REQUEST FOR AUTHORIZATION
FOR THE INCIDENTAL HARASSMENT OF MARINE MAMMALS
RESULTING FROM MODIFICATION, EXPANSION, AND FUTURE OPERATIONS OF DRY DOCK 1
AT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE
October 1, 2019, through September 30, 2020

Submitted to:

Office of Protected Resources,
National Marine Fisheries Service,
National Oceanographic and Atmospheric Administration

Prepared by:

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Prepared for:

U.S. Department of the Navy
Commanding Officer, Portsmouth Naval Shipyard
Kittery, Maine

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ACRONYMS AND ABBREVIATIONS

μPa	micropascal
ASW	Auxiliary Salt Water
BMPs	best management practices
CFR	Code of Federal Regulations
CI	confidence interval
CIA	Controlled Industrial Area
CV	coefficient of variation
cy	cubic yard
dB	decibel
dBA	decibel with A-weighting filter
dB PEAK	Peak sound level
dB SEL_{cum}	cumulative sound exposure level
ESA	Endangered Species Act
◦F	degrees Fahrenheit
Hz	hertz
HVAC	Heating, ventilation, and air conditioning
IHA	Incidental Harassment Authorization
kHz	kilohertz
km	kilometer
km^2	square kilometer
LOA	Letter of Authorization
L_{Eq}	Equivalent sound level
L_{pk} Flat	Flat weighted peak sound level
m	meter
MLLW	mean lower low water
PSO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
Navy	United States Department of the Navy
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PTS	permanent threshold shift

R&D	Research and Development
re 1 µPa	referenced at 1 micropascal
ROI	Region of Influence
RMS	root mean square
sec	second
SEL	sound exposure level
Shipyard	Portsmouth Naval Shipyard
SPL	sound pressure level
TL	transmission loss
TTS	temporary threshold shift
U.S.	United States
WFA	weighting factor adjustment
ZOI	zone of influence

1 INTRODUCTION AND DESCRIPTION OF ACTIVITIES

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals.

1.1 Introduction

Pursuant to the Marine Mammal Protection Act (MMPA) Section 101(a)(5)(D), the United States Navy (Navy) submits this application to National Marine Fisheries Service (NMFS) for an Incidental Harassment Authorization (IHA) for the incidental taking of marine mammal species during construction associated with the proposed expansion and modification of Dry Dock 1 at Portsmouth Naval Ship Yard (the Shipyard) at Kittery, Maine, between October 1, 2019 through September 30, 2020. Additional in-water work may occur prior to the start of the requested IHA time period that is not anticipated to generate noise. 50 Code of Federal Regulations 216.104 sets out 14 specific items that must be included in requests for take pursuant to Section 101(a)(5)(A) of the MMPA; those 14 items are represented by the 14 chapters of this application.

The Navy proposes to expand and modify Dry Dock 1 at the Portsmouth Naval Shipyard (Shipyard) in Kittery, Maine. The Proposed Action would be composed of multiple projects taking place in and adjacent to Dry Dock 1 in the Controlled Industrial Area (CIA) that occupies the western extent of the Shipyard (Figure 1-1). Currently, dimensional limitations impede operations at Dry Dock 1 and subsequent maintenance. The project elements include construction of a super flood basin, extension of portal crane rail and utilities, and construction of two new dry docking positions capable of servicing *Virginia* class (Block I-IV)[1] submarines within the super flood basin. These elements would occur within the same footprint and in close succession.

This IHA application includes all pile driving, and drilling activities associated with the Proposed Action occurring during year 1 of construction as contained in Table 1-1. The project is expected to last 6 years and an application for a Letter of Authorization (LOA) will be prepared for construction years 2-6.

Under the MMPA of 1972, as amended (16 United States Code Section 1371(a)(5)(D)), the Navy is requesting an IHA for impact and vibratory pile driving and rock drilling that is expected to result in the unintentional taking of marine mammals.

The Navy anticipates the project will require 6 years to complete. This IHA is for year 1 in-water construction occurring from October 1, 2019 through September 30, 2020. An LOA will be prepared for construction years 2 through 6. The LOA would address construction impacts for years 2-6 and would include additional construction stressors (i.e. confined blasting) occurring during the construction period. Dates and durations for year 1 construction are described in detail in Chapter 2.

1 A block is a group of submarines with similar design characteristics within a class of submarines.

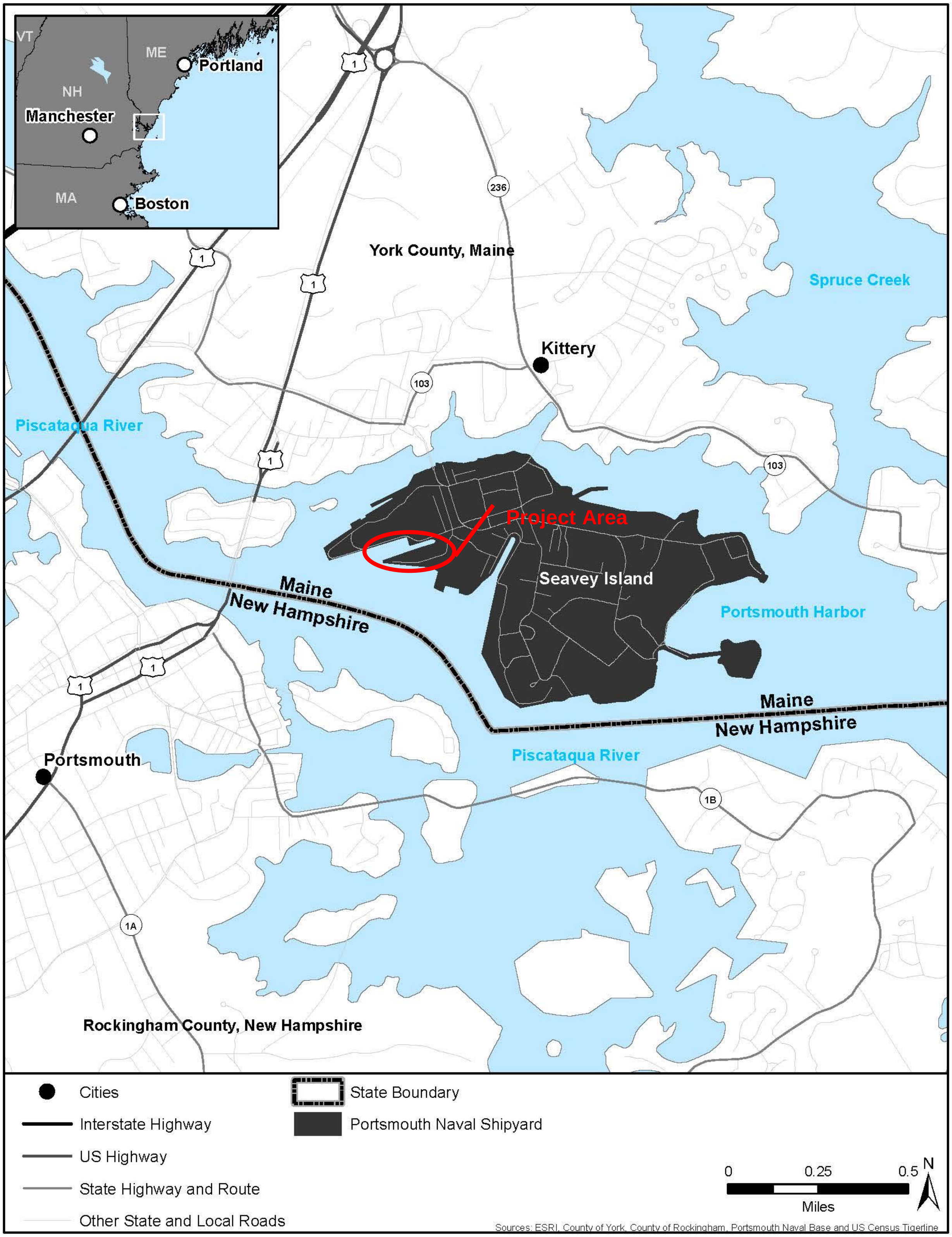

Figure 1-1. Site Location Map for Portsmouth Naval Ship Yard

1.2 Description of Activities

Under the Proposed Action, the expansion and modification would occur as multiple construction projects. Prior to the start of construction, the entrance to Dry Dock 1 would be dredged to previously permitted maintenance dredge limits. Dredging activity at the Shipyard is typically performed using a clamshell dredge. This dredging effort is required to support the projects and additional project related dredging would occur intermittently throughout the Proposed Action. Since dredging and disposal activities would be slow moving and conspicuous to marine mammals, they pose negligible risks of physical injury.

The first project (P-310), would create the super flood basin; the second project (P-1074) would provide additional crane and rail road extensions, increase crane rail capacity, provide a maintenance access tunnel to Dry Dock 1, and provide various utilities; and the third project (P-381) would modify the super flood basin to create two additional dry docking positions capable of servicing *Virginia* class submarines (Figure 1-2). In-water construction for year 1 construction activities would include, pile driving (vibratory and impact) and rock drilling associated with P-310 (construct super flood basin) and P-1074 (utility and Berth 2 improvements). The action would take place in and adjacent to Dry Dock 1 in the CIA occupying the western extent of the Shipyard. Construction activities associated with P-381 (construct dry docking positions) are not anticipated to begin until January 2021; therefore, construction activities associated with P-381 are not discussed further in this IHA application.

1.2.1 P-310

To begin the project, a super flood basin would be created in front of the entrance of Dry Dock 1 by constructing closure walls that span from Berth 1 to Berth 11B (Figure 1-3). The super flood basin would operate like a navigation lock-type structure: artificially raising the elevation of the water within the basin and dry dock above the tidally controlled river in order to lift the submarines to an elevation where they can be safely transferred into the dry dock without the use of buoyancy assist tanks. The super flood basin would be located between Berths 1 and 11 and extend approximately 580 feet from the existing outer seat of the dry dock (approximately 175 feet beyond the waterside end of Berth 1). The super flood basin would consist of three primary components: south closure wall, entrance structure, and west closure wall (see Figure 1-3). The closure wall would be approximately 320 feet long and have an opening for a caisson gate. The Dry Dock 3 caisson would be repurposed for use in the new closure wall. A weir structure or discharge pipe would be built into the closure wall or incorporated into the modified caisson to control over-topping and ensure the super flood elevation, which is the minimum water elevation required to provide sufficient depths and clearance to safely support transit of *Los Angeles* class submarines into Dry Dock 1, through the entire super flood evolution. The gross area of the super flood basin would be approximately 152,000 sf (3.5 acres).

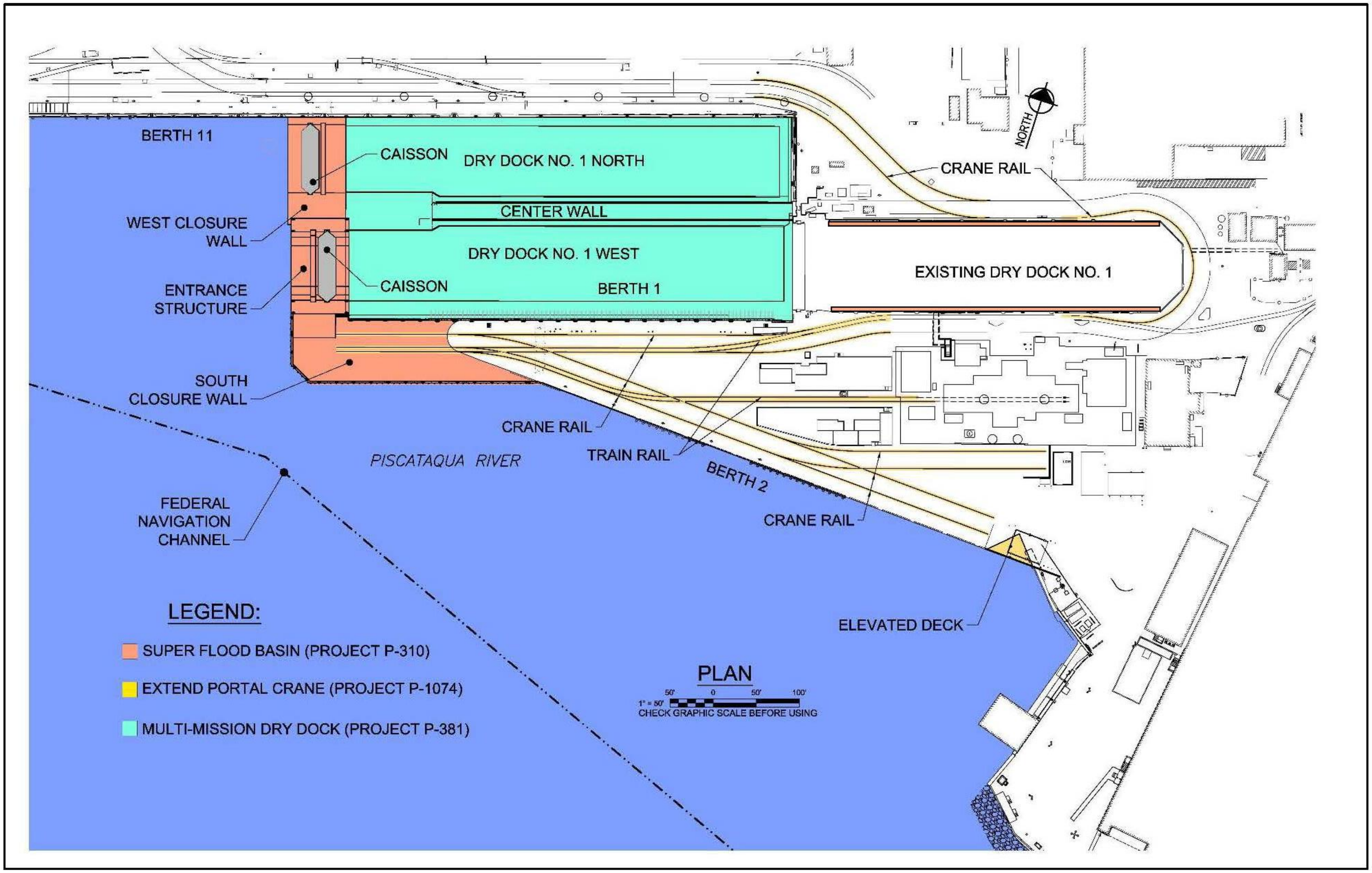

Figure 1-2. General Plan P-310, P-1074 and P-381

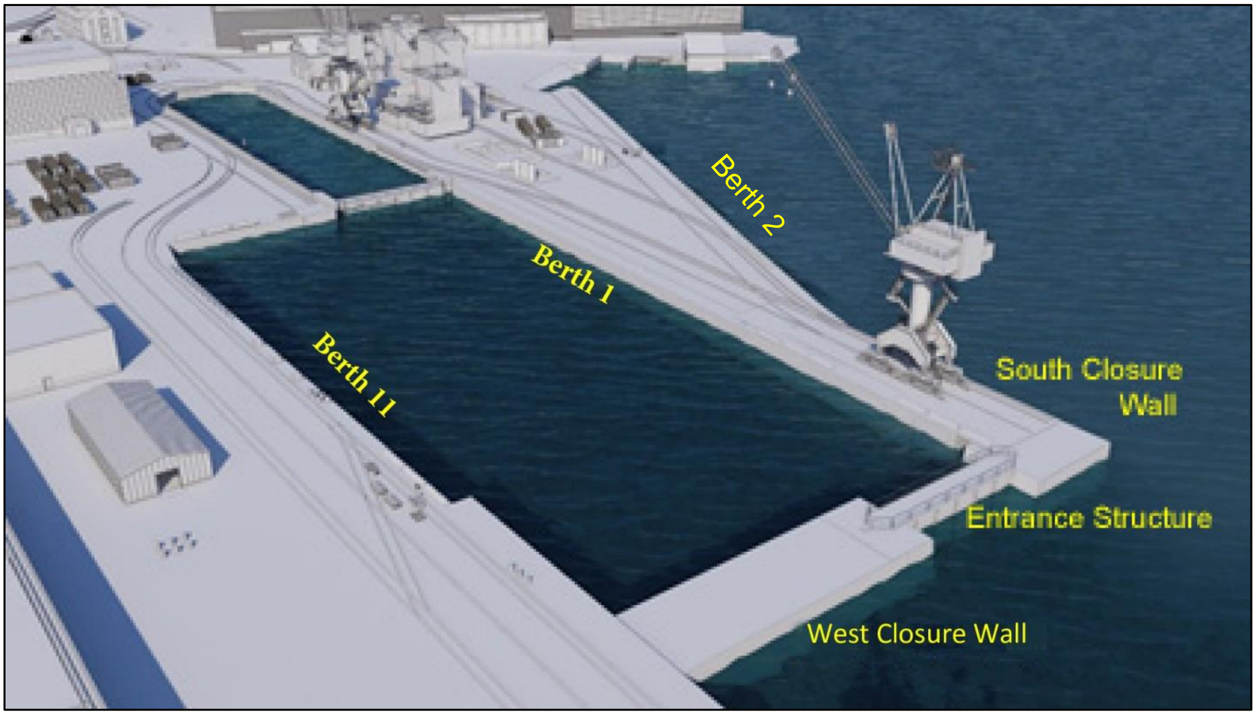

Figure 1-3. Concept Drawing of P-310

Concrete components for the closure walls, caisson seat, and sill would be cast in place or be pre-cast off-site then floated or hauled into place, as appropriate. The closure walls would be equipped with winches and mooring hardware on either side of the basin entrance to assist with vessel docking, and to support berthing of the caisson gate while not in place. Electrical utilities would be provided to support lighting along the closure wall and meet the electrical requirements of the caisson gate. Mooring hardware and electrical utilities would also support the berthing of ships force barges at the south closure wall. Ships force barges are vessels in which a group of sailors live and work during the overhaul. The south closure wall would consist of two, 70-foot diameter sheet pile cells that would be connected together and to the point of Berths 1 and 2 by interconnecting arcs. The sheeting for the two cells would be driven to bedrock to make up the shell of the structure south of the caisson and seat. By installing the sheets to bedrock, the cells would provide a barrier to exfiltration. Each of the cells would be filled with mass concrete and topped with a reinforced concrete cap that would act as the deck to the structure. To provide corrosion protection from the marine environment, a concrete facing would extend down the exterior of the sheets to below mudline. A sacrificial (i.e., does not provide structural support) sheet pile wall would be installed outboard of the structural sheets and would remain for the life of the structure (i.e. permanently).

The west closure wall would consist of parallel sheet pile walls with a tie-back system and is anticipated to be constructed in year 2 of this project. Therefore, impacts to marine mammals resulting from construction would be assessed under the LOA for construction years 2 through 6.

Before the closure walls are constructed, modifications to Berth 1 and Berth 11 (A and B) are required. Improvements along Berth 1 would include driving steel sheet piles to create a bulkhead outboard of the existing quay wall, and placing concrete within the void between the sheet piles and the existing quay wall (Figure 1-4). This sheet pile bulkhead would provide a more impervious façade than the existing granite block quay wall to reduce water exfiltration from within the basin. The sheet pile bulkhead would be equipped with a concrete curb that would increase the height of Berth 1 by approximately 1 ft to an elevation of 15.6 ft above MLLW. To accommodate the super flood elevation improvements along Berth 11 (A and B), bedrock grouting below the bulkhead from the west closure wall to the northwest corner of the basin would be installed to mitigate exfiltration along the berth. The stormwater drainage system at Berth 1 would be rerouted to a new outfall at the east end of Berth 2. The existing storm drain outfalls at Berth 11 that are located within the limits of the basin have valves to prevent backflow of seawater into the storm drain collection system during super flood operations. The storm drain outlet piping would be modified to ensure landside drainage during super flood is accommodated.

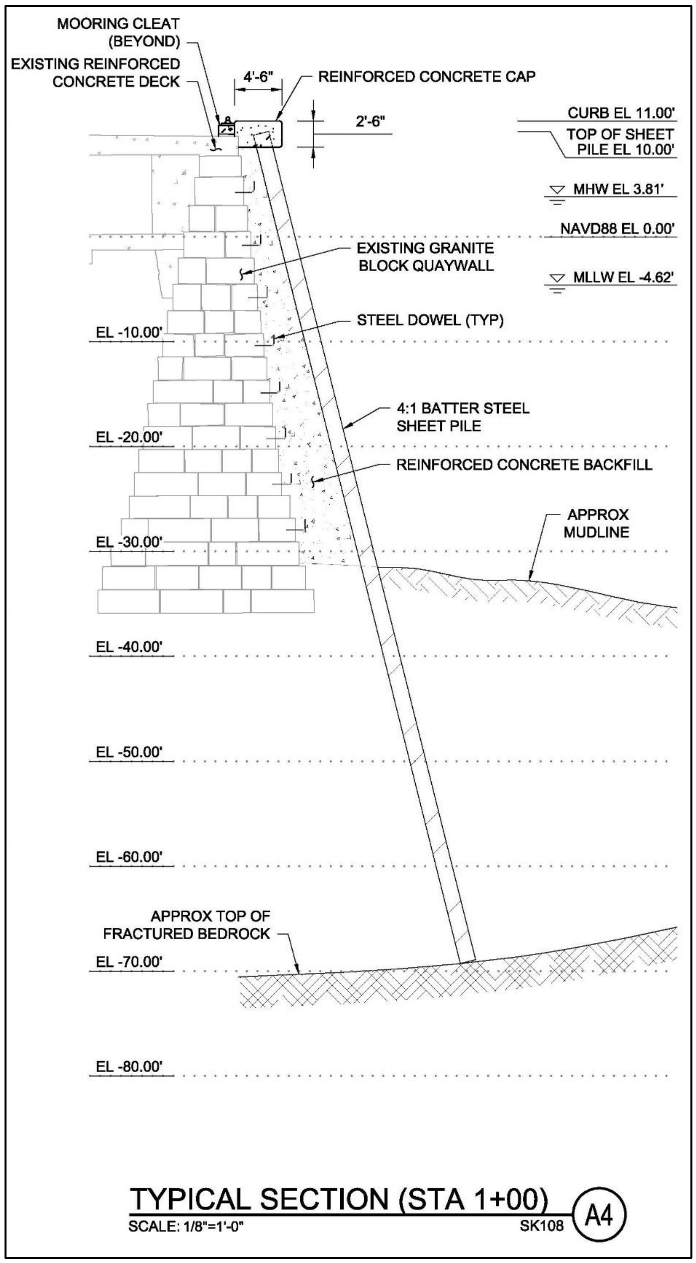

Figure 1-4. P-310 Proposed Berth 1 Modifications

As part of P-310, construction of the basin closure wall would bisect the existing Berth 11B resulting in loss of a fitting-out pier. As a result, Berth 2 would replace Berth 11B for submarine outfitting. To accommodate this function, the existing fender system on Berth 2 would be relocated and expanded to accommodate fitting-out activities on the berth. Approximately 4,000 sf (surface area) of additional fender panel would be required, including 3,550 sf (surface area) below MLLW. The new fender panels would be approximately 6 inches (0.5 ft) thick and their installation below MLLW would result in at total fill volume of approximately 65 cy. No in-water pile driving would be required at Berth 2 to support pier outfitting.

Construction phasing would be required to minimize impacts on critical dry dock operations. Five notional construction phases were identified of which the first three would occur during year 1. This phasing schedule could change due to fleet mission requirements and submarine maintenance schedules. The first phase of construction would occur when a submarine is present and would be limited to site reconnaissance, field measurements, contractor submittals and general mobilization activities. Phase 2 would include construction of the southern closure wall and caisson seat foundation; Berth 1 and Berth 11 (A and B) improvements; Dry Dock 1 utility improvements; and dredging. Upland construction activities would include work on the Dry Dock 1 gallery improvements and commencement of the portal crane rail extension. Phase 3 would include construction of the west closure wall, caisson seat float in, and additional Dry Dock 1 utility gallery improvements. Only the caisson seat float-in portion of Phase 3 would occur during year 1. Six, temporary dolphins, comprised of eight, 14-inch H-Piles, would be installed to assist with float-in and placement of the caisson seat. Overall, construction associated with P-310, Phases 2and 3 are estimated to take approximately 12 months to complete, of which pile driving/extraction/drilling would take 212 days.

1.2.2 P-1074

P-1074 would provide improvements and expansion of the existing portal crane rail and utilities in and around Dry Dock 1 and Berths 1 and 2 and would largely occur landside between Berths 1 and 2 (Figure 1-2). The southeastern corner of Berth 2 would be stabilized through installation of a pile-supported, reinforced concrete, elevated deck located landside of the existing granite block wall. The elevated deck would extend across a notch in the granite wall. In-water work associated with this project would include installation of eight micropiles with a 16-inch dual second casing to support the elevated deck. The outer casing would be driven to refusal and the micropiles would be drilled inside the outer casing (Figure 1-5).

1.3 Estimated Construction Schedule

Table 1-1 provides the estimated construction schedule for year 1 construction P-310 and P-1074. Because of mission requirements and operational schedules at the dry docking positions and berths, these schedules are subject to change.

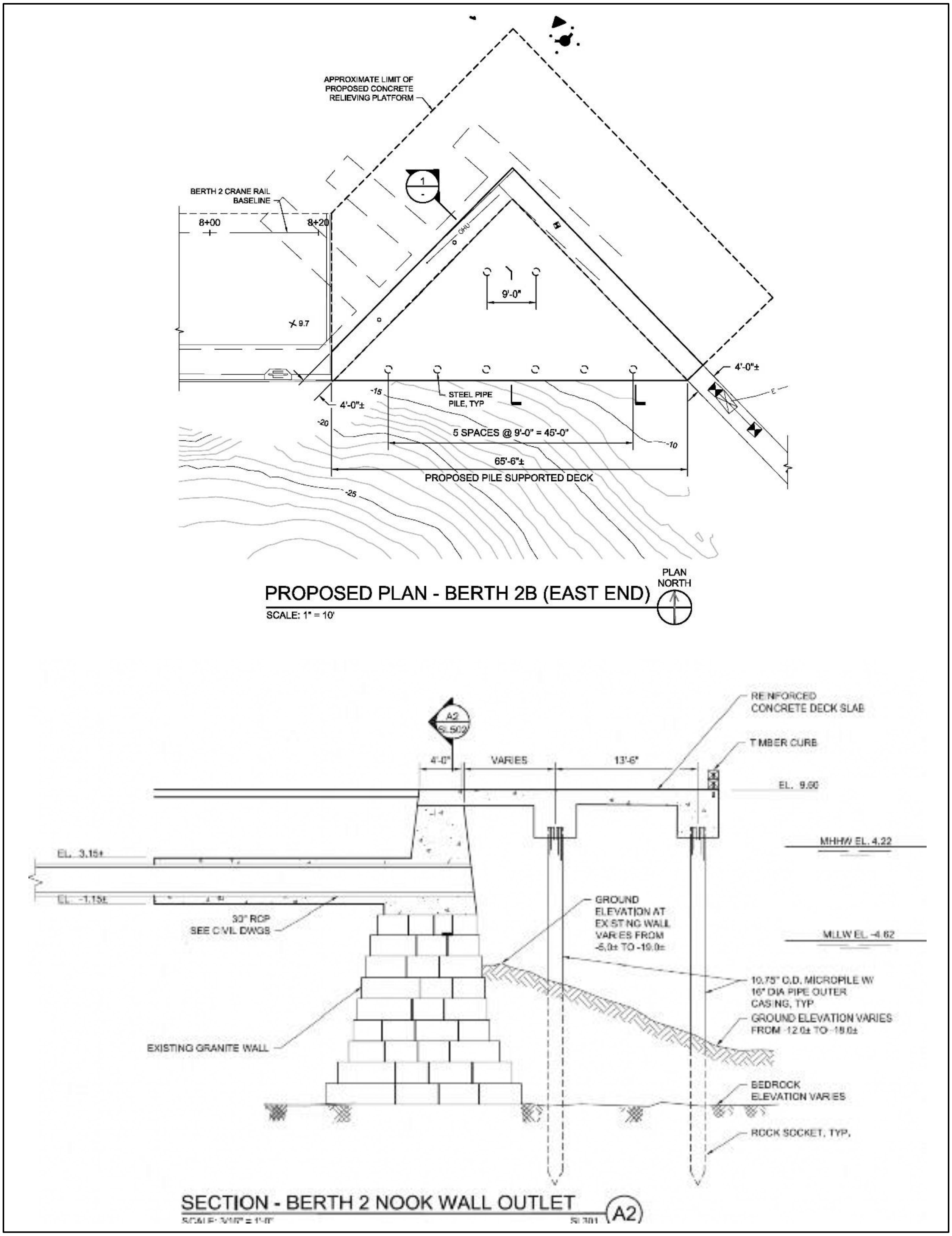

Figure 1-5. P-1074 Relieving Platform Construction Details

Table 1-1. Preliminary Estimated In-Water Construction Schedule

Project	*Task*	*Estimated Construction Start*	*Estimated Construction End*	*Key Project Components*
P-310: Phase 1	Mobilization, reconnaissance, field measurements	July 2019	August 2019	Key Project Component – No in-water work
P-310: Phase 2	Dredging	July 2019	Aug 2019	6,700 cy
	Falsework for south closure wall	Oct 2019	Jan 2020	32 Steel H-shaped piles (14-inch)
	Sheetpile wall along Berth 1	Oct 2019	April 2020	320 Z-shaped steel sheet piles (2-foot)
	South closure wall cells	Oct 2019	Jan 2020	310 Flat web steel sheet piles (1.5-foot)
	Dredging of Closure Wall footprint	Sept 2019	Dec 2019	20,000 cy
	Berth 1 and 2 closure combi-wall	Jan 2020	March 2020	52 Z-shaped steel sheet pile (2-foot) and 17 Steel H-Piles (14 inch)
	South closure wall façade	Dec 2019	Feb 2020	145 Z-shaped steel sheet piles (2-foot)
	Caisson seat foundation	March 2020	Aug 2020	10 Drilled shafts (8-foot diameter steel pipe casing); 135 Z-shaped steel sheet piles (2-foot)
	Dredging of Berth 1 and rudder pit	Feb 2020	March 2020	4,000 cy
P-310: Phase 3	Caisson Seat Float-in	May 2020	Sept 2020	Temporary dolphins - 48 piles, 36-inch steel pipe
P-1074	Elevated deck	April 2020	July 2020	Eight, 16-inch diameter steel pipe piles

1.3.1 Pile Installation

Three types of piles are proposed to be used for the construction of the super flood basin; AZ sheet piles, steel pipe piles, and steel H-piles[2]. The majority of piles would be AZ sheet piles, which are approximately 2-feet wide, roughly Z-shaped steel piles with interlocking edges installed adjacent to each other to create a wall. Circular pipe piles are round steel piles up to 36 inches in diameter. Pipe piles are typically used individually as a base for a structure or clustered together in a configuration called a dolphin used for berthing a ship. Steel H-piles are solid steel piles that are shaped like the letter "H". From a pile driving noise perspective, sheet piles have less contact area and drive easier than larger round pipe piles or H-piles resulting in lower noise levels for sheet piles when compared to pipe or H-piles.

Pile installation would occur using barge mounted cranes equipped with both vibratory and impact hammers. Piles would be installed initially using vibratory means and then finished with impact hammers, if necessary. Impact hammers would also be used to push obstructions out of the way and where sediment conditions do not permit the efficient use of vibratory hammers.

2 Flat sheet piles are formed in circles and arcs to create gravity cells. The cells are held together through the tensile strength of the interlock.

Vibratory hammers are routinely used to install piles when permitted by the sediment type. Vibratory hammers typically produce lower source levels of noise than impact hammers, and they can be considered as an alternative to impact hammers in order to reduce underwater sound during construction activities (ICF Jones and Strokes and Illingworth and Rodkin, Inc. 2012). They are considered a non-impulsive noise source as the hammer continuously drives the pile into the substrate. A vibratory hammer operates by using counterweights that spin to create a vibration. The vibration of the hammer causes the pile to vibrate at a high speed. The vibrating pile then causes the soil underneath it to "liquefy" and allow the pile to move easily into or out of the sediment. A model of vibratory hammer likely to be used for the project is the MKT vibratory hammer.

Impact hammers are the most common pile driving method used to install piles of various sizes (ICF Jones and Strokes and Illingworth and Rodkin, Inc. 2012). Impact hammers typically produce greater source levels of noise than vibratory hammers and are an impulsive noise source. Impact pile drivers are piston-type drivers that use various means to lift a piston (ignition, hydraulics, or steam) to a desired height and drop the piston (via gravity) against the head of the pile in order to drive it into the substrate. The size and type of impact driver used depend on the energy needed to drive a certain type of pile in various substrates to the necessary depth. The magnitude and characteristics of underwater noise generated by a pile strike depend on the energy of the strike and the pile size and composition. A model of impact hammer that may be used for the project is the APE D36-26 impact hammer. It is assumed that the piles installed for this project would be set with a vibratory hammer and then finished with an impact hammer in order to reach bearing depth or to have the required load-bearing capacity if installed using vibratory methods only.

Impact hammers would utilize soft start techniques to minimize noise impacts in the water column. The Navy does not yet know what type/size of impact hammers would be used to complete the work. For purposes of this analysis, underwater noise was modeled without accounting for potential noise minimization measures.

1.3.2 Drilling

Drilling is considered an intermittent, non-impulsive noise source, similar to vibratory pile driving. Very little information is available regarding source levels for in-water drilling activities associated with nearshore pile installation. Dazey et al. (2012) attempted to characterize the source levels of several marine pile-drilling activities. One such activity was auger drilling (including installation and removal of the associated steel casing). Recent in-water construction noise monitoring conducted at the Shipyard during improvements to Berth 11 recorded noise levels for drilling with a rock bit and drilling with an augur to be 140.3 decibel (dB) root mean square (RMS) and 149.3 dB RMS, respectively. Maine DOT (2013) reported on sound pressure levels from drilled shaft installations for the Sarah Mildred Long Bridge replacement project in the Piscataqua River. Sound levels on that project were determined to be 100 dB at 5 ft below the water surface 150 ft from the sound source, and 105 dB at 10 ft below the water surface 30 ft from the sound source. Maine DOT (2013) also reported on underwater sound levels caused by geotechnical drills as a surrogate for a typical drilled shaft drill. Estimated sound levels for underwater geotechnical drills were reported to range from 118 to 145 dB peak (approximately 120 db SEL and 130 dB RMS) at 1 m from the source, with noise levels decreasing to about 101 dB by 150 m from the source. The drilling apparatus utilized would vary depending on the different applications during in-water construction activities. Based on the examples provided, it is generally assumed that drilling would produce less in-water noise than both impact and vibratory pile driving.

For the 8-foot shafts, a socket drill would be used to bore to bedrock and excavate a socket. The casings would then be lowered into the socket and grouted in place. The socket drill would operate within a casing that would contain sediments disturbed during drilling and act as a barrier to noise. Sediment and bedrock excavated during drilling would be disposed of at an approved landfill facility off of the Shipyard.

2 DATES, DURATION, AND LOCATION OF ACTIVITIES

The dates and duration of such activity and the specific geographical region where it will occur.

2.1 Dates and Duration of Activities

Construction activities are expected to begin in June 2019 and proceed to completion in January 2025. Year 1 in-water construction activities expected to result in incidental takes of marine mammals would occur for 212 days over a period of approximately 12 consecutive months of the project beginning in October 2019. For year 1, all work will be limited to daylight construction. Pile driving (vibratory as well as impact), drilling, and vibratory extraction will only be conducted during daylight hours.

Table 2-1 summarizes the in-water demolition and construction activities included in this request for incidental take authorization and reflects the current pile driving and drilling durations for Year 1. Table 2-1 updates the previous information that was used in the work plan (Table 1 of Appendix A). These activities are scheduled to take place during the timeframe covered by this IHA application. Pile installation not completed during the first year would be included in a separate LOA application. Impact and vibratory hammers would be used to install piles. Where bedrock is present, a rock drill would be used. The type/size of impact hammer used to complete the work would be determined by the contractor selected to perform the work.

