REQUEST FOR LETTER OF AUTHORIZATION
UNDER THE MARINE MAMMAL PROTECTION ACT
FOR REPAIR AND REPLACEMENT OF THE Q8 BULKHEAD
AT
NAVAL STATION NORFOLK, NORFOLK, VIRGINIA
January 1, 2025, through December 31, 2029

Submitted to:

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

Prepared by:

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January 2024

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ACRONYMS AND ABBREVIATIONS

BMP	best management practice
CBBT	Chesapeake Bay Bridge Tunnel
CV	coefficient of variation
dB	decibel
dBA	A-weighted decibel
DTH	down-the-hole
ESA	Endangered Species Act
FR	Federal Register
ft	foot
Hz	hertz
JEBLC	Joint Expeditionary Base Little Creek
JMSPH	James River at Hampton Roads Harbor Polyhaline
kHz	kilohertz
km	kilometer
LOA	Letter of Authorization
m	meter
MLW	mean low water
MMPA	Marine Mammal Protection Act
NAVSTA	Naval Station
Navy	Department of the Navy
NMFS	National Marine Fisheries Service
PSO	protected species observer
PTS	permanent threshold shift
R&D	research and development
ROI	region of influence
RMS	root mean square
sec	second
SEL	sound exposure level
SEL_{CUM}	cumulative sound exposure level
SMC	Southern Migratory Coastal
SPL	sound pressure level

sq km	square kilometer
TL	transmission loss
TTS	temporary threshold shift
WFA	weighting factor adjustment
UME	unusual mortality event

1 INTRODUCTION AND DESCRIPTION OF ACTIVITIES

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

1.1 Introduction

Pursuant to the Marine Mammal Protection Act (MMPA) Section 101(a)(5)(A), the U.S. Department of the Navy (Navy) submits this application to National Marine Fisheries Service (NMFS) for a Letter of Authorization (LOA) for the incidental taking of marine mammal species during construction activities associated with the proposed repair and replacement of the Q8 Bulkhead at Naval Station (NAVSTA) Norfolk in Norfolk, Virginia, (Figure 1-1) between January 1, 2025, and December 31, 2029. The Code of Federal Regulations Title 50, Section 216.104 sets out 14 specific items that must be included in requests for take pursuant to Section 101(a)(5)(A) of the MMPA; those 14 items are represented by the 14 chapters of this application.

NAVSTA Norfolk, a Command of the Navy, proposes to repair and replace the Q8 Bulkhead. The Q8 Bulkhead is located on the north end of the main waterfront from Pier 11 to the northern jetty just past Pier 14 (Figure 1-2). Work will occur in three phases over a period of approximately three years.

The Q8 Bulkhead was originally constructed in 1957 and consists of an approximately 2,583-foot (ft)-long anchored concrete sheet pile wall, beginning about 400 ft south of Pier 12 and terminating 1,024 ft north of Pier 14. The bulkhead supports parking, storage areas, pier access, and moorings of tugs, barges, and yard craft. The existing bulkhead is comprised of 48-inch tongue and grove concrete sheet pile sections with an 18-inch concrete pile fender system.

Pile driving activities are expected to occur over a period of three years; however, potential funding and scheduling delays are possible, and the Navy is requesting coverage for the full five-year period from January 1, 2025, through December 31, 2029. A detailed description of the project is provided in Section 1.2. Dates and duration of in-water activities expected to result in incidental taking of marine mammals are described in Section 2.

The region of influence (ROI) is the full extent of potential underwater noise impacts for the project. Within the ROI, individual harassment and shutdown zones occur for the various pile types and installation methods. It is within these zones that takes of marine mammals, as defined under the MMPA, can be anticipated as described in Section 6.7.

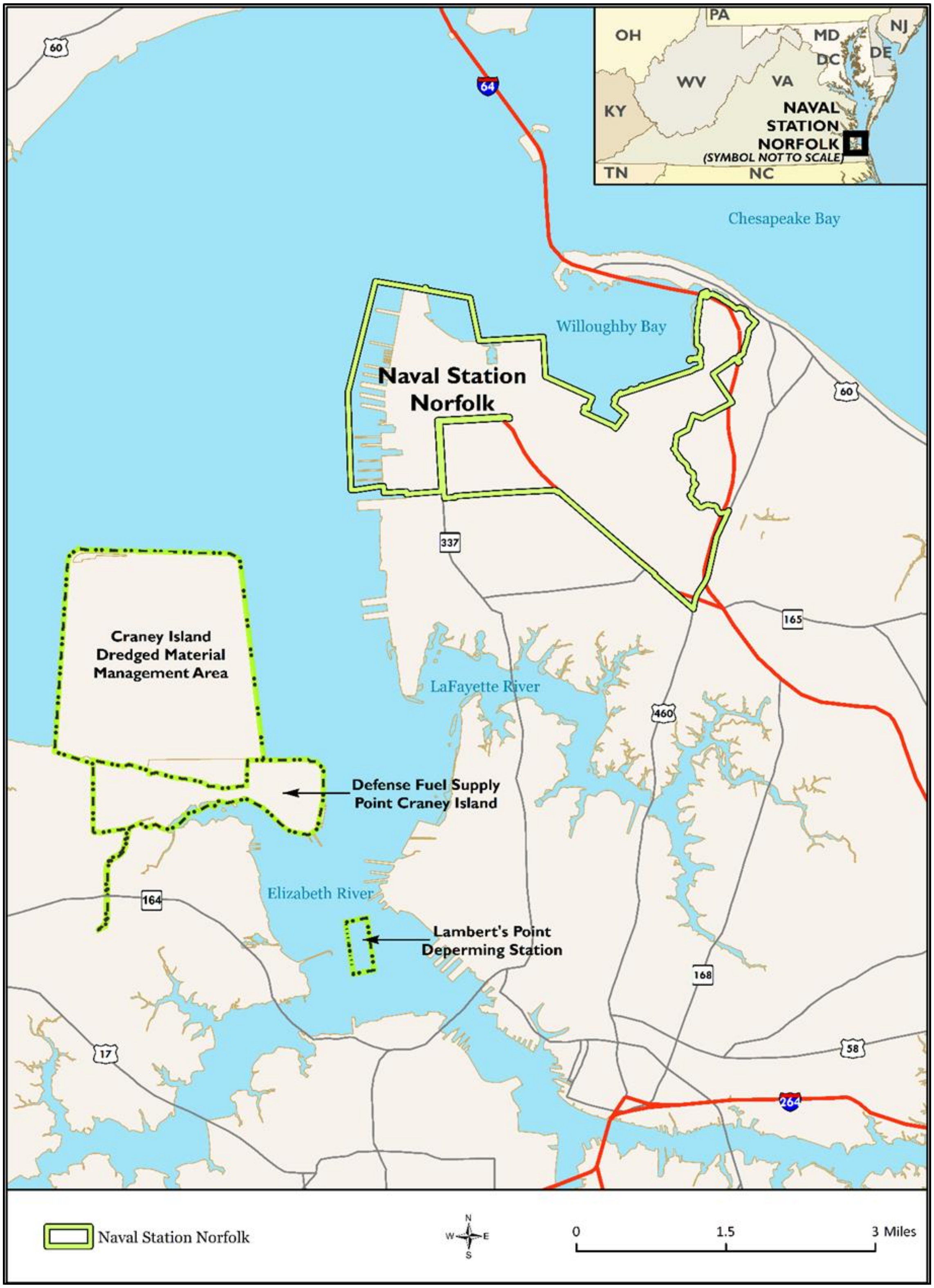

Figure 1-1. Site Location Map for Naval Station Norfolk

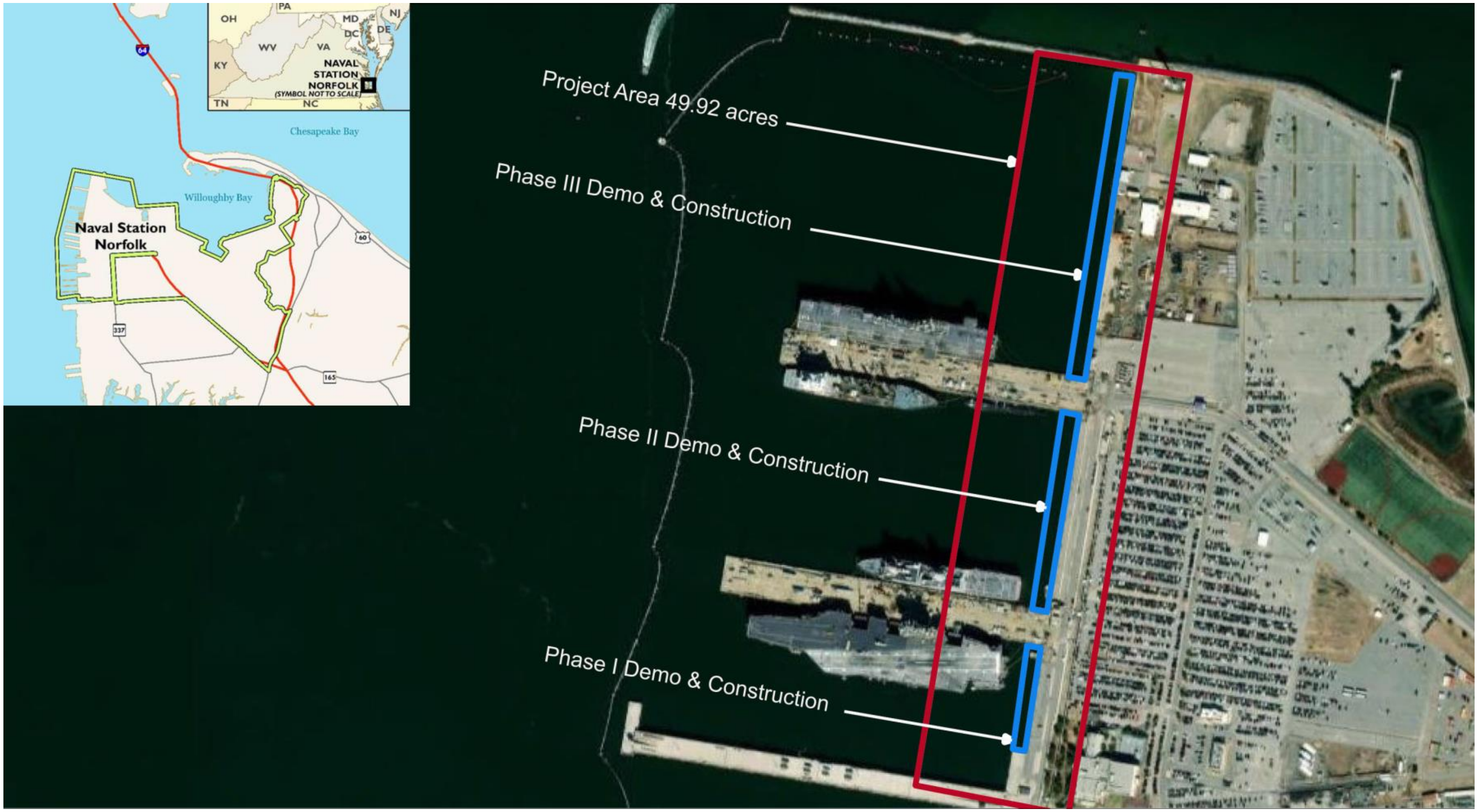

Figure 1-2. Project Site Map

1.2 Project Description

The project scope associated with this LOA application includes the repair and replacement of the Q8 Bulkhead at NAVSTA Norfolk in Norfolk, Virginia (Figure 1-2). The repairs/replacement of the bulkhead are needed because the existing bulkhead has failed in multiple locations, creating sinkholes and unsafe conditions. The repairs/replacement are needed to ensure full functionality of the bulkheads and prevent further erosion to the installation waterfront. Without the repairs, the Navy's mission would be compromised. The existing tongue and groove sheet piles have numerous holes between the sheets (approximately 47) which have allowed for migration of retained fill into the waterway and has contributed to the formation of sinkholes and subsurface voids on the landward side of the bulkhead. Vehicles and pedestrians are currently restricted from the bulkhead to approximately 20 ft landward. Furthermore, over-dredging of sub-aqueous river bottom in front of the toe of the existing sheets has decreased bottom tip embedment of the sheets to such an extent that a significant percentage of the design factor of safety against catastrophic bulkhead failure has been lost, and the sheets are effectively overloaded beyond acceptable Design Code limits.

Landward of the existing bulkhead, pavement will be removed and disposed of at an off-site disposal area. Excavation beneath the existing pavement would occur to expose the existing concrete relieving platform for inspection, to facilitate removal and replacement of existing stormwater outfall pipes and catch basins, and to accommodate installation of a new tie-back rod system. These excavated materials will be stockpiled for re-use.

Upon completion of the replacement of stormwater outfall pipes, pile extraction and installation activities would begin in phases. Phase I of construction will occur between Piers 12 and 14 and includes vibratory extraction of 139 18-inch square pre-stressed concrete fender piles; vibratory installation of 183 56-inch steel sheet piles; and impact installation of 109 18-inch square pre-stressed concrete fender piles. Phase I construction is currently scheduled to begin in January 2025, with an estimated completion date of January 2026. Phase II will occur between Piers 11 and 12 and includes vibratory extraction of 61 18-inch square pre-stressed concrete fender piles; vibratory installation of 81 56-inch steel sheet piles; and impact installation of 49 18-inch square pre-stressed concrete fender piles. Phase II construction is currently scheduled to begin in January 2026, with an estimated completion date of January 2027. Finally, Phase III of construction will occur north of Pier 14 and includes vibratory extraction of 178 16-inch composite fender piles; vibratory installation of 283 56-inch steel sheet piles; impact installation of 105 16-inch composite fender piles; and impact installation of 26 18-inch square pre-stressed concrete fender piles. Phase III construction is currently scheduled to begin in January 2027, with an estimated completion date of December 2028. The LOA is requested for the full five-year period through December 31, 2029, in order to provide LOA coverage in the event of funding or schedule delays or construction-related delays (e.g., weather, equipment).

For all project phases, new sheet pile wall will be installed outboard of the existing sheet pile wall, with a tie-back system installed and the space between the existing sheet pile and new sheet pile filled and sealed with cementitious fill. A continuous concrete cap will be installed on top of the new sheet pile wall to provide a means of protection for the steel. The existing fender piles will be removed and reused where possible, with new 18-inch concrete and 16-inch composite piles installed as needed and according to Table 1-1.

Figure 1-2 identifies the structure footprints to be demolished, constructed, and what will remain. All sheet piles will be installed approximately 1 ft in front of the existing concrete sheet plie, which will remain in place. The interstitial space between the new and existing sheet pile will be filled with a cementitious flowable fill and a continuous reinforced concrete cap will be installed along the top of the new steel sheet pile bulkhead.

A preliminary work schedule with details on the specific numbers of piles to be removed/extracted and installed is provided in Table 1-1.

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

Facility	*Method of Pile Driving/Extraction*	*Pile Type*	*Pile Size*	*Number of Sheets (pairs)/ Piles*	*Impact Pile Driving (Strike/ Pile)* [1]	*Vibratory Pile Driving/Extracting (Minutes to drive a single pile)* [2]	*Maximum number of piles installed each day*	*Average Water Depth*	*Total Number of Days of In-Water Construction*
Phase I Construction, Piers 12–14	Vibratory Install	ASTM A572, Grade 50 Steel Sheet Pile	56-inch Wide	183 piles (bulkhead)	NA	24 minutes	6	35 ft	31 days[3]
	Vibratory Extract	Pre-stressed Concrete Fender Piles	18-inch square	139 piles (fender)	NA	14 minutes	6	35 ft	24 days
	Impact Install	Pre-stressed Concrete Fender Piles	18-inch square	109 piles (fender)	307	NA	6	35 ft	19 days[3]
Phase II Construction, Piers 11–12	Vibratory Install	ASTM A572, Grade 50 Steel Sheet Pile	56-inch Wide	81 piles (bulkhead)	NA	28 minutes	6	24 ft	15 days[3]
	Vibratory Extract	Pre-stressed Concrete Fender Piles	18-inch square	61 piles (fender)	NA	26 minutes	6	24 ft	11 days
	Impact Install	Pre-stressed Concrete Fender Piles	18-inch square	49 piles (fender)	499	NA	6	24 ft	11 days[3]

Facility	Method of Pile Driving/Extraction	Pile Type	Pile Size	Number of Sheets (pairs)/ Piles	Impact Pile Driving (Strike/ Pile) [1]	Vibratory Pile Driving/Extracting (Minutes to drive a single pile) [2]	Maximum number of piles installed each day	Average Water Depth	Total Number of Days of In-Water Construction
Phase III Construction, North of Pier 14	Vibratory Install	ASTM A572, Grade 50 Steel Sheet Pile	56-inch Wide	283 piles (bulkhead)	NA	38 minutes	6	19 ft	48 days[3]
	Vibratory Extract	Composite (HDPE or FRP) Fender Piles[1]	16-inch diameter	178 piles (fender)	NA	20 minutes	6	19 ft	30 days
	Impact Install	Composite (HDPE or FRP) Fender Piles	16-inch diameter	105 piles (fender)	540	NA	6	19 ft	18 days[3]
	Impact Install	Pre-stressed Concrete Fender Piles	18-inch square	26 piles (fender)	540	NA	6	19 ft	5 days[3]

Key: FRP = fiber reinforced polymer (fiberglass); ft = feet; HDPE = high-density polyethylene (plastic); NA = not applicable.

Notes:

1. Pile installation hours and number of strikes per pile are based on previous experience. The actual driving time/strikes depend on the actual method of installation. Method of installation and hammer size will be the responsibility of the installation contractor.
2. Pile extraction hours are based on previous experience. The actual extraction time and the actual method of pile extraction depends on the contractor and condition of piles.
3. Denotes activities that may occur concurrently.

1.3 In-Water Construction Activities

1.3.1 Pile Removal

Piles are anticipated to be removed with a vibratory hammer; however, direct pull or clamshell removal may be used depending on site conditions. All three pile removal methods are described below.

All materials and waste would be disposed of in accordance with applicable federal and state requirements.

1.3.1.1 Vibratory Extraction

Vibratory extraction using a barge-mounted crane with a vibratory driver is a common method for removing all pile types. The vibratory driver is a large mechanical device (5 to 16 tons) suspended from a crane by a cable and positioned on top of a pile. The pile is then loosened from the sediments by activating the driver and slowly lifting up on the driver with the aid of the crane. Once the pile is released from the sediments, the crane continues to raise the driver and pull the pile from the sediment. The driver is typically shut off once the pile is loosened from the sediments. The pile is then pulled from the water and placed on a barge. Vibratory extraction usually takes between less than 1 minute (for timber piles) to 30 minutes per pile depending on the pile size, type, and substrate conditions.

1.3.1.2 Clamshell

In some cases, removal with a vibratory driver is not possible because the pile may break apart from the force of the clamp and the vibration. If piles break or are damaged, a clamshell apparatus may be lowered from the crane in order to remove pile stubs. A clamshell is a hinged steel apparatus that operates similar to a set of steel jaws. The bucket is lowered from a crane and the jaws grasp the pile stub as the crane pulls upward. The use and size of the clamshell bucket would be minimized to reduce the potential for generating turbidity from disturbing and resuspending bottom sediment during pile removal.

1.3.1.3 Direct Pull

Based on site conditions, piles may be removed by wrapping the piles with a cable or chain and pulling them directly from the sediment with a crane. In some cases, depending on access and location, piles may be cut at or below the mud-line.

1.3.2 Pile Installation

Pile installation/removal would occur using land-based or barge-mounted cranes, as appropriate. Concrete and composite piles will be installed using an impact hammer. Steel piles will be installed using a vibratory hammer. Hammers can be steam, air, or diesel drop, single-acting, double-acting, differential-acting, or hydraulic type.

Impact hammers are the most common pile driving method used to install piles of various sizes (Caltrans, 2015). 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 depends 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 depends on the energy of the strike and the pile size and composition. A model of impact hammer that may be used for the project is the APE D36-26 impact hammer.

Impact hammers would utilize soft start techniques to minimize noise impacts in the water column. The Navy does not yet know what type or size of hammers would be used to complete the work. The Navy has modeled for all of those potential scenarios. Level A (permanent threshold shift [PTS] onset) and Level B (behavioral) takes have been calculated based on the largest harassment zones for Level A (impact) and Level B (vibratory); therefore, takes are likely overestimated in this application. For purposes of this analysis, underwater noise was modeled without accounting for potential noise minimization measures.

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

1.3.3 Construction Access and Project Staging

Barges would be used as platforms for conducting in-water work activities and to haul materials and equipment to and from work sites. Barges would be moored with spuds or anchors. Potential laydown and staging areas identified on land include a 50-ft strip of land that lies parallel to the bulkheads and will extend from the exterior face of the existing bulkhead to a point 50 ft inland from the face of the bulkhead. Proper erosion and sediment controls, such as straw wattles and silt fence, will be required to encapsulate any stockpiles of debris, soil, or aggregates.

1.3.4 Concurrent Activities

In order to maintain the project schedule and complete the work as efficiently as possible, it is likely that multiple pieces of equipment would operate at the same time within the bulkhead areas. A maximum of four pieces of equipment (during Phase III) could potentially operate in the project area at a single time. Table 1-2 provides a summary of possible equipment combinations that could be used simultaneously over the course of the LOA period. An analysis of concurrent activities with respect to noise generation from multiple sources is provided in Section 6.8.2. There are anticipated to be scenarios when an impact hammer and one or two vibratory hammers could work simultaneously. When two non-impulsive continuous noise sources, such as vibratory hammers or underwater saws, have overlapping sound fields, there is potential for higher sound levels than for non-overlapping sources. The Level B harassment zones for simultaneous use of an impact hammer and a vibratory hammer are calculated using the largest zone for either the impact pile driving or the vibratory pile driving. Based on this guidance from NMFS, revised proxy source levels have been developed for the concurrent activities and acoustic analysis has been completed (see Section 6.8.2).

Table 1-2 Summary of Multiple Equipment Scenarios

Project Phase	***Equipment Types***	***Quantity***
Phase I	Vibratory hammer, remove (1); Vibratory hammer, install (1); Impact install (1)	3
Phase II	Vibratory hammer, remove (1); Vibratory hammer, install (1); Impact install (1)	3
Phase III	Vibratory hammer, remove (1); Vibratory hammer, install (1); Impact install (2)	4

2 DATES, DURATION, AND LOCATION OF ACTIVITIES

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

2.1 Dates and Duration of Activities

Repair and replacement of the Q8 Bulkhead would be conducted from January 1, 2025, through December 31, 2028. Permit issuance to the end of December 2029 is requested to provide buffer for project delays, which are common due to unforeseen circumstances such as weather, personnel, and equipment availability/malfunction. The Navy will coordinate with the NMFS to ensure that impacts to managed and protected species and their habitat are minimized. Table 2-1 provides the estimated construction schedule and production rates for proposed construction activities.

No in-water work would begin at the project site until the Navy has received all required permits and approvals.

Table 2-1. In-Water Construction Activities

Location	*Activity*	*Amount and Schedule*	*Type and Size*	*Method*	*Daily Production Rate (Piles/day)*	*Total Production Days*
Phase I Construction, Piers 12–14	Demolition of Existing Fender Piles	139 fender piles January 2025 – January 2026	18-inch pre-stressed concrete square	Vibratory Hammer	6	24 days
	Installation of Sheet Piles	183 sheet piles January 2025 – January 2026	56-inch steel sheet	Vibratory Hammer	6	31 days
	Installation of Fender Piles	109 fender piles January 2025 – January 2026	18-inch pre-stressed concrete square	Impact Hammer	6	19 days
Phase II Construction, Piers 11–12	Demolition of Existing Fender Piles	61 fender piles January 2026 – January 2027	18-inch pre-stressed concrete square	Vibratory Hammer	6	11 days
	Installation of Sheet Piles	81 sheet piles January 2026 – January 2027	56-inch steel sheet	Vibratory Hammer	6	15 days
	Installation of Fender Piles	49 fender piles January 2026 – January 2027	18-inch pre-stressed concrete square	Impact Hammer	6	11 days
Phase III Construction,	Demolition of Existing Fender Piles	178 fender piles January 2027– December 2028	16-inch composite round	Vibratory Hammer	6	30 days

Location	Activity	Amount and Schedule	Type and Size	Method	Daily Production Rate (Piles/day)	Total Production Days
North of Pier 14	Installation of Sheet Piles	283 sheet piles January 2027–December 2028	56-inch steel sheet	Vibratory Hammer	6	48 days
	Installation of Fender Piles	105 fender piles January 2027–December 2028	16-inch composite round	Impact Hammer	6	18 days
	Installation of Fender Piles	26 fender piles January 2027–December 2028	18-inch pre-stressed concrete square	Impact Hammer	6	5 days
Total piles extracted / installed		378 / 836				
Total days pile extraction and driving						212 days

2.2 Project Location Description

NAVSTA Norfolk, the center of naval operations on the East Coast, is part of the world's largest naval complex and is the primary homeport of the U.S. Atlantic Fleet. NAVSTA Norfolk supports the operational readiness of the U.S. Atlantic Fleet, providing facilities and services to enable mission accomplishment.

