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Incidental Harassment Authorization Application for Waterfront Improvement Projects at Portsmouth Naval Shipyard Kittery, Maine

January 1, 2017, through December 31, 2017

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Submitted to:

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

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For:
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Kittery, Maine

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Acronyms and Abbreviations

µ	micro
µPa	micro Pascals
°F	degrees Fahrenheit
CeTAP	Cetaceans and Turtle Assessment Program
CIA	controlled industrial area
CNO	Chief of Naval Operations
CV	coefficient of variation
dB	decibel
EA	environmental assessment
ESA	Endangered Species Act
FHWG	Fisheries Hydroacoustic Working Group
HVAC	heating, ventilation, and air conditioning
Hz	hertz
km	kilometer
L_{eq}	equivalent sound level
MMPA	Marine Mammal Protection Act
NAVSEA	Naval Sea Systems Command
NOAA	National Oceanic and Atmospheric Administration
Pa	Pascal
ppt	parts per thousand
PTS	permanent threshold shift
rms	root-mean-squared
SEL	sound exposure level
SPL	sound pressure level

TL	transmission loss
TTS	temporary threshold shift
U.S.C.	U.S. Code
USCG	U.S. Coast Guard
ZOI	zone of influence

1 Description of the Activity

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

The U.S. Department of the Navy (Navy) is proposing to restore and modernize waterfront infrastructure associated with Dry Docks 1 and 3 at Portsmouth Naval Shipyard (the Shipyard) in Kittery, York County, Maine. The proposed action would include two waterfront improvement projects, structural repairs to Berths 11, 12, and 13, and replacement of the Dry Dock 3 caisson. The waterfront improvement projects would be constructed between October 2016 and October 2022, with in-water work expected to begin no earlier than January 2017. The Navy is preparing an environmental assessment (EA) to analyze the potential environmental consequences of the proposed action.

1.2 Proposed Action

The Shipyard is located in Kittery, Maine, on Seavey Island in the Piscataqua River, which flows between Maine and New Hampshire (see Figure 1-1). The Shipyard occupies the whole of Seavey Island, encompassing 278 acres on what were originally five separate islands (Seavey, Pumpkin, Dennett's, Clarks, and Jamaica). Over the past 200 years, as a result of expansion from land-making activity, four of these islands (Seavey, Pumpkin, Dennett's, and Jamaica) were consolidated into one large island, which kept the name Seavey Island. Clarks Island is now attached to Seavey Island by a causeway.

The purpose of the proposed action is to modernize and maximize dry dock capabilities for performing current and future missions efficiently and with maximum flexibility. The need for the proposed action is to correct deficiencies associated with the pier structure at Berths 11, 12, and 13 and the Dry Dock 3 caisson and concrete seats and ensure that the Shipyard can continue to support its primary mission to service, maintain, and overhaul submarines. By supporting the Shipyard's mission, the proposed action would assist in meeting the larger need for the Navy to provide capabilities for training and equipping combat-capable naval forces ready to deploy worldwide. In this regard, the proposed action furthers the Navy's execution of its congressionally mandated roles and responsibilities under 10 United States Code [U.S.C.] Section 5062.

The Shipyard's physical environment and industrial operations have evolved over its long history to meet changing mission requirements. The Shipyard's dry docks were constructed between 1900 and 1943 and remain the core of the Shipyard's operations today. The Shipyard's dry docks are located in the controlled industrial area (CIA), which is fenced and has controlled access at several gates to provide security for dry dock operations. Each dry dock's mission is described below:

> **Dry Dock 1 –** Supports Chief of Naval Operations (CNO)-mandated engineering overhauls of *Los Angeles*-class submarines. During engineering overhauls, a submarine's components are disassembled, thoroughly cleaned or replaced if worn out, and then reassembled.
>
> **Dry Dock 2 –** Supports fuel servicing, maintenance, and overhaul of *Los Angeles*-class submarines.
>
> **Dry Dock 3 –** Supports maintenance and overhaul of *Virginia*-class submarines. Dry Dock 3 is the Shipyard's premier *Virginia*-class dry dock.

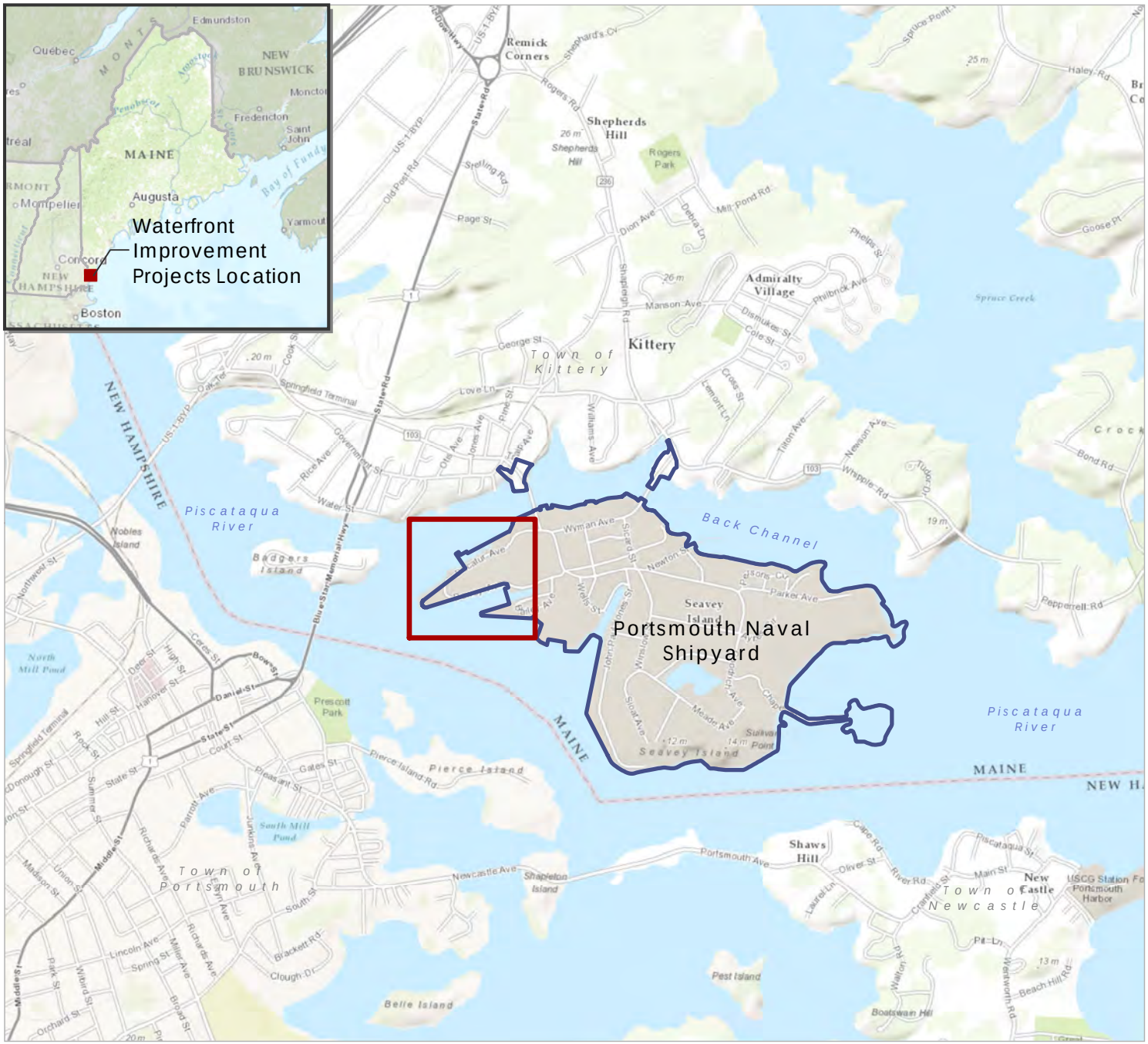

Figure 1-1
Location Map
Portsmouth Naval Shipyard
York County, Maine

Legend

Installation Area

N

0 1,000 2,000 3,000 4,000 Feet

Source: ESRI 2013; Department of Defense 2014.

Path: \\prtbhp1\GIS\Buffalo\Portsmouth_Railway\Maps\MXD\Reports\IHA_Application\Figure_1-1_Regional Map.mxd

Berths 11, 12, and 13

The pier infrastructure at Berths 11, 12, and 13 supports part of the west circuit of the Shipyard's portal crane rail system (see Figure 1-2). Portal cranes, which are track-mounted cranes on a central shaft atop four steel legs, are used to preassemble pieces of submarines, move them to a dry dock, and lift or reposition them as needed. Portal cranes also are used to lift and move large equipment. Age-related structural weaknesses in this pier, called the "fitting-out" pier, directly impact operation of the west circuit of the portal crane rail system—and consequently impact maintenance schedules and the associated costs of maintenance services at Dry Docks 1 and 3. The sides of the pier are open at Berths 11, 12, and 13, and water action has corroded the steel piles over the decades, weakening the overall structure that supports the portal crane rail system. Accelerated corrosion of the piles at Berths 11, 12, and 13 has reduced and will continue to reduce the rated load-bearing capacity of these piles—or the maximum weight they can support with limited risk of failure, which, in turn, prevents the Shipyard's portal cranes from operating at their full 60-ton load-bearing capacity. The Shipyard has been maintaining the piles at the fitting-out pier by installing pile jackets (i.e., fabric pouches that are installed around a pile over steel reinforcing bars and then filled with mortar). However, when pile jackets are installed, the rated load-bearing capacity of the piles must be reduced because of a combination of the reduced strength of the piles and the added weight of the pile jackets. Erosion of soil from the open sides of the pier and age-related failure of the pier deck additionally affect the structural integrity of these berths.

Dry Dock 3 Caisson and Seats

The steel caisson and seats at the entrance to Dry Dock 3 form the watertight enclosure for the dry dock. The existing caisson has been in use since 1962, has reached the end of its service life, and is showing signs of deterioration. At the inner and outer caisson seats, spalled concrete (i.e., concrete that has broken, flaked, or become pitted) allows some seawater to infiltrate the dry dock. Failure of either the caisson or caisson seats would cause uncontrolled flooding of the dry dock, potentially resulting in major damage to multi-billion-dollar vessels and injuries to personnel working in the dry dock. The caisson and caisson seats may no longer meet the requirements of the Naval Sea Systems Command (NAVSEA) Safety Certification Program for dry-docking facilities if they continue to deteriorate (Department of Defense [DOD] Standard Practice 1625C [SH] [MIL-STD-1625C[SH] 29 1987).

Alternative Addressed in this Application

The EA for the proposed action analyzes two action alternatives. Alternative 1, the Preferred Alternative, incorporates in-water construction techniques at Berths 11, 12, and 13 and the Dry Dock 3 caisson that would require less (or no) pile driving, potentially reducing impacts on in-water resources, including marine mammals, fish, and benthic communities. Alternative 2 considers construction of conventional sheet-pile bulkheads at Berths 11, 12, and 13 and a temporary circular, cellular sheet-pile cofferdam at the Dry Dock 3 caisson to create a dry workspace. Alternative 2 thus would require a greater number of piles and more pile-driving than Alternative 1. For this application, the Preferred Alternative (Alternative 1) has been modeled and analyzed. In the unlikely case that the Navy implements Alternative 2, actual impacts from noise would be worse than predicted in this application, and the Navy would initiate a new consultation with the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service.

Alternatives 1 and 2 are discussed in Chapter 2 of the EA, and general information on the construction processes for the proposed Berths 11, 12, and 13 structural repairs and Dry Dock 3 caisson replacement is provided in Appendix A of the EA.

Figure 1-2
Dry Docks, Berths, and the Portal Crane Rail System
Portsmouth Naval Shipyard
York County, Maine

Legend

- Dry Dock
- Berth
- Installation Area
- Portal Crane Rail

N

0 250 500 750 Feet

Source: ESRI 2013; Department of Defense 2014.

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This application focuses primarily on the in-water construction activities that will occur during the first year of construction, including completion of the king pile and concrete shutter panel bulkhead at Berth 11. Additional applications will be submitted for each subsequent year of in-water construction at Berths 11, 12, and 13. The preferred construction method for the Dry Dock 3 caisson replacement minimizes the extent and duration of in-water work and does not require pile-driving. Therefore, the Dry Dock 3 caisson replacement is not discussed further in this application. The general construction timeframes for both projects are provided in Table 1-1. It is important to note that these construction schedules are subject to change, depending on mission requirements and operational schedules at the affected dry docks and berths.

Table 1-1 Construction Timeframes for the Proposed Waterfront Improvement Projects

Project	Estimated Construction Start	Estimated Construction End
Berths 11, 12, and 13 Structural Repairs	October 2016	October 2022
Phase 1	*October 2016*	*June 2019*
In-Water Work - Phase 1 (Berth 11)	*January 2017*	*August 2018*
Phase 2	*October 2020*	*October 2022*
In-Water Work - Phase 2 (Berths 12 and 13)	*To be determined based on availability of berths*	*To be determined based on availability of berths*
Dry Dock 3 Caisson Replacement	February 2017	August 2018
In-Water Work – Outer Caisson Seat Repairs	*March 2017*	*July 2017*

Note: Due to mission requirements and operational schedules at the affected dry docks and berths, the general construction schedules above are subject to change.

1.3 Construction Methods and Descriptions

This section describes the typical methods of pile installation and extraction and dredging that would be used to accomplish the work included as part of this Proposed Action.

1.3.1 Pile Installation and Extraction with a Vibratory Hammer

Vibratory hammers are routinely used to install and extract smaller 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 produced during construction activities (ICF Jones and Strokes and Illingworth and Rodkin, Inc. 2012). However, they are considered a non-impulsive noise source as the hammer continuously drives the pile into the substrate; therefore, the total sound energy imparted can be comparable to impact driving. 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. The model of vibratory hammer likely to be used for the project is the MKT vibratory hammer. Piles installed with a vibratory hammer would include:

- 15-inch timber piles used to reconstruct timber dolphins at the corners of Berth 11
- 25-inch steel sheet piles used for the bulkhead at Berth 11

Extracted piles would include:

- 15-inch timber fender piles at Berth 11

- 15-inch timber piles making up the existing dolphins at the corner of Berth 11.

1.3.2 Pile Installation with an Impact 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. The model of impact hammer likely to be used for the project is the APE D36-26 impact hammer. Piles that would be installed through impact driving include 14-inch steel H-type piles used as sister piles at Berth 11 and to align and construct a temporary trestle support system during in-water construction at the berth

These piles must be installed with an impact hammer because the piles will not reach bearing depth or have the required load-bearing capacity if installed using vibratory methods only.

1.3.3 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). Due to a lack of information regarding pile-drilling source levels, it is generally assumed that drilling would produce less in-water noise than both impact and vibratory pile driving. Three drill models are likely to be used in different applications during in-water construction at Berth 11:

- The Bauer BG 24 rotary drill rig would be used to install king piles at Berth 11
- The SoilMec PSM-20 wet rotary drill rig would be used to install rock anchors to laterally support the bulkheads at the berth
- The Cassagrande M9 hydraulic rotary drill would be used to install micro piles at Berth 11C, if a bulkhead is not provided at this berth, to support a proposed utility tunnel.

1.3.4 Dredging

At the start of in-water construction, a level trench would be dredged along the footprint of the bulkhead. The dredged trench and the bottoms of the panels would be slightly lower than the Shipyard's permitted dredge depth at these berths to prevent the bottom of the bulkhead from being undermined during future maintenance dredging. At locations where a bedrock layer occurs above the permitted dredge depth, the panels would be installed slightly above the bedrock (MN-FST 2015). The model of the dredge that would be used would be determined by the construction contractor.

2 Dates, Duration, and Region of Activity

The date(s) and duration of such activity and the specific geographical region where it would occur.

2.1 Dates of Construction

In-water construction associated with the Proposed Action would occur in phases over a six-year construction period. In-water construction is scheduled to begin in January 2017 and be completed by October 2022. This application is for the first year of in-water construction, from January 1, 2017 to December 31, 2017. No seasonal limitations would be imposed on the construction timeline. Construction schedules for in-water work at Berth 11 are under development and subject to change based on operational requirements. Therefore, this IHA application covers all in-water construction planned for Berth 11 structural repairs. The Navy intends to apply for sequential IHAs to cover each of the subsequent years of construction.

2.2 Duration of Activities

Table 2-1 summarizes the in-water construction activities,—pile extraction, driving, and drilling, scheduled to take place during the timeframe covered by this IHA application. Note that pile- driving days are not necessarily consecutive. Also note that certain activities may occur at the same time, decreasing the total number of pile-driving days, thus making the total days described below a conservative estimate. Additional discussion follows below.