Table 2-1. Pile Driving and Drilling Durations for Year 1

Activity	*Pile Purpose*	*Pile Count*	*Pile Type and Size*	*Method of Install*	*Piles Installed/ Extracted per day/Shafts Drilled*	*Total Pile Driving Days*
Pre-construction /Falsework	Temporary Structure for South closure wall	Oct 2019-Jan 2020 32 piles (cell and connector cell wall ring forms)	14-inch Steel HP	Impact with initial vibratory set	2 / day	16 days
P310 Super Flood Basin[1]	Sheet Pile Wall along Berth 1	Oct 2019-April 2020 320 piles	24-inch Z-shaped steel sheet piles	Impact with initial vibratory set	12 (24 linear feet (lf) / day)	27 days
	South Closure Wall Construction	Oct 2019-Jan 2020 310 piles (South closure wall cells)	Flat web steel sheet piles (1.5 ft)	Impact with initial vibratory set	12 (18 lf/day)	31 days
		Removal of temporary structure Dec 2019-Jan 2020 32 piles (cell and connector cell wall ring forms)	14-inch steel HP	Vibratory extraction	8 / day	4 days
		Jan 2020-Mar 2020 52 sheet piles (Berth 1 and 2 closure)	Z-shaped steel sheet piles (2-ft)	Impact with initial vibratory set	12 (24 lf/day) –	5 days
		Jan 2020-Mar 2020 17 piles (combi-wall)	14-inch steel HP	Impact with initial vibratory set	1/day	17 days

Table 2-1. Pile Driving and Drilling Durations for Year 1

Activity	***Pile Purpose***	***Pile Count***	***Pile Type and Size***	***Method of Install***	***Piles Installed/ Extracted per day/Shafts Drilled***	***Total Pile Driving Days***
P310 Super Flood Basin[1] (Cont.)	South Closure Wall Construction	Dec 2019-Feb 2020 145 piles (South closure wall façade sheeting formwork)	Z-shaped steel sheet piles (2-ft width for south wall)	Impact with initial vibratory set	12 (24 lf/day)	12 days
		Mar 2020-Aug 2020 135 piles (sheet pile cutoff wall)	Z-shaped steel sheet piles (2-ft) will surround 10 drilled shafts	Impact with initial vibratory set	12 (24 lf/day)	12 days
		Mar 2020- Aug 2020 10 drilled shafts	8-ft diameter steel pipe casing	drilling (rock)	Less than 1 pipe casing installed/ day and 1 shaft drilled in 2 days	32 days
	Caisson Seat Float-in	May 2020-Sept 2020 48 piles (8 entrance structure float-in temporary dolphins with 6 piles each)	Steel (conservative estimate = 3-ft diameter)	Impact with initial vibratory set	1/day	48 days
P1074 Extension of Portal Crane Rail and Utilities	Elevated Deck Support	Apr 2020-July 2020 8 piles	16-inch steel pipe	Impact with initial vibratory set	1 / day	8 days
Total Piles Installed/Shafts Drilled		1,067[2]/10				
Total Days of Pile Installation/Extraction/Drilling						212

Source: Appledore Marine Engineering, LLC 2018 This information reflects the current pile driving and drilling durations for year 1 and has been revised since the approval of the work plan presented in Appendix A.

Notes:

1- Maximum vibratory pile driving duration in a day would be approximately 3 hours for pile install associated with the P310 Super flood basin (Appledore Marine Engineering LLC 2018).

2 – Note that 32 of these piles will be removed at the conclusion of south closure wall construction.

Pile-driving days are not necessarily consecutive and certain activities may occur at the same time, decreasing the total number of pile-driving days. The contractor could be working in more than one area of the berths at a time. Sound source verification of each activity will be conducted both individually and if activities occur simultaneously (see Chapter 13). It is not possible to predict if and/or how often work will occur simultaneously. This is simply a reference which may occur as construction schedule allows. The annual report required as part of the permit will include the information on days of duration of overlap.

2.2 Project Location Description

The Shipyard is located in the Piscataqua River in Kittery, Maine. The Piscataqua River originates at the boundary of Dover, New Hampshire, and Elliot, Maine. The river flows in a southeasterly direction for 13 miles before entering Portsmouth Harbor and emptying into the Atlantic Ocean. The lower Piscataqua River is part of the Great Bay Estuary system and varies in width and depth. Many large and small islands break up the straight-line flow of the river as it continues toward the Atlantic Ocean. Seavey Island, the location of the Proposed Action, is located in the lower Piscataqua River approximately 547 yards from its southwest bank, 219 yards from its north bank, and approximately 2.5 miles from the mouth of the river.

2.2.1 Bathymetric Setting

Water depths in the proposed project area range from 21 feet to 39 feet at Berths 11, 12, and 13. Water depths in the lower Piscataqua River near the proposed project area range from 15 feet in the shallowest areas to 69 feet in the deepest areas. The river is approximately 3,300 feet wide near the proposed project area, measured from the Kittery shoreline north of Wattlebury Island to the Portsmouth shoreline west of Peirce Island. The furthest direct line of sight from the proposed project area would be 0.8 mile to the southeast and 0.26 mile to the northwest.

2.2.2 Tides, Circulation, Temperature, and Salinity

The tides in the Piscataqua River are semi-diurnal, with two high tides and two low tides per day. The tidal range between low and high tides in the Piscataqua River near Portsmouth Harbor is about 7 feet to 8 feet (NOAA n.d.). The tidal flow in the lower portion of the river is rather strong, with currents ranging from 5 to 10 knots (5.8 to 11. 5 miles per hour [mph]) (Garman and Harris 1995). Tidal waters from the Atlantic Ocean enter the Great Bay Estuary through the Portsmouth River mouth at high tide (Jones 2000), flooding the three major portions of the estuary, the Piscataqua River, Little Bay, and Great Bay. Efforts have begun to model the hydrodynamics and current flow patterns in the Great Bay Estuary as part of an effort to develop modeling capabilities for simulating hydrodynamic flows in estuaries with intertidal areas, but the Great Bay model has not yet been field-verified (Jones 2000).

Water temperature varies with season, ranging between 33 degrees Fahrenheit (°F) and 42°F in the winter/spring months, and between 48°F and 66°F in the summer/fall months (NERACOOS n.d.). The salinity in the vicinity of the proposed project area is considered that of sea water, 25 parts per thousand (ppt) and greater (NOAA 1985).

2.2.3 Substrates and Habitats

The nearshore environment of the Shipyard is characterized by a mix of hardbottom, gravel, soft sediments, rock outcrops, and rocky shoreline associated with fast tidal currents near the installation. The nearshore areas surrounding Seavey Island are predominately hardbottom (65 percent of benthic habitat) and gravel (26 percent) habitat, with only 9 percent soft bottom sediments within the surveyed area around Seavey Island (Tetra Tech 2016). Much of the shoreline in the proposed project area is composed of hard shores (rocky intertidal). In general, rocky intertidal areas consist of bedrock that alternates between marine and terrestrial habitats, depending on the tide (Department of the Navy 2013). Rocky intertidal areas consist of “bedrock, stones, or boulders that singly or in combination cover 75 percent or more of an area that is covered less than 30 percent by vegetation” (Navy 2013). The existing pier and hardened shoreline at the Shipyard provide substrate for the growth of algae and invertebrates.

2.2.4 Ambient Sound

2.2.4.1 Underwater Sound

The lower Piscataqua River is home to Portsmouth Harbor and is used by commercial, recreational, and military vessels. Between 150 and 250 commercial shipping vessels transit the lower Piscataqua River each year (Magnusson et al. June 2012). Commercial fishing vessels are also very common in the river year-round, as are recreational vessels, which are more common in the warmer summer months.

The ambient underwater soundscape refers to noise that already exists in the environment prior to the introduction of another noise-generating activity. Ambient underwater sound can originate from a number of sources that are both natural and manmade. Natural sources of ambient sound include biological sources, such as various marine species, and physical sources, such as wind, waves, and rain (Richardson et al. 1995). Human-generated sound sources can include vessel noise (i.e., commercial shipping/container vessels), seismic air guns, and marine construction (i.e., pile driving or drilling).

Understanding the overall impact that the introduction of additional noise could have on the marine mammals present in the area requires knowing the background noise of an area. If background noise levels from vessels and other non-impulsive sources in the vicinity of the project exceed those of the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service threshold for behavioral disturbance from non-impulsive sources, i.e., 120 dB or greater, then marine mammals would not be affected by any sound less than the existing dominant noise levels. In that case, the threshold for behavioral disturbance is equal to the ambient sound level. For example, if the background ambient noise levels average 140 dB, then additional sounds less than 140 dB would not expose animals to harassing levels of noise, and the relevant threshold for behavioral disturbance becomes 140 dB.

Thirteen underwater acoustic recordings were logged in 2017 with sensors placed in depths of 15 feet (4.5 m) within the security fencing area of the Shipyard Berth 11. Recordings ranged from a 140 dB to 161.3 dB peak sound pressure level (SPL) and from 128.2 dB to 133.8 dB RMS SPL. Conditions at which the recordings were made were with little wind and near peak tidal flow. A mean SPL of 131 dB RMS was evenly distributed within the security fencing area and is consistent with observations made at other locations near the Shipyard and documented background sound levels in estuarine or tidal locations (Hydrosonic LLC 2017a). Due to the close proximity to the shipyard that measurements were recorded, ambient underwater noise levels further into the navigation channel are likely to be within the 120 dB range. Therefore, for purposes of this analysis, ambient underwater noise in the project area is considered to be 120 dB RMS.

2.1.1.1 Airborne Sound

The Shipyard is a dynamic industrial facility situated on an island with a narrow separation of waterways between the installation and the communities of Kittery and Portsmouth. The predominant noise sources from Shipyard industrial operations consist of dry dock cranes; passing vessels; and industrial equipment (e.g., forklifts, loaders, rigs, vacuums, fans, dust collectors, blower belts, heating, air conditioning, and ventilation [HVAC] units, water pumps, and exhaust tubes and lids). Other components such as construction, vessel ground support equipment for maintenance purposes, vessel traffic across the Piscataqua River, and vehicle traffic on the Shipyard's bridges and on local roads in Kittery and Portsmouth produce noise, but such noise generally represents a transitory contribution to the average noise level environment (Blue Ridge Research and Consulting [BRRC] 2015; ESS Group 2014).

Ambient sound levels recorded at the Shipyard are considered typical of a large outdoor industrial facility and vary widely in space and time (ESS Group 2015). Table 2-2 summarizes in-air sound exposure and the average ambient sound levels were recorded at Berth 11 in 2014 during normal operations (morning and afternoon hours), as well as the predominant operational and natural sound sources identified. Note that these levels are referenced to 20 micropascals (µPa), the appropriate reference for in-air sound measurements and are "A-weighted". Environmental noise measurements are usually on an "A-weighted" scale that filters out very low and very high frequencies in order to replicate human sensitivity. They differ from most of the sound levels that will appear in the rest of the document, which are referenced to 1 µPa, the appropriate reference for in-water sound measurements.

Table 2-2. In-Air Sound Exposure Levels and Average Ambient Sound Levels Recorded at Berth 11

Measurement Location	***Sound Exposure Level (SEL dBA re 20 µPa)***		***Equivalent Sound Level (L_{eq} dBA re 20 µPa)***		***Predominant Sources***
	Morning	***Afternoon***	***Morning***	***Afternoon***	
Berth 11	100.4	94.0	69.6	63.2	Operational source: trucks and forklifts passing by, drilling rig, circular saw noise, passing boats, front-end loaders passing by. Natural sources: wind noise and seagulls.

Source: ESS Group 2014; BRRC 2015.

Key:

dBA = A-weighted decibel

L_{eq} = Equivalent sound level. L_{eq} is the continuous sound level that would be present if all the variations in sound occurring over a specified time period had the same total sound energy. It correlates reasonably well with the effects of noise on people, even for wide variations in environmental sound levels and time patterns.

SEL = Sound exposure level. It provides a measure of total sound energy of an acoustic event. It is commonly used for describing sound from passing vehicles

re 20 µPa = referenced at 1 micropascal

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3 MARINE MAMMAL SPECIES AND NUMBERS

The species and numbers of marine mammals likely to be found within the activity area.

Pinnipeds and cetaceans occur within the region but only five species (harbor porpoise, harbor seal, gray seal, hooded seal, and harp seal) have been documented within the vicinity of the Shipyard (Table 3-1). These species are not listed under the Endangered Species Act (ESA) but all are protected under the MMPA.

Table 3-1 lists the species that may occur within the vicinity of the Shipyard and estimated densities as well as season of occurrence within the proposed project area. Section 3.1 provides a description of each of the species and their population abundance. Chapter 4 contains life history information for each species.

Table 3-1. Marine Mammals Potentially Present in Piscataqua River in the Vicinity of the Shipyard

Species and Stock	***Stock Abundance***	***Relative Occurrence in Gulf of Maine***	***Season(s) of Occurrence***	***Density in the Project Area (species/km²)***
Harbor porpoise (*Phocoena phocoena*) Gulf of Maine/Bay of Fundy	79,883 (CV = 0.32)[1]	Occasional	Spring to Summer (March – June)	0.04[4]
Harbor seal (*Phoca vitulina vitulina*) Western North Atlantic	75,834 (CV = 0.15)[2]	Common	Year-round	2.48 [4]
Gray seal (*Halichoerus grypus*) Western North Atlantic	505,000 (95% CI = 329,000 – 682,000)[3]	Common	Year-round	0.20[4]
Hooded seal *(Crystphora cristata)* Western North Atlantic stock	592,100[5]	Rare	Winter to Spring (January-May)	0[7]
Harp seal *(Pagophilus groenlandicus)* Western North Atlantic stock	7,100,000[6]	Rare	Winter to Spring (January – May)	0[7]

Key: CV = coefficient of variation; CI = confidence interval
Sources:
1- Palka 2012, as presented in Hayes et al. 2017
2- Waring et al. 2015
3- DFO 2014, as presented in Hayes et al. 2017 (model based estimates derived from pup surveys)
4- CIANBRO 2018a,b
5- Waring et al. 2007. The population estimate for the Western North Atlantic hooded seal population was not updated in Hayes et al. 2017.
6- Waring et al. 2014
7- Density data are taken from the Navy Marine Species Density Database

For species that regularly occur in the Piscataqua River, but do not have site-specific abundances, marine mammal density estimates were derived from the Berth 11 Waterfront Improvements

Construction project monitoring and used to determine the number of animals potentially exposed in a Zone of Influence (ZOI) on any one day of pile driving, extraction, or drilling. This method was used for harbor seal and gray seal. Although harbor porpoise is less likely to frequent the river than the harbor seal and gray seal, harbor porpoise sightings (although few) were recorded in the project area during Berth 11 Waterfront Improvements construction monitoring and thus the same method for density determination for harbor and gray seal was applied for harbor porpoise.

Density data for the hooded seal and harp seal are taken from the Navy Marine Species Density Database. These data are generally used for broad-scale offshore activities; however, due to a lack of any other data for these two species within the general project area, these data are presented as the best available data for the Piscataqua River.

3.1 Species Abundance

3.1.1 Harbor Porpoise

Shipboard and aerial surveys for the Gulf of Maine/Bay of Fundy harbor porpoise stock were conducted from June through August 2011 (Palka 2012 as reported in Hayes et al. 2017). The aerial survey portion took place approximately 5,313 kilometers (km) along the waters north of New Jersey from the coastline to the 100-meter (m) depth contour through the U.S and Canadian Gulf of Maine and up to and including the lower Bay of Fundy. The shipboard portion of the survey covered 3,107 km of area along the offshore waters of central Virginia to Massachusetts, within deeper waters than the 100-m depth contour out to beyond the U.S. Exclusive Economic Zone). A concurrent survey conducted within the waters between Virginia and central Florida did not record any observations of harbor porpoise. The best current abundance estimate of the Gulf of Maine/Bay of Fundy harbor porpoise stock is from this 2011 survey is 79,883 (CV = 0.32) (Hayes et al. 2017).

3.1.2 Harbor Seal

The most recent survey conducted was in 2012 within Coastal Maine and southern New England (Waring et al. 2015). The previous survey (conducted in 2001) observed count was 99,340 harbor seals and the 2012 observed count was 75,834. Although the latest count was 24 percent lower than the previous survey in 2001, Waring et al. (2015) did not consider the population to be declining as pup counts recorded at 23,722 (CV = 0.096) and 23,830 (CV = 0.159) for 2001 and 2012, respectively, were not significantly different. Seal abundance and distribution is uncertain in the northeastern U.S and much of the data did not cover the center of the population of Maine. Hence, it was likely there were non-pups in the population that were outside the study area and not included in the count (Hayes et al. 2017). The overall best current abundance estimate for harbor seals is 75,834 (CV = 0.15) from the 2012 survey (Waring et al. 2015).

3.1.3 Gray Seal

The western North Atlantic stock gray seal is equivalent to the eastern Canada population and ranges from New Jersey to Labrador. In the mid-1980s, small numbers of animals and pupping was observed on several islands along the Maine coast and in Massachusetts. NMFS initiated aerial surveys in December 2001 to monitor gray seal pup production on Muskeget Island and adjacent sites in Nantucket Sound, and Green and Seal Islands off the coast of Maine. Through genetic tissue sampling, this stock in the U.S. comes from recolonized Canadian gray seals. Present data are insufficient to calculate the minimum population estimate in U.S. waters. The population estimate is the best available science and is based on modeling of the total Canadian gray seal population which is estimated to be 505,000 (95% CI = 29,000 – 682,000; DFO 2014) (Hayes et al. 2017).

3.1.4 Hooded Seal

The hooded seal occurs throughout the North Atlantic and Arctic Oceans. Hooded seal population estimates are produced from whelping pack surveys of which there are three whelping areas in the Northwest Atlantic. Hooded seal pup production was estimated at 25,000 to 32,000 annually between 1966 and 1977. Pup production continued to show an increase and based on a 1990 survey it was suggested that production increased by 5 percent annually since 1984. The last update to population estimates for western North Atlantic hooded seals was in 2005 at an estimate of 592,100 (Waring et al. 2007).

3.1.5 Harp Seal

The harp seal occurs throughout the North Atlantic and Arctic Oceans. Abundance estimates for the western North Atlantic stock are based on years of aerial surveys and mark-recaptures methods. Population numbers are estimated by surveying the whelping concentrations and estimating total population adult numbers from pup production. Calculated population estimates based on these methods have showed a steady increase from 5.5 million in 2000 to 10.8 million in 2010. The latest population data available is from 2012 in which a population model was applied to population estimates from 1952-2012 and resulted in 7.1 million animals (Waring et al. 2014).

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4 AFFECTED SPECIES STATUS AND DISTRIBUTION

A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities.

4.1 Harbor Porpoise

4.1.1 Status and Management

The harbor porpoise is a member of the family Phocoenidae. Adult harbor porpoises range from 5 to 5.5 feet in length and can weigh up to 170 pounds. They are a toothed whale species and can be recognized by their small, robust, dark gray body with grayish-white sides, triangular dorsal fin, and short rostrum. Harbor porpoises are considered sexually dimorphic, with females being slightly larger than males (NOAA 2015a).

Based on genetic analysis, it is assumed that harbor porpoises in the U.S. and Canadian waters are divided into four populations, as follows: 1) Gulf of St. Lawrence; 2) Newfoundland; 3) Greenland; and 4) Gulf of Maine/Bay of Fundy (NMFS 2017). For management purposes in U.S. waters, harbor porpoises have been divided into 10 stocks along both the East and West Coasts. Harbor porpoise are protected under the MMPA, but not listed under the ESA.

4.1.2 Distribution

Harbor porpoises are found commonly in coastal and offshore waters of both the Atlantic and Pacific Oceans. In the western North Atlantic, the species is found in both U.S. and Canadian waters. More specifically, the species can be found between West Greenland and Cape Hatteras, North Carolina (NOAA 2015a). Of those 10 stocks that occur in U.S. waters, only one, the Gulf of Maine/Bay of Fundy stock, is found along the U.S. East Coast, and thus only individuals from this stock could be found in the proposed project area. The species is primarily found over the Continental Shelf in waters less than approximately 500 feet deep (Hayes et al. 2017). In general, the species is commonly found in bays, estuaries, and harbors (NOAA 2015a).

4.1.3 Site-Specific Occurrence

Marine mammal monitoring was conducted during the Berth 11 Waterfront Improvements project from April 2017 through December 2017 (Cianbro 2018a) and January through December 2018 (Cianbro 2018b, 2019). A total of five harbor porpoise were observed traveling quickly through the river channel and past the proposed project area; three in 2017 and two in 2018 (Cianbro 2018b).

4.2 Harbor Seal

4.2.1 Status and Management

Harbor seals are members of the true seal family Phocidae. Adults are sexually dimorphic and males are generally larger than females. Adult harbor seals can reach up to 6.3 feet in length and weigh up to 245 pounds. As with other phocids, harbor seals lack external ear flaps, and their rear flippers do not rotate. Harbor seals are commonly a blue-gray color on their back with a speckling of both light and darker colors; however, their coloration may vary. Their concave, dog-like snout and their “banana-like” position while hauled out aids in their identification (NOAA 2016). Harbor seals are protected under the MMPA, but not listed under the ESA.

4.2.2 Distribution

Harbor seals can be found in nearshore waters along both the North Atlantic and North Pacific coasts, generally at latitudes above 30°North (Burns 2009). In the western Atlantic Ocean, the harbor seal's range extends from the eastern Canadian Arctic to New York; however, they can be found as far south as the Carolinas (Waring et al. 2015). In New England, the species can be found in coastal waters year-round (Waring et al. 2015). Overall, there are five recognized subspecies of harbor seal, two of which occur in the Atlantic Ocean. The western Atlantic harbor seal (*Phoca vitulina vitulina*) is the subspecies likely to occur in the proposed project area. There is some uncertainly about the overall population stock structure of harbor seals in the western North Atlantic Ocean. However, it is theorized that harbor seals along the eastern U.S. and Canada are all from a single population (Temte et al. 1991).

4.2.3 Site-Specific Occurrence

Harbor seals are the most abundant pinniped in the Piscataqua River. There were 200 harbor seals observed within the proposed project area between the months of April and December 2017 and 249 were observed between January and December 2018 during the Berth 11 Waterfront Improvements project (Cianbro 2018a, 2019). The primary behaviors observed during monitoring were milling (diving) that occurred almost 60 percent of the time followed by swimming and traveling by the proposed project area at 29 percent and 12 percent, respectively (Cianbro 2018a). Marine mammal surveys were conducted for one day of each month in 2017 (NAVFAC Mid-Atlantic 2018). Harbor seals were observed throughout the year and did not show any seasonality in their presence. A high frequency of seals was documented near the proposed project area. Seals frequent the river in general as the majority of harbor seals occur along the Maine coast with a large portion of them hauling out at the Isles of Shoals (Figure 4-1). Pupping season for harbor seals is May to June. No harbor seal pups were observed during the surveys as pupping sites are north of Maine-New Hampshire border (Waring et al. 2016).

4.3 Gray Seal

4.3.1 Status and Management

Gray seals, which are also members of the "true seal" family (Phocidae), are a coastal species that generally remains within the Continental Shelf region. However, they do venture into deeper water, as they have been known to dive up to 1,560 feet to capture prey during feeding. Gray seals primarily feed on fish, squid, various crustacean species, and octopus. Adult gray seals are sexually dimorphic, with males generally being larger than females. Adult males can reach up to 10 feet in length and weigh up to 880 pounds. Adult females can reach up to 7.5 feet in length and can weigh up to 550 pounds. As a true seal, this species lacks external ear flaps, and its rear flippers do not rotate. Depending on its geographic location and sex, gray seal appearance and coloration varies. Adult females have a silver-gray coat with darker spots scattered over their body, and while males generally have similar color patterns, they have a prominent, long-arched nose (NOAA 2015b).

Gray seals can be found on both sides of the North Atlantic. Within this area, Gray seals are split into three primary populations: 1) eastern Canada, 2) northwestern Europe, and 3) the Baltic Sea (Katona et al. 1993). Gray seals are protected under the MMPA, but are not listed under the ESA.

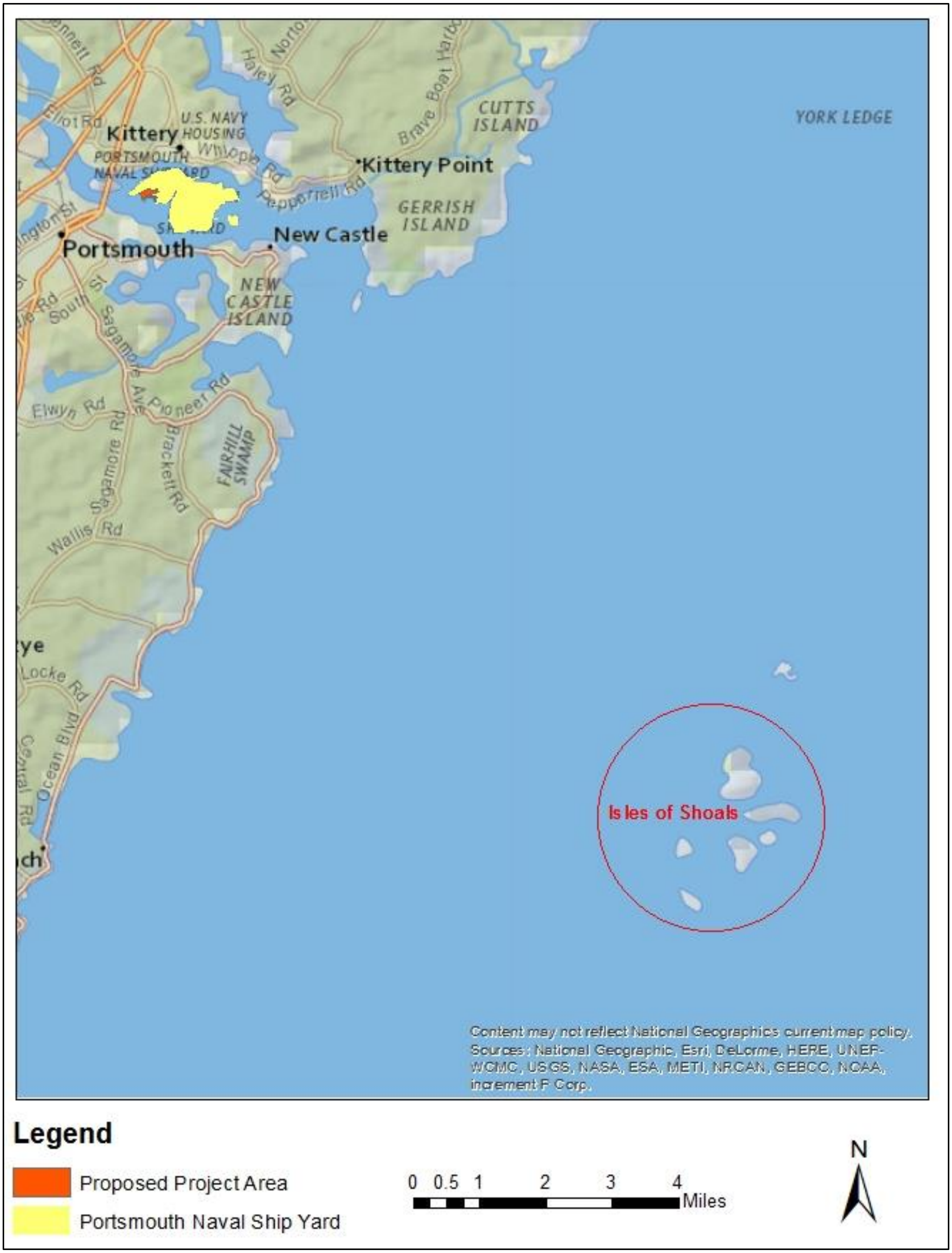

Figure 4-1. Location of Isles of Shoals Relative to Portsmouth Naval Ship Yard

4.3.2 Distribution

Gray seals within U.S. waters are considered the western North Atlantic stock and are expected to be part of the eastern Canadian population. In U.S. waters, year-round breeding of approximately 400 animals has been documented on areas of outer Cape Cod and Mukeget Island in Massachusetts. In general, this species can be found year-round in the coastal waters of the Gulf of Maine (Hayes et al. 2017).

4.3.3 Site-Specific Occurrence

There were 25 gray seals observed within the proposed project area between the months of April and December 2017 (Cianbro 2018a) and 12 observed during the months of January through December 2018 (Cianbro 2019). The primary behavior observed during surveys was milling at just over 60 percent of the time followed by swimming within and traveling through the proposed project area. Only approximately 5 percent of the time were gray seals observed foraging (Cianbro 2018a). Monthly marine mammal surveys also took place during 2017 and recorded six sightings of gray seal (NAVFAC Mid-Atlantic 2018). Pupping season for gray seals is December through February. No gray seal pups were observed during the surveys as pupping sites for gray seals (like harbor seals) are north of Maine-New Hampshire border (Waring et al. 2016).

4.4 Hooded Seal

4.4.1 Status and Management

Hooded seals are also members of the true seal family (Phocidae) and are generally found in deeper waters or on drifting pack ice. Similar to both the gray seal and harbor seal, hooded seals are also sexually dimorphic. Males are generally much larger than females, reaching up to 8 feet in length and weighing approximately 660 pounds. Females generally reach up to 7 feet in length and weigh up to 440 pounds. Adult hooded seals are a silver-gray color with dark marks in varying sizes and shapes on their coats. They also have a distinctive block-shaped head. As with other true seal species, hooded seals lack external ear flaps, and their rear flippers do not rotate (NOAA 2015c).

The world population of hooded seals has been divided into three stocks, which coincide with specific breeding areas, as follows: 1) Northwest Atlantic, 2) Greenland Sea, and 3) White Sea (Waring et al. 2007). Hooded seals are protected under the MMPA, but are not listed under the ESA.

4.4.2 Distribution

The hooded seal is a highly migratory species, and its range can extend from the Canadian Arctic to Puerto Rico. In U.S. waters, the species has an increasing presence in the coastal waters between Maine and Florida (Waring et al. 2007). In the U.S., they are considered members of the western North Atlantic stock and generally occur in New England waters from January through May and further south in the summer and fall seasons (Waring et al. 2007).

4.4.3 Site-Specific Occurrence

Hooded seals are known to occur in the Piscataqua River; however, they are not as abundant as the more commonly observed harbor seal. Anecdotal sighting information indicates that two hooded seals were observed from the Shipyard in August 2009, but no other observations have been recorded (Trefry November 20, 2015). Hooded seals were not observed during marine mammal monitoring or survey events that took place in 2017 and 2018 (Cianbro 2018a,b; NAVFAC Mid-Atlantic 2018; Lamontagne 2018, personal communication).

4.5 Harp Seal

4.5.1 Status and Management

Harp seals are also members of the true seal family. Unlike the gray seal, harbor seal, and hooded seal, harp seals exhibit little sexual dimorphism. Males are generally only slightly larger than females, reaching up to 6 feet in length and weighing approximately 300 pounds. Females generally reach up to 5 feet in length and weigh up to 290 pounds. Adult harp seals are a light-gray color with black faces and a horseshoe-shaped black saddle on their back. They also have a distinctive block-shaped head. As with other true seal species, harp seals lack external ear flaps, and their rear flippers do not rotate (NOAA 2015d).

Harp seals are classified into three stocks, which coincide with specific pupping sites on pack ice. These pupping sites are as follows: 1) Eastern Canada, including the areas off the coast of Newfoundland and Labrador and the area near the Magdalen Islands in the Gulf of St. Lawrence; 2) the West Ice off eastern Greenland, and 3) the ice in the White Sea off the coast of Russia (Waring et al. 2014). Harp seals are protected under the MMPA, but are not listed under the ESA.

4.5.2 Distribution

The harp seal is a highly migratory species, and its range can extend from the Canadian Arctic to New Jersey. In U.S. waters, the species has an increasing presence in the coastal waters between Maine and New Jersey (Waring et al. 2014). In the U.S., they are considered members of the western North Atlantic stock and generally occur in New England waters from January through May (Waring et al. 2014). The observed influx of harp seals and geographic distribution in New England to mid-Atlantic waters is based primarily on strandings and secondarily on fishery bycatch.

4.5.3 Site-Specific Occurrence

Harp seals are known to occur in the Piscataqua River; however, they are not as abundant as the more commonly observed harbor seal and were last documented in the river in 2016 (NAVFAC Mid-Atlantic 2016; 81 FR 52614). Harp seals were not observed during marine mammal monitoring or survey events that took place in 2017 and 2018 (Cianbro 2018a,b; Cianbro 2019; NAVFAC Mid-Atlantic 2018; Lamontagne 2018, personal communication).

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5 TAKE AUTHORIZATION REQUESTED

The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment, injury and/or death), and the method of incidental taking.

5.1 Take Authorization Request

Under Section 101 (a)(5)(D) of the MMPA, the Navy requests an IHA for the incidental take of marine mammals by harassment as described within this application during proposed modification and expansion of Dry Dock 1 at the Shipyard in Kittery, Maine. As described in detail in Chapter 6, the Navy requests an IHA for the incidental take of marine mammals listed in Table 5-1 for a period of 1 year from October 1, 2019, to September 30, 2020:

Table 5-1. Total Underwater Exposure Estimates by Species

Species	*Level A*[1]	*Level B*
Harbor porpoise	5	8
Harbor seal	287	396
Gray seal	24	33
Hooded seal[2]	0	5
Harp seal[2]	0	5

Notes:
1- Maximum potential numbers;
2- To guard against unauthorized take, assume take of 1/month of construction from January 2020 through May 2020 when these species may occur (NMFS 2018c).

Except with respect to certain activities not pertinent here, the MMPA defines ''harassment'' as:

any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment] (50 CFR, Part 216, Subpart A, Section 216.3-Definitions).

5.2 Method of Incidental Taking

This authorization request considers noise from vibratory and impact pile installation and drilling as outlined in Chapters 1 and 2 that has the potential to disturb or displace marine mammals or produce a temporary shift in their hearing ability (temporary threshold shift) resulting in Level B harassment as defined above. Impact pile driving of steel piles has the potential to produce a permanent shift in the ability of seals to hear, resulting in Level A harassment. Level A harassment will be minimized to the extent practicable given the methods of installation and measures designed to minimize the possibility of injury to marine mammals that are presented below.

- Vibratory pile drivers will be the primary method of steel pile installation. Vibratory pile drivers also have relatively low sound levels (<180 dB re 1 micropascal [µPa] at 10 m) and are not expected to cause injury to marine mammals.

- Drilling will be required to create shafts for accommodating 8-ft diameter steel pipe casing. Sound from drilling activities is consistent with the low levels creating by vibratory pile drivers and is also not expected to cause injury to marine mammals.
- All pile driving will either not start or be halted if marine mammals approach the Level A injury zone (“shutdown zone”).

Construction associated with the Dry Dock 1 expansion is not anticipated to affect the prey base or significantly affect other habitat features of marine mammals that would meet the definition of take. See Chapter 11 for more details on the impact reduction and mitigation measures proposed.

6 NUMBERS AND SPECIES EXPOSED

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in Section 5, and the number of times such takings by each type of taking are likely to occur.

6.1 Introduction

The NMFS application for IHAs requires applicants to determine the number of marine mammals that are expected to be incidentally harassed by an action and the nature of the harassment (Level A or Level B). Section 5 defines MMPA Level A and Level B harassment. This section presents how these definitions informed the quantitative acoustic analysis methodologies used to assess the potential for the Proposed Action to affect marine mammals during the first year of activities.

The construction activities for the modification and expansion of Dry Dock 1 project outlined in Sections 1 and 2 have the potential to result in Level A and Level B exposure from noise produced by in-water pile driving, extraction, and drilling. Other construction activities (i.e. dredging, upland construction, utility improvements) are not expected to result in takes as defined under the MMPA.