The station occupies 4,600 acres of land on a peninsula known as Sewell's Point in the northwest corner of Norfolk, Virginia, near the mouth of the Chesapeake Bay (Figure 1-1). The station is bordered by the Chesapeake Bay and Willoughby Bay to the north, the Elizabeth River to the west, and the City of Norfolk to the east and south. NAVSTA Norfolk includes Chambers Field (formerly known as Naval Air Station Norfolk), Fleet Industrial Supply Center, Naval Facilities Engineering Command Mid-Atlantic, Fleet Training Center, and numerous other tenants. The station is home to 59 ships (including five aircraft carriers), 187 aircraft, 18 aircraft squadrons, and 326 tenant commands. Waterfront structures include 13 large piers, numerous small piers, and bulkheads.

2.2.1 Bathymetric Setting

NAVSTA Norfolk is located within the James River at Hampton Roads Harbor Polyhaline (JMSPH) drainage basin in the Chesapeake Bay.

The bathymetry of the Proposed Action area reflects the effects of natural sedimentation and erosion processes combined with modifications from dredging to maintain permitted depths in support of navigational safety, both within the Hampton Roads harbor and in the adjacent portions of the lower James River and Chesapeake Bay. The tidal range in the area is approximately 2.85 ft. Tides are diurnal, with two high tides and two low tides per day (USACE and Port of Virginia, 2017).

Twenty-five significant navigation projects have been constructed within the Norfolk Harbor, ranging in depth from 6 to 50 ft when measured at mean low water (MLW). The major deep-draft channels serving Norfolk Harbor are authorized to a depth of 55 ft below MLW. The Norfolk Harbor Reach portion of the Federal Navigation Channel offshore from NAVSTA Norfolk has a permitted dredge depth of -55 ft mean lower low water, but it is maintained at a depth of -50 ft mean lower low water. The Navy deepened the channels from the Craney Island Reach of the Norfolk Harbor and Channels Project through Lambert's Bend and from Lambert's Bend to the Norfolk Naval Shipyard to a depth of 47 ft to meet Navy operational needs. Both of these reaches are maintained with 3 ft of overdredge (USACE and Port of Virginia, 2017). Other deep-draft channels, anchorages, and turning basins in Norfolk Harbor are maintained at depths varying from 24 to 50 ft below MLW.

The annual shoaling rate for NAVSTA Norfolk was estimated as 1 to 2 ft per year (Hoffman, 1980). On average, maintenance dredging of the Navigation Channel occurs every two years (USACE and Port of Virginia, 2018).

2.2.2 Shorelines

The shorelines in the NAVSTA Norfolk area are highly modified with bulkheads to support the infrastructure of the Naval station.

2.2.3 Water Quality

Water quality within the project area reflects the water quality of the Chesapeake Bay mainstem and tributaries, including the Elizabeth River, James River, Lafayette River, Lynnhaven River, and Norfolk Harbor proper, many of which are considered impaired waterways. Water quality at NAVSTA Norfolk also reflects permitted discharges (e.g., stormwater) and periodic maintenance dredging operations.

In general, water salinities in the Hampton Roads Harbor typically range from 20 to 30 parts per thousand, and dissolved oxygen concentrations meet the criteria for open water designated use (5.0 milligrams per liter) (USACE and Port of Virginia, 2018). Per the Virginia Department of Environmental Quality's 2022 Integrated Report, waters immediately adjacent to NAVSTA Norfolk are not impaired with respect to dissolved oxygen, chlorophyll a, submerged aquatic vegetation, and benthic community (VDEQ, 2022).

However, the JMSPH watershed presently (2018) is not supporting aquatic life, fish consumption, or open water beneficial uses. The Chesapeake Bay and Tidal Tributaries, including portions of the James River, do not support fish consumption because of a fish advisory for elevated polychlorinated biphenyl concentrations in anadromous striped bass. The Chesapeake Bay segment of JMSPH is impaired for aquatic life due to estuarine bioassessments (defined as an inadequate benthic community based on the Chesapeake Bay Benthic Index of Biological Integrity [Llanso and Dauer, 2002]). Insufficient information is available to assess impairments related to wildlife use or shellfish.

2.2.4 Sediments

Sediment characterizations at NAVSTA Norfolk have been conducted in support of periodic maintenance dredging operations that are required to maintain permitted depths and ensure navigational safety, as well as in support of natural resources surveys. NAVSTA Norfolk sediments are dominated by silt-clay size particles (Tetra Tech, Inc., 2016). No elevated concentrations, i.e., greater than 500 milligrams per kilogram (or parts per million), of total petroleum hydrocarbons occurred in samples taken at multiple locations at Piers 11, 12, or 14 (CH2M, 2018).

2.2.5 Ambient Sound

2.2.5.1 Underwater Sound

Underwater ambient sound in the vicinity of NAVSTA Norfolk is composed of sounds produced by a number of natural and anthropogenic sources and varies both geographically and temporally. Natural sound sources include wind, waves, precipitation, and biological sources such as shrimp, fish, and cetaceans. These sources produce sound in a wide variety of frequency ranges (Urick, 1983; Richardson et al., 1995) and can vary over both long time scales (days to years) and short time scales (seconds to hours). In shallow waters, precipitation may contribute up to 35 decibels (dB) to the existing sound level, and increases in wind speed of 5 to 10 knots can cause a 5-dB increase in ambient ocean sound between 20 hertz (Hz) and 100 kilohertz (kHz) (Urick, 1983).

Human-generated sound is a significant contributor to the ambient acoustic environment. Normal port activities include vessel traffic from large ships, support vessels and security boats, and loading and maintenance operations, which all generate underwater sound (Urick, 1983). NAVSTA Norfolk is located in close proximity to shipping channels and several Port of Virginia facilities, which altogether have an annual average of 1,459 vessel calls (NMFS, 2020). Other sources of human-generated underwater sound not specific to naval installations include sounds from echo sounders on commercial and recreational vessels, industrial ship noise, and noise from recreational boat engines. Ship and small boat noise comes from propellers and other on-board rotating equipment.

The underwater acoustic environment will vary depending on the amount of anthropogenic activity, weather conditions, and tidal currents. At high-use installations such as NAVSTA Norfolk, anthropogenic noise may dominate the ambient soundscape. In areas with less anthropogenic activity, ambient sound is likely to be dominated by sound from natural sources.

Underwater ambient sound was recorded at 10 meters (m) from pile driving locations prior to and following pile driving events at NAVSTA Norfolk Pier 4 (Illingworth and Rodkin, 2017) in October 2014. Anthropogenic noise resulted primarily from transient vessel traffic and local work-site compressors and generators. During two days of recording, one-second underwater sound levels averaged 122 and 123 dB root mean square (RMS) (range 118 to 132 dB).

2.2.5.2 Airborne Sound

Airborne sound is produced by common industrial equipment, including trucks, cranes, compressors, generators, pumps, and other equipment that might typically be employed along industrial waterfronts. Sound levels are highly variable based on the types and operational states of equipment at the recording location, and sound levels may vary within a single installation such as NAVSTA Norfolk, with some piers/wharves very loud and others relatively quiet.

Airborne ambient sound was recorded 15 m from pile driving locations but outside of pile driving events at NAVSTA Norfolk Pier 4 (Illingworth and Rodkin, 2017) in October 2014. RMS maximum sound level ranged from 72 to 100 A-weighted decibels (dBA), and one-minute equivalent continuous sound level over a period of time ranged from 66 to 88 dBA on one day of monitoring. Maximum sound level ranged from 76 to 85 dBA, and the equivalent continuous sound level ranged from 66 to 81 dBA on another day of monitoring.

3 MARINE MAMMAL SPECIES AND NUMBERS

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

3.1 Marine Mammal Species Likely to be Found Within the Action Area

Five marine mammal species are included in this Application for an LOA because surveys, monitoring, and stranding reports have detected them within the project area (Table 3-1). Reports that were evaluated for this application are listed in Table 3-1 and include nearshore at-sea surveys conducted on behalf of the Navy in the mouth of the Chesapeake Bay and the Navy's Virginia Capes training and testing area east of Virginia Beach, marine mammal stranding reports, and pinniped tracking and haul out monitoring in the vicinity of the Chesapeake Bay Bridge Tunnel (CBBT). Sightings of marine mammals in shipboard surveys and haul out monitoring are the most useful evidence of the occurrence of a species in the area, but where sightings are scarce, the summaries below also utilize stranding reports as an indicator of the frequency of occurrence of a species.

The following sections summarize available data on the occurrence of the potentially affected species in these survey and monitoring areas and describe qualitatively the likelihood of encountering any of these species in the vicinity of the proposed activities. Additional information on population abundance and trends for each marine mammal stock as a whole is also presented below. Section 4 (Affected Species Status and Distribution) contains information on the distribution and status of each potentially affected species.

3.2 Estimates of Abundance Within the Action Area

Estimating potential marine mammal abundance over time and space is challenging because the animals are highly mobile and often difficult to detect. Marine mammal species are not distributed evenly, but occur in groups in areas that are biased towards greater importance, such as areas of high prey abundance, haul out sites, or areas with lower predation risk. Many species are not resident in the area year-round but are occasionally or seasonally present. When they are detected, it may not be clear whether they are seasonally resident, migrating through the area in a predictable manner, or outliers that are not conforming to some pattern. Patterns in the occurrences of many marine mammal species are still being worked out, making it difficult in a relatively limited area like the project area to understand how abundant the species may be.

Methods used to estimate marine mammal stock abundance and population trends are described in NMFS stock assessment reports and may utilize data from at-sea surveys and monitoring of identifiable individuals, among other methods. Stock assessment reports account for many sources of uncertainty in abundance estimates. For example, surveys generally cannot cover the entire area in which the species may occur at a given time. An additional complication is the overlap of various stocks, such as common bottlenose dolphins, in a survey area.

Table 3-1 lists the species that may occur within the vicinity of NAVSTA Norfolk, population abundance, and estimated densities, as well as relative frequency and season of occurrence within the proposed project area.

Table 3-1. Marine Mammals Potentially Present Within the Lower Chesapeake Bay

Species and Stock[1]	*Stock Abundance*	*Relative Occurrence*[4]	*Season(s) of Occurrence*	*Density in the Project Area (individuals/ sq km)*
Humpback whale (*Megaptera novaeangliae*) Gulf of Maine stock	896[4]	Likely	Winter to spring (October – March) with peak in winter (December – January)	N/A[2]
Bottlenose dolphin (*Tursiops truncatus*) • Western North Atlantic Northern Migratory Coastal stock • Western North Atlantic Southern Migratory Coastal stock • Northern North Carolina Estuarine System Stock	• NM stock: 6,639[1] • SM stock: 3,751[1] • NC ES stock: 823[1]	Likely	Year-round with peaks in summer and fall (June – November)	Summer/Fall: 3.51 Winter/Spring: 0.73[3] All Seasons: 1.38[5]
Harbor porpoise (*Phocoena phocoena*) Gulf of Maine/Bay of Fundy stock	95,543[1]	Likely	Winter to spring	N/A[2]
Harbor seal (*Phoca vitulina*) Western North Atlantic stock	75,834[1]	Likely	Winter to spring (November – April)	N/A[2]
Gray seal (*Halichoerus grypus*) Western North Atlantic stock	27,131[1]	Likely	Winter to spring (November – April)	N/A[2]

Key: ES = Estuarine System; N/A = not available; NC = North Carolina; NM = Northern Migratory; SM = Southern Migratory; sq km = square kilometer

Notes:

1. NMFS 2021 Bottlenose Dolphin W.N. Atlantic Northern Migratory Coastal, NMFS 2021 Bottlenose Dolphin W.N. Atlantic Southern Migratory Coastal, NMFS 2021 Bottlenose Dolphin Northern North Carolina Estuarine System, NMFS 2022 Harbor Porpoise Gulf of Maine-Bay of Fundy, NMFS 2022 Harbor Seal Western North Atlantic, NMFS 2021 Gray Seal Western North Atlantic.
2. No density estimates found for Chesapeake Bay. Species assumed to be absent in lower Chesapeake Bay in the Navy Marine Species Density Database (Navy, 2017).
3. Englehaupt et al., 2022
4 HDR Inc. and Mott MacDonald, 2019
5. Average density for all seasons as used in past applications at this installation (Pier 3 Demolition and Reconstruction).

3.2.1 Humpback Whale

The Navy's nearshore survey effort for humpback whales (Aschettino et al., 2015, 2016, 2017, 2018, 2019, 2021, 2022) has identified high levels of occurrence in waters in and around the mouth of the Chesapeake Bay and the Virginia coast. The number of humpback whales identified in this study reflects the level of effort and study objectives in each field season, among other variables, but the number of unique humpback whales identified each season (31 during the 2014-2015 field season, 38 during the 2015-2016 field season, 59 during the 2016-2017 field season, 28 during the 2017-2018 field season, 37 during the 2018-2019 field season, 28 for the 2019-2020 field season, and 32 for the 2020-2021 field season) indicates the importance of the study area to this species. Coupled with identifications made in the Outer Continental Shelf Cetacean Study, 208 unique humpback whales have been seen in the area over the life of the study (Aschettino et al., 2022). Several satellite-tagged humpback whales were detected west of the CBBT, including five individuals with locations near NAVSTA Norfolk and Joint Expeditionary Base Little Creek (JEBLC) (Aschettino et al., 2017, 2021). Group size was typically one to two individuals, most of which were juveniles and 11 percent of sightings were groups (Aschettino, 2020).

The 2019 NMFS stock assessment for the Gulf of Maine stock of humpback whales reported a count of 1,396 individuals as the minimum number alive in 2016 (Hayes et al., 2019). An unusual mortality event (UME) was declared following elevated humpback whale mortalities along the Atlantic Coast from Maine to Florida beginning in January 2016 (NOAA Fisheries, 2023). About half of the whales examined showed evidence of vessel strike or entanglement. As of January 2023, a total of 180 humpback whale mortalities have been reported, including 26 in Virginia since 2016. Comparatively, 37 humpback whales have stranded in Virginia from 1988 to 2016 (Costidis et al., 2017). Twenty-seven of the 37 strandings occurred on ocean-facing beaches; however, some have occurred within the lower Chesapeake Bay. Most of these animals showed signs of ship strikes or entanglement. Humpback whale strandings increased, particularly along the Virginia and North Carolina coasts, and most stranded animals were sexually immature. In addition, the small size of many of these whales strongly suggested that they had only recently separated from their mothers (NMFS, 2020). Strandings involved primarily juvenile whales and occurred in all seasons but were most common in the spring.

Current data suggest that the Gulf of Maine humpback whale stock is steadily increasing in numbers (NMFS, 2020). This is consistent with an estimated average growth trend of 3.1 percent (standard error = 0.005) in the North Atlantic population overall for the period 1979 to 1993 (Stevick et al., 2003).

3.2.2 Bottlenose Dolphin

Bottlenose dolphins are the most abundant marine mammal species encountered in surveys and stranding reports on the coast off Virginia Beach, Virginia, and in the Chesapeake Bay near NAVSTA Norfolk, and JEBLC-Fort Story (Barco & Swingle, 2014; Engelhaupt et al., 2014, 2015, 2016). They occur in greatest numbers in this area annually from May through October. Densities in the nearshore zone were calculated as 3.88 individuals per square kilometer (sq km) in fall, 0.63 individuals per sq km in winter, 10 individuals per sq km in spring, and 3.55 individuals per sq km in summer (Engelhaupt et al., 2016). Bottlenose dolphins are also the most commonly stranded marine mammal in the state, with strandings mostly occurring from April through October, which corresponds to their abundance in shipboard surveys (Swingle et al., 2015). Between 2014 and 2018, 692 common bottlenose dolphins that were ascribed to the Northern Migratory Coastal Stock stranded along the Atlantic coast between North Carolina and New York (Hayes et al., 2021). Barco and Swingle (2014) reported 1,593 strandings from 1988 to 2013, including a UME that peaked in Virginia in 2013. Strandings in subsequent years ranged from 67 to 101 animals (Swingle et al., 2014, 2015, 2016, 2017).

The 2020 NMFS stock assessment for three bottlenose dolphin stocks that may be in the project area reported an estimated abundance of 6,639 (coefficient of variation [CV] = 0.41) for the Northern Migratory Coastal stock, 3,751 (CV = 0.60) for the Southern Migratory Coastal (SMC) stock, and 823 (CV = 0.06) for the Northern North Carolina Estuarine System stock (Hayes et al., 2021). An analysis of trends in abundance for common bottlenose dolphins coast-wide from New Jersey to Florida indicated a statistically significant decline in population size between 2011 and 2016 (Garrison et al., 2017), which may be a result of the UME that occurred from 2013 to 2015.

3.2.3 Harbor Porpoise

Reports from marine mammal surveys in the Chesapeake Bay in the vicinity of NAVSTA Norfolk and the nearshore off Virginia Beach mention one sighting of a group of two harbor porpoises in 2015 (Engelhaupt et al., 2016), and passive acoustic recorders detected the species in low numbers near NAVSTA Norfolk and JEBLC during winter and spring deployments from August 2012 to September 2013 (Engelhaupt et al., 2014). Stranding reports from 2004 to 2013 cite 89 harbor porpoise strandings along the mouth of the Chesapeake Bay and ocean-facing beaches on the Virginia Beach coastline (Barco & Swingle, 2014). Subsequent stranding reports from Virginia cite from one to five strandings annually from 2014 through 2018 (Swingle et al., 2015, 2016, 2017, 2018; Costidis et al., 2019). All of these reports indicate that harbor porpoises are most likely to be present in the region in winter and spring months, and observations of the species off the coasts of Maryland (Wingfield et al., 2017) and New Jersey (Whitt et al., 2015) support this finding.

The 2021 NMFS stock assessment for the Gulf of Maine/Bay of Fundy stock reported an estimated abundance of 95,543 (f = 0.31) (Hayes et al., 2022). A trend analysis has not been conducted for this stock.

Stranding reports discuss wide historic fluctuations in harbor porpoise strandings in Virginia, ranging from 40 porpoises in 1999 and 30 in 2001 to two each in 2011 and 2012 (Costidis et al., 2019) and five or fewer from 2014 to 2018 (Swingle et al., 2015, 2016, 2017, 2018; Costidis et al., 2019). In 2019, six harbor porpoises stranded in Virginia, bringing the total since 2015 to 17 (Hayes et al., 2022). These fluctuations in stranding numbers have not been correlated to fluctuations in population or stock abundance, threats such as potential fisheries bycatch, or other factors.

3.2.4 Harbor Seal

Harbor seals are the most common pinnipeds in Virginia and haul out on rocks around the portal islands of the CBBT and on mud flats on the nearby southern tip of the Eastern Shore from December through April. After reviewing all images from the 2015-2016, 2016-2017, 2017-2018, and 2018-2019 CBBT field seasons, 112 harbor seals were uniquely identified (Rees et al., 2016; Jones et al., 2018). When estimating harbor seal abundance through mark-recapture (photographic images), values ranged from 81 to 242 individuals (Jones et al., 2023). However, when including data from acoustic telemetry studies, a correction factor was applied that increased the estimates to 124 to 252 unique individuals (Jones et al., 2023). The Eastern Shore site had a best total estimate of 105 sightings during the 2015-2016 season, 197 sightings during the 2017-2018 season, and 160 sightings during the 2018-2019 season (Rees et al., 2016).

Harbor seals strand in low numbers on the coast of Virginia and Chesapeake Bay. From 1988 to 2013, 82 strandings were reported (Barco & Swingle, 2014), and in the following years between one and four stranded harbor seals were reported each year (Swingle et al., 2015, 2016, 2017, 2018; Costidis et al., 2019).

The 2021 NMFS stock assessment for the Western North Atlantic stock reported an estimation of 61,336 seals (CV = 0.08) (Hayes et al., 2022). This stock is present primarily in U.S. waters. Several researchers consider that harbor and gray seal distribution along the U.S. Atlantic coast appears to be expanding or shifting (DiGiovanni et al., 2011; DiGiovanni et al., 2018; Johnston et al., 2015). This range expansion may be due to rapid growth of gray seal populations in Canada and the Northeastern United States (Cammen et al., 2018). Count trend data for harbor and gray seals in southern New England and Long Island index sites from 1986 to 2011 indicate that harbor and gray seals are showing an increased use of their more southerly range and are extending their time spent at these haul out sites (DiGiovanni et al., 2011).

3.2.5 Gray Seal

Haul out monitoring conducted during 2014-2015 and 2015-2016 at the CBBT reported three individual for both survey seasons (Rees et al., 2016). Haul out monitoring conducted during 2016-2017 and 2017-2018 at the CBBT and the southern tip of the Eastern Shore of Virginia, reported only one individual at the Eastern Shore for the 2017-2018 season (Jones et al., 2018).

Gray seals strand in low numbers on the coast of Virginia and the Chesapeake Bay. From 1988 to 2013, 15 strandings were reported (Barco & Swingle, 2014), and in the following years from zero to four stranded gray seals were reported each year (Swingle et al., 2015, 2016, 2017, 2018; Costidis et al., 2019).

The 2021 NMFS stock assessment for the Western North Atlantic stock reported 27,300 (CV = 0.22) in U.S. waters (Hayes et al., 2022). An additional portion of the stock occurs in Canadian waters. Gray seal abundance is likely increasing in U.S. and Canadian waters (Hayes et al., 2022).

4 AFFECTED SPECIES STATUS AND DISTRIBUTION

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

4.1 Humpback Whale

4.1.1 Status and Management

A recent status review identified 15 distinct population segments globally based primarily on breeding areas (Bettridge et al., 2015). Partially based on this status review, NMFS issued a final rule to divide the globally listed species into 14 distinct population segments and revise the listing status of each breeding population (Volume 81 Federal Register [FR] pages 62260-62320, September 8, 2016). After evaluating the danger of extinction of each distinct population segment, four distinct population segments (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) are currently listed under the Endangered Species Act (ESA) as endangered and one distinct population segment (Mexico) is listed as threatened. The remaining nine distinct population segments, including the West Indies distinct population segment that occurs within the project area, do not warrant listing under the ESA because they are neither in danger of extinction nor likely to become so in the foreseeable future. All humpback whales feeding in the North Atlantic are considered part of the West Indies distinct population segment (Bettridge et al., 2015), including the Gulf of Maine stock. The West Indies distinct population segment feeding range primarily includes the Gulf of Maine, eastern Canada, and western Greenland (80 FR 22304-22345, April 21, 2015) and breeding grounds include waters of the Dominican Republic and Puerto Rico (81 FR 62260-62320, September 8, 2016).

For management purposes in U.S. waters, NMFS identified stocks that are based on feeding areas. Although the western North Atlantic population was once treated as a single management stock, the Gulf of Maine stock has been identified as a discrete subpopulation based on strong fidelity of humpbacks feeding in that region (Hayes et al., 2019). The Gulf of Maine stock is the only stock of humpbacks in the Atlantic managed under NMFS jurisdiction. However, it should be noted that several other discrete humpback whale subpopulations, based on feeding grounds, are present in the western North Atlantic, including the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland (Hayes et al., 2019). The Gulf of Maine stock is designated as Strategic by NMFS.

4.1.2 Distribution

Humpback whales are distributed worldwide in all major oceans and most seas. Most humpback whale sightings are in nearshore and continental shelf waters; however, humpback whales frequently travel through deep oceanic waters during migration (Calambokidis et al., 2001; Clapham & Mattila, 1990). Humpback whales of the western North Atlantic are typically found in Labrador Current, North Atlantic Gyre, and Gulf Stream open ocean areas during seasonal migrations from northern latitude feeding grounds, occupied during the summer, to southern latitude calving and breeding grounds occupied in the winter (Hayes et al., 2019). The Gulf of St. Lawrence, Newfoundland Grand Banks, West Greenland, and Scotian Shelf are summer feeding grounds for humpbacks (Cetacean and Turtle Assessment Program, 1982; Kenney & Winn, 1986; Stevick et al., 2006; Whitehead, 1982). The Gulf of Maine is also one of the principal summer feeding grounds for humpback whales in the North Atlantic. The largest numbers of humpback whales are present from mid-April to mid-November. Other feeding locations in this ecosystem are Stellwagen Bank, Jeffreys Ledge, the Great South Channel, the edges and shoals of Georges Bank, Cashes Ledge, and Grand Manan Banks (Cetacean and Turtle Assessment Program, 1982; Kenney & Winn, 1986; Stevick et al., 2006; Whitehead, 1982). LaBrecque et al. (2015) delineated a humpback whale feeding area in the Gulf of Maine, Stellwagen Bank, and Great South Channel, substantiated through vessel-and aerial-based survey data, photo-identification data, radio-tracking data, and expert judgment. Humpback whales feed in this area from March through December. Humpback feeding habitats are typically shallow banks or ledges with high seafloor relief (Hamazaki, 2002; Payne et al., 1990).

