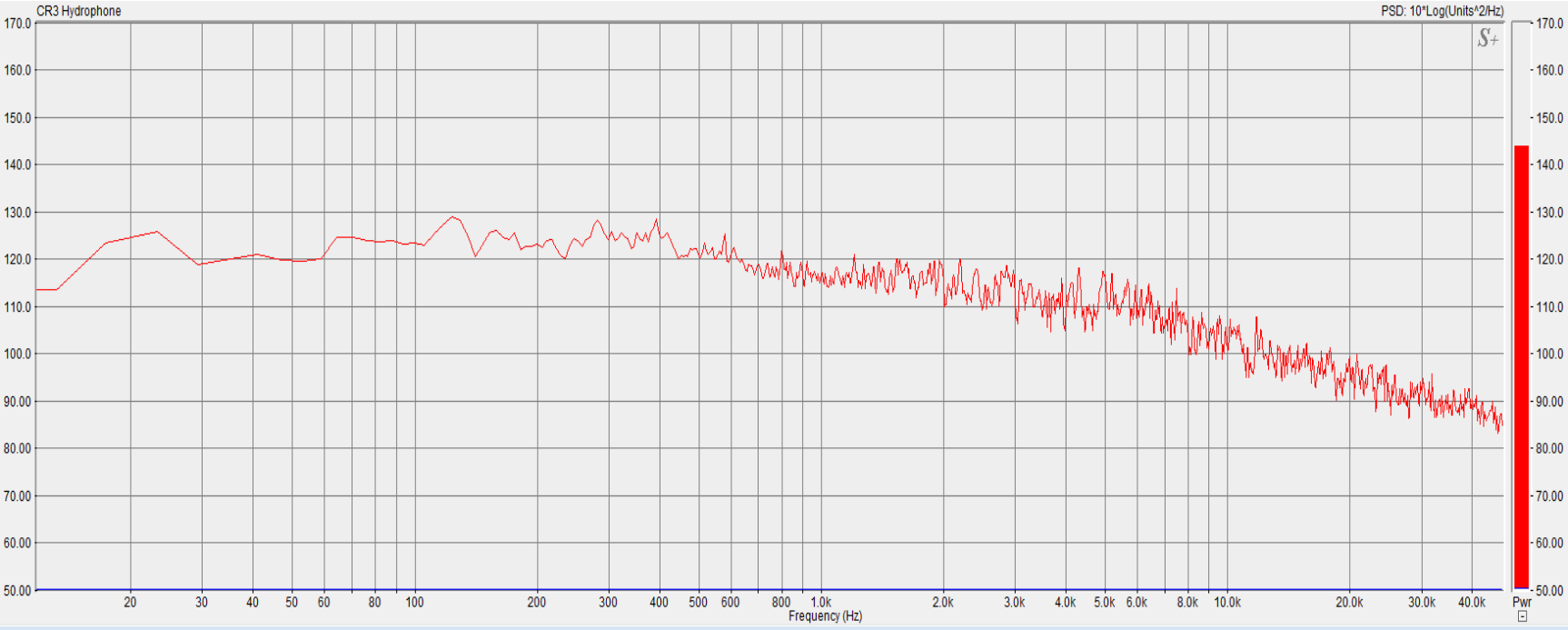


Figure 6. 14” H-Pile May 14, 2020

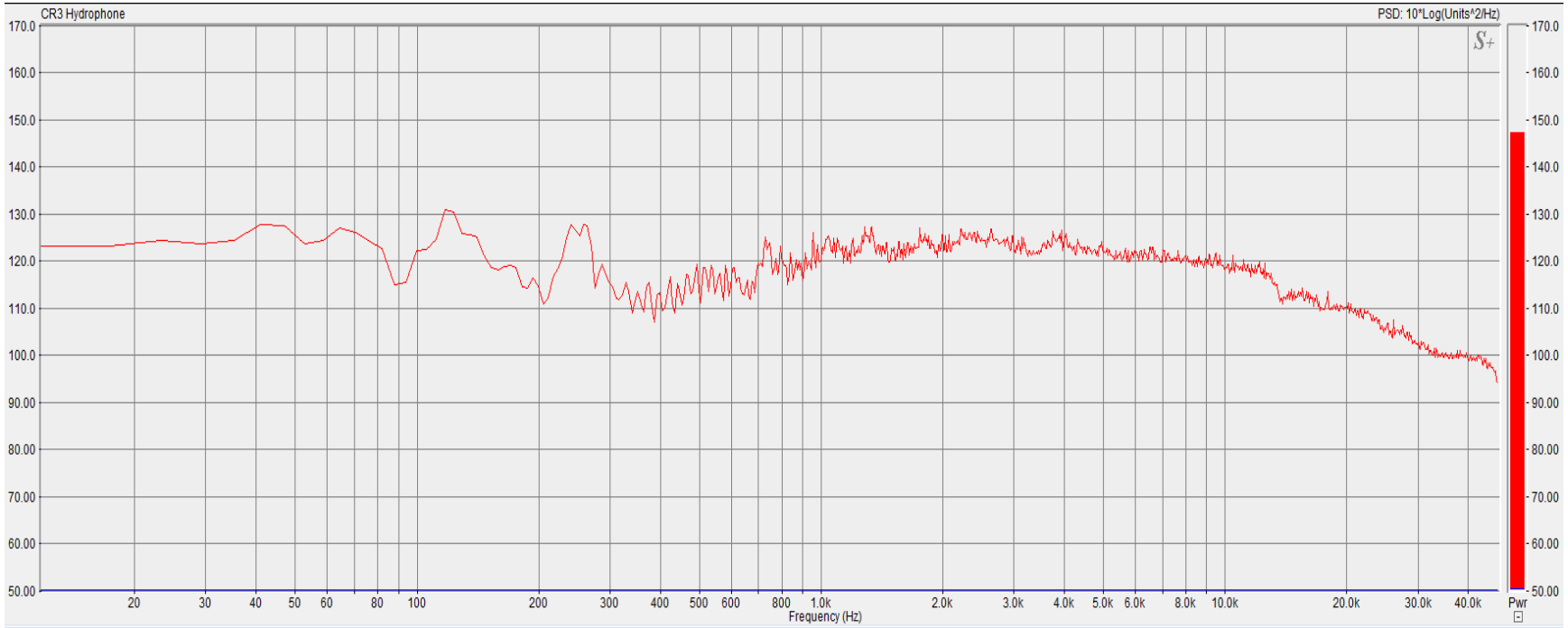


Figure 7. NZ Sheet May 21, 2020

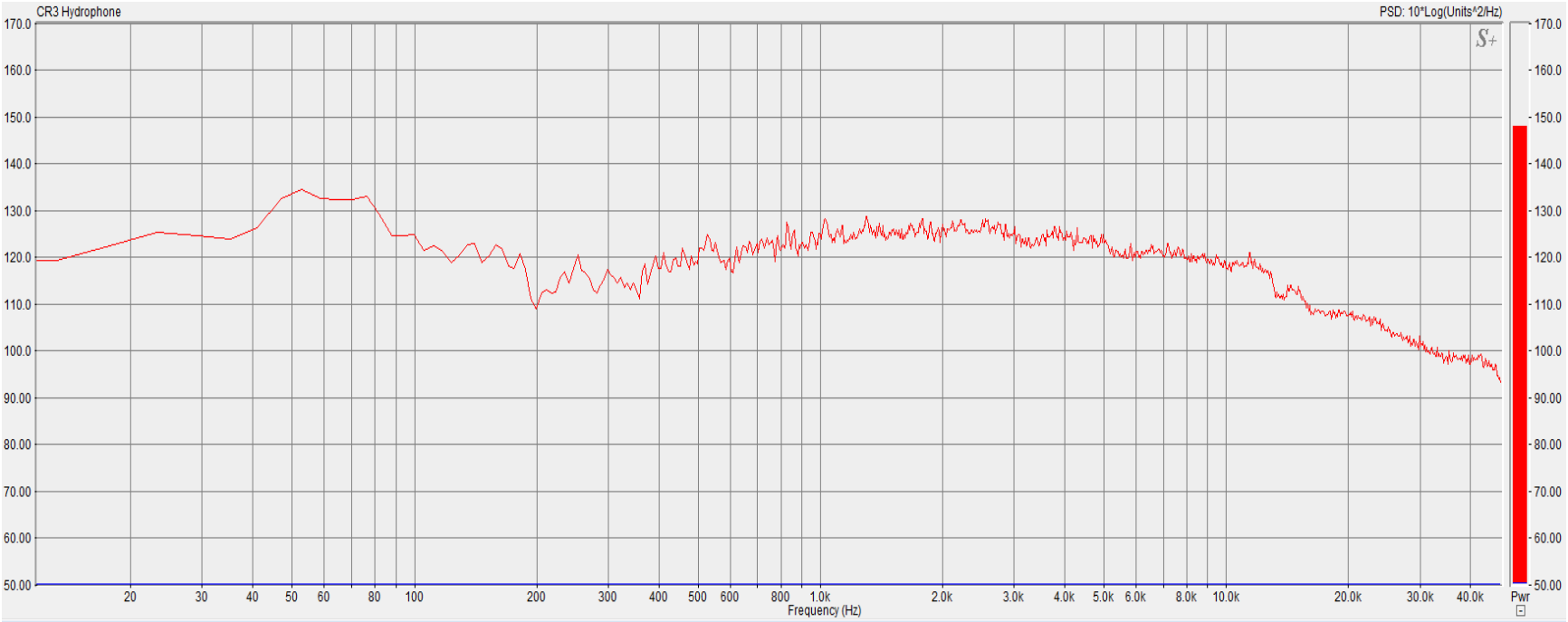


Figure 8. NZ Sheet May 21, 2020

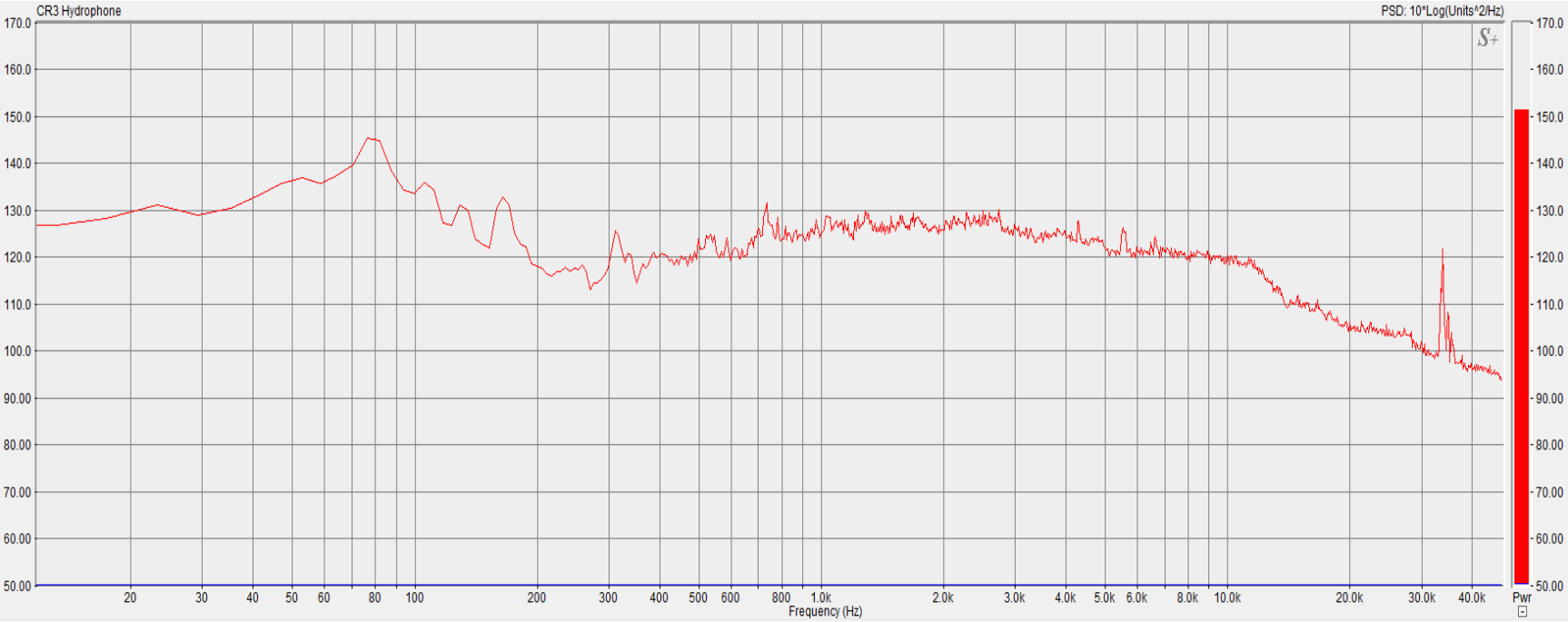


Figure 9. NZ Sheet May 21, 2020

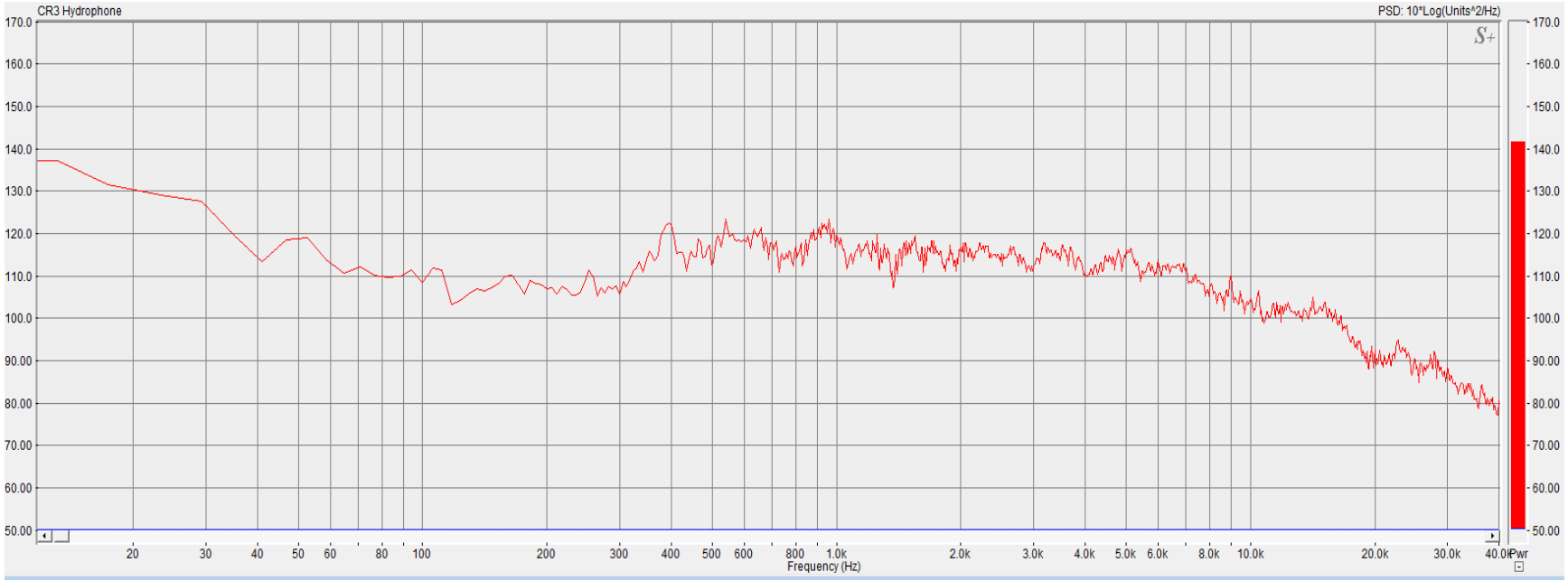


Figure 10. Flat Web Sheet June 11, 2020

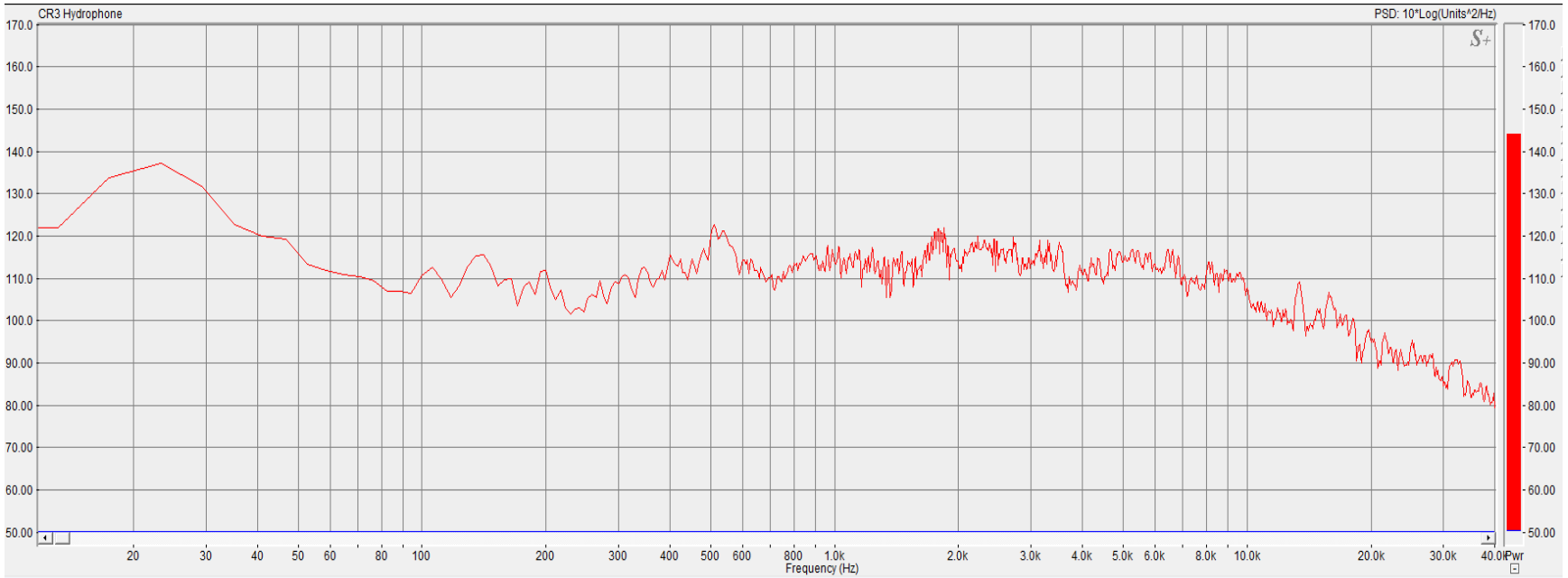


Figure 11. Flat Web Sheet June 11, 2020

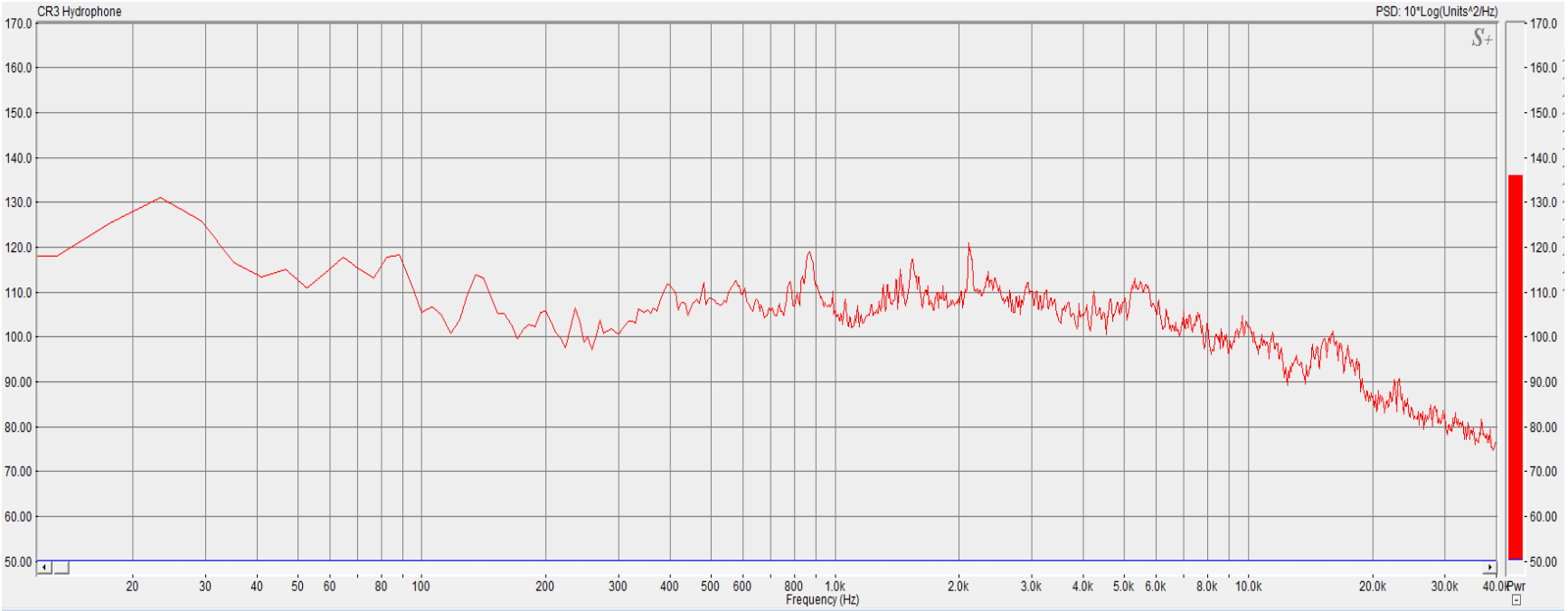


Figure 12. Flat Web Sheet June 11, 2020

THIS PAGE INTENTIONALLY LEFT BLANK

START OF JULY/AUGUST HYDROACOUSTIC REPORT

Monitoring for Vibratory Hammer Use:

Vibratory hammers are used to install piles when allowed by the sediment type. This style of hammer produces a significantly lower source level of sound pressure when compared to the impact hammer. For this reason, vibratory hammers will be the primary method of steel pile installation. These hammers lack the rapid rise in amplitude but have longer durations of an event. Vibratory hammers are considered a non-impulsive source as the hammer uses counterweights that spin to create a vibration. The vibration of the hammer will "liquefy" the soil allowing the pile to move into or out of the sediment.