Table 2-1 Activity Summary for Year 1 of the Berths 11, 12, and 13 Structural Repairs

Activity/Method	Timing	Number of Days	Pile Type	Number of Piles Installed	Number of Piles Extracted
Extract timber piles/vibratory hammer	January 2017 to December 2017	10[1]	15-inch timber pile	-	77
Install temporary sister piles for trestle system/ vibratory hammer	January 2017 to December 2017	16[2]	14-inch steel H-type	64	-
Install permanent king piles for bulkhead/auger drilling	January 2017 to December 2017	10	36-inch steel H-type piles	94	-
Install steel sheet-pile bulkhead/vibratory hammer (sheet piles and sheet pile returns)	January 2017 to December 2017	6	24-inch steel sheet-piles	112	-
Install permanent sister piles/impact hammer	January 2017 to December 2017	13[2]	14-inch steel H-type	50	-
Install timber dolphin	January 2017 to January 2017	1[1]	15-inch timber piles	7	-

Table 2-1 Activity Summary for Year 1 of the Berths 11, 12, and 13 Structural Repairs

Activity/Method	Timing	Number of Days	Pile Type	Number of Piles Installed	Number of Piles Extracted
Extract temporary sister piles for trestle system/vibratory hammer	January 2017 to December 2017	16[2]	14-inch steel H-type	-	64
Totals		**72**		**327**	**141**

[1] Estimate based on assumption of 30 minutes to drive each pile and 30-minute transition and set up time, resulting in one pile per hour and eight piles per day (ICF Jones and Strokes and Illingworth and Rodkin, Inc. 2012).

[2] Estimate based on assumption of a one-hour transition and set up time, resulting in one pile per two hours and four piles per day (ICF Jones and Strokes and Illingworth and Rodkin, Inc. 2012).

Note: The Navy provided the following information in response to technical questions:

King Piles – estimate of 10 per day

Sheet piles- estimate of 20 per day, based on 20 piles in 8 hours (i.e., one day) because they will be installed two at a time

2.2.1 Pile-Driving, Extraction, and Drilling

The number of piles that can be driven per day varies for different project elements and is subject to change based on site conditions at the time.

Berth 11 (A, B, and C)

At the beginning of the in-water work, existing timber piles would be removed from the berth faces and the timber dolphin at the western end of the berth, and the contractor either would construct a temporary construction trestle or place a jack-up barge alongside the berths to provide additional construction workspace. Pile-driving and extraction would be needed to construct and disassemble the temporary construction trestle if the construction contractor selects this method over use of a jack-up barge, which would require no pile driving. The trestle system has been included in this analysis in order to model a conservative, worst-case scenario. If a jack-up barge is used instead of a trestle system, less pile driving will be needed, resulting in fewer marine mammal takes than predicted in this application.

For the proposed king pile and concrete shutter panel bulkhead (see Figures 2-1 and 2-2), the contractor would likely create templates and work in increments along the berth from the trestle or jack-up barge. For example, an approximately 50-foot-long template would allow installation of about 10 king piles and 20 sheet piles (along segments of the berths where sheet piles would be installed). The work would consist of setting a template (including temporary piles and horizontal members), which might take one or two days. Then the contractor would drill the rock sockets, which could take about one day per socket. King piles would be regularly spaced along the berths and grouted into sockets drilled into the bedrock (i.e., “rock-socketed”).

The concrete shutter panels would then be installed in stacks between the king piles along most of the length of Berth 11. Installation of the concrete piles is not included in the noise analysis because no pile driving would be required. Along an approximately 16-foot section at the eastern end of Berth 11A and an additional 101 feet between Berths 11A and 11B, the depth to bedrock is greater, thus allowing a conventional sheet-pile bulkhead to be constructed. The steel sheet-piles would be driven to bedrock using a vibratory hammer. Sheet piles installed with a vibratory hammer also would be used to construct “returns,” which would be shorter bulkheads connecting the new bulkheads to the existing bulkhead under the pier. Installation of the sheeting with a vibratory hammer is estimated to take less than one hour per pair of sheets. (the contractor would probably install two sheets at a time), and so the time required to

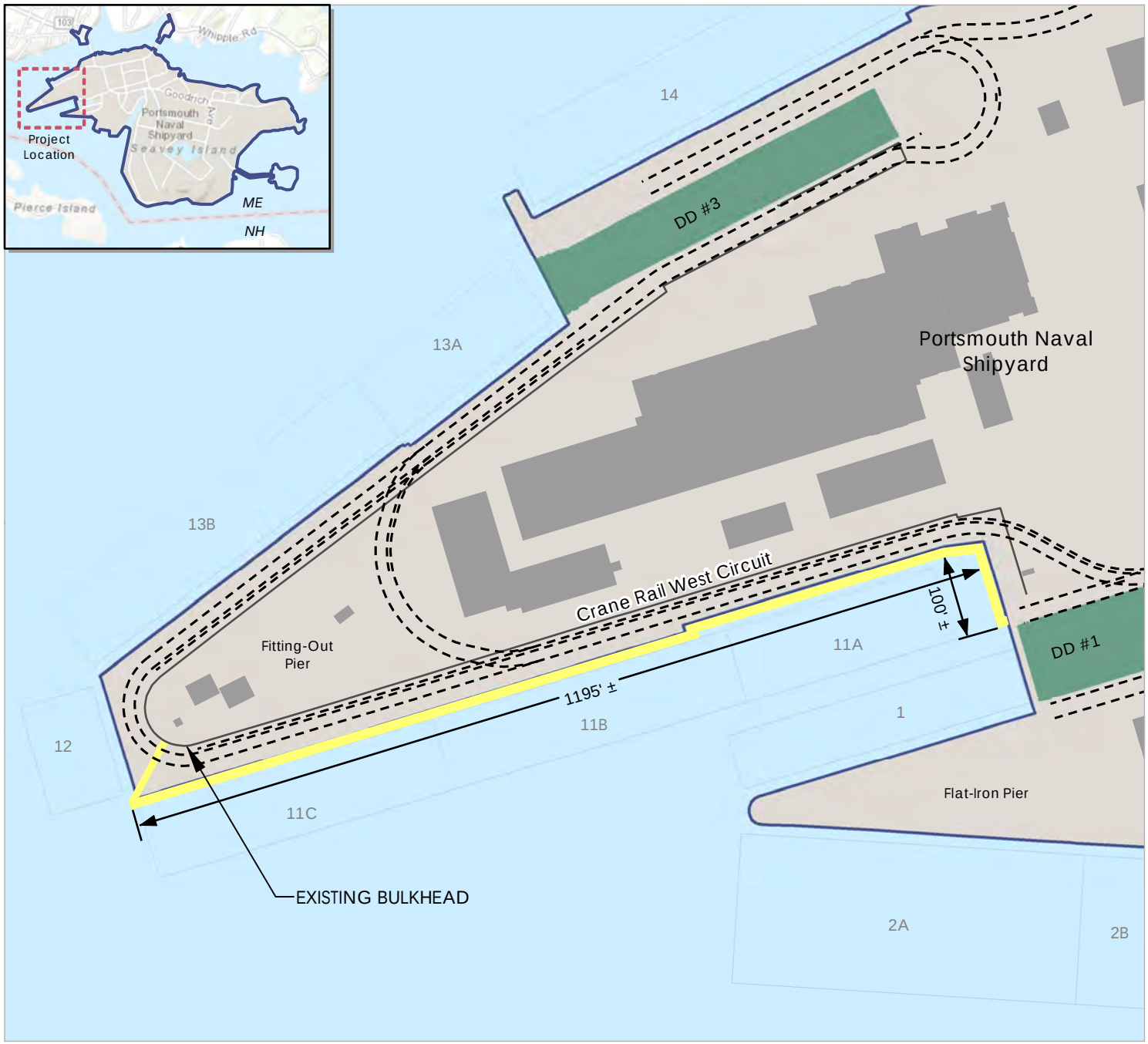

Figure 2-1
Berths 11 (A, B, and C) Bulkhead
Portsmouth Naval Shipyard
York County, Maine

Legend

- Proposed Bulkhead Phase 1
- Dry Dock
- Berth
- Existing Structures
- Installation Area
- Portal Crane Rail

N

0 100 200 300 400 Feet

Source: ESRI 2013; Department of Defense 2014.

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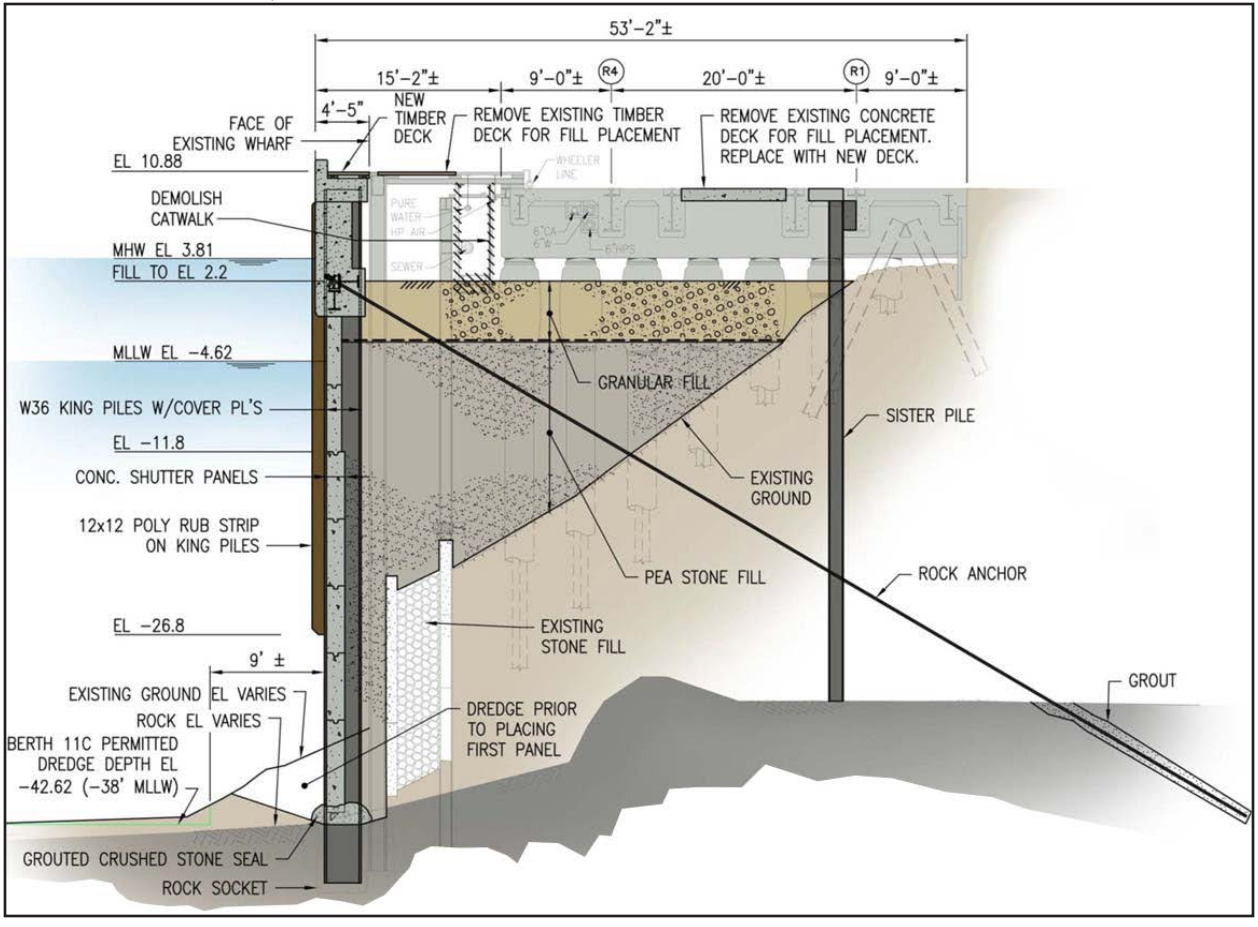

Figure 2-2
Berth 11 Bulkhead Conceptual Design
Portsmouth Naval Shipyard
York County, Maine

install the sheeting (10 pairs = 20 sheets) using vibratory hammers would only be about 8 hours per 10 pairs of sheets. Time requirements for all other pile types were estimated based on information compiled from ICF Jones and Strokes and Illingworth and Rodkin, Inc. (2012).

If sufficient construction funds are available, the Navy may install a king pile and concrete shutter panel bulkhead at Berth 11C as part of Phase 1. The bulkhead would extend from the western end of Berth 11B to the southern end of Berth 12. The in-water construction process would be the same as the process described above. The analysis in this application includes construction at Berth 11C. Once the Berth 11 bulkheads are complete, the timber dolphins at the western end of the berth would be replaced with a similar dolphin constructed of approximately seven piles.

Additional in-water work would be required to install steel H-type sister piles at the location of the inboard portal crane rail beam at Berth 11, including Berth 11C. The sister piles would provide additional support for the portal crane rail system and restore its load-bearing capacity. The sister piles would be driven into the bedrock below the pier, in water generally less than 10 feet deep, using an impact hammer. The timing of this work depends on operational schedules at the berths. The sister piles may be installed either before or after the bulkheads are constructed.

2.2.2 Dredging

Dredging would be completed in a continuous operation along the entire berth before any king-pile sockets are drilled in order to create the trench needed to seat the bulkhead. Dredging the bulkhead footprint at Berth 11 would take approximately two weeks.

2.3 Project Area 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 then 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.

2.3.1 Bathymetric Setting

Water depths in the Project area range from 21 feet to 39 feet at Berths 11, 12, and 13. Water depths in the lower Piscataqua River near the 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 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 Project area would be 0.8 mile to the southeast and 0.26 mile to the northwest.

2.3.2 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. Recent 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 Project area is considered that of sea water, 25 parts per thousand (ppt) and greater (NOAA November 1985).

2.3.3 Substrates and Habitats

Benthic sediments and substrates in the Project area were characterized during a benthic survey completed in May 2014 (CR Environmental, Inc. 2014). Surficial sediments were characterized using video transects and grab samples captured at five locations along Berths 11, 12, and 13. Sediment characteristics varied between the five locations. At the sample locations at both the north and south sides of the fitting-out pier (Berths 11 and 13), where the current was generally low energy, sediment consisted of soft mud, sand, pebbles, and old mussel shells. At the end of the pier (Berth 12), in an area of higher current flow, the substrate consisted of hard sand, pebbles/cobbles, and small boulders (CR Environmental, Inc. 2014).

Much of the shoreline in the Project area has been characterized as 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 are characterized by "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.

2.3.4 Vessel Traffic and Ambient Underwater Soundscape

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). The size of these vessels is limited by the 106-foot width of the river at the Sarah Long Bridge that spans the river (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 in the vicinity of the project exceed those of the NOAA Fisheries Service thresholds, i.e., 120 decibel (dB) or greater, then marine mammals would not be affected by any sound less than the existing dominant noise levels. For example, if the background noise levels average 140 dB, then additional sounds less than 140 dB would not expose animals to harassing levels of noise. Any sounds less than 140 dB would become part of the background noise level and would not be audible above the dominant background noise.

A recent ambient noise study conducted by ESS Group took in-water ambient sound pressure level measurements over the duration of a single day, November 25, 2014, at three locations at the Shipyard (one reading each at Berths 11, 12, and 13). Peak sound levels at Berth 11 reached a maximum instantaneous sound level of 79.7 L_{peak} dB re 1µPa, and the sound exposure level was 75.7 L_{sel} dB re 1µPa. Peak sound levels at Berth 12 reached a maximum instantaneous sound level of 103.9 L_{peak} dB re 1µPa, and sound exposure level was 80.5 L_{sel} dB re 1µPa. Peak sound levels at Berth 13 reached a maximum instantaneous sound level of 91.7 L_{peak} dB re 1µPa, and sound exposure level was 52.8 L_{sel} dB re 1µPa. However, boat traffic was limited the day of the study; three boats passed at a distance greater than 66 yards from site. Therefore, given the short duration of the measurements, it would be difficult to determine whether vessel noise associated with the Proposed Action would add greatly to the existing background vessel noise in the lower Piscataqua River. However, based on these measurements, it cannot be assumed that the sound produced by vibratory pile driving would be completely masked by background vessel noise, especially in areas close to the vibratory hammer.

2.3.5 Existing Airborne Noise

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 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 µPa, the appropriate reference for in-air sound measurements. 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 Ambient Sound Levels Recorded at Berths 11, 12, and 13

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 sources: trucks and forklifts passing, drilling rig, circular saw noise, passing boats, front-end loaders passing. 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 of 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.

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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.

Five marine mammal species, including one cetacean and four pinnipeds, may inhabit or transit the waters near the Shipyard in the lower Piscataqua River. These include the harbor porpoise (*Phocoena phocoena*), grey seal (*Halichoerus grypus*), harbor seal (*Phoca vitulina*), hooded seal (*Crystphora cristata*), and harp seal (*Pagophilus groenlandicus*). None of the marine mammals that may be found in the Piscataqua River are listed under the Endangered Species Act (ESA). All marine mammal species are protected under the Marine Mammal Protection Act (MMPA). Section 3 summarizes the population status and abundance of these species, while Section 4 contains detailed life history information for each. Table 3-1 lists the marine mammal species that could occur in the vicinity of the Shipyard and their estimated densities within the Project area. As there are not specific density data for any of the species in the Piscataqua River, density data from the nearshore zone outside the mouth the Piscataqua River in the Atlantic Ocean have been used instead. Therefore, it can be assumed that the density estimates presented here for each species are conservative and much higher than densities that would typically be expected in an estuarine environment such as the lower Piscataqua River in the vicinity of the Shipyard.