On breeding grounds, females with calves occur in much shallower waters than other groups of whales, and breeding adults use deeper, more offshore waters (Smultea, 1994; Ersts & Rosenbaum, 2003). The habitat requirements of wintering humpbacks appear to be controlled by the conditions necessary for calving, such as warm water and relatively shallow, low-relief ocean bottom in protected areas created by islands or reefs (Clapham, 2000; Craig & Herman, 2000; Smultea, 1994).

4.1.3 Site-Specific Occurrence

Although humpback whales are migratory between feeding areas and calving areas, individual variability in the timing of migrations may result in the presence of individuals in high-latitude areas throughout the year (Straley, 1990). Records of humpback whales off the U.S. mid-Atlantic coast (New Jersey to North Carolina) from January through March suggest these waters may represent a supplemental winter feeding ground used by juvenile and mature humpback whales of U.S. and Canadian North Atlantic stocks (LaBrecque et al., 2015).

Humpback whales are most likely to occur near the mouth of the Chesapeake Bay and coastal waters of Virginia Beach between January and March; however, they could be found in the area year-round, based on shipboard sighting and stranding data (Barco & Swingle, 2014; Aschettino et al., 2015, 2016, 2017, 2018). Photo-identification data support the repeated use of the mid-Atlantic region by individual humpback whales. Results of the vessel surveys show site fidelity in the survey area for some individuals and a high level of occurrence within shipping channels, an important high-use area by both the Navy and commercial traffic (Aschettino et al., 2015, 2016, 2017, 2018). Nearshore surveys conducted in early 2015 reported 61 individual humpback whale sightings, and 135 individual humpback whale sightings in late 2015 through May 2016 (Aschettino et al., 2016). Subsequent surveys confirmed the occurrence of humpback whales in the nearshore survey area: 248 individuals were detected in 2016-2017 surveys (Aschettino et al., 2017), 32 individuals were detected in 2017-2018 surveys (Aschettino et al., 2018), and 80 individuals were detected in 2019 surveys (Aschettino et al., 2019). As of March 2022, there have been 246 unique humpback whales photo-identified (Aschettino et al., 2022). Sightings in the Hampton Roads area in the vicinity of NAVSTA Norfolk were reported in nearshore surveys and through tracking of satellite-tagged whales in 2016, 2017, and 2019. The numbers of whales detected, most of which were juveniles, reflect the varying level of survey effort and changes in survey objectives from year to year, and do not indicate abundance trends over time.

4.2 Bottlenose Dolphin

4.2.1 Status and Management

Along the U.S. East Coast and northern Gulf of Mexico, the bottlenose dolphin stock structure is well studied. There are currently 53 management stocks identified by NMFS in the western North Atlantic and Gulf of Mexico, including oceanic, coastal, and estuarine stocks (Hayes et al., 2021; Waring et al., 2015; Waring et al., 2016).

There are two morphologically and genetically distinct bottlenose dolphin morphotypes (distinguished by physical differences) described as coastal and offshore forms (Duffield et al., 1983; Duffield, 1986). The offshore form is larger in total length and skull length and has wider nasal bones than the coastal form. Both inhabit waters in the western North Atlantic Ocean and Gulf of Mexico (Curry & Smith, 1997; Hersh & Duffield, 1990; Mead & Potter, 1995) along the U.S. Atlantic coast. The coastal morphotype of bottlenose dolphin is continuously distributed along the Atlantic coast south of Long Island, New York, around the Florida peninsula, and along the Gulf of Mexico coast. This type typically occurs in waters less than 25-m deep (Waring et al., 2015). The range of the offshore bottlenose dolphins includes waters beyond the continental slope (Kenney, 1990), and offshore bottlenose dolphins may move between the Gulf of Mexico and the Atlantic (Wells et al., 1999).

Two coastal stocks are likely to be present in the project area: Western North Atlantic Northern Migratory Coastal stock and Western North Atlantic SMC stock, both of which are designated as Strategic and Depleted under the MMPA. The Northern North Carolina Estuarine System stock may also be present, and is designated as Strategic by NMFS.

4.2.2 Distribution

The bottlenose dolphin occurs in tropical to temperate waters of the Atlantic Ocean as well as inshore, nearshore, and offshore waters of the Gulf of Mexico and U.S. East Coast (Hayes et al., 2021; Waring et al., 2015; Waring et al., 2016). They generally do not range north or south of 45 degrees latitude (Jefferson et al., 2015; Wells & Scott, 2008). They occur in most enclosed or semi-enclosed seas in habitats ranging from shallow, murky, estuarine waters to deep, clear offshore waters in oceanic regions (Jefferson et al., 2015; Wells & Scott, 2008). Open-ocean populations occur far from land; however, population density appears to be highest in nearshore areas (Scott & Chivers, 1990). Bottlenose dolphins occur in the North Atlantic Gyre and Gulf Stream open ocean areas.

4.2.3 Site-Specific Occurrence

Bottlenose dolphins are the most abundant marine mammal along the Virginia coast and within the Chesapeake Bay, typically traveling in groups of two to 15 individuals, but occasionally in groups of over 100 individuals (Engelhaupt et al., 2014, 2015, 2016). Several coastal stocks could be present in the project area, overlapping in their distribution in certain seasons (Hayes et al., 2021). Bottlenose dolphins of the Western North Atlantic Northern Migratory Coastal stock winter along the coast of North Carolina and migrate as far north as Long Island, New York, in the summer. They are rarely found north of North Carolina in the winter (Hayes et al., 2021). The SMC stock occurs in waters of southern North Carolina from October to December, moving south during winter months and north to North Carolina during spring months. During July and August, the SMC stock is presumed to occupy coastal waters north of Cape Lookout, North Carolina, to the eastern shore of Virginia (Hayes et al., 2021). It is possible that these animals also occur inside the Chesapeake Bay and in nearshore coastal waters. The North Carolina Estuarine System stock dolphins may also occur in the Chesapeake Bay during July and August (Hayes et al., 2021).

Vessel surveys conducted along coastal and offshore transects from NAVSTA Norfolk to Virginia Beach in most months from August 2012 to August 2015 reported bottlenose dolphins throughout the survey area, including the vicinity of NAVSTA Norfolk (Engelhaupt et al., 2014, 2015, 2016; 2022). The final results from this project confirmed earlier findings that bottlenose dolphins are common in the study area, with highest densities in the coastal waters in summer and fall months. Peak estimated abundance in coastal waters of the study area is 1,090 individuals present during the warm-water season (June-November; density = 3.51 individuals per sq km; Engelhaupt et al., 2022). However, bottlenose dolphins do not completely leave this area during colder months, with approximately 225 individuals still present in winter and spring months (Engelhaupt et al., 2022).

4.3 Harbor Porpoise

4.3.1 Status and Management

The Gulf of Maine-Bay of Fundy stock occurs off the mid-Atlantic states and is the only stock under NMFS management in the region. Harbor porpoises are not listed as depleted under the MMPA, nor are they listed under the ESA.

4.3.2 Distribution

Harbor porpoises inhabit cool temperate-to-subpolar waters, often where prey aggregations are concentrated (Watts & Gaskin, 1985). Thus, they are frequently found in shallow waters, most often near shore, but they sometimes move into deeper offshore waters. Harbor porpoises are rarely found in waters warmer than 63 degrees Fahrenheit (17 degrees Celsius) (Read, 1999) and closely follow the movements of their primary prey, Atlantic herring (Gaskin, 1992).

In the western North Atlantic, harbor porpoises range from Cumberland Sound on the east coast of Baffin Island, southeast along the eastern coast of Labrador to Newfoundland and the Gulf of St. Lawrence, then southwest to about 34 degrees north on the coast of North Carolina (Waring et al., 2016).

Harbor porpoises are seen from the coastline to deep waters (greater than 5,906 ft) (Westgate et al., 1998), although most of the population is found over the continental shelf. During winter (January to March), intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada (Waring et al., 2016). Harbor porpoises sighted off the mid-Atlantic states during winter include porpoises from other western North Atlantic populations (Rosel et al., 1999). There does not appear to be a temporally coordinated migration or a specific migratory route to and from the Bay of Fundy region (Waring et al., 2016). During fall (October-December) and spring (April-June), harbor porpoises are widely dispersed from New Jersey to Maine, with lower densities farther north and south (LaBrecque et al., 2015).

4.3.3 Site-Specific Occurrence

Based on stranding reports, passive acoustic recorders, and shipboard surveys, harbor porpoises occur in coastal waters primarily in winter and spring months, but there is little information on their presence in the Chesapeake Bay. They do not appear to be abundant in the NAVSTA Norfolk area in most years, but this is confounded by wide variations in stranding occurrences over the past decade.

4.4 Harbor Seal

4.4.1 Status and Management

Harbor seals are not listed as depleted under the MMPA, nor are they listed under the ESA. The Western North Atlantic stock occurs in the project area.

4.4.2 Distribution

The harbor seal is one of the most widely distributed seals, found in temperate to polar coastal waters of the northern hemisphere (Jefferson et al., 2015). Harbor seals occur in nearshore waters and are rarely found more than 20 kilometers (km) from shore, where they frequently occupy bays, estuaries, and inlets (Baird, 2001). Individual seals have been observed several kilometers upstream in coastal rivers (Baird, 2001). Haul out sites vary but include intertidal and subtidal rock outcrops, sandbars, sandy beaches, and even peat banks in salt marshes (Burns, 2008; Gilbert & Guldager, 1998; Prescott, 1982; Schneider & Payne, 1983; Wilson, 1978). On the western Atlantic coast, their approximate year-round coastal range includes the Gulf of St. Lawrence, Scotian Shelf, Gulf of Maine, Bay of Fundy, and northeast U.S. continental shelf south to the Virginia/North Carolina border.

Harbor seals are found year-round in the coastal waters of eastern Canada and Maine; from September to May they also occur from southern New England to New Jersey (Hayes et al., 2018; Katona et al., 1993). A general southward movement from the Bay of Fundy to southern New England waters occurs in autumn and early winter (Barlas, 1999; Jacobs & Terhune, 2000; Rosenfeld et al., 1988; Whitman & Payne, 1990). A northward movement from southern New England to Maine and eastern Canada occurs before the pupping season, which takes place from mid-May through June along the Maine coast (DeHart, 2002; Kenney, 1994; Richardson et al., 1995; Whitman & Payne, 1990; Wilson, 1978). Pupping sites are on the Maine coast, although anecdotal reports suggest that some pupping is occurring at high-use haul out sites off Manomet, Massachusetts, and the Isles of Shoals, Maine (Hayes et al., 2017).

Harbor seal distribution along the U.S. Atlantic coast has shifted in recent years, with an increased number of seals reported from southern New England to the mid-Atlantic region (DiGiovanni et al., 2011; Hayes et al., 2017; Kenney, 2019; Waring et al., 2016). Regular sightings of seals in Virginia have become a common occurrence in winter and early spring (Costidis et al., 2019). Winter haul out sites for harbor seals have been documented in the Chesapeake Bay at the CBBT, on the Virginia Eastern Shore, and near Oregon Inlet, North Carolina (Waring et al., 2016; Rees et al., 2016; Jones et al., 2018).

4.4.3 Site-Specific Occurrence

Harbor seals regularly haul out on rocks around the portal islands of the CBBT and on mud flats on the nearby southern tip of the Eastern Shore from November through April (Rees et al., 2016; Jones et al., 2018; Jones & Rees, 2020, 2021, 2022). One hundred fifty-five unique harbor seals have been uniquely identified since the surveys began in 2015 (Jones et al., 2022). Of these unique individuals, 88 (57 percent) were recorded only once, whereas 67 (43 percent) were recorded more than once. Seals captured in 2018, 2020, and 2022 on the Eastern Shore and tagged with satellite-tracked tags that lasted from 2 to 5 months spent at least 450 cumulative days in Virginia waters for those tagged in 2018 and 2020 and an average of approximately 37 days for seals tagged in 2022 before departing the area (Jones et al., 2023). All tagged seals returned regularly to the capture site while in Virginia waters, but individuals utilized offshore and Chesapeake Bay waters to different extents (Ampela et al., 2019, 2021, 2023). The area that was utilized most heavily was near the Eastern Shore capture site, but some seals ranged into the Chesapeake Bay.

4.5 Gray Seal

4.5.1 Status and Management

The Western North Atlantic stock of gray seal occurs in the project area. Gray seals are not listed as depleted under the MMPA, nor are they listed under the ESA.

4.5.2 Distribution

The western North Atlantic stock is centered in the Canadian Maritimes, including the Gulf of St. Lawrence and the Atlantic coasts of Nova Scotia, Newfoundland, and Labrador, Canada, and the northeast U.S. continental shelf (Hayes et al., 2022). However, gray seals range south into the northeastern United States, with strandings and sightings as far south as North Carolina (Hammill et al., 1998; Waring et al., 2004). Gray seal distribution along the U.S. Atlantic coast has shifted in recent years, with an increased number of seals reported in southern New England (DiGiovanni et al., 2011; Kenney, 2019; Waring et al., 2016). Along the coast of the United States, gray seals are known to pup at three or more colonies in Massachusetts and Maine.

The gray seal is considered a coastal species and may forage far from shore but does not appear to leave the continental shelf regions (Lesage & Hammill, 2001). Gray seals haul out on land-fast ice, exposed reefs, or beaches of undisturbed islands (Hall & Thompson, 2009; Lesage & Hammill, 2001). Remote uninhabited islands tend to have the largest gray seal haul outs (Reeves et al., 1992).

4.5.3 Site-Specific Occurrence

Gray seals are uncommon in Virginia and in the Chesapeake Bay, based on rare stranding reports. Recent sightings included a gray seal in the lower Chesapeake Bay during the winter of 2014 to 2015, one sighting in the 2017-2018 field season, two sightings in the 2018-2019 field season, one sighting in the 2019-2020 field season, and five sightings in the 2020-2021 field season (Rees et al., 2016; Jones et al. 2018; Jones & Rees, 2020, 2021, 2022). Sightings of gray seals were less common than harbor seals, and when sighted their presence was more likely to occur on the Eastern Shore site than the CBBT site (Jones et al., 2018; Jones & Rees, 2020, 2021, 2022).

5 TAKE AUTHORIZATION REQUESTED

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

5.1 `Take Authorization Request

Under Section 101 (a)(5)(A) of the MMPA, the Navy requests LOA for the take of marine mammals incidental to noise generated during pile extraction, pile driving, and drilling activities described in this application. As described in detail in Chapter 6, the Navy requests an LOA for takes of marine mammals listed in Table 5-1 for the period of January 1, 2025, through December 31, 2029.

Table 5-1. Total Underwater Exposure Estimates by Species for Individual and Concurrent Activities

LOA Construction Year	Species	Individual Activities		Concurrent Activities	
		Level A (PTS Onset)	Level B (Behavioral)	Level A (PTS Onset)	Level B (Behavioral)
Phase I January 2025 – January 2026	Humpback whale	0	2	0	2
	Bottlenose dolphin	0	5,414	0	2,888
	Harbor porpoise	2	0	2	0
	Harbor seal	101	905	41	367
	Gray seal	0	1	0	1
Phase II January 2026– January 2027	Humpback whale	0	2	0	2
	Bottlenose dolphin	0	2,609	0	2,179
	Harbor porpoise	2	0	2	0
	Harbor seal	50	453	65	588
	Gray seal	0	1	0	1
Phase III January 2027– December 2028	Humpback whale	0	4	0	2
	Bottlenose dolphin	0	6,168	0	6,712
	Harbor porpoise	2	2	2	0
	Harbor seal	137	1,236	33	294
	Gray seal	0	2	0	1

Key: LOA = Letter of Authorization; PTS = permanent threshold shift
Notes: Concurrent activities are planned as noted in Tables 1-1 and 6-9. Because activities that may occur over multiple project phases, concurrent takes were calculated on the maximum possible days of concurrent work. Therefore, concurrent takes are likely to be overestimated over the life of the 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 by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment] (16 United States Code section 1362; see also Code of Federal Regulations Title 50, Section 216.3).

5.2 Method of Incidental Taking

This authorization request considers noise from vibratory pile extraction and installation, impact pile installation, and pre-drilling as outlined in Section 1 (Introduction and Description of Activities) that has the potential to disturb or displace marine mammals, resulting in Level A and Level B harassment as defined above. Impact pile driving has the potential to produce a PTS in the ability of marine mammals to hear, resulting in Level A harassment. Level A (PTS onset) harassment will be minimized to the extent practicable given the methods of installation and measures designed to minimize the possibility of injury to marine mammals that are presented below.

- All pile driving will either not start or be halted if marine mammals approach a “shutdown zone.” For humpback whales, work will shut down anytime this species enters a Level A disturbance zone. For all other species, the shutdown zones for individual activities are shown in Table 5-2 and in Table 5-3 for concurrent activities.
- A “take” will be recorded if a marine mammal enters a “disturbance zone” but does not approach or enter the shutdown zone for that activity and species. The disturbance zone will be the Level B (behavioral) harassment zone and, where present, the Level A (PTS onset) harassment zone beyond the shutdown zones shown in Table 5-2 for individual activities and 5-3 for concurrent activities. Work will be allowed to proceed without cessation while marine mammals are in the disturbance zones and a Level A or Level B “take” would be recorded. Marine mammal behavior within the disturbance zone will be monitored and documented.
- Where the Level B (behavioral) harassment zone is too large to practically monitor due to the size of the zone and limited potential for land-based protected species observers (PSOs) in the surrounding environment, the Navy proposed to monitor a portion of the Level B harassment zone on all pile driving days (Chapter 11).
- Impact pile-driving activities would utilize a “soft start” to allow sensitive species to move away from the noise source before the commencement of pile-driving. Soft start requires contractors to provide an initial set of strikes at reduced energy, followed by a 30-second waiting period, then two subsequent reduced energy strike sets. A soft start will be implemented at the start of each day’s impact pile driving and any time following cessation of impact pile driving for a period of 30 minutes or longer.
- All pile driving and drilling activities would occur during daylight hours.

Replacement of the Q8 Bulkhead is not anticipated to affect the prey base or significantly affect other habitat features of marine mammals that would meet the definition of take. See Chapter 11 for more details on impact reduction and mitigation measures proposed.

Based on estimates of sound source levels and underwater acoustic transmission loss (TL), the Navy has identified the areas surrounding sound producing activities within which sound levels would result in Level A (PTS onset) harassment and Level B (behavioral) harassment (refer to Chapter 6). The Navy proposes to monitor the Level A (PTS onset) zones in their entirety and to monitor portions of the Level B (behavioral) zone (Table 11-1). If a marine mammal enters the “disturbance zone,” it will be noted as either a Level A or Level B take as authorized in the LOA. Sound producing activities will cease when a marine mammal enters the shutdown zone(s) to prevent a prolonged exposure to sound that could reach the threshold for the onset of PTS. While the Navy believes this procedure will minimize the number of Level A (PTS onset) acoustic exposures, it is possible that an animal could be present undetected within the Level A (PTS onset) zone during pile driving. Therefore, the Navy requests authorization for potential Level A (PTS onset) takes associated with this activity.

A standard construction shutdown zone of 10 m (33 ft) will also be applied to prevent non-acoustic injury to marine mammals from all potentially hazardous in-water activities occurring in the project area.

Table 5-2. Proposed Shutdown Zone Distances by Activity (Individual)

Pile type, size, and driving method	*Level A Shutdown Distance (m) for Humpback Whales[1]*	*Level A Shutdown Distance (m) for Harbor Porpoise*	*Level A Shutdown Distance (m) for all other Species*
Vibratory drive 56-inch steel sheet piles, Year 1, Phase I	40	60	30
Vibratory remove 18-inch pre-stressed square concrete piles, Year 1, Phase I	10	20	10
Impact drive 18-inch pre-stressed square concrete piles, Year 1 Phase I	50	60	30
Vibratory drive 56-inch steel sheet piles, Year 2, Phase II	40	60	30
Vibratory remove 18-inch pre-stressed square concrete piles, Year 2, Phase II	20	30	10
Impact drive 18-inch pre-stressed square concrete piles, Year 2, Phase II	70	80	40
Vibratory drive 56-inch steel sheet piles, Year 3, Phase III	50	80	30
Vibratory remove 16-inch round composite piles, Year 3, Phase III	10	20	10
Impact drive 18-inch pre-stressed square concrete piles, Year 3, Phase III	70	80	40
Impact drive 16-inch round composite piles, Year 3, Phase III	50	50	30

Key: m = meters
Notes:
1. Work will shut down if a humpback whale is sighted in any Level A zone, therefore, there would be no Level A takes of this species.

Table 5-3. Proposed Shutdown Zone Distances by Activity (Concurrent)

Activity	*Project Phase and Pile Location*	*Concurrent Scenario*	*Level A Shutdown Distance (m) for Humpback Whales[1]*	*Level A Shutdown Distance (m) for Harbor Porpoise*	*Level A Shutdown Distance (m) for all other Species*
Vibratory Pile Extraction (1) and Vibratory Pile Installation (1)	Phase I Piers 12-14	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles[1]	50	10	70
Vibratory Pile Extraction (1), Vibratory Pile Installation (1), and Impact Installation (1)	Phase I Piers 12-14, Piers 11-12, and North of Pier 14	Vibratory extract 18-inch concrete piles; vibratory install 56-inch steel sheet piles; impact install 18-inch concrete piles[1]	70	10	90
Vibratory Pile Extraction (1) and Vibratory Pile Installation (1)	Phase II Piers 11-12	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles[1]	50	10	70
Vibratory Pile Installation (1) and Impact Installation (1)	Phase II Piers 11-12 and North of Pier 14	Vibratory install 56-inch steel sheet piles and impact install 18-inch concrete piles[1]	50	10	80
Vibratory Pile Extraction (1) and Vibratory Pile Installation (1)	Phase III North of Pier 14	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles[1]	50	10	70
Vibratory Pile Installation (1) and Impact Installation (1)	Phase III North of Pier 14	Vibratory install 56-inch steel sheet piles and impact install 16-inch composite piles[1]	50	10	80

Key: m = meters
Notes:
1. Work will shut down if a humpback whale is sighted in any Level A zone, therefore, there would be no Level A takes of this species

6 NUMBERS AND SPECIES EXPOSED

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

6.1 Introduction

In-water pile driving (which includes vibratory extraction) will temporarily increase the local underwater and airborne noise environment near the project area. Research suggests that increased noise may impact marine mammals in several ways depending on many factors, as detailed in Section 7 (Impacts to Marine Mammal Species or Stocks). Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic source and the potential effects that sound may have on the physiology and behavior of that marine mammal. Although it is known that sound is important for marine mammal communication, navigation, and foraging (National Research Council, 2003, 2005), there are many unknowns in assessing impacts, such as the potential interaction of different effects and the significance of responses by marine mammals to sound exposures (Nowacek et al., 2007; Southall et al., 2007). Furthermore, many other factors besides the received level of sound may affect an animal's reaction, such as the animal's physical condition, behavioral context (i.e., foraging, mating, and migration), prior experience with the sound, and proximity to the source of the sound.

The methods for estimating the number and types of exposure are summarized below.

Exposure of each species was determined by:

- estimating the area of impact where noise levels exceed acoustic thresholds for marine mammals (Sections 6.7 and 6.8);
- evaluating potential presence of each species at NAVSTA Norfolk based on historical occurrence, density, or by site-specific survey as outlined in Section 6.12;
- estimating potential harassment exposures by multiplying the density or site-specific abundance, as applicable, of each marine mammal species calculated in the area of impact by their probable duration during construction (Section 6.13); and
- applying any site-specific assumptions or deviations to standard take calculation methodology used on previous applications at this installation.

6.2 Description of Noise Sources

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

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

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

Key: dB = decibel; Hz = hertz; m = meter; dB re 1 µPa = decibels referenced to 1 micropascal; dB re 1 $\mu Pa^2 sec$ = decibels referenced to 1 micropascal-squared second; RMS = root mean square; SEL = sound exposure level; sec = second

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

Impulsive sounds (e.g., explosions, seismic airgun pulses, and impact pile-driving), which are referred to as pulsed sounds in Southall et al. (2007, 2019), are brief, broadband, atonal transients (Harris, 1998) and occur either as isolated events or repeated in some succession (Southall et al., 2007, 2019). Impulsive sounds are characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures (Southall et al., 2007, 2019). Impulsive sounds generally have a greater capacity to induce physical injury compared with sounds that lack these features (Southall et al., 2007, 2019).

Non-impulsive sounds (referred to as non-pulsed in Southall et al., 2007, 2019) can be tonal, broadband, or both. They lack the rapid rise time and can have longer durations than impulsive sounds. Non-impulsive sounds can be either intermittent or continuous. Examples of non-impulsive sounds include vessels, aircraft, and machinery operations such as drilling, dredging, and vibratory pile-driving (Southall et al., 2007, 2019). For purposes of this analysis, rock hammering is treated as a non-impulsive sound.

In some environments, the duration of both impulsive and non-impulsive sounds can be extended due to reverberations. Appendix A provides additional information on the fundamentals of underwater sound and a review of pile driving sound pressure levels (SPLs) from similar projects as those proposed in this application.