Measuring Vibratory Pile Driving/Extracting

- Maximum Peak Pressure: The highest instantaneous level of pressure during a single strike. This is expressed in units of dB re 1 µPa.
- Mean (Leq): Equivalent continuous sound level in decibels, equivalent to the total sound energy measured over a stated period of time and also known as the time-average sound level. This is expressed in units of dB re 1 µPa.
    - *Method*: Convert raw data collected in voltage to sound pressure. Convert the sound pressure to dB values.
- Median: Middle number taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the middlemost number in the set.
- Minimum: The lowest pressure data (SPL) taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the smallest number in the set.
- Maximum: The highest pressure data (SPL) taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the largest number in the set.
- cSEL, SELcum: Cumulative sound exposure level an animal is exposed to during a specified duration of time. This is expressed in units of dB re 1 μPa^2 x sec.
- Duration: The length of time for how long something lasts, from one set interval to another. This is expressed in units of milliseconds (ms), seconds, and/or minutes.
    - *Method:* Calculate length of total *active* hammer time (only when the hammer is running).
- Power Spectral Density: The average power in a sound during a certain time range and in a certain frequency range. This will be able to give a visualization for which frequency variations are strong and which are weak. This is expressed in units of dB re μPa^2 per Hz.
    - *Method*: Computed from the fast-Fourier transform of the signal multiplied by its complex conjugate, the resulting quantity is divided by the frequency bin-width of each FFT result and the square root taken of the result.
    - For vibratory drilling, the power spectral density will be computed over the entire duration of the total active hammer. This will exclude periods of hammer shut-down to ensure results computed only include duration of total active hammer time.

Only three power spectral density spectrums for each pile type have been added to reduce the length of the report, however, all PSD spectrums can be provided if requested.

Monitoring for Drilling Use:

Drilling to remove overburden sediments and rock within steel casing is anticipated to occur and recent studies show that source characters consist of both non-impulsive and impulsive components. A rock drill will be used in the case of any bedrock present. Any form of driving/drilling could have an increased duration from the initial transient sound due to reverberation. Post processing of drilling use will be analyzed with components of a non-impulsive source as well as components of an impulsive source.
For impulsive components of drilling, the level B ZOI will be all portions of the project area where marine mammals are exposed to impulsive underwater sounds greater than 160 dB SPL. This information is computed over a time interval between the first 5% and last 5% of the accumulated energy of each strike (RMS 90%).

Measuring Drilling

- Maximum Peak Pressure: The highest instantaneous level of pressure during a single strike. This is expressed in units of dB re 1 µPa.
- Mean (Leq): Equivalent continuous sound level in decibels, equivalent to the total sound energy measured over a stated period of time and also known as the time-average sound level. This is expressed in units of dB re 1 µPa.
    - *Method*: Convert raw data collected in voltage to sound pressure. Convert the sound pressure to dB values.
- Median: Middle number taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the middlemost number in the set.
- Minimum: The lowest pressure data (SPL) taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the smallest number in the set.
- Maximum: The highest pressure data (SPL) taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the largest number in the set.
- cSEL, SELcum: Cumulative sound exposure level an animal is exposed to during a specified duration of time. This is expressed in units of dB re 1 μPa^2 x sec.
- Duration: The length of time for how long something lasts, from one set interval to another. This is expressed in units of milliseconds (ms), seconds, and/or minutes.
    - *Method:* Calculate length of total *active* hammer time (only when the hammer is running).
- Power Spectral Density: The average power in a sound during a certain time range and in a certain frequency range. This will be able to give a visualization for which frequency variations are strong and which are weak. This is expressed in units of dB re μPa^2 per Hz.
    - *Method*: Computed from the fast-Fourier transform of the signal multiplied by its complex conjugate, the resulting quantity is divided by the frequency bin-width of each FFT result and the square root taken of the result.
    - For drilling, the power spectral density will be computed over the entire duration of the total active hammer. This will exclude periods of hammer shut-down to ensure results computed only include duration of total active hammer time.
- Number of hammer strikes (only used for impulsive components of drilling).

Note: 84" Casing incorrectly labeled as 96" Pipe/Can

- Mean duration of a pile strike. This will be based on the RMS SPL 90% energy window criterion.
  - RMS 90% energy window: Measure of the average or effective pressure over the duration of post-processed data. This method omits the first and last 5% of the post-processed data taken from the RMS SPL. This is expressed in units of dB re 1 µPa.

Date	Pile Type	Hammer Type	Record Start Time	Record Stop Time	Active Duration (sec)	Hammer Strikes	Distance (meters)	Mean (dB)	Median (dB)	Maximum (dB)	Minimum (dB)	cSEL (dB)	RMS SPL 90%
7-Jul-20	Flat Web	Vibro	10:45	10:46	57	N/A	20	142.2	158.06	164.25	149.68	165.02	x
							106	134.9	149.13	155.84	140.24	160.52	x
7-Jul-20	Flat Web	Vibro	10:47	10:48	78	N/A	20	143.1	157.37	166.43	149.82	164.66	x
							106	135.5	149.63	158.47	142.92	159.87	x
7-Jul-20	Flat Web	Vibro	10:50	10:51	35	N/A	20	147.4	159.67	164.78	155.04	168.53	x
							106	132.5	153.09	157.22	144.76	163.19	x
7-Jul-20	Flat Web	Vibro	10:57	10:59	102	N/A	20	150.5	162.48	166.07	156.88	170.51	x
							106	140.0	153.52	157.26	146.74	161.37	x
7-Jul-20	Flat Web	Vibro	11:09	11:10	85	N/A	20	147.8	160.27	167.28	151.90	167.50	x
							106	133.7	154.86	160.13	141.72	162.42	x
7-Jul-20	Flat Web	Vibro	11:18	11:19	85	N/A	20	149.3	160.61	167.28	150.91	167.54	x
							106	136.5	151.86	159.46	140.25	161.97	x
7-Jul-20	Flat Web	Vibro	11:22	11:25	224	N/A	20	157.4	164.82	172.32	153.38	176.98	x
							106	143.2	158.43	165.59	143.85	172.11	x
7-Jul-20	96" Pipe/Can	Digging Bucket	11:26	11:30	227	N/A	10	150.1	160.36	176.07	154.03	171.37	x
							106	143.2	152.43	164.82	145.91	162.79	x
7-Jul-20	96" Pipe/Can	Digging Bucket	11:30	11:32	85	N/A	10	148.4	157.80	171.70	149.67	166.60	x
							106	141.1	148.62	160.89	140.28	158.81	x
7-Jul-20	96" Pipe/Can	Digging Bucket	11:33	11:36	170	N/A	10	154.7	155.88	184.39	141.25	171.52	x
							106	148.5	150.62	173.61	132.48	163.76	x
7-Jul-20	96" Pipe/Can	Digging Bucket	11:38	11:40	100	N/A	10	153.1	152.07	175.57	141.79	162.68	x
							106	146.3	145.11	163.45	131.82	153.61	x
7-Jul-20	96" Pipe/Can	Digging Bucket	11:42	11:43	103	N/A	10	163.8	164.49	179.52	142.48	173.49	x
							106	156.3	157.82	167.05	130.16	166.73	x
7-Jul-20	96" Pipe/Can	Digging Bucket	11:50	11:53	177	N/A	10	159.4	160.80	178.56	142.51	173.62	x
							106	153.1	154.83	169.32	133.86	164.74	x
7-Jul-20	96" Pipe/Can	Digging Bucket	11:55	11:56	95	N/A	10	141.2	144.88	176.76	141.12	159.81	x
							106	135.8	137.52	165.49	130.48	140.37	x
7-Jul-20	96" Pipe/Can	Spinner	11:58	12:01	138	40	10	161.1	156.75	182.55	141.40	172.34	145.62
							106	155.8	150.03	172.59	132.76	165.28	139.75
7-Jul-20	96" Pipe/Can	Digging Bucket	12:02	12:03	31	N/A	10	153.4	159.05	183.14	142.53	167.66	x
							106	146.8	151.73	171.65	133.24	158.89	x
7-Jul-20	96" Pipe/Can	Digging Bucket	12:03	12:05	124	N/A	10	149.5	164.45	185.52	142.65	167.66	x
							106	142.9	156.28	172.19	133.52	159.17	x
7-Jul-20	96" Pipe/Can	Digging Bucket	12:06	12:06	6	N/A	10	128.0	143.16	174.32	141.60	150.03	x
							106	121.5	137.81	162.82	132.54	141.94	x
7-Jul-20	96" Pipe/Can	Digging Bucket	12:08	12:09	83	N/A	10	148.9	162.14	172.38	155.67	169.72	x
							106	142.2	154.20	159.88	145.39	160.76	x
7-Jul-20	96" Pipe/Can	Digging Bucket	12:11	12:12	63	N/A	10	134.8	143.13	157.18	140.60	151.22	x
							106	126.7	136.02	146.46	130.24	144.73	x
7-Jul-20	96" Pipe/Can	Digging Bucket	14:05	14:08	200	N/A	10	144.8	153.24	175.62	147.24	166.02	x
							106	138.4	144.79	164.86	136.41	155.88	x
7-Jul-20	96" Pipe/Can	Digging Bucket	14:16	14:30	855	N/A	10	145.5	154.83	188.11	145.82	175.98	x
							106	139.8	143.49	177.28	135.30	165.44	x
8-Jul-20	96" Pipe/Can	Spinner	9:00	9:15	916	92	10	153.7	156.37	175.76	138.78	175.27	140.00
							106	147.6	150.49	166.24	129.51	168.19	134.21
8-Jul-20	96" Pipe/Can	Digging Bucket	9:17	9:47	1810	N/A	10	153.4	161.65	175.93	138.00	180.75	x
							106	147.3	153.75	166.46	130.18	172.24	x
8-Jul-20	96" Pipe/Can	Spinner	9:53	9:59	186	42	10	149.6	156.83	175.92	135.19	168.21	142.29
							106	143.4	150.28	165.14	126.48	160.92	135.02
8-Jul-20	96" Pipe/Can	Auger	10:15	10:27	729	88	10	155.5	159.24	179.58	133.35	176.48	144.82
							106	148.9	152.95	160.42	125.76	167.51	137.91