In-water pile driving will temporarily increase the local underwater and airborne noise levels in the vicinity of the proposed project area. Research suggests that increased noise may impact marine mammals in several ways and depends on many factors. This is discussed in more detail in Chapter 7. Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic source and the potential effects that sound may have on the physiology and behavior of that marine mammal. Although it is known that sound is important for marine mammal communication, navigation, and foraging (National Research Council, 2003, 2005), there are many unknowns in assessing impacts, such as the potential interaction of different effects and the significance of responses by marine mammals to sound exposures (Nowacek et al., 2007; Southall et al., 2007). Furthermore, many other factors besides the received level of sound may affect an animal's reaction, such as the animal's physical condition, prior experience with the sound, and proximity to the source of the sound.

Vibratory pile driving/extraction described in Chapter 1 of this application is expected to result in Level A exposure of marine mammals as defined under the MMPA but the noise-related impacts discussed in this application may result in Level B harassment from vibratory pile driving activities. Impact pile driving could result in Level A and Level B exposure of marine mammals as defined under the MMPA. The methods for estimating the number and types of exposure are summarized below.

Exposure of each species was determined by:

- Estimating the area of impact where noise levels exceed acoustic thresholds for marine mammals (Sections 6.7 and 6.8);
- Evaluating potential presence of each species at the Shipyard based on site-specific surveys and monitoring as outlined in Section 6.10; and
- Estimating potential harassment exposures by multiplying the density or site-specific abundance, as applicable, of each marine mammal species calculated in the area of impact by their probable duration during construction (Section 6.12).

Each of the three items above is discussed in the following sections.

6.2 Description of Noise Sources

Ambient sound is a composite of sounds from multiple sources, including environmental events, biological sources, and anthropogenic activities. Physical noise sources include waves at the surface, precipitation, earthquakes, ice, and atmospheric noise, among other events. Biological sources include marine mammals, fish, and invertebrates. Anthropogenic sounds are produced by vessels (small and large), dredging, aircraft overflights, and construction activities. Known noise levels and frequency ranges associated with anthropogenic sources similar to those that would be used for this project are summarized in Table 6-1. Details of each of the sources are described in the following text.

Table 6-1. Representative Levels of Underwater Anthropogenic Noise Sources

Noise Source	*Frequency Range (Hz)*	*Source Level*	*Reference*
Dredging	1-500	161–186 dB RMS re 1 µPa at 1 m	Richardson et al., 1995; DEFRA, 2003; Reine et al., 2014
Small vessels	860–8,000	141–175 dB RMS re 1 µPa at 1 m	Galli et al., 2003; Matzner and Jones, 2011; Sebastianutto et al., 2011
Large ship	20-1,000	176–186 dB re 1 μPa^2sec SEL at 1 m	McKenna, 2011
Tug docking gravel barge	200–1,000	149 dB RMS at 100 m	Blackwell and Greene, 2002

Key: dB = decibel; Hz = hertz; m = meter; re 1 µPa = reference at 1 micropascal; RMS = root mean square; SEL = sound exposure level; sec = second

In-water construction activities associated with the proposed projects include impact and vibratory pile driving as well as drilling. The sounds produced by these activities fall into two sound types: impulsive and non-impulsive (defined below). Impact pile driving produces impulsive sounds, while vibratory pile driving produces non-impulsive sounds. The distinction between these two general sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing (Ward, 1997).

Impulsive sounds (e.g., explosions, seismic airgun pulses, and impact pile driving), which are referred to as pulsed sounds in Southall et al. (2007), are brief, broadband, atonal transients (Harris, 1998) and occur either as isolated events or repeated in some succession (Southall et al., 2007). Impulsive sounds are characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures (Southall et al., 2007). Impulsive sounds generally have a greater capacity to induce physical injury compared with sounds that lack these features (Southall et al., 2007).

Non-impulsive sounds (referred to as non-pulsed in Southall et al., 2007) can be tonal, broadband, or both. They lack the rapid rise time and can have longer durations than impulsive sounds. Non-impulsive sounds can be either intermittent or continuous. Examples of non-impulsive sounds include vessels, aircraft, and machinery operations such as drilling, dredging, and vibratory pile driving (Southall et al., 2007).

In some environments, the duration of both impulsive and non-impulsive sounds can be extended due to reverberations.

6.3 Vocalizations and Hearing of Marine Mammals

All marine mammals that have been studied can produce sounds and use sounds to forage, orient, detect, and respond to predators, and facilitate social interactions (Richardson et al., 1995). Measurements of marine mammal sound production and hearing capabilities provide some basis for assessing whether exposure to a particular sound source may affect a marine mammal behaviorally or physiologically. Marine mammal hearing abilities are quantified using live animals either via behavioral audiometry or electrophysiology (see Schusterman, 1981; Au, 1993; Wartzok and Ketten, 1999; Nachtigall et al., 2007). Behavioral audiograms, which are plots of animals' exhibited hearing threshold versus frequency, are obtained from captive, trained live animals using standard testing procedures with appropriate controls and are considered to be a more accurate representation of a subject's hearing abilities. Behavioral audiograms of marine mammals are difficult to obtain because many species are too large, too rare, and too difficult to acquire and maintain for experiments in captivity. Consequently, our understanding of a species' hearing ability may be based on the behavioral audiogram of a single individual or small group of animals. In addition, captive animals may be exposed to local ambient sounds and other environmental factors that may impact their hearing abilities and may not accurately reflect the hearing abilities of free-swimming animals.

For animals not available in captive or stranded settings (including large whales and rare species), estimates of hearing capabilities are based on anatomical and physiological structures, the frequency range of the species' vocalizations, and extrapolations from related species.

Electrophysiological audiometry measures small electrical voltages produced by neural activity when the auditory system is stimulated by sound. The technique is relatively fast, does not require a conscious response, and is routinely used to assess the hearing of newborn humans. It has recently been adapted for use on non-humans, including marine mammals (Dolphin, 2000). For both methods of evaluating hearing ability, hearing response in relation to frequency is a generalized U-shaped curve or audiogram showing the frequency range of best sensitivity (lowest hearing threshold) and frequencies above and below with higher threshold values.

NMFS reviewed studies of hearing sensitivity of marine mammals and developed thresholds for use as guidance when assessing the effects of anthropogenic sound on marine mammals based on measured or estimated hearing ranges (NMFS, 2016a). The guidance places marine mammals into the following functional hearing groups based on their generalized hearing sensitivities: high-frequency cetaceans, mid-frequency cetaceans, low-frequency cetaceans (mysticetes), otariid pinnipeds (sea lions and fur seals), and phocid pinnipeds (true seals). Table 6-2 provides sound production and hearing capabilities for marine mammal species that are assessed in this application.

Table 6-2. Hearing and Vocalization Ranges for Marine Mammal Functional Hearing Groups in Piscataqua River, Maine

Functional Hearing Group	*Relevant Species*	*Functional Hearing Range [1]*
High-frequency cetaceans	Harbor porpoise	275 Hz to 160 kHz
Phocid pinnipeds	Harbor seal, gray seal, Hooded seal, Harp seal	In-water: 50 Hz to 86 kHz In-air: 75 Hz to 30 kHz

Key: Hz = Hertz; kHz = kilohertz

Notes: In-water hearing data from NMFS, 2016a. In-air data from Schusterman, 1981; Hemilä et al., 2006; Southall et al., 2007.

6.4 Sound Exposure Criteria and Thresholds

Under the MMPA, NMFS has defined levels of harassment for marine mammals. Level A harassment is defined as, “Any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild.” Level B harassment is defined as, “Any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding, or sheltering.”

To date, no studies have been conducted that examine impacts to marine mammals from pile driving sounds from which empirical noise thresholds have been established. Currently, NMFS uses underwater sound exposure thresholds to determine when an activity could result in impacts to a marine mammal defined as Level A (injury) or Level B (disturbance including behavioral and temporary threshold shift) harassment (NMFS, 2016) (Table 6-3).

NMFS (2016) equates the onset of permanent threshold shift (PTS), which is a form of auditory injury, with Level A harassment under the MMPA and “harm” under the ESA and has developed acoustic threshold levels for determining the onset of PTS in marine mammals exposed to underwater impulsive and non-impulsive sound sources. The Level A criteria use cumulative SEL metrics (dB SEL_{CUM}) and peak pressure (dB PEAK) rather than the previously used dB RMS metric. Level B harassment is considered to occur when marine mammals are exposed to impulsive underwater sounds > 160 dB RMS re 1 µPa from impact pile driving and to non-impulsive underwater sounds >120 dB RMS re 1 µPa (NMFS, 2005). The onset of temporary hearing threshold shift (TTS) is a form of Level B harassment under the MMPA and “harassment” under the ESA. All forms of harassment, either auditory or behavioral, constitute “incidental take” under these statutes.

NMFS uses generic sound exposure thresholds to determine when an activity in the ocean that produces airborne sound might result in impacts to a marine mammal (70 FR 1871). Construction-period airborne noise would have little impact to cetaceans because noise from airborne sources would not transmit as well underwater (Richardson et al., 1995); thus, noise would primarily be a problem for hauled-out pinnipeds near the project location. NMFS has identified behavioral harassment threshold criteria for airborne noise generated by pile driving for pinnipeds regulated under the MMPA. Level A injury threshold criteria for airborne noise have not been established. The Level B behavioral harassment threshold for harbor seals is 90 dB RMS re 20 µPa (unweighted) and for other pinnipeds except harbor seals is 100 dB RMS re 20 µPa (unweighted).

6.5 Limitations of Existing Noise Criteria

The application of the 120 dB RMS re 1 µPa behavioral threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. The 120 dB RMS re 1 µPa threshold level for non-impulsive noise originated from research conducted by Malme et al. (1984, 1988) for California gray whale response to continuous industrial sounds such as drilling operations.

Table 6-3. Injury and Disturbance Threshold Criteria for Underwater and Airborne Noise

Marine Mammal Hearing Group	*Underwater*					*Airborne*
	Impulsive (i.e., Impact Pile Driving)			*Non-Impulsive, Continuous (i.e., Vibratory Pile Driving)*		*(Impact and Vibratory Pile Driving)*[2]
	L_{pk}, flat (re 1 µPa)	*L_E, SELcum (24-hr) (1 µPa²s)*	*Impulsive (1 µPa)*	*SELcum (24-hr) (1 µPa²s)*	*Non-impulsive (1 µPa)*	*(re 20 µPa) RMS*
	Level A PTS Onset Threshold (weighted)[1]		*Level B Disturbance Threshold (Unweighted)*	*Level A PTS Onset (Weighted)*[1]	*Level B Disturbance Threshold (Unweighted)*	*Level B Disturbance Guideline (haulout)*[3]
High-frequency cetaceans (true porpoises)	202 dB	155 dB	160 dB	173 dB	120 dB	NA
Phocid pinnipeds (true seals)	218 dB	185 dB	160 dB	201 dB	120 dB	90 dB/100 dB[4] (unweighted)

Notes:

L_{pk} flat - The subscript "flat" indicates peak sound pressure should be flat weighted or unweighted within the generalized hearing group.

L_E - cumulative sound exposure and indicating designated marine mammal auditory weighting function is for the recommended accumulation period of 24 hours.

1- Values being presented as the threshold are only the values for the species group's best hearing sensitivity because it is frequency weighted. These are frequency weighted thresholds determined from the minimum value of the exposure function and the weighting function at its peak (i.e., area of best sensitivity; equivalent to K+C)

2- Airborne disturbance thresholds not specific to pile driver type.

3- Sound level at which pinniped haulout disturbance has been documented. This is not considered an official threshold, but is used as a guideline.

4- 90 dB RMS re 20 µPa (unweighted) for harbor seals; 100 dB RMS re 20 µPa (unweighted) for pinnipeds except harbor seals.

Sources: NMFS 2009, 2016a.

To date, there is little research or data supporting a response by pinnipeds or odontocetes to non-impulsive sounds from vibratory pile driving as low as the 120 dB threshold. The threshold is based on indirect evidence from studies of gray whale responses to playbacks of industrial noise conducted in the 1980s (NMFS, 2018). Southall et al. (2007) reviewed studies conducted to document behavioral responses of harbor seals and northern elephant seals to non-impulsive sounds under various conditions and concluded that those limited studies suggest that exposures between 90 dB and 140 dB RMS re 1 µPa generally do not appear to induce strong behavioral responses. A more recent observational study found evidence of weak but statistically significant avoidance behavior of bottlenose dolphins (*Tursiops truncatus*) and harbor porpoises in response to estimated received levels of 99-132 dB re 1µPa²s during vibratory pile driving (Graham et al., 2017). Branstetter et al. (2018) tested for the effects of vibratory pile driver noise on bottlenose dolphin echolocation by exposing penned dolphins to playback recordings at source levels of 110, 120, 130, and 140 dB re 1µPa, respectively. They found evidence of altered behavior (an almost complete cessation of echolocation clicks) only at the highest source level, for which the received level was roughly estimated as 128 dB re 1µPa. The effect on behavior diminished significantly, indicating acclimation, as the animals resumed echolocation during subsequent replications.

6.6 Auditory Masking

Natural and artificial sounds can disrupt behavior through auditory masking or interference with a marine mammal's ability to detect and interpret other relevant sounds, such as communication and echolocation signals (Wartzok et al., 2004). Masking occurs when both the signal and masking sound have similar frequencies and either overlap or occur very close to each other in time. A signal is very likely to be masked if the noise is within a certain "critical bandwidth" around the signal's frequency and its energy level is similar or higher (Holt, 2008). Noise within the critical band of a marine mammal signal will show increased interference with detection of the signal as the level of the noise increases (Wartzok et al., 2004). For example, in delphinid subjects, relevant signals needed to be 17 to 20 dB louder than masking noise at frequencies below 1 kHz to be detected and 40 dB greater at approximately 100 kHz (Richardson et al., 1995). Noise at frequencies outside of a signal's critical bandwidth will have little to no effect on the detection of that signal (Wartzok et al., 2004).

Additional factors influencing masking are the temporal structure of the noise and the behavioral and environmental context in which the signal is produced. Continuous noise is more likely to mask signals than is intermittent noise of the same amplitude; quiet "gaps" in the intermittent noise allow detection of signals that would not be heard during continuous noise (Brumm and Slabbekoorn, 2005). The behavioral function of a vocalization (e.g., contact call, group cohesion vocalization, echolocation click, etc.) and the acoustic environment at the time of signaling may both influence call source level (Holt et al., 2011), which directly affects the chances that a signal will be masked (Nemeth and Brumm, 2010). Miksis-Olds and Tyack (2009) showed that during increased noise, manatees modified vocalizations differently depending on whether or not a calf was present.

Masking noise from anthropogenic sources could cause behavioral changes if it disrupts communication, echolocation, or other hearing-dependent behaviors. As noted above, noise frequency and amplitude both contribute to the potential for vocalization masking; noise from pile driving typically covers a frequency range of 10 Hz to 1.5 kHz, which is likely to overlap the frequencies of vocalizations produced by species that may occur in the proposed project area. Amplitude of noise from both impact and vibratory pile driving methods is variable and may exceed that of marine mammal vocalizations within an unknown range of each incident pile. Depending on the animal's location and vocalization source level, this range may vary over time.

Although sound pressure levels from impact pile driving are greater, the zone of potential masking effects from vibratory pile driving may be as large or greater due to the duration and continuous nature of vibratory pile driving. The potential for masking differs between species, depending on the overlap between pile driving noise and the animals' hearing and vocalization frequencies. In this respect, harbor porpoises, which use high-frequency sound, are probably less vulnerable to masking from pile driving than are seals. In addition, harbor porpoise that may be subject to masking are transitory within the vicinity of the proposed project area. The animals most likely to be at risk for vocalization masking are resident pinnipeds (harbor seals and gray seals around local haulout areas). Animals will often compensate for increasing noise levels by increasing the signal level, repetition rate, duration, or changing the frequency, of their vocalizations, a phenomenon termed the "Lombard effect" (Hotchkin and Parks, 2013). Possible behavioral reactions to vocalization masking include changes to vocal behavior (including cessation of calling), habitat abandonment (long- or short-term), and modifications to the acoustic structure of vocalizations (which may help signalers compensate for masking) (Brumm and Slabbekoorn, 2005; Brumm and Zollinger, 2011). The extent to which the animals' behaviors would mitigate the potential for masking is uncertain, and, accordingly, the Navy has estimated that masking as well as compensatory behavioral responses are likely within the zones of behavioral harassment estimated for vibratory and impact pile driving.

6.7 Modeling Potential Noise Impacts from Pile Driving

6.7.1 Underwater Sound Propagation

Pile driving will generate underwater noise that potentially could result in disturbance to marine mammals swimming by the proposed project area. Transmission loss (TL) underwater is the decrease in acoustic intensity as an acoustic pressure wave propagates out from a source until the source becomes indistinguishable from ambient sound. TL parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water depth, water chemistry, and bottom composition and topography. A “Practical Spreading” value of 15 (referred to as “practical spreading loss”) is widely used for intermediate or spatially varying conditions when actual values for transmission loss are unknown. This value was used to model the estimated range from pile driving activity to various expected SPLs at potential project structures. This model follows a geometric propagation loss based on the distance from the driven pile, resulting in a 4.5 dB reduction in level for each doubling of distance from the source. In this model, the SPL at some distance away from the source (e.g., driven pile) is governed by a measured source level, minus the TL of the energy as it dissipates with distance. The TL equation is:

$$TL = 15\log_{10}\left(\frac{R_1}{R_2}\right)$$

where

TL is the transmission loss in dB,

R_1 is the distance of the modeled SPL from the driven pile, and

R_2 is the distance from the driven pile of the initial measurement.

The TL model described above was used to calculate the expected noise propagation from both impact and vibratory pile driving, using representative source levels to estimate the zone of influence (ZOI) or area exceeding the noise criteria. The extent of representative ZOIs are depicted in Figures 6-1 through 6-6 based on a pile furthest from the shore, illustrating the maximum ZOI that would be produced from pile driving. This TL model simplifies the estimation of ZOIs, but it should be recognized that noise propagation away from the source will be influenced by a variety of factors, especially bathymetry and the presence or absence of reflective or absorptive conditions, including the sea surface and sediment type.

6.7.2 Underwater Noise from Pile Driving

The intensity of pile driving sound is greatly influenced by factors such as the type of piles, type of driver, and the physical environment in which the activity takes place. To estimate sound source levels for any of the proposed construction elements, acoustic monitoring results from past projects conducted at the Shipyard and associated monitoring reports were reviewed as well as projects that are most similar to the Proposed Action in terms of type and size of pile, method of installation, and substrate conditions. The evaluation is presented in the approved work plan contained in Appendix A, and the representative SPLs used in the analysis are presented in Table 6-4. It should be noted that several design changes have occurred between the time when the work plan was completed and the IHA was prepared. Therefore, several discrepancies occur between the two documents, particularly in regards to project phasing and P-

381 design elements. However, the pile sizes, SPLs and other pertinent data remain consistent, especially for year 1 activities.

For the analyses that follow, the TL model described above was used to calculate the maximum (where uninterrupted by the shoreline) distances to the Level A and Level B Harassment thresholds for each activity within the region of influence (ROI) for underwater noise (Figure 6-1), starting from representative source levels (Table 6-4). The study area (or ROI) is the extent of effects from underwater noise from the Proposed Action on the environment. Within the ROI, the ZOI is the extent of noise impacts identified for each individual activity used to evaluate noise effects to marine mammals. To calculate the maximum distances to Level A (PTS onset) thresholds associated with each particular source, NMFS' (2016, updated in 2018b) Technical Guidance was followed and the Optional User Spreadsheet (NMFS, 2018c) was used. The Technical Guidance provides Level A (PTS onset) thresholds and auditory weighting functions for each marine mammal hearing group, whereas the Spreadsheet contains default weighting factor adjustments (WFAs) for different types of broadband sources. The WFAs assign a single frequency to represent the sound spectrum of the source, approximating what the animal is exposed to. The WFA frequency, when applied to the auditory weighting function of the group, determines what adjustment is made to the source level prior to calculating the threshold distance.

Table 6-4. Underwater Noise Source Levels Modeled for Impact and Vibratory Pile Driving/Drilling

Pile Type	*Installation Method*	*Pile Diameter*	*Peak (dB re 1 µPa)*	*RMS (dB re 1 µPa)*	*SEL (dB re 1 µPa² sec)*
Steel pipe	Vibratory	36-inch	NA	175	175
	Impact	36-inch	209	198	183
	Vibratory	16-inch	NA	162	162
	Impact	16-inch	182	163	158
Steel H	Vibratory	14-inch	NA	158	158
	Impact	14-inch	194	177	162
AZ Steel Sheet	Vibratory	24-inch	NA	163	163
	Impact	24-inch	205	190	180
Casing	Drilling	96-inch	NA	166.2	166.2

Sources: United States Navy 2015; CALTRANS 2015; Jasco 2012

Notes: All SPLs are unattenuated; dB=decibels; NA = Not applicable; the SPL for vibratory install of 14-inch piles was also used for modeling vibratory extraction of that pile type; single strike SEL are the proxy sources levels presented for impact pile driving and were used to calculate distances to PTS.

dB re 1 µPa = dB referenced to a pressure of 1 microPascal, measures underwater SPL. dB re 1 µPa²-sec = dB referenced to a pressure of 1 microPascal squared per second, measures underwater SEL

Calculation spreadsheets are contained in Appendix B

Calculated distances to the underwater marine mammal injury (PTS onset) SEL thresholds and behavioral thresholds for the two hearing groups are provided in Table 6-5 and Table 6-6 for impact and vibratory pile driving activities, respectively. Adjusted maximum distances are provided for the behavioral thresholds where the extent of noise reaches land prior to reaching the calculated radial distance to the threshold. Areas encompassed within the threshold (ZOI) were calculated using the location of a representative pile.

Pile locations were chosen to model the greatest possible affected areas; typically, these locations would be at the seaward end of the pier. Figure 6-2 illustrates the extent and area of each Level A Injury ZOI for a 36-inch steel pipe piles. The 36-inch diameter steel piles will be installed for the temporary structure and will subsequently be removed at the end of the final year of construction (structure is expected to remain in place during year 1 construction). The furthest extent to the Level B behavioral disturbance threshold would be a distance of 46,415.9 m but due to surrounding landmasses and structures, the area of disturbance will actually be 0.8544 square kilometers (km^2) or the area of the entire ROI for underwater noise as depicted in Figure 6-1. The maximum distance to Level A injury during temporary structure construction would be approximately 533 m and 239 m for harbor porpoise and seals, respectively, during impact pile driving. Similar to Level B, the area of disturbance is reduced due to surrounding landmasses and structures. Level A injury distances during vibratory pile driving are smaller at approximately 16.5 m and 6.8 m (Figure 6-2) for harbor porpoise and seals, respectively. The temporary structure also includes installing 14-inch steel H-piles by both vibratory and impact methods but the extent to which the noise from the 14-inch piles would reach the thresholds is about 10 percent of those generated by the 36-inch steel pipe piles (see Table 6-5 and Table 6-6). Further, the 14-inch steel H-piles would be removed using vibratory extraction at the conclusion of south closure wall construction of which the distance to Level A for harbor porpoise and seals would be approximately 5 m and 2 m, respectively (Table 6 5 and Table 6 6) (Figure 6-3).

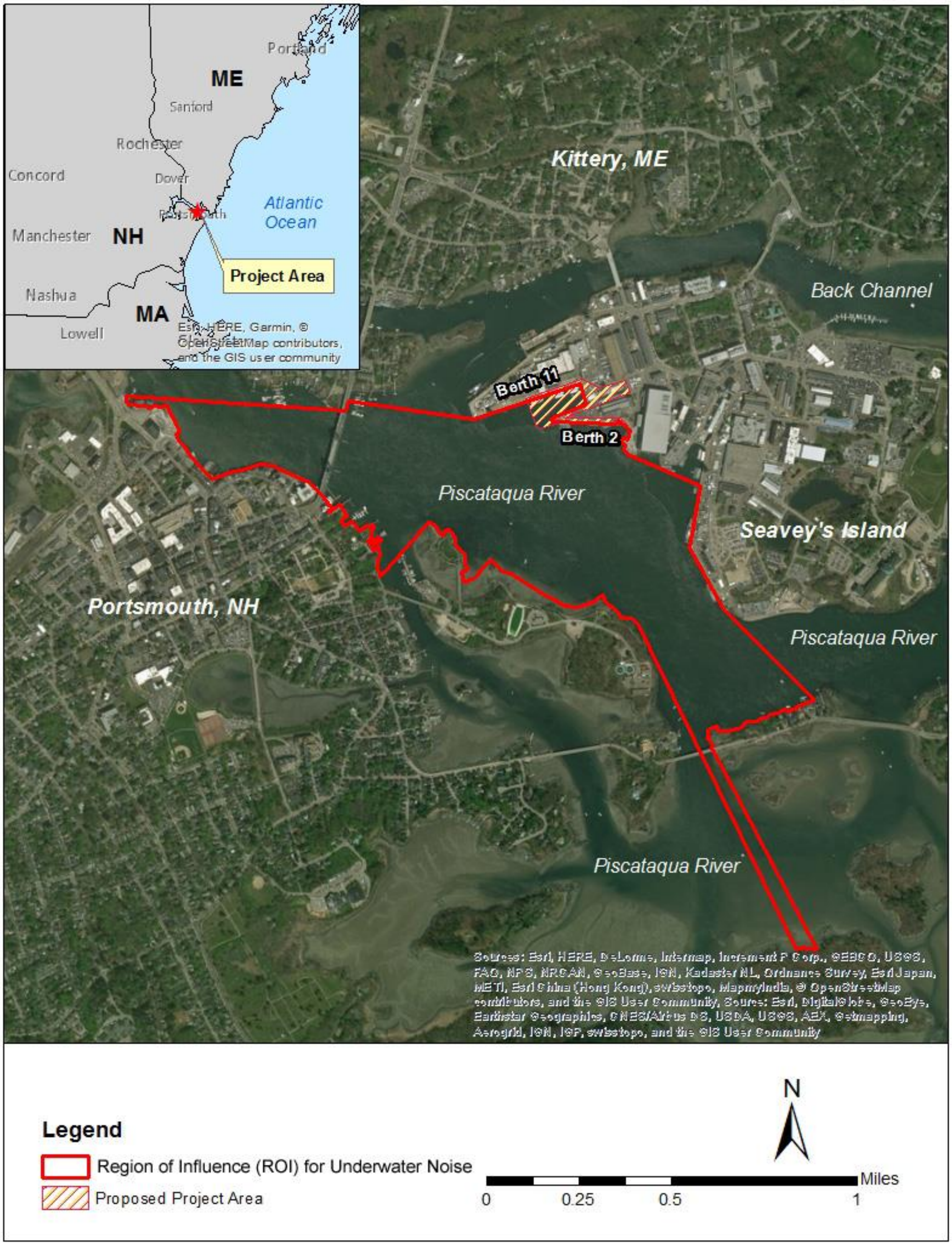

Figure 6-1. Region of Influence for Underwater Noise

Table 6-5. Calculated Maximum Distances Corresponding to MMPA Thresholds for Underwater Sound from Impulsive Noise (Impact Pile Driving)*

Activity	*Pile Purpose*	*Pile Size and Count*	*Total Pile Driving Days*	*Injury (PTS Onset) Level A*		*Behavior Disturbance Level B*	
				Harbor Porpoise Distance to 155 dB SEL_{cum} Threshold/Area of ZOI	*Phocids Distance to 185 dB SEL_{cum} Threshold/Area of ZOI*	*Harbor Porpoise and Phocids 160 dB RMS Threshold*	*Area of ZOI by Threshold (160 dB RMS)*
General Information	Temporary Structure	14-inch steel H-piles (32 piles total to form cell and connector cell wall ring forms)	16 days	33.7 m/0.003554 km^2	15.1 m/0.000713 km^2	135.9 m	0.050717 km^2
P310 Super Flood Basin	Sheet Pile Wall along Berth 1	24-inch Z-shaped steel sheet piles (320 total piles)	27 days	1,763 m/0.849159 km^2	792 m/0.624685 km^2	1,000 m	0.728736 km^2
	Closure Wall Construction	18-inch flat web steel sheet piles (310 total piles to form South closure wall cells)	31 days	1,763 m/ 0.849159 km^2	792 m/0.624685 km^2	1,000 m	0.728736 km^2
		24-inch Z-shaped steel sheet piles (52 total piles to form Berth 1 and 2 closure sheet pile)	5 days	1,763 m/0.849159 km^2	792 m /0.624685 km^2	1,000 m	0.728736 km^2
		steel HP 14 piles (17) for combi-wall with sheet pile in previous row)	17 days	21.2 m/0.001405 km^2	9.5 m/0.000282 km^2	135.9 m	0.050717 km^2
		24-inch Z-shaped steel sheet piles (145 total piles to form South closure wall façade sheeting formwork)	12 days sheet	1,763 m/0.849159 km^2	792 m/0.624685 km^2	1,000 m	0.728736 km^2

Table 6-5. Calculated Maximum Distances Corresponding to MMPA Thresholds for Underwater Sound from Impulsive Noise (Impact Pile Driving)*

Activity	*Pile Purpose*	*Pile Size and Count*	*Total Pile Driving Days*	*Injury (PTS Onset) Level A*		*Behavior Disturbance Level B*	
				Harbor Porpoise Distance to 155 dB SEL_{cum} Threshold/Area of ZOI	*Phocids Distance to 185 dB SEL_{cum} Threshold/Area of ZOI*	*Harbor Porpoise and Phocids 160 dB RMS Threshold*	*Area of ZOI by Threshold (160 dB RMS)*
		24-inch Z-shaped sheet piles (135 total sheet piles to form sheet pile cutoff wall and will surround 10 drilled shafts)	12 days	1,763 m/0.849159 km^2	792 m/0.624685 km^2	1,000 m	0.728736 km^2
	Caisson Seat Float-in	36-inch steel pipes (48 piles total to form 8 entrance structure float-in temporary dolphins with 6 piles each)	48 days	533.1 m/ 0.438896 km^2	239.5 m/0.123328 km^2	3,414.5 m	0.854418 km^2
P1074 Extension of Portal Crane Rail and Utilities	Elevated Deck Support	16-inch steel pipe (8 Total)	8 days	11.5 m/0.000413 km^2	5.2 m/0.000085 km^2	15.8 m	0.00078 km^2

Source: Appledore Marine Engineering, LLC 2018;
Notes:
*- To determine underwater ZOIs, radial distances from the source will be clipped along the shoreline using GIS
lf = linear feet; N/A = Not Applicable
[1]- The SPLs from installing 14-inch steel HP would be superceded by SPLs generated from installing the Z-shaped sheet piles during combination wall construction.
Calculated values rounded up to the nearest meter.
Proxy sources used were unattenuated SPLs.

Table 6-6. Calculated Maximum Distances Corresponding to MMPA Thresholds for Underwater Sound from Non-Impulsive Noise (Vibratory Pile Driving/Drilling)*

Activity	*Pile Purpose*	*Pile Size and Count*	*Total Pile Driving Days*	*Injury (PTS Onset) Level A*		*Behavior Disturbance Level B*	
				Harbor Porpoise Distance to 173 dB SEL_{cum} Threshold/Area of ZOI	*Phocids Distance to 201 dB SEL_{cum} Threshold/Area of ZOI*	*Harbor Porpoise and Phocids Distance to 120 dB RMS Ambient Threshold*	*Area of ZOI Encompassed by Threshold*
Pre-construction/ Falsework	Temporary Structure for south closure wall	14-inch steel H-piles (32 piles totals to form cell and connector cell wall ring forms)	16 days	1.9 m/0.000011 km^2	0.8 m/0.000002 km^2	3,414.5 m	0.854418 km^2
P310 Super Flood Basin	Sheet Pile Wall along Berth 1	24-inch Z-shaped steel sheet piles (320 total piles)	27 days	13.7 m/0.000587 km^2	5.6 m/0.000098 km^2	7,356.4 m	0.854418 km^2
	Closure Wall Construction	18-inch flat web steel sheet piles (310 total piles to form South closure wall cells)	31 days	13.7 m/0.000587 km^2	5.6 m/0.000098 km^2	7,356.4 m	0.854418 km^2
		Removal of temporary structure Dec 2019-Jan 2020 32 piles (cell and connector cell wall ring forms	4 days	4.9 m/0.000075 km^2	2 m/0.000013 km^2	3,414.5 m	0.854418 km^2
		24-inch Z-shaped steel sheet piles (52 total piles to form Berth 1 and 2 closure sheet pile)	5 days	13.7 m/0.000587 km^2	5.6 m/0.000098 km^2	7,356.4 m	0.854418 km^2
		14-inch steel HP piles (17 total for combi-wall)[1]	17 days	1.2 m/0.000005 km^2	0.5 m/0.000001 km^2	3,414.5 m	0.854418 km^2

Table 6-6. Calculated Maximum Distances Corresponding to MMPA Thresholds for Underwater Sound from Non-Impulsive Noise (Vibratory Pile Driving/Drilling)*

Activity	Pile Purpose	Pile Size and Count	Total Pile Driving Days	Injury (PTS Onset) Level A		Behavior Disturbance Level B	
				Harbor Porpoise Distance to 173 dB SEL_{cum} Threshold/Area of ZOI	*Phocids Distance to 201 dB SEL_{cum} Threshold/Area of ZOI*	*Harbor Porpoise and Phocids Distance to 120 dB RMS Ambient Threshold*	*Area of ZOI Encompassed by Threshold*
		24-inch Z-shaped steel sheet piles (145 total piles to form South closure wall façade sheeting formwork)	12 days	13.7 m/0.000587 km^2	5.6 m/0.000098 km^2	7,356.4 m	0.854418 km^2
		24-inch Z-shaped steel sheet piles (135 total sheet piles to form sheet pile cutoff wall and will surround 10 drilled shafts)	12 days	13.7 m/0.000587 km^2	5.6 m/0.000098 km^2	7,356.4 m	0.854418 km^2
		10 drilled shafts to support 8-ft casings	32 days	56.5 m/0.010005 km^2	23.2 m/0.001682 km^2	12,022.6 m	0.854418 km^2
	Caisson Seat Float-in	36-inch steel pipe (48 piles total to form 8 entrance structure float-in temporary dolphins with 6 piles each)	48 days	16.5 m/0.000851 km^2	6.8 m/0.000145 km^2	46,415.9 m	0.854418 km^2
P1074 Extension of Portal Crane Rail and Utilities	Relieving Platform Support	16-inch steel pipes (8 total)	8 days	2.2 m/0.000015 km^2	0.9 m/0.000003 km^2	6,309.6 m	0.854418 km^2

Source: Appledore Marine Engineering, LLC 2018;
Notes:
*- To determine underwater ZOIs, radial distances from the source will be clipped along the shoreline using GIS
N/A = Not Applicable

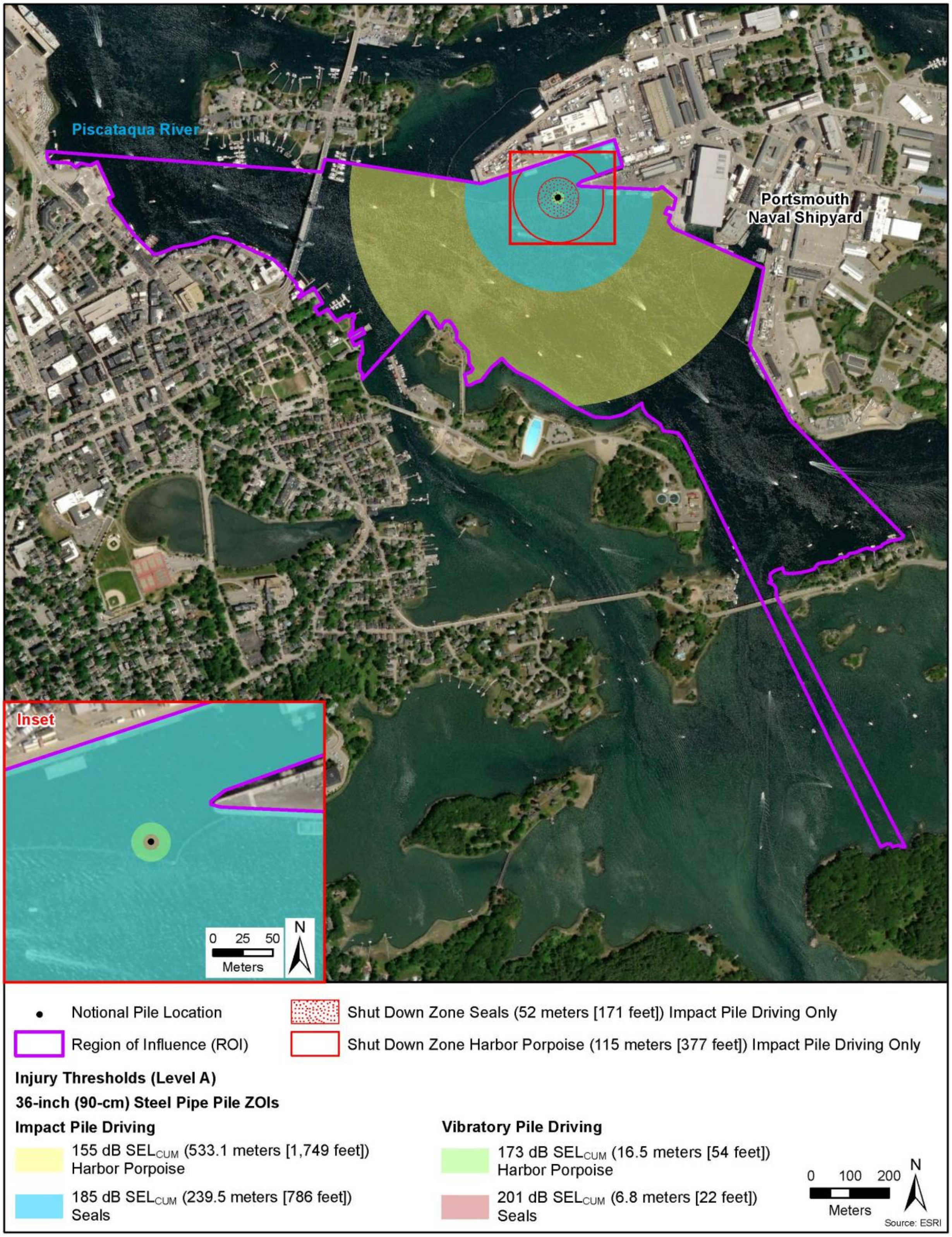

Figure 6-2. Representative ZOI for Level A Injury due to Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 36-inch Steel pipe piles

Figures 6-4 and 6-5 present Level A injury and Level B behavioral disturbance distances to thresholds during impact and vibratory installation of Z-shaped sheet piles that will accommodate the Berth 1 and Berth 2 combi-wall and south closure walls of the Super Flood Basin. Impact pile driving the sheet piles will generate noise levels that will extend out a distance of 1,763 m and 792 m for harbor porpoise and seal thresholds, respectively (Figure 6-3). Vibratory installation of the sheet piles would significantly reduce the distances to Level A injury as those distance would be approximately 14 m and 6 m for harbor porpoise and seals, respectively (Figure 6-4). As shown in Figure 6-4 and 6-5, the areas encompassing the behavioral disturbance thresholds would be 0.7287 km^2 (maximum radial of 1,000 m) for impact pile driving and 0.8544 km^2 (maximum radial of 7,356 m) for vibratory. Drilling is required for creating 10 shafts that will support 8-ft diameter casings. Drilling is treated like non-impulsive continuous noise. Areas encompassing Level A shutdown zones would be less than 0.010 km^2 for harbor porpoise and pinnipeds (Figure 6-6) and would also encompass an area of 0.8544 km^2 for behavioral disturbance to these species (the entire ROI for underwater noise).