Table 3-1 Marine Mammal Species Potentially Present in the Piscataqua River in the Vicinity of the Shipyard

Species	Stock(s) Abundance(1)	Relative Occurrence in Piscataqua River	Season(s) of Occurrence	Approximate Density in the Vicinity of the Project Area (individuals per km^2)(3)			
				Winter	Spring	Summer	Fall
Harbor Porpoise *Phocoena phocoena* Gulf of Maine/Bay of Fundy stock	79,883 (CV= 0.32)	Occasional use	Spring to Fall (April to December)[4]	1.2122	1.1705	0.7903	0.9125
Grey Seal *Halichoerus grypus* Western North Atlantic stock	331,000(2)	Common	Year-round	0.2202	0.2202	0.2202	0.2202
Harbor Seal *Phoca vitulina* Western North Atlantic stock	70,142 (CV= 0.29)	Common	Year-round	0.1998	0.1998	0.1998	0.1998
Hooded Seal *Crystphora cristata* Western North Atlantic stock	592,900(2)	Rare	Winter to Spring (January – May)	N/A	N/A	N/A	N/A

Table 3-1 Marine Mammal Species Potentially Present in the Piscataqua River in the Vicinity of the Shipyard

Species	Stock(s) Abundance[1]	Relative Occurrence in Piscataqua River	Season(s) of Occurrence	Approximate Density in the Vicinity of the Project Area (individuals per km^2)[3]			
				Winter	Spring	Summer	Fall
Harp Seal *Pagophilus groenlandicus* Western North Atlantic stock	71,000,000	Rare	Winter to Spring (January – May)	0.0125	0.0125	0.0125	0.0125

Source: Waring et al. 2014, except where noted.

Notes:
(1) No population estimate is available for the U.S. western North Atlantic stock; therefore, the best population estimates are those for the Canadian populations as reported in Waring et al. 2014.
(2) Source: Waring et al. 2007. The population estimate for the Western North Atlantic hooded seal population was not updated in Waring et al. 2014.
(3) Density data are taken from the Navy Marine Species Density Database (Crain 2015; Krause 2015). It should be noted that these data overestimate the potential species density in the Piscataqua River. The Navy Marine Species Density Database data presented in the table are based on a relative environmental suitability study and represent data with low confidence. These data are generally used for broad-scale offshore activities; however, due to a lack of any other data within the general Project area, these data are presented as the best available data for the Piscataqua River.
(4) Densities shown for seasons when each species would not be likely to occur in the river

Key:
CV = coefficient of variation
km^2 = square kilometer

3.1 Species Descriptions and Abundances

3.1.1 Harbor Porpoise

Species Description

The harbor porpoise is a member of the *Phocoenidae* family. 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 greyish-white sides, triangular dorsal fin, and short rostrum. Harbor porpoises are considered sexually dimorphic, with females being slightly larger than males (NOAA Fisheries Service 2014a).

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 Fisheries Service 2014a). 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. For management purposes in U.S. waters, harbor porpoises have been divided into 10 stocks along both the East and West Coasts. Of those 10 stocks, 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 Project area. The species is primarily found over the Continental Shelf in waters less than approximately 500 feet deep (Waring et al. 2014). In general, the species is commonly found in bays, estuaries, and harbors (NOAA Fisheries Service 2014a).

Population Abundance

Line-transect surveys have been conducted in the Gulf of Maine between 1991 and 2011. Based on the 2011 aerial surveys, the best abundance estimate for the Gulf of Maine/Bay of Fundy stock of harbor porpoise is 79,883 animals (CV=0.32). The aerial surveys included central Virginia to the lower Bay of Fundy. The minimum population estimate is 61,415 animals (Waring et al. 2014). Because no trend analysis has been conducted for this stock, no population trend is available. A Bayesian population model was used to determine the currently accepted population growth rate. Fertility data and age-at-death data from stranded animals and animals taken in gillnets were used for the model (Waring et al. 2014). It was then determined that the potential natural growth rate for the Gulf of Maine/Bay of Fundy stock of harbor porpoises was 0.046 (Waring et al. 2014). The harbor porpoise is likely the most abundant cetacean within the Piscataqua River (Smith n.d.).

3.1.2 Grey Seal

Species Description

Grey seals, which are 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 (NOAA Fisheries Service 2013). Grey seals primarily feed on fish, squid, various crustacean species, and octopus. Adult grey 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 (NOAA Fisheries Service 2013). Adult females can reach up to 7.5 feet in length and can weigh up to 550 pounds (NOAA Fisheries Service 2013). As a true seal, this species lacks external ear flaps, and its rear flippers do not rotate. Depending on its geographic location and sex, grey seal appearance and coloration varies. Adult females have a silver-grey coat with darker spots scattered over their body, and while males generally have similar color patterns, they have a prominent, long-arched nose (NOAA Fisheries Service 2013).

Grey seals can be found on both sides of the North Atlantic. Within this area, the species is split into three primary populations: 1) eastern Canada, 2) northwestern Europe, and 3) the Baltic Sea (Katona et al. 1993). Grey seals within U.S. waters are considered the western North Atlantic stock and are expected to be part of the eastern Canadian population (Waring et al. 2014). 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 (Waring et al. 2014).

Population Abundance

There are currently no population estimates for the western North Atlantic grey seal stock (Waring et al. 2014). However, estimates are available for portions of the total population for certain time periods (Waring et al. 2014). For example, between 1993 and 2004, the grey seal population in Canada was estimated at between 144,000 and 223,220 individuals. This estimate was based on three separate surveys and also depended on the population-estimation model that was used (Mohn and Bowen 1996; Department of Fisheries and Oceans 2003; Trzcinski et al. 2005). The most recent Canadian grey seal population estimate is 331,000. This estimate is based on surveys conducted during 2012 in the Gulf of St. Lawrence, Nova Scotia Eastern Shore, and Sable Island (Waring et al. 2014). In U.S. waters, grey seals are known to pup at three separate locations: 1) Muskeget Island, Massachusetts; 2) Green Island, Maine; and 3) Seal Island, Maine. Surveys of these areas indicate that in these colonies pup production is increasing, as are the colony populations. General population increases in U.S. waters are likely a result of this natural increase and immigration of individuals from Canadian populations (Waring et al. 2014).

3.1.3 Harbor Seal

Species Description

Harbor seals are also members of the true seal family (*Phocidae*) and can be found in nearshore waters along both the North Atlantic and North Pacific coasts, generally at latitudes above 30°N (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. 2014). In New England, the species can be found in coastal waters year-round (Waring et al. 2014). Overall, there are five recognized subspecies of harbor seal, two of which occur in the Atlantic Ocean. The western Atlantic harbor seal (*Phoca vitulina concolor*) is the subspecies likely to occur in the 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).

Similar to grey seals, adult harbor seals are sexually dimorphic. Males are generally larger than females. Adult harbor seals can reach up to 6.3 feet in length and weigh up to 245 pounds (NOAA Fisheries Service 2014c). As with other members of the *Phocidae* family, 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 Fisheries Service 2014c).

Population Abundance

An aerial abundance survey was conducted in 2012 during the pupping season along the entire Maine coast. As a result of this survey, the best estimate of abundance for the western North Atlantic stock of harbor seal was 70,142 animals. The minimum population was estimated as 55,409 animals (also based on the 2012 aerial abundance survey). No trend analysis has been conducted for this species, likely because of the long interval between the 2012 survey and the previous 2001 survey and the somewhat imprecise abundance estimates that were generated from them. In the Piscataqua River, harbor seals are the most abundant pinniped species (Smith n.d.).

3.1.4 Hooded Seal

Species Description

Hooded seals are also members of the true seal family (*Phocidae*) and are generally found in deeper waters or on drifting pack ice. 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). 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).

Similar to both the grey 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 (NOAA Fisheries Service 2012b). Females generally reach up to 7 feet in length and weigh up to 440 pounds (NOAA Fisheries Service 2012b). 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 Fisheries Service 2012b).

Population Abundance

Population abundance of hooded seals in the western North Atlantic is derived from pup production estimates. These estimates are developed from whelping pack surveys. The most recent population estimate in the western North Atlantic was derived in 2005. There have been no recent surveys conducted or population estimates developed for this species. The 2005 best population estimate for hooded seals is 592,100 individuals, with a minimum population estimate of 512,000 individuals (Waring et al. 2007). Currently, not enough data are available to determine what percentage of this estimate may represent the population within U.S. waters. A population trend also cannot be developed for this species due to a lack of sufficient data. 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).

3.1.5 Harp Seal

Species Description

Harp seals are also members of the true seal familclassified into three stocks, which coincide with specific pupping sites on pack ice, 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). The hooded 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 in the winter and spring (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.

Unlike the grey seal, harbor seal, and hooded seal, harp seals exhibit little sexual dimorphism. Males are generally only slightly larger than females, reaching up to 6’3” in length and weighing approximately 310 pounds (Reeves et al. 2002). Females generally reach up to 5’11” in length and weigh up to 290 pounds (Reeves et al. 2002). 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, hooded seals lack external ear flaps, and their rear flippers do not rotate (NOAA Fisheries Service 2015).

Population Abundance

Population abundance of harp seals in the western North Atlantic is derived from aerial surveys and mark-recapture (Waring et al. 2014). The most recent population estimate in the western North Atlantic was derived in 2012 from an aerial harp seal survey. The 2012 best population estimate for hooded seals is 7.1 million individuals (Waring et al. 2014). Currently, not enough data are available to determine what percentage of this estimate may represent the population within U.S. waters. A population trend also cannot be developed for this species due to a lack of sufficient data, as recent increases in strandings may not be indicative of population size. Harp seals are known to occur in the Piscataqua River; however, they are not as abundant as the more commonly observed harbor seal (Crain 2015).

3.1.6 Species Considered But Not Included in Analysis

Bottlenose Dolphin (*Tursiops truncatus*)

The western North Atlantic northern migratory stock of bottlenose dolphin (*Tursiops truncates*) can be found between Long Island, New York, and Cape Hatteras, North Carolina, during summer months (July

through September) (Cetacean and Turtle Assessment Program [CeTAP] 1982). During winter months, dolphins from this stock are rarely seen north of the North Carolina/Virginia border (Waring et al. 2014). Consequently, the range of this dolphin is well outside of the Project area. The estimated density of this species in the lower Piscataqua River reflects its rarity, with estimated densities ranging from 0.0664 to 0.1439 individuals per square kilometer (km^2) for fall and summer (Crain 2015; Krause 2015). Based on the known occurrence of this species in warmer southern waters during the winter months and rare occurrence within the lower Piscataqua River during summer months, it is not expected that the Atlantic white-sided dolphin would occur within the vicinity of the Project area during the in-water construction period. Bottlenose dolphins are not listed as threatened or endangered under the ESA, and the western North Atlantic northern stock is not considered strategic under the MMPA. Because the occurrence of this species in the Project area is predicted to be rare, the potential for bottlenose dolphin takes are not analyzed in this application.

Atlantic White-sided dolphin (*Lagenorhynchus acutus)*

Atlantic white-sided dolphins (*Lagenorhynchus acutus*) of the western North Atlantic stock inhabit waters from central west Greenland to North Carolina and as far east as the Mid-Atlantic ridge (Hamazaki 2002; Doksaeter et al. 2008; Waring et al. 2008). While members of Western North Atlantic stock of this dolphin do inhabit the Gulf of Maine, they are most common between Hudson Canyon and Georges Bank, which is approximately 70 miles (113 km) offshore of the Project area (Waring et al. 2014). Based on the known occurrence of this species in New England offshore waters east and north of the Project area during the spring, summer, and fall months, and their overall lack of presence throughout the region during winter months, it is not expected that the Atlantic white-sided dolphin would occur within the vicinity of the Project during the in-water construction period. White-sided dolphins are not listed as threatened or endangered under the ESA, and the Western North Atlantic stock is not considered strategic under the MMPA. As the occurrence of this species in the Project area is predicted to be rare, the potential for white-sided dolphin takes are not analyzed in this application.

3.2 Spatial Distribution

Density assumes that marine mammals are uniformly distributed within a given area, although this is rarely the case. Marine mammals are usually concentrated in areas of greater importance--for example, areas of high productivity, lower predation, safe calving, and prime foraging. Density can occasionally be calculated for smaller areas that are used regularly by marine mammals, but more often than not scientific data are insufficient to represent the spatial distribution of animals for small regions such as the construction area encompassed by the Project. Therefore, given the lack of availability of specific marine mammal data for the Portsmouth Naval Shipyard, this IHA application assumes that marine mammals are uniformly distributed in the study area.

3.3 Submergence

Cetaceans spend their entire lives in the water and spend most of their time (more 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.

Seals and sea lions (pinnipeds) spend significant amounts of time out of the water during breeding, molting, and "hauling out" (resting out of the water on land or marine structures) periods. When not actively diving, pinnipeds at the surface often orient their bodies vertically in the water column and often hold their heads above the water surface. Consequently, pinnipeds may not be exposed to underwater sounds to the same extent as cetaceans occurring in the same location.

For the purpose of assessing impacts from underwater sound at the Shipyard, the Navy assumed that that both cetaceans and pinnipeds that occur in the vicinity would be submerged 100 percent of the time. This approach could be considered conservative because seals spend a portion of their time hauled out, and the closest known haul-out site for seals within the Piscataqua River is 1.5 miles downstream of the Project area. Therefore, seals are expected to be exposed to less sound than is estimated by this approach.

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4 Status and Distribution of Marine Mammal Species or Stock that Could Potentially be Affected

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.

Five marine mammal species could occur within the waters adjacent to the Shipyard with confirmed or historic occurrence in the Project area. None of these species are listed under the ESA. The population status, distribution, behavior and ecology, and acoustics (uses of sound and hearing ability) of each species are described below. Background on acoustics and definitions of metrics are provided in Section 6 of this document.

4.1 Harbor Porpoise, Gulf of Maine/Bay of Fundy Stock

4.1.1 Population Status

The Gulf of Maine/Bay of Fundy stock of the harbor porpoise is not categorized as depleted under the MMPA. The stock is considered a strategic stock as a result of the estimated average annual human-related mortality exceeding the potential biological removal for this stock.

4.1.2 Distribution

The Gulf of Maine/Bay of Fundy stock of the harbor porpoise is generally found over the Continental Shelf, ranging from the Gulf of Maine/Bay of Fundy region to North Carolina, in varying abundance and depending on the season (Waring et al. 2014). July through September are the primary months this species can be found in the Gulf of Maine and the southern Bay of Fundy area (Waring et al. 2014). During this time, harbor porpoises are generally found in less than approximately 500 feet of water (Waring et al. 2014). During other times of year, this species is more dispersed throughout a larger region that includes Maine though New Jersey. Harbor porpoises are primarily found throughout this area during the fall months (October through December) and spring months (April through June) (Waring et al. 2014). During winter months (January through March), harbor porpoises are generally found in much lower densities between New York and Canada, as well as dispersed between New Jersey and North Carolina (Waring et al. 2014; CeTAP 1982). At this time, there has been no research that supports either a migration triggered by water temperature or a specific migration route through the species' range. Harbor porpoises are known to occur in the Piscataqua River and are the most commonly observed cetacean species for the river (Smith n.d.).

4.1.3 Behavior and Ecology

Harbor porpoises feed individually, with their primary prey consisting of demersal and benthic species such as schooling fish and cephalopods (Reeves et al. 2002; NOAA Fisheries Service 2014a). In the Bay of Fundy, harbor porpoises feed on Atlantic herring (*Clupea harengus*) during the summer months (Gannon et al. 1997). During fall months in the Gulf of Maine, harbor porpoises also primarily feed on Atlantic herring, along with silver hake (*Merluccius bilinearis*), red hake (*Urophycis chuss*), white hake *(Urophycis tenuis*), and pearlside (*Maurolicus pennanti*) (Gannon et al 1997). Harbor porpoises are most commonly found in bays, estuaries, and harbors and are generally solitary animals, usually observed either alone or in small groups (NOAA Fisheries Service 2014a; Reeves et al. 2002). The species in highly mobile, and individuals can travel many miles in one day within home ranges of thousands of square miles (Reeves et al. 2002). Harbor seals generally do not approach human activities and tend to be hard to follow because they spend little time at the surface. In the Gulf of Maine, a main issue of concern with this species is interaction with the gillnet fishery. As harbor porpoises commonly feed on small,

schooling fish, such as those targeted by gillnets, they often become entangled in these nets when pursuing prey (NOAA Fisheries Service January 2010).