Date	Pile Type	Hammer Type	Record Start Time	Record Stop Time	Active Duration (sec)	Hammer Strikes	Distance (meters)	Mean (dB)	Median (dB)	Maximum (dB)	Minimum (dB)	cSEL (dB)	RMS SPL 90%
3-Aug-20	96" Pipe/Can	Auger	13:06	13:09	221	14	10	141.2	153.94	175.77	137.48	169.16	134.95
							74	134.8	142.11	163.43	133.07	159.43	127.61
3-Aug-20	96" Pipe/Can	Auger	14:00	14:01	126	27	10	148.7	150.53	176.82	142.34	165.48	148.98
							74	142.2	144.07	164.26	137.19	157.19	132.77
3-Aug-20	96" Pipe/Can	Auger	14:37	14:43	329	11	10	141.9	149.89	172.19	137.39	166.20	148.48
							74	137.1	143.10	162.69	131.30	157.66	131.10
3-Aug-20	96" Pipe/Can	Digging Bucket	14:56	14:59	193	N/A	10	147.1	157.25	175.77	137.48	168.13	x
							74	139.9	151.63	159.24	135.79	162.81	x
3-Aug-20	96" Pipe/Can	Digging Bucket	15:04	15:27	1338	N/A	10	155.8	160.74	192.76	135.54	188.90	x
							74	149.2	154.31	178.38	130.24	176.98	x
5-Aug-20	96" Pipe/Can	Auger	11:54	12:07	787	N/A	10	155.8	166.33	181.54	133.85	186.84	x
							75	147.4	160.16	170.56	131.50	178.45	x
5-Aug-20	96" Pipe/Can	Auger	12:08	12:28	1183	16	10	157.1	154.92	182.64	135.94	183.26	141.86
							75	150.5	146.17	166.04	131.21	175.75	128.58
5-Aug-20	96" Pipe/Can	Auger	12:31	12:33	84	23	10	136.4	142.64	174.82	129.38	133.04	140.17
							75	129.8	135.30	156.98	125.50	123.82	126.41
5-Aug-20	96" Pipe/Can	Auger	12:34	13:00	1561	46	10	143.5	157.86	189.01	132.89	181.82	142.72
							75	136.7	148.47	177.17	128.20	172.39	127.65
13-Aug-20	96" Pipe/Can	Auger	8:44	9:01	1015	33	10	146.4	171.26	184.47	148.22	188.76	149.74
							84	141.6	153.63	167.38	137.49	173.31	132.89
13-Aug-20	96" Pipe/Can	Auger	9:04	9:58	3268	1453	10	145.1	176.23	191.72	150.23	192.93	154.30
							84	138.2	154.71	167.76	129.53	171.43	134.16
13-Aug-20	96" Pipe/Can	Auger	10:12	10:35	1371	121	10	146.2	172.78	189.73	149.48	190.68	151.95
							84	140.6	152.49	165.11	131.67	171.01	133.02