Figure 6-7 presents the maximum distances to Level A injury and Level B behavioral disturbance during impact and vibratory installation of 16-inch steel piles to accommodate extension of the portal crane rail and utilities. The maximum distances to Level A injury would be during impact pile driving of these piles would be at 11.5 m and 5 m, respectively, for harbor porpoise and seal. Vibratory installation of this size pile will result in smaller distance to Level A for harbor porpoise and seals at 2.2 m and less than 1 m, respectively. The distance to the 120 dB RMS would be 6,309 m but due to intersecting land masses and shoreline the area encompassing behavioral disturbance would be 0.8544 km^2 (the entire ROI for underwater noise).

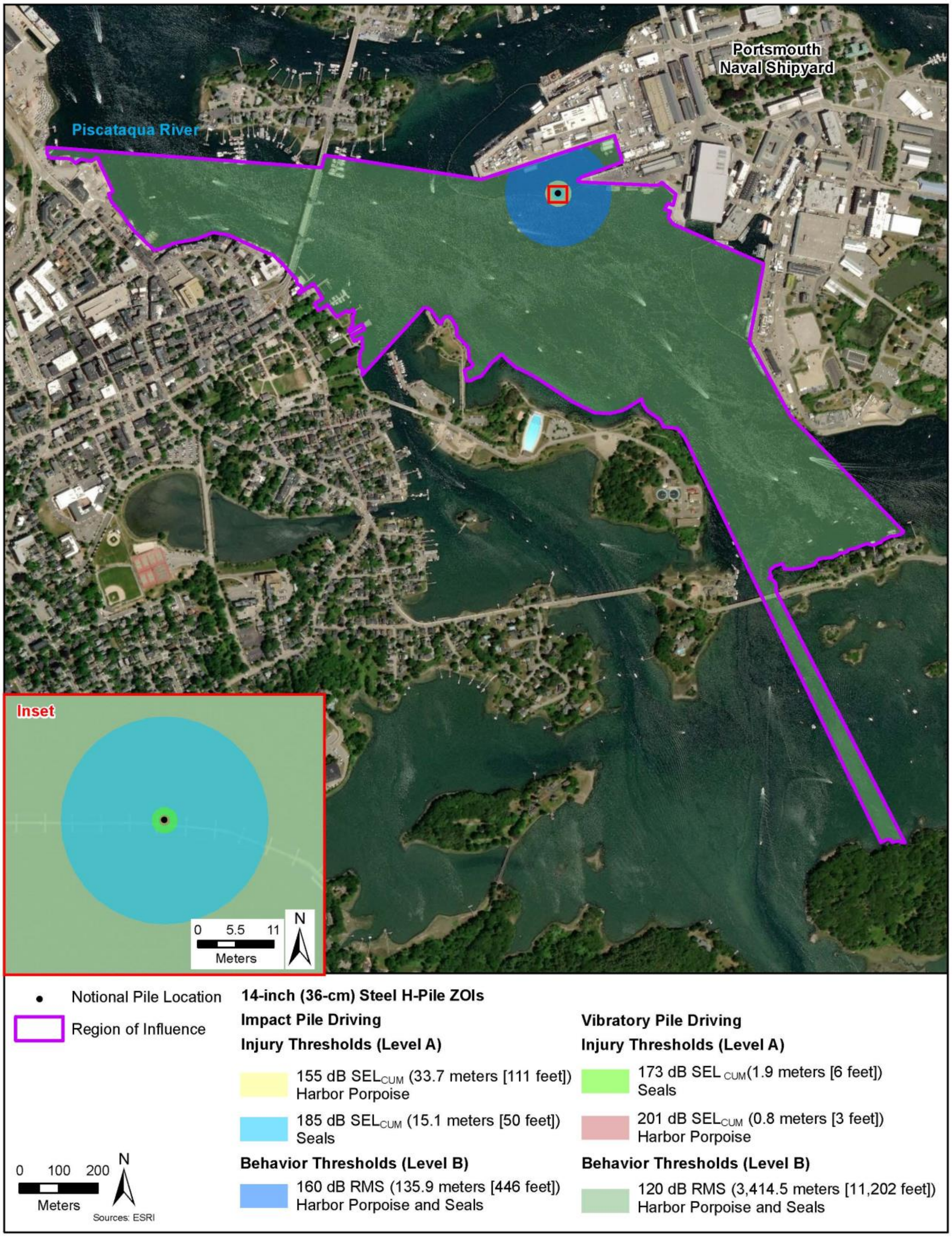

Figure 6-3. Representative ZOI for Level A Injury and Level B Behavioral Disturbance due to Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 14-inch Steel H-Piles

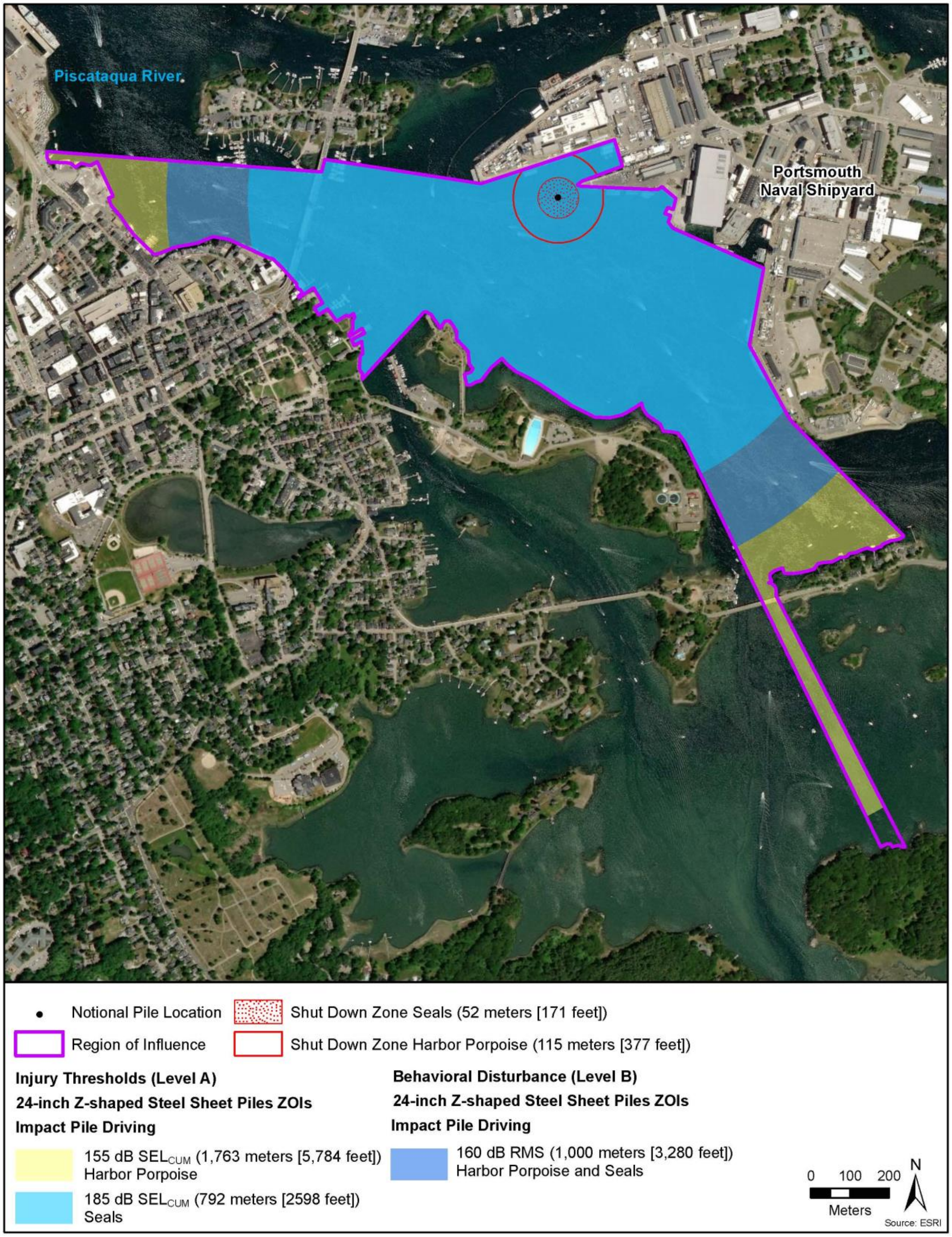

Figure 6-4. Representative ZOI for Level A Injury and Level B Behavioral Disturbance due to Underwater Pile Driving Noise during Impact Pile Driving 24-inch Z-shaped Sheet Piles

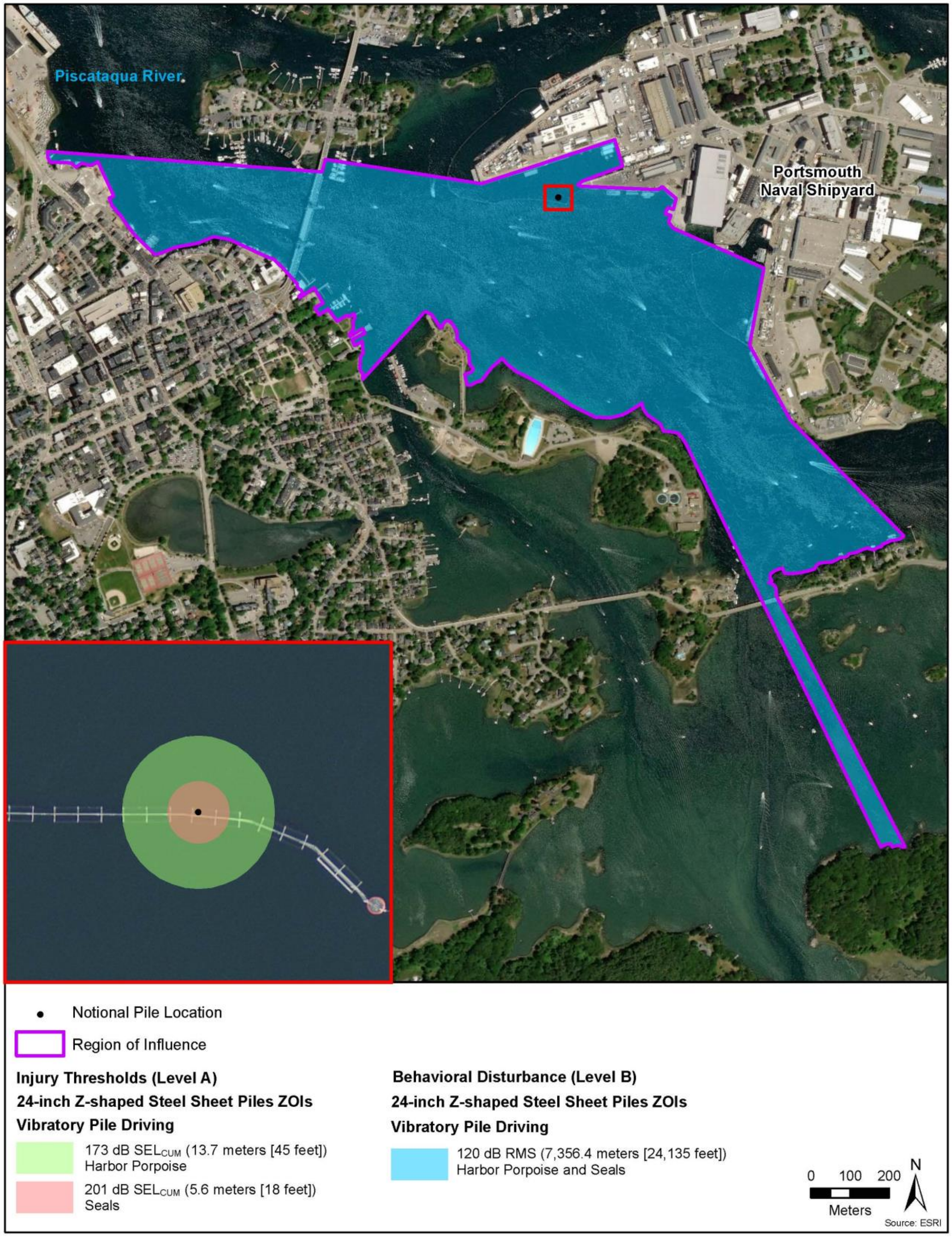

Figure 6-5. Representative ZOI for Level A Injury and Level B Disturbance due to Underwater Pile Driving Noise during Vibratory Pile Driving 24-inch Z-shaped Sheet Piles

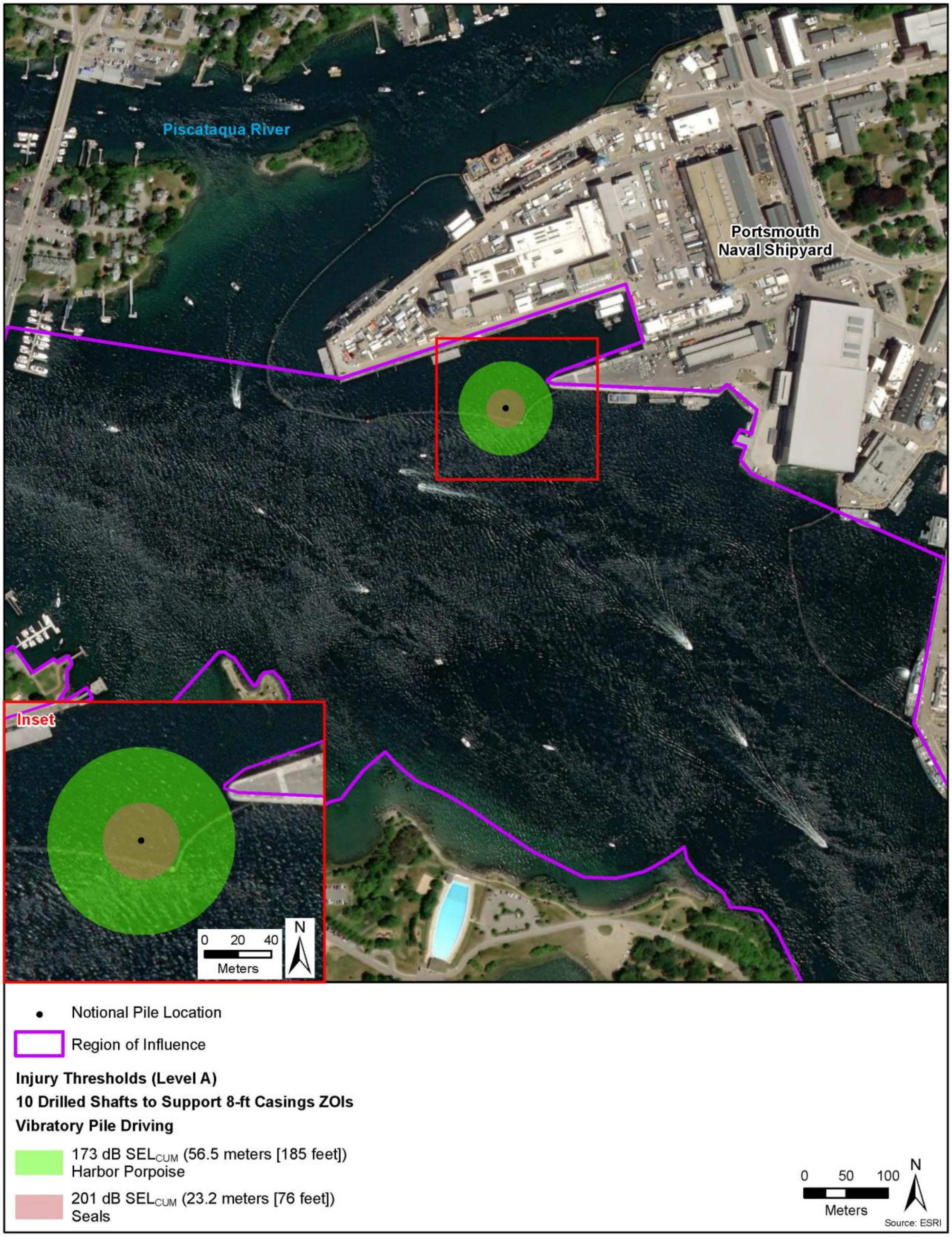

Figure 6-6. Representative ZOI for Level A Injury due to Underwater Drilling of Shafts for 8-ft Diameter Casings

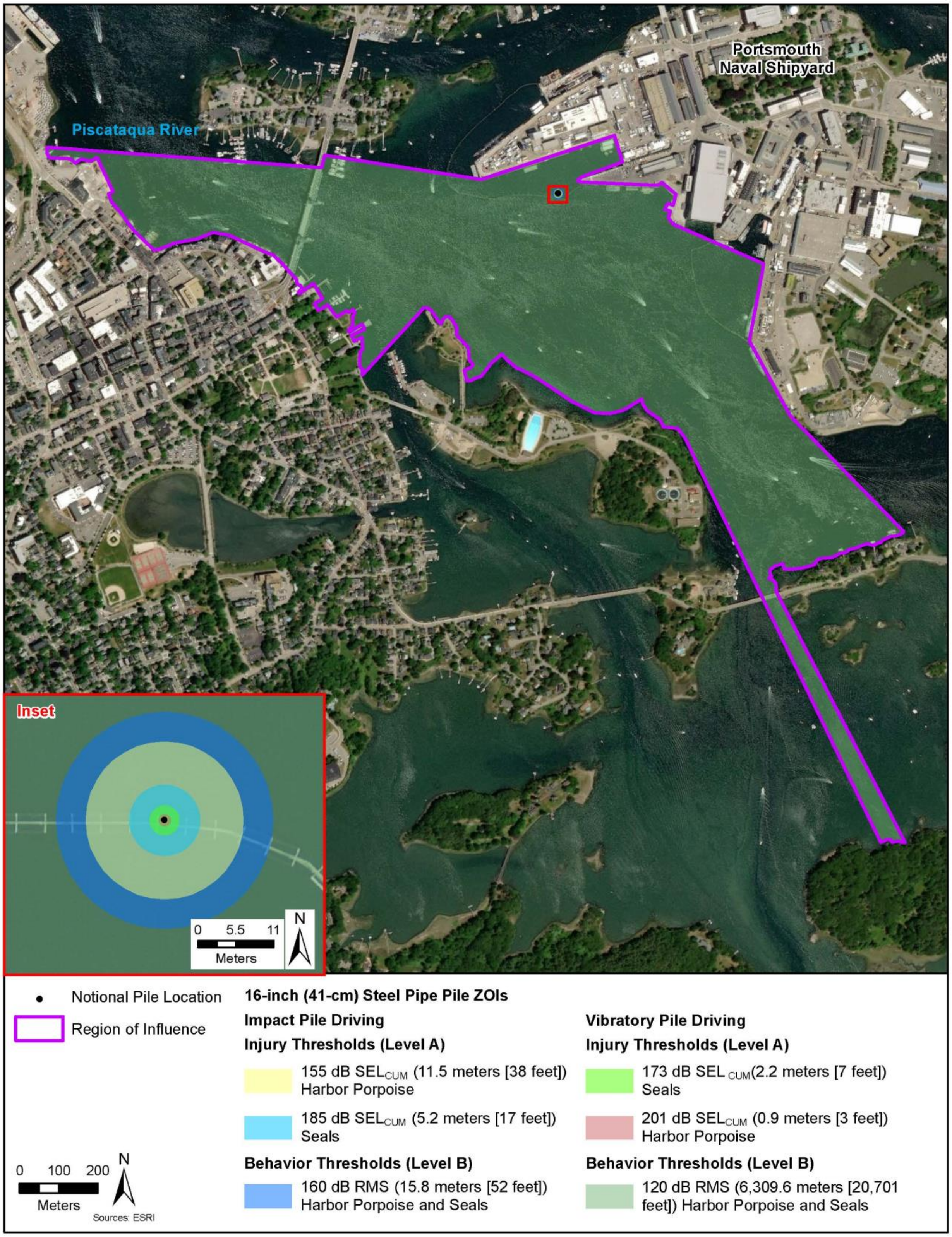

Figure 6-7. Representative ZOI for Level A Injury and Level B Behavioral Disturbance due to Underwater Pile Driving Noise during Impact and Vibratory Pile Driving 16-inch Steel Pipe Piles

6.8 Distance to Airborne Sound Threshold

Pile driving and drilling can generate airborne noise that could potentially result in disturbance to marine mammals (pinnipeds) that are hauled out or at the water's surface. As a result, the Navy analyzed the potential for pinnipeds hauled out or swimming at the surface to be exposed to airborne SPLs that could result in Level B behavioral harassment. The airborne noise threshold for behavioral harassment for all pinnipeds, except harbor seals, is 100 dB RMS re 20 µPa (unweighted) and for harbor seals is 90 dB RMS re 20 µPa (unweighted) (see Table 6-3). Construction noise behaves as point-source and, thus, propagates in a spherical manner with a 6 dB decrease in SPL over water ("hard site" condition) per doubling of distance. The water surface is considered a hard site and acts as a reflective surface where it does not provide any attenuation (Washington Department of Transportation 2018). A spherical spreading loss model, assuming average atmospheric conditions, was used to estimate the distance to the 100 dB and 90 dB RMS re 20 µPa (unweighted) airborne thresholds. The TL equation is:

$$TL = 20\log_{10}\left(\frac{R_1}{R_2}\right)$$

where

TL is the transmission loss in dB,

R_1 is the distance of the modeled SPL from the driven pile, and

R_2 is the distance from the driven pile of the initial measurement.

The intensity of pile driving sounds is greatly influenced by factors such as the type of piles, hammers, and the physical environment in which the activity takes place. Drilling activities create non-impulsive continuous noise that is similar to that of vibratory pile driving. To determine reasonable airborne source SPLs, source levels were chosen based on a review of available pile driving and drilling in-situ recordings. These proxy sources are presented in Table 6-7 below.

Table 6-7. Airborne Noise Source Levels Modeled from Impact and Vibratory Pile Driving/Drilling (dB)

Pile Size (diameter in inches)	***Impact***	***Vibratory/Drilling***
	Root Mean Square (RMS) L_{max} (Unweighted)	***RMS L_{eq} (Unweighted)***
36-inch steel pipe	113[1]	92[1]
18-inch steel pipe	ND	88[1]
24-inch steel pipe	110[2]	92[2]
12-inch steel pipe	89[2,4]	ND
24-inch steel sheet	88[1]	82[1]
8-ft shafts	NA	88[3]

Sources: [1]- United States Navy 2017;[2]- United States Navy 2015;[3]-Pommerenck 2014

Notes:

[4]- Measured at a distance of 50 m (164 ft).

All values relatives to dB re 20 µPa = dB referenced to a pressure of 20 microPascals at 15 meters (50-feet) (except where noted)

Key:

L_{eq}= Equivalent continuous Sound Pressure Level; L_{max}= RMS maximum level of a noise. ND = No Data. No data were available for 14- or 16-inch piles. NA = Not applicable

The distances to the pinniped airborne noise thresholds produced by the loudest pile installation method (impact installation of 36-inch steel pipe) are shown in Table 6-8 and Figure 6-8. Because these areas are smaller than the underwater behavioral threshold zones, a separate analysis of Level B take was not conducted for the airborne zones. Animals in the airborne zones would already have been exposed within a Level B underwater zone; therefore, no additional takes due to exposure to airborne noise are requested.

Table 6-8. Calculated and Measured Distances to Pinniped Behavioral Airborne Noise Thresholds

Pile Type	*Pile Size*	*Installation Method*	*Harbor Seal Threshold = 90 dB RMS*	*Pinnipeds except Harbor Seals Threshold = 100 dB RMS*
Steel pipe	36-inch	Impact	212 m	67 m
		Vibratory	19 m	6 m
	24-inch	Impact	150 m	47 m
	18-inch	Vibratory/Drilling[1]	12 m	6 m
Steel Sheet	24-inch	Impact	12 m	4 m
		Vibratory	6 m	2 m

Note: No data available for 14-inch steel H or 16-inch steel pipe thus 18-inch proxy used for vibratory and 24-inch used for impact to be conservative. [1]-Drilling the shafts will result in the same distances to thresholds as what was modeled for vibratory install of 18-inch steel pipe piles.

6.9 Estimated Duration of Pile Driving

Pile driving/extraction for the DD1 project will take approximately 212 nonconsecutive days over a period of approximately 12 consecutive months. Vibratory pile driving is assumed to occur during 176 days of steel impact pile driving and will extend an additional 36 days for drilling (8-ft casings) and vibratory extraction of the temporary piles.

The number of impact pile strikes will vary and depend on the substrate at each pile location and the pile size and type.

6.10 Basis for Estimating Take by Harassment

The Navy is seeking authorization for the potential taking of small numbers of harbor porpoises, gray seals, harbor seals, hooded seals, and harp seals near the Shipyard as a result of pile removal and pile driving during demolition and construction activities associated with the proposed project. The takes requested are expected to have a less than significant effect on individual animals and no effect on the populations of these species. Effects experienced by individual marine mammals are expected to be primarily limited to short-term disturbance of normal behavior or temporary displacement of animals near the source of the noise. Some Level A exposures are anticipated; however, the likelihood of Level A exposures during the project would be minimized due to the best management practices and mitigation measures outlined in Chapter 11.

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

6.11 Estimating Potential Exposures to Pile Driving Noise

Cetaceans spend their entire lives in the water and spend most of their time (greater than 90 percent for most species) entirely submerged below the surface. When at the surface, cetacean bodies are almost entirely below the water's surface, with only the blowhole exposed to allow breathing. This makes cetaceans difficult to locate visually and also exposes them to underwater noise, both natural and anthropogenic, essentially 100 percent of the time because their ears are nearly always below the water's surface.

Pinnipeds (seals and sea lions) spend significant amounts of time out of the water during breeding, molting, and hauling out periods. In the water, pinnipeds spend varying amounts of time underwater. When not actively diving, pinnipeds at the surface often orient their bodies vertically in the water column and hold their heads above the water surface. Consequently, pinnipeds may not be exposed to underwater sounds to the same extent as cetaceans.

For the purpose of assessing impacts from underwater sound, the Navy assumed that all cetacean and pinniped species spend 100 percent of their time in the water. This approach is conservative because seals spend a portion of their time hauled out and, therefore, are expected to be exposed to less sound than is estimated by this approach.

To quantitatively assess exposure of marine mammals to noise levels from pile driving over the NMFS threshold guidance, two methods were used depending on the species spatial and temporal occurrence. For species with rare or infrequent occurrence, the likelihood of occurrence was reviewed based on the information in Chapter 3 and the potential maximum duration of work days and total work days. Two species were in this category, hooded seals and harp seals. NMFS authorized one Level B take per month of each of these species for the Berth 11 Waterfront Improvements Construction project (NMFS 2018a). To date, the monitoring for that project has not recorded a sighting of either species in the project area during 154 days total of monitoring (Cianbro 2018a,b). Hooded and harp seals have the potential to occur in the area from January through May. In order to guard against unauthorized take, the Navy is proposing one Level B take per month of construction for harp and hooded seal (Total of 5 Level B takes of each species from January 2020 through May 2020). Consistent with past applications at the Shipyard, no Level A takes are requested for these species.

For species that regularly occur in the Piscataqua River, but do not have site-specific abundances, marine mammal density estimates were derived from the Berth 11 Waterfront Improvements Construction project monitoring and used to determine the number of animals potentially exposed in a ZOI on any one day of pile driving, extraction, or drilling. This method was used for harbor seal and gray seal. The monitoring data provided accurate counts of numbers of animals observed within the acoustic ZOIs throughout the year and represent the best available science for these species. However, in some instances, the same individual seals were counted more than once per day. This was unavoidable due to the difficulty of distinguishing individuals, and makes the resulting density estimates conservative.

Although harbor porpoise is less likely to frequent the river than the harbor seal and gray seal, harbor porpoise sightings (although few) were recorded in the project area during Berth 11 Waterfront Improvements Construction monitoring and thus the same method for density determination for harbor and gray seal was applied for harbor porpoise using the Berth 11 construction monitoring data.

To determine the number of animals potentially exposed in the ZOI, the following equation was used:

$$\text{Exposure estimate} = (N \times ZOI) \times \text{maximum days of pile driving}$$

where

N = density estimate used for each species

ZOI = Zone of Influence; the area where noise exceeds the noise threshold value

The following assumptions were used to calculate potential exposures to impact and vibratory pile driving noise for each threshold:

- Each animal can be "taken" via Level B harassment once every 24 hours.
- The pile type, size, and installation method that produce the largest ZOI were used to estimate exposure of marine mammals to noise impacts.
- All pilings will have an **underwater** noise disturbance distance equal to the pile that causes the greatest noise disturbance (i.e., the piling farthest from shore) installed with the method that has the largest ZOI. If vibratory pile driving would occur, the largest ZOI for Level B harassment will be produced by vibratory driving. In this case, the ZOI for an impact hammer will be encompassed by the larger ZOI from the vibratory driver. **Vibratory and impact driving was assumed to occur on all 176 days of steel pile driving. However, vibratory driving will extend an additional 36 days for drilling (8-ft casings) and vibratory extraction of the temporary piles for a total of 212 vibratory pile driving/Extraction/drilling days.**
- All pilings will have an **airborne** noise disturbance distance equal to the pile that causes the greatest noise disturbance (i.e., the piling furthest from shore) installed with the method that has the largest ZOI. The largest ZOI will be produced by impact driving. The ZOI for a vibratory hammer will be encompassed by the larger ZOI from the impact driver. Impact pile driving was assumed to occur on all days of pile driving. Exposures to airborne noise were considered included in the larger underwater ZOIs from vibratory or impact driving and were not calculated for pinnipeds because no haulouts occurred in the airborne ZOI.
- Days of pile driving were conservatively based on a relatively slow daily production rate, but actual daily production rates may be higher, resulting in fewer actual pile driving days. The pile driving days are used solely to assess the number of days during which pile driving could occur if production was delayed due to equipment failure, safety, etc. In a real construction situation, pile driving production rates would be maximized when possible.

6.12 Exposure Estimates

Exposure estimates for each species are discussed in the following sections and presented in Table 6-9. Annual reporting requirements will provide details of how many actual and extrapolated animals of each species are exposed to noise levels considered potential Level A or Level B harassment.

Table 6-9. Total Underwater Exposure Estimates by Species

Marine Mammals	Underwater Vibratory Pile Driving Criteria (e.g., non-impulsive/continuous sounds)			Underwater Impact[1] Pile Driving Criteria (e.g., impulsive sounds)			Total Takes (Level A + Level B))
	Level A Injury Threshold 173 dB Harbor Porpoise	Level A Injury Threshold 201 dB Seals	Level B Disturbance Threshold 120 dB[3] rms	Level A Injury Threshold[1]155 dB[2] SEL Harbor Porpoise	Level A Injury 185 dB SEL Seals	Level B Disturbance Threshold 160 dB[3] rms	
Harbor porpoise	0	NA	7	5	NA	1	13
Harbor seal	NA	1	391	NA	286	5	683
Gray seal	NA	1	32	NA	23	1	57
Hooded seal	NA	0	5	NA	0	0	5
Harp seal	NA	0	5	NA	0	0	5
Total all species	**0**	**2**	**440**	**5**	**309**	**7**	**763**

Notes:
[1] A marine mammal exposed to a sound pressure level or sound exposure level in excess of a given threshold value is counted as a single take, regardless of how many times or from different activities during the day the animal is exposed to sound in excess of thresholds. Level A takes would be minimized and mitigated by the implementation of monitoring and shutdown procedures.
[2] dB re 1 µPa^2-sec;
[3] dB re 1µPa rms

Exposure estimates generally do not differentiate age, sex, or reproductive condition. However, some inferences can be made based on what is known about the life stages of the animals that visit or inhabit the Piscataqua River. When possible and with the available data, this is discussed by species in the sections that follow.

6.12.1 Harbor Porpoise

Harbor porpoises may be present in the proposed project area during spring, summer, and fall, from April to December. Based on density data from the Navy Marine Species Density Database, their presence is highest in spring, decreases in summer, and slightly increases in fall. During construction monitoring in the project area 3 harbor porpoise were sighted between April and December of 2017 and 2 harbor porpoise were sighted in early August of 2018 (Cianbro 2018a,b). From this data, density of harbor porpoise for the largest ZOI was determined to be 0.04/km^2 (see Section 6.11). This density was used to determine abundance of animals that could be present in the area for exposure, using the equation abundance = n * ZOI.