4.1.4 Acoustics

Harbor porpoises are considered high-frequency cetaceans, along with 19 other species and subspecies. In general, the estimated bandwidth for functional hearing in high-frequency cetaceans is 200 hertz (Hz) to 180 kilohertz (kHz) (Southall et al. 2007). Hearing capabilities for harbor porpoises have been tested both behaviorally and with the auditory evoked potential technique. Based on an audiogram developed from behavioral methods, detection thresholds were estimated between 250 Hz and 180 kHz. Within that, the range of best hearing was from 16 to 140 kHz, and maximum sensitivity was recorded at 100 to 140 kHz (Kastelein et al. 2002). Harbor porpoises are vocal animals, using echolocation for feeding and navigation and vocalizing for socialization (Southall et al. 2007).

4.2 Grey Seal, Western North Atlantic Stock

4.2.1 Population Status

The western North Atlantic stock of the grey seal is not categorized as strategic or depleted under the MMPA.

4.2.2 Distribution

The general range of the western North Atlantic stock of the grey seal is between New York and Labrador, Canada (Katona et al. 1993; Lesage and Hammill 2001). The western North Atlantic Ocean hosts three breeding colonies: 1) Sable Island; 2) Gulf of St. Lawrence; and 3) the coast of Nova Scotia (Laviguer and Hammill 1993 in Waring et al. 2014). No known haul-out sites for grey seals are in the immediate vicinity of the Project area. The closest known haul-out site for seals within the Piscataqua River is 1.5 miles downstream of the Project area. In coastal Maine, grey seals are known to pup on Green Island and Sea Island and are year-round residents in southern Maine waters (Waring et al. 2014). Grey seals are known to occur within the Piscataqua River but are not as commonly observed as harbor seals (Smith n.d.). During spring and summer months, grey seals are most commonly observed on offshore ledges off the central coast of Maine (Richardson et al. 1995).

4.2.3 Behavior and Ecology

Grey seals gather in large groups (often several hundred animals or more) for breeding, molting and resting. However, they are assumed to be solitary feeders, with some foraging in waters close to their haul-out colonies, while others travel great distances away from their colonies (Reeves et al. 2002). Foraging grey seals can remain at sea for up to 20 days (Reeves et al. 2002). Grey seals are opportunistic feeders whose primary food resources include fish, squid, various crustacean species, and octopus (NOAA Fisheries Service 2013). They can also dive deep (up to 1,560 feet) to capture prey when necessary (NOAA Fisheries Service 2013). Grey seals pups are generally born between January and February in the western Atlantic Ocean, and breeding rookeries generally consist of beaches, rocky islands, coasts, caves, and ice floes (NOAA Fisheries Service 2013).

4.2.4 Acoustics

Grey seals, along with other members of the *Phocididae* family, are capable of hearing in both air and water. In general, the estimated bandwidth for functional hearing for phocids in water is 75 Hz to 75 kHz and in air is 75 Hz to 30 kHz (Southall et al. 2007). Phocids, and pinnipeds in general, are also known to produce a wide variety of low-frequency social sounds, with varying hearing capabilities in air and in water (Southall et al. 2007). Hearing capabilities for grey seals both in water and in air have been tested behaviorally and with the auditory evoked potential technique (Southall et al. 2007).

4.3 Harbor Seal, Western North Atlantic Stock

4.3.1 Population Status

The western North Atlantic stock of harbor seal is not categorized as strategic or depleted under the MMPA.

4.3.2 Distribution

The western North Atlantic stock of harbor seal is primarily found along the coastal and inshore regions of the northeastern U.S. and Canada. The species primarily occupies bays, estuaries, and inlets and is rarely observed more than 7.7 miles from shore (Baird 2001). Harbor seals are also often found upstream in coastal rivers (Baird 2001). The greatest concentrations within this region occur in coastal Maine, where they reside year-round (Katona et al. 1993; Waring et al. 2014). In the western North Atlantic, the harbor seal is distributed from the eastern Canadian Arctic and Greenland south to the southern extent of New England and New York State, with more recent occurrences in Virginia and the Carolinas (Mansfield 1967; Baird 2001). While technically year round residents, harbor seals generally migrate out of Canadian and Maine waters toward southern New England during fall and early winter. This is followed by a northward movement back into Maine waters prior to the pupping season, which occurs between mid-May and June (Waring et al. 2014). Harbor seals are known to occur in the Piscataqua River and are the most commonly observed pinniped species for the river (Smith, n.d.). No known haul-out sites for harbor seals are in the immediate vicinity of the Project area, with the closest known haul-out site for seals within the Piscataqua River being 1.5 miles downstream from the Project area.

4.3.3 Behavior and Ecology

Harbor seals gather in large groups of several hundred seals during molting season on sandy or cobble beaches or tidal sand bars (Reeves et al. 2002). While at sea, however, they are solitary and can spend up to several weeks at sea foraging. Harbor seals' diet varies greatly. They feed on demersal fish, pelagic schooling fish, octopus, and squid, and their diet largely depends on what is available (Reeves et al.2002). In New England waters, harbor seals feed primarily on sandlance (*Ammodytidae*), silver hake, Atlantic herring, and redfish (*Sebastes fasciatus*). Other prey species include cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), pollock (*Pollachius virens*), flounders (*Plueronectidae*), mackerel (*Scomber Scomrus*), and squid. While feeding, harbor seals spend 85 percent of their time diving, sometimes reaching depths of up to 500 feet.

In general, harbor seals mate at sea, and females give live birth during the spring and summer; however, the pupping season varies by latitude. Along the Maine coast, pupping season generally occurs from mid-May through June (Kenney 1994 in Waring et al. 2014; deHart 2002 in Waring et al. 2014) and to a much lesser extent at high-use haul-out sites off of Manomet, Massachusetts (Waring et al. 2014).

4.3.4 Acoustics

Harbor seals (similar to grey seals and other phocid seals), are capable of hearing in both air and water. In general, the estimated bandwidth for functional hearing for phocid seals in water is 75 Hz to 75 kHz and in air is 75 Hz to 30 kHz (Southall et al. 2007). In air, harbor seal males produce a variety of low-frequency (<4 kHz) vocalizations, including snorts, grunts, and growls. Male harbor seals produce communication sounds in the frequency range of 100 to 1,000 Hz (Richardson et al. 1995). Harbor seals hear nearly as well in air as underwater (Kastak and Schusterman 1998). Kastak and Schusterman (1998) reported airborne low-frequency (100 Hz) sound detection thresholds at 65.4 dB re 20 μPa for harbor seals. In air, they hear frequencies from 0.25 kHz to 30 kHz and are most sensitive to frequencies from 6 to 16 kHz (Richardson et al. 1995; Terhune and Turnbull 1995; Wolski et al. 2003).

Adult males also produce underwater sounds during the breeding season that typically range from 0.025 to 4 kHz at a duration range of 0.1 second to multiple seconds (Hanggi and Schusterman 1994). Hanggi and Schusteman (1994) found that there is individual variation in the dominant frequency range of sounds between different males, and Van Parijs et al. (2003) reported oceanic, regional, population, and site-specific variation that could be vocal dialects. In water, the species hears frequencies from 1 to 75 kHz (Southall 2007) and can detect sound levels as weak as 60 to 85 dB re 1 μPa within that band. They are most sensitive at frequencies below 50 kHz; above 60 kHz, sensitivity rapidly decreases.

4.4 Hooded Seal, Western North Atlantic Stock

4.4.1 Population Status

The western North Atlantic stock of the hooded seal is not categorized as strategic or depleted under the MMPA.

4.4.2 Distribution

Hooded seals generally inhabit the Arctic Ocean and northern Atlantic Ocean. The western Atlantic stock is known to whelp in three locations off Canada's east coast: 1) the area off the coast of Newfoundland and Labrador (the Front herd); 2) the Gulf of St. Lawrence (the Gulf herd); and 3) the Davis Strait (Waring et al. 2007). Hooded seals are observed within New England waters between January and May (Waring et al. 2007). Molting occurs between June and August in the Denmark Strait in Greenland. After this, they disperse widely (Waring et al. 2007). Breeding then occurs in February at the three whelping locations. Hooded seals are known to occur in the Piscataqua River; however, they are not as abundant as the more commonly observed harbor seal (Smith n.d.).

4.4.3 Behavior and Ecology

With the exception of breeding and molting, hooded seals are primarily solitary (Reeves et al. 2002). Both males and females are aggressive during mating season and often vocalize loudly while on the ice. Breeding generally occurs in aggregations on pack ice (Reeves et al. 2002). Hooded seals feed primarily on squid and fish, particularly cod and redfish; however, they also feed on crustaceans, starfish, and mussels (Reeves et al. 2002; NOAA Fisheries Service 2012b). Hooded seals are deep divers and usually dive to depths of 325 to 1,900 feet for up to 15 minutes (NOAA Fisheries Service 2012b). There is no information on hooded seal behavior in the Piscataqua River.

4.4.4 Acoustics

Along with other pinniped species and subspecies, hooded seals are capable of hearing in both air and water. Hearing capabilities of this species have not been directly tested as they have for other species. However, as hooded seals are within the *Phocididae* family, the functional hearing limit of these is species is expected to be similar to that of other phocid seals. In general, the estimated bandwidth for functional hearing for phocids in water is 75 hertz (Hz) to 75 kHz and in air is 75 Hz to 30 kHz (Southall et al. 2007). Pinnipeds in general are also known to produce a wide variety of low-frequency social sounds, with varying hearing capabilities in air and in water (Southall et al. 2007).

4.5 Harp Seal, Western North Atlantic Stock

4.5.1 Population Status

The western North Atlantic stock of the harp seal is not categorizedunder the MMPA as strategic or depleted(Waring et al. 2014).

4.5.2 Distribution

Harp seals generally inhabit the Arctic Ocean and northern Atlantic Ocean. The western Atlantic stock is known to whelp in three locations off Canada's east coast: 1) Eastern Canada, including tareas 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 observed within New England waters between January and May (Waring et al. 2014). Breeding occurs at different times at each whelping location, but generally between late-February and April. Adults then assemble on suitable pack ice to undergo the annual molt, after which they migrate towards the Arctic feeding grounds (Waring et al. 2014). Harp seals are known to occur in the Piscataqua River; however, they are not as abundant as the more commonly observed harbor seal (Crain 2015).

4.5.3 Behavior and Ecology

During breeding season, harp seals can be found in large numbers— up to several thousand seals— on the pack ice (NOAA Fisheries Service 2015). Harp seals feed primarily on a varied mix of species of finfish and invertebrates, particularly capelin, cod, and krill (NOAA Fisheries Service 2015). Harp seals are modest divers and usually dive to depths of up to 1,200 feet for up to 16 minutes (NOAA Fisheries Service 1015). There is no information on harp seal behavior in the Piscataqua River.

4.5.4 Acoustics

Along with other pinniped species and subspecies, harp seals are capable of hearing in both air and water. Hearing capabilities of this species have not been directly tested as they have for other species. However, as harp seals are within the *Phocididae* family, the functional hearing limit of these species is expected to be similar to that of other phocid seals. In general, the estimated bandwidth for functional hearing for phocids in water is 75 Hz to 75 kHz and in air is 75 Hz to 30 kHz (Southall et al. 2007). Pinnipeds in general are also known to produce a wide variety of low-frequency social sounds, with varying hearing capabilities in air and in water (Southall et al. 2007).

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5 Harassment 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.

Under Section 101 (a)(5)(D) of the MMPA, the Navy requests an Incidental Harassment Authorization (IHA) for the take of small numbers of marine mammals, by Level B behavioral harassment only, incidental to pile driving and drilling operations associated with the Waterfront Improvement Project at Portsmouth Naval Shipyard, Kittery, Maine. The Navy requests an IHA for incidental take of marine mammals described within this application for one year, commencing January 1, 2017 (or the issuance date, whichever is later). The Navy plans to request coverage under a new IHA for in-water construction activities during each subsequent year of the construction period, which is scheduled to end in March 2022. The Navy is not requesting a multi-year Letter of Authorization (LOA) at this time because the activities described herein are not expected to rise to the level of injury or death, which would require a LOA.

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 causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment] (50 C.F.R, Part 126, Subpart A, Section 216.3-Definiations).*

Level A harassment, an authorization for which is not requested herein, is the more severe form of harassment because it may result in injury, whereas Level B harassment may result in disturbance without the potential for injury.

5.1 Take Authorization Request

Under Section 101(a)(5)(D) of the MMPA, the Navy requests an IHA from NOAA Fisheries Service for Level B take (behavioral harassment) of small numbers of marine mammals described within this application as a result of in-water pile-driving, extraction, and drilling activities. The Navy requests coverage under the IHA to begin on January 1, 2017.

The exposure assessment methodology taken in this IHA application attempts to quantify potential exposures to marine mammals resulting from pile driving, extraction, and drilling. Section 6 presents a detailed description of the acoustic exposure assessment methodology. Results from this approach tend to provide an overestimation of exposures because all animals are assumed to be available to be exposed 100 percent of the time, and the formulas used to estimate transmission loss used idealized parameters, which are unrealistic in nature. Modeling was conducted for a full year, covering all four seasons.

The analysis for the Project predicts 96 potential exposures (see Section 6 for estimates of exposures by species and activity type) that could be classified as Level B harassment as defined under MMPA over the course of the project. The Navy's mitigation procedures, presented in Section 11, include monitoring of mitigation zones prior to initiating pile driving, extraction, or drilling; use of soft-start procedure; and instantaneous in situ hydroacoustic recordings. These mitigation measures would be implemented to

decrease the likelihood that marine mammals would be exposed to sound pressure levels that would cause Level B harassment.

The Navy does not anticipate that 96 actual harassment incidents would result from in-water activities for the waterfront improvement projects. However, to allow for scientific uncertainty regarding the exact mechanisms of potential physical and behavioral effects, and as a conservative approach, the Navy is requesting authorization for take (Level B harassment) of 96 marine mammals over the course of one year in this IHA application.

5.2 Method of Incidental Taking

Construction activities associated with the Project as outlined in Sections 1 and 2 have the potential to disturb or displace small numbers of marine mammals. Specifically, only underwater sounds generated from pile-installation activities (impact/vibratory pile driving, extraction, and drilling) may result in "take" in the form of Level B harassment (behavioral disturbance). Level B harassment is not anticipated from airborne sounds generated during pile installation or during other construction activities (see Section 6.3.4 below). Level A harassment is not anticipated to result from any of the construction activities, and measures designed to minimize the possibility of injury to marine mammals have been developed. Specifically, use of vibratory hammers and drilling would be the primary methods of installation and are not expected to cause injury to marine mammals due to these methods' relatively low source levels (≤ 180 dB). Also, pile driving would either not start or be halted if marine mammals approach the shutdown zone, which is defined as the distance at which Level A harassment is possible. See Section 11 for more details on the impact reduction and mitigation measures proposed. Furthermore, the pile-driving activities analyzed are similar to other construction activities within Washington State and California, which have taken place with no reported injuries or mortality to marine mammals (e.g., ICF Jones and Stokes and Illingworth and Rodkin, Inc. 2012). Chapter 6 discusses the numbers of takes requested for the marine mammal species in the Project area for this IHA.

6 Number 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 NOAA Fisheries Service 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.

The construction activities for the waterfront improvement projects outlined in Sections 1 and 2 have the potential to take marine mammals by harassment only, primarily as a result of noise produced by in-water pile driving, extraction, and drilling. Other construction activities are not expected to result in takes as defined under the MMPA.

In-water pile driving would temporarily increase the local underwater noise environment in the vicinity of the Project area. Research suggests that increased noise may impact marine mammals in several ways, dependent on many factors (see Section 7 for additional discussion). The following sections provide a background on underwater sound, description of noise sources in the Project area, applicable noise criteria, and the basis for the calculation of take by Level B harassment. Level A harassment of cetaceans and pinnipeds for this project is not expected to occur because the area of potential Level A harassment is small, marine mammals are not expected to approach within this distance, and, if they did, monitoring as described later in this application would ensure curtailment of the activity before a Level A take occurs. Therefore, Level A harassment is not discussed in this application.

6.2 Fundamentals of Sound

Sound is a physical phenomenon consisting of regular pressure oscillations that travel through a medium, such as air or water. Sound frequency is the rate of oscillation, measured in cycles per second, or Hz. The amplitude (loudness) of a sound is its pressure, whereas its intensity, or power, is its pressure squared. The standard international unit of measurement for pressure is the Pascal, which is a force of 1 Newton exerted over an area of 1 square meter; sound pressures are measured in microPascals (μPa).

Due to the wide range of pressure and intensity encountered during measurements of sound, a logarithmic scale is used, based on the decibel, which, for sound intensity, is 10 times the log10 of the ratio of the measurement to reference value. For sound pressure level (SPL), the amplitude ratio in dB is 20 times the log10 ratio of measurement to reference. Hence, each increase of 20 dB in SPL reflects a 10-fold increase in signal amplitude (whether expressed in terms of pressure or particle motion). That is, 20 dB means 10 times the amplitude, 40 dB means 100 times the amplitude, 60 dB means 1,000 times the amplitude, and so on. Because the dB is a relative measure, any value expressed in dB is meaningless without an accompanying reference. In describing underwater sound pressure, the reference amplitude is usually 1 μPa and is expressed as “dB re 1 μPa.” For in-air sound pressure, the reference amplitude is usually 20 μPa and is expressed as “dB re 20 μPa.”