6.3 Vocalizations and Hearing of Marine Mammals

All marine mammals that have been studied can produce sounds and use sounds to forage, orient, detect and respond to predators, and facilitate social interactions (Richardson et al., 1995). Measurements of marine mammal sound production and hearing capabilities provide some basis for assessing whether exposure to a particular sound source may affect a marine mammal behaviorally or physiologically.

Marine mammal hearing abilities are quantified using live animals either via behavioral audiometry or electrophysiology (Schusterman, 1981; Au, 1993; Wartzok and Ketten, 1999; Nachtigall et al., 2007). Behavioral audiograms, which are plots of animals' exhibited hearing threshold versus frequency, are obtained from captive, trained live animals using standard testing procedures with appropriate controls and are considered to be a more accurate representation of a subject's hearing abilities. Behavioral audiograms of marine mammals are difficult to obtain because many species are too large, too rare, and too difficult to acquire and maintain for experiments in captivity. Consequently, our understanding of a species' hearing ability may be based on the behavioral audiogram of a single individual or small group of animals. In addition, captive animals may be exposed to local ambient sounds and other environmental factors that may impact their hearing abilities and may not accurately reflect the hearing abilities of free-swimming animals.

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

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

NMFS reviewed studies of hearing sensitivity of marine mammals and developed thresholds for use as guidance when assessing the effects of anthropogenic sound on marine mammals based on measured or estimated hearing ranges (NMFS, 2018). The guidance places marine mammals into the following functional hearing groups based on their generalized hearing sensitivities: high-frequency cetaceans, mid-frequency cetaceans, low-frequency cetaceans (mysticetes), otariid pinnipeds (sea lions and fur seals), and phocid pinnipeds (true seals). Research is underway to subdivide these hearing groups in the future (Southall et al., 2019). Table 6-2 provides sound production and hearing capabilities for marine mammal species that are assessed in this application.

Table 6-2. Hearing and Vocalization Ranges for Marine Mammal Functional Hearing Groups Potentially Present in the Action Area

Functional Hearing Group	***Relevant Species***	***Functional Hearing Range[1]***
Low-frequency cetaceans	Humpback whale	7 Hz to 35 kHz
Mid-frequency cetaceans	Bottlenose dolphin	150 Hz to 160 kHz
High-frequency cetaceans	Harbor porpoise	275 Hz to 160 kHz
Phocid pinnipeds	Harbor seal and gray seal	In-water: 50 Hz to 86 kHz In-air: 75 Hz to 30 kHz

Key: Hz = hertz; kHz = kilohertz

Notes:

1. In-water hearing data from NMFS (2018). In-air data from Schusterman (1981); Hemilä et al. (2006); Southall et al. (2007, 2019).

6.4 Sound Exposure Criteria and Thresholds

To date, no studies have been conducted that examine impacts to marine mammals from pile driving sounds from which empirical noise thresholds have been established. NMFS uses underwater sound exposure thresholds to determine when an activity could result in Level A (PTS onset) or Level B (behavioral) harassment to marine mammals (70 FR 1871) (Table 6-3).

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

Marine Mammals	*Airborne Noise (impact and vibratory pile driving) (re 20 µPa)[1]*	*Underwater Vibratory Pile Driving Noise (non-impulsive sounds)[2]*		*Underwater Impact Pile Driving Noise (impulsive sounds)[2]*	
	Disturbance Guideline (haul out)[3]	*Level A Injury (PTS onset) Threshold[4]*	*Level B Disturbance Threshold*	*Level A (PTS onset) Threshold[5,6]*	*Level B Disturbance Threshold*
Low-Frequency Cetaceans	Not applicable	199 dB SEL_{CUM}[7]	120 dB RMS	219 dB Peak[4] 183 dB SEL_{CUM}[7]	160 dB RMS
Mid-Frequency Cetaceans	Not applicable	198 dB SEL_{CUM}[7]	120 dB RMS	230 dB Peak[4] 185 dB SEL_{CUM}[7]	160 dB RMS
High-Frequency Cetaceans	Not applicable	173 dB SEL_{CUM}[7]	120 dB RMS	202 dB Peak[4] 155 dB SEL_{CUM}[7]	160 dB RMS
Phocid pinnipeds	Harbor Seal – 90 dB RMS (unweighted) Other Phocids – 100 dB RMS (unweighted)	201 dB SEL_{CUM}[7]	120 dB RMS	218 dB Peak[4] 185 dB SEL_{CUM}[7]	160 dB RMS

Key: dB = decibel; Peak = peak pressure; PTS = permanent threshold shift; re 20 µPa = referenced to 20 micropascal; RMS = root mean square; SEL_{CUM} = cumulative sound exposure level

Notes:

1. Airborne disturbance thresholds not specific to pile driver type.
2. Underwater root mean square and peak sound pressure level (SPL_{PEAK}) have a reference value of 1 µPa. Cumulative sound exposure level (SEL_{CUM}) has a reference value of decibels at 1 μPa^2 sec.
3. Sound level at which pinniped haul out disturbance has been documented. This is not considered an official threshold but is used as a guideline.
4. Flat weighted or unweighted peak SPL within the generalized hearing range.
5. Dual metric acoustic thresholds for impulsive sounds: whichever results in the largest isopleth for calculating PTS onset is used in the analysis.
6. Values presented as the sound exposure level threshold are only the values for the species group's best hearing sensitivity because it is frequency weighted. Frequency weighted thresholds are determined from the minimum value of the exposure function and the weighting function at its peak (i.e., area of best sensitivity; equivalent to K+C).
7. Cumulative sound exposure level over 24 hours.

NMFS (2018) equates the onset of PTS (i.e., permanent auditory injury) with Level A harassment under the MMPA and "harm" under the ESA and has developed acoustic threshold levels for determining the onset of PTS in marine mammals exposed to underwater impulsive and non-impulsive sound sources. The Level A criteria use cumulative sound exposure level (SEL_{CUM}) metrics (dB SEL_{CUM}) and peak pressure rather than the previously used dB RMS metric (Table 6-3). NMFS also established thresholds for temporary threshold shift (TTS) (i.e., temporary reduced hearing sensitivity following exposure to intense sounds) in the 2018 guidance document. The onset of TTS is a form of Level B harassment under the MMPA and “harassment” under the ESA. NMFS did not state the thresholds for other forms of behavioral disturbance in the 2018 guidance document, and thus earlier thresholds for Level B harassment are still accepted. Level B harassment is considered to occur when marine mammals are exposed to impulsive underwater sounds greater than 160 dB RMS referenced to 1 micropascal (re 1 µPa) from impact pile driving and to non-impulsive underwater sounds greater than 120 dB RMS re 1 µPa (70 FR 1871) (Table 6-3). NMFS does not currently recommend calculations of TTS exposures separate from assessments of Level B harassment using the earlier thresholds for behavioral disturbance (81 FR 51693). Therefore, zones of influence for TTS were not estimated in this analysis. All forms of harassment, either auditory or behavioral, constitute “incidental take” under these statutes.

NMFS uses generic sound exposure thresholds to determine when an activity in the ocean that produces airborne sound might result in impacts to a marine mammal (70 FR 1871). Construction-period airborne noise would have little impact on cetaceans because they generally do not have their ears in the air and because noise from airborne sources would not transmit as well underwater (Urick, 1983; Richardson et al., 1995). In contrast, pinnipeds spend significant amounts of time out of the water while hauled out. In the water, when not actively diving, they often orient their bodies vertically in the water column and hold their heads above the water surface. Consequently, airborne noise may be a concern for pinnipeds near the project location. NMFS has identified behavioral harassment threshold criteria for airborne noise generated by pile driving for pinnipeds regulated under the MMPA. Level A injury threshold criteria for airborne noise have not been established. The Level B behavioral harassment threshold for harbor seals is 90 dB RMS referenced to 20 µPa (unweighted) and is 100 dB RMS referenced to 20 µPa (unweighted) for all other phocid seals, including gray seals.

6.5 Limitations of Existing Noise Criteria

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

To date, there is little research or data supporting a response by pinnipeds or non-delphinid cetaceans to non-impulsive sounds from vibratory pile-driving as low as the 120 dB threshold. Southall et al. (2007) reviewed studies conducted to document behavioral responses of harbor seals and northern elephant seals to non-impulsive sounds under various conditions and concluded that those limited studies suggest that exposures between 90 dB and 140 dB RMS re 1 µPa generally do not appear to induce strong behavioral responses.

A more recent observational study found evidence of weak but statistically significant avoidance behavior of bottlenose dolphins and harbor porpoises in response to estimated received levels of 99 to 132 dB referenced to 1 micropascal (dB re 1 µPa) during vibratory pile driving (Graham et al., 2017). Branstetter et al. (2018) tested for the effects of vibratory pile driver noise on bottlenose dolphin echolocation by exposing penned dolphins to playback recordings at source levels of 110, 120, 130, and 140 dB re 1 µPa. They found evidence of altered behavior (an almost complete cessation of echolocation clicks) only at the highest source level, for which the received level was roughly estimated as 128 dB re 1 µPa. The effect on behavior diminished significantly, indicating acclimation, as the animals resumed echolocation during subsequent replications.

6.6 Auditory Masking

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

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

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

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

6.7 Modeling Potential Noise Impacts from Pile-Driving

6.7.1 Underwater Sound Propagation

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

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

where

TL is the transmission loss in dB,

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

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

The degree to which underwater noise propagates away from a noise source is dependent on a variety of factors, most notably by the bathymetry and presence or absence of reflective or absorptive conditions, including the sea surface and sediment type. The TL model described above was used to calculate the expected noise propagation from both impact and vibratory pile driving, vibratory pile extraction, and pre-drilling activities. This TL model used representative source levels for previous pile driving projects to estimate harassment zones, or area exceeding the noise criteria.

6.7.2 Underwater Noise from In-water Construction

The intensity of pile driving sound is greatly influenced by factors such as the type of piles, type of driver, and the physical environment in which the activity takes place. To determine reasonable SPLs from pile driving, studies with similar properties to the Proposed Action were evaluated. Data from prior pile driving projects within the Mid-Atlantic region were reviewed in the analysis in addition to other known pile driving projects. The evaluation is presented in Appendix A and the representative SPLs used in the analysis are presented in Table 6-4.

For the analyses that follow, the TL model described above was used to calculate the expected harassment zones at representative pile driving locations within which pile driving noise would equal or exceed the thresholds for Level A (PTS onset) and Level B (behavioral for each marine mammal functional hearing group). For vibratory and impact behavioral zones and peak injury zones, a representative source level (Table 6-4) was used to estimate the area exceeding the noise criteria. The Technical Guidance (NMFS, 2018) provides Level A (PTS onset) thresholds and auditory weighting functions for each marine mammal hearing group, whereas the Spreadsheet contains default weighting factor adjustments (WFAs) for different types of broadband sources (NMFS, 2018). The WFAs assign a single frequency to represent the sound spectrum of the source, approximating what the animal is exposed to. The WFA frequency, when applied to the auditory weighting function of the group, determines what adjustment is made to the source level prior to calculating the threshold distance. To calculate the maximum distances to Level A (PTS onset) thresholds associated with each particular source, NMFS' Technical Guidance (2018) was followed and the Optional User Spreadsheet (NMFS, 2018) was used. See Appendix A for calculated distances to Level A (PTS onset) thresholds.

Table 6-4. Underwater Noise Proxy Source Levels Used for Acoustic Modeling

Pile Size and Type	*Installation Method*	*Average Peak SPL (dB re 1 μPa)*	*Average RMS SPL (dB re 1 μPa)*	*Average SEL (dB re 1 μPa² sec)*	*Source*
56-inch steel sheet pile	Vibratory[1]	NA	168	NA	Illingworth and Rodkin, 2017
18-inch pre-stressed square concrete pile	Impact[2]	185	170	160	Caltrans, 2020
	Vibratory[3]	185	162	157	Caltrans, 2020
16-inch round composite pile	Impact[4]	184	169	157	e4sciences, 2023
	Vibratory[5]	NA	158	NA	Illingworth and Rodkin, 2017

Key: All SPLs are unattenuated; dB = decibels; NA = not applicable; SEL= sound exposure level; RMS = root mean square; SPL = sound pressure level; single strike SEL are the proxy source levels presented for impact pile-driving and were used to calculate distances to PTS; dB re 1 μPa = dB referenced to a pressure of 1 microPascal, measures underwater SPL. dB re 1 μPa²-sec = dB referenced to a pressure of 1 microPascal squared per second, measures underwater SEL.

Notes:

1. A proxy value for vibratory driving 56-inch sheet piles was not found so data for 48-inch steel shell piles was used (highest avg from Table 3 in Illingworth and Rodkin (2017)).
2. Data for 18-inch concrete piles (Table 2-4 of CALTRANS 2020).
3. Data on vibratory extraction of concrete piles is not available. See 84 FR 28479, where it was suggested that proxy source sound levels for timber piles be used as they are expected to have similar sound levels to concrete. See also Table I.36-1a in Caltrans (2020).
4. Data for 16-inch composite piles (Table 10 of e4sciences 2023).
5. Vibratory proxy for plastic piles unavailable; assume sound pressure level to be consistent with timber which was used as a proxy.

6.8 Distance to Underwater Sound Thresholds

6.8.1 Individual Activities

Calculated distances to Level A (PTS Onset) harassment and Level B (Behavioral) harassment thresholds for the four hearing groups are provided in Table 6-5 and Figures 6-1 through 6-4 for impact pile driving generated from the bulkhead repairs.

Table 6-6 and Figures 6-5 through 6-10 summarize the calculated maximum distances corresponding to the underwater marine mammal harassment zones from non-impulsive noise sounds (vibratory pile driving and removal) associated with the bulkhead repairs.

Areas encompassed within the harassment zones were calculated using the location of a representative pile. Sound source locations were chosen to model the greatest possible affected areas.

The maximum distance to the Level A (PTS onset) during impact pile driving would result from the impact driving of 16-inch composite piles during Phase III of construction (48.1 m for harbor porpoise, 40.4 m for humpback whale, 21.6 m for phocid pinnipeds, and 1.4 m for bottlenose dolphins). The farthest extent to the Level B (behavioral) harassment threshold during impact pile driving would be 25 m for all species, resulting from impact driving of 18-inch square concrete piles.

The maximum distance to the Level A (PTS onset) during vibratory pile extraction or driving would result from the vibratory installation of 56-inch steel sheet piles during Phase III of construction (72 m for harbor porpoise, 48.7 m for humpback whale, 29.6 m for phocid pinnipeds, and 4.3 m for bottlenose dolphins). The maximum distance to the Level B (behavioral) harassment threshold would occur during vibratory driving of 56-inch sheet piles (15,849 m).

Table 6-5. Calculated Maximum Distances Corresponding to MMPA Thresholds for Underwater Sound from Impact Pile Driving

Project Phase and Location	Pile Size and Type	Total Pile Driving Days	Injury (PTS Onset)[1] Level A				Behavioral Disturbance[2] Level B	
			LF Cetacean	MF Cetacean	HF Cetacean	Phocid Seal	All Species	
			Maximum Distance to 183 dB SEL_{CUM} Threshold (m)/ Area[3] (sq km[ll])	Maximum Distance to 185 dB SEL_{CUM} Threshold/ Area[3] (sq kml)	Maximum Distance to 155 dB SEL_{cum} Threshold (m)/ Area[3] (sq kml)	Maximum Distance to 185 dB SEL_{CUM} Threshold (m)/ Area[3] (sq km)	Maximum Distance to 160 dB RMS Threshold (m)	Area Within 160 dB RMS Threshold (sq km)
Phase I, Piers 12-14	18-inch pre-stressed square concrete	19	43.9/0.003027	1.6/0.000004	52.3/0.004341	23.5/0.000867	46.4	0.003382
Phase II, Piers 11-12	18-inch pre-stressed square concrete	11	60.8/0.005807	2.2/0.000008	72.4/0.008234	32.5/0.001659	46.4	0.003382
Phase III, North of Pier 14	16-inch round composite	18	40.4/0.002542	1.4/0.000003	48.1/0.003608	21.6/0.000722	39.8	0.002489
	18-inch pre-stressed square concrete	5	64.0/0.006434	2.3/0.000008	76.3/0.009145	34.3/0.001848	46.4	0.003382

Key: dB = decibel; HF = high-frequency; LF = low-frequency; m = meters; MF = mid-frequency; m = meter, PTS = permanent threshold shift; RMS = root mean square; SEL_{CUM} = cumulative sound exposure level; sq km = square kilometer; sq m = square meter

Notes:

1. Injury thresholds are dB SEL_{CUM}, as listed in Table 6-3.
2. Behavioral disturbance thresholds are dB RMS, as listed in Table 6-3.
3. Areas calculated using geographic information system data as determined by transmission loss modeling.

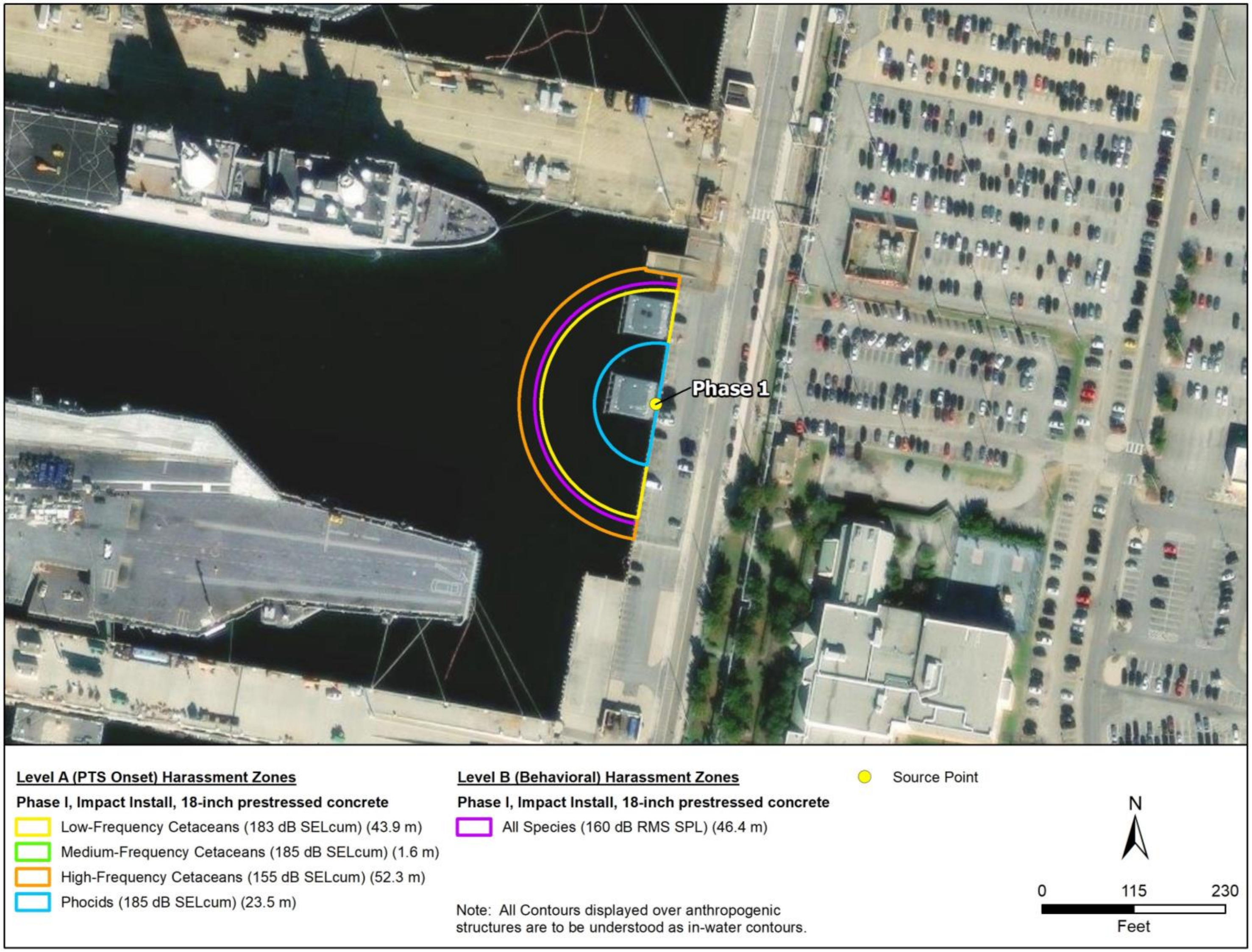

Figure 6-1. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Impact Pile Driving 18-inch Concrete Fender Piles, Phase I

Note: Basemap aerial imaging has changed with updates, however source point is the same as previous applicable versions.

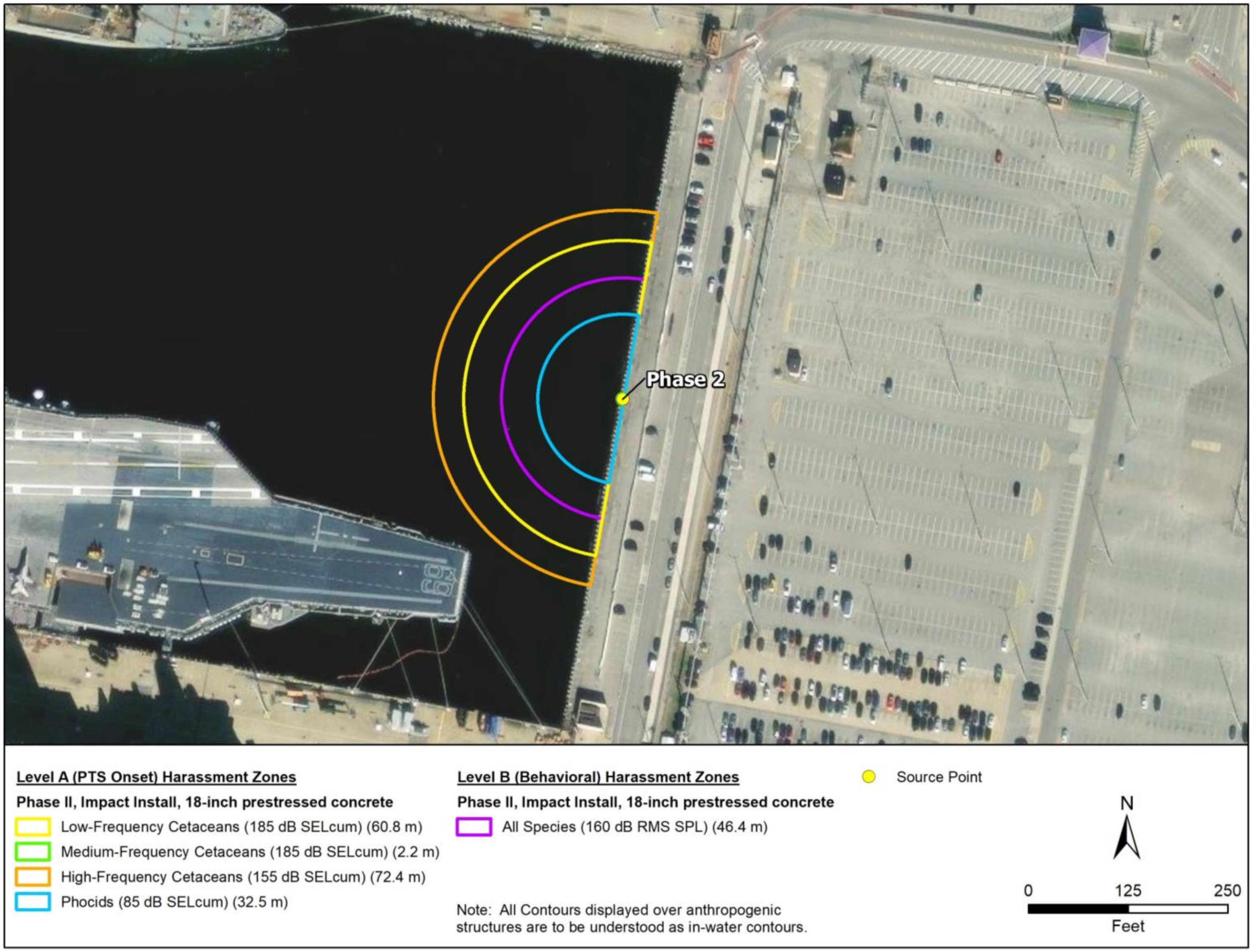

Figure 6-2. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Impact Pile Driving 18-inch Concrete Fender Piles, Phase II

Note: Basemap aerial imaging has changed with updates, however source point is the same as previous applicable versions.