Potential takes could occur if harbor porpoises move through the area on foraging trips, primarily during impact pile driving of sheet piles. It is anticipated that should harbor porpoise be present there could be up to 5 Level A takes and no Level B takes. Monitoring of the 0.8491 km^2 area would need to occur to minimize Level A takes of harbor porpoises that could result in injury. Due to the size of the ZOI, monitoring of the Level A ZOI would occur over an area up to 150 m from the sound source (0.0387

km^2), depending on the pile being driven (Table 11-1). No Level A takes are anticipated during vibratory pile driving but there would be up to 8 Level B takes of harbor porpoise which encompasses a larger area of 0.8544 km^2 as compared to Level A areas that are very small (0.0005 km^2) for vibratory and would be monitorable. Level B take of harbor porpoise may result in behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, harbor porpoises may move away from the sound source and be temporarily displaced from waters near the construction areas. However, a harbor porpoise sighted in the river was observed passing through and did not spend any time in the river (NAVFAC Mid-Atlantic 2018). With the absence of any regular occurrence adjacent to the project site, potential takes by disturbance would have a negligible short-term effect on individual harbor porpoises and would not result in population-level impacts.

6.12.2 Harbor Seal

Harbor seals may be present year-round in the project vicinity, with constant densities throughout the year. Harbor seals are the most common pinniped in the Piscataqua River near the Shipyard. Sightings of this species were recorded during monthly surveys conducted in 2017 (NAVFAC Mid-Atlantic 2018) as well as during Berth 11 construction monitoring in 2017 and 2018 (Cianbro 2018a,b). As discussed in Section 6.11, density for harbor seals was based on the Berth 11 Waterfront Improvement Construction monitoring and was determined to be 2.48 /km^2 (Cianbro 2018a,b).

Potential takes could likely involve harbor seals that are moving through the area on foraging trips or to the downstream haul-out site as a result of underwater or airborne noise during pile driving or drilling. It is estimated that there could be up to 286 Level A takes and 5 level B takes during impact pile driving. The larger number of Level A takes is the result of changes to SEL metrics for injury that have not been applied to behavioral thresholds. Monitoring to a distance of 1,000 m would encompass both Level A and Level B thresholds of which the Level A could occur during impact driving of the sheet piles, which would occur from October 2019 to April 2020. It should be noted that Level A takes of harbor seals would likely be multiple exposures of the same individuals, rather than single exposures of unique individuals. This request overestimates the likely Level A exposure because: (1) seals are unlikely to enter the shutdown zone during active pile driving, and (2) the estimate assumes that new seals are in the Level A ZOI every day during pile driving. Harbor seals that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, harbor seals may move away from the sound source and be temporarily displaced from waters near the construction areas (Aarts, Brasseur and Kirkwood 2018). Level A takes would be mitigated or minimized by implementing monitoring and shutdown procedures. Vibratory pile driving would result in 391 level B takes and 1 Level A take. With the absence of any major rookeries and only one isolated haul-out site at Hicks Rocks approximately 1.5 miles from the proposed project area, potential takes by disturbance would have a negligible short-term effect on individual harbor seals and would not result in population-level impacts.

6.12.3 Gray Seal

Gray seals may be present year-round in the project vicinity, with constant densities throughout the year. Gray seals are less common in the Piscataqua River than the harbor seal. Sighting of gray seals were recorded during monthly surveys conducted in 2017 (NAVFAC Mid-Atlantic 2018) as well as during Berth 11 construction monitoring in 2017 and 2018 (Cianbro 2018a,b). As discussed in Section 6.11, density for harbor seals was based on the Berth 11 Waterfront Improvement Construction monitoring and was determined to be 0.20/km^2 (Cianbro 2018a,b).

Potential takes could likely involve gray seals that are moving through the area on foraging trips or to the downstream haul-out site as a result of underwater or airborne noise during pile driving or drilling. It is estimated that there could be up to 23 Level A takes and 1 level B takes during impact pile driving. The larger number of Level A takes is the result of changes to SEL metrics for injury that have not been applied to behavioral thresholds. Monitoring to a distance of 1,000 m would encompass both Level A and Level B thresholds and as discussed above for harbor seals, Level A exposure would occur during install of sheet piles between October 2019 and April 2020. Gray seals that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, gray seals may move away from the sound source and be temporarily displaced from waters near the construction areas. Level A takes would be mitigated or minimized by implementing monitoring and shutdown procedures. Vibratory pile driving/drilling activity would result in up to 32 level B takes and 1 Level A take. With the absence of any major rookeries and only one isolated haul-out site at Hicks Rocks approximately 1.5 miles from the proposed project area, potential takes by disturbance would have a negligible short-term effect on individual gray seals and would not result in population-level impacts.

6.12.4 Hooded Seal

Hooded seals may be present in the project vicinity during from January through May, though their exact seasonal densities are unknown. In general, hooded seals are much rarer than the harbor seal and gray seal in the Piscataqua River. As discussed in Section 6.11, NMFS authorized one Level B take per month of a hooded seal for the Berth 11 Waterfront Improvements Construction project (NMFS 2018a). To date, the monitoring for that project density surveys have not recorded a sighting of hooded seal in the project area (Cianbro 2018a,b; NAVFAC Mid-Atlantic 2018; Lamontagne 2018, personal communication). In order to guard against unauthorized take, the Navy is requesting one Level B take of hooded seal per month of construction from January 2020 through May 2020 when a hooded seal may occur in the area (Total of 5 Level B takes). No Level A takes are requested for this species because this species has not been observed in the vicinity of the Shipyard during past marine mammal monitoring events.

Potential takes would likely involve hooded seals that are moving through the area on foraging trips or to the downstream haul-out site as a result of underwater or airborne noise during pile driving or extraction. Hooded seals that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, hooded seals may move away from the sound source and be temporarily displaced from waters near the construction areas. With the absence of any major rookeries and only one isolated haul-out site 1.5 miles downstream of the proposed project area, potential takes by disturbance would have a negligible short-term effect on individual hooded seals and would not result in population-level impacts.

6.12.5 Harp Seal

Harp seals may be present in the project vicinity January through May. In general, harp seals are much rarer than the harbor seal and gray seal in the Piscataqua River. As discussed in Section 6.11 and above for hooded seals, the Navy is requesting one Level B take of harp seal per month of construction as was authorized by NMFS for the Berth 11 Waterfront Improvements project (NMFS 2018a) during the timeframe (January 2020 through May 2020) when harp seal may occur (Total of 5 Level B takes). Anticipating one Level B harp seal take per month of construction for 5 months would guard against potential unauthorized take of this species. To date, the monitoring for the Berth 11 Waterfront

Improvements Construction project has not recorded a sighting of harp seal in the project area (Cianbro 2018a,b; NAVFAC Mid-Atlantic 2018; Lamontagne 2018, personal communication). Therefore, no Level A takes are requested.

Potential takes would likely involve harp seals that are moving through the area on foraging trips or to the downstream haul-out site as a result of underwater or airborne noise during pile driving or extraction. Harp seals that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, harp seals may move away from the sound source and be temporarily displaced from waters near the construction areas. With the absence of any major rookeries and only one isolated haul-out site 1.5 miles from the proposed project area, potential takes by disturbance would have a negligible short-term effect on individual harp seals and would not result in population-level impacts.

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7 IMPACTS TO MARINE MAMMAL SPECIES OR STOCKS

The anticipated impact of the activity upon the species or stock of marine mammals

7.1 Potential Effects of Pile Driving on Marine Mammals

7.1.1 Potential Effects Resulting from Underwater Noise

The effects of pile driving on marine mammals are dependent on several factors, including the species, size, and depth of the animal; the depth, intensity, and duration of the pile driving sound; the depth of the water column; the substrate of the habitat; the distance between the pile and the animal; and the sound propagation properties of the environment. Impacts on marine mammals from pile driving activities are expected to result primarily from acoustic pathways. As such, the degree of effect is intrinsically related to the received level and duration of the sound exposure, which are in turn influenced by the distance between the animal and the source. The farther away from the source, the less intense the exposure should be. The substrate and depth of the habitat affect the sound propagation properties of the environment. Shallow environments are typically more structurally complex, which leads to rapid sound attenuation. In addition, substrates that are soft (e.g., sand) will absorb or attenuate the sound more readily than hard substrates (e.g., rock), which may reflect the acoustic wave. Soft porous substrates will also likely require less time to drive the pile, and possibly less forceful equipment, which will ultimately decrease the intensity of the acoustic source (Dahl et al., 2015).

Potential impacts on marine species are expected to be the result of physiological responses to both the type and strength of the acoustic signature (Viada et al., 2008). Behavioral impacts may also occur, though the type and severity of these effects are more difficult to define due to limited studies addressing the behavioral effects of impulsive as well as non-impulsive sounds on marine mammals. Potential effects can range from brief acoustic effects such as behavioral disturbance, tactile perception, physical discomfort, slight injury of the internal organs and temporary to permanent impairment of the auditory system to death of the animal (Yelverton et al., 1973; O'Keefe and Young, 1984; Ketten, 1995; Navy, 2001; Dahl et al., 2015; Finneran 2015; Kastelein et al., 2016, 2018).

7.1.1.1 Physiological Responses

Direct tissue responses to impact/impulsive sound stimulation may range from mechanical vibration or compression with no resulting injury to tissue trauma (injury). Because the ears are the most sensitive organ to pressure, they are the organs most sensitive to injury (Ketten, 2000). Sound-related trauma can be lethal or sub-lethal. Lethal impacts are those that result in immediate death or serious debilitation in or near an intense source (Ketten, 1995). Sub-lethal damage to the ear from a pressure wave can rupture the tympanum, fracture the ossicles, damage the cochlea, cause hemorrhage, and leak cerebrospinal fluid into the middle ear (Ketten 2004). Sub-lethal impacts also include hearing loss, which is caused by exposure to perceptible sounds. Moderate injury implies partial hearing loss. Permanent hearing loss (also called PTS) can occur when the hair cells of the ear are damaged by a very loud event, as well as prolonged exposure to noise. Instances of TTS and/or auditory fatigue are well documented in marine mammal literature as being one of the primary avenues of acoustic impact. TTS has been documented in controlled settings using captive marine mammals exposed to strong SELs at various frequencies (Ridgway et al., 1997; Kastak et al., 1999; Finneran et al., 2005; Finneran 2015). While injuries to other sensitive organs are possible, they are less likely since pile driving impacts are almost entirely acoustically mediated, versus explosive sounds, which also include a shock wave that can result in damage. Based on the mitigation measures outlined in Chapter 11 and the conservative modeling assumptions discussed in Chapter 6, harbor seals and gray seal are likely to be present as they are common in the area but not necessarily at high densities. They have been present during previous construction activities at the Shipyard of which behaviors recorded did not indicate injury or harm. Therefore, auditory effects could be experienced by individual seals, but will not cause population-level impacts or affect the continued survival of the species.

7.1.1.2 Behavioral Responses

Behavioral responses to sound are highly variable and context-specific. For each potential behavioral change, the magnitude of the change ultimately determines the severity of the response. A number of factors may influence an animal's response to noise, including its previous experience, its auditory sensitivity, its biological and social status (including age and sex), and its behavioral state and activity at the time of exposure. Habituation occurs when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok et al., 2004). Animals are most likely to habituate to sounds that are predictable and unvarying. The opposite process is sensitization, when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. Behavioral state or differences in individual tolerance levels may affect the type of response as well. For example, animals that are resting may show greater behavioral change in response to disturbing noise levels than animals that are highly motivated to remain in an area for feeding (Richardson et al., 1995; National Research Council, 2003; Wartzok et al., 2004). Indicators of disturbance may include sudden changes in the animal's behavior or avoidance of the affected area. A marine mammal may show signs that it is startled by the noise and/or it may swim away from the sound source and avoid the area. Increased swimming speed, increased surfacing time, and cessation of foraging in the affected area would indicate disturbance or discomfort. Pinnipeds may increase their haulout time, possibly to avoid in-water disturbance.

Controlled experiments with captive marine mammals showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway et al., 1997; Finneran et al., 2003). Observed responses of wild marine mammals to loud pulsed sound sources (typically seismic guns or acoustic harassment devices, and also including pile driving) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds, 2002; also see reviews in Gordon et al., 2004; Wartzok et al., 2004; and Nowacek et al., 2007). Some studies of acoustic harassment and acoustic deterrence devices have found habituation in resident populations of seals and harbor porpoises (see review in Southall et al., 2007). Blackwell et al. (2004) found that ringed seals exposed to underwater pile driving sounds in the 153 to 160 dB RMS range tolerated this noise level and did not seem unwilling to dive. One individual was as close as 207 feet (63 m) from the pile driving. Responses of two pinniped species to impact pile driving at the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project were mixed (CALTRANS, 2001; 2006; 2010). Harbor seals were observed in the water at distances of approximately 1,300 to 1,650 ft (400 to 500 m) from the pile driving activity and exhibited no alarm responses, although several showed alert reactions, and none of the seals appeared to remain in the area. One of these harbor seals was even seen to swim to within 492 feet (150 m) of the pile driving barge during pile driving.

Observations were made during construction at Berth 11 where a variety of behaviors were observed for seals. Harbor seals were observed milling and swimming within the area at 59 percent and 29 percent, respectively. No foraging behavior was observed. Gray seals were exhibiting these same behaviors but were also observed foraging approximately 5 percent of the time. One undefined seal behavior was recorded frequently was one in which individuals would be bobbing, diving and resurfacing repeatedly for 2 to 6 minutes before final dive. Harbor porpoise were only observed with one behavior and that was of porpoising through the river channel.

Studies of marine mammal responses to continuous noise, such as vibratory pile installation, are limited. Marine mammal monitoring at the Port of Anchorage marine terminal redevelopment project found no response by marine mammals swimming within the threshold distances to noise impacts from construction activities including pile driving (both impact hammer and vibratory driving) (Integrated Concepts & Research Corporation, 2009). Most marine mammals observed during the two lengthy construction periods (i.e., beluga whales, harbor seals, harbor porpoises, and Steller sea lions) were observed in smaller numbers. Background noise levels at this port are typically at 125 dB.

A comprehensive review of acoustic and behavioral responses to noise exposure by Nowacek et al. (2007) concluded that one of the most common behavioral responses is displacement. To assess the significance of displacement, it is necessary to know the areas to which the animals relocate, the quality of that habitat, and the duration of the displacement in the event that they return to the pre-disturbance area. Short-term displacement may not be of great concern unless the disturbance happens repeatedly. Similarly, long-term displacement may not be of concern if adequate replacement habitat is available.

Marine mammals encountering pile driving operations over the project's proposed construction timeframe will likely avoid affected areas in which they experience noise-related discomfort, limiting their ability to forage or rest there. As described in the section above, individual responses to pile driving noise are expected to be variable: some individuals may occupy the project area during pile driving without apparent discomfort, but others may be displaced with undetermined long-term effects. For example, harbor seals have been observed to temporarily avoid areas within 15 mi of active pile driving starting from predicted received levels of between 166 and 178 dB re 1 µPa (Russell et al., 2016). Avoidance of the affected area during pile driving operations will reduce the likelihood of injury impacts but will reduce access to foraging areas. Noise-related disturbance may also inhibit some marine mammals from transiting the area. Given the duration of the in-water construction period, there is a potential for displacement of marine mammals from the affected area due to these behavioral disturbances during the in-water construction period. However, habituation over time may occur, along with a decrease in the severity of responses. Also, since pile driving will only occur during daylight hours, marine mammals transiting the proposed project area or foraging or resting in the proposed project area at night will not be affected. Effects of pile driving activities will be experienced by individual marine mammals, but will not cause population-level impacts or affect the continued survival of the species.

7.1.2 Potential Effects Resulting from Airborne Noise

Marine mammals that occur in the proposed project area could be exposed to airborne sounds associated with pile driving that have the potential to cause behavioral harassment, depending on their distance from pile driving activities. Airborne pile driving noises are expected to have very little impact to cetaceans because noise from atmospheric sources does not transmit well through the air-water interface (Richardson et al., 1995), consequently, cetaceans are not expected to be exposed to airborne sounds that will result in harassment as defined under the MMPA. Airborne noise will primarily be an issue for pinnipeds that are swimming or hauled out within the range of impact as defined by the acoustic criteria discussed in Chapter 6. Most likely, airborne sound will cause behavioral responses similar to those discussed above in relation to underwater noise. For instance, anthropogenic sound could cause hauled-out pinnipeds to exhibit changes in their normal behavior, such as reduction in vocalizations, or cause them to temporarily abandon their usual or preferred locations and move farther from the noise source. Pinnipeds swimming in the vicinity of pile driving may avoid or withdraw from the area or may show increased alertness or alarm (e.g., heading out of the water, looking around). However, studies of ringed seals by Blackwell et al. (2004) and Moulton et al. (2005) indicate a tolerance or lack of response to unweighted airborne sounds as high as 112 peak dB and 96 dB RMS, which suggests that habituation occurred.

California sea lions and harbor seals were present during impact installation and vibratory extraction of piles at Naval Base Kitsap Bremerton in February 2014 and November 2014 to February 2015 (Northwest Environmental Consulting, 2014; 2015). In February 2014, California sea lions were observed basking on the Port Security Barrier within the underwater behavioral disturbance zone (384 ft [117 m] from the driven pile), and no behavioral harassment takes were documented because they did not enter the water. California sea lions and harbor seals were observed in the water during vibratory hammer activity. Protected Species Observers (PSOs) detected 160 individuals during vibratory pile extraction within the 5,249 ft (1,600 m) vibratory disturbance zone, resulting in exposure to noise levels above the Level B threshold. PSOs detected 125 individuals during impact pile driving within the 384 ft (117 m) impact disturbance zone, resulting in exposure to noise levels above the Level B threshold. There were no shutdowns of pile driving activity because pinnipeds never entered the shutdown zones. No visible behaviors indicating a reaction to noise disturbance were observed. Behaviors observed included hauling-out (resting), foraging, milling, and traveling.

Based on these observations, marine mammals in the impact zones may exhibit temporary behavioral reactions to airborne pile driving noise. Because the impact areas for airborne noise are smaller than the underwater behavioral threshold zones, a separate analysis of Level B take was not conducted for the airborne zones. Animals in the airborne zones would already have been exposed within a Level B underwater zone; therefore, no additional takes due to exposure to airborne noise are requested because any of these additional temporary behavioral reactions to airborne pile driving noise are included within the take estimate from the underwater noise. These exposures may have a temporary effect on individual or groups of animals, but this level of exposure is very unlikely to result in population-level impacts. Further, there are no known haul-out sites for any seal species within the vicinity of the proposed project area. The closest known haul-out site to the proposed project area is 1.5 miles downriver of the proposed project area. Therefore, acoustic disturbance to hauled-out pinnipeds is unlikely.

7.2 Conclusions Regarding Impacts on Species or Stocks

Individual marine mammals may be exposed to increased sound during pile driving operations, which may result in Level B behavioral harassment and, for harbor seals and gray seals, some Level A harassment. Any marine mammals that are exposed (harassed) may change their normal behavior patterns (e.g., swimming speed, foraging habits, etc.) or be temporarily displaced from the area of construction. Any exposures to Level B harassment will likely have only a minor effect on individuals and no effect on the population. For harbor seals and gray seals, exposure to Level A harassment during impact pile driving could result in a permanent change in hearing thresholds. To avoid permanent impacts to harbor seal hearing, shutdown zones will be implemented. The sound generated from vibratory pile driving will not result in injury to marine mammals because the areas where injury could potentially occur (Level A) are relatively small and shutdown zones will be implemented as shown in Table 11-1 in which pile driving will shutdown if marine mammals approach these zones. Mitigation is expected to minimize most potential adverse underwater impacts to marine mammals from impact pile driving. Nevertheless, some exposure is unavoidable. The expected level of unavoidable exposure (defined as acoustic harassment) is presented in Chapter 6. This level of effect is not anticipated to have any adverse impact to population recruitment, survival, or recovery.

8 IMPACTS TO SUBSISTENCE USE

The anticipated impact of the activity on the availability of the species or stock of marine mammals for subsistence uses.

This section is not applicable. The project would take place in the coastal Atlantic Ocean of Maine-specifically, the Piscataqua River. No traditional subsistence hunting areas are within the region.

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9 IMPACTS TO THE MARINE MAMMAL HABITAT AND THE LIKELIHOOD OF RESTORATION

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

Impacts to habitat will be temporary and include increased human activity and noise levels; localized, minor impacts to water quality; and changes in prey availability near the individual project sites. Impacts will not result in permanent impacts to habitats used directly by marine mammals.

9.1 Effects from Human Activity and Noise

Existing human activity and underwater noise levels, primarily due to industrial activity and vessel traffic, could increase above baseline temporarily during in-water construction.

Marine mammals in proposed project and surrounding areas encounter vessel traffic associated with both Navy and non-Navy activities. Behavioral changes in response to vessel presence include avoidance reactions, alarm/startle responses, temporary abandonment of haulouts by pinnipeds, and other behavioral and stress-related changes (such as altered swimming speed, direction of travel, resting behavior, vocalizations, diving activity, and respiration rate) (Watkins, 1986; Würsig et al., 1998; Terhune and Verboom, 1999; Ng and Leung, 2003; Foote et al., 2004; Mocklin, 2005; Bejder et al., 2006; Nowacek et al., 2007). Some dolphin species approach vessels and are observed bow riding or jumping in the wake of vessels (Norris and Prescott, 1961; Shane et al., 1986; Würsig et al., 1998; Ritter, 2002). In other cases, neutral behavior (i.e., no obvious avoidance or attraction) has been reported (review in Nowacek et al., 2007). Little is known about the biological importance of changes in marine mammal behavior under prolonged or repeated exposure to high levels of vessel traffic, such as increased energetic expenditure or chronic stress, which can produce adverse hormonal or nervous system effects (Reeder and Kramer, 2005).

During proposed construction activities, additional vessels may operate in the proposed project area, but will operate at low speeds within the relatively limited construction zone and access route during the in-water construction period. The presence of vessels will be temporary and occur at current Navy facilities that have some level of existing vessel traffic. Therefore, effects are expected to be limited to short-term behavioral changes and are not expected to rise to the level of take or harassment as defined under the MMPA.

Additional noise could be generated by barge mounted equipment, such as cranes and generators, but this noise will typically not exceed existing underwater noise levels resulting from existing routine waterfront operations. While the increase may change the quality of the habitat, it is not expected to exceed the Level A or B harassment thresholds, and impacts to marine mammals from these noise sources is expected to be negligible.

9.2 Pile Driving and Drilling Effects on Potential Foraging Habitat

Temporary and localized reduction in water quality will occur as a result of in-water construction activities. Most of this effect will occur during the installation of piles when bottom sediments are disturbed. The installation of piles will disturb bottom sediments and may cause a temporary increase in suspended sediment in the project area. Using available information collected from a project in the Hudson River, pile driving activities are anticipated to produce total suspended sediment (TSS) concentrations of approximately 5.0 to 10.0 mg/L above background levels within approximately 300 feet (91 meters) of the pile being driven (FHWA 2012). During pile extraction, sediment attached to the pile moves vertically through the water column until gravitational forces cause it to slough off under its own weight. The small resulting sediment plume is expected to settle out of the water column within a few hours. Studies of the effects of turbid water on fish (marine mammal prey) suggest that concentrations of suspended sediment can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). The TSS levels expected for pile driving or removal (5.0 to 10.0 mg/L) are below those shown to have adverse effects on fish (580.0 mg/L for the most sensitive species, with 1,000.0 mg/L more typical) and benthic communities (390.0 mg/L (EPA 1986)). Effects to turbidity and sedimentation are expected to be short-term, minor, and localized. Since the currents are so strong in the area, suspended sediments in the water column should dissipate and quickly return to background levels. Following the completion of sediment-disturbing activities, the turbidity levels are expected to return to normal ambient levels following the end of construction in all construction scenarios. Turbidity within the water column has the potential to reduce the level of oxygen in the water and irritate the gills of prey fish species in the proposed project area. However, turbidity plumes associated with the Project would be temporary and localized, and fish in the proposed project area would be able to move away from and avoid the areas where plumes may occur. Therefore, it is expected that the impacts on prey fish species from turbidity, and therefore on marine mammals, would be minimal and temporary. In general, the area likely impacted by the Project is relatively small compared to the available habitat in Great Bay Estuary. As a result, activity at the Project site would be inconsequential in terms of its effects on marine mammal foraging.

9.2.1 Underwater Noise Impacts on Fish

The greatest potential impact to fish during construction would occur during impact pile driving when pile driving will exceed the established underwater noise injury thresholds for fish. However, the duration of impact pile driving would be limited to the final stage of installation ("proofing") after the pile has been driven as close as practicable to the design depth with a vibratory driver. Vibratory pile driving would possibly elicit behavioral reactions from fish such as temporary avoidance of the area but is unlikely to cause injuries to fish or have persistent effects on local fish populations. In addition, it should be noted that the area in question is low-quality habitat since it is already highly developed and experiences a high level of anthropogenic noise from normal Shipyard operations and other vessel traffic. In general, impacts on marine mammal prey species are expected to be minor and temporary. Therefore, adverse effects to the marine mammal prey base will be insignificant and will not rise to the level of MMPA take.

9.3 Summary of Impacts on Marine Mammal Habitat

All marine mammal species using habitat near the proposed project area are primarily transiting the area; no known foraging or haul-out areas are located within 1.5 miles of the proposed project area. The most likely impacts on marine mammal habitat for the Project are from underwater noise, turbidity, and potential effects on the food supply. However, it is not expected that any of these impacts would be significant.

Construction may have temporary impacts on benthic invertebrate species, another marine mammal prey source. Benthic invertebrates that are commonly prey for marine mammals, such as squid species, were not detected during a 2014 benthic survey of the proposed project area (C.R. Environmental, Inc. 2014). Direct benthic habitat loss would result with the permanent loss of approximately 3.5 acres of benthic habitat from construction of the super flood basin. The water surface of Great Bay Estuary extends approximately 4.45 square miles (124,000,000 sf) at low tide (Mills, No date). Therefore, the loss of 152,000 sf would represent approximately one-tenth of one percent of the benthic habitat in the estuary at low tide. However, the areas to be permanently removed are beneath and adjacent to the existing berths along the Shipyard's industrial waterfront and are regularly disturbed as part of the construction dredging to maintain safe navigational depths at the berths. Further, vessel activity at the berths creates minor disturbances of benthic habitats (e.g., vessel propeller wakes) during waterfront operations. Therefore, impacts of the project are not likely to have adverse effects on marine mammal foraging habitat in the proposed project area.

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10 IMPACTS TO MARINE MAMMALS FROM LOSS OR MODIFICATION OF HABITAT

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The proposed activities would result in the loss of 3.5 acres of benthic habitat but as discussed in section 9.3, these areas are routinely dredged and would not significantly impact available prey for marine mammals. The water surface of Great Bay Estuary extends approximately 4.45 square miles (124,000,000 sf) at low tide (Mills, No date). Therefore, the loss of 152,000 sf would represent approximately one-tenth of one percent of the benthic habitat in the estuary at low tide. The most important impacts on marine fish species consumed by marine mammals will result from potential injury and behavioral disturbance to fish species during pile driving. Information provided in Chapter 9 indicates there may be temporary impacts, but those impacts will be short-term and construction noise will cease upon the completion of in-water construction activities.

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11 MEANS OF EFFECTING THE LEAST PRACTICABLE ADVERSE IMPACTS

The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

The Navy will employ the minimization measures listed in this chapter to avoid and minimize impacts on marine mammals, their habitats, and forage species. Best Management Practices (BMPs) and minimization measures are included in the construction contract plans and must be agreed upon by the contractor prior to any construction activities.

11.1 General Construction Best Management Practices

- The construction contractor will be responsible for preparation of an environmental protection plan. The plan will be submitted and implemented prior to the commencement of any construction activities and is a binding component of the overall contract. The plan shall identify construction elements and recognize spill sources at the site. The plan shall outline BMPs, responsive actions in the event of a spill or release, and notification and reporting procedures. The plan shall also outline contractor management elements such as personnel responsibilities, project site security, site inspections, and training.
- No petroleum products, chemicals, or other toxic or harmful materials shall be allowed to enter surface waters.
- Washwater resulting from washdown of equipment or work areas shall be contained for proper disposal and shall not be discharged unless authorized.
- Equipment that enters surface waters shall be maintained to prevent any visible sheen from petroleum products.
- No oil, fuels, or chemicals shall be discharged to surface waters or onto land where there is a potential for re-entry into surface waters to occur. Fuel hoses, oil drums, oil or fuel transfer valves, fittings, etc. shall be checked regularly for leaks. Materials will be maintained and stored properly to prevent spills.
- No cleaning solvents or chemicals used for tools or equipment cleaning shall be discharged to ground or surface waters.
- Any floating debris generated during installation will be retrieved. Any debris in a containment boom will be removed by the end of the work day or when the boom is removed, whichever occurs first. Retrieved debris will be disposed of at an upland disposal site.

11.2 Minimization Measures for Marine Mammals

The following mitigation measures will be implemented during pile driving to minimize marine mammal exposure to Level A injurious noise levels generated from impact pile driving and to reduce to the lowest extent practicable exposure to Level B disturbance noise levels.

11.2.1 Coordination

The Navy shall conduct briefings between construction supervisors and crews, the marine mammal monitoring team, and Navy staff prior to the start of all pile driving activity and when new personnel join the work, to explain responsibilities, communication procedures, marine mammal monitoring protocol, and operational procedures.

11.2.2 Acoustic Minimization Measures

Vibratory installation will be used to the extent possible to drive steel piles to minimize high SPLs associated with impact pile driving.

11.2.3 Soft Start

The objective of a soft start is to provide a warning and/or give animals in close proximity to pile driving a chance to leave the area prior to a vibratory or impact driver operating at full capacity, thereby exposing fewer animals to loud underwater and airborne sounds.

- A soft start procedure will be used for impact pile driving at the beginning of each day's in-water pile driving or any time pile driving has ceased for more than 1 hour.
- The contractor will provide an initial set of strikes from the impact hammer at reduced energy, followed by a 30-second waiting period, then two subsequent sets. (The reduced energy of an individual hammer cannot be quantified because it varies by individual drivers. Also, the number of strikes will vary at reduced energy because raising the hammer at less than full power and then releasing it results in the hammer "bouncing" as it strikes the pile, resulting in multiple "strikes.")

11.2.4 Visual Monitoring and Shutdown Procedures

A marine mammal monitoring plan will be approved by NMFS prior to commencement of project activities. At a minimum, the plan will include the following:

- For all impact and vibratory pile driving, Level A shutdown and Level B behavioral disturbance zones will be monitored.
- The shutdown zone for impact pile driving of sheet piles and 36-inch steel pipe piles (120 m for harbor porpoise and 50 m for seals) was based on Level A distances previously calculated for installation of 36-inch steel pipe piles and, upon negotiation, accepted by NMFS as reasonable and protective (Table 11-1) (Guan 2018). These zones represent the largest area that can reasonably be monitored and were chosen with confidence based on current monitoring of harbor porpoise and seals for the Berth 11 project.
- During all in-water construction or demolition activities having the potential to affect marine mammals, in order to prevent injury from physical interaction with construction equipment, a shutdown zone of 33 feet or 10 meters will be implemented to ensure marine mammals are not present within this zone. These activities could include, but are not limited to: 1) the movement of a barge to the construction site, or 2) the removal of a pile from the water column/substrate via a crane (i.e., a "dead pull"). For some sound-generating activities, the potential for Level A harassment by acoustic injury extends less than 10 m from the source, and for these activities, the shutdown zone automatically mitigates/minimizes Level A acoustic harassment.

Table 11-1. Proposed Shutdown and Disturbance Zones by Activity and Marine Mammal

Pile Type	*Installation Method*	*Pile Diameter*	*Level A Injury and Shut Down Zone For Harbor Porpoise*	*Level A Injury and Shut Down Zone for Seals*	*Level B Behavioral Disturbance Zone*[1]
Steel pipe	Vibratory	36-inch	20 meters	10 meters	ROI
	Impact	36-inch	120 meters[1]	50 meters[1]	ROI
	Vibratory	16-inch	10 meters	10 meter	ROI
	Impact	16-inch	15 meters	10 meters	16 meters
Steel H	Vibratory	14-inch	10 meters	10 meters	ROI
	Impact	14-inch	35 meters	20 meters	136 meters
AZ Steel Sheet	Vibratory	24-inch	20 meters	10 meters	ROI
	Impact	24-inch	120 meters[1]	50 meters[1]	1,000 meters
Casing	Drilling	96-inch	60 meters	25 meters	ROI

Notes: [1] = Monitoring zone distance negotiated with NMFS

- 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 impact pile driving. Therefore, the ZOI for disturbance for 36-inch steel pipe piles would be the entire ROI; the maximum distance for Level B disturbance. Because only a small fraction of the piles associated with the Proposed Action are 36-inches in diameter, these piles would only be driven for a few months. Therefore, the disturbance zone may be reduced as summarized in Table 11-1, when these piles are not being installed.
- The shutdown zone would be visually monitored for all pile driving days and the full extent of the disturbance zone would be visually monitored for two thirds of the pile- driving days as monitoring of the shutdown zone would require the partial monitoring of the disturbance zone.
- If a marine mammal species for which incidental take has not been authorized is seen approaching or entering the shutdown zone or the disturbance zone during impact or vibratory pile driving, pile driving will cease. If such circumstances recur, the Navy will consult with NMFS concerning the potential need for an additional take authorization.
- Pile driving will cease if any marine mammal is detected in the shutdown zone. If a marine mammal is observed in the disturbance zone, but not approaching or entering the shutdown zone, a "take" will be recorded, and the work will be allowed to proceed without cessation. Its behavior will be monitored and documented.
- In the event of a shutdown, pile driving will be halted and delayed until either the animal has voluntarily left and been visually confirmed beyond the shutdown zone or the disturbance zone, for pinnipeds and cetaceans, respectively, or 30 minutes have elapsed without re-detection of the animal.
- Monitoring will take place from 30 minutes prior to initiation through 30 minutes post-completion of pile driving. Prior to the start of pile driving, the shutdown zone and disturbance zone will be monitored for 30 minutes to ensure that the zones are clear of marine mammals. Pile driving will only commence once observers have declared the shutdown zone clear of pinnipeds and the shutdown/behavior zones are clear of cetaceans.

- Visual monitoring will be conducted by experienced biologists with training in marine mammal detection and the ability to describe relevant behaviors that may occur in proximity to in-water construction activities (hereafter "Protected Species Observers [PSOs]").
- Monitoring will be conducted by, at a minimum, a two-person marine mammal monitoring team designated by the construction contractor. Given the configuration of the ZOI (relatively narrow and linear [Figure 11-1]), it is assumed that two to four marine mammal observers would be sufficient to monitor the ZOI given the abundance of suitable vantage points along the ZOI. However, additional monitors may be added if warranted by the level of marine mammal activity in the area. Trained PSOs will be placed at the best vantage point(s) practicable (e.g., from a small boat, construction barges, on shore, or any other suitable location) to monitor for marine mammals and implement shutdown/delay procedures when applicable by calling for the shutdown to the pile driver operator. The marine mammal observers shall have no other construction related tasks while conducting monitoring.
- If the shutdown zone is obscured by fog or poor lighting conditions, pile driving will not be initiated until the entire shutdown zone is visible.

11.2.5 Acoustic Measurements.

Acoustic measurements will continue during in-water construction for the Project and will be used to empirically adjust the shutdown and disturbance zones, upon approval from NMFS. For further detail regarding our acoustic monitoring plan, see Section 13.