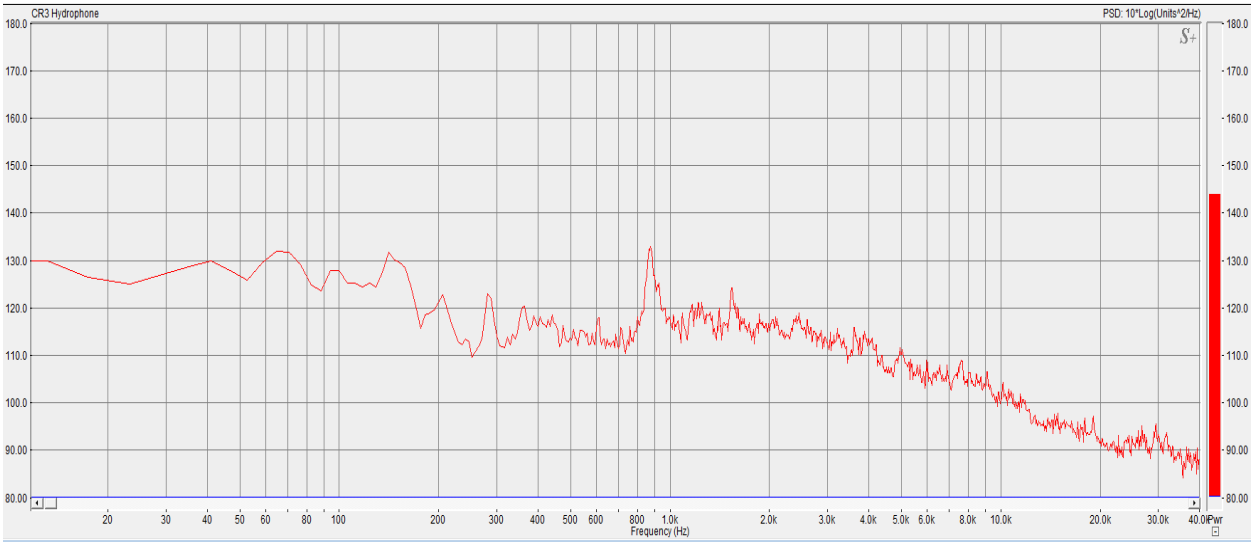


Figure 1. PSD Flat Web July 7, 2020 10:47am

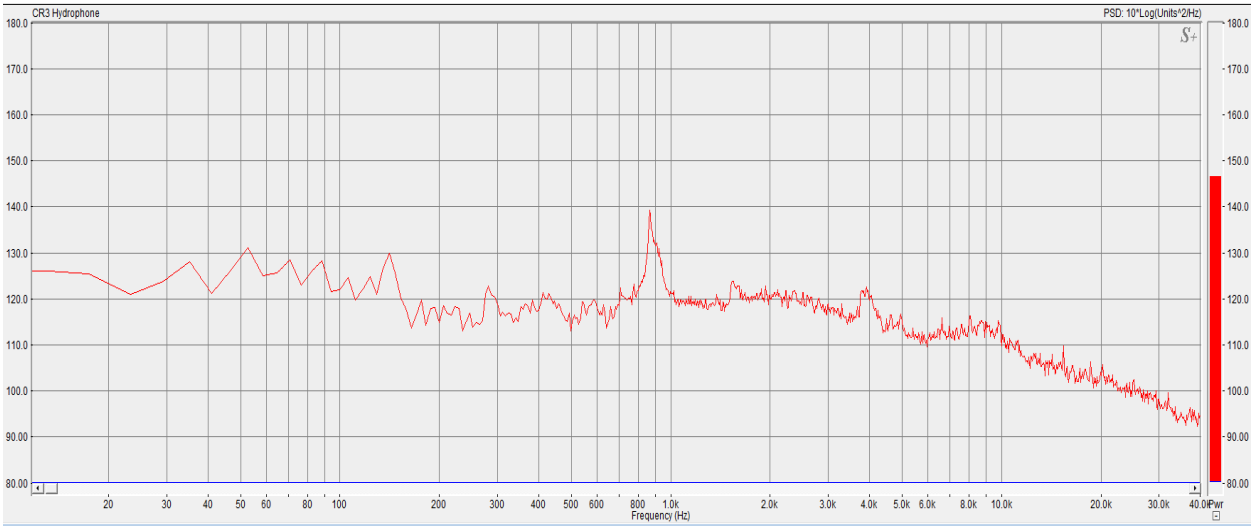


Figure 2. PSD Flat Web July 7, 2020 11:09am

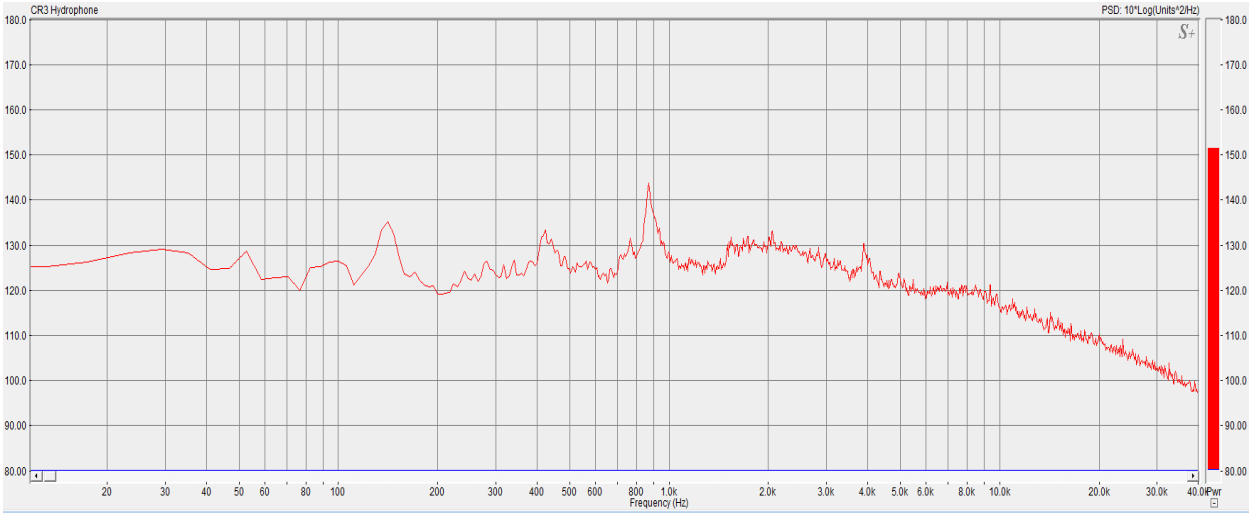


Figure 3. PSD Flat Web July 7, 2020 11:22am

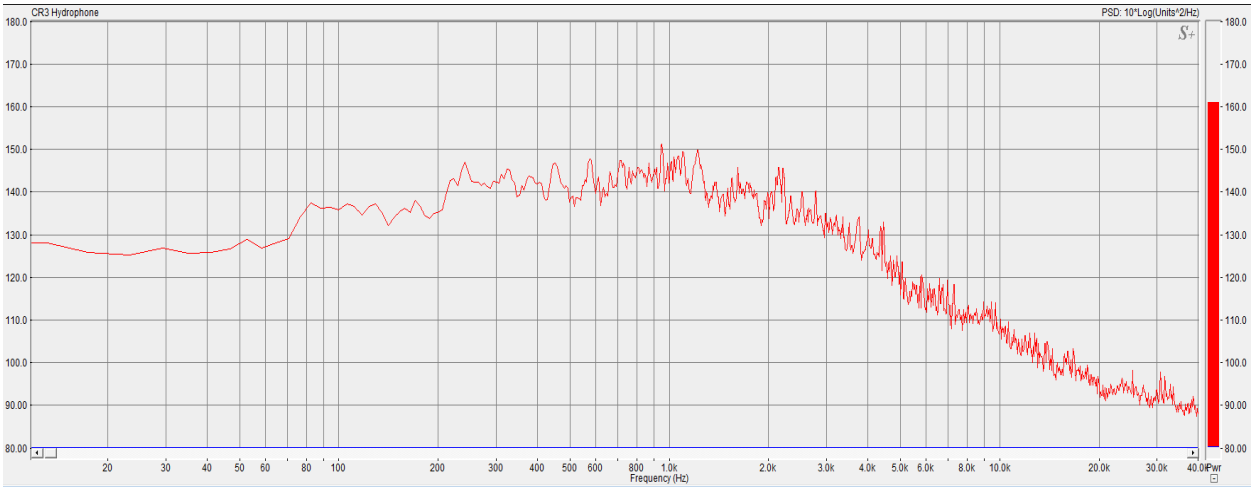


Figure 4. PSD Digging Bucket July 8, 2020 11:42am

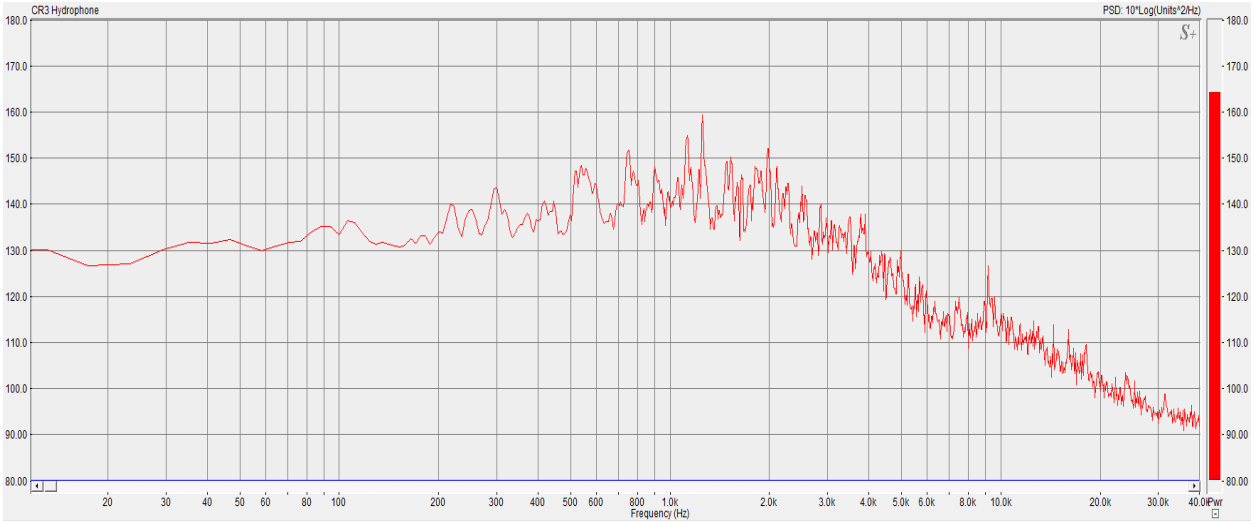


Figure 5. PSD Spinner July 8, 2020 11:58am

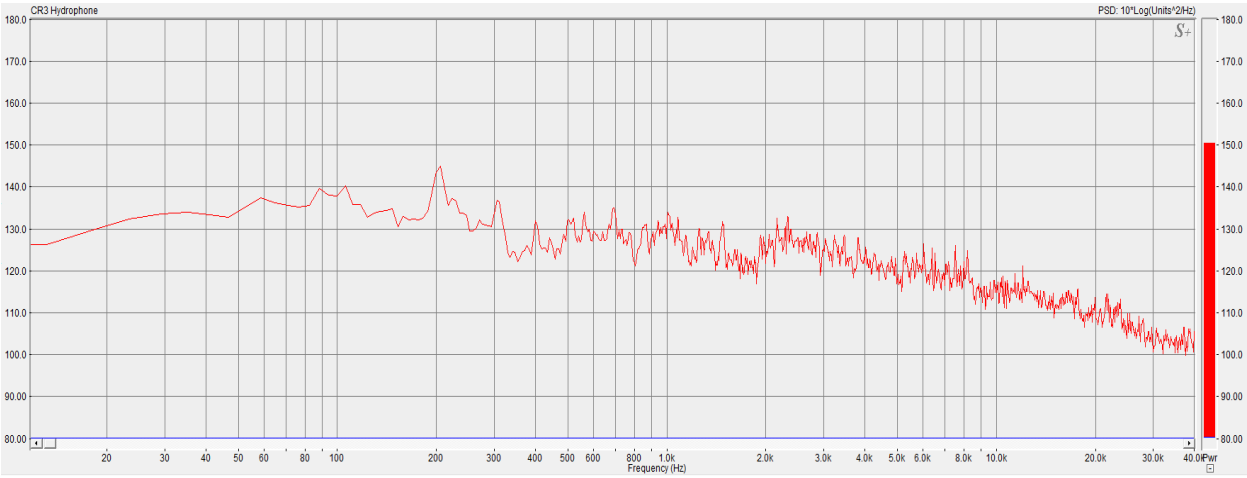


Figure 6. PSD Digging Bucket July 8, 2020 12:08am

Submittal 1359B Hydroacoustic Monitoring Daily Reports

Specification Section 01 57 19.00 22

SD-06 Daily Reports

Covers Submittal #1359B

P310 DD1 Super Flood Basin and P1074 Portal Crane Rail Extension

January 5, 2021

Presented To:

PNSY Public Works Department

Portsmouth Naval Shipyard

Kittery, Maine 03904

By:

Cianbro Corporation

Pittsfield, Maine 04967

List of Attachments

A. Daily Report –June 18, 2020 through June 26, 2020

Monitoring for Vibratory Hammer Use:

Vibratory hammers are used to install piles when allowed by the sediment type. This style of hammer produces a significantly lower source level of sound pressure when compared to the impact hammer. For this reason, vibratory hammers will be the primary method of steel pile installation. These hammers lack the rapid rise in amplitude but have longer durations of an event. Vibratory hammers are considered a non-impulsive source as the hammer uses counterweights that spin to create a vibration. The vibration of the hammer will "liquefy" the soil allowing the pile to move into or out of the sediment.

Measuring Vibratory Pile Driving/Extracting

- Maximum Peak Pressure: The highest instantaneous level of pressure during a single strike. This is expressed in units of dB re 1 µPa.
- Mean (Leq): Equivalent continuous sound level in decibels, equivalent to the total sound energy measured over a stated period of time and also known as the time-average sound level. This is expressed in units of dB re 1 µPa.
    - *Method*: Convert raw data collected in voltage to sound pressure. Convert the sound pressure to dB values.
- Median: Middle number taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the middlemost number in the set.
- Minimum: The lowest pressure data (SPL) taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the smallest number in the set.
- Maximum: The highest pressure data (SPL) taken from the output values of post-processed data. This is expressed in units of dB re 1 µPa.
    - *Method:* Arrange numbers from least to greatest, take the largest number in the set.
- cSEL, SELcum: Cumulative sound exposure level an animal is exposed to during a specified duration of time. This is expressed in units of dB re 1 μPa^2 x sec.
- Duration: The length of time for how long something lasts, from one set interval to another. This is expressed in units of milliseconds (ms), seconds, and/or minutes.
    - *Method:* Calculate length of total *active* hammer time (only when the hammer is running).
- Power Spectral Density: The average power in a sound during a certain time range and in a certain frequency range. This will be able to give a visualization for which frequency variations are strong and which are weak. This is expressed in units of dB re μPa^2 per Hz.
    - *Method*: Computed from the fast-Fourier transform of the signal multiplied by its complex conjugate, the resulting quantity is divided by the frequency bin-width of each FFT result and the square root taken of the result.
    - For vibratory drilling, the power spectral density will be computed over the entire duration of the total active hammer. This will exclude periods of hammer shut-down to ensure results computed only include duration of total active hammer time.

Only five power spectral density spectrums have been added to reduce the length of the report, however, all PSD spectrums can be provided if requested.

Attachment A

Date	Pile Type	Hammer Type	Record Start Time	Record Stop Time	Active Duration (sec)	Hammer Strikes	Distance (meters)	Mean (dB)	Median (dB)	Maximum (dB)	Minimum (dB)	cSEL (dB)	RMS SPL 90%
18-Jun-20	30" Pipe Pile	Vibro	9:19	9:23	229	N/A	20	175.4	176.24	178.42	131.55	190.73	x
							106	165.8	166.21	167.03	141.80	184.18	x
26-Jun-20	Flat Web	Vibro	10:07	10:07	18	N/A	10	141.1	142.91	156.18	129.17	173.02	x
							106	132.0	131.53	145.82	120.82	162.97	x
26-Jun-20	Flat Web	Vibro	10:20	10:22	75	N/A	10	146.8	151.66	155.53	129.99	170.61	x
							106	133.4	142.83	147.65	118.35	161.82	x
26-Jun-20	Flat Web	Vibro	10:29	10:30	23	N/A	10	169.3	167.24	170.28	156.22	178.22	x
							106	157.8	159.88	162.01	144.51	167.56	x
26-Jun-20	Flat Web	Vibro	10:41	10:44	192	N/A	10	173.7	170.28	173.02	142.82	189.37	x
							106	160.5	160.61	165.96	133.63	181.65	x
26-Jun-20	Flat Web	Vibro	10:50	10:52	135	N/A	10	154.3	148.38	156.82	144.52	175.48	x
							106	140.4	140.41	145.30	132.15	162.14	x
26-Jun-20	Flat Web	Vibro	11:03	11:03	39	N/A	10	145.7	145.95	154.25	134.27	164.49	x
							106	136.0	137.29	143.99	123.61	153.63	x
26-Jun-20	Flat Web	Vibro	11:04	11:05	58	N/A	10	151.9	148.37	158.23	145.95	170.88	x
							106	140.7	140.62	150.69	134.86	158.31	x
26-Jun-20	Flat Web	Vibro	11:08	11:09	51	N/A	10	152.8	154.27	161.48	149.50	175.22	x
							106	144.9	145.37	152.76	138.94	163.02	x
26-Jun-20	Flat Web	Vibro	11:12	11:15	125	N/A	10	158.1	152.91	157.29	136.29	179.43	x
							106	143.9	144.50	149.37	125.81	166.90	x
26-Jun-20	Flat Web	Vibro	11:21	11:24	213	N/A	10	150.0	149.73	156.96	135.62	178.56	x
							106	139.0	140.08	146.94	124.56	162.06	x
26-Jun-20	Flat Web	Vibro	11:28	11:28	25	N/A	10	142.6	143.64	144.62	133.93	158.27	x
							106	130.2	132.11	135.25	122.56	145.99	x
26-Jun-20	Flat Web	Vibro	11:29	11:30	32	N/A	10	151.9	149.57	156.21	148.23	164.89	x
							106	140.8	141.41	144.92	136.37	155.32	x
26-Jun-20	Flat Web	Vibro	11:31	11:33	73	N/A	10	154.9	151.62	156.24	132.88	172.64	x
							106	142.1	142.56	145.86	119.76	161.80	x