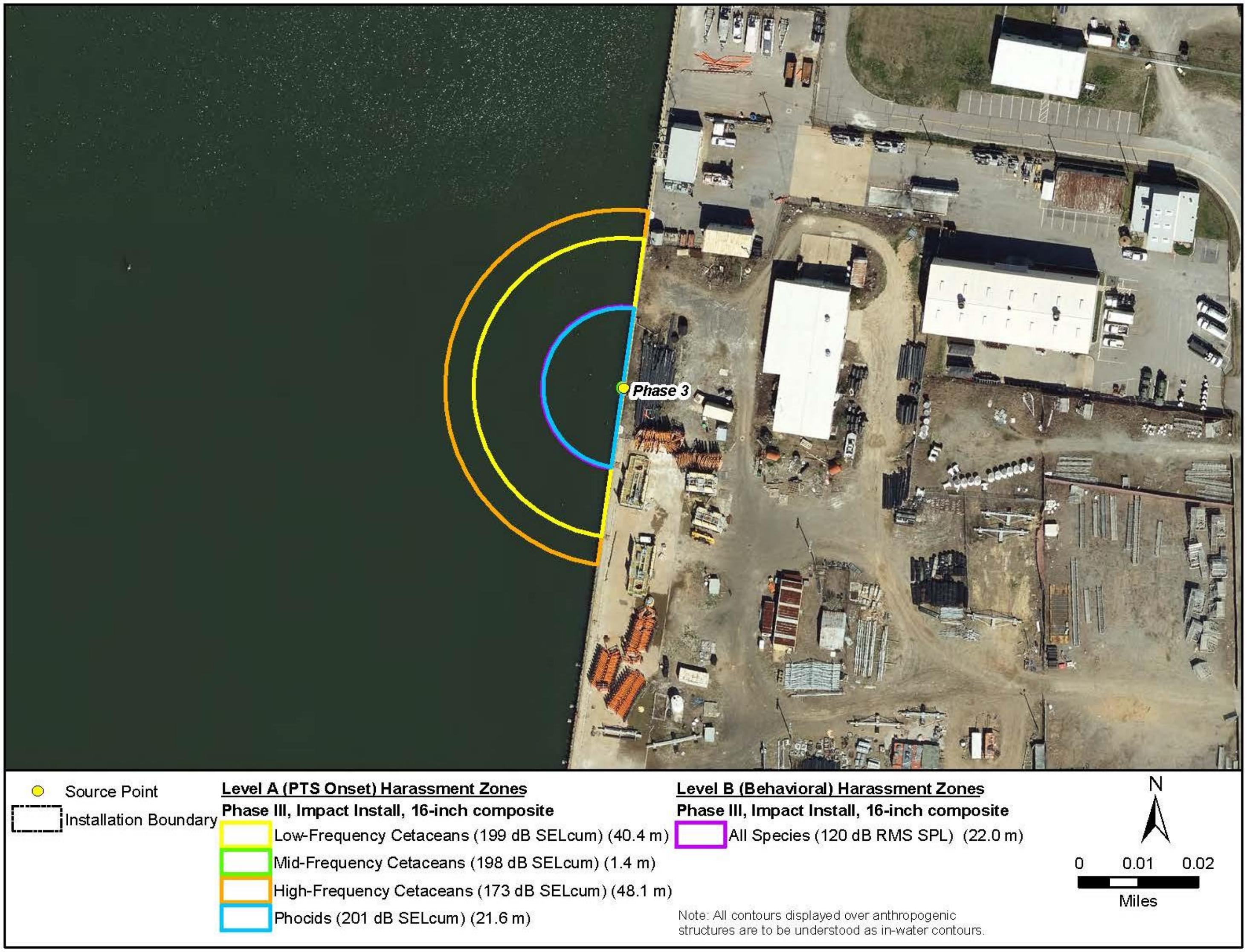

Figure 6-3. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Impact Pile Driving 16-inch Composite Fender Piles, Phase III

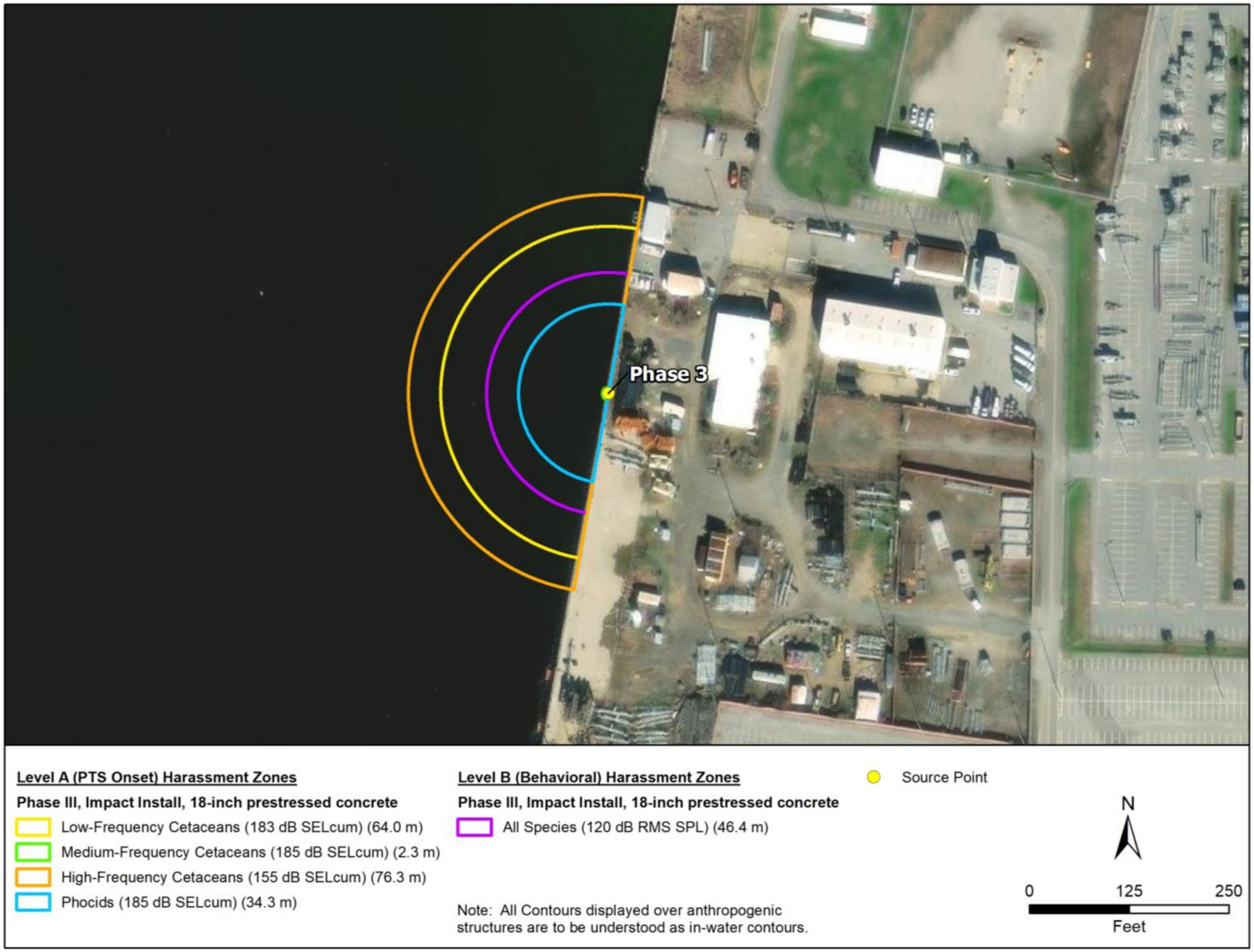

Figure 6-4. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Impact Pile Driving 18-inch Concrete Fender Piles, Phase III

Note: Basemap aerial imaging has changed with updates, however source point is the same as previous applicable versions.

Table 6-6 Calculated Maximum Distances Corresponding to MMPA Thresholds for Underwater Sound from Vibratory Pile Driving and Extraction

Project Phase and Location	Pile Size and Type	Total Pile Driving Days	Injury (PTS Onset)[1] Level A				Behavioral Disturbance[2] Level B	
			LF Cetacean	MF Cetacean	HF Cetacean	Phocid		
			Maximum Distance to 199 dB SELcum Threshold (m)/Area[3] (sq m)	Maximum Distance to 198 dB SELcum Threshold (m)/Area[3] (sq m)	Maximum Distance to 173 dB SELcum Threshold (m)/Area[3] (sq m)	Maximum Distance to 201 dB SELcum Threshold (m)/Area[3] (sq m)	Maximum Distance to 120 dB RMS SPL Threshold (m)	Area within 120 dB RMS SPL Threshold (sq km)
Phase I Construction, Piers 12-14	56-inch steel sheet	31	35.9/0.002048	3.2/0.000019	53.0/0.004447	21.8/0.000761	15,849	92.963287
	18-inch pre-stressed square concrete	14	10.0/0.000165	0.9/0.000002	14.7/0.00035	6.1/0.000063	6,310	43.397949
Phase II Construction, Piers 11-12	56-inch steel sheet	265	39.7/0.00251	3.5/0.000023	58.7/0.005463	24.2/0.000941	15,849	93.523935
	18-inch pre-stressed square concrete	98	15.1/0.000372	1.3/0.000004	22.3/0.000801	9.2/0.000142	6,310	44.318491
Phase III Construction,	56-inch steel sheet	3	48.7/0.003699	4.3/0.000027	72.0/0.008104	29.6/0.00136	15,849	85.931194

Project Phase and Location	Pile Size and Type	Total Pile Driving Days	Injury (PTS Onset)[1] Level A				Behavioral Disturbance[2] Level B	
			LF Cetacean	MF Cetacean	HF Cetacean	Phocid		
			Maximum Distance to 199 dB SELcum Threshold (m)/Area[3] (sq m)	Maximum Distance to 198 dB SELcum Threshold (m)/Area[3] (sq m)	Maximum Distance to 173 dB SELcum Threshold (m)/Area[3] (sq m)	Maximum Distance to 201 dB SELcum Threshold (m)/Area[3] (sq m)	Maximum Distance to 120 dB RMS SPL Threshold (m)	Area within 120 dB RMS SPL Threshold (sq km)
North of Pier 14	16-inch composite	2	6.8/0.00007	0.6/0.0000004	10.1/0.000156	4.2/0.000026	3,415	11.505933

Key: dB = decibel; HF = high-frequency; LF = low-frequency; m = meters; MF = mid-frequency; m = meter, PTS = permanent threshold shift; RMS = root mean square; SEL_{CUM} = cumulative sound exposure level; sq km = square kilometer; sq m = square meter

Notes:

1. Injury thresholds are dB SEL_{CUM}, as listed in Table 6-3.
2. Behavioral disturbance thresholds are dB RMS, as listed in Table 6-3.
3. Areas calculated using geographic information system data as determined by transmission loss modeling.

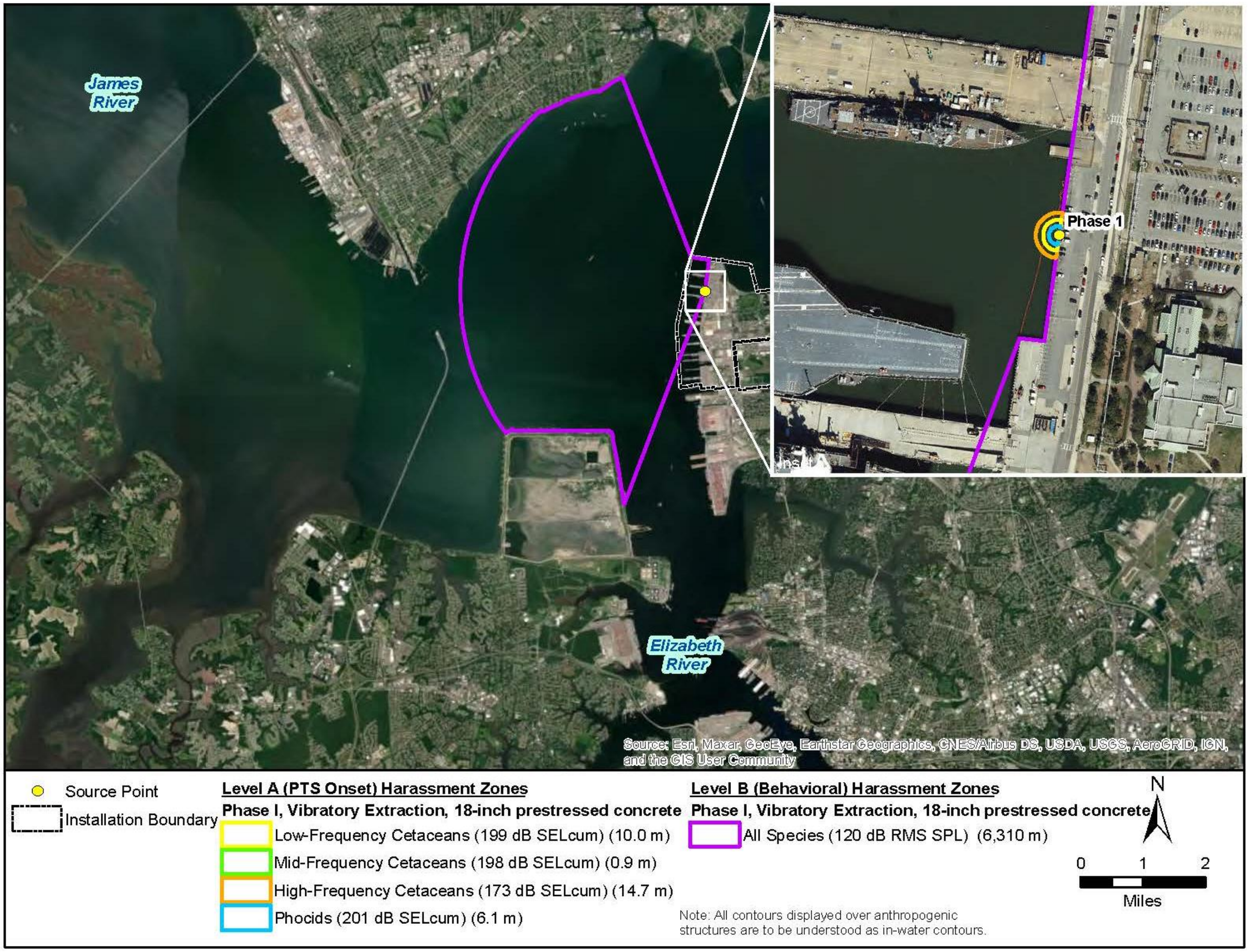

Figure 6-5. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Vibratory Extraction of 18-Inch Concrete Fender Piles, Phase I

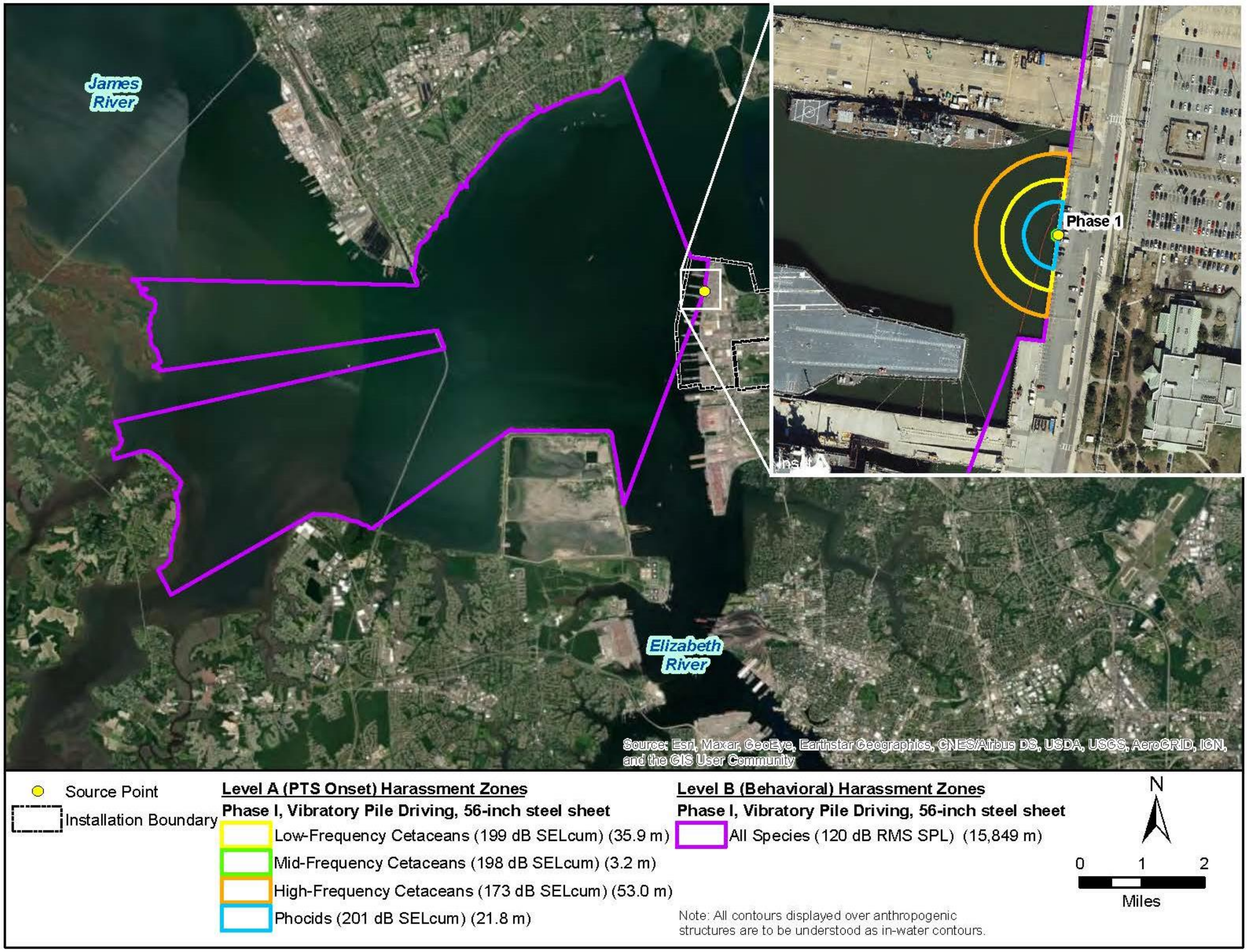

Figure 6-6. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Vibratory Pile Driving 56-inch Steel Sheet Piles, Phase I

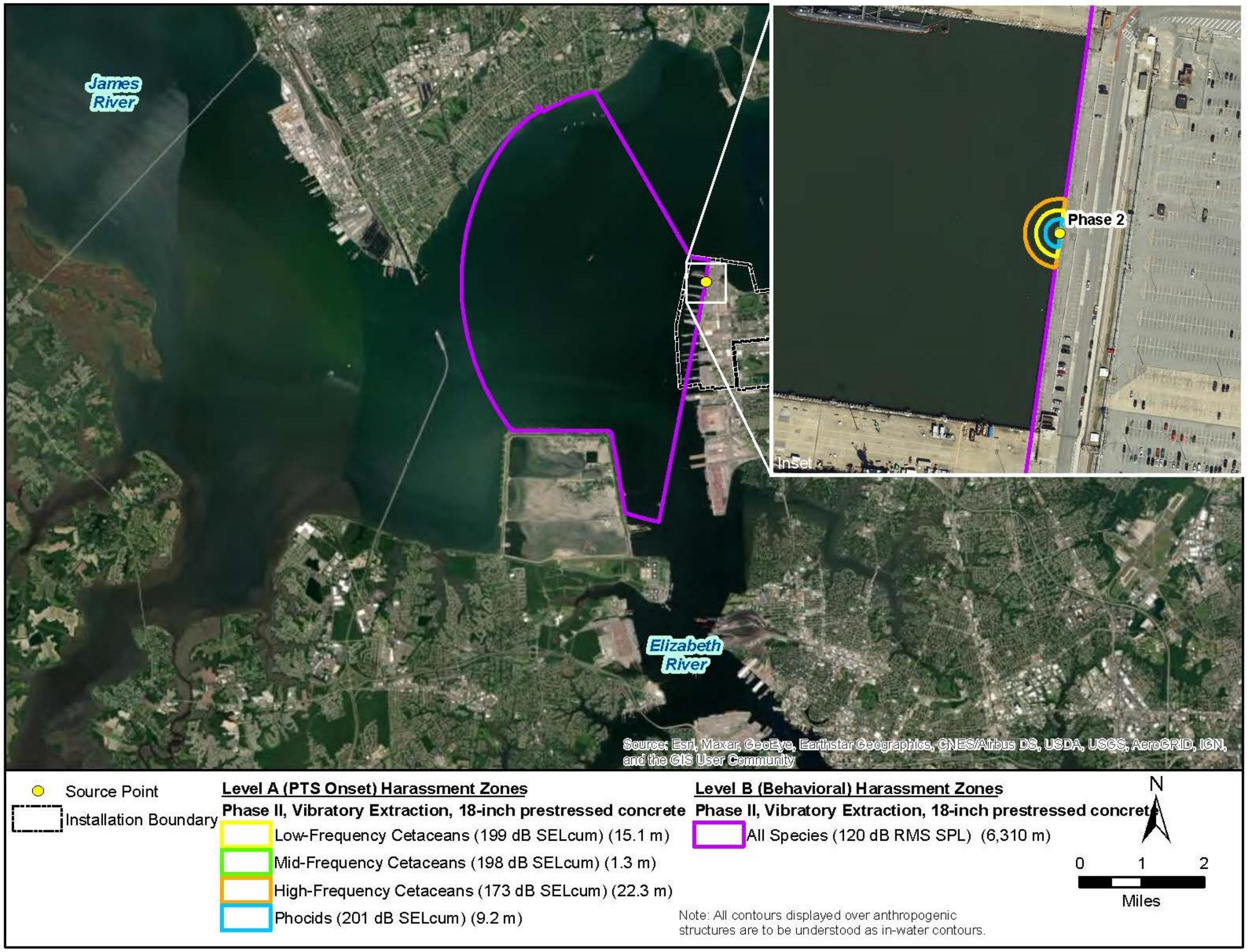

Figure 6-7. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Vibratory Extraction of 18-Inch Concrete Fender Piles, Phase II

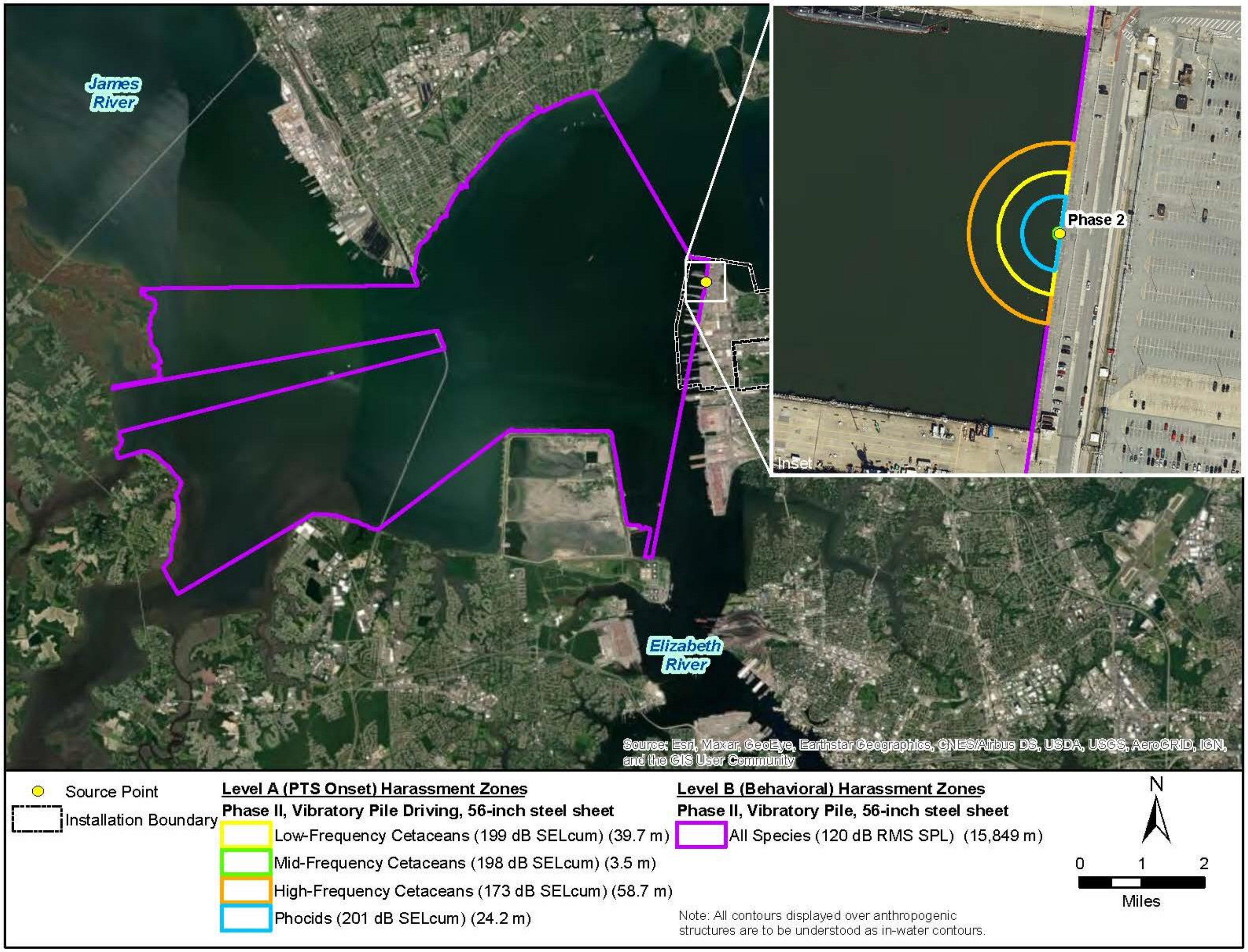

Figure 6-8. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Vibratory Pile Driving 56-inch Steel Sheet Piles, Phase II