The method commonly used to quantify airborne sounds consists of evaluating all frequencies of a sound according to a weighted filter that mimics human sensitivity to amplitude as a function of frequency. This is called A-weighting, and the decibel level measured is called the A-weighted sound level (dBA).

Methods of frequency weighting that reflect the hearing of marine mammals have been proposed (Southall et al. 2007; Finneran and Jenkins 2012) and are being used in new analyses of Navy testing and training effects, but they have not been adopted for pile-driving and other non-explosive impulsive sounds (Marine Species Modeling Team 2012). Therefore, underwater sound levels are not weighted and measure the entire frequency range of interest. In the case of marine construction work, the frequency range of interest is 20 Hz to 20 kHz.

Table 6-1 summarizes commonly used terms to describe underwater sounds. Two common descriptors are the instantaneous peak SPL and the root mean square (rms) SPL. The peak pressure is the instantaneous maximum or minimum overpressure observed during each pulse or sound event and is presented in dB re 1 μPa. The rms level is the square root of the mean of the squared pressure level (intensity) as measured over a specified time period. All underwater sound levels throughout the remainder of this application are presented in dB re 1 μPa unless otherwise noted.

Table 6-1 Definition 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 μPa (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels (dB) as 20 times the logarithm to the base 10 of the ratio between the pressure exerted by the sound to a reference sound pressure. Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, 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 20,000 Hz.
Peak Sound Pressure (unweighted), dB re 1 μPa	Peak sound pressure level is based on the largest absolute value of the instantaneous sound pressure over the frequency range from 20 Hz to 20,000 Hz. This pressure is expressed in this application as dB re 1 μPa.
Root Mean Square (rms), dB re 1 μPa	The rms level is the square root of the energy divided by a defined time period. For pulses, the rms has been defined as the average of the squared pressures over the time that comprises that portion of waveform containing 90 percent 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-second 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 Spectra, dB over frequency	A graphical plot illustrating the 6 to 12 Hz band-center frequency sound pressure over a frequency range (e.g., 10 to 5,000 Hz in this application).

Table 6-1 Definition of Acoustical Terms

Term	Definition
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A- or C-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, that serves as the baseline or existing level of environmental noise at a given location.

6.3 Effects of Pile-installation Activities

6.3.1 Description of Noise Sources

Underwater sound levels are composed of multiple sources, including physical noise, biological noise, and anthropogenic noise. Physical noise sources include waves at the surface, earthquakes, ice movement, and atmospheric noise. Biological noise includes sounds produced by marine mammals, fish, and invertebrates. Anthropogenic noise consists of noise sources such as vessels (small and large), dredging, aircraft overflights, and construction activities. Known noise levels and frequency ranges associated with anthropogenic sources similar to the vessels and equipment that would be used for the Project are summarized in Table 6-2. Details of each of the sources are described in the following text.

Table 6-2 Representative Noise Levels of Anthropogenic Sources

Noise Source	Frequency Range (Hz)[1]	Underwater Noise Level (dB re 1 uPa)[2]	Reference
Small vessels	250-1,000	151 dB rms at 1 meter (m)	Richardson et al. 1995
Tug docking of a gravel barge	200-1,000	149 dB rms	Blackwell and Greene 2002
Vibratory driving of 30-inch steel pipe pile	10-1,500	~168 dB rms at 10m	WSDOT 2010a, 2010b
Impact driving of 30-inch steel pipe pile	10-1,500	~193 dB rms at 10m	WSDO 2005, 2008; Caltrans 2007; Reyff 2005
Impact driving of 36-inch steel pipe pile	10-1,500	195 dB rms at 10m	Hastings and Popper 2005

[1] These are the dominant frequency ranges but there is often considerable energy outside these ranges.
[2] These are average source SPLs at a particular location; site-specific bathymetry and substrate will affect SPLs.

In-water construction activities associated with the Project would include impact pile driving, drilling, and vibratory pile driving. The sounds produced by these activities fall into one of two sound types: pulsed and non-pulsed (defined below). Impact pile driving produces pulsed sounds, while vibratory pile driving produce non-pulsed (or continuous) 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 (e.g., Ward 1997 as cited in Southall et al. 2007).

Pulsed sounds (e.g., explosions, gunshots, sonic booms, seismic airgun pulses, and impact pile driving) are brief, broadband, atonal transients (American National Standards Institute 1986; Harris 1998) and occur either as isolated events or are repeated in some succession (Southall et al. 2007). Pulsed 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). Pulsed sounds generally have increased capacity to induce physical injury compared to sounds that lack these features (Southall et al. 2007).

Non-pulse (intermittent or continuous sounds) can be tonal, broadband, or both (Southall et al. 2007). Some non-pulse sounds can be transient signals of short duration but without the essential properties of pulses (e.g., rapid rise time) (Southall et al. 2007). Examples of sources of non-pulse sounds include vessels, aircraft, machinery operations such as drilling or dredging, vibratory pile driving, and active sonar systems (Southall et al. 2007). The duration of such sounds, as received at a distance, can be greatly extended in highly reverberant environments (Southall et al. 2007).

6.3.2 Sound Exposure Criteria and Thresholds

Under the MMPA, NOAA Fisheries Service 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."*

Since 1997, NOAA Fisheries Service has used generic sound exposure thresholds to determine when an activity in the ocean that produces sound might result in impacts to a marine mammal such that a take by harassment might occur (NOAA Fisheries Service 2005). Recent studies of pile driving, primarily for use in constructing offshore wind turbines, have validated the distances over which underwater sound from pile driving may exceed NOAA Fisheries Service thresholds (Bailey et al. 2010), as well as behavioral responses of harbor porpoises and bottlenose dolphins to intense sound from pile driving (Brandt et al. 2012; Brandt et al. 2011; Thompson et al. 2010; David 2006).

Current NOAA Fisheries Service practice regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds exposed to impulsive or continuous sounds of 180 and 190 dB rms or above, respectively, are considered to have been taken by Level A (injurious) harassment. Level A harassment is assumed to result in a "stress response." The stress response per se is not considered injury but refers to an increase in energetic expenditure that is a result of exposure to the stressor and that is predominantly characterized by either the stimulation of the sympathetic nervous system or the hypothalamic-pituitary-adrenal axis (Reeder and Kramer 2005). The presence and magnitude of a stress response in an animal depends on the animal's life history stage, environmental conditions, reproductive state, and experience with the stressor (Department of the Navy 2010a).

Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to sounds at or above 160 dB rms for impulse sounds (*e.g.*, impact pile driving) and 120 dB rms for continuous noise (*e.g.,* vibratory pile driving or drilling) but below injurious thresholds. Behavioral harassment may or may not result in a stress response. The criteria for vibratory pile driving would also be applicable to vibratory pile extraction. The application of the 120 dB rms threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. As a result, these levels are considered precautionary (NOAA Fisheries Service2009, 74 FR 41684). NOAA Fisheries Service is developing new science-based thresholds to improve and replace the current generic exposure level thresholds, but the criteria have not been finalized (Southall et al. 2007; NOAA Fisheries Service2013). The current Level A (injury) and Level B (disturbance) thresholds are provided in Table 6-3.

Table 6-3 Injury and Disturbance Thresholds for Underwater and Airborne Sounds

Marine Mammal Functional Hearing Group	Airborne Marine Construction Criteria (Impact and Vibratory Pile Driving) (re 20 µPa)	Underwater Vibratory Pile Driving and Drilling Criteria (e.g., non-pulsed/continuous sounds) (re 1 µPa)		Underwater Impact Pile-driving Criteria (e.g., pulsed sounds) (re 1 µPa)	
	Distance Guideline Threshold (Haul out)[1]	Level A Injury Threshold	Level B Disturbance Threshold	Level A Injury Threshold	Level B Disturbance Threshold
Cetaceans (whales, dolphins, porpoises)	N/A	180 dB rms	120 dB rms	180 dB rms	160 dB rms
Pinnipeds (seals, sea lions, walrus; except harbor seal)	100 dB rms *(unweighted)*	190 dB rms	120 dB rms	190 dB rms	160 dB rms
Harbor seal	90 dB rms *(unweighted)*	190 dB rms	120 dB rms	190 dB rms	160 dB rms

1 Sound level at which pinniped haul out disturbance has been documented. Not an official threshold, but used as a guideline.

Key:
dB = decibel

6.3.3 Limitations of Existing Noise Criteria

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. The 120 dB rms threshold level for continuous noise originated from research conducted by Malme et al. (1984, 1986) for California gray whale response to continuous industrial sounds such as drilling operations. The 120 dB rms continuous sound threshold should not be confused with the 120 dB rms pulsed sound criterion established for migrating bowhead whales in the Arctic as a result of research in the Beaufort Sea (Richardson et al. 1995; Miller et al. 1999). 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.

6.3.4 Ambient Noise

Ambient noise by definition is background noise, and it has no single source or point. Ambient noise varies with location, season, time of day, and frequency. Ambient noise is continuous but with much variability on time scales ranging from less than 1 second to 1 year (Richardson et al. 1995). Ambient underwater noise at the Project area is widely variable over time due to a number of natural and anthropogenic sources. Sources of naturally occurring underwater noise include wind, waves, precipitation, and biological noise (such as shrimp, fish, and cetaceans). There is also human-generated noise from ship or boat traffic and other mechanical means (Urick 1983). Anthropogenic sources of underwater noise at industrial waterfronts could come from cranes, generators, and other types of mechanized equipment on wharves or the adjacent shoreline. In the vicinity of the Project area, the average broadband ambient underwater noise levels are commonly 52.8 to 80.5 L_{sel} dB re 1µPa with

substantially higher maximum peak readings (79.9 to 103.9 L_{peak} dB re 1μPa) due to passing boats and industrial noise (ESS Group, Inc. 2015).

6.4 Distance to Sound Thresholds

6.4.1 Underwater Sound Propagation Formula

Pile driving would generate underwater noise that potentially could result in disturbance to marine mammals in and near the Project area. Transmission loss (TL) underwater is the decrease in acoustic intensity as an acoustic pressure wave propagates out from a source. TL parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water depth, water chemistry, and bottom composition and topography. The formula for transmission loss is:

TL = B * log10(R) + C * R, where
B = logarithmic (predominantly spreading) loss
C = linear (scattering and absorption) loss
R = range from source in meters

For underwater calculations in this assessment, linear loss (C) was not used (i.e. C=0), and transmission loss was calculated using only logarithmic spreading. Therefore, the revised formulas for transmission loss were as follows:

1. Cylindrical Spreading: $TL = 10 \log (R_1/R_0)$

   where:
   TL = transmission loss[1]
   R_1 = range at which NOAA Fisheries acoustic criteria is reached
   R_0 = reference range (i.e., at 10 meters)

   This transmission loss model was used for piles being driven in a water depth less than approximately 10 feet. Specifically, this model was used for the 14-inch steel H-type (sister) piles that would be driven using an impact hammer at Rail Beam R1 at Berths 11, 12, and 13 (shown on Figure 2-2).

2. Practical Spreading: $TL = 15 \log (R_1/R_0)$

   where:
   TL = transmission loss
   R_1 = range at which NOAA Fisheries acoustic criteria is reached
   R_0 = reference range (i.e., at 10 meters)

   This transmission loss model was used for the piles being driven (or drilled) in water depths of between approximately 10 and 50 feet. These pile types and sizes included:

   - **25-inch steel sheet piles,** which would be driven using a vibratory hammer at **Berth 11**.
   - **14-inch steel H-type piles,** which would be driven using an impact hammer at **Berth 11**during trestle alignment and construction.

[1] Transmission Loss = source level – acoustic criteria threshold level

- **15-inch timber piles,** which would be installed using a vibratory hammer to reconstruct timber dolphins at the corner of **Berths 11 and 12**.
- **36-inch steel H-type (king) piles** at **Berth 11** which would be drilled and rock-socketed into the bedrock.

This model was also used for piles extracted in water depths of 10 to 50 feet and included:

- **14-inch steel H-type piles,** which would be used to align and construct the trestle that would be extracted using a vibratory hammer at **Berth 11**.
- **15-inch timber fender piles,** which would be extracted using a vibratory hammer at **Berth 11** and the timber dolphin at the corners of **Berths 11 and 12**.

6.4.2 Underwater Noise from Pile Driving and Drilling

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. A large quantity of literature regarding SPLs recorded from pile-driving projects is available for consideration. In order to determine reasonable SPLs and the associated effects on marine mammals that are likely to result from pile driving at the Shipyard, studies with similar properties to the Proposed Action were evaluated.

Pile Driving

Source levels for the two pile-driving methods that are proposed for use during the project were obtained from the "Compendium of Pile Driving Sound Data," which is included as Appendix I to "Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish" (ICF Jones & Stokes and Illingworth & Rodkin, Inc. 2012). The information presented in the compendium is a compilation of sound pressure levels recorded during various in-water pile-driving projects in California, Oregon, Washington, and Nebraska. The compendium is a commonly used reference document for pile-driving source levels when analyzing impacts on protected species, including marine mammals, from pile-driving activities.

Source levels were collected for the four types of piles that would be installed and two pile-driving methods proposed for the Project:

1. <u>14-inch steel H-type piles</u> — Used as sister piles and to align and construct the trestle; installed via impact hammer.
2. <u>15-inch timber piles</u> — Used for re-installation of dolphins at Berths 11, 12, and 13 and installed via vibratory hammer.
3. <u>25-inch steel sheet piles</u> — Used for the bulkhead at Berth 11 and installed via vibratory hammer.

Reference source levels for the Project were determined using data for piles of similar sizes, the same pile-driving method as that proposed for the Project, and at similar water depths. While the pile sizes and water depths chosen as proxies do not exactly match those for the Project, they are the closest matches available, and it is assumed that the source levels shown in Table 6-4 and Table 6-5 are the most representative for each pile type and associated pile-driving method.

Table 6-4 Source Levels for In-Water Impact Hammer 14-inch Steel H-type (Sister) Piles

Pile Size and Pile Type	Water Depth (m)	Distance Measured (m)	Peak (dB)	RMS (dB)	SEL (dB)	Location
12-inch Steel H-type pile – Thick	5	10	200	183	170	CA (Specific location unknown)
15-inch Steel H-type pile – Thick	3	10	195	180	170	Ballena Isle Marina Alameda, CA San Francisco Bay
12- to 15-inch H-type pile – Thick (Average)	**4**	**10**	**198**	**182**	**170**	

Source: ICF Jones & Stokes and Illingworth & Rodkin, Inc. 2012.

Note:
All source levels are referenced to 1 microPascal (re 1 µPa).
[1] As printed in source material

Key:
dB = decibel
m = meter
RMS = root mean square
SEL = sound exposure level

Table 6-5 Source Levels for In-Water Vibratory Hammer 25-inch Steel Sheet Piles, 20-inch Steel Sheet Piles and 15-inch Timber Piles

Pile Size and Pile Type	Water Depth (m)	Distance Measured (m)	Peak (dB)	RMS (dB)	SEL (dB)	Location
24-inch AZ* Steel Sheet[1]	15	10	177	163	162	Berth 23, Port of Oakland, CA
24-inch AZ Steel Sheet[1]	15	10	175	162	162	Berth 30, Port of Oakland, CA
24-inch AZ Steel Sheet[1]	15	10	177	163	163	Berth 35/37 Port of Oakland, CA
24-inch AZ Steel Sheet – Typical[1]	15	10	175	160	160	CA (Specific location unknown)
24-inch AZ Steel Sheet – Loudest[1]	15	10	182	165	165	CA (Specific location unknown)
24-inch AZ Steel Sheet (Average)[1]	**15**	**10**	**178**	**163**	**163**	
15-inch Timber Pile[2]	**10**	**16**	**164**	**150**	**NP**	WSF Port Townsend Ferry Terminal, WA

Source:
[1] ICF Jones & Stokes and Illingworth & Rodkin, Inc. 2012.
[2] WSDOT 2010.

Note:
All source levels are referenced to 1 microPascal (re 1 µPa)
AZ refers to a specific sheet pile shape and interlock style

Key:
dB = decibel
m = meter
RMS = root mean square
SEL = sound exposure level

The exact source level for a given pile and pile-driving method largely depends not only on the pile size and water depth but also on site-specific conditions such as environmental and physical factors, including water temperature and sediment composition. Therefore, in this analysis, several source levels for each pile type and associated pile-driving method were averaged when multiple levels were available. These averaged source levels were used as inputs to determine transmission loss, which, in turn, was used in the propagation models described above. It should be noted that the source levels presented in the tables below do not take into account any mechanisms to attenuate the sound, such as a bubble curtain.

Drilling

Drilling is considered an intermittent, non-impulsive noise source, similar to vibratory pile driving. Very little information is available regarding source levels of in-water drilling activities associated with nearshore pile installation such as that proposed for the Berths 11, 12, and 13 structural repairs project. 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). The average sound pressure levels re 1 µPa RMS were displayed for casing installation, auger drilling (inside the casing), and casing removal. For the purposes of this plan, it is assumed that the casing installation and removal activities would be conducted in a manner similar to that described in Dazey et al. (2012), primarily via oscillation. These average source levels are reported in Table 6-6.