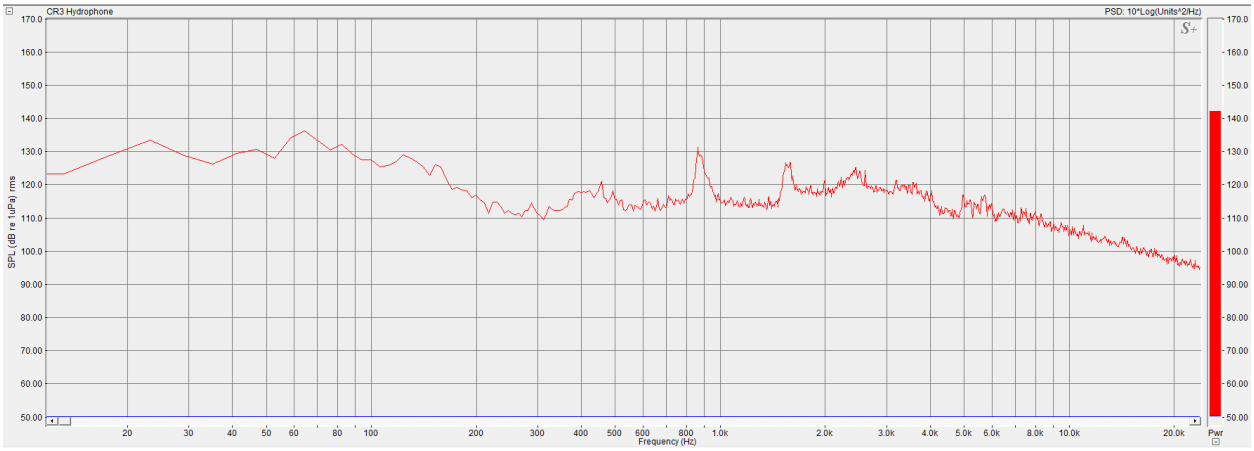


Figure 1. PSD Flat Web June 26, 2020 11:12am

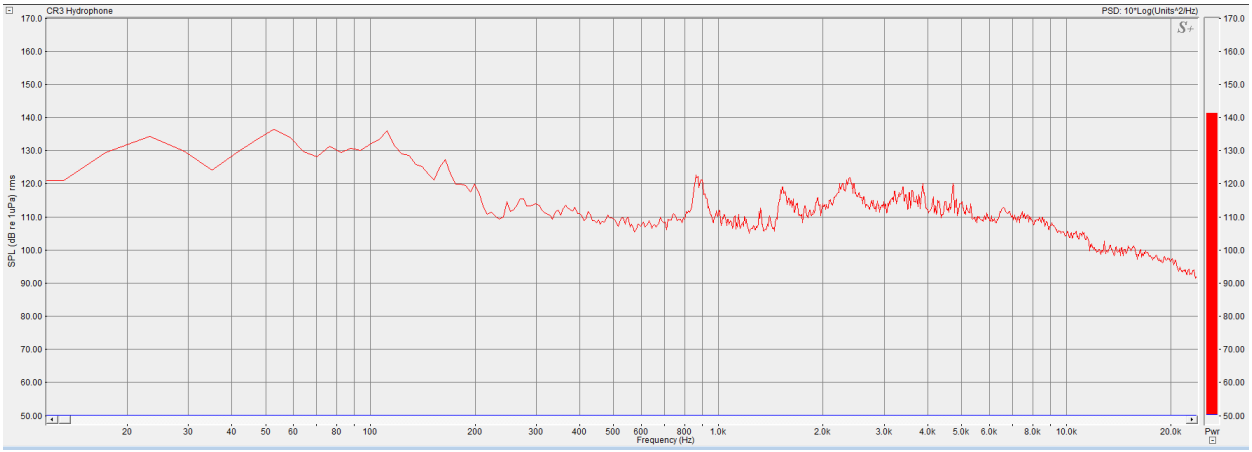


Figure 2. PSD Flat Web June 26, 2020 11:21am

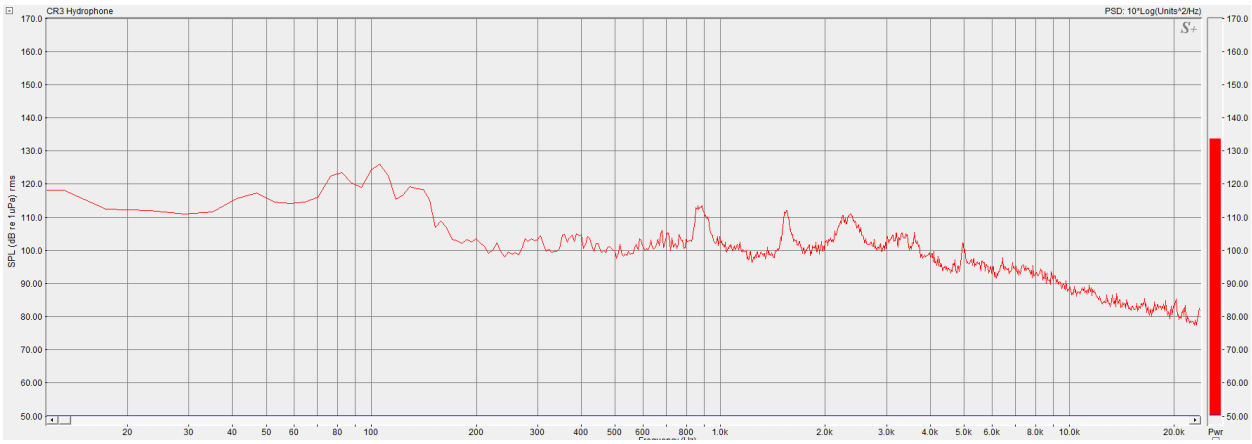


Figure 3. PSD Flat Web June 26, 2020 11:28am

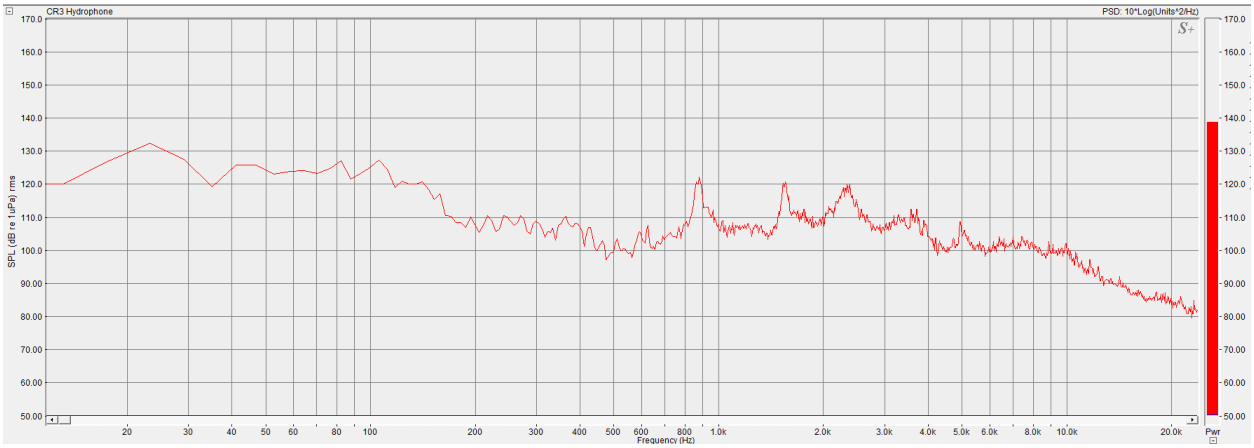


Figure 4. PSD Flat Web June 26, 2020 11:29am

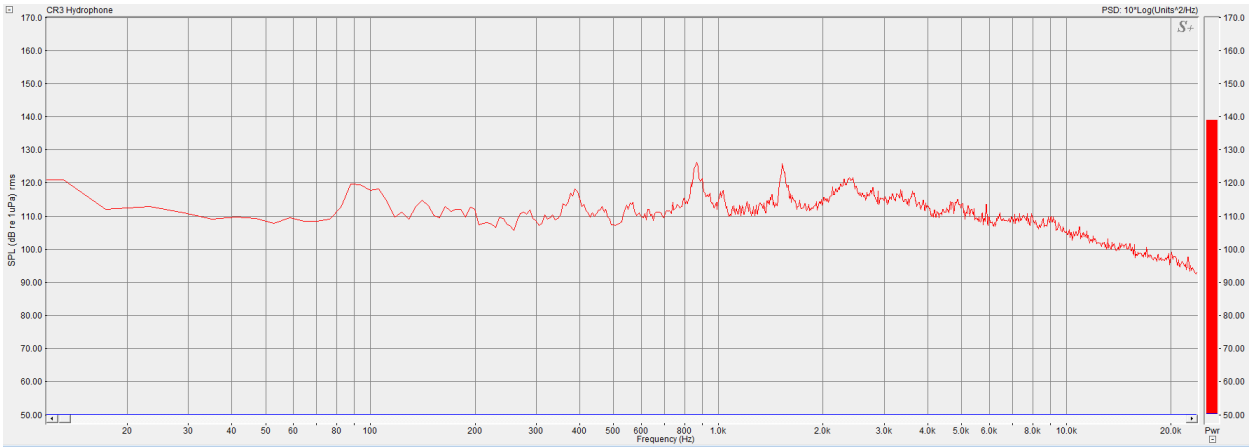


Figure 5. PSD Flat Web June 26, 2020 11:31am

HYDROACOUSTIC MONITORING - PORTSMOUTH NAVAL SHIPYARD

Hydroacoustic Monitoring of Background Sound Levels and Construction Sound Source Verification on the Piscataqua River, Kittery, Maine

Surveys conducted in Winter, Spring, Summer, and Fall of 2020

Contract No. N4008518R8709 – X004

DRAFT REPORT

Preliminary Results from 04 December 2020

By

Prime contractor: JESCO Environmental & Geotechnical Services, Inc.

1701 South Thibodeaux Rd.
Jennings, LA 70546 USA
https://jescous.com/

Subcontractor: T&T Braveheart, LLC

9738 Teichman Rd.
Galveston, TX 77554

Revised: 14 January 2021

1. Introduction

JESCO Environmental and Geotechnical Services, Inc. (JESCO) and T&T Braveheart, LLC (T&T Braveheart) under US Naval Facilities Engineering Command (NAVFAC) Contract N4008518R8709-X004 conducted hydroacoustic monitoring and sound source verification at construction sites at the Portsmouth Naval Shipyard in Kittery, ME and in the surrounding waters of the Piscataqua River. The information provided by the acoustic data will be used by the installation in during consultations with NOAA Fisheries and in National Environmental Protection Act (NEPA) determinations with respect to marine mammals and endangered species.