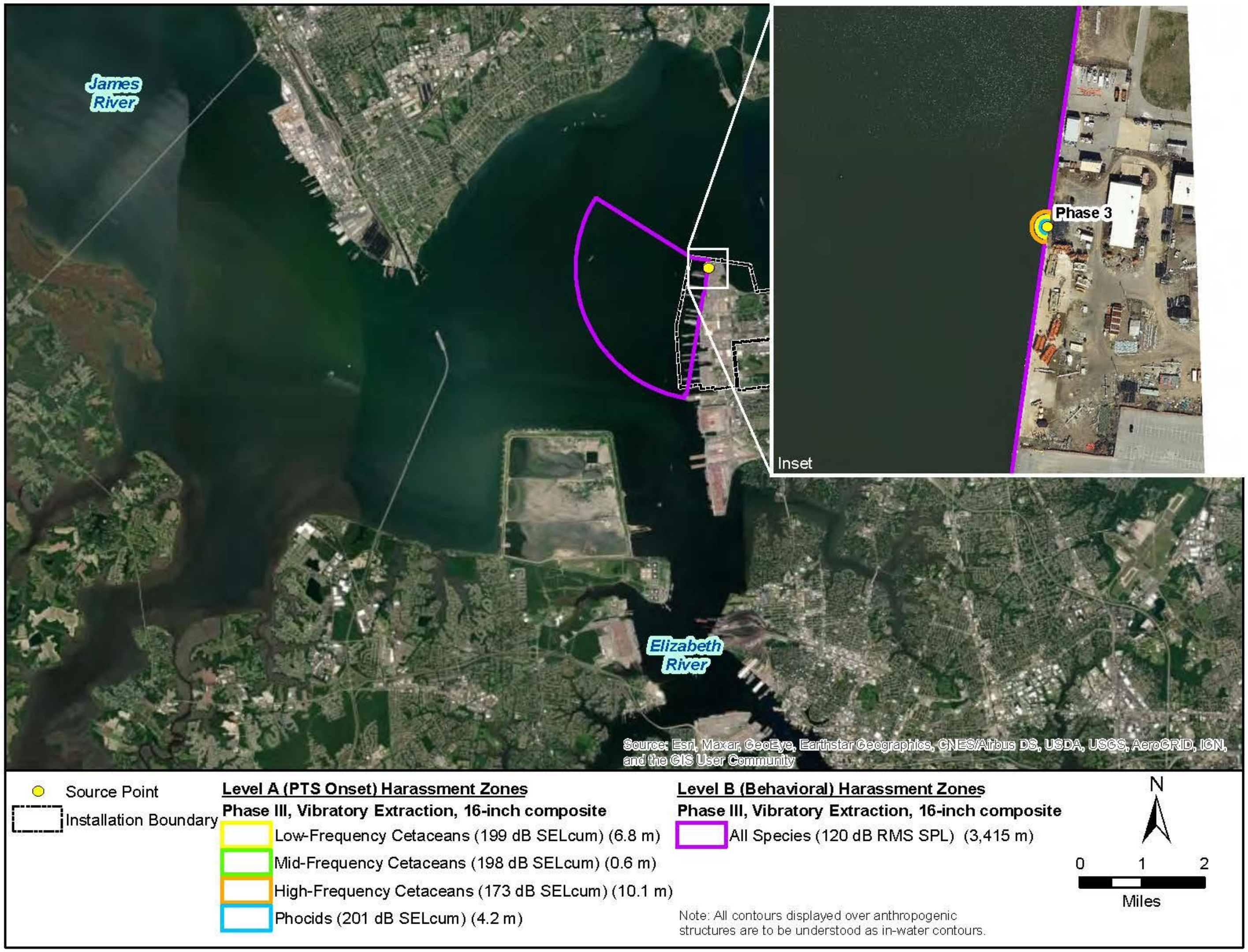

Figure 6-9. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Vibratory Extraction of 18-Inch Composite Fender Piles, Phase III

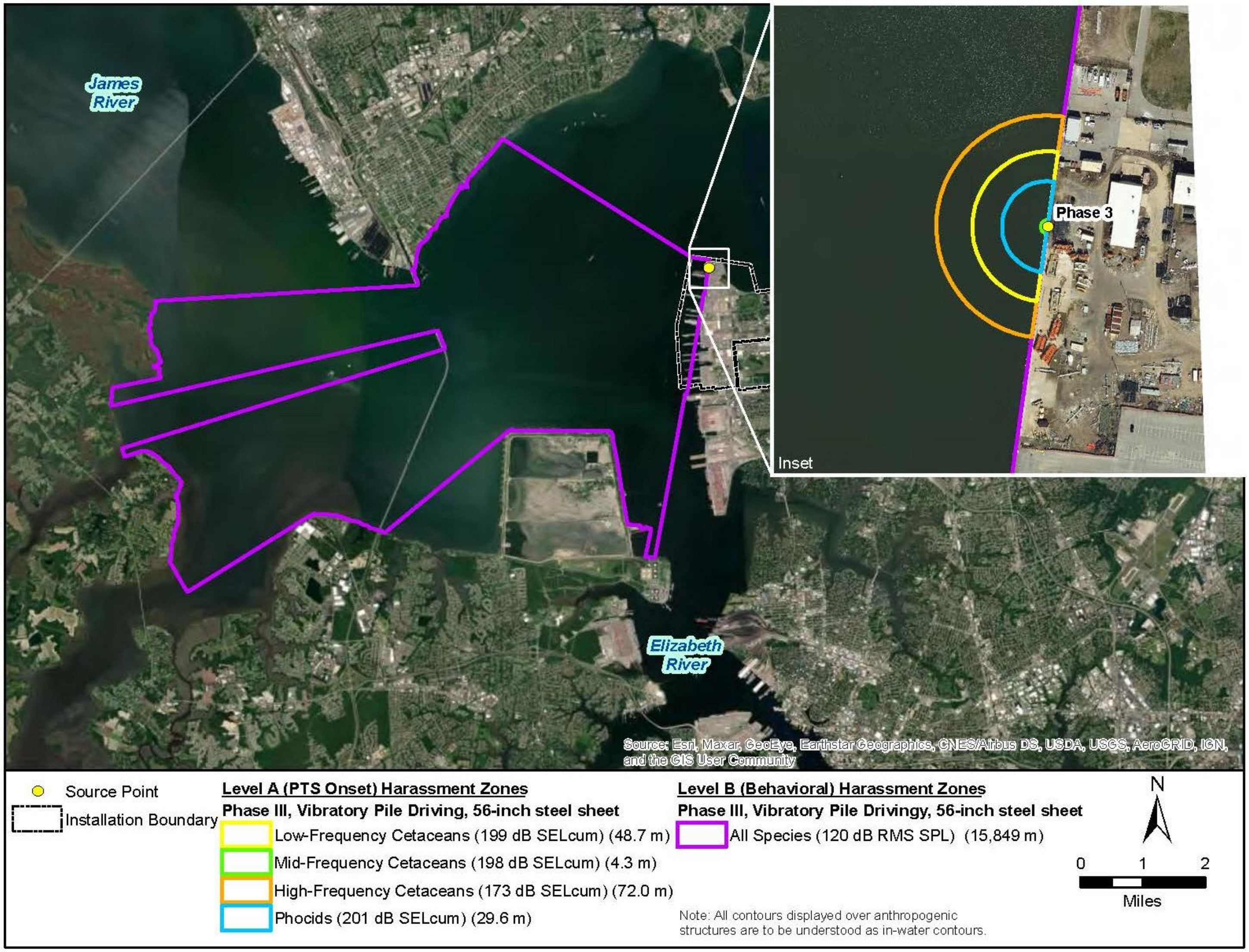

Figure 6-10. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Vibratory Pile Driving 56-inch Steel Sheet Piles, Phase III

6.8.2 Concurrent Activities

Simultaneous use of pile drivers/hammers could result in increased SPLs and harassment zone sizes given the proximity of the component sites and the rules of decibel addition.

According to recent guidance provided by NMFS, when two noise sources have overlapping sound fields, there is potential for higher sound levels than for non-overlapping sources because the isopleth of one sound source encompasses the sound source of another isopleth. In such instances, the sources are considered additive and combined using the rules of decibel addition. For addition of two simultaneous sources, the difference between the two sound source levels is calculated, and if that difference is between 0 and 1 dB, 3 dB are added to the higher sound source level; if the difference is between 2 or 3 dB, 2 dB are added to the highest sound source level; if the difference is between 4 to 9 dB, 1 dB is added to the highest sound source level; and with differences of 10 dB or more, there is no addition (NMFS 2021, unpublished).

Table 6-7 Rules for Combining Sound Levels

Difference in Sound Source Level (dB)	*Rule*
0 or 1 dB	Add 3 dB to the higher source level
2 or 3 dB	Add 2 dB to the higher source level
4 to 9 dB	Add 1 dB to the higher source level
10 dB or more	Add 0 dB to the higher source level

Source: NMFS, 2021 (unpublished)
Key: dB = decibels

For simultaneous usage of three or more continuous sound sources, the three overlapping sources with the highest sound source levels are identified. Of the three highest sound source levels, the lower two are combined using the above rules, then the combination of the lower two is combined with the highest of the three. For example, with overlapping isopleths from 24-, 36-, and 42-inch diameter steel pipe piles with sound source levels of 161, 167, and 168 dB RMS, respectively, the 24- and 36- inch would be added together. Given that 167 minus 161 equals 6 dB, 1 dB is then added to the highest of the two sound source levels (167 dB), for a combined noise level of 168 dB. Next, the newly calculated 168 dB is added to the 42-inch steel pile with sound source levels of 168 dB. Since 168 minus 168 equals 0 dB, 3 dB is added to the highest value, or 171 dB in total for the combination of 24-, 36-, and 42-inch steel pipe piles (NMFS, 2021, unpublished).

Table 6-8 Revised Proxy Values for Simultaneous Use of Non-Impulsive Sources

Equipment	*RMS*	*Vibratory Extract*	*Revised Proxy*
Vibratory hammer (56-inch sheet pile)	168	162	169
Vibratory hammer (18-inch concrete)	162	162	165
Vibratory hammer (56-inch sheet pile)	168	158	168

Note: Vibratory extract proxy sources available in Appendix A Underwater Acoustic Transmission Loss Model document in Table 4.

Table 6-9 Estimated Harassment Zones Resulting from Concurrent Activities

Activity	Project Phase and Pile Location	Concurrent Scenario	Piles Per Day	Total Pile Driving Days	Level A (PTS Onset) Harassment				Level B (Behavioral) Harassment All Species
					LF Cetaceans	MF Cetaceans	HF Cetaceans	Phocids	
					Maximum Distance to 199 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)	Maximum Distance to 198 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)	Maximum Distance to 173 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)	Maximum Distance to 201 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)	Maximum Distance to 120 dB RMS SPL Threshold(m)/Area of Harassment Zone (km^2)
Vibratory Pile Extraction (1) and Vibratory Pile Installation (1)	Phase I Piers 12-14	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles[1]	12	15	46.3 / 0.003407	4.1 / 0.000031	68.5 / 0.00743	28.2 / 0.001274	18,478 / 96.014966
Vibratory Pile Extraction (1), Vibratory Pile Installation (1), and Impact Installation (1)	Phase I Piers 12-14, Piers 11-12, and North of Pier 14	Vibratory extract 18-inch concrete piles; vibratory install 56-inch steel sheet piles; impact install 18-inch concrete piles[1, 2, 3]	18	19	60.7 / 0.017332	5.4 / 0.000137	89.8 / 0.037634	36.9 / 0.006398	18,478 / 103.001094
Vibratory Pile Extraction (1) and Vibratory Pile Installation (1)	Phase II Piers 11-12	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles[1]	12	4	46.3 / 0.003397	4.1 / 0.00003	68.5 / 0.016154	28.2 / 0.001268	18,478 / 93.295658

Activity	*Project Phase and Pile Location*	*Concurrent Scenario*	*Piles Per Day*	*Total Pile Driving Days*	*Level A (PTS Onset) Harassment*				*Level B (Behavioral) Harassment All Species*
					LF Cetaceans	*MF Cetaceans*	*HF Cetaceans*	*Phocids*	
					Maximum Distance to 199 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)	*Maximum Distance to 198 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)*	*Maximum Distance to 173 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)*	*Maximum Distance to 201 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)*	*Maximum Distance to 120 dB RMS SPL Threshold(m)/Area of Harassment Zone (km^2)*
Vibratory Pile Installation (1) and Impact Installation (1)	Phase II Piers 11-12 and North of Pier 14	Vibratory install 56-inch steel sheet piles and impact install 18-inch concrete piles[3]	18	11	48.7 / 0.007384	4.3 / 0.000054	72 / 0.016154	29.6 / 0.002712	15,849 / 100.588184
Vibratory Pile Extraction (1) and Vibratory Pile Installation (1)	Phase III North of Pier 14	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles[1]	12	31	46.3 / 0.003273	4.1 / 0.000019	68.5 / 0.007233	28.2 / 0.001192	18,478 / 97.877432
Vibratory Pile Installation (1) and Impact Installation (1)	Phase III North of Pier 14	Vibratory install 56-inch steel sheet piles and impact install 16-inch composite piles[3]	12	15	48.7 / 0.003627	4.3 / 0.000021	72 / 0.007996	29.6 / 0.001316	15,849 / 85.07705

Notes: 1. Shorter duration of driving/extraction per pile for multiple vibratory hammers was used as once that is complete, activity would no longer be concurrent.
2. Greatest number of strikes per pile possible was used as a conservative estimate to compare potential Level A and B harassment zones of impact and vibratory activity.
3. Larger zone between impact and vibratory activity was used to determine the maximum distance to the thresholds.

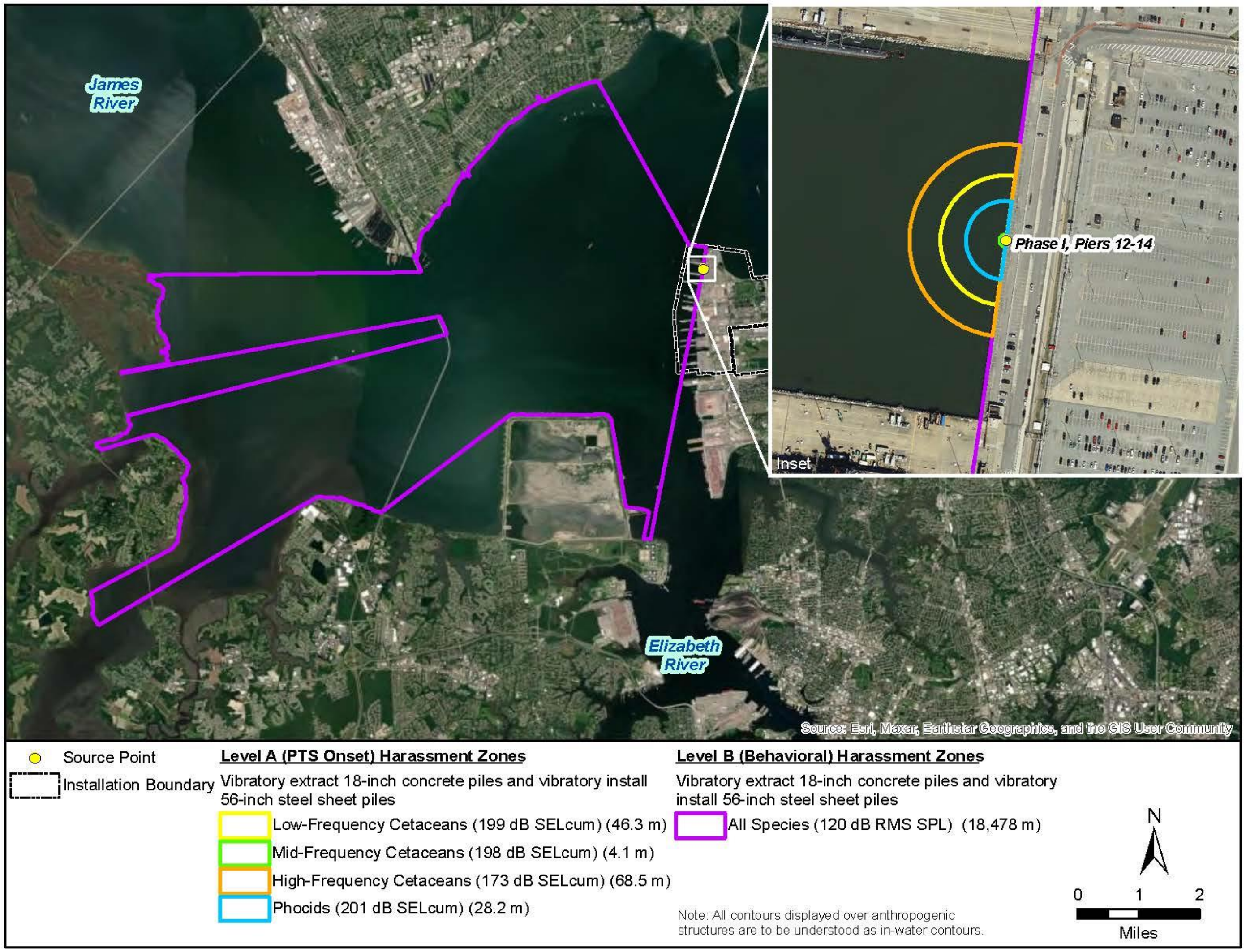

Figure 6-11. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities: Vibratory Extraction of 18-inch Concrete Piles and Vibratory Installation of 56-inch Steel Sheet Piles, Phase I

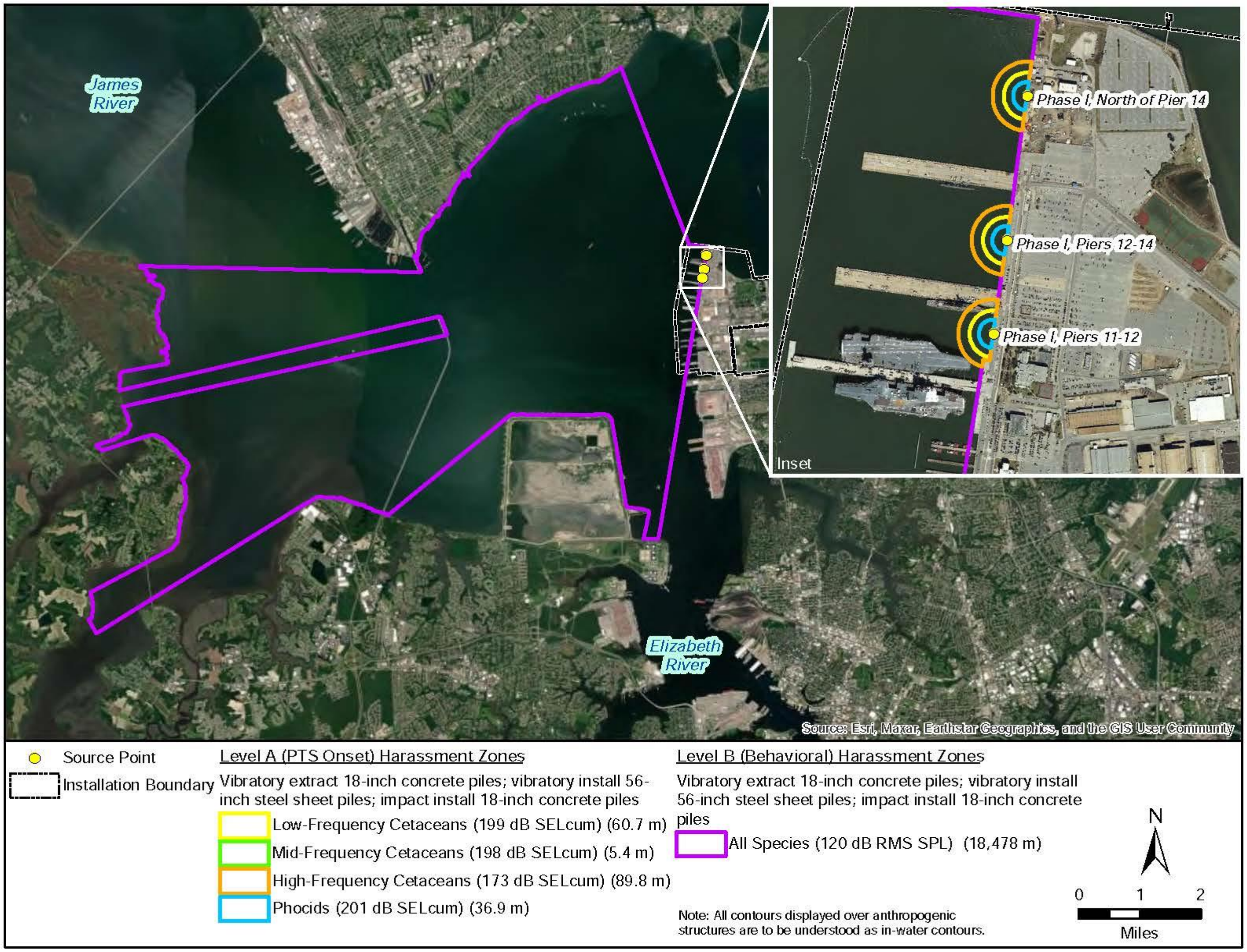

Figure 6-12. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities: Vibratory Extraction of 18-inch Concrete Piles, Vibratory Installation of 56-inch Steel Sheet Piles, and Impact Installation of 18-inch Concrete Piles, All Phases

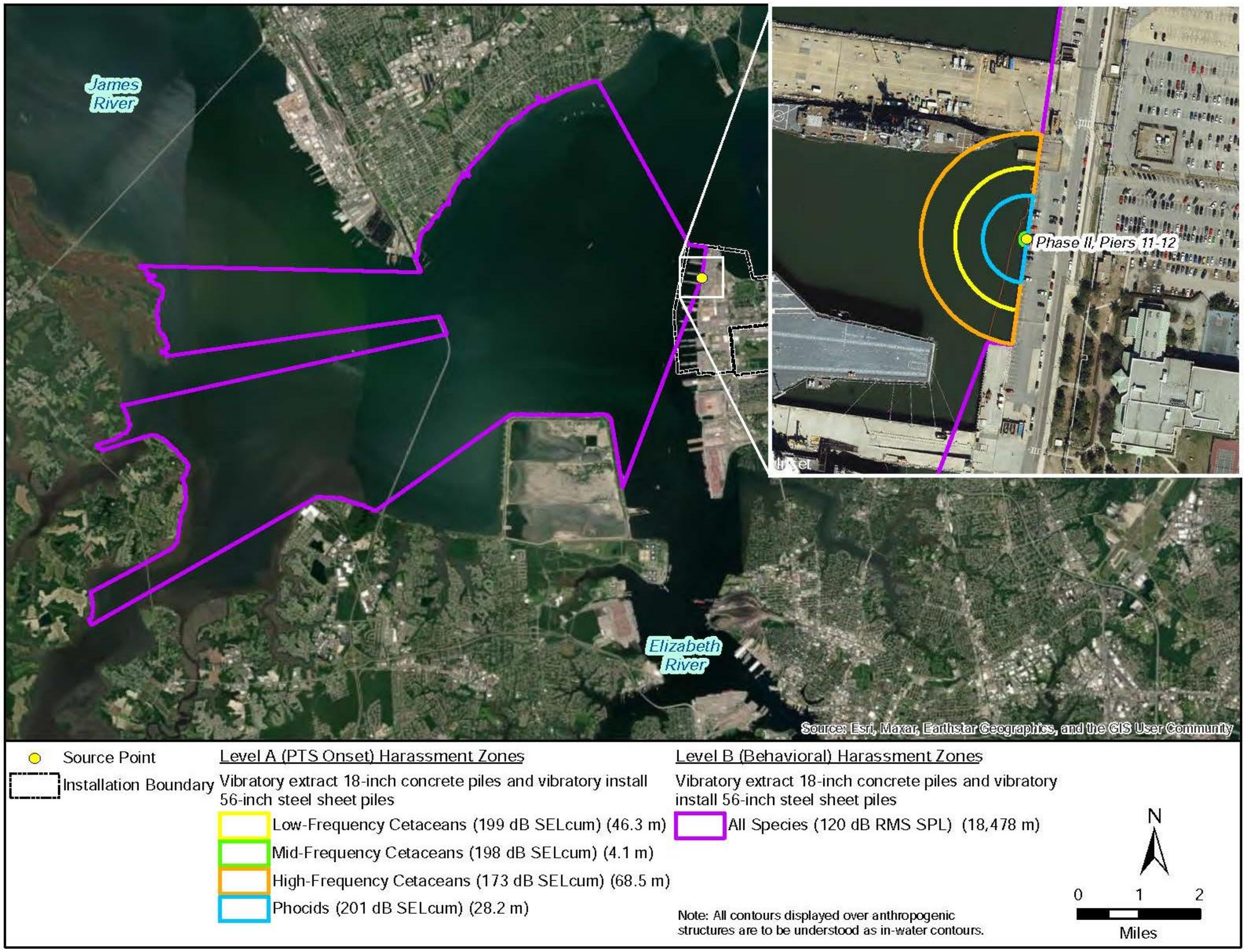

Figure 6-13. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities: Vibratory Extraction of 18-inch Concrete Piles and Vibratory Installation of 56-inch Steel Sheet Piles, Phase II