11.2.6 Data Collection

NMFS requires that at a minimum, the following information be collected on the sighting forms:

- Name of marine mammal observer
- Date and time that pile removal or installation begins and ends, type of pile driving (impact or vibratory), pile size and type (i.e., concrete or steel)
- Construction activities occurring during each observation period
- Weather parameters identified in the acoustic monitoring (e.g., percent cover, visibility)
- Water conditions (e.g., sea state, tidal state [incoming, outgoing, slack, low, and high])
- Species, numbers, and, if possible, sex and age class of marine mammals
- Time of sighting
- Marine mammal behavior patterns observed, including bearing and direction of travel, and, if possible, the correlation to SPLs
- Distance from pile removal and installation activities to marine mammals and distance from the marine mammal to the observation point
- Locations of all marine mammal observations
- Other human activity in the area

The Navy will note behavioral observations, to the extent practicable, if an animal has remained in the area during construction activities. Therefore, it may be possible to identify if the same animal or different individuals are being taken.

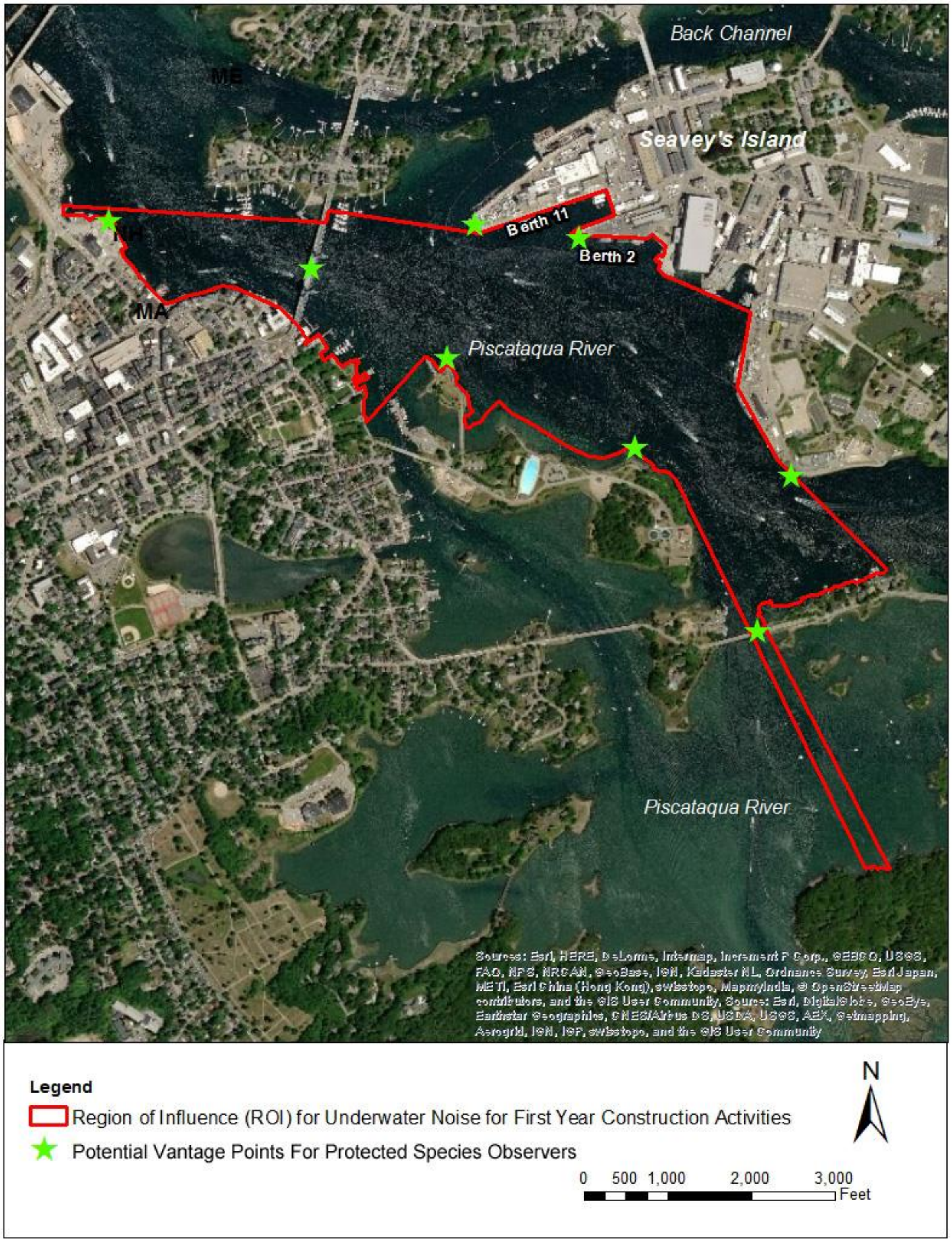

Figure 11-1. Potential Vantage Points for Protected Species Observers

11.2.7 Mitigation Effectiveness

As identified in 11.2.4, all observers utilized for mitigation activities will be experienced biologists with training in marine mammal detection and behavior. Due to their specialized training, the Navy expects that visual mitigation will be highly effective. Trained observers have specific knowledge of marine mammal physiology, behavior, and life history that may improve their ability to detect individuals or help determine whether observed animals are exhibiting behavioral reactions to construction activities.

Visual detection conditions in the proposed project area are generally excellent. Located in Portsmouth Harbor, the area is sheltered from large swells and infrequently experiences strong winds. Observers will be positioned in locations that provide the best vantage point(s) for monitoring, such as on nearby piers or on a small boat, and the shutdown and disturbance zones cover relatively small and accessible areas of the lower Piscataqua River. As such, proposed mitigation measures are likely to be very effective.

12 ARCTIC PLAN OF COOPERATION

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:

(i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;

(ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;

(iii) A description of what measures the applicant has taken an/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and

(iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

This section is not applicable. There is not subsistence use of marine mammal species or stocks in the proposed project area.

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13 MONITORING AND REPORTING MEASURES

The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding.

13.1 Monitoring Plan

The following monitoring measures would be implemented along with the mitigation measures (Section 11) in order to reduce impacts to marine mammals to the lowest extent practicable during the period of this IHA. A marine mammal monitoring plan will be developed further and submitted to NMFS for approval well in advance of the start of construction during the IHA period. The monitoring plan will include the following components: acoustic measurements and visual observations.

The Navy intends to complete marine mammal and acoustic surveys of the proposed project area in order to provide a more robust assessment of sound levels from pile driving and marine mammal responses, and to refine avoidance and minimization measures as warranted by the results. For in-water pile driving activities occurring during the first year of construction, the monitoring described below would be implemented.

13.2 Reporting Plan

The Navy will implement in situ acoustic monitoring efforts to measure SPL from in-water construction activities. The Navy will collect and evaluate acoustic sound record levels for 10 percent of the pile driving activities conducted. Hydrophones would be placed at locations 33 feet from the noise source and, where the potential for Level A harassment exists, at a second representative monitoring location at an intermediate distance between the cetacean and phocid shutdown zones. For the 10 percent of pile driving events acoustically measured, 100 percent of the data will be analyzed.

At a minimum, the methodology includes:

- For underwater recordings, a stationary hydrophone system with the ability to measure SPLs will be placed in accordance with NOAA Fisheries Service's most recent guidance for the collection of source levels.
- Hydroacoustic monitoring will be conducted for 10 percent of each different type of pile and each method of installation and removal. Monitoring will occur at source (33 feet); at a location intermediate of the pinniped and cetacean shutdown ZOIs; and occasionally near the predicted ZOIs for Level B (behavioral) harassment. The resulting data set will be analyzed to examine and confirm sound pressure levels and rates of transmission loss for each separate in-water construction activity. With NOAA Fisheries Service's concurrence, these metrics will be used to recalculate the limits of injury and disturbance zones for the Letter of Authorization being prepared for construction years 2 through 6 of this project, and to make corresponding adjustments in marine mammal monitoring of these zones. Hydrophones will be placed using a static line deployed from a stationary (temporarily moored) vessel. Locations of hydroacoustic recordings will be collected via GPS. A depth sounder

and/or weighted tape measure will be used to determine the depth of the water. The hydrophone will be attached to a weighted nylon cord to maintain a constant depth and distance from the pile. The nylon cord or chain will be attached to a float or tied to a static line.

- Each hydrophone (underwater) will be calibrated at the start of each action and will be checked frequently to the applicable standards of the hydrophone manufacturer.
- For each monitored location, a single hydrophone will be suspended midway in the water column in order to evaluate site-specific attenuation and propagation characteristics that may be present throughout the water column.
- In addition to determining the area encompassed by the 160 and 120 dB RMS isopleths for marine mammals, hydrophones would also be placed at other distances as appropriate to accurately capture source levels and spreading loss.
- Environmental data would be collected, including but not limited to, the following: wind speed and direction, air temperature, humidity, surface water temperature, water depth, wave height, weather conditions, and other factors that could contribute to influencing the airborne and underwater sound levels (e.g., aircraft, boats, etc.).
- The construction contractor would supply the acoustics specialist with the substrate composition, hammer model and size, hammer energy settings and any changes to those settings during the piles being monitored, depth of the pile being driven, and blows per foot for the piles monitored.
- For acoustically monitored piles, data from the continuous monitoring locations will be post-processed to obtain the following sound measures:
    - Maximum peak pressure level recorded for all the strikes associated with each pile, expressed in dB re 1 µPa. This maximum value will originate from the phase of pile driving during which hammer energy was also 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 in [dB re 1 µPa]
        - mean duration of a pile strike (based on the 90% energy criterion)
        - number of hammer strikes
        - mean, median, minimum, and maximum single strike SEL in [dB re μPa^2 sec]
    - cumulative SEL as defined by the mean single strike SEL + 10*log (# hammer strikes) in [dB re μPa^2 sec]
    - Median integration time used to calculate SPL RMS
    - A frequency spectrum (pressure spectral density) in [dB re μPa^2 per Hz] based on the average of up to eight successive strikes with similar sound. Spectral resolution will be 1 Hz, and the spectrum will cover nominal range from 7 Hz to 20 kHz.
    - Finally, the cumulative SEL 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 measure is defined as the sum of all single strike SEL values. The sum is taken of the antilog, with $\log_{10}$ taken of result to express in [dB re μPa^2 sec].

13.2.1 Visual Marine Mammal Observations

Visual monitoring of the entire Level A shutdown zones would occur for 100 percent of pile driving activities as indicated in Table 11-1. The entire Level B disturbance zone will be visually monitored during two-thirds of all pile-driving days. If a marine mammal is observed entering the disturbance zone, an exposure would be recorded and behaviors documented. The Navy will use the data collected during monitoring days to extrapolate and calculate total takes for all pile-driving days. All observers will be trained in marine mammal identification and behaviors. NOAA Fisheries Service requires that the observers have no other construction-related tasks while conducting monitoring.

13.2.2 Methods of Monitoring

The Navy will monitor the shutdown zone and disturbance zone before, during, and after pile driving activities. Based on NOAA Fisheries Service requirements, the Marine Mammal Monitoring Plan would include the following procedures:

- PSOs will be located on land, land-based features such docks, piers, or bridges, or small craft vessels in order to properly observe the entire shut-down zone(s);
- The number of PSOs would vary from 2 to 4 depending on the size of the zone associated with the type of noise generating activity occurring;
- PSOs will be located at the best vantage point(s) to observe the zone associated with behavioral impact thresholds;
- During all observation periods, observers will use binoculars and the naked eye to search continuously for marine mammals;
- Monitoring distances will be measured with range finders;
- Distances to animals will be based on the best estimate of the PSO, relative to known distances to objects in the vicinity of the PSO;
- Bearing to animals will be determined using a compass;
- At the beginning of each survey phase (pre-construction, during construction, and post-construction);
- A census of pinniped species hauled out in the vicinity of pile driving encompassing the Level B harassment ZOIs will be performed;
- In-water activities will be curtailed under conditions of fog or poor visibility that might obscure the presence of a marine mammal within the shutdown zone;
- Pre-Activity Monitoring:
  - The shutdown and disturbance zones will be monitored for 30 minutes prior to in-water construction/demolition activities. If a marine mammal is present within the shutdown zone, the activity will be delayed until the animal(s) leave the shutdown zone. Activity will resume only after the PSO has determined that, through sighting or by waiting approximately 30 minutes, the animal has moved outside the shutdown zone. If a marine mammal is observed approaching the shutdown zone, the PSO who sighted that animal will notify the shutdown PSO of its presence.
- During Activity Monitoring:
  - If a marine mammal is observed entering the disturbance zone, that pile segment will be completed without cessation, unless the animal enters or approaches the shutdown

zone, at which point all pile driving activities will be halted. If an animal is observed within the shutdown zone during pile driving, then pile driving will be stopped as soon as it is safe to do so. Pile driving can only resume once the animal has left the shutdown zone of its own volition or has not been re-sighted for a period of 30 minutes.

- Post-Activity Monitoring:
    - Monitoring of the shutdown and disturbance zones will continue for 30 minutes following the completion of the activity.

13.2.3 Data Collection

NOAA Fisheries Service requires that the PSOs use NOAA Fisheries Service-approved sighting forms. NOAA Fisheries Service requires that, at a minimum, the following information be collected on the sighting forms:

- Date and time that pile driving or removal begins or ends;
- Construction activities occurring during each observation period;
- Weather parameters identified in the acoustic monitoring (e.g., wind, humidity, temperature);
- Tide state and water currents;
- Visibility;
- Species, numbers, and, if possible, sex and age class of marine mammals;
- Marine mammal behavior patterns observed, including bearing and direction of travel, and, if possible, the correlation to SPLs;
- Distance from pile driving activities to marine mammals and distance from the marine mammal to the observation point;
- Locations of all marine mammal observations;
- Other human activity in the area.

To the extent practicable, the Navy will record behavioral observations that may make it possible to determine whether the same or different individuals are being “taken” as a result of project activities over the course of a day.

13.3 Reporting

A draft report would be submitted to NOAA Fisheries Service within 45 calendar days of the completion of acoustic measurements and marine mammal monitoring. The results would be summarized in graphical form and include summary statistics and time histories of sound values based upon the data from the piles monitored for this IHA period. A final report would be prepared and submitted to the NOAA Fisheries Service within 30 days following receipt of comments on the draft report from the NOAA Fisheries Service. At a minimum, the report shall include:

- General data:
    - Date and time of activities.
    - Water conditions (e.g., sea state, tidal state).
    - Weather conditions (e.g., percent cover, visibility).
- Specific pile data for acoustically monitored piles:
    - Description of the activities being conducted.
    - Size and type of piles.
    - The machinery used for installation or removal.
    - The power settings of the machinery used for installation or removal.
- Specific acoustic monitoring information:

  - A description of the monitoring equipment.
  - The distance between hydrophone(s) and pile.
  - The depth of the hydrophone(s).
  - The physical characteristics of the bottom substrate where the piles were driven or extracted (if possible).
  - Acoustic data (per Section 13.1.1 above) for each.
- Pre-activity observational survey-specific data:
  - Dates and time survey is initiated and terminated.
  - Description of any observable marine mammal behavior in the immediate area during monitoring.
  - If possible, the correlation to underwater sound levels occurring at the time of the observable behavior.
  - Actions performed to minimize impacts to marine mammals.
- During activity observational survey-specific data:
  - Description of any observable marine mammal behavior within monitoring zones (shutdown and disturbance) or in the immediate area surrounding monitoring zones (shutdown and disturbance).
  - If possible, the correlation to underwater sound levels occurring at the time of this observable behavior.
  - Actions performed to minimize impacts to marine mammals.
  - Times when pile extraction is stopped due to presence of marine mammals within the shutdown zones and time when pile driving resumes.
- Post-activity observational survey-specific data:
  - Results, which include the detections of marine mammals, species and numbers observed, sighting rates and distances, and behavioral reactions within and outside of monitoring zones.
  - A refined take estimate based on the number of marine mammals observed during the course of construction.

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14 RESEARCH EFFORTS

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

The U.S. Navy is one of the world's leading organizations in assessing the effects of human activities in the marine environment, including marine mammals. From 2004 through 2013, the Navy has funded over $240M specifically for marine mammal research. Navy scientists work cooperatively with other government researchers and scientists, universities, industry, and non-governmental conservation organizations in collecting, evaluating, and modeling information on marine resources. They also develop approaches to ensure that these resources are minimally impacted by existing and future Navy operations. It is imperative that the Navy's research and development (R&D) efforts related to marine mammals are conducted in an open, transparent manner with validated study needs and requirements. The goal of the Navy's R&D program is to enable collection and publication of scientifically valid research as well as development of techniques and tools for Navy, academic, and commercial use. Historically, R&D programs are funded and developed by the Navy's Chief of Naval Operations Energy and Environmental Readiness and Office of Naval Research, Code 322 Marine Mammals and Biological Oceanography Program. Primary focus of these programs since the 1990s is on understanding the effects of sound on marine mammals, including physiological, behavioral, and ecological effects.

The Office of Naval Research's current Marine Mammals and Biology Program thrusts include, but are not limited to: (1) monitoring and detection research; (2) integrated ecosystem research, including sensor and tag development; (3) effects of sound on marine life (such as hearing, behavioral response studies, physiology [diving and stress], and Population Consequences of Acoustic Disturbance); and (4) models and databases for environmental compliance.

To manage some of the Navy's marine mammal research programmatic elements, the Navy developed the Living Marine Resources (LMR) Research and Development Program (http://www.lmr.navy.mil/) in 2011. The goal of the LMR Research and Development Program is to identify and fill knowledge gaps and to demonstrate, validate, and integrate new processes and technologies to minimize potential effects to marine mammals and other marine resources. Key elements of the LMR program include:

- Providing science-based information to support Navy environmental effects assessments for research, development, acquisition, testing, and evaluation as well as Fleet at-sea training, exercises, maintenance, and support activities;
- Improving knowledge of the status and trends of marine species of concern and the ecosystems of which they are a part;
- Developing the scientific basis for the criteria and thresholds to measure the effects of Navy-generated sound;
- Improving understanding of underwater sound and sound field characterization unique to assessing the biological consequences resulting from underwater sound (as opposed to tactical applications of underwater sound or propagation loss modeling for military communications or tactical applications); and
- Developing technologies and methods to monitor and, where possible, mitigate biologically significant consequences to LMR resulting from naval activities, emphasizing those consequences that are most likely to be biologically significant.

Overall, the Navy will continue to research and contribute to university/external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include monitoring programs, data sharing with NMFS from research and development efforts, and current research as previously described.

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Appendix A

Portsmouth Naval Shipyard Transmission Loss Model Work Plan

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Work Plan
Acoustic Transmission Loss Modeling for the Environmental Assessment of Modification and Expansion of Dry Dock 1 at Portsmouth Naval Shipyard Kittery, Maine

Final

June 1, 2018

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Acronyms and Abbreviations

ANSI	American National Standards Institute
$_{c}$SEL	cumulative SEL
dB	decibel(s)
dB $_{PEAK}$	instantaneous peak SPL in decibels (can apply to either airborne or underwater sound)
dB_{pk}	peak pressure
dB re 1 µPa	dB referenced to a pressure of 1 microPascal (measures underwater SPL)
dB re 1 µPa^2-sec	dB referenced to a pressure of 1 microPascal squared per second (measures underwater SEL)
dB re 20 µPa	dB referenced to a pressure of 20 microPascals (measures airborne SPL)
dB SEL_{CUM}	cumulative sound exposure level
EFH	Essential Fish Habitat
ESA	Endangered Species Act
GIS	geographical information systems
IHA	Incidental Harassment Authorization
kHz	kilohertz
lf	linear feet
L_{eq}	Equivalent continuous Sound Pressure Level
L_{max}	RMS maximum level of a noise
$L_{pk\ flat}$	peak sound pressure should be flat weighted or unweighted
L_E	cumulative sound exposure with accumulation period of 24 hours.
LOA	Letter of Authorization
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
ND	No data
NA	not applicable
NR	Not Reported

PTS	permanent threshold shift
RMS	root mean square
SEL	sound exposure level
SPL	sound pressure level
TTS	temporary threshold shift
TL	transmission loss
μPa	microPascal(s)
WFA	Weighting Factor Adjustments
ZOI	zone of influence

1 Overview

The Proposed Action is to modify and expand Dry Dock 1 at the Portsmouth Naval Shipyard (Shipyard) in Kittery, Maine. The elements of the Proposed Action includes construction of a super flood basin, extension of portal crane rail and utilities, and construction of two dry docks capable of servicing *Virginia* class (Block I-IV) submarines within the super flood basin. These elements would occur within the same footprint and in close succession. This Work Plan includes all pile driving and drilling activities associated with the Proposed Action that would occur during year 1 of construction as contained in Table 1. The project is expected to last 6 years and a Letter of Authorization (LOA) will be prepared for construction years 2-6. For the LOA this workplan would be amended with a memo identifying any additional new noise sources, proxy sound levels, and impacts.

The goal of this task is to develop a rigorous, defensible model of underwater and airborne sound transmission loss from proposed first year project activities for the purpose of mapping zones of influence (ZOIs) within which "takes" of marine mammals, as defined under the Marine Mammal Protection Act (MMPA). This task will also support the analysis of project effects on fish and Essential Fish Habitat (EFH). The key components of this analysis include 1) the definition of acoustic source levels; 2) mathematical models and assumptions for acoustic transmission loss from the source; 3) the application of thresholds for different levels of effect on marine mammals and other species to determine the distances within which those thresholds are exceeded; 4) mapping the resulting model of acoustic transmission loss onto the project area using geographical information systems (GIS) to quantify the areas of ZOIs; and 5) use of appropriate density data to estimate the number of animals that would be subject to acoustic harassment within ZOIs.

This submittal presents Cardno's Work Plan to accomplish this task. The proposed approach is consistent with that used in recent Navy applications for Incidental Harassment Authorizations and Letters of Authorization for similar construction activities at Navy installations on the Atlantic and Pacific coasts. A glossary of acoustical terms is provided in Section 8 at the end of the plan.

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Table 1. Pile Driving and Drilling for Construction Year 1

Activity	Pile Purpose	Pile Count	Pile Type and Size	Method of Install	Piles Installed per day/Shafts Drilled	Total Pile Driving Days	Average Hammer Operation (Seconds/blows per Pile)	Average Hammer Operation (Seconds/blows per Day)	Calendar (Weeks/ Days)
General Information	Temporary Structure*	48 piles (8 entrance structure float-in dolphins with 6 piles each)	Steel (conservative estimate = 3-ft diameter)	Impact w/ initial vibratory set	1 / day	48 days	300 seconds of driving @ 1 impact / second. Approx. 300 blows / pile depending on soil conditions.	300 seconds of driving @ 1 impact / second. Approx. 300 blows	48 days
		32 piles (cell and connector cell wall ring forms)	Steel, HP 14	Impact w/ initial vibratory set	5 / day	7 days	300 seconds of driving @ 1 impact / second. Approx. 300 blows / pile depending on soil conditions.	1500 seconds/1,500 blows	7 days
P310 Super Flood Basin	Sheet Pile Wall along Berth 1	320 piles (400 lf)	Z-shaped steel sheet piles (2-ft)	Impact w/ initial vibratory set	17 (25lf / day)	19 days	300 seconds of driving @ 1 impact / second. Approx. 300 blows / pile depending on soil conditions.	5,100 seconds/5,100 blows	19 days
	Closure Wall Construction	350 piles (South closure wall cells)	Flat web steel sheet piles (1.5 ft)	Impact w/initial vibratory set	17 (25 lf/day)	21 days	300 seconds of driving @1 impact/second. Approx. 300 blows/pile depending on soil conditions	5,100 seconds/5,100 blows	21 days
		110 piles (Berth 1 and 2 closure sheet pile and HP combi-wall 140 lf)	Z-shaped steel sheet piles (2-ft) Steel, HP 14	Impact w/initial vibratory set	17 (25 lf/day)	7 days	300 seconds of driving @1 impact/second. Approx. 300 blows/pile depending on soil conditions	5,100 seconds/5,100 blows	7 days

Activity	***Pile Purpose***	***Pile Count***	***Pile Type and Size***	***Method of Install***	***Piles Installed per day/Shafts Drilled***	***Total Pile Driving Days***	***Average Hammer Operation (Seconds/blows per Pile)***	***Average Hammer Operation (Seconds/blows per Day)***	***Calendar (Weeks/ Days)***
		320 piles (South closure wall façade sheeting formwork 475 lf)	Z-shaped steel sheet piles (2-ft width for south wall)	Impact w/initial vibratory set	17 (25 lf/day)	19 days	300 seconds of driving @1 impact/second. Approx. 300 blows/pile depending on soil conditions	5,100 seconds/5,100 blows	19 days
		250 (sheet pile cutoff wall 360 lf)	Z-shaped steel sheet piles (2-ft will surround 10 drilled shafts	Impact w/initial vibratory set	17 (25 lf/day)	15 days	300 seconds of driving @ 1 impact/second. Approx. 300 blows/pile depending on soil conditions	5,100 seconds/5,100 blows	15 days
		10 drilled shafts	8-ft diameter steel pipe casing	Impact/drilling (rock)	Less than 1 pipe casing installed/ day and 1 shaft drilled in 2 days	20 days	N/A	N/A	20 days
P1074 Extension of Portal Crane Rail and Utilities	Relieving Platform Support	8	16-inch steel pipe	Impact w/ initial vibratory set	4 / day	2 days	300 seconds of driving @ 1 impact / second. Approx. 300 blows / pile depending on soil conditions.	1,200 seconds/1,200 blows	2 days

Source: Appledore Marine Engineering, LLC 2018;

Notes:

*- vibratory extraction at end of project or cut off at mudline; lf = linear feet; N/A = Not Applicable

Construction Timeline – P310: Total anticipated duration of 2 years (Late Summer 2019 to late Summer 2021); P381: Total duration of 5 years (Summer 2021 to Summer 2026)

South closure wall: Phase 1 estimated duration is 2 months (Aug 2019 through Oct 2019); Phase 2 estimated duration is 7 months (Nov 2019 through May 2020).

North closure wall: Estimated duration is 7 months (Dec 2020 through June 2021).

2 Species to be Assessed for Impacts from Acoustic Sources

Species proposed to be assessed for impacts from acoustic sources are listed in Table 2. The list of marine mammal species is based on Marine Mammal Stock Assessment Reports in the Atlantic and recent nearshore marine mammal surveys at the Shipyard. The list of fish species is based on literature cited in previous Shipyard NEPA documents. Updated lists of ESA candidate fish species and other fish species of concern (provided at http://www.nmfs.noaa.gov/pr/species/index.htm), would also be considered, pending further analysis of their likelihood of occurrence within the project area.

Table 2. Species to be Assessed for Impacts from Acoustic Sources

Common Name	***Scientific Name***	***Regulatory Authority***
Atlantic sturgeon	*Acipenser oxyrinchus*	ESA
Shortnose sturgeon	*Acipenser brevirostrum*	ESA
Harbor porpoise	*Phocoena phocoena*	MMPA
Harbor seal	*Phoca vitulina*	MMPA
Gray seal	*Halichoerus grypus*	MMPA
Hooded seal	*Cystophora cristata*	MMPA
Harp seal	*Pagophilus groenlandicus*	MMPA

3 Acoustic Source Levels

3.1 Underwater Acoustics

3.1.1 Ambient Acoustics

Thirteen underwater acoustic recordings were logged in 2017 with sensors placed in depths of 15 feet (4.5 m) within the security fencing area of the Shipyard Berth 11. Recordings ranged from a 140 dB to 161.3 dB peak SPL and from 128.2 dB to 133.8 dB RMS SPL. Conditions at which the recordings were made was with little wind and near peak tidal flow. A mean SPL of 131 dB RMS was evenly distributed within the security fencing area and is assumed to be higher further into the navigation channel, pending verification from surveys to be conducted. An ambient RMS SPL of 130 dB is consistent with observations made at other locations near the Shipyard and documented background sound levels in estuarine or tidal locations (Hydrosonic LLC 2017a).

3.1.2 Proxy Source Levels

As shown in Table 1, the first year of the project includes multiple construction elements that create various acoustic levels. The sources include impact and vibratory pile driving of varying sizes of steel pipe piles as well as steel sheet piles. Construction of a temporary structure would be required at the start of the project and would subsequently be removed at the conclusion of the project. Construction of the super flood basin would require drilling activities and the modification of the super flood basin into two additional dry docks would require drilling and blasting. All of these activities create varying sound levels. To estimate sound source levels for each of the proposed first year construction elements, acoustic monitoring results from past projects conducted at the Shipyard and associated acoustic monitoring reports were reviewed as well as projects that are most similar to the Proposed Action in terms of the type and size of pile, method of installation, and substrate conditions. Data from other similar projects was reviewed but excluded due to lack of similarity with the project site (California Department of Transportation [Caltrans] 2015; NAVFAC SW 2015; United States Navy 2015a, 2017; and Hydrosonic, LLC 2017a,b). The sound pressure level (SPL) evaluation for each pile size and resulting chosen proxy source level is discussed below and presented in Table 3. The recommended proxy source levels will be used for modeling the distance to underwater noise thresholds for fish and marine mammals.

Table 3. Underwater Sound Pressure Levels from Similar In-situ Monitored Construction Activities and Recommended Proxy Source Levels

Project and Location	***Pile Size, Type***	***Installation Method***	***Water Depth (meters)***	***Sound Pressure Levels (SPL) or Sound Exposure Level (SEL) at 10 meters distance***		
				Average Peak SPL, dB re 1 μPa	***Average Root Mean Square SPL, dB re 1 μPa***	***Average SEL, dB re 1 μPa²-sec***
Naval Base Point Loma Fuel Pier[1]	36-inch steel pipe	Vibratory	1-9	NR	175	175
36-inch Diameter Steel Pipe - Vibratory – Recommended Proxy Source Levels				**NR**	**175**	**175**
Philadelphia Naval Shipyard[2]	36-inch steel pipe	Impact	12	205	184	173
36-inch Diameter Steel Pipe – Impact – Recommended Proxy Source Level				**205**	**184**	**173**
EHW-1 Pile Replacement, Bangor Naval Base, WA[3]	16-inch steel pipe	Vibratory	9-12	NA	162	NA
16-inch Diameter Steel Pipe – Vibratory - Recommended Proxy Source Levels				**NA**	**162**	**162**
Stockton Marine, CA[4]	16-inch steel pipe	Impact	3	182	163	158
Sand Mound Test Pile Project, CA[4]	16-inch steel pipe	Impact	3	182	NA	158
16-inch Diameter Steel Pipe – Impact- Recommended Proxy Source Level				**182**	**163**	**158**
Portsmouth Naval Shipyard, Berth 11[5]	14-inch steel H-piles	Vibratory	4.5	NA	148	148
14-inch Diameter Steel H-piles – Vibratory- Recommended Proxy Source Levels				**NA**	**148**	**148**
Portsmouth Naval Shipyard, Berth 11[6]	14-inch steel H-piles	Impact	15	194	177	160
14-inch Diameter Steel H-pile – Impact – Recommended Proxy Source levels				**194**	**177**	**178**

Table 3. Underwater Sound Pressure Levels from Similar In-situ Monitored Construction Activities and Recommended Proxy Source Levels

Project and Location	***Pile Size, Type***	***Installation Method***		***Sound Pressure Levels (SPL) or Sound Exposure Level (SEL) at 10 meters distance***		
			Water Depth (meters)	***Average Peak SPL, dB re 1 μPa***	***Average Root Mean Square SPL, dB re 1 μPa***	***Average SEL, dB re 1 μPa²-sec***
Port of Oakland, Berth 23, Oakland, CA[4]	24-inch steel sheet	Vibratory	15	177	163	163
Naval Station Mayport, Fl[2]	48-inch steel sheet	Vibratory	NA	NA	156	156
24-inch AZ Steel Sheet – Vibratory- Recommended Proxy Source Level				**177**	**163**	**163**
Port of Oakland, Oakland, CA[4]	24-inch AZ steel sheet	Impact	15	205	189	179
24-inch AZ Steel Sheet – Impact – Recommended Proxy Source Levels				**205**	**189**	**179**

[1]- NAVFAC SW 2015; [2]-United States Navy 2017;[3] – United States Navy 2015a; 4 - Caltrans 2015; [5] – Hydrosonic, LLC. 2017a; [6]-Hydrosonic, LLC. 2017b.
All SPLs are unattenuated; NR = Not reported; dB=decibels; NA = Not available
dB re 1 μPa = dB referenced to a pressure of 1 microPascal, measures underwater SPL.
dB re 1 μPa²-sec = dB referenced to a pressure of 1 microPascal squared per second, measures underwater SEL.

36-inch Diameter Steel Pipe Piles

For pile driving 36-inch diameter steel pipe piles, one California project and one East Coast project in Philadelphia were reviewed. Thirty-one, 36-inch steel pipe piles were reviewed for SPLs at 10 meters in both shallow depths (1 to 9 meters) and deep water depths (225 to 400 meters) at the Naval Base Point Loma Fuel pier in San Diego, California (NAVFAC SW 2015). The maximum SPL for shallow (two piles only) was 172 dB RMS. The maximum for the remaining deep water piles was 175 dB RMS. To be conservative, 175 dB RMS is the proxy source recommended for vibratory pile driving at the proposed Shipyard Dry Dock 1. Nine 36-inch diameter steel pipe piles were evaluated for impact pile driving SPLs at Philadelphia Naval Shipyard (United States Navy 2017). The average measurements recorded were 205 dB peak, 184 dB RMS, and 173 dB SEL. Due to East Coast project data and similar depth as the project area, these are the proxy sources recommended for impact pile driving 36-inch diameter steel pipe piles at the proposed Shipyard Dry Dock 1 project.

16-Inch Diameter Steel Pipe Piles

For pile driving of 16-inch diameter steel pipe piles, SPLs were evaluated from one project in Washington for vibratory and two projects in California for impact pile driving. There were no East Coast projects available for evaluating this size pile. For vibratory pile driving, the EHW-1 project in Washington installed piles for pile replacement at Naval Base Kitsap Bangor in Hood Canal. Due to similar depths to the Shipyard project area, the proxy source level of 162 dB RMS from the EHW-1 project is the recommended proxy source level for vibratory pile driving. The Stockton Marina and Sand Mound Test Pile Projects in California both had the same average peak and SEL measurements. Measurements were taken for only one 16-inch diameter pile at Sand Mound Test Pile project and measurements for two 16-inch piles were collected at Stockton Marina. Because of additional data points, the proxy source levels of 182 dB Peak, 163 dB RMS, and 158 dB SEL from Stockton Marina are recommended for impact pile driving 16-inch diameter steel pipe piles at the proposed Shipyard Dry Dock 1 project.

<u>14-Inch Diameter Steel H-Piles</u>

For pile driving 14-inch diameter steel H-piles, acoustic monitoring reports for the NAVFAC Structural Repairs at berth 11A, 11B, and 11C project at the Shipyard were reviewed (Hydrosonic, LLC 2017a,b). Test piles were installed using an APE Model 200 vibratory hammer to apparent refusal. Final driving was performed with an APOE Model 30-52 diesel impact hammer and both vibratory and impact hammers were handled by a Manitowoc model 4000W crawler crane operating on a barge. Recordings taken during impact pile driving were 194 dB peak, 177 dB RMS, and 160 dB SEL. The recommended proxy source for RMS is 177 dB based on a mean 90% RMS blow intensity and mean single-single strike SEL of 160 dB is based on 61 blows (Hydrosonic LLC 2017a). Because these proxy source levels are based on actual measured and recommended source levels for this size pile and within the project area, it is recommended that the proxy source levels of 194 dB peak, 177 dB RMS, and 160 dB SEL are used for impact pile driving of 14-inch diameter steel H-piles at the proposed Shipyard Dry Dock 1 project.