On December 4, 2020, eight 16-inch steel pipe piles were installed by Cianbro Corporation for a bridge crossing at the Super Flood Basin construction site. Figure 1 shows the construction area and highlights the location of the pile driving activity on December 4, 2020.

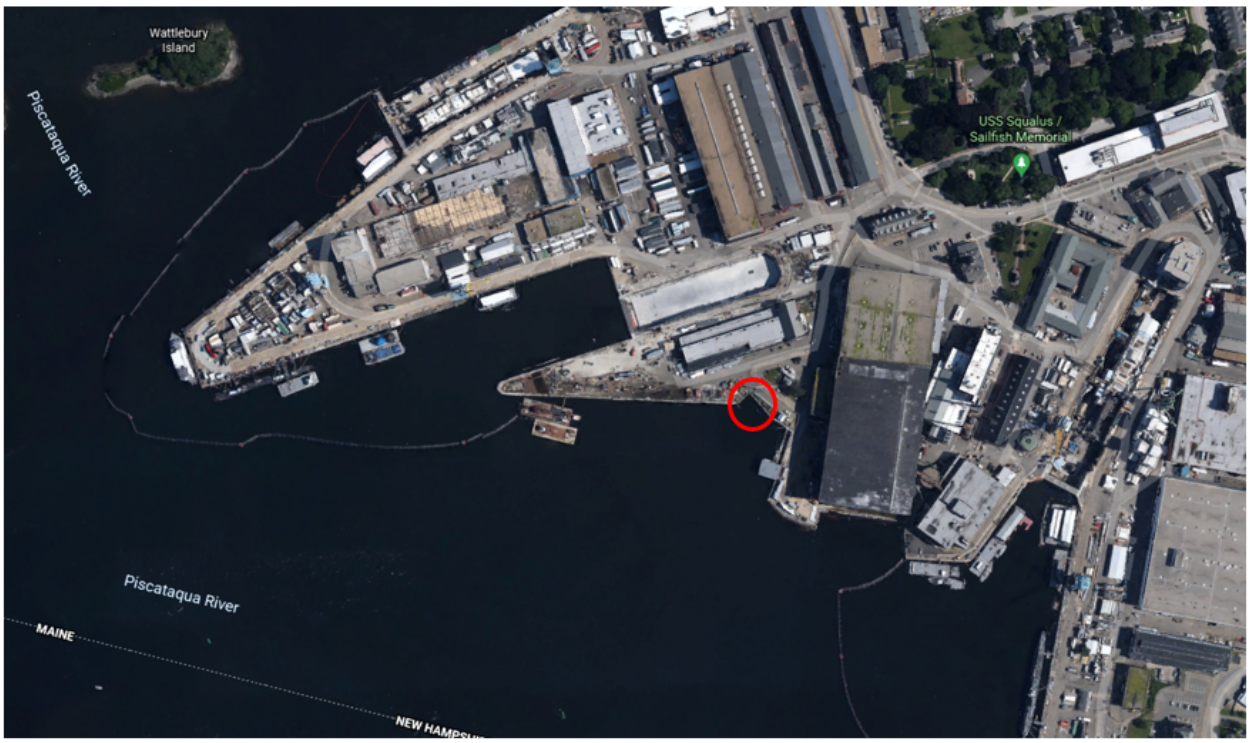


Figure 1- The Super Flood Basin construction site at the Portsmouth Naval Shipyard in Kittery, ME. The red circle highlights the pile driving area on December 4.

An APE Model 200 Vibratory Extractor with a hammer weight of 5,788 kg that can produce a driving force of 1,513 kN was used. Figure 2 is a sketch from the field notes and depicts how the eight piles were installed on a triangular grid. The distance between the piles and the near field hydrophone ranged from 4 to 25 m.

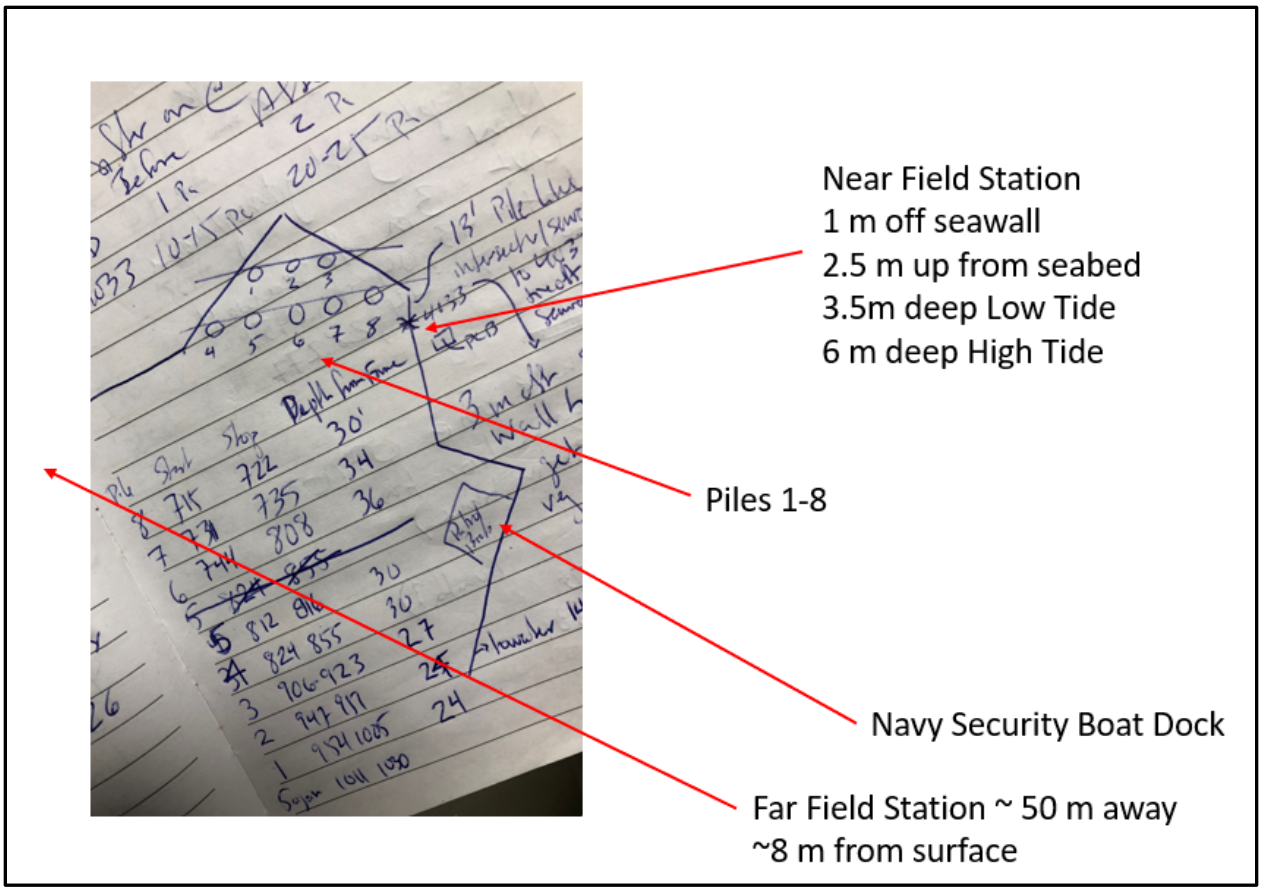


Figure 2 - A sketch of the pile installation design with locations of the hydrophones shown.

2. Methods

The seawall at the deployment site had dense seaweed growth. To avoid physical entanglement and sound attenuation from the seaweed, the hydrophone was cast 3 m away from the seawall and suspended 2 m above the seabed by a buoy on a tag line from an anchor. The tidal range this day was 3 m, and the water depth at low tide was 3 m. Due to these constraints, the placement depth was selected to keep the hydrophone at least 1 m below the sea surface at low tide. At high tide, the hydrophone sat at a depth of about 2 m.

The data were sampled with a National Instruments cDAQ-9239 set at 50,000 samples/second with one channel recording in water sound from a Reson TC 4033 Hydrophone passing through a Reson VP-1000 gain stage. The VP-1000 was set to 0 dB gain with a 5 Hz high pass filter engaged. The second channel recorded in air sound from a PCB Peizoelectronics 378B02 Microphone. The data were analyzed and reported in 1-second intervals for root mean square sound pressure level (RMS SPL), peak SPL, and Sound Exposure Level (SEL). The results are presented below.

3. Results

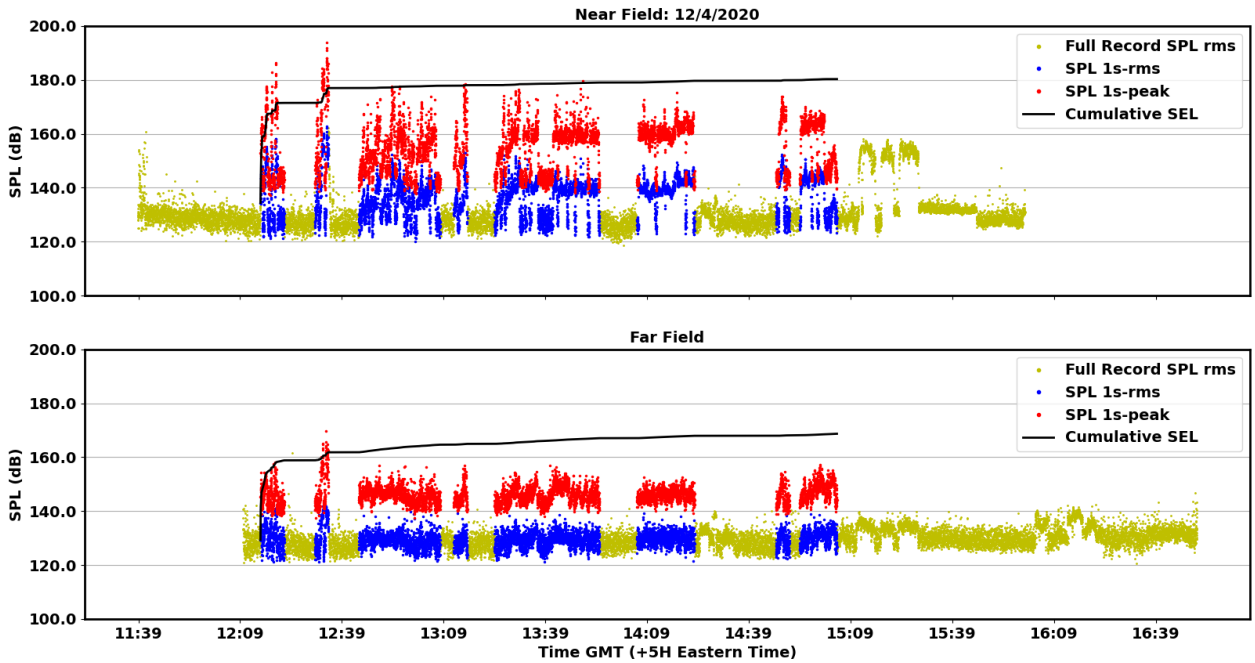


Figure 3 - Time series of near and far field hydrophone data. The day long record of 1 second RMS SPL is shown in yellow. Pile drive intervals are highlighted with the 1-second RMS SPL in blue and the 1-second peak SPL in red. The black line shows the cumulative SEL throughout the day. All sound levels are in dB re 1 µPa.