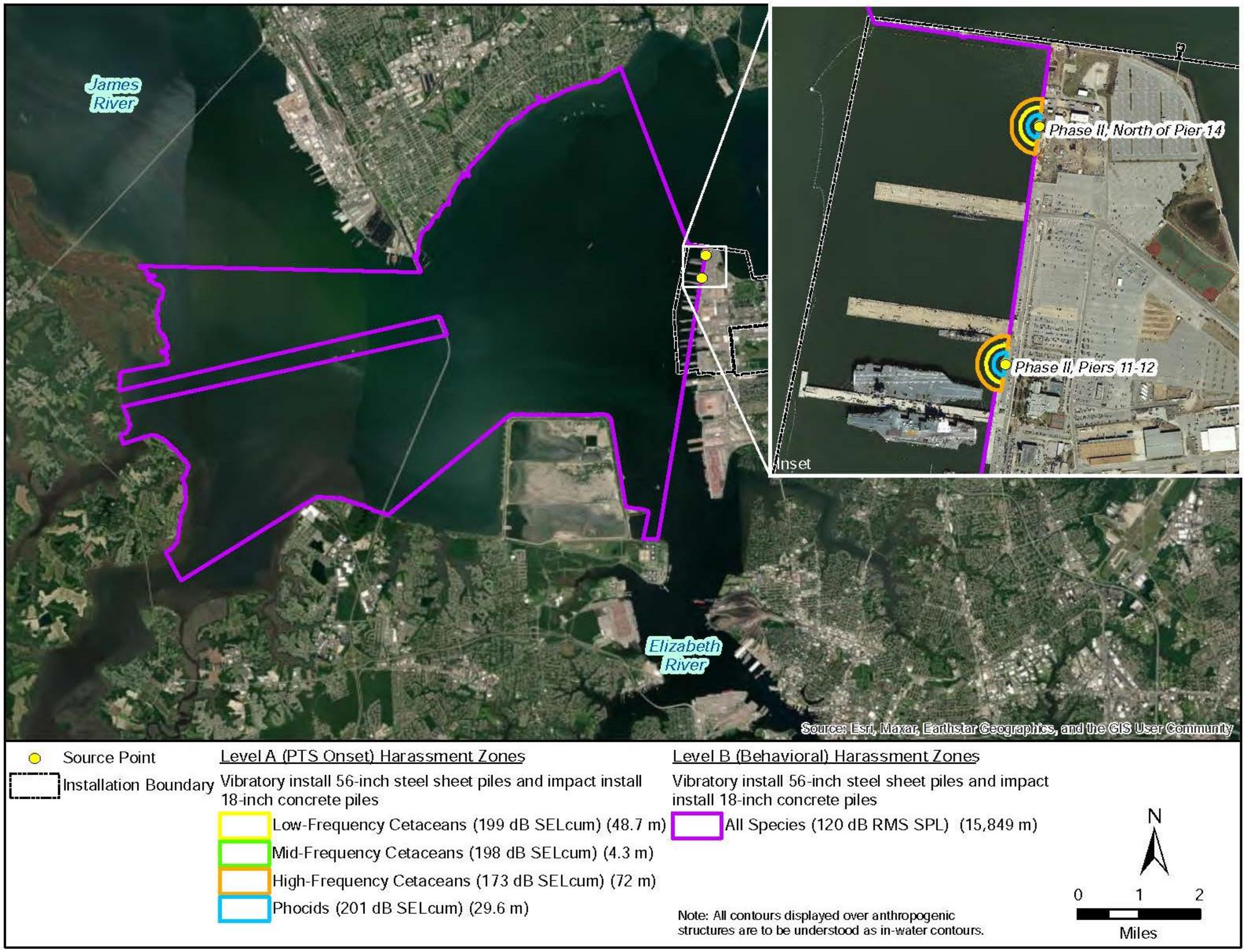

Figure 6-14. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities: Vibratory Installation of 56-inch Steel Sheet Piles and Impact Installation of 18-inch Concrete Piles, Phase II and III

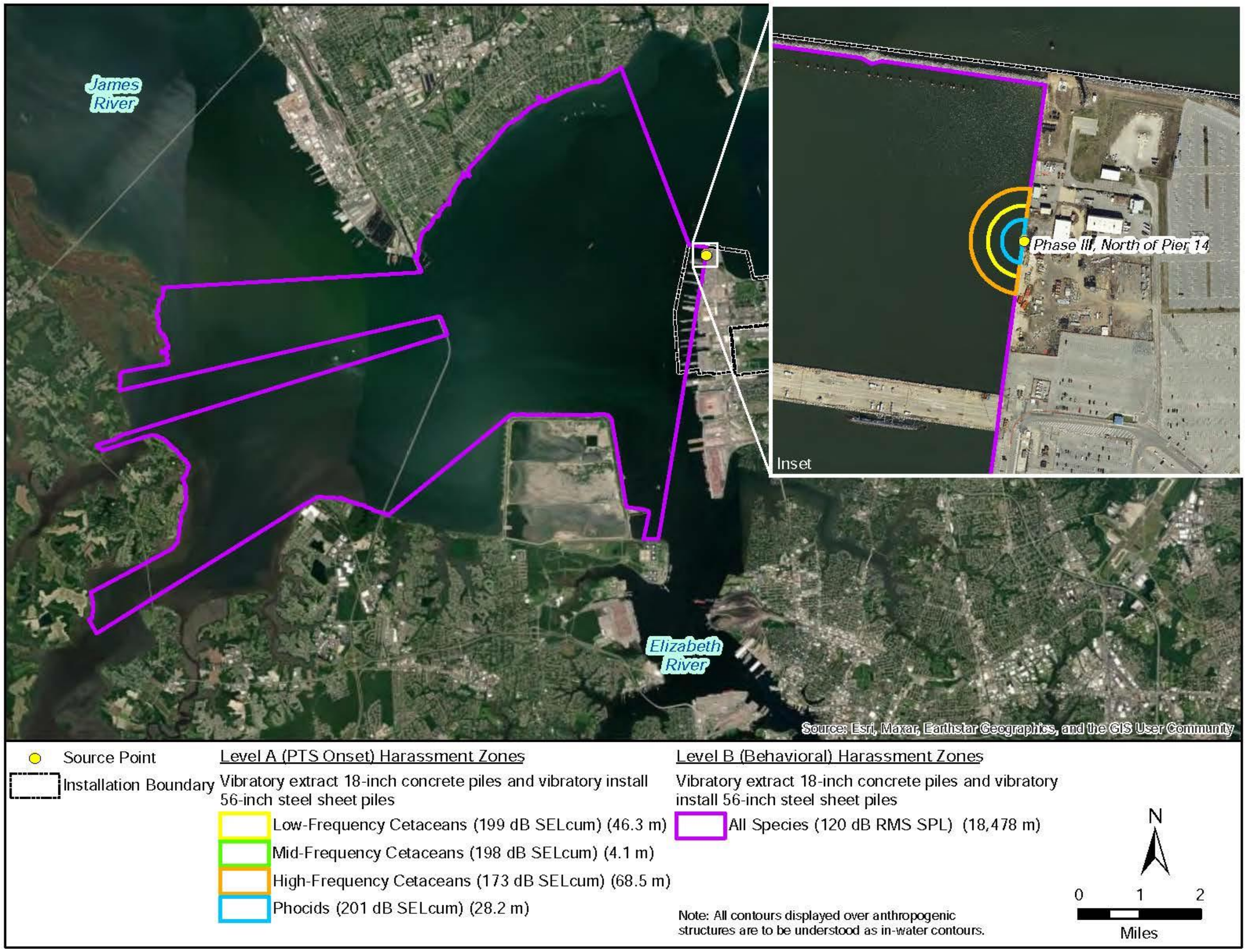

Figure 6-15. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities: Vibratory Extraction of 18-inch Concrete Piles and Vibratory Installation of 56-inch Steel Sheet Piles, Phase III

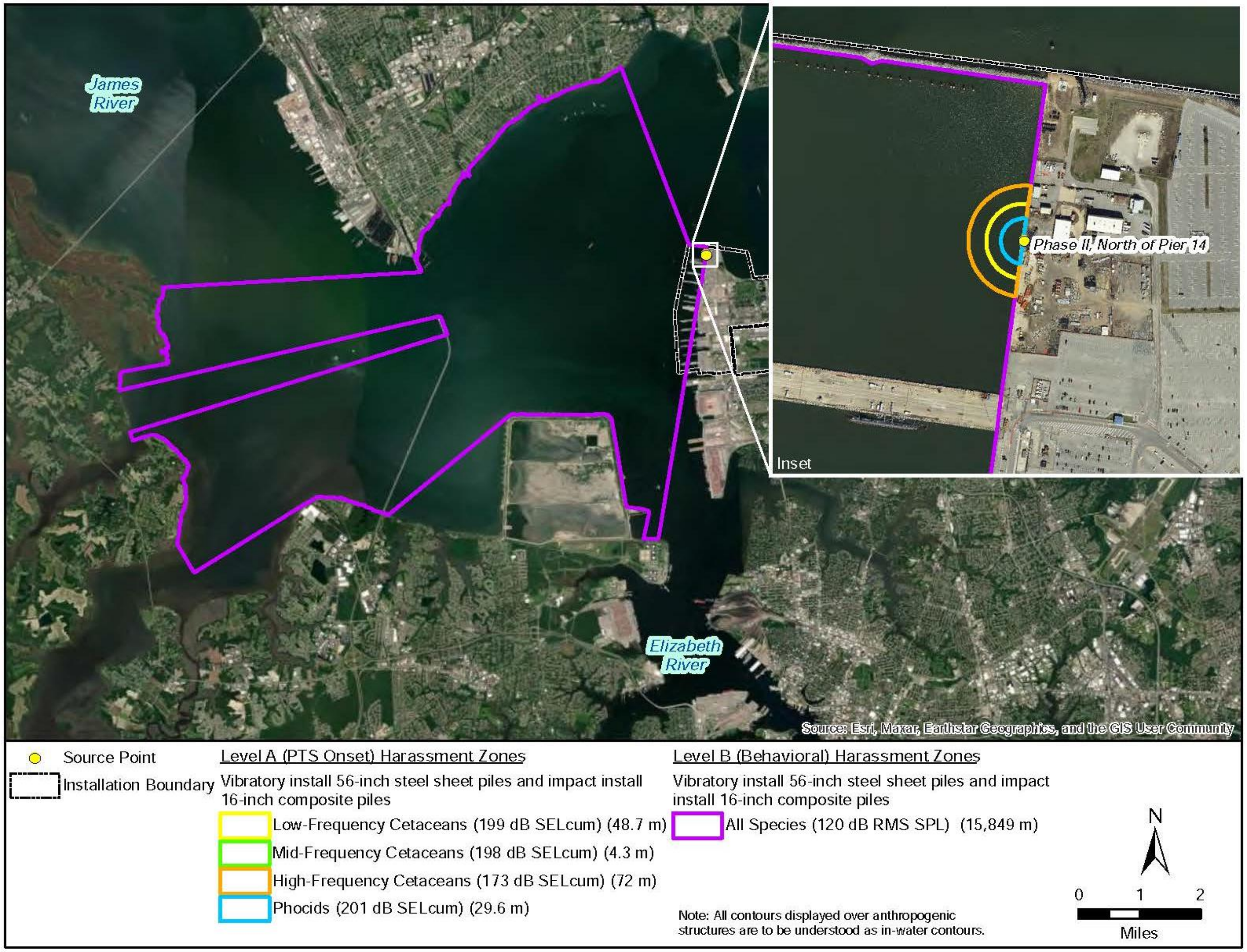

Figure 6-16. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities: Vibratory Installation of 56-inch Steel Sheet Piles and Impact Installation of 16-inch Composite Piles, Phase III

6.9 Airborne Sound Propagation

Pile driving can generate airborne noise that could potentially result in disturbance to pinnipeds that are hauled out or swimming or resting at the water's surface. There is no threshold for Level A injury for airborne sound for marine mammals. As a result, the Navy analyzed the potential for seals to be exposed to airborne SPLs that could result in Level B behavioral harassment. The airborne noise threshold for behavioral harassment for harbor seals is 90 dB RMS re 20 µPa (unweighted) and is 100 dB RMS re 20 µPa (unweighted) for other pinnipeds (see Table 6-3). Construction noise behaves as point-source and propagates in a spherical manner with a 6 dB decrease in SPL over water ("hard-site" condition) per doubling of distance (WSDOT, 2019). The water surface is considered a hard site and acts as a reflective surface where it does not provide any attenuation (WSDOT, 2019). There are no known seal haul out sites in the vicinity of the project area. Therefore, it is assumed that areas affected by airborne noise would be smaller than the underwater behavioral threshold zones, and a separate analysis of airborne noise and associated takes was not conducted. Seals in the airborne zones would already be exposed within the corresponding Level B underwater zone.

6.10 Estimated Duration of Construction

Pile driving and extraction for the proposed project will take approximately 74 nonconsecutive days during the first phase of construction over a period of 12 months from January 1, 2025, to January 1, 2026; approximately 37 nonconsecutive days during the second phase of construction over a period of 12 months from January 1, 2026, through January 1, 2027; and approximately 101 days during the third and final phase of construction over a period of 15 months from January 1, 2027, through December 31, 2028 Some activities may occur concurrently, depending on schedules, contractor selected, and equipment availability. Should concurrent activities occur, they are estimated to take approximately 30 nonconsecutive days during Phase I, 48 nonconsecutive days during Phase II, and 24 nonconsecutive days during Phase III.

6.11 Basis for Estimating Take by Harassment

The Navy is seeking authorization for the potential taking of humpback whale, common bottlenose dolphin, harbor porpoise, harbor seal, and gray seals near NAVSTA Norfolk as a result of pile driving and extraction activities associated with the proposed 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.

6.12 Estimating Potential Exposures to In-Water Construction Noise

6.12.1 Approach to Estimating Abundance of Marine Mammals Exposed to Noise

Density estimates are available for bottlenose dolphins based on shipboard surveys of the mouth of the Chesapeake Bay and Virginia coast (Engelhaupt et al., 2014, 2015, 2016). The Navy has developed a Marine Mammal Species Density Database (Navy, 2017) for the East Coast and Atlantic Fleet Training and Testing Study Area, but there are no densities available for the remaining species in the project area. As discussed in Section 3.1 (Marine Mammal Species Likely to be Found within the Activity Area), using a density-based analysis for species that occur intermittently may not adequately account for their unique temporal and spatial distributions in a limited study area.[1] For rare species, historical occurrence and numbers, and group size were reviewed to develop a realistic estimate of potential exposure to project impacts.

A density-based analysis for bottlenose dolphins uses the following equation to estimate exposure to noise-relative project impacts:[2]

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

where

N = seasonal density estimate used for the species; and

Harassment Zone = the area where noise exceeds the noise threshold value within the ROI.

For the remaining species with no density estimates available for the Chesapeake Bay/Virginia coastline (humpback whale, harbor porpoise, harbor seal, gray seal), the likelihood of occurrence was reviewed based on the information in Section 3 (Marine Mammal Species and Numbers) and Section 4 (Affected Species Status and Distribution) and coordination with NMFS on recent applications at the Installation (Pier 3 replacement Incidental Harassment Authorization and LOA applications). The rationale for estimating probable abundance and duration is described for each species in Section 6.13 (Exposure Estimates). Results of the calculations for all potentially affected marine mammal species are described in Section 6.13.

6.12.2 Assumptions

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

Pinnipeds spend significant amounts of time out of the water during breeding and molting periods, and while resting at haul out sites. In the water, pinnipeds spend varying amounts of time underwater. When not actively diving, pinnipeds at the surface often orient their bodies vertically or horizontally in the water column and hold their heads above the water surface. Consequently, pinnipeds may not be exposed to underwater sounds to the same extent as cetaceans.

To assess impacts from underwater sound, the Navy assumed that all cetacean and pinniped species spend 100 percent of their time underwater. This approach is conservative because seals spend a portion of their time hauled out and are therefore expected to be exposed to less sound than is estimated by this approach. The following additional assumptions were used to calculate potential exposures to impact and vibratory pile driving noise for each threshold:

- The timeframe for takings would be one potential take per individual per 24 hours.

1 Previously, a density-based exposure analysis was required for these species. The analyses often resulted in zero exposure estimates because of the small size of the affected area and the low densities of most species. Therefore, to obtain coverage for potential exposure to these animals, the Navy would typically augment the requested take by the typical group size of animals. NMFS has subsequently requested that future Navy applications do not use a density estimate for marine mammal species with a low likelihood of occurrence.

2 If exposure is greater than or equal to 0.5 animals, the product is rounded up to a whole number.

- The pile type, size, and installation method that produce the largest harassment zones were used to estimate exposure of marine mammals to noise impacts.
- Exposures to airborne noise were considered included in the larger underwater harassment zones from vibratory driving and, therefore, airborne noise exposures were not calculated for seals because no haul outs occur within the airborne harassment zones for the proposed project.
- Take estimates applied NMFS-suggested methods from project discussions with NMFS biologists on the LOA application for replacement of Pier 3 at NAVSTA Norfolk (currently under review; Navy, 2022).

6.13 Exposure Estimates

Exposure estimates for each species are discussed in the following sections and presented in Table 6-10 for individual activities and Table 6-11 for concurrent activities. Reporting requirements will provide details of how many actual and extrapolated animals of each species are exposed to noise levels considered potential Level A or Level B harassment.

Table 6-10. Underwater Exposure Estimates by Species for Individual Activities

LOA Construction Phase	*Individual Activity*	*Species*	*Level A (PTS Onset)*	*Level B (Behavioral)*
Phase I January 2025 – January 2026	Vibratory extract 18-inch pre-stressed concrete square piles (24 days)	Humpback whale	0	0.8
		Bottlenose dolphin	0	1,437
		Harbor porpoise[1]	2	0
		Harbor seal	32.6	293.8
		Gray seal	0	0.4
	Vibratory install 56-inch steel sheet piles (31 days)	Humpback whale	0	1
		Bottlenose dolphin	0	3,977
		Harbor porpoise[1]	2	0
		Harbor seal	42.2	379.4
		Gray seal	0	0.5
	Impact install 18-inch pre-stressed concrete square piles (19 days)	Humpback whale	0	0.6
		Bottlenose dolphin	0	0
		Harbor porpoise[1]	2	0
		Harbor seal	25.8	232.6
		Gray seal	0	0.3
	Total Phase I Requested Take	Humpback whale	0	2
		Bottlenose dolphin	0	5,414

		Harbor porpoise[1]	2	0
		Harbor seal	101	905
		Gray seal	0	1
Phase II January 2026 – January 2027	Vibratory extract 18-inch pre-stressed concrete square piles (11 days)	Humpback whale	0	0.4
		Bottlenose dolphin	0	673
		Harbor porpoise[1]	2	0
		Harbor seal	15.0	134.6
		Gray seal	0	0
	Vibratory install 56-inch steel sheet piles (15 days)	Humpback whale	0	0.5
		Bottlenose dolphin	0	1,936
		Harbor porpoise[1]	0.5	0
		Harbor seal	20.4	183.6
		Gray seal	0	0.23
	Impact install 18-inch pre-stressed concrete square piles (11 days)	Humpback whale	0	0.4
		Bottlenose dolphin	0	0
		Harbor porpoise[1]	2	0
		Harbor seal	15.0	134.6
		Gray seal	0	0
	Total Phase II	Humpback whale	0	2
		Bottlenose dolphin	0	2,609
		Harbor porpoise[1]	2	0
		Harbor seal	50	453
		Gray seal	0	1
Phase III January 2027– December 2028	Vibratory extract 16-inch composite fender piles (30 days)	Humpback whale	0	1
		Bottlenose dolphin	0	476
		Harbor porpoise[1]	2	0
		Harbor seal	40.8	367.2
		Gray seal	0	0.45
	Vibratory install 56-inch steel sheet piles (48 days)	Humpback whale	0	1.6
		Bottlenose dolphin	0	5,692

		Harbor porpoise[1]	2	2
		Harbor seal	65.3	587.5
		Gray seal	0	0.7
	Impact install 16-inch composite piles (18 days)	Humpback whale	0	0.6
		Bottlenose dolphin	0	0
		Harbor porpoise[1]	2	0
		Harbor seal	24.5	220.3
		Gray seal	0	0.3
	Impact install 18-inch pre-stressed concrete square piles (5 days)	Humpback whale	0	0.2
		Bottlenose dolphin	0	0
		Harbor porpoise[1]	2	0
		Harbor seal	6.8	61.2
		Gray seal	0	0
	Total Phase III	Humpback whale	0	4
		Bottlenose dolphin	0	6,168
		Harbor porpoise[1]	2	2
		Harbor seal	137	1,236
		Gray seal	0	2

Key: PTS = permanent threshold shift

[1] To calculate harbor porpoise take the incidence of exposure (# days of activity/density) was rounded to 1 and then multiply by 2 animals per incidence. NMFS guidance is to take the average group size for harbor porpoise (2) for Level A and the remaining total take as Level B. By splitting take per activity, the value is automatically inflated compared to take per total phase due to the rounding.

Table 6-11. Underwater Exposure Estimates by Species for Concurrent Activities

LOA Construction Phase	***Concurrent Activity***	***Year***	***Species***	***Level A (PTS Onset)***	***Level B (Behavioral)***
Phase I	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles	1	Humpback whale	0	0.5
			Bottlenose dolphin	0	1,988
			Harbor porpoise[1]	2	0
			Harbor seal	20	184
			Gray seal	0	0.25
		1; 2; 3	Humpback whale	0	0.6

	Vibratory extract 18-inch concrete piles; vibratory install 56-inch steel sheet piles; impact install 18-inch concrete piles		Bottlenose dolphin	0	2,701
			Harbor porpoise[1]	2	0
			Harbor seal	26	233
			Gray seal	0	0.3
	Total Phase I Requested Take	1; 2; 3	Humpback whale	0	2
			Bottlenose dolphin	0	4,689
			Harbor porpoise[1]	2	0
			Harbor seal	46	417
			Gray seal	0	1
Phase II	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles	2	Humpback whale	0	0.1
			Bottlenose dolphin	0	515
			Harbor porpoise[1]	2	0
			Harbor seal	5	49
			Gray seal	0	0.1
	Vibratory install 56-inch steel sheet piles and impact install 18-inch concrete piles	2; 3	Humpback whale	0	0.4
			Bottlenose dolphin	0	1,527
			Harbor porpoise[1]	2	0
			Harbor seal	15	135
			Gray seal	0	0.2
	Total Phase II	2; 3	Humpback whale	0	2
			Bottlenose dolphin	0	2,042
			Harbor porpoise[1]	2	0
			Harbor seal	20	184
			Gray seal	0	1
Phase III	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles	3	Humpback whale	0	1
			Bottlenose dolphin	0	4,187
			Harbor porpoise[1]	2	0
			Harbor seal	42	379
			Gray seal	0	0.5
		3	Humpback whale	0	0.5

	Vibratory install 56-inch steel sheet piles and impact install 16-inch composite piles		Bottlenose dolphin	0	1,761
			Harbor porpoise[1]	2	0
			Harbor seal	20	184
			Gray seal	0	0.25
	Total Phase III	3	Humpback whale	0	4
			Bottlenose dolphin	0	5,948
			Harbor porpoise[1]	2	2
			Harbor seal	62	563
			Gray seal	0	1

Key: PTS = permanent threshold shift

[1] To calculate harbor porpoise take the incidence of exposure (# days of activity/density) was rounded to 1 and then multiply by 2 animals per incidence. NMFS guidance is to take the average group size for harbor porpoise (2) for Level A and the remaining total take as Level B. By splitting take per activity, the value is automatically inflated compared to take per total phase due to the rounding.

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

6.13.1 Humpback Whale

Humpback whales are seen in the mouth of the Chesapeake Bay and nearshore waters of Virginia during winter and spring months. Most detections during shipboard surveys were of one or two juveniles per sighting. Although two individuals were detected in the vicinity of project activities, there is no evidence that they linger for multiple days. Because no density estimates are available for the species in this area, the Navy estimated two takes for every 60 days of pile driving, based on the potential group size of two animals. The resulting estimate of potential exposures from individual activities to Level B noise ranges from two individuals each in Years 1 and 2 and four individuals in Year 3 (Table 6-10). There are estimated to be two takes from concurrent activities in each Year (Table 6-11). The majority of affected humpback whales would be expected to be juveniles.