A separate vibratory pile driving acoustic monitoring study recorded sound from piles driven through rock, pulled, and re-driven several times to reach the required depth. Eight recordings showed a range of 140.9 dB to 150.6 dB RMS. From graphical representation, the recommended source level was determined to be 148.0 dB which presented the upper third quartile of the source data, or the 75th percentile of recordings (Hydrosonic, LLC 2017b). Because this proxy source levels is based on actual measured and recommended source levels for this size pile and within the project area, the 148 dB RMS SPL is recommended for vibratory installation of 14-inch steel H-piles at the proposed Shipyard Dry Dock 1 project.

<u>24-Inch AZ Steel Sheet Piles</u>

For pile driving of 24-inch steel sheet piles, SPLs were evaluated from one project in California for impact pile driving and one project in California and one in Florida for vibratory pile driving. The only impact pile driving project available for evaluation was Port of Oakland, Berth 23. No additional projects, including East Coast projects, were identified for evaluation. At the Port of Oakland, five piles were installed and average measurements recorded at 205 dB peak, 189 dB RMS, and 179 dB SEL. These are the proxy sources recommended for impact pile driving 24-inch steel sheet piles at the proposed Shipyard Dry Dock 1 project.

For vibratory pile driving, the same project in Oakland (Berth 23) as well one East Coast project were evaluated. Only one data point was available for the Port of Oakland project. For the Naval Station Mayport project in Florida, measurements were taken from vibratory pile driving 48-inch sheet piles which were made up of four individual 12-inch pieces that were connected and driven as one unit. Measurements were collected from 17 sheet piles with an average range of 135 dB to 158 dB at distances ranging from 8- to 12-meters from the pile. The average measurement normalized to 10-meters resulted in 156 dB RMS SPL. For the sake of being conservative and measurements for sheet piles are of the same size, the proxy source level of 163 dB RMS SPL (the same value is assumed for SEL) for vibratory installation of 24-inch steel sheets is recommended for the Shipyard Dry Dock 1 project.

Drilling

Drilling would be required to create shafts for purposes of accommodating 8-ft diameter steel pipe casing and to install rock anchors. Dazey et al. 2012 had recordings of casing installation and removal in Bechers Bay Santa Rosa Island, California at 157 dB RMS and 152 dB RMS, respectively. The installation of the pipe casing would be considered "non-impulsive, continuous" and the 157 dB RMS for casing install referenced in 3318 Federal Register Volume 83, Number 6 published on January 24, 2018 is appropriate.

Augur drilling was recorded at 151 dB RMS at this same project and at a SPL of 154 dB RMS (location not provided). Drilling was conducted at Berth 11 at the Shipyard where recordings for drilling with a rock bit and drilling with an augur were 140.3 dB RMS and 149.3 dB RMS, respectively, and are recommended proxy source levels for the Shipyard Dry Dock 1 project for rock anchors (CIANBRO 2017).

3.2 Airborne Acoustics

To estimate airborne sound pressure level (SPLs) and their associated effects on marine mammals that are likely to result from pile driving at Dry Dock 1 during first year construction, in-air acoustic monitoring of pile driving activities at Puget Sound Ferry terminals and U.S. Navy Installations were reviewed (United States Navy 2015b, 2017). The recommended proxy source values are summarized in Table 4 and will be used to model distances to airborne noise thresholds (see Chapter 5). Airborne SPLs for 14-inch steel H-piles were not available. Hydrosonic LLC 2017 had reported that impact pile driving blows were not audible in the air during driving of H-piles and where recordings were taken east of Berth 11 near the Memorial Bridge. It is suspected that sound propagation upriver was significantly attenuated due to the support pile locations within the existing berth structure where they are behind other piles, fender structures, and construction barges.

Table 4. Summary of Recommended Proxy Airborne Source Levels

Pile Size (diameter in inches)	*Impact*	*Vibratory*
	Root Mean Square (RMS) L_{max} (Unweighted)	*Root Mean Square L_{eq} (Unweighted)*
36-inch steel pipe	113[1]	92[1]
18-inch steel pipe	ND	88[1]
24-inch steel pipe	110[2]	92[2]
12-inch steel pipe	89[2,3]	ND
24-inch steel sheet	88[1]	82[1]

Sources: 1- United States Navy 2017; 2-United States Navy 2015a; 3-measured at a distance of 50 m (164 ft). All values relatives to dB re 20 µPa = dB referenced to a pressure of 20 microPascals at 15 meters (50-feet) (except where noted); $L_{eq=}$ Equivalent continuous Sound Pressure Level; L_{max}= RMS maximum level of a noise. ND = No Data. No data were available for 14- or 16-inch piles.

4 Acoustic Transmission Loss Models

4.1 Model for Level A (Injury) Harassment of Marine Mammals

Acoustic transmission loss modeling for cumulative sound exposure that may result in Level A (Injury) Harassment to marine mammals will be conducted using National Marine Fisheries Service (NMFS) marine mammal acoustic technical guidance (*Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing—Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts, August 2016*). This 2016 guidance provides acoustic thresholds for the onset of permanent threshold shift (PTS), which would be considered Level A (injury) Harassment under the MMPA. PTS from pile driving activities will be calculated for marine mammals in the project area using the *Optional User Spreadsheet* (herein referred to as NMFS spreadsheet) provided on the NMFS website (NMFS 2018a). The 2016 guidance on PTS replaces the previous thresholds and methods for determining injury. It does not replace the existing thresholds for assessing non-injury (behavioral) level B takes from acoustic sources, which will be analyzed as described in the following section. There are no Level A thresholds for airborne sound.

Per 81 *Federal Register* 51693, NMFS does not currently recommend calculations of temporary threshold shifts (TTS) exposures separate from assessments of Level B harassment using the prior existing thresholds for enumerating Level B (behavioral) takes (See Section 4.2). Therefore, distances to TTS thresholds will not be estimated, and the ZOIs for sound producing activities resulting in Level B (behavioral) harassment for marine mammals both under and above water will be used in the Incidental Harassment Authorization (IHA) application. An IHA would be prepared for Year 1 of the proposed project and the remaining years (2-6) would be included in a subsequent LOA that would be prepared.

For impact pile driving, the single strike SEL/pulse equivalent will be used and for vibratory pile driving the RMS SPL source level will be used. An intermediate "practical spreading" value of 15 (referred to as "practical spreading loss") is widely used for intermediate or spatially varying conditions when actual values for transmission loss are unknown. It is generally accepted by NMFS for use in pile driving applications and has been used in most Navy projects that involve pile driving. Per the NMFS Spreadsheet, default Weighting Factor Adjustments (WFA) will be used for calculating PTS from both vibratory and impact pile driving, using 2.5 kilohertz (kHz) and 2.0 kHz, respectively. These WFAs are acknowledged by NMFS as conservative.

The NMFS spreadsheet generates threshold distances to PTS for the situation in which an animal remains stationary for the entire 24-hour duration of activity. Although this situation is unlikely because marine mammals are likely to avoid the area when the pile driver is in operation (Russell et al. 2016), it provides a boundary condition for the maximum distance at which PTS could occur. As such, we propose to develop monitoring criteria in the IHA application for the curtailment of pile driving in situations when the prolonged presence of a marine mammal within these distances would raise the possibility of Level A harassment (PTS) if action is not taken to reduce acoustic exposure. In order to properly calculate the distances to PTS, number of pile strikes per pile and duration of vibratory pile driving in a day is required for the project. Table 1 provides pile installation activity for the project that will be used in the NMFS Spreadsheet.

4.2 Model for Level B (Behavioral) Harassment of Marine Mammals

Cardno proposes to use a general formula for underwater acoustic transmission loss in decibels (dB) as a function of distance from the source as follows:

TL = $B \, * \, log10\left(\frac{R1}{R2}\right) + \, C \, * \, (R1 - R2)$, where

B = logarithmic (predominantly spreading) loss,

C = linear (scattering and absorption) loss,

R_1 = receiver distance, and

R_2 = range at which the source measurement was made (standardized to a 10-meter distance for pile driving)

The B term has a value of 10 for cylindrical spreading, which is most applicable in shallow/confined waters where sound is reflected, and 20 for spherical spreading, which is most applicable in deep/unconfined waters where sound can propagate in all three dimensions. An intermediate "practical spreading" value of 15 is applicable where the environment contains elements of both (see Section 4.1) The amount of linear loss (C) is proportional to the frequency of sound. Due to the low frequencies of sound generated by impact and vibratory pile driving, this factor would be conservatively assumed to equal zero for all calculations and transmission loss will be calculated using only logarithmic spreading. For this project we recommend the assumption of practical spreading loss, which with the conservative assumption that C = 0, simplifies to:

$$TL = 15\, log10\left(\frac{R1}{R2}\right)$$

TL starts at 0 dB at the referenced source level distance (R_2=10-meters) and increases at a declining logarithmic rate, at approximately 4.5 dB per doubling of distance with practical spreading loss. This formula would be used to estimate the distances to critical threshold levels that bound the ZOIs for MMPA Level B (Behavioral) Harassment due to impulsive and continuous underwater sound.

In modeling transmission loss from the proposed project area, the conventional assumption would be made that acoustic propagation from the source is impeded by natural and relatively dense manmade features that extend into the water, resulting in acoustic shadows behind such features. Figure 1 illustrates the maximum extent of the underwater acoustic ZOI from proposed first year project activities using these assumptions.

4.3 Model for Fish

A Working Group organized under the American National Standards Institute (ANSI)-Accredited Standards Committee S3, Subcommittee 1, and Animal Bioacoustics, developed sound exposure guidelines for fish (Popper et al., 2014), hereafter referred to as the ANSI Sound Exposure Guideline technical report.

Cardno proposes to use the Transmission Loss (TL) formula below for determining distance to thresholds for ESA-listed sturgeon:

$$Transmission\ Loss\ (TL) = 15 * Log10[radius].$$

To calculate distance to thresholds (see Chapter 5), number of pile strikes per pile are required for the project. Table 1 provides pile installation activity for the project.

Figure 1. Maximum Extent of First Year Underwater Acoustic Zone of Influence for the Proposed Action

4.4 Airborne Noise

For airborne noise, the assumption is made that sound propagates freely in all directions from the source, resulting in spherical spreading loss, which equates to 6 dB decrease in SPL per doubling of distance. The water surface is considered a hard site and acts as a reflective surface where it does not provide any attenuation (Washington Department of Transportation 2018). Proxy source levels in Table 3 would be used to calculate these distances:

$$TL = 20\log\left(\frac{R1}{R2}\right).$$

5 Sound Exposure Criteria and Thresholds

5.1 Marine Mammals

The MMPA defines "harassment" as: any act of pursuit, torment, or annoyance which: (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment] (50 Code of Federal Regulations, Part 216, Subpart A, Section 216.3-Definitions). Level A is the more severe form of harassment because it may result in injury, whereas Level B only results in disturbance without the potential for injury.

As introduced in Chapter 4, NMFS finalized the acoustic threshold levels for determining the onset of PTS in marine mammals in response to underwater impulsive and non-impulsive sound sources (NMFS 2016). The criteria use cumulative SEL metrics (dB SEL_{cum}) and peak pressure (dB_{pk}) rather than the dB RMS metric. NMFS equates the onset of PTS, which is a form of auditory injury, with Level A harassment under the MMPA and "harm" under the ESA. Level B harassment is considered to occur when marine mammals are exposed to impulsive underwater sounds > 160 dB RMS re 1 µPa from impact pile driving and to non-impulsive underwater sounds > 120 dB RMS re 1 µPa (NMFS 2005) (Table 5). Behavioral harassment may or may not result in a stress response. The application of the 120 dB RMS threshold is considered precautionary (NMFS 2009, 74 *Federal Register* 41684) as it can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. As a matter of fact, the ambient noise level for the Piscataqua River at the shipyard is 130 dB RMS SPL (see section 3.1.1). For this project, it is recommended that the Level B ZOI be located at the 130 dB isopleth. The onset of TTS is a form of Level B harassment under the MMPA and "harassment" under the ESA. All forms of harassment, either auditory or behavioral, constitute "incidental take" under these statutes.

Acoustic disturbance levels from vibratory or impact pile driving have the potential to exceed the harassment levels defined in Table 5 for both impulsive and non-impulsive/continuous sound levels. This table incorporates PTS thresholds in combination with prior existing thresholds for Level B exposure.

For airborne sounds, there are no thresholds for Level A harassment to any marine mammal, and no Level B thresholds for cetaceans. Level B airborne sound exposure thresholds for harbor seals and other pinnipeds are included in Table 5.

To date, there is no research or data supporting a response by pinnipeds or odontocetes to continuous sounds from vibratory pile driving as low as the 120 dB RMS threshold. Southall et al. (2007) reviewed studies conducted to document behavioral responses of harbor seals and northern elephant seals to continuous sounds under various conditions, and concluded that those limited studies suggest that exposures between 90 dB and 140 dB re 1 μPa RMS generally do not appear to induce strong behavioral responses. Broadband underwater noise from vessels typically ranges from about 140 to 180 dB re 1 μPa RMS at the source (e.g., Erbe et al. 2012), and in a heavily used waterway such as the Piscataqua River can reasonably be expected to mask the sound of the vibratory driver as it diminishes to an SPL below this range at relatively large distances from the project site. Under these circumstances, it would be very unlikely that a marine mammal would differentiate and respond negatively to the distant sound of the vibratory driver in a way that would constitute harassment under the MMPA. The proposed approach is to model the transmission of continuous sound to the 130 dB and the 120 dB isopleths, or to the point at which the shoreline blocks transmission.

Table 5. Marine Mammal Injury and Disturbance Thresholds for Underwater and Airborne Sounds of Functional Hearing Groups that may be Present

Marine Mammal Hearing Group	*UNDERWATER*					*AIRBORNE*
	Impulsive (i.e., Impact Pile Driving)			*Non-Impulsive, Continuous (i.e., Vibratory Pile Driving)*		*(Impact and Vibratory Pile Driving)*
	L_{pk}, flat (re 1 µPa)	*L_E, SELcum (24-hr) (1 µPa²s)*	*Impulsive (1 µPa)*	*SELcum (24-hr) (1 µPa²s)*	*Non-impulsive (1 µPa)*	*(re 20 µPa) RMS*
	Level A PTS Onset Threshold (weighted)		*Level B Disturbance Threshold (Unweighted)*	*Level A PTS Onset (Weighted)*	*Level B Disturbance Threshold (Unweighted)*	*Level B Disturbance Guideline (haulout)[1]*
High-frequency cetaceans (true porpoises, *Kogia*, river dolphins, *cephalorhynchid, Lagenorbynchus cruciger & L. australis*)	202 dB	155 dB	160 dB	173 dB	120/130 dB	NA
Phocid pinnipeds (underwater) (true seals)	218 dB	185 dB	160 dB	201 dB	120/130 dB	90 dB (unweighted)

[1] – Sound level at which pinniped haulout disturbance has been documented. This is not considered an official threshold, but is used as a guideline. L_{pk} flat - The subscript "flat" indicates peak sound pressure should be flat weighted or unweighted within the generalized hearing group. L_E - cumulative sound exposure and indicating designated marine mammal auditory weighting function is for the recommended accumulation period of 24 hours. Sources: NMFS 2009, 2016.

5.2 Fish

As discussed in Chapter 4, the model for fish and criteria and thresholds from the ANSI Sound Exposure Guideline technical report (Popper et al. 2014) would be used to calculate distance to thresholds for fish.

Criteria and thresholds to estimate impacts from sound produced by impact pile driving activities are presented below in Table 6. Consistent with the *ANSI Sound Exposure Guideline* technical report (Popper et al., 2014), dual metric sound exposure criteria are utilized to estimate mortality and injury from exposure to air guns and are appropriate for evaluating exposure to impact pile driving. It is assumed that a specified effect will occur when either metric (cumulative sound exposure level or peak sound pressure level) is met or exceeded.

Table 6. Sound Exposure Criteria for Mortality and Injury to Fish from Impact Pile Driving

	Onset of Mortality		***Onset of Injury***	
Fish Hearing Group	***SEL_{cum}***	***SPL_{peak}***	***SEL_{cum}***	***SPL_{peak}***
Fishes without a swim bladder	> 219	> 213	> 216	> 213
Fishes with a swim bladder not involved in hearing	210	> 207	203	> 207
Fishes with a swim bladder involved in hearing	207	> 207	203	> 207
Fishes with a swim bladder and high-frequency hearing	207	> 207	203	> 207

Notes: SEL_{cum} = Cumulative sound exposure level (decibel referenced to 1 micropascal squared seconds [dB re 1 μPa^2-s]), SPL_{peak} = Peak sound pressure level (decibel referenced to 1 micropascal [dB re 1 μPa]), ">" indicates that the given effect would occur above the reported threshold.

In addition, the received SEL from an individual pile strike is below a certain level, then the accumulated energy from multiple strikes would not contribute to injury, regardless of how many pile strikes occur. This SEL is referred to as "effective quiet", and is assumed to be 150 dB (re: 1 μPa^{2}sec). Effective quiet establishes a limit on the maximum distance from the pile where injury to fishes is expected – the distance at which the single-strike SEL attenuates to 150 dB. Beyond this distance, no physical injury is expected, regardless of the number of pile strikes. However, the severity of the injury can increase within this zone as the number of strikes increases.

NMFS also recognizes a 150 dB RMS as a conservative guideline for evaluating potential effects of noise on fish, including pile driving (NMFS 2015). Based on their assessment, sound pressure levels in excess of 150 dB re 1 μPa are expected to cause temporary behavioral changes, such as elicitation of a startle response or avoidance of an area. Those levels are not expected to cause direct permanent injury. That is not to say that exposure to noise levels of 150 dB RMS re 1μPa will always result in behavioral modifications, but that there is the potential, upon exposure to noise at this level, to experience some behavioral response (e.g., temporary startle to avoidance of an insonified area).

In summary, based on the best available information for other fish species, underwater noise at or above the levels presented in Table 6 have the potential to cause injury or behavioral modification to fish.

6 GIS Mapping of ZOIs

To create a GIS map of the modeled ZOIs (similar to Figure 1), the following are proposed 1) use of a high-resolution ArcGIS aerial of the proposed project area, combined with a GIS bathymetry map (if available) so that the shoreline boundaries of ZOIs can be accurately drawn; 2) define a modeled sound source location that provides a reasonable approximation for the proposed project activities with the greatest potential for effects, e.g., near the heads of the piers to be constructed and demolished; 3) the application of rules for sound propagation and acoustic shadowing along bearing angles that intersect shoreline obstructions; and 4) the translation of the transmission loss model into a graphical depiction of diminishing sound pressure isopleths as a function of the sound source level and transmission loss over distance.

The calculations are made in an Excel workbook, which is used to create a multi-ring buffer of isopleths (i.e., sound contours) diminishing in 1 dB increments from the sound source location. This is created in GIS and clipped to the ZOI map. The graphical outputs will be modified based on different source levels. Figure 2 provides an example of the isopleths within the project ZOI for illustrative purposes.

7 Description of Take Calculation

Consistent with other Navy projects, take estimates associated with each activity will be calculated using the following general formula:

$$Take\ estimate\ =\ species\ density\ *\ area\ of\ ZOI\ for\ the\ activity\ *\ days\ of\ activity$$

Species density estimates will be based on nearshore surveys conducted at PNSY (NAVFAC 2018). From this source, an estimate of animals that can reasonably be expected in a specific ZOI within a specific timeframe will be determined. This gives a number of takes per day, which is then multiplied by the number of days during which sound exposure would occur. The final take estimate will be rounded at the end of the calculation process to the nearest whole number after multiplying by the number of days. Under the MMPA, an animal can be taken only once per day; multiple exposures at the threshold level do not constitute additional takes, although they could contribute to the severity of the effect.

Figure 2. Example of ZOI with Noise Isopleths

8 Glossary

Table 8. Glossary of Acoustical Terms

Term	*Definition*
Decibel (dB)	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for water is 1 microPascal (µPa) and for air is 20 µPa (approximate threshold of human audibility).
Sound Pressure Level (SPL)	Sound pressure is the force per unit area, usually expressed in microPascals where 1 Pascal equals 1 Newton exerted over an area of 1 square meter. The SPL is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressure exerted by the sound to a reference sound pressure. SPL is the quantity that is directly measured by a sound level meter.
Frequency, hertz (Hz)	Frequency is expressed in terms of oscillations, or cycles, per second. Cycles per second are commonly referred to as hertz (Hz). Typical human hearing ranges from 20 Hz to 20 kHz.
Peak Sound Pressure, dB re 1 microPascal (µPa)	Peak SPL is based on the largest absolute value of the instantaneous sound pressure over the frequency range from 20 Hz to 20 kHz. This pressure is expressed in this application as dB re 1 µPa.
Root-Mean-Square (RMS), dB re 1µPa	The RMS level is the square root of the mean of the squared pressure level(s) as measured over a specified time period. For pulses, the RMS has been defined as the average of the squared pressures over the time that comprise that portion of waveform containing 90 % of the sound energy for one impact pile driving impulse.
Sound Exposure Level (SEL), dB re 1 µPa^2 sec	Sound exposure level is a measure of energy. Specifically, it is the dB level of the time integral of the squared-instantaneous sound pressure, normalized to a 1-sec period. It can be an extremely useful metric for assessing cumulative exposure because it enables sounds of differing duration, to be compared in terms of total energy.
Waveforms, µPa over time	A graphical plot illustrating the time history of positive and negative sound pressure of individual pile strikes shown as a plot of µPa over time (i.e., seconds).
Frequency Spectrum, dB over frequency range	The amplitude of sound at various frequencies, usually shown as a graphical plot of the mean square pressure per unit frequency (µPa^2/Hz) over a frequency range (e.g., 10 Hz to 10 kHz in this application).
A-Weighting Sound Level (dBA)	The SPL in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the low and high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective human reactions to noise.
Ambient Noise Level	The background sound level, which is a composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.

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June 14, 2018

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Subject: Underwater Acoustic Transmission Loss Modeling for the Proposed Modification and Expansion of Dry Dock 1 at Portsmouth Naval Shipyard, Kittery, Maine – Year 1

Dear Justine,

This letter transmits the subject project-specific Zone of Influence (ZOI) maps and supporting data tables that illustrate the results of the modeled calculations of the predicted transmission of underwater and airborne acoustics that would occur during year 1 construction to accommodate modification and expansion of Dry Dock 1 at Portsmouth Naval Shipyard (Shipyard). The elements of the project are as follows:

- P-310 – Construct the super flood basin;
- P-1074 – Extend the portal crane rail and utilities around Dry Dock 1 and Berth 2; and
- P-381 – Modify the super flood basin to create two additional dry docks capable of servicing Virginia class submarines.

This memo and forthcoming Incidental Harassment Authorization (IHA) addresses P-310 and elements of P-1074 that would occur during year 1 construction. The project as a whole is expected to last a duration of 6 years. Therefore, an addendum to this memo and a subsequent LOA would be prepared for remaining elements of the project to occur during years 2 through 6.

This deliverable follows the project-specific Work Plan dated May 30, 2018. The Work Plan's methodology and approach for modeling underwater acoustics are described below. The resulting acoustic data calculations and graphic representations are provided in the following tables and figures.

Table 1 presents a breakdown of pile driving/drilling activity by structure, pile types and quantities, pile installation durations (seconds and days) as well as blow counts for impact pile driving activities. Proxy sources researched and recommended for these pile types and drilling activities are provided in Tables 2 and 3 for underwater acoustic sound pressure levels and airborne acoustic sound pressure levels, respectively. Tables 4 through 7 present the calculated distances to injury and behavior thresholds for harbor porpoise, seals, and fish based on the construction detailed elements contained in Table 1 and proxy sources from Tables 2 and 3.

The following figures are also included with this deliverable:

Figure 1: Predicted Maximum Distance to Level A Injury for Marine Mammals During Vibratory Pile Driving
Figure 2: Predicted Maximum Distance to Level A Injury Thresholds for Marine Mammals During Impact Pile Driving
Figure 3: Predicted Maximum Level B Harassment Zone for Airborne Noise
Figure 4: Predicted Maximum Distance to Level A Injury Impacts for Fish During Impact Pile Driving

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Table 1. Pile Driving and Drilling for Construction Year 1

Activity	*Pile Purpose*	*Pile Count*	*Pile Type and Size*	*Method of Install*	*Piles Installed per day/Shafts Drilled*	*Total Pile Driving Days*	*Average Hammer Operation (Seconds/blows per Pile)*	*Average Hammer Operation (Seconds/blows per Day)*	*Calendar (Weeks/ Days)*
General Information	Temporary Structure*	48 piles (8 entrance structure float-in dolphins with 6 piles each)	Steel pipe (conservative estimate = 36-inch diameter)	Impact w/ initial vibratory set	1 / day	48 days	300 seconds of driving/Approx. 300 blows / pile depending on soil conditions.	300 seconds of driving/Approx300 blows	48 days
		32 piles (cell and connector cell wall ring forms)	Steel H-pile (14-inch)	Impact w/ initial vibratory set	5 / day	7 days	300 seconds of driving/Approx. 300 blows / pile depending on soil conditions.	1500 seconds/1,500 blows	7 days
P310 Super Flood Basin	Sheet Pile Wall along Berth 1	320 piles (400 linear feet)	Z-shaped steel sheet pile (24-inch)	Impact w/ initial vibratory set	17 (25 linear feet / day)	19 days	300 seconds of driving/Approx. 300 blows / pile depending on soil conditions.	5,100 seconds/5,100 blows	19 days
	Closure Wall Construction	350 piles (South closure wall cells)	Flat web steel sheet pile (18-inch)	Impact w/initial vibratory set	17 (25 linear feet/day)	21 days	300 seconds of driving/Approx. 300 blows / pile depending on soil conditions.	5,100 seconds/5,100 blows	21 days
		110 piles (Berth 1 and 2 closure sheet pile and HP combi-wall 140 linear feet)	Z-shaped steel sheet pile (24-inch) Steel H-pile (14-inch)	Impact w/initial vibratory set	17 (25 linear feet/day)	7 days	300 seconds of driving/Approx. 300 blows / pile depending on soil conditions.	5,100 seconds/5,100 blows	7 days

Activity	***Pile Purpose***	***Pile Count***	***Pile Type and Size***	***Method of Install***	***Piles Installed per day/Shafts Drilled***	***Total Pile Driving Days***	***Average Hammer Operation (Seconds/blows per Pile)***	***Average Hammer Operation (Seconds/blows per Day)***	***Calendar (Weeks/ Days)***
		320 piles (South closure wall façade sheeting formwork 475 linear feet)	Z-shaped steel sheet pile (24-inch width for south wall)	Impact w/initial vibratory set	17 (25 linear feet/day)	19 days	300 seconds of driving/Approx. 300 blows / pile depending on soil conditions.	5,100 seconds/5,100 blows	19 days
		250 (sheet pile cutoff wall 360 linear feet)	Z-shaped steel sheet pile (24-inch will surround 10 drilled shafts	Impact w/initial vibratory set	17 (25 linear feet/day)	15 days	300 seconds of driving/Approx. 300 blows / pile depending on soil conditions.	5,100 seconds/5,100 blows	15 days
		10 drilled shafts	Steel pipe casing (8-ft diameter)	Impact/drilling (rock)	Less than 1 pipe casing installed/ day and 1 shaft drilled in 2 days	20 days	N/A	assumes 8 hours of drilling in a day	20 days
P1074 Extension of Portal Crane Rail and Utilities	Relieving Platform Support	8	Steel pipe (16-in)	Impact w/ initial vibratory set	4 / day	2 days	300 seconds of driving @ 1 impact / second. Approx. 300 blows / pile depending on soil conditions.	1,200 seconds/1,200 blows	2 days

Source: Appledore Marine Engineering, LLC 2018;
Notes:
*- vibratory extraction at end of project or cut off at mudline; N/A = Not Applicable

Table 2. Underwater Noise Source Levels Modeled for Impact and Vibratory Pile Driving/Drilling

Pile Type	*Installation Method*	*Pile Diameter*	*Peak (dB re 1 µPa)*	*RMS (dB re 1 µPa)*	*SEL (dB re 1 µPa² sec)*
Steel pipe	Vibratory	36-inch	NA	175	175
	Impact	36-inch	205	184	173
	Vibratory	16-inch	NA	162	162
	Impact	16-inch	182	163	158
Steel H	Vibratory	14-inch	NA	148	148
	Impact	14-inch	194	177	160
AZ Steel Sheet	Vibratory	24-inch	NA	163	163
	Impact	24-inch	205	189	179
Casing	Drilling	96-inch	NA	157	157

Sources: NAVFAC SW 2015; United States Navy 2017; United States Navy 2015a; Caltrans 2015; Hydrosonic, LLC. 2017a,b; Dazey et al. 2012
All SPLs are unattenuated; dB=decibels; NA = Not applicable.
dB re 1 µPa = dB referenced to a pressure of 1 microPascal, measures underwater SPL. dB re 1 µPa^2-sec = dB referenced to a pressure of 1 microPascal squared per second, measures underwater SEL

Table 3. Airborne Noise Source Levels Modeled for Impact and Vibratory Pile Driving

Pile Size (diameter in inches)	*Impact*	*Vibratory*
	Root Mean Square (RMS) L_{max} (Unweighted)	*Root Mean Square L_{eq} (Unweighted)*
72-inch steel pipe[4]	105	102
36-inch steel pipe	113[1]	92[1]
18-inch steel pipe	ND	88[1]
24-inch steel pipe	110[2]	92[2]
12-inch steel pipe	89[2,3]	ND
24-inch steel sheet	88[1]	82[1]

Sources: 1)- United States Navy 2017; 2)-United States Navy 2015a; 3)-measured at a distance of 50 m (164 ft); 4)-WSDOT 2011, proxy source for 96-inch diameter not available. Largest pile with data was 72-inch diameter. All values relatives to dB re 20 µPa = dB referenced to a pressure of 20 microPascals at 15 meters (50-feet) (except where noted); L_{eq}= Equivalent continuous Sound Pressure Level; L_{max}= RMS maximum level of a noise. ND = No Data. No data were available for 14- or 16-inch piles.

Marine Mammals

Underwater Acoustics

Marine mammals that may be present within the project area include harbor porpoise, harbor seal, gray seal, hooded seal, and harp seal. As shown in Tables 4 and 5, acoustic transmission loss modeling for cumulative sound exposure that may result in Level A (Injury) harassment to marine mammals was conducted using National Marine Fisheries Service (NMFS) marine mammal acoustic technical guidance (*Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing—Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts, August 2016*). This guidance provides acoustic thresholds for the onset of permanent threshold shift (PTS), which would be considered Level A (injury) Harassment under the MMPA. PTS from pile driving activities was calculated using the NMFS *Optional User Spreadsheet.*

Level B harassment is considered to occur when marine mammals are exposed to impulsive underwater sounds > 160 dB RMS re 1 µPa from impact pile driving and to non-impulsive underwater sounds > 120 dB RMS re 1 µPa (NMFS 2005). Behavioral harassment may or may not result in a stress response. The application of the 120 dB RMS threshold is considered precautionary (NMFS 2009, 74 *Federal Register* 41684) as it can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. As a matter of fact, the ambient noise level for the Piscataqua River at the shipyard is 130 dB RMS SPL. For this project, the tables Level B distance to both the 120 and 130 dB isopleth. If determined to be appropriate, only the 130 dB Isopleth will be depicted in the IHA. Level B Behavioral disturbance thresholds were calculated using the following practical spread loss model:

$$TL = 15\ log10\left(\frac{R1}{R2}\right)$$

As shown in Table 4 and Figure 1, the maximum distance to Level A injury would be 22 m for harbor porpoise and 9 m for seals during vibratory pile driving or drilling. The maximum distance to behavioral thresholds for both harbor porpoise and seals would be 0.046 km (120 dB RMS Isopleth) or 0.01 km (130 dB RMS Isopleth).

As shown in Table 5 and Figure 2, the maximum distance to Level A injury would be 1,907 m for harbor porpoise and 857 m for seals during impact pile driving. The maximum distance to behavioral disturbance threshold (160 dB RMS) would be 858 m for both harbor porpoise and seals

Table 4. Calculated Maximum Distances Corresponding to MMPA Thresholds for Underwater Sound from Non-Impulsive Noise (Vibratory Pile Driving/Drilling)*

Activity	*Pile Purpose*	*Pile Size and Count*	*Total Pile Driving Days*	*Injury (PTS Onset) Level A*		*Behavior Disturbance Level B*
				High-Frequency Cetaceans (Harbor Porpoise) – 173 dB SEL_{cum} Threshold	*Phocid Pinnipeds (Seals) – 201 dB SEL_{cum} Threshold*	*Harbor Porpoise and Seals 120 dB RMS Threshold/130 dB RMS Baseline*
General Information	Temporary Structure**	36-inch steel pipe (48 piles total to form 8 entrance structure float-in dolphins with 6 piles each)	48 days	17 m	7 m	46,416 m/10,000 m
		14-inch steel H-piles (32 piles totals to form cell and connector cell wall ring forms)	7 days	< 1 m	< 1 m	736 m/158 m
P310 Super Flood Basin	Sheet Pile Wall along Berth 1	24-inch Z-shaped steel sheet piles (320 total piles to form 400 linear feet)	19 days	17 m	7 m	7,356 m/1,585 m
	Closure Wall Construction	18-inch flat web steel sheet piles (350 total piles to form South closure wall cells)	21 days	17 m	7 m	7,356 m/1,585 m
		24-inch Z-shaped steel sheet piles (110 total piles to form Berth 1 and 2 closure sheet pile and HP combi-wall of 140 linear feet)[1]	7 days	17 m	7 m	7,356 m/1,585 m

Activity	Pile Purpose	Pile Size and Count	Total Pile Driving Days	Injury (PTS Onset) Level A: High-Frequency Cetaceans (Harbor Porpoise) – 173 dB SEL_{cum} Threshold	Injury (PTS Onset) Level A: Phocid Pinnipeds (Seals) – 201 dB SEL_{cum} Threshold	Behavior Disturbance Level B: Harbor Porpoise and Seals 120 dB RMS Threshold/130 dB RMS Baseline
		24-inch Z-shaped steel sheet piles (320 total piles to form South closure wall façade sheeting formwork 475 linear feet)	19 days	17 m	7 m	7,356 m/1,585 m
		24-inch Z-shaped steel sheet piles (250 total sheet piles to form sheet pile cutoff wall of 360 linear feet and will surround 10 drilled shafts)	15 days	17 m	7 m	7,356 m/1,585 m
		10 drilled shafts to support 8-ft casings	20 days	22 m	9 m	2,929 m/631 m
P1074 Extension of Portal Crane Rail and Utilities	Relieving Platform Support	16-inch steel pipes (8 total)	2 days	6 m	2 m	6,310 m/1,359 m

Source: Appledore Marine Engineering, LLC 2018;
Notes:
*- To determine underwater ZOIs, radial distances from the source will be clipped along the shoreline using GIS
**- vibratory extraction at end of project or cut off at mudline; N/A = Not Applicable
The 130 dB RMS baseline is included as this is the ambient measurement recorded in the project area.