Table 1- Summary of 1-second RMS SPL and peak SPL data per pile along with driving method, pile number and duration of the drive in seconds. The SEL per pile is also shown. Sound level values are in dB re 1 µPa.

Time				Duration	1 second Peak (dB 1µPa)		1 second RMS (dB 1µPa)		Cumulative
EST	**Pile**	**Station**	**Sensor**	**Seconds**	**Mean**	**Range**	**Mean**	**Range**	**SEL (dB 1µPa)**
12/4/20 7:15	8Vibro	Yellow	TC-4033	419	168.3	137.1 - 186.4	145.2	121.1 - 158.1	171.5
12/4/20 7:15	8Vibro	Yellow	PCB	419	99.2	95.6 - 104.8	82.5	79.8 - 87.4	108.8
12/4/20 7:15	8Vibro	White	TC-4033	419	147.6	138.2 - 158.2	132.6	121.2 - 146.6	158.8
12/4/20 7:31	7Vibro	Yellow	TC-4033	239	178.1	138.8 - 193.9	151.7	122.4 - 162.7	175.5
12/4/20 7:31	7Vibro	Yellow	PCB	239	117	95.0 - 140.6	104.5	78.6 - 128.2	128.3
12/4/20 7:31	7Vibro	White	TC-4033	239	155.7	137.5 - 169.7	135	121.2 - 143.8	158.8
12/4/20 7:44	6Vibro	Yellow	TC-4033	1439	161.1	137.9 - 177.7	138.7	120.1 - 152.4	170.3
12/4/20 7:44	6Vibro	Yellow	PCB	1439	100.4	95.1 - 107.9	83.7	78.7 - 89.5	115.3
12/4/20 7:44	6Vibro	White	TC-4033	1439	146.9	137.4 - 156.8	129.9	121.6 - 139.7	161.4
12/4/20 8:12	5Vibro	Yellow	TC-4033	239	165.6	138.9 - 178.3	141.2	123.3 - 153.3	165

12/4/20 8:12	5Vibro	Yellow	PCB	239	100.4	95.4 - 105.6	83.7	78.8 - 88.0	107.5
12/4/20 8:12	5Vibro	White	TC-4033	239	147.2	139.9 - 156.8	129.5	122.6 - 139.1	153.3
12/4/20 8:24	4Vibro	Yellow	TC-4033	1859	161.3	138.0 - 179.8	139.4	121.9 - 152.1	172.1
12/4/20 8:24	4Vibro	Yellow	PCB	1859	101.8	94.7 - 110.4	84.7	78.4 - 92.5	117.4
12/4/20 8:24	4Vibro	White	TC-4033	1859	147.3	138.0 - 156.9	130.2	121.3 - 138.8	162.9
12/4/20 9:06	3Vibro	Yellow	TC-4033	1019	161.7	139.0 - 175.3	140.9	122.7 - 149.4	171
12/4/20 9:06	3Vibro	Yellow	PCB	1019	102.6	95.3 - 108.2	85.2	80.1 - 90.1	115.3
12/4/20 9:06	3Vibro	White	TC-4033	1019	146.6	139.2 - 152.7	130.5	121.5 - 139.1	160.6
12/4/20 9:47	2Vibro	Yellow	TC-4033	239	163.6	139.3 - 173.8	143.5	123.1 - 152.4	167.3
12/4/20 9:47	2Vibro	Yellow	PCB	239	103.8	95.8 - 110.5	86.4	80.1 - 92.4	110.2
12/4/20 9:47	2Vibro	White	TC-4033	239	146.9	138.8 - 154.5	130.5	122.2 - 140.2	154.3
12/4/20 9:54	1Vibro	Yellow	TC-4033	659	161.6	139.6 - 170.0	141.6	123.2 - 150.6	169.8
12/4/20 9:54	1Vibro	Yellow	PCB	659	103.7	91.2 - 111.1	86.3	76.3 - 92.9	114.5
12/4/20 9:54	1Vibro	White	TC-4033	659	149.2	139.7 - 157.3	131.4	123.8 - 139.0	159.6

Table 2 – 1-minute in air Leq and Leq(A) measured at the near field microphone along with pile number and driving method. The values are in dB re 1µPa.

Time	**dB re 20µPa**		**Pile Number**
GMT	**Leq**	**Leq(A)**	**w/ Method**
12/4/2020 12:15	118.3	106.8	8Vibro
12/4/2020 12:16	125.9	119.7	8Vibro
12/4/2020 12:17	106.6	90.6	8Vibro
12/4/2020 12:18	121.5	118.5	8Vibro
12/4/2020 12:19	127.4	124.8	8Vibro
12/4/2020 12:20	107.2	89.2	8Vibro
12/4/2020 12:21	106.2	89.4	8Vibro
12/4/2020 12:31	116.0	113.4	7Vibro
12/4/2020 12:32	115.8	113.3	7Vibro
12/4/2020 12:33	131.2	130.5	7Vibro
12/4/2020 12:34	132.0	131.7	7Vibro
12/4/2020 12:44	107.3	99.8	6Vibro
12/4/2020 12:45	111.9	109.9	6Vibro
12/4/2020 12:46	111.7	108.6	6Vibro

12/4/2020 12:47	110.0	104.9	6Vibro
12/4/2020 12:48	111.3	106.8	6Vibro
12/4/2020 12:49	118.8	115.2	6Vibro
12/4/2020 12:50	114.3	109.3	6Vibro
12/4/2020 12:51	112.5	107.9	6Vibro
12/4/2020 12:52	111.3	107.0	6Vibro
12/4/2020 12:53	121.6	120.4	6Vibro
12/4/2020 12:54	119.2	117.7	6Vibro
12/4/2020 12:55	119.6	116.7	6Vibro
12/4/2020 12:56	117.1	113.0	6Vibro
12/4/2020 12:57	116.0	108.1	6Vibro
12/4/2020 12:58	112.5	107.9	6Vibro
12/4/2020 12:59	110.3	105.3	6Vibro
12/4/2020 13:00	107.7	102.5	6Vibro
12/4/2020 13:01	113.2	109.8	6Vibro
12/4/2020 13:02	119.0	115.7	6Vibro
12/4/2020 13:03	113.9	110.4	6Vibro
12/4/2020 13:04	115.2	110.2	6Vibro
12/4/2020 13:05	118.2	112.7	6Vibro
12/4/2020 13:06	115.9	107.0	6Vibro
12/4/2020 13:07	105.3	91.1	6Vibro
12/4/2020 13:12	111.7	109.7	5Vibro
12/4/2020 13:13	107.9	102.0	5Vibro
12/4/2020 13:14	117.5	115.5	5Vibro
12/4/2020 13:15	122.8	121.1	5Vibro
12/4/2020 13:24	107.5	99.3	4Vibro
12/4/2020 13:25	110.7	105.2	4Vibro
12/4/2020 13:26	118.7	115.3	4Vibro
12/4/2020 13:27	112.8	108.4	4Vibro
12/4/2020 13:28	117.8	115.0	4Vibro
12/4/2020 13:29	117.0	114.9	4Vibro
12/4/2020 13:30	121.4	119.2	4Vibro
12/4/2020 13:31	120.5	119.4	4Vibro
12/4/2020 13:32	114.6	112.7	4Vibro
12/4/2020 13:33	117.0	114.8	4Vibro
12/4/2020 13:34	114.2	111.8	4Vibro
12/4/2020 13:35	116.6	114.5	4Vibro
12/4/2020 13:36	117.5	114.9	4Vibro
12/4/2020 13:37	106.7	93.8	4Vibro
12/4/2020 13:38	106.1	90.5	4Vibro
12/4/2020 13:39	106.9	91.2	4Vibro

12/4/2020 13:40	105.7	95.1	4Vibro
12/4/2020 13:41	117.2	115.7	4Vibro
12/4/2020 13:42	116.8	114.6	4Vibro
12/4/2020 13:43	117.2	115.5	4Vibro
12/4/2020 13:44	116.2	114.7	4Vibro
12/4/2020 13:45	115.6	113.5	4Vibro
12/4/2020 13:46	116.5	115.2	4Vibro
12/4/2020 13:47	116.3	114.0	4Vibro
12/4/2020 13:48	117.2	115.5	4Vibro
12/4/2020 13:49	118.5	116.8	4Vibro
12/4/2020 13:50	117.2	115.7	4Vibro
12/4/2020 13:51	115.2	112.2	4Vibro
12/4/2020 13:52	116.5	114.4	4Vibro
12/4/2020 13:53	116.4	114.6	4Vibro
12/4/2020 13:54	115.5	112.4	4Vibro
12/4/2020 14:06	114.7	113.5	3Vibro
12/4/2020 14:07	118.2	117.3	3Vibro
12/4/2020 14:08	117.7	115.9	3Vibro
12/4/2020 14:09	115.4	114.0	3Vibro
12/4/2020 14:10	116.7	114.3	3Vibro
12/4/2020 14:11	112.4	111.1	3Vibro
12/4/2020 14:12	115.9	115.0	3Vibro
12/4/2020 14:13	116.4	114.6	3Vibro
12/4/2020 14:14	117.6	116.2	3Vibro
12/4/2020 14:15	116.1	115.2	3Vibro
12/4/2020 14:16	116.6	113.5	3Vibro
12/4/2020 14:17	121.5	119.0	3Vibro
12/4/2020 14:18	119.7	118.0	3Vibro
12/4/2020 14:19	119.4	118.2	3Vibro
12/4/2020 14:20	119.2	117.5	3Vibro
12/4/2020 14:21	120.1	118.5	3Vibro
12/4/2020 14:22	118.7	116.5	3Vibro
12/4/2020 14:47	111.6	109.4	2Vibro
12/4/2020 14:48	124.8	123.1	2Vibro
12/4/2020 14:49	121.1	119.1	2Vibro
12/4/2020 14:50	106.8	91.6	2Vibro
12/4/2020 14:54	117.8	116.8	1Vibro
12/4/2020 14:55	122.1	120.1	1Vibro
12/4/2020 14:56	119.7	118.9	1Vibro
12/4/2020 14:57	119.7	118.4	1Vibro
12/4/2020 14:58	120.5	119.4	1Vibro

12/4/2020 14:59	118.9	117.9	1Vibro
12/4/2020 15:00	121.2	120.3	1Vibro
12/4/2020 15:01	115.8	114.0	1Vibro
12/4/2020 15:02	105.8	99.9	1Vibro
12/4/2020 15:03	109.9	106.3	1Vibro
12/4/2020 15:04	109.3	105.2	1Vibro