IHA applications for other construction projects have reported that, due to a lack of information regarding pile-drilling source levels, it is generally assumed that pile drilling would produce less in-water noise than both impact and vibratory pile driving. Based on the general lack of information about these activities and the assumption that in-water noise from pile drilling would be less than either impact or vibratory pile driving, it is assumed that the source levels presented in Table 6-6 are the most applicable for acoustic impact analysis at Berths 11, 12, and 13.

Table 6-6 Average Source Levels for Auger Drilling Activities During Pile Installation

Drilling Activity	Water Depth (m)	Distance Measured (m)	RMS (dB)	Location
Casing Installation	1-5	1	157	Bechers Bay Santa Rosa Island, CA
Auger Drilling	1-5	1	151	Bechers Bay Santa Rosa Island, CA
Casing Removal	1-5	1	152	Bechers Bay Santa Rosa Island, CA

Source: Dazey et al. 2012.

Note: All source levels are referenced to 1 microPascal (re 1 µPa)

Key:
dB = decibel
m = meter
RMS = root mean square

Pile Extraction

Vibratory pile extraction is considered an intermittent, non-impulsive noise source. Little information is available specific to vibratory extraction for most types of piles. The source level for timber-pile extraction was obtained from "Port Townsend Test Pile Project: Underwater Noise Monitoring Draft

Final Report," prepared by Jim Loughlin for the Washington State Department of Transportation Office of Air Quality and Noise (WSDOT 2010).

Source levels for vibratory extraction of H-type piles were obtained from "Underwater Acoustic Measurements of Vibratory Pile Driving at the Pipeline 5 Crossing in the Snohomish River, Everett, Washington," prepared by Greeneridge Science, Inc., for the City of Everett (Burgess et al. 2005).

For vibratory pile extraction of the 24-inch steel sheet piles (used as a proxy for the 20-inch steel sheet piles that would be extracted at the circular, cellular cofferdam), the average value for the vibratory installation source levels from Table 6-5 was used. Sources including ICF Jones & Stokes and Illingworth & Rodkin, Inc. (2012) report the same values for vibratory installation and extraction, assuming that the two activities would produce similar source levels if water depth, pile size, and equipment remain constant.

Source levels were collected from the documents and reports described above for four types of piles for vibratory pile extraction proposed for these projects (see Table 6-7):

1. 15-inch timber fender piles — Extracted via vibratory extractor at Berth 11 and the corner of Berths 11 and 12.

Table 6-7 Average Source Level for Vibratory Pile Extraction15-inch Timber Fender Piles

Pile Size and Pile type	Water depth (m)	Distance Measured (m)	Peak (dB)	RMS (dB)	Location
15-inch Timber Fender Pile[1]	**10m**	**16m**	**164**	**150**	WSF Port Townsend Ferry Terminal, WA

Notes
[1] WSDOT 2010.
[2] All source levels are referenced to 1 microPascal (re 1 µPa)

Key:
dB = decibel
m = meter
RMS = root mean square

Reference source levels for the Project were determined using data for piles of similar size, the same extraction method as that proposed for the Project, and at similar water depths. While the pile sizes and water depths chosen as proxies do not exactly match those for the Project, they are the closest matches available, and it is assumed that the source levels shown in Table 6-7 are representative of the vibratory pile extraction method used for the Project.

Zones of Influence

NOAA Fisheries has established disturbance and injury acoustic thresholds for marine mammals. A zone of influence (ZOI) is the in-water area in which sound from an in-water activity would exceed a particular threshold level. Determining a ZOI for each sound source is necessary to establish monitoring areas and to estimate the number of Level B takes (harassment). Attenuation distances to the NOAA Fisheries thresholds for Level B takes for pile driving are described in Table 6-8. These attenuation distances have been developed using the propagation models described in Section 6.4.1. Modeling was performed for

each driving, drilling, installing, and removing activity described above using the depth-appropriate model. Activities that would result in the longest attenuation distances were selected as the worst-case sound exposure distances that would determine the ZOI for each project location. These worst-case sound exposure distances are shown in Table 6-8.

Table 6-8 Pile-driving Sound Exposure Distances (In-water)

Drilling Activity	Behavioral Thresholds for Cetaceans and Pinnipeds	Propagation Model	Attenuation Distance to Threshold
Vibratory Hammer	120 dB RMS	Practical Spreading Loss (3 m to15 m water depth)	4.57 mi (7.35 km)
Impact Hammer	160 dB RMS	Cylindrical Spreading Loss (<3 m water depth)	0.984 mi (1.58 km)

Note: All source levels are referenced to 1 microPascal (re 1 μPa)

Key:
dB = decibel
mi = miles
km = kilometers
m = meters
RMS = root mean square

During operation of the vibratory hammer, modeled sound would attenuate to 120 dB at approximately 4.57 miles from the Berth 11 Structural Repairs Project. During operation of the impact hammer, modeled sound would attenuate to 160 dB at approximately 0.98 miles from the Berths 11 Structural Repairs Project site. It should be noted that these attenuation distances are based on sound characteristics in open water. The Project area is located in a river surrounded by topographic features and not in open water; therefore, given the numerous land features and islands within the vicinity of the Project sites in the Piscataqua River, these attenuation distances are extremely conservative.

While the Project would involve impact pile driving that would exceed acoustic thresholds for Level A takes, no Level A takes are expected because attenuation out to the pinniped injury threshold of 190 dB rms is calculated at 282 feet (85.9 meters), and attenuation out to the 180 dB RMS injury threshold for cetaceans is calculated at 52 feet (15.8 meters). These very small areas can easily be monitored for marine mammals, and mitigative measures could be implemented to ensure that no Level A takes occur.

The ZOIs for each of the two separate sound sources (vibratory and impact hammers) at Berth 11are shown on Figure 6-1. Work would occur in phases over several years. All of the construction-related in-water sound occurring within the waters of these ZOIs would exceed the designated NOAA Fisheries thresholds for behavioral take. The ZOIs were used to calculate potential takes from each sound source and would be monitored during in-water work at Berth 11 to estimate actual harassment takes of marine mammals. The total area ensonified by these two sources is 0.36 square miles (mi^2) (233.4 acres).

The numerous topographic features present in and along the Piscataqua River would greatly limit the area that would be impacted from in-water sound. Sound from either source would be truncated with minimal attenuation. The ZOIs for Berth 11 have been determined using the entire length of the berth and the returns that would be constructed between the existing bulkhead and the new bulkhead. Due to the numerous islands and other land features at and around the site, the ZOIs for both the vibratory hammer and impact hammer are identical.

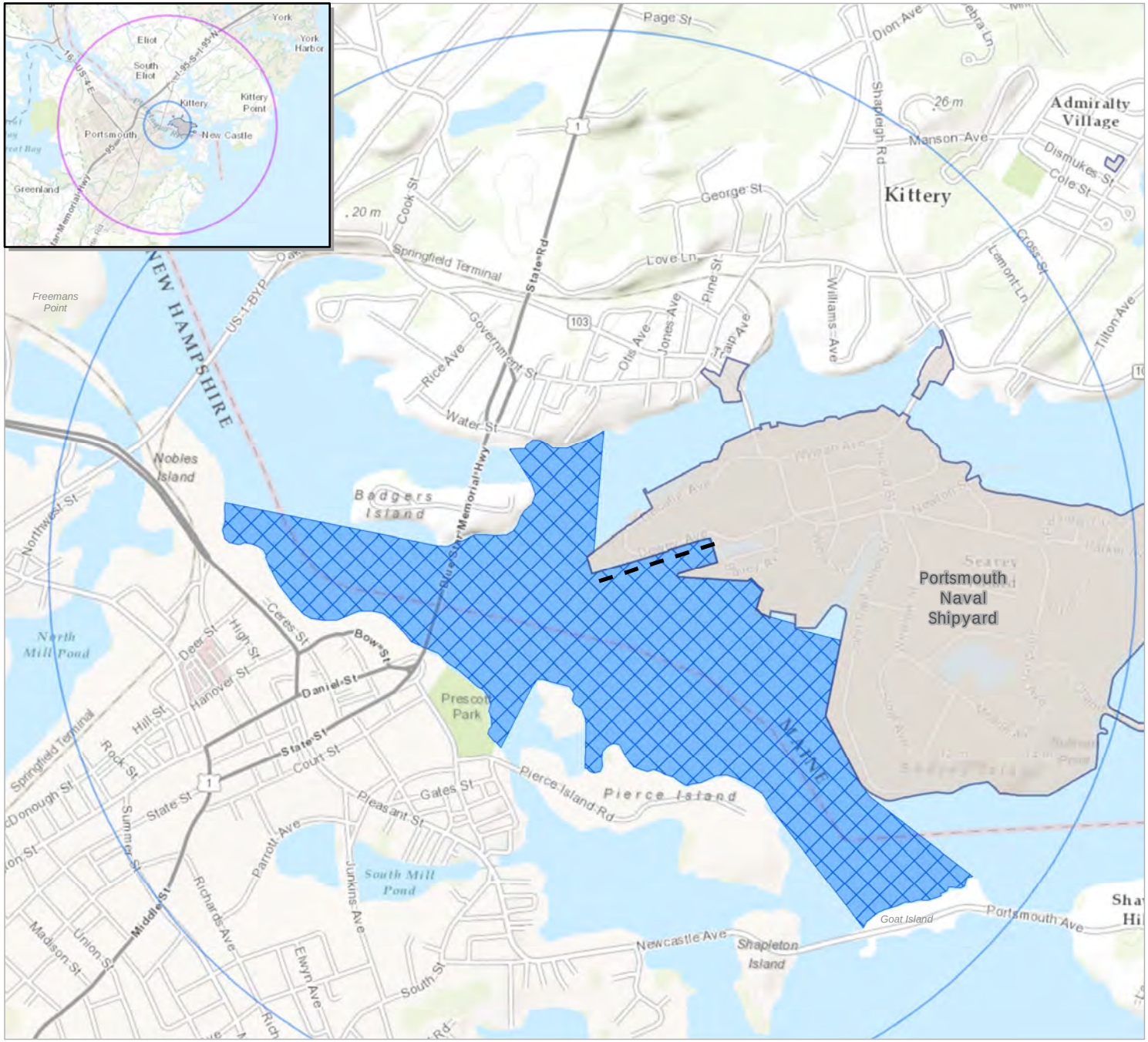

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Figure 6-1
Zone of Influence
for Underwater Vibratory Hammer
and Underwater Impact Hammer
at Berth 11 (A, B, and C)
Portsmouth Naval Shipyard
York County, Maine

Legend

- Berth 11
- Zone of Influence for Underwater Vibratory Hammer
- Zone of Influence for Underwater Impact Hammer
- 4.57 mi (7.35 Km) Radius
- 0.98 mi (1.58 Km) Radius
- Installation Area

N

0 1,000 2,000 3,000 Feet

Source: ESRI 2013; Department of Defense 2014.

No sound is expected to attenuate to the 120-decibel threshold for vibratory pile driving because topographic features along the river would prevent attenuation to the full distance of 4.57 miles. The longest attenuation distance from the Project area would occur almost directly to the southeast where, during vibratory pile driving, sound would attenuate through the waters east of Pierce Island to meet land at Goat Island at a distance of 0.88 miles from the Project area (Figure 6-1).

Very little sound would reach the 160 dB threshold at the fill distance of 0.984 miles for the impact hammer due to these topographical features. The longest attenuation distance from the Berth 11 Project site would again occur to the southeast where, during impact pile driving, sound would attenuate through the waters east of Pierce Island to the 160 dB threshold (a distance of 0.88 miles) at Goat Island (Figure 6-1).

6.4.3 Airborne Sound from Pile Driving and Drilling

Pile driving can generate airborne noise that could potentially result in disturbance of marine mammals (pinnipeds) 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 near the project sites to be exposed to airborne SPLs that could result in Level B behavioral harassment. The appropriate airborne noise thresholds for behavioral disturbance for all pinnipeds, except harbor seals is 100 dB re 20 µPa rms (unweighted) and for harbor seals is 90 dB re 20 µPa rms (unweighted) (see Table 6-3). A spherical spreading loss model, assuming average atmospheric conditions, is typically used to estimate the distance to the 100 dB and 90 dB re 20 µPa rms (unweighted) airborne thresholds. The formula for calculating spherical spreading loss is:

$$TL = 20\log r$$

where:

TL = Transmission loss
r = ratio of receiver distance

*Spherical spreading results in a 6 dB decrease in SPL per doubling of distance.

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. In order to determine reasonable airborne SPLs and their associated effects on marine mammals that are likely to result from pile driving at Portsmouth Naval Shipyard, studies with similar properties to the proposed action were evaluated. In Order to determine if airborne noise impacts would need to be considered, the worst case scenario, impact driving of the 14-inch h-type piles, was modeled. As values for impact-driven H-type piles, including the 14-inch size, were not available source levels for various larger round piles were examined as conservative proxies. Airborne transmission loss was calculated using the spherical spreading model described above. Using this model, the greatest possible distances to airborne harassment thresholds were estimated, using a source level of 111 dB 20 µPa rms for 24" round steel piles, as 552.5 ft (168.3 m) to the 90 dB threshold for harbor seals and 174.5 ft (53.2 m) to the 100 dB threshold for all other seals. All proxy source levels analyzed and the associated distances ZOI thresholds are provided in Table 6-9. Other types of pile driving and extraction that would occur during the project would generate lower airborne sound pressures, with smaller distances and areas of potential disturbance, and for that reason are not considered further in this application. Since protective measures are in place out to the distances calculated for the underwater Level B thresholds, the distances for the airborne thresholds will be effectively covered by monitoring. The closest known haul-out site for seals within the Piscataqua River

is 1.5 miles (2414 m) downstream of the Project area (see Figure 6-2) while the attenuation distance to the 90 dB threshold is 0.108 miles (174.5 m) and the 100 dB threshold is 0.033 miles (53.2 m). Therefore, acoustic disturbance to pinniped species while hauled out is unlikely, and takes resulting from airborne sound from pile driving and drilling are not considered further in this application.

Table 6-9 Calculated Distances to Airborne Noise Thresholds During Impact Pile-Driving for Proxy Source Levels

Pile Driving Source	Source Level (dB rms measured at 15m)	Maximum Distance to 90 dB Threshold (Harbor Seal)	Maximum Distance to 100 dB Threshold (Pinnipeds except Harbor Seals)
30-inch round steel pile-impact driven	110[1]	492.2 ft (150.0 m)	155.2 ft (47.3 m)
24-inch round steel pile-impact driven	111[1]	552.5 ft (168.3 m)	174.5 ft (53.2 m)
18-inch round steel pile-impact driven	103[2]	219.9 ft (67.0 m)	69.6 ft (21.2 m)

Source:
[1] Navy 2013
[2] Source: Washington State Department of Transportation (WDSOT) 2010

Note: All source levels are referenced to 20 microPascal (re 20 µPa)

Key:
dB = decibel
mi = miles
km = kilometers
m = meters
rms = root mean square

6.4.4 Auditory Masking

Natural and artificial sounds can disrupt behavior by masking, or interfering with a marine mammal's ability to hear other sounds. Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher levels. If the second sound is manmade and disrupts hearing-related behavior such as communications or echolocation (Wartzok et al. 2003/04), it could be considered harassment under the MMPA. Noise can only mask a signal if it is within a certain "critical band" 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. 2003, 2004). In delphinid subjects, for example, relevant signals needed to be 17 to 20 dB rms louder than masking noise at frequencies below 1 kHz in order to be detected and 40 dB greater at approximately 100 kHz (Richardson et al. 1995). It is important to distinguish between temporary threshold shift (TTS) and permanent threshold shift (PTS), which persist after the sound exposure, from masking, which occurs during the sound exposure. Because masking (without a resulting threshold shift) is not associated with abnormal physiological function, it is not considered a physiological effect in this IHA application, but rather a potential behavioral effect.