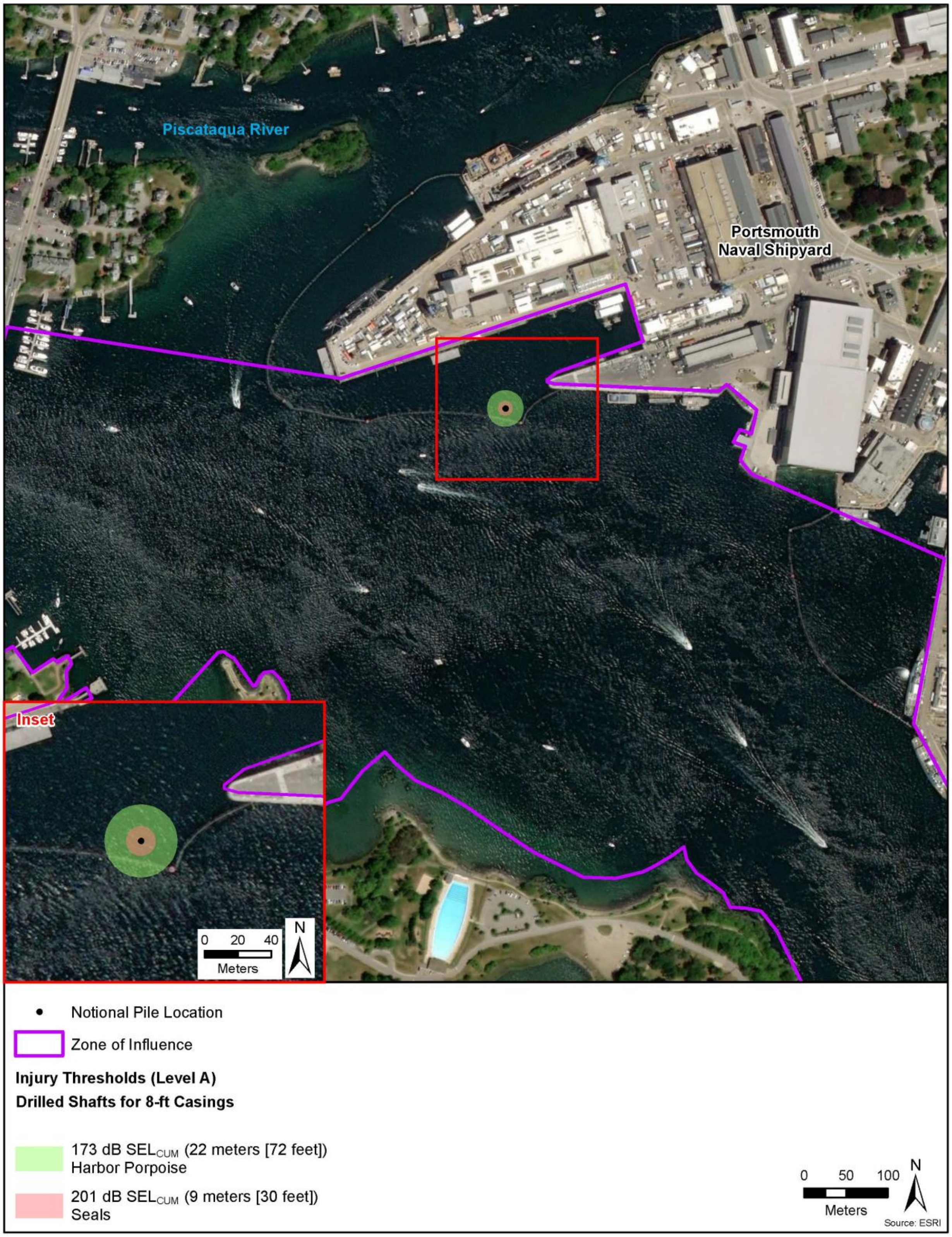

Figure 1. Predicted Maximum Distance to Level A Injury for Marine Mammals During Vibratory Pile Driving

Table 5. Calculated Maximum Distances Corresponding to MMPA Thresholds for Underwater Sound from Impulsive Noise (Impact Pile Driving)*

				Injury (PTS Onset) Level A		***Behavior Disturbance Level B***
Activity	***Pile Purpose***	***Pile Size and Count***	***Total Pile Driving Days***	***High-Frequency Cetaceans (Harbor Porpoise) – 155 dB SEL_{cum} Threshold***	***Phocid Pinnipeds (Seals) – 185 dB SEL_{cum} Threshold***	***Harbor Porpoise and Seals 160 dB RMS Threshold***
General Information	Temporary Structure**	36-inch steel pipes (48 piles total to form 8 entrance structure float-in dolphins with 6 piles each)	48 days	115 m	52 m	398 m
		14-inch steel H-piles (32 piles total to form cell and connector cell wall ring forms)	7 days	46 m	20 m	136 m
P310 Super Flood Basin	Sheet Pile Wall along Berth 1	24-inch Z-shaped steel sheet piles (320 total piles to form 400 linear feet)	19 days	1,907 m	857 m	858 m
	Closure Wall Construction	18-inch flat web steel sheet piles (350 total piles to form South closure wall cells)	21 days	1,907 m	857 m	858 m
		24-inch Z-shaped steel sheet piles (110 total piles to form Berth 1 and 2 closure sheet pile and HP combi-wall of 140 linear feet)[1]	7 days	1,907 m	857 m	858 m

				Injury (PTS Onset) Level A		***Behavior Disturbance Level B***
Activity	***Pile Purpose***	***Pile Size and Count***	***Total Pile Driving Days***	***High-Frequency Cetaceans (Harbor Porpoise) – 155 dB SEL_{cum} Threshold***	***Phocid Pinnipeds (Seals) – 185 dB SEL_{cum} Threshold***	***Harbor Porpoise and Seals 160 dB RMS Threshold***
		24-inch Z-shaped steel sheet piles (320 total piles to form South closure wall façade sheeting formwork 475 linear feet)	19 days	1,907 m	857 m	858 m
		24-inch Z-shaped sheet piles (250 total sheet piles to form sheet pile cutoff wall of 360 linear feet and will surround 10 drilled shafts)	15 days	1,907 m	857 m	858 m
P1074 Extension of Portal Crane Rail and Utilities	Relieving Platform Support	16-inch steel pipe (8 Total)	2 days	29 m	13 m	16 m

Source: Appledore Marine Engineering, LLC 2018;
Notes:
*- To determine underwater ZOIs, radial distances from the source will be clipped along the shoreline using GIS
**- vibratory extraction at end of project or cut off at mudline; lf = linear feet; N/A = Not Applicable
[1]The SPLs from installing 14-inch steel HP would be superceded by SPLs generated from installing the Z-shaped sheet piles during combination wall construction.
Calculated values rounded up to the nearest meter.
Proxy sources used were unattenuated SPLs.

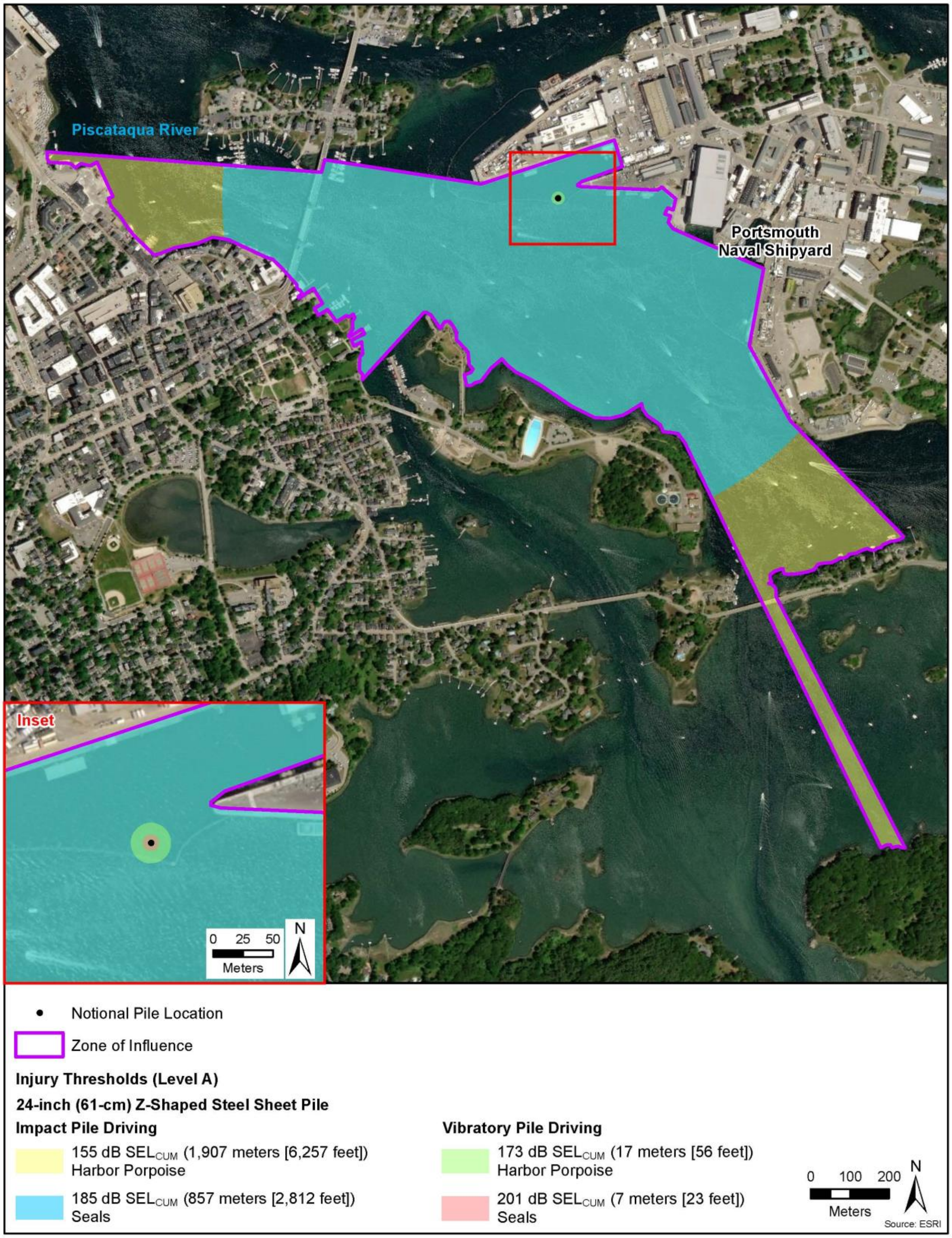

Figure 2. Predicted Maximum Distance To Level A Injury Thresholds for Marine Mammals During Impact Pile Driving

Airborne Acoustics

For airborne noise, the assumption is made that sound propagates freely in all directions from the source, resulting in spherical spreading loss, which equates to 6 dB decrease in SPL per doubling of distance. The water surface is considered a hard site and acts as a reflective surface where it does not provide any attenuation (Washington Department of Transportation 2018). Proxy source levels in Table 3 were used to calculate the distances to behavior thresholds using the formula below:

$$TL = 20\log\left(\frac{R1}{R2}\right).$$

The airborne noise threshold for behavioral harassment for seals, is 90 dB RMS re 20 µPa (unweighted) for harbor seals and is used as a conservative threshold for all true seals in this analysis. As shown in Table 6 and Figure 3, the maximum distance to the behavioral disturbance threshold for seals is 212 m during impact pile driving and 19 m during vibratory pile driving.

Table 6. Calculated and Measured Distances to Pinniped Behavioral Airborne Noise Thresholds

Pile Type	***Pile Size***	***Installation Method***	***Harbor Seal Threshold = 90 dB RMS***	***Pinnipeds except Harbor Seals Threshold = 100 dB RMS***
Steel pipe	36-inch	Impact	212 m	67
		Vibratory	19 m	6
	24-inch	Impact	150 m	47
	18-inch	Vibratory	12 m	6
Steel Sheet	24-inch	Impact	12 m	4
		Vibratory	6 m	2

No data available for 14-inch steel H or 16-inch steel pipe thus 18-inch proxy used for vibratory and 24-inch used for impact to be conservative.

Fish

Sound exposure guidelines developed by Popper et al (2014) are contained in Table 7 below. The Transmission Loss formula below was used for determining distance to thresholds as calculated and shown in Table 6.

$$Transmission\ Loss = 15 * Log10[radius].$$

As shown in Table 7 and Figure 4, the maximum distance to the 207 dB peak onset of injury threshold is calculated to 7 meters or less. The 203 dB cumulative SEL injury threshold is calculated to 74 meters or less which is assuming 5,100 strikes would be required to impact install 17 sheet piles per day. This guideline is the lowest level where injury is found (Popper et al., 2014) and results in an area where fish are anticipated to potentially be exposed to injury. In all cases, because the cumulative SEL formula takes into account all impact pile strikes within a 24-hour period, the size of the injury zones are presented as they have increased to their maximum extent through the course of a pile driving day. As a result, during the early portion of the construction day, the injury zone will be smaller and will only gradually increase out to a maximum extent as calculated in Table 6 after all strikes have been

Figure 3. Predicted Maximum Level B Harassment Zone for Airborne Noise

completed. Further, the formula assumes fish are remaining within the range to effect during the entirety of active impact pile driving. In other words, an individual fish would have to be constantly within the calculated range during all impact pile driving in order to accumulate energy from every impact strike.

The maximum distance to exposure above the 150 dB RMS behavioral threshold would be 3,981 m. At this distance, fish present within this threshold could modify their behavior (i.e., site avoidance or move further offshore).

Table 7. Maximum Range to Fish Sound Thresholds from Pile Driving/Drilling

Method, Pile Type and Size	***Threshold (distance)***		
	> 207 dB PEAK (onset of injury)	***203 dB Cumulative SEL (injury)***	***150 dB RMS (potential behavioral guideline)***
Impact			
36-inch steel pipe	7 m	4 m	97 m
16-inch steel pipe	<1 m	1 m	74 m
14-inch steel H	1 m	2 m	631 m
24-inch steel sheet	7 m	74 m	3,981 m
Vibratory/Drilling			
Casing via Drilling	N/A	N/A	29 m
36-inch steel pipe	N/A	N/A	464 m
16-inch steel pipe	N/A	N/A	63 m
14-inch steel H	N/A	N/A	7 m
24-inch steel sheet	N/A	N/A	74 m

Notes:
Practical spreading loss model (15 log R, or 4.5 dB per doubling of distance) used for calculations. Cumulative SEL calculated as Single Strike SEL + 10 * log (number of pile strikes), assumes 300 strikes/day for 36-inch; 5,100 strikes/day for sheet piles; 1,200 strikes/day for 16-inch; 1,500 strikes/day for 14-inch steel HP.
Key: dB = decibel; km = kilometer; N/A = not applicable; < = less than; > = greater than or equal to; RMS = root mean square; SEL = sound exposure level

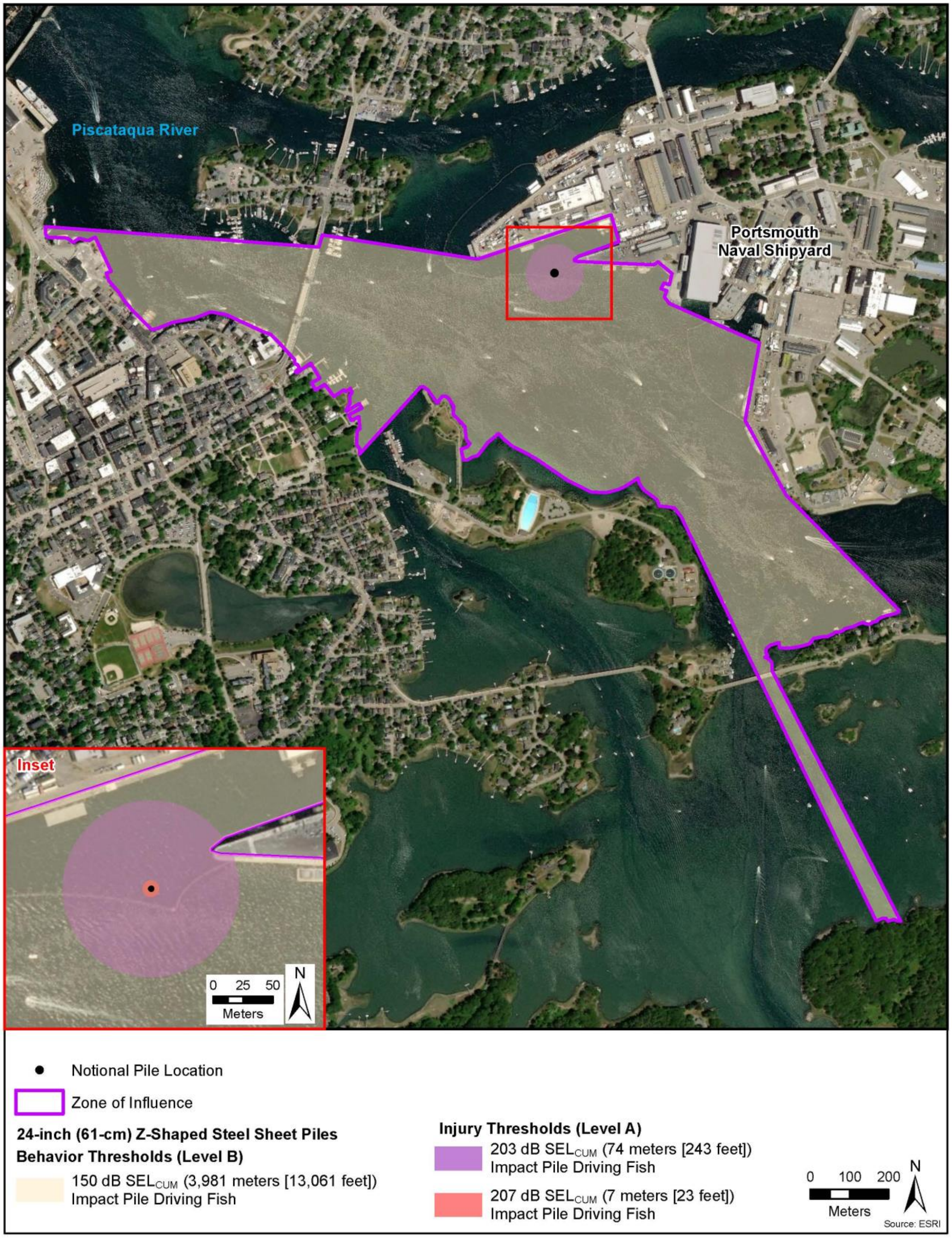

Figure 4. Maximum Noise ZOI for Level A Injury Impacts to Fish During Impact Pile Driving

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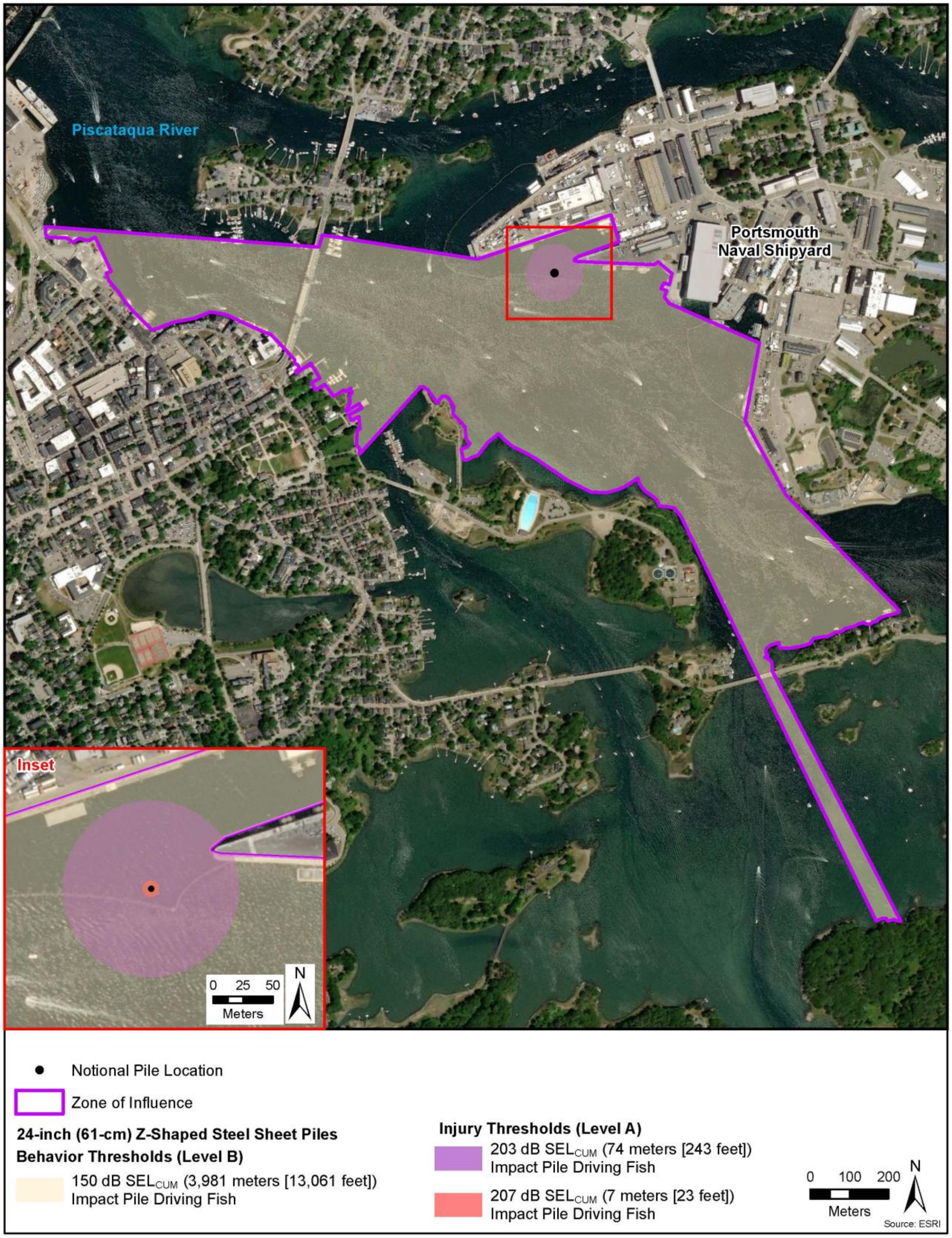

Figure 4. Maximum Noise ZOI for Level A Injury Impacts to Fish During Impact Pile Driving

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Appendix B

Noise Calculations Spreadsheets

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E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	Temporary Structure: Connector Cell Wall Ring Forms - Install via Impact hammer - 32 14-inch steel H-piles

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	0
Number of piles per day	0
Strike Duration[Δ] (seconds)	0
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	0
Distance of source level measurement (meters)[+]	0

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	0
Distance of source level measurement (meters)[+]	0
Source level at 1 meter	#NUM!

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**189.8**

SEL_{cum}

Source Level (Single Strike SEL)	162
Number of strikes per pile	300
Number of piles per day	2
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	205
Distance of source level measurement (meters)[+]	10
Source level at 1 meter	220.0

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**28.3**	**1.0**	**33.7**	**15.1**	**1.1**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**1.2**	**NA**	**15.8**	**1.4**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a\,[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	Temporary Structure: Connector Cell Wall Ring Forms - Install via vibratory hammer -32 14-inch steel H piles

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	158
Number of piles within 24-h period	2
Duration to drive a single pile (minutes)	5
Duration of Sound Production within 24-h period (seconds)	600
10 Log (duration of sound production)	27.78
Propagation (xLogR)	15
Distance from source level measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**1.3**	**0.1**	**1.9**	**0.8**	**0.1**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	Temporary Structure: Connector Cell Wall Ring Forms -Vibratory EXTRACTION -32 14-inch steel H piles (8/day) @ 8 minutes - CHANGED TO 5 MINUTES PER PILE TO MATCH NMFS

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	158
Number of piles within 24-h period	8
Duration to drive a single pile (minutes)	5
Duration of Sound Production within 24-h period (seconds)	2400
10 Log (duration of sound production)	33.80
Propagation (xLogR)	15
Distance from source level measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**3.3**	**0.3**	**4.9**	**2.0**	**0.1**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	P310 Super Flood Basin, Sheet Pile wall along Berth 1 - 320 sheet piles (400 linear feet) and 145 sheet piles (south closure wall façade sheeting formwork)

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	0
Number of piles per day	0
Strike Duration[Δ] (seconds)	0
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	0
Distance of source level measurement (meters)+	0

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

+Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	0
Distance of source level measurement (meters)+	0
Source level at 1 meter	#NUM!

+Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**215.6**

SEL_{cum}

Source Level (Single Strike SEL)	180
Number of strikes per pile	300
Number of piles per day	12
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)+	10

+Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	205
Distance of source level measurement (meters)+	10
Source level at 1 meter	220.0

+Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**1,480.0**	**52.6**	**1,763.0**	**792.0**	**57.7**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**1.2**	**NA**	**15.8**	**1.4**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	P310 Super Flood Basin, Sheet Pile wall along Berth 1 - 320 Sheet piles (400 linear feet) and 145 sheet piles (south closure wall façade sheeting formwork)

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)¥	2.5	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	163
Number of piles within 24-h period	12
Duration to drive a single pile (minutes)	5
Duration of Sound Production within 24-h period (seconds)	3600
10 Log (duration of sound production)	35.56
Propagation (xLogR)	15
Distance from source level measurement (meters)⁺	10

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} **Threshold**	199	198	173	201	219
PTS Isopleth to threshold (meters)	**9.3**	**0.8**	**13.7**	**5.6**	**0.4**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	Temporary Structure: Connector Cell Wall Ring Forms - Install via Impact hammer - 32 14-inch steel H-piles

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)¥	2	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL$_{cum}$ (USING RMS SPL SOURCE LEVEL)

SEL$_{cum}$

Source Level (RMS SPL)	0
Number of piles per day	0
Strike Duration$^{\Delta}$ (seconds)	0
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	0
Distance of source level measurement (meters)⁺	0

$^{\Delta}$Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	0
Distance of source level measurement (meters)⁺	0
Source level at 1 meter	#NUM!

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL$_{cum}$ Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL$_{cum}$ (SINGLE STRIKE EQUIVALENT)

Unweighted SEL$_{cum\ (at\ measured\ distance)}$ = SEL$_{ss}$ + 10 Log (# strikes)	**186.8**

SEL$_{cum}$

Source Level (Single Strike SEL)	162
Number of strikes per pile	300
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)⁺	10

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	205
Distance of source level measurement (meters)⁺	10
Source level at 1 meter	220.0

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL$_{cum}$ Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**17.8**	**0.6**	**21.2**	**9.5**	**0.7**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**1.2**	**NA**	**15.8**	**1.4**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a\,[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	Temporary Structure: Connector Cell Wall Ring Forms - Install via vibratory hammer -32 14-inch steel H piles

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	158
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	5
Duration of Sound Production within 24-h period (seconds)	300
10 Log (duration of sound production)	24.77
Propagation (xLogR)	15
Distance from source level measurement (meters)⁺	10

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**0.8**	**0.1**	**1.2**	**0.5**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	P310 Super Flood Basin, Closure Wall Const. - 310 sheet piles, South closure wall cells

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)¥	2	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	0
Number of piles per day	0
Strike Duration^Δ (seconds)	0
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	0
Distance of source level measurement (meters)⁺	0

^ΔWindow that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	0
Distance of source level measurement (meters)⁺	0
Source level at 1 meter	#NUM!

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**215.6**

SEL_{cum}

Source Level (Single Strike SEL)	180
Number of strikes per pile	300
Number of piles per day	12
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)⁺	10

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	205
Distance of source level measurement (meters)⁺	10
Source level at 1 meter	220.0

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**1,480.0**	**52.6**	**1,763.0**	**792.0**	**57.7**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**1.2**	**NA**	**15.8**	**1.4**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	P310 Super Flood Basin, Closure Wall Const - 310 sheet piles, south closure wall cells

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	163
Number of piles within 24-h period	12
Duration to drive a single pile (minutes)	5
Duration of Sound Production within 24-h period (seconds)	3600
10 Log (duration of sound production)	35.56
Propagation (xLogR)	15
Distance from source level measurement (meters)⁺	10

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**9.3**	**0.8**	**13.7**	**5.6**	**0.4**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	P310 Super Flood Basin,Closure Wall Const. - 52 sheet piles + 17 steel HP 14 sheet piles for Combi-wall (Berth 1 and Berth 2 closure) and 135 sheet piles (for cut off wall) to surround 10 drilled shafts

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	0
Number of piles per day	0
Strike Duration[∆] (seconds)	0
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	0
Distance of source level measurement (meters)⁺	0

[∆] Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	0
Distance of source level measurement (meters)⁺	0
Source level at 1 meter	#NUM!

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	**Low-Frequency Cetaceans**	**Mid-Frequency Cetaceans**	**High-Frequency Cetaceans**	**Phocid Pinnipeds**	**Otariid Pinnipeds**
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**215.6**

SEL_{cum}

Source Level (Single Strike SEL)	180
Number of strikes per pile	300
Number of piles per day	12
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)⁺	10

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	205
Distance of source level measurement (meters)⁺	10
Source level at 1 meter	220.0

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	**Low-Frequency Cetaceans**	**Mid-Frequency Cetaceans**	**High-Frequency Cetaceans**	**Phocid Pinnipeds**	**Otariid Pinnipeds**
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**1,480.0**	**52.6**	**1,763.0**	**792.0**	**57.7**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**1.2**	**NA**	**15.8**	**1.4**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	**Low-Frequency Cetaceans**	**Mid-Frequency Cetaceans**	**High-Frequency Cetaceans**	**Phocid Pinnipeds**	**Otariid Pinnipeds**
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	P310 Super Flood Basin, Sheet Pile wall along Berth 1 - 320 Sheet piles (400 linear feet) and 145 sheet piles (south closure wall façade sheeting formwork)

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	163
Number of piles within 24-h period	12
Duration to drive a single pile (minutes)	5
Duration of Sound Production within 24-h period (seconds)	3600
10 Log (duration of sound production)	35.56
Propagation (xLogR)	15
Distance from source level measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	**Low-Frequency Cetaceans**	**Mid-Frequency Cetaceans**	**High-Frequency Cetaceans**	**Phocid Pinnipeds**	**Otariid Pinnipeds**
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**9.3**	**0.8**	**13.7**	**5.6**	**0.4**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	**Low-Frequency Cetaceans**	**Mid-Frequency Cetaceans**	**High-Frequency Cetaceans**	**Phocid Pinnipeds**	**Otariid Pinnipeds**
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	P310 Super Flood Basin, Closure Wall Const - 10 drilled shafts (assumes drilling with rock-socket drill at 166.2 dB RMS) to support 10 8-ft diameter casings. 8hrs at less than one shaft drilled per day
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value.

Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 47), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	166.2
Duration of Sound Production (hours) within 24-h period	8
Duration of Sound Production (seconds)	28800
10 Log (duration of sound production)	44.59
Propagation (xLogR)	15

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**6.1**	**0.3**	**5.3**	**3.3**	**0.2**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a\,[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	Temporary Structure: Connector Cell Wall Ring Forms -Vibratory EXTRACTION -32 14-inch steel H piles (8/day) @ 8 minutes - CHANGED TO 5 MINUTES PER PILE TO MATCH NMFS

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)¥	2.5	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	166.2
Number of piles within 24-h period	0.5
Duration to drive a single pile (minutes)	480
Duration of Sound Production within 24-h period (seconds)	14400
10 Log (duration of sound production)	41.58
Propagation (xLogR)	15
Distance from source level measurement (meters)⁺	10

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**38.2**	**3.4**	**56.5**	**23.2**	**1.6**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent

VERSION 2.0: 2018

KEY

	User Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	Temporary Structure: Float-in Dolphins- Install via impact hammer - 48 36-inch steel pipe piles

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	0
Number of piles per day	0
Strike Duration[Δ] **(seconds)**	0
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	0
Distance of source level measurement (meters)⁺	0

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	0
Distance of source level measurement (meters)⁺	0
Source level at 1 meter	#NUM!

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**207.8**

SEL_{cum}

Source Level (Single Strike SEL)	183
Number of strikes per pile	300
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)⁺	10

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	205
Distance of source level measurement (meters)⁺	10
Source level at 1 meter	220.0

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**447.5**	**15.9**	**533.1**	**239.5**	**17.4**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**1.2**	**NA**	**15.8**	**1.4**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a\,[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	Temporary Structure: Float-in Dolphins - Install via vibratory hammer - 48 36-inch steel pipe piles

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)¥	2.5	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	175
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	5
Duration of Sound Production within 24-h period (seconds)	300
10 Log (duration of sound production)	24.77
Propagation (xLogR)	15
Distance from source level measurement (meters)+	10

+Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**11.2**	**1.0**	**16.5**	**6.8**	**0.5**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	P1074 Extension of Portal Crane Rail and Utilities, Relieving Platform Support (8 16-inch steel pipe piles)

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 75), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	0
Number of piles per day	0
Strike Duration[Δ] (seconds)	0
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	0
Distance of source level measurement (meters)[+]	0

[Δ] Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	0
Distance of source level measurement (meters)[+]	0
Source level at 1 meter	#NUM!

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

E.1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**182.8**

SEL_{cum}

Source Level (Single Strike SEL)	158
Number of strikes per pile	300
Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)[+]	10

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

PK

Source Level (PK SPL)	205
Distance of source level measurement (meters)[+]	10
Source level at 1 meter	220.0

[+] Unless otherwise specified, source levels are referenced 1 m from the source.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**9.6**	**0.3**	**11.5**	**5.2**	**0.4**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**1.2**	**NA**	**15.8**	**1.4**	**NA**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a\,[1+(f/f_2)^2]^b}\right\}$$

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.0: 2018

KEY

(green)	**User Provided Information**
(pink)	**NMFS Provided Information (Technical Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	PNSY Modification and Expansion of DD1
PROJECT/SOURCE INFORMATION	P1074 Extension of Portal Crane Rail and Utilities, Relieving Platform Support (8 16-inch steel pipe piles)

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)¥	2.5	

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	162
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	5
Duration of Sound Production within 24-h period (seconds)	300
10 Log (duration of sound production)	24.77
Propagation (xLogR)	15
Distance from source level measurement (meters)+	10

+Unless otherwise specified, source levels are referenced 1 m from the source.

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**1.5**	**0.1**	**2.2**	**0.9**	**0.1**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1 OR E2 method to calculate isopleths (not required to fill in sage boxes for both)

E.3-1: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Shot Duration[Δ] (seconds)	
10 Log (duration of sound production)	#NUM!
Propagation (xLogR)	

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

PK

Source Level (PK SPL)	

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Additionally, explosives have thresholds associate with lung and g.i. tract injury that need to be considered.

PTS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS SEL_{cum} Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**NA**	**NA**	**NA**	**NA**	**NA**

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

TTS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	168	170	140	170	188
TTS SEL_{cum} Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**
PK Threshold	213	224	196	212	226
TTS PK Isopleth to threshold (meters)	**NA**	**NA**	**NA**	**NA**	**NA**

E.3-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE/SHOT/PULSE EQUIVALENT)

SEL_{cum}		PK	
Source Level (Single shot SEL)		Source Level (PK SPL)	
Propagation (xLogR)			

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.
Additionally, explosives have thresholds associate with lung and g.i. tract injury that need to be considered.

PTS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS SEL_{cum} Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	NA	NA	NA

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

TTS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	168	170	140	170	188
TTS SEL_{cum} Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	213	224	196	212	226
TTS PK Isopleth to threshold (meters)	NA	NA	NA	NA	NA

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a\,[1+(f/f_2)^2]^b}\right\}$							

F: MOBILE SOURCE: Impulsive, Intermittent ("SAFE DISTANCE" METHODOLOGY)

VERSION 2.0: 2018

KEY

(green)	User Provided Information
(pink)	NMFS Provided Information (Technical Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]		

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 71), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either F1 OR F2 method to calculate isopleths (not required to fill in sage boxes for both)

F1: METHOD[‡] TO CALCULATE PK and SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Source Level (RMS SPL)	
Source Velocity (meters/second)	
Pulse Duration[^] (seconds)	
1/Repetition rate^ (seconds)	
Duty Cycle	#DIV/0!
Source Factor	#DIV/0!

‡Methodology assumes propagation of 20 log R; Activity duration (time) independent

[^]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

^Time between onset of successive pulses.

PK

Source Level (PK SPL)	

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS SEL_{cum} Isopleth to threshold (meters)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	NA	NA	NA

F2: ALTERNATIVE METHOD[†] TO CALCULATE PK and SEL_{cum} (SINGLE SHOT/PULSE EQUIVALENT)

SEL_{cum}

Source Level (Single shot/pulse SEL)	
Source Velocity (meters/second)	
1/Repetition rate^ (seconds)	
Source Factor	#DIV/0!

†Methodology assumes propagation of 20 log R; Activity duration (time) independent

^Time between onset of successive pulses.

PK

Source Level (PK SPL)	

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS SEL_{cum} Isopleth to threshold (meters)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	NA	NA	NA

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$