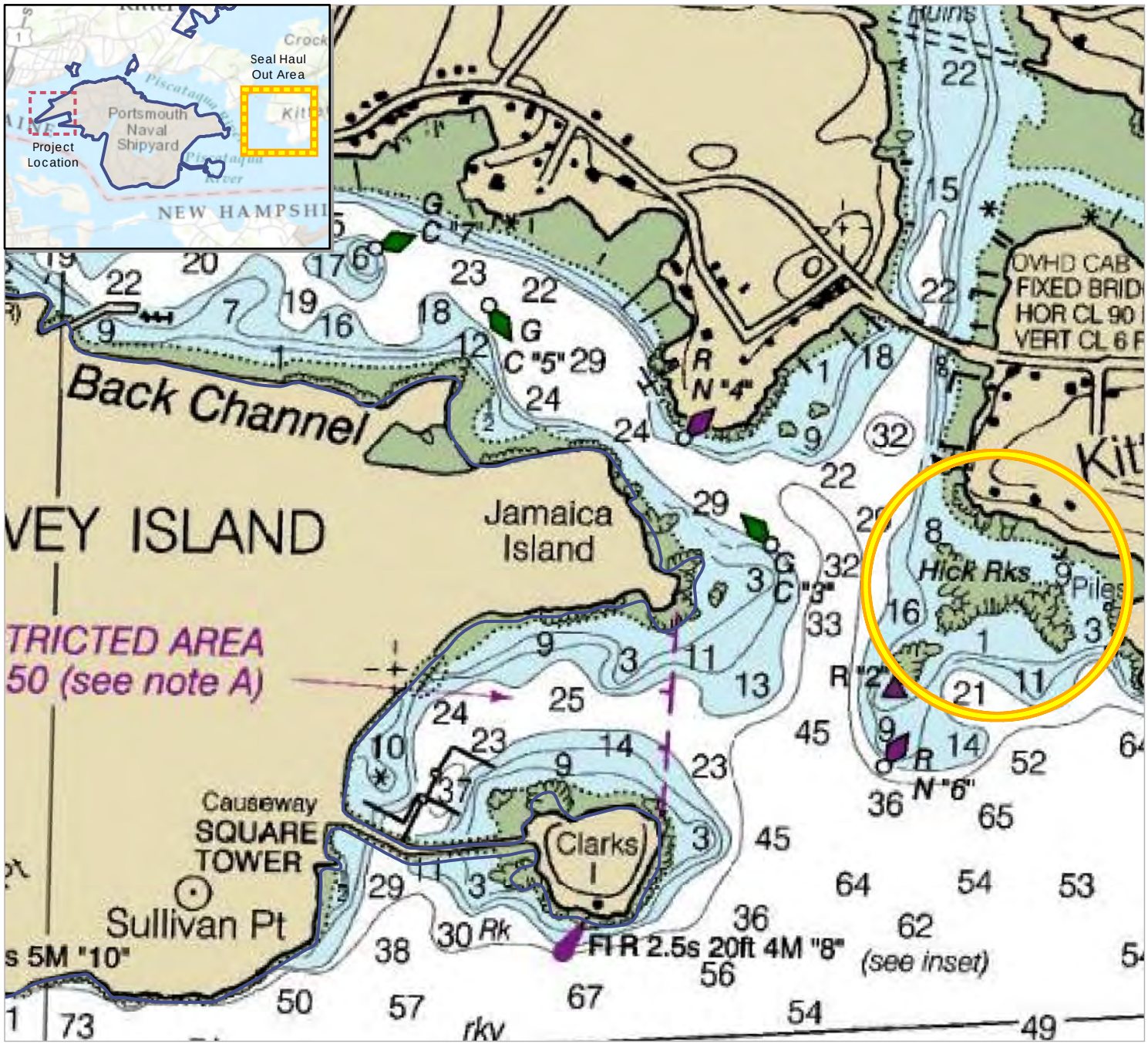

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Figure 6-2
Seal Haul-Out Site at
Hicks Rocks
Portsmouth Naval Shipyard
York County, Maine

Legend

- Installation Area
- Seal Haul Out Site
- Project Area

N

0 250 500 750 1,000 Feet

Source: ESRI 2013; Department of Defense 2014.

The most intense underwater sounds expected to result from the Project are those produced by impact pile driving. Given that the energy distribution of pile driving covers a broad frequency spectrum, sound from these sources would likely be within the audible range of grey seals, harbor seals, hooded seals, and harp seals. Impact pile-driving activity is relatively short term, with rapid pulses occurring for approximately 15 minutes per pile. Vibratory pile driving is also relatively short term, with rapid oscillations occurring for approximately 1.5 hours per pile. It is possible that impact and vibratory pile driving resulting from the Project may mask some acoustic signals that are relevant to the daily behavior of marine mammal species, but the short-term duration and limited areas affected make it very unlikely that fitness of individuals or stocks would be affected. Masking effects are, therefore, treated as negligible. Any masking event that could possibly rise to Level B harassment under the MMPA would occur concurrently within the zones of behavioral harassment already estimated for vibratory and impact pile driving, and which have already been taken into account in the exposure analysis.

6.5 Basis for Estimating Take by Harassment

The Navy is seeking authorization for the potential taking of small numbers of harbor porpoises grey 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 Project. The takes requested are expected to have no more than a minor effect on individual animals and no effect on the populations of these species. Any effects experienced by individual marine mammals are expected to be limited to short-term disturbance of normal behavior or temporary displacement of animals near the source of the noise.

6.5.1 Harbor Porpoise

Harbor porpoises may be present in the 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. However, in general, the porpoises are known to occasionally occur in the river. Average density for the predicted seasons of occurrence was used to determine abundance of animals that could be present in the area for exposure, using the equation abundance = n * ZOI. Estimated abundance for harbor porpoises was 0.88/day. (Average density for spring, summer, and fall = 0.9578.)

Potential takes could occur if harbor porpoises move through the area on foraging trips during pile driving or extraction. Harbor porpoises that are taken could exhibit 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. 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.

6.5.2 Grey Seal

Grey seals may be present year-round in the project vicinity, with constant densities throughout the year. Grey seals are less common in the Piscataqua River than the harbor seal. Average density for the predicted seasons of occurrence was used to determine abundance of animals that could be present in the area for exposure, using the equation abundance = n * ZOI. Estimated abundance for grey seals was 0.21/day (average year-round density = 0.2202).

Potential takes could likely involve grey 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. Grey seals that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, grey 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 Project area, potential takes by disturbance would have a negligible short-term effect on individual grey seals and would not result in population-level impacts.

6.5.3 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. Average density for the predicted seasons of occurrence was used to determine abundance of animals that could be present in the area for exposure, using the equation abundance = n * ZOI. Abundance for harbor seals was 0.19/day. (Average year-round density = 0.1998.)

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 extraction. 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. With the absence of any major rookeries and only one isolated haul-out site 1.5 miles from the 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.

6.5.4 Hooded Seal

Hooded seals may be present in the project vicinity during the winter and spring, from January through May, though their exact seasonal densities are unknown. In general, hooded seals are much rarer than the harbor seal and grey seal in the Piscataqua River. 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). These animals are conservatively assumed to be present within the underwater Level B ZOI during each day of in-water pile driving. Average density for the predicted seasons of occurrence was used to determine abundance of animals that could be present in the area for exposure, using the equation abundance = n * ZOI. Abundance for hooded seals was 0/day (average density for winter and spring = unknown, known to be rare).

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 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.

6.5.5 Harp Seal

Harp seals may be present in the Project vicinity during the winter and spring, from January through February. In general, harp seals are much rarer than the harbor seal and grey seal in the Piscataqua River. These animals are conservatively assumed to be present within the underwater Level B ZOI during each day of in-water pile driving. Average density for the predicted seasons of occurrence was used to determine abundance of animals that could be present in the area for exposure, using the equation abundance = n * ZOI. Abundance for harp seals was 0.014/day (average year-round density = 0.0125).

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 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.

6.6 Description of Take Calculation

The take calculations presented here relied on the best data currently available for marine mammal populations within close proximity to the Piscataqua River. There are not population data for any marine mammal species specifically within the Piscataqua River; however, the population data used are from the most recent NOAA Fisheries Service Stock Assessment Reports (SAR) for the Atlantic Ocean. The most recent SAR population number was used for each species. The specific SAR used is discussed within each species take calculation in Sections 6.6.1 through 6.6.5. The formula was developed for calculating take due to pile driving, extraction, and drilling and applied to the species-specific noise-impact threshold. The formula is founded on the following assumptions:

- All piles to be installed would have a noise disturbance distance equal to the pile that causes the greatest noise disturbance.
- Pile driving could potentially occur every day of the in-water work window; however, it is estimated no more than a few hours of pile driving would occur per day.
- An individual can only be taken once per day due to sound from pile driving, whether from impact or vibratory pile driving, or vibratory extraction
- The conservative assumption is made that all pinnipeds within the ZOI would be underwater during at least a portion of the noise generating activity and, hence, exposed to sound at the predicted levels.

The calculation for marine mammal takes is estimated by:

$$\text{Take estimate} = (n * ZOI) * X \text{ days of total activity}$$

where:

n = density estimate used for each species/season
X = number of days of pile driving, estimated based on the total number of piles and the average number of piles that the contractor can install per day.
ZOI = noise threshold zone of influence (ZOI) impact area

The calculation n * ZOI produces an estimate of the abundance of animals that could be present in the area for exposure. The abundance is then multiplied by the total number of days of pile-driving to determine the take estimate. Because the estimate must be a whole number, this value was rounded up.

The ZOI impact area is the estimated range of impact on marine mammals during in-water construction. The ZOI is the area in which in-water sound would exceed designated NOAA Fisheries Service thresholds.. The formula for determining the area of a circle ($\pi * radius^2$) was used to calculate the ZOI around each pile, for each threshold. The distances specified were used for the radius in the equation. All impact pile driving take calculations were based on the estimated threshold ranges without using a bubble curtain with 10 dB attenuation as a mitigation measure. The ZOI impact area took into consideration the

possible affected area of the Piscataqua River from the furthest pile driving/extraction site with attenuation due to land shadowing from bends in the river. As described in Section 6.4 with regard to the distances, because of the proximity of some of the piles to the shore, the narrowness of the river at the Project area, and the maximum fetch (*i.e.*, area impacted by wind and wind-generated waves), the ZOIs for each threshold aren't necessarily spherical and may be truncated.

6.6.1 Harbor Porpoise

As described in Section 6.5.1, the average number of harbor porpoises present within ZOIs for Level B harassment by impact and/or vibratory pile driving is 0.88/day, resulting in a take estimate of 64 Level B exposures for 72 days of pile installation.

6.6.2 Grey Seal

As described in Section 6.5.2, the average number of grey seals present within ZOIs for Level B harassment by impact and/or vibratory pile driving is 0.21/day, resulting in a take estimate of 16 Level B exposures for 72 days of pile driving.

6.6.3 Harbor Seal

As described in Section 6.5.3, the average number of harbor seals present within ZOIs for Level B harassment by impact and/or vibratory pile driving is 0.19/day, resulting in an estimate of 14 Level B exposures for 72 days of pile-driving.

6.6.4 Hooded Seal

As described in Section 6.5.4, the average number of hooded seals present within ZOIs for Level B harassment by impact and/or vibratory pile driving is 0/day, resulting in an estimate of 0 Level B exposures for 72 days of piledriving.

6.6.5 Harp Seal

As described in Section 6.5.5, the average number of harp seals present within ZOIs for Level B harassment by impact and/or vibratory pile driving is 0.014/day, resulting in an estimate of 2 Level B exposures for 72 days of pile driving.

6.7 Summary

Based on the modeling results presented above, the total numbers of takes that the Navy is requesting for the five marine mammal species that may occur within the Project area during the duration of proposed in-water construction activities are presented below in Table 6-10. Takes are currently expected to occur year-round. There is the potential for 64 Level B disturbance takes of harbor porpoises, 16 Level B disturbance takes of grey seals, 14 Level B disturbance takes of harbor seals, 0 Level B disturbance takes of hooded seals, and 2 Level B takes of harp seals. Takes may occur from either impact or vibratory pile-driving operations. The analysis conservatively assumes that both types of pile-driving operations could occur concurrently.

Table 6-10 Total Number of Takes, by Species and Impact Injury Threshold

Species	Impact Injury Threshold (190 dB rms)	Impact Injury Threshold (180 dB rms)	Both Impact Disturbance Threshold (160 dB) and Vibratory Disturbance Threshold (120 rms)
Harbor porpoise	N/A	0	64
Grey seal	0	N/A	16
Harbor seal	0	N/A	14
Hooded seal	0	N/A	0
Harp Seal	0	N/A	2
Total	**0**	**0**	**96**

Note: All source levels are referenced to 1 microPascal (re 1 µPa).

Key:
dB = decibel
rms = root-mean squared
N/A = Not applicable

7 Impacts on 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 and Drilling on Marine Mammals

7.1.1 Underwater Noise Effects

The effects of pile driving on marine mammals are dependent on several factors, including the size, type, 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 standoff distance between the pile and the animal; and the sound-propagation properties of the environment. Impacts to 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 (i.e., mud) would absorb or attenuate the sound more readily than hard substrates (rock), which may reflect the acoustic wave. Soft, porous substrates would also likely result in shorter durations of pile driving, and possibly less driving force, which would ultimately decrease the intensity of the acoustic source.

Impacts to 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 are also expected, though the type and severity of these effects are more difficult to define due to limited studies addressing the behavioral effects of impulsive sounds on marine mammals. Potential effects from impulsive sound sources can range from brief acoustic effects such as behavioral disturbance, tactile perception, physical discomfort, slight injury of the internal organs and the auditory system, to death of the animal (Yelverton et al. 1973; O'Keeffe and Young 1984; Navy 2001).

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 impacts include hearing loss, which is caused by exposure to perceptible sounds. Severe damage from a pressure wave to the ear can include rupture of the tympanum, fracture of the ossicles, damage to the cochlea, hemorrhage, and cerebrospinal fluid leakage into the middle ear (NOAA Fisheries Service 2008). Moderate injury implies partial hearing loss. Permanent hearing loss, or permanent threshold shifts (PTS), can occur when the hair cells are damaged by one very loud event or by prolonged exposure to noise. Instances of temporary threshold shifts (TTS) and/or auditory fatigue are well documented in marine mammal literature as being one of the primary avenues of acoustic impact. Temporary loss of hearing sensitivity (TTS) has been documented in controlled settings using captive marine mammals exposed to strong sound exposure levels at various frequencies (Ridgway et al. 1997; Kastak et al. 1999; Finneran et al. 2005), but it has not been documented in wild marine mammals exposed to pile driving. While injuries to other sensitive organs are possible, they are less likely because pile-driving impacts are almost entirely acoustically mediated, unlike explosive sounds, which also include a shock wave that can result in damage.

No physiological responses are expected from pile-driving operations occurring during the Project, for several reasons. First, vibratory pile driving, which is being utilized as the primary installation method, does not generate high enough peak SPLs that are commonly associated with physiological damage. Any use of impulsive pile driving would only occur from a short period of time (~30 to 120 minutes per steel pile). Additionally, the mitigation measures that the Navy would be employing (see Section 11) would greatly reduce the chance that a marine mammal may be exposed to SPLs that could cause physical harm. The Navy would have trained biologists monitoring a shutdown zone equivalent to the Level A Harassment zone (inclusive of the 180 dB re 1 μ Pa (cetaceans) and 190 dB re 1 μ Pa (pinnipeds) isopleths (contour lines) to ensure no marine mammals are injured.

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 (National Research Council of the National Academies 2005).

Habituation can occur when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok et al. 2003/04). 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 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 (NRC) 2003; Wartzok et al. 2003/04).

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, but also including pile driving) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds 2002; CALTRANS 2001, 2006; also see reviews in Gordon et al. 2004; Wartzok et al. 2003/04; and Nowacek et al. 2007). Responses to continuous noise, such as vibratory pile installation, have not been documented as well as responses to pulsed sounds.

With both types of pile driving, it is likely that the onset of pile driving could result in temporary, short-term changes in the animal's typical behavior and/or avoidance of the affected area. A marine mammal may show signs that it is startled by the noise and/or may swim away from the sound source and avoid the area. Other potential behavioral changes could include increased swimming speed, increased surfacing time, and decreased foraging in the affected area. Pinnipeds may increase their haul-out time, possibly to avoid in-water disturbance (CALTRANS 2001, 2006). Since pile driving would likely only occur for a few hours per day and over a short period of time, it is unlikely to result in permanent displacement. Any potential impacts from pile-driving activities could be experienced by individual marine mammals but would not cause population level impacts or affect the long-term fitness of a species.

7.1.2 Airborne Noise Effects

Marine mammals that occur in or near the Project area could be exposed to airborne sounds associated with pile-driving that have the potential to cause harassment, depending on their distance from pile-driving activities. Airborne pile-driving noise would have less impact on cetaceans than pinnipeds because noise from atmospheric sources does not transmit well underwater (Richardson et al. 1995); thus

airborne noise would be an issue only for hauled-out pinnipeds in or near the Project area. Most likely, airborne sound would 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 habitat and move farther from the source. Studies 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 dB peak and 96 dB rms. Based on these observations, pinnipeds could exhibit temporary behavioral reactions to airborne noise; however, exposure is not likely to result in population-level impacts.

There are no known haul-out sites for any seal species within the vicinity of the Project area. The closest known seal haul-out site to the Project area is on the Piscataqua River 1.5 miles downstream of the Project area. Therefore, acoustic disturbance to hauled-out pinnipeds is unlikely.

7.1.3 Conclusions Regarding Impacts to Species or Stocks

Individual marine mammals may be exposed to SPLs during pile driving, and extraction operations at the Shipyard may result in Level B Behavioral harassment. Any marine mammals that are taken (harassed) may change their normal behavior patterns (i.e., swimming speed, foraging habits, etc.) or be temporarily displaced from the area of construction. Any takes would likely have only a minor effect on individuals and no effect on populations. The sound generated from vibratory pile driving is non-pulsed (e.g., continuous), which is not known to cause injury to marine mammals. Mitigation is likely to avoid most potential adverse underwater impacts to marine mammals from impact pile driving. Nevertheless, some level of impact is unavoidable. The expected level of unavoidable impact (defined as an acoustic or harassment “take”) is described in Sections 5 and 6. This level of effect is not anticipated to have any detectable adverse impact on population recruitment, survival, or recovery (i.e., no more than a negligible adverse effect).

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8 Impact on Subsistence Use

The anticipated impact of the activity on the availability of the species or stocks 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 on 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.

9.1 Pile-driving and Drilling Effects on Potential Prey (Fish)

Fish are a primary dietary component of the cetaceans and pinnipeds discussed in this application. Similar to marine mammals, fish can also be affected by noise both physiologically and behaviorally. However, the amount of information regarding impacts on fish from human-generated acoustic sources is limited. The acoustic threshold criteria for physiological impacts on fish were developed by the Fisheries Hydroacoustic Working Group (FHWG) in 2008. The criteria determined by the FHWG is based on impacts from pile driving; however, it is assumed that because this is the most current information for any physiological acoustic impacts on fish, the criteria can be used for other human-generated sound sources. The FHWG determined that potential injury for all fish species is based on dual criteria: (1) Peak SPL of 206 dB re 1µPa, and (2) 187 dB accumulated SEL (dBcSEL; re 1µPa2-sec) for fish weighing 2 grams or more or 183 dB accumulated SEL (dBcSEL; re 1µPa2-sec) for fish weighing 2 grams or less (Palmer 2012). To assess behavioral disturbance, NOAA Fisheries Service has adopted a threshold criterion of 150 dB re 1µPaRMS for fish of all sizes (Palmer 2012).

Construction activities will produce both pulsed (i.e., impact pile driving) and continuous (i.e., vibratory pile driving) sounds. Fish react to sounds that are especially strong and/or intermittent low-frequency sounds. Short-duration, sharp sounds can cause overt or subtle changes in fish behavior and local distribution. Hastings and Popper (2005; Popper and Hastings 2009) identified several studies that suggest fish may relocate to avoid certain areas of noise energy. Sound pulses at received levels of 160 dB re 1 µPa may cause subtle changes in fish behavior. SPLs of 180 dB may cause noticeable changes in behavior (Chapman and Hawkins 1969; Pearson et al. 1992; Skalski et al. 1992). SPLs of sufficient strength have been known to cause injury to fish and fish mortality (CALTRANS 2001; Longmuir and Lively 2001). The most likely impact to fish from pile-driving activities at the Project area would be temporary behavioral avoidance of the immediate area. The duration of fish avoidance of this area after pile driving stops is unknown, but a rapid return to normal recruitment, distribution, and behavior is anticipated. 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.

9.2 Pile-driving and Drilling Effects on Potential Foraging Habitat

During the course of the Project, various activities are expected to disturb the sediment. These activities include pile-driving, dredging, and filling. In order to minimize the amount of debris, sediment, and silt escaping when backfill ing the Berth 11 bulkhead, the Navy will install geotextile fabric against the interior of the bulkhead to catch debris, sediment, and silt forced through seams in the bulkhead when the backfill is compacted. In addition, a temporary silt curtain and boom would be installed outside of Berth 11, approximately 18 feet off the berth, during backfilling to catch additional debris, sediment, and silt that escapes the bulkhead.

Pile-driving and dredging activities may re-suspend disturbed sediment and result in turbid conditions within the immediate Project area. Suspended sediments may be transported and re-deposited downstream of the prevailing currents, which could increase siltation in the vicinity of the Shipyard. Resulting

sedimentation is also expected to be localized and temporary. 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 within the temporary offshore workspace 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 cetacean or pinniped prey fish species in the Project area. However, turbidity plumes associated with the Project would be temporary and localized, and fish in the 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.

9.3 Summary of Impacts on Marine Mammal Habitat

All marine mammal species using habitat near the Project area are primarily transiting the area; no known foraging or haul-out areas are located within 1.5 miles of the 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 Project area (CR Environmental, Inc. 2014). Direct benthic habitat loss would be avoided to the extent practicable by minimizing the construction footprint, and this loss would be temporary across most of the Project area as disturbed areas are expected to recolonize with a similar benthic community composed of organisms or offspring of organisms from adjacent benthic areas.

Construction of the bulkhead at Berth 11 would result in permanent loss of benthic habitat. This permanent loss would be insignificant on a landscape-scale, given the abundant habitat in the surrounding estuary system that is of similar or better quality. Indirect impacts on benthic habitat and organisms are likely to result from turbidity and resulting sedimentation caused by dredging activities. There would be temporary and minor direct and indirect adverse impacts on benthic habitat and benthic invertebrate species during construction as a result of sediment disturbance, turbidity, and sedimentation. However, the impacts that would result from the proposed activities would be similar to those resulting from maintenance dredging at the Shipyard. Within a short time after construction is complete, the benthic habitat would be expected to return to pre-construction conditions, allowing the recolonization of benthic invertebrates.

Given the short daily duration of noise associated with individual pile driving and removal and the relatively small areas being affected, pile-driving and extraction activities associated with the Proposed Action are not likely to have a permanent, adverse effect on any Essential Fish Habitat (EFH) or population of fish species. Therefore, pile driving and removal are not likely to have a permanent, adverse effect on marine mammal foraging habitat at the Project area.

10 Anticipated Impacts of Loss or Modification of Habitat

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

During the course of the Project, various activities would cause benthic disturbance. These include dredging, pile driving, pile extraction, and filling. These activities would not result in the significant permanent loss or modification of habitat for marine mammals or their prey. The greatest impact on marine mammals associated with the Project would be the potential minimal and temporary loss of habitat due to elevated noise levels and the potential temporary impact on prey species due to turbidity. These temporary impacts are discussed in detail in Section 9.0, Anticipated Impact on Habitat.

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11 Means of Effecting the Least Practicable Adverse Impacts – Mitigation Measures

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 exposures outlined in Section 6 represent the maximum expected number of marine mammals that could be exposed to acoustic sources reaching Level B harassment levels. The Navy proposes to employ a number of mitigation measures, discussed below, in an effort to minimize the number of marine mammals potentially affected.

11.1 Mitigation for Pile-driving Activities

11.1.1 Proposed Measures

The modeling results for ZOIs discussed in Section 6 were used to develop mitigation measures for pile driving, drilling, and extraction at Berth 11. The ZOIs effectively represent the mitigation zone that would be established to prevent Level A harassment to marine mammals.

1. **Shutdown and Buffer Zone during Pile Driving and Removal**

   - During pile driving and removal, the shutdown zone shall include all areas where the underwater SPLs are anticipated to equal or exceed the Level A (injury) harassment criteria for marine mammals (180 dB rms isopleth for cetaceans; 190 dB rms isopleth for pinnipeds). During all pile-driving and removal activities, regardless of predicted SPLs, the entire Level A zone, or shutdown zone, will be monitored to prevent injury to marine mammals from their physical interaction with construction equipment during in-water activities. Pile-driving or removal operations will cease if a marine mammal approaches the zone. Pile-driving/removal operations will restart once the marine mammal is visibly seen leaving the Level A zone, or after 15 minutes have passed with no sightings.
   - During pile-driving and removal, the buffer zone shall include areas where the underwater SPLs are anticipated to equal or exceed the Level B (disturbance) harassment criteria for marine mammals (underwater: 160 dB rms isopleths for impact pile driving, 120 dB rms isopleth for vibratory pile-driving). The distance encompassing these zones will be adjusted to accommodate any difference between predicted and measured sound levels.
   - Due to the increased costs associated with monitoring the entire Level B zone, or buffer zone, the zone will be monitored during two-thirds of all pile-driving days . If a marine mammal is observed entering the buffer zone, an exposure would be recorded and behaviors documented. The Navy will extrapolate data collected during monitoring days and extrapolate and calculate total takes for all pile-driving days.
   - All buffer and shutdown zones will initially be based on the distances from the source that were predicted for each threshold level.

2. **Shutdown Zone during Other In-water Construction or Demolition Activities**

   - 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 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").

3. **Visual Monitoring**

   - Impact Installation: Monitoring will be conducted within the Level A harassment shutdown zone during all pile-driving operations and the Level B harassment buffer zone during two-thirds of pile-driving days. Monitoring will take place from 15 minutes prior to initiation through 30 minutes post-completion of pile-driving/removal activities.
   - A minimum of two marine species observers will be in place during all pile-driving/removal operations. Marine species observers ("observer(s)") designated by the contractor will be placed at the best vantage point(s) practicable to monitor for marine mammals and implement shutdown/delay procedures when applicable by calling for the shutdown to equipment operators. The observer(s) shall have no other construction-related tasks while conducting monitoring and will be trained on the observation zones, potential species, how to observe, and how to fill out the data sheets by the Navy Natural Resources Manager prior to any pile-driving activities.
   - The Navy shall conduct a pre-construction briefing with the contractor. During the briefing, all contractor personnel working in the Project area will watch the Navy's Marine Species Awareness Training video. An informal guide will be included with the monitoring plan to aid in identifying species if they are observed in the vicinity of the Project area.
   - Prior to the start of pile-driving/removal activity, the shutdown and safety zones will be monitored for 15 minutes to ensure that they are clear of marine mammals. Pile-driving will only commence once observers have declared the shutdown zone clear of marine mammals; animals will be allowed to remain in the buffer zone and their behavior will be monitored and documented.
   - If a marine mammal approaches/enters the shutdown zone during the course of pile-driving/removal operations, pile-driving will be halted and delayed until either the animal has voluntarily left and been visually confirmed beyond the shutdown zone or 15 minutes have passed without re-detection of the animal.
   - In the unlikely event of conditions that prevent the visual detection of marine mammals, such as heavy fog, activities with the potential to result in Level A or Level B harassment will not be initiated. Impact pile-driving would be curtailed, but vibratory pile driving or extraction would be allowed to continue if such conditions arise after the activity has begun.

4. **Acoustic Measurements.** Acoustic measurements will continue during subsequent years of in-water construction for the Project and will be used to empirically adjust the shutdown and buffer zones. For further detail regarding our acoustic monitoring plan, see Section 13.

5. **Soft Start.** The use of a soft-start procedure is believed to provide additional protection to marine mammals by providing a warning and/or giving marine mammals a chance to leave the area prior to the hammer operating at full capacity. The Project will use soft-start techniques (ramp-up/dry fire) recommended by NOAA Fisheries Service for impact and vibratory pile driving/removal. These measures are as follows:

   "Soft start must be conducted at beginning of day's activity and at any time pile driving has ceased for more than 30 minutes. If vibratory pile driving has been occurring but impact has not for more than 30 minutes, soft start for the impact hammer must occur. The soft-start requires contractors to initiate noise from vibratory hammers for 15 seconds at reduced energy followed by a 30-second waiting period. This procedure should be repeated two additional times. If an impact hammer is used, contractors are required to provide an initial set of three strikes from the impact hammer at 40 percent energy, followed by a 30-second waiting period, then two subsequent 3-strike sets."

   The 30-second waiting period is proposed based on the Navy's recent experience and consultation with NOAA Fisheries Service on a similar project at Naval Base Kitsap at Bangor (Department of the Navy 2010b).

6. **Daylight Construction**. Pile driving/removal (vibratory as well as impact), drilling, and vibratory extraction will only be conducted during daylight hours.

11.1.2 Measures Considered but not Proposed

The use of bubble curtains to reduce underwater sound from impact pile driving was considered but is not proposed because the piles would be installed in relatively deep water, and strong tidal currents (up to 3 knots) at the Project sites would disperse the bubbles and compromise the effectiveness of sound attenuation (CALTRANS 2009). Other considerations were that the potential for Level A exposures and the number and relative intensity of Level B exposures has already been reduced by primary reliance on vibratory installation of steel piles--in itself, an accepted mitigation measure to reduce the intensity of underwater sound from pile driving (CALTRANS 2009).

11.2 Mitigation Effectiveness

It should be recognized that although marine mammals will be protected from Level A harassment by marine mammal observers (MMOs) monitoring the near-field injury zones, mitigation may not be 100-percent effective at all times in locating marine mammals in the buffer zone. The efficacy of visual detection depends on several factors, including the observer's ability to detect the animal, the environmental conditions (visibility and sea state), and monitoring platforms.

All observers utilized for mitigation activities will have 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 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 buffer zones cover relatively small and accessible areas of the lower Piscataqua River. As such, proposed mitigation measures are likely to be very effective.

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12 Minimization of Adverse Effects on Subsistence Use

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 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 NOAA Fisheries Service 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 Project area in order to provide a more robust assessment of sound levels from steel pile driving and marine mammal responses, and to refine avoidance and minimization measures as warranted by the results. For all in-water activities, the monitoring described below would be implemented. The Navy would conduct post-project surveys as well on a quarterly basis to document any changes in populations of marine mammals.

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, sufficient to confirm measured contours associated with the acoustic ZOIs. Acoustic sound recordings will be collected sufficient to document sound source levels for 10 percent of the proposed piles to be driven and extracted.

The Navy will conduct acoustic monitoring at the source (33 feet) and, where the potential for Level A harassment exists, at a second representative monitoring location at an intermediate distance between the cetacean and pinniped shutdown zones. In conjunction with measurements of SPLs at the source and shutdown monitoring locations, there will also be intermittent verification for impact driving or pile driving and extraction to determine the actual distance to either the 120 dB re 1μPa rms isopleth or the point at which the SPL (maximum rms) from the equipment diminishes to the median ambient SPL (rms) and hence becomes indistinguishable. 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, 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 190, 180, 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.
- For each pile monitored, underwater SPLs would be continuously measured for the entire duration of pile driving, including soft starts. Sound pressure levels will be monitored in real time.
- 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 chief inspector 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, 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, minimum, and maximum single strike SEL in [dB re μPa2 sec]
  - cumulative SEL as defined by the mean single strike SEL + 10*log (# hammer strikes) in [dB re μPa2 sec]

- A frequency spectrum (pressure spectral density) in [dB re µPa2 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 log10 taken of result to express in [dB re µPa2 sec].

13.2.1 Visual Marine Mammal Observations

The Navy will collect sighting data and behavioral responses to construction for marine mammal species observed in the region of activity during the period of construction. 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 safety zone before, during, and after pile-driving activities. Based on NOAA Fisheries Service requirements, the Marine Mammal Monitoring Plan would include the following procedures:

- MMOs will be primarily located on boats, docks, and piers at the best vantage point(s) in order to properly see the entire shut down zone(s).
- MMOs 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 MMO, relative to known distances to objects in the vicinity of the MMO;
- 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 buffer zones will be monitored for 15 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 MMO has determined that, through sighting or by waiting approximately 15 minutes, the animal has moved outside the shutdown zone. If a marine mammal is observed approaching the shutdown zone, the MMO who sighted that animal will notify the shutdown MMO of its presence.

- During Activity Monitoring:
  - If a marine mammal is observed entering the buffer 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 15 minutes.
- Post-Activity Monitoring:
  - Monitoring of the shutdown and buffer zones will continue for 30 minutes following the completion of the activity.

13.2.3 Data Collection

NOAA Fisheries Service requires that the MMOs 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 or in the immediate area surrounding monitoring zones.
  - 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 safety zones.
  - A refined take estimate based on the number of marine mammals observed during the course of construction

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14 Research

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

To minimize the likelihood that impacts will occur to the species, stocks, and subsistence use of marine mammals, all construction activities will be conducted in accordance with all federal, state, and local regulations, and minimization measures proposed by the Navy will be implemented to protect marine mammals. The Navy will coordinate all activities with the relevant federal and state agencies. These include, but are not limited to: the NOAA Fisheries Service, U.S. Fish and Wildlife Service, U.S. Coast Guard, and the U.S. Army Corps of Engineers (USACE). The Navy will share field data and behavioral observations on all marine mammals that occur in the Project area. Results of each monitoring effort will be provided to NOAA Fisheries Service in one summary report within 45 days of the conclusion of monitoring. This information could be made available to regional, state, and federal resource agencies, scientists, professors, and other interested private parties upon written request to NOAA Fisheries Service.

Additionally, the Navy provides a significant amount of funding and support for marine research. The Navy provided $26 million in Fiscal Year 2008 and $22 million in Fiscal Year 2009 to universities, research institutions, federal laboratories, private companies, and independent researchers around the world to study marine mammals.

The Navy sponsors 70 percent of all U.S. research concerning the effects of human-generated sound on marine mammals and 50 percent of such research conducted worldwide. Major topics of Navy-supported research include the following:

- Gaining a better understanding of marine species distribution and important habitat areas,
- Developing methods to detect and monitor marine species before and during training,
- Understanding the effects of sound on marine mammals, and
- Developing tools to model and estimate potential effects of sound.

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and other research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods in Navy activities. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential monitoring tool. 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 NOAA Fisheries Service from research and development efforts, and future research as described previously.

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