To protect humpback whales from injurious noise impacts, the Navy will implement a shutdown if any whales are seen by marine mammal monitors in an injury zone (Table 5-2). Therefore, no Level A takes are requested for humpback whales.

6.13.2 Bottlenose Dolphin

Bottlenose dolphins are abundant along the Virginia coast and within the Chesapeake Bay and can be seen annually in Virginia from May through October. Shipboard surveys of marine mammals in the vicinity of NAVSTA Norfolk and nearshore Virginia coast have provided seasonal densities of bottlenose dolphins. However, following the methods used in the Pier 3 Incidental Harassment Authorization issued in March 2022 and the subsequent LOA application for remaining work, a density of 1.38 animals per sq km has been applied (87 FR 15945; Navy, 2022; NMFS, 2023). Exposure to Level A and Level B harassment due to pile driving was estimated using the equation in Section 6.11 (Estimating Potential Exposures to Pile Driving Noise), in which the inputs are density, harassment zone, and maximum number of pile driving days. Based on the proposed activities, takes were estimated and included in Tables 6-10 and 6-11.

Total bottlenose dolphin Level B takes are estimated to be 14,191 for individual activities (all three years) while concurrent activity take estimates result in 12,679 Level B takes. To be conservative, the Navy is requesting the maximum amount of take associated with the individual activities. However, because some activities may occur individually or concurrently, the resulting takes are likely to be less than this estimate and actual takes of this species will be reported in the required annual reports.

The largest injury zone for bottlenose dolphins is 4.3 m resulting from the vibratory driving of 56-inch steel sheet piles in Year 3. This and all Level A harassment zones for bottlenose dolphins fall within the proposed 10-m shutdown zone (Table 5-2). Therefore, no Level A takes are requested for bottlenose dolphins.

6.13.3 Harbor Porpoise

Harbor porpoises appear to be rare in the Chesapeake Bay waters in most years, and there is no information about how long they would linger in the area, when present. For this analysis, it is assumed that any harbor porpoises that occur in the NAVSTA Norfolk vicinity are transiting through the area. Elsewhere in their range they typically occur in groups of two to three individuals (Carretta et al., 2001; Smultea et al., 2017). Because there are no density estimates for the species in project area, the Navy conservatively estimated one exposure of two porpoises for every 60 days of pile driving. Additionally, during consultation with NMFS on the Pier 3 LOA, NMFS recommended using a group size of two for Level A harassment and remaining takes would be attributed to Level B harassment. Using this methodology, there would be two Level A takes and zero Level B takes each in Years 1 and 2, and there would be two Level A and two Level B takes in Year 3 (Table 6-10). For concurrent activities, it is estimated that there would be two Level A takes in each year and no Level B takes (Table 6-11). Animals of any age, sex, or reproductive status could be exposed to elevated underwater noise.

6.13.4 Harbor Seal

Harbor seals regularly haul out on rocks around the portal islands of the CBBT (between approximately 20 and 26 km from the project area and on mud flats on the nearby southern tip of the Eastern Shore, over 35 km from the project area [Rees et al., 2016; Jones et al., 2018]), and some individuals regularly range into the Chesapeake Bay. Their occurrence is seasonal, from November to April. Although density estimates are not available for this area, haul out survey data can be used to estimate exposure to pile driving noise at the project location. The maximum seal count on a single survey day during four survey seasons at CBBT was 45 and during two survey seasons at the Eastern Shore haul out site the maximum count was 69 (Rees et al., 2016; Jones et al., 2018). Animals move between haul out sites; therefore, the highest maximum count at the Eastern Shore haul out was used to estimate exposures of harbor seals. Tracking of seven satellite-tagged harbor seals that were captured in the winter at the Eastern Shore haul out site revealed that four seals made trips into the Chesapeake Bay, including one seal that stayed in the bay until it migrated from the area (Ampela et al., 2019). Tracking data indicate that one of these seals entered Hampton Roads Harbor, transited past NAVSTA Norfolk and on to the Warwick River, a minor tributary of James River located approximately 24 km northwest of NAVSTA Norfolk. None of the other seals entered Hampton Roads Harbor. Three tagged seals never entered the Chesapeake Bay. All tagged seals migrated from the area by mid-April. The tagged seals made a total of 56 trips, defined as travel greater than 10 km away from the capture site, while in Virginia waters, of which 36 percent were within the Chesapeake Bay.

Consistent with the Pier 3 replacement LOA application currently under NMFS review (Navy, 2022), the Navy calculated harbor seal takes based on 13.6 seals per day, multiplied by the number of pile-driving days expected during the months that harbor seals are expected to be within the project area (November 1 through April 30). Level A takes were calculated based on the assumption that approximately 10 percent of harbor seal exposures would be at or above the Level A harassment threshold and remaining takes were attributed to Level B harassment.

A total of 288 Level A and 2,594 Level B takes are estimated for individual activities for all three years, while concurrent activities could result in 128 Level A and 1,164 Level B takes across all three years (Tables 6-10 and 6-11, respectively). To be conservative, the Navy is requesting the maximum amount of take associated with the individual activities. However, because activities may occur either individually or concurrently, the resulting takes are likely to be less than this estimate and actual takes of this species will be reported in the required annual reports.

6.13.5 Gray Seal

Very little information is available about the occurrence of gray seals in the Chesapeake Bay and coastal waters. Although the population of the United States may be increasing, there are only a few records at known haul out sites in Virginia used by harbor seals, strandings are rare, and they have not been reported in shipboard surveys. Assuming that they may utilize the Chesapeake Bay waters, the Navy conservatively estimates that one gray seal may be exposed to elevated noise levels for every 60 days of vibratory pile driving during the six-month period when they are most likely to be present. Furthermore, 10 percent of those takes would be attributed to Level A take while 90 percent would be attributed to Level B take. This methodology results in one Level B and zero Level A takes for Year 1, one Level B and zero Level A takes for Year 2, and 2 Level B takes and zero Level A takes for Year 3 of construction for individual activities (Table 6-10). Concurrent activities would result in 1 Level B and zero Level A takes for each year (Table 6-11). Because activities may occur either individually or concurrently, the resulting takes are likely to be less than this estimate and actual takes of this species will be reported in the required annual reports.

7 IMPACTS TO MARINE MAMMAL SPECIES OR STOCKS

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

7.1 Potential Effects of In-water Construction on Marine Mammals

7.1.1 Potential Effects Resulting from Underwater Noise

Potential impacts to marine species can be caused by physiological responses to both the type and strength of the acoustic signature (Viada et al., 2008). Behavioral impacts may also occur, though the type and severity of these effects are more difficult to define due to limited studies addressing the behavioral effects of impulsive sounds on marine mammals. Potential effects from impulsive sound sources can range from Level B effects such as brief behavioral disturbance, tactile perception, and physical discomfort, to Level A impacts, which may include slight injury of the internal organs primarily within air spaces (e.g., lungs, sinuses, ears, and gastrointestinal tract) and the auditory system, and possible death of the animal (Yelverton et al., 1973; O'Keeffe & Young, 1984; Ketten, 1995; Navy, 2001; Dahl et al., 2015; Finneran, 2015; Kastelein et al., 2016; Kastelein et al., 2018).

7.1.1.1 Physiological Responses

Direct tissue responses to impact/impulsive sound stimulation may range from mechanical vibration or compression with no resulting injury to tissue trauma (injury). Because the ears are the most sensitive organ to pressure, they are the organs most sensitive to injury (Ketten, 2000). Sound-related trauma can be lethal or sub-lethal. Lethal impacts are those that result in immediate death or serious debilitation in or near an intense source (Ketten, 1995). Sub-lethal damage to the ear from a pressure wave can rupture the tympanum, fracture the ossicles, and damage the cochlea; it can also cause hemorrhage, and cause leakage of cerebrospinal fluid into the middle ear (Ketten, 2004). Sub-lethal impacts also include hearing loss, which is caused by exposure to perceptible sounds. Moderate injury implies partial hearing loss. Permanent hearing loss (or PTS) can occur when the hair cells of the ear are damaged by a very loud event, as well as by prolonged exposure to noise. Instances of TTSs 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 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; Mooney et al., 2009; Kastelein et al., 2015; Finneran, 2015). While injuries to other sensitive organs are possible, they are less likely since pile driving impacts are almost entirely acoustically mediated, versus explosive sounds that also include a shock wave that can result in damage.

7.1.1.2 Behavioral Responses

Considerable variability has been observed in marine mammal responses to sound. For each potential behavioral change, the magnitude of the change ultimately determines the severity of the response. Other variables and contextual factors that may affect the probability and magnitude of a behavioral response include subject-specific factors (e.g., age, sex, presence of a calf, and group size and composition), characteristics of the sound (frequency, duration, similarity to predator sounds, and whether it is continuous or intermittent); whether the sound is approaching or moving away; the presence of predators, prey, or conspecifics; and navigational constraints on the animal (Ellison et al., 2011; Southall et al., 2021).

Habituation occurs when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok et al., 2004). Animals are most likely to habituate to sounds that are predictable and unvarying. The opposite process is sensitization—when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. Behavioral state or differences in individual tolerance levels may affect the type of response as well. For example, animals that are resting may show greater behavioral change in response to disturbing noise levels than animals that are highly motivated to remain in an area for feeding (National Research Council, 2003; Wartzok et al., 2004; Southall et al., 2007; Richardson et al., 1995). Indicators of disturbance may include sudden changes in the animal's behavior or avoidance of the affected area. A marine mammal may show signs that it is startled by the noise and/or it may swim away from the sound source and avoid the area. Increased swimming speed, increased surfacing time, and cessation of foraging in the affected area would indicate disturbance or discomfort. Pinnipeds may increase their haul out time, possibly to avoid in-water disturbance.

Methods have been developed and refined to categorize and assess the severity of acute responses, considering impacts to individuals that may consequently impact populations (Southall et al., 2007; Southall et al., 2021). These severity scales assess immediate discrete responses in relation to behaviors affecting vital rates, including survival, reproduction, and foraging. Using these scales, a behavioral response by a wild (non-captive) marine mammal may range from low severity (e.g., detectable interruptions in foraging, diving, or courtship behavior) to moderate severity (e.g., avoidance, sustained foraging reduction) to high severity (e.g., separation of mother-offspring, prolonged displacement from foraging habitat, repeated breeding disruption leading to reduced reproductive success). The revised report updated the single severity response criteria defined in Southall et al. (2007) into three parallel severity tracks that score behavioral responses from 0 to 9. The three severity tracks are (1) survival, (2) reproduction, and (3) foraging. This approach is acknowledged as being relevant to vital rates, defining behaviors that may affect individual fitness, which may ultimately affect population parameters. It is noted that not all the responses within a given category need to be observed but that a score is assigned for a severity category if any of the responses in that category are displayed. To be conservative, the highest (or most severe) score is to be assigned for instances when several responses are observed from different categories. Captive animal behavior studies allow for controlled, repeated exposures with very precise measures, but captive marine mammals may have training and motivational contexts that make their responses difficult to compare to free-ranging, non-captive animals (Southall et al., 2021).

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, including pile driving) have been varied, but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton & Symonds, 2002; Gordon et al., 2004; Wartzok et al., 2004; Nowacek et al., 2007). Some studies of acoustic harassment and acoustic deterrence devices have found habituation in resident populations of seals and harbor porpoises (see review in Southall et al., 2007). Blackwell et al. (2004) found that ringed seals exposed to underwater pile driving sounds in the 153 to 160 dB RMS range tolerated this noise level and did not seem unwilling to dive. One individual was as close as 63 m from the pile driving.

While in general, the louder the sound source, the more intense the behavioral response, it was clear that the proximity of a sound source and the animal's experience, motivation, and conditioning were also critical factors influencing the response (Southall et al., 2007). Ellison et al. (2011) submit that "exposure context" greatly influences the type of behavioral response exhibited by an animal and outlined an approach to assessing the effects of sound on marine mammals that considers not just the received level of sound, but also in what activity the animal is engaged, the nature and novelty of the sound (i.e., is this a new sound from the animal's perspective), and the distance between the sound source and the animal.

Responses of harbor seals to impact pile driving at the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project were mixed (Caltrans, 2001; Thorson & Reyff, 2006; Thorson, 2010). Harbor seals were observed in the water at distances of approximately 400 to 500 m from the pile driving activity and exhibited no alarm responses, although several showed alert reactions, and none of the seals appeared to remain in the area. It is likely that seals were transiting through the pile driving area to the haul out site or feeding areas despite pile driving noise. One of these harbor seals was even seen to swim to within 150 m of the pile driving barge during pile driving.

Telemetry studies and modeling of harbor seal usage of offshore wind farm sites in Britain showed significant displacement of harbor seals during periods when impact pile driving was taking place (up to 25 km from the center of the wind farm), but use of the area resumed during breaks in pile driving greater than two hours (Russell et al., 2016). Another telemetry study conducted in the Wadden Sea found that reactions to pile driving were diverse. Reactions included altered surfacing or diving behavior and changes in swim direction, including swimming away from the source, heading into shore or traveling perpendicular to the incoming sound, coming to a halt, and slowing descent speed (suggesting a transition from foraging to more horizontal movement). Additionally, seals within 33 km of the pile driving were more likely to swim away (Aarts et al., 2017).

Studies of marine mammal responses to continuous noise, such as vibratory pile driving, are limited. Observations of marine mammals on Naval Base Kitsap Bangor during a test pile installation/removal project concluded that pinniped (harbor seal and California sea lion) foraging behaviors decreased slightly during construction periods involving impact and vibratory pile driving, and both pinnipeds and harbor porpoises were more likely to change direction while traveling during construction (HDR Inc., 2012). Pinnipeds were more likely to dive and sink when closer to pile driving activity, and a greater variety of other behaviors were observed with increasing distance from pile driving. Most harbor porpoises were observed swimming or traveling through the project area and no obvious behavioral changes were associated with pile driving. As detailed in Section 6.5, Branstetter et al. (2018) found evidence of altered behavior resulting from vibratory pile driving in bottlenose dolphins (an almost complete cessation of echolocation clicks) only at the highest source level (roughly estimated as 128 dB re 1 µPa); however, the effect on behavior diminished significantly, indicating acclimation.

A total of three years of marine mammal monitoring were conducted during vibratory and impact pile driving for the construction of Explosives Handling Wharf 2 at Naval Base Kitsap Bangor in Washington (Hart Crowser, Inc., 2013, 2014, 2015). Results from monitoring varied slightly year to year, but in general it was found that harbor seals were most frequently observed having no motion to the construction zone during vibratory pile driving, and during impact driving, seals were most frequently observed moving away from the pile. Harbor porpoises were only observed at a greater distance from the construction area than seals, where the predominant behavior during construction (vibratory pile driving) was swimming or traveling through the project area. Harbor porpoise foraging was reported during pre-construction monitoring, but not during pile driving. Marine mammal observers did not detect adverse reactions to these construction activities at Naval Base Kitsap Bangor that would be consistent with distress, injury, or high-speed withdrawal from the area, nor did they report obvious changes in less acute behaviors.

Marine mammal monitoring at the Port of Anchorage marine terminal redevelopment project in Alaska found no response by marine mammals swimming within the threshold distances to noise impacts from construction activities including pile driving (both impact hammer and vibratory driving). Most marine mammals observed during the two lengthy construction seasons were beluga whales, while harbor seals, harbor porpoises, and Steller sea lions were observed in smaller numbers. Background noise levels at this port are typically at 125 dB.

A comprehensive review of acoustic and behavioral responses to noise exposure by Nowacek et al. (2007) concluded that one of the most common behavioral responses is displacement. To assess the significance of displacements, it is necessary to know the areas to which the animals relocate, the quality of that habitat, and the duration of the displacement in the event that they return to the pre-disturbance area. Short-term displacement may not be of great concern unless the disturbance happens repeatedly. Similarly, long-term displacement may not be of concern if adequate replacement habitat is available. Modeling of population-level impacts of pile driving noise for offshore wind farm development suggests that behavioral displacement could lead to reduced reproductive success of displaced female harbor seals during construction years. However, the common pattern at the population level was short-term reductions in abundance during and immediately after the construction period, followed by recovery with no observable long-term consequences (Thompson et al., 2013).

Marine mammals encountering pile driving operations over a project's construction timeframe would likely avoid affected areas in which they experience noise-related discomfort, limiting their ability to forage or rest there. As described in the section above, individual responses to pile driving noise are expected to be variable. Some individuals may occupy a project area during pile driving without apparent discomfort, but others may be displaced with undetermined effects. Avoidance of the affected area during pile driving operations would reduce the likelihood of injury impacts but would also reduce access to foraging areas. Noise-related disturbance may also inhibit some marine mammals from transiting the area. Given the duration of the in-water construction period, there is a potential for displacement of marine mammals from affected areas due to these behavioral disturbances during the in-water construction season. However, in some areas habituation may occur resulting in a decrease in the severity of response. Since pile driving will only occur during daylight hours, marine mammals transiting a project area or foraging or resting in a project area at night will not be affected. Effects of pile driving activities will be experienced by individual marine mammals but will not cause population-level impacts or affect the continued survival of the species because the effects are temporary, highly localized in a peripheral portion of their range, and likely would affect a small portion of the stock.

7.1.2 Potential Effects Resulting from Airborne Noise

Pinnipeds that occur in the project area could be exposed to airborne sounds associated with pile driving that have the potential to cause behavioral harassment, depending on their distance from pile driving activities. Airborne pile driving noises are expected to have very little impact to cetaceans because most noise from atmospheric sources does not transmit well through the air-water interface (Urick, 1972; Richardson et al., 1995); consequently, cetaceans are not expected to be exposed to airborne sounds that will result in harassment as defined under the MMPA. Airborne noise will primarily be an issue for pinnipeds that are swimming or hauled out within the range of impact as defined by the acoustic criteria discussed in Section 6 (Numbers and Species Exposed). Most likely, airborne sound will cause behavioral responses similar to those discussed above in relation to underwater noise. For instance, anthropogenic sound could cause hauled out pinnipeds to exhibit changes in their normal behavior, such as reduction in vocalizations, or cause them to temporarily abandon their usual or preferred locations and move farther from the noise source. Pinnipeds swimming near pile driving may avoid or withdraw from the area, or may show increased alertness or alarm (e.g., heading out of the water and looking around). However, studies of ringed seals by Blackwell et al. (2004) and Moulton et al. (2005) indicate a tolerance or lack of response to unweighted airborne sounds as high as 112 dB peak pressure and 96 dB RMS, which suggests that habituation occurred.

California sea lions and harbor seals were present during impact installation and vibratory extraction of piles at Naval Base Kitsap Bremerton in February 2014 and from November 2014 to February 2015 (Northwest Environmental Consulting, 2014, 2015). In February 2014, California sea lions were observed basking on the port security barrier within the underwater behavioral disturbance zone (117 m from the driven pile) and no behavioral harassment takes were documented because they did not enter the water. California sea lions and harbor seals were observed in the water during vibratory driver activity. Marine mammal observers detected 160 individuals during vibratory pile extraction within the 1,600-m vibratory disturbance zone, resulting in exposure to noise levels above the Level B threshold. Marine mammal observers detected 125 individuals during impact pile driving within the 117-m impact disturbance zone, resulting in exposure to noise levels above the Level B threshold. There were no shutdowns of pile driving activity because pinnipeds never entered the injury zones. No visible behaviors indicating a reaction to noise disturbance were observed. Behaviors observed included hauling-out (resting), foraging, milling, and traveling.

Based on these observations, marine mammals in the zones of influence for airborne noise may exhibit temporary behavioral reactions to airborne pile driving noise. These exposures may have a temporary effect on seals, but this level of exposure is very unlikely to result in population-level impacts because the effects are temporary, highly localized, and relatively few harbor and gray seals occur in the project area. In particular, the closest known haul out sites for seals in the vicinity of NAVSTA Norfolk are the CBBT portal islands (located approximately 20 to 26 km from the project location) and the mud flats on the nearby southern tip of the Eastern Shore (more than 35 km from the project location), which rules out the possibility of behavioral disturbance to hauled out seals due to pile driving noise.

7.2 Conclusions Regarding Impacts on Species or Stocks

Individual marine mammals may be exposed to increased SPLs during pile driving operations, which may result in Level B behavioral harassment. Any marine mammals that are exposed (harassed) may change their normal behavior patterns (i.e., swimming speed, foraging habits) or be temporarily displaced from the area of construction. Any exposures to Level B harassment will likely have only a minor effect on individuals and no effect on the population. The proposed shutdown zone of 150 m from the point of noise generation will help to minimize the number of Level A takes; therefore, the requested Level A takes in the application are likely to be overestimated. Additionally, work would stop if a humpback whale were to enter any Level A harassment zone (Table 5-2); therefore, there are no Level A takes anticipated for this species. Exposure to Level B behavioral disturbance is possible at the project area, as discussed in Section 6 (Numbers and Species Exposed). However, this level of effect is not anticipated to have any adverse impact to population recruitment, survival, or recovery because the effects are temporary, highly localized in a peripheral portion of their range, and would potentially affect a small portion of the stock. No major feeding or reproductive areas, or pinniped haul out sites would be affected by project activities.

8 IMPACTS TO SUBSISTENCE USE

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

This section is not applicable. The project is located at NAVSTA Norfolk, in Norfolk, Virginia. No traditional subsistence hunting areas are within the region.

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

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

Impacts to habitat include increased human activity and noise levels; localized, minor impacts to water quality; and changes in prey availability near the individual project sites. Since the focus of the Proposed Action is pile driving, no habitat loss is expected. The new bulkhead will be installed in front of the existing bulkhead. The nearshore area adjacent to the Q8 Bulkhead is routinely disturbed through prop wash and maintenance dredging and no submerged aquatic vegetation exists. Benthic organisms will be disturbed and lost during construction activities but are expected to recolonize the areas once construction is complete.

9.1 Effects from Human Activity and Noise

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

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

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

9.2 Impacts on Prey Base

Pile installation and removal will impact marine habitats used by fish and benthic invertebrate species, which comprise the prey base for marine mammals. Marine habitats used by prey species that occur in the project area include nearshore intertidal and subtidal habitats, including marine vegetation and piles used for structure and cover. The greatest impact to prey species during pile installation will result from behavioral disturbance due to pile driving noise. Secondary impacts include temporary benthic habitat displacement and re-suspension of sediments.

9.2.1 Water Quality

Temporary and localized reduction in water quality will occur because of in-water construction activities. Most of this effect will occur during the installation and removal of piles when bottom sediments are disturbed. The installation of piles will disturb bottom sediments and may cause a temporary increase in suspended sediment in the project area. Using available information collection from a project in the Hudson River, pile driving activities are anticipated to produce total suspended sediment concentrations of approximately 5.0 to 10.0 milligrams per liter above background levels within approximately 300 ft (91 m) of the pile being driven (NMFS, 2017). This estimate was based on information collected from similar activities conducted in the Hudson River, which has a high percentage of silt and clay in bottom sediments (NYSDEC, 2000). During pile extraction, sediment attached to the pile moves vertically through the water column until gravitational forces cause it to slough off. The small resulting sediment plume is expected to settle out of the water column within a few hours. Studies of the effects of turbid water on fish suggest that concentrations of suspended sediment can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton, 1993). The total suspended sediment levels expected for pile driving or removal (5.0 to 10.0 milligrams per liter) are below those shown to have adverse effects on fish (580.0 milligrams per liter for the most sensitive species, with 1,000.0 milligrams per liter more typical) and benthic communities (390.0 milligrams per liter [EPA, 1986]). Turbidity within the water column has the potential to reduce the level of oxygen in the water and irritate the gills of prey fish species in the construction area. However, turbidity plumes would be temporary and localized, and fish in the construction area would likely move away from the affected areas. Therefore, it is expected that the impacts on fish species from turbidity and therefore on marine mammals, would be minimal and temporary.

Pile extraction and installation may have impacts on benthic invertebrate species primarily associated with disturbance of sediments that may cover or displace some invertebrates. The impacts will be temporary and highly localized, and no habitat will be permanently displaced by construction. Therefore, it is expected that impacts on foraging opportunities for marine mammals due to project activities would be minimal.

9.2.2 Underwater Noise Impacts on Prey Base

Calculated distances to injury thresholds are 2 m or less for fish species. Given the small size of the potentially affected area, the injury zones will be negligible for all life stages of fish, and by extension the impact on marine mammal predators will be negligible. Impact pile driving is likely to exceed the established underwater noise TTS for fish. TTS zones will be greatest during impact driving of composite piles (26 m) (Appendix A). Given the relatively small size of these zones, adverse impacts on prey availability for marine mammals are negligible and do not rise to the level of MMPA take. Ample foraging opportunities exist in the general area outside of these zones.

9.3 Likelihood of Habitat Restoration

The impacts of the Proposed Action on marine habitats will be temporary and highly localized; therefore, no habitat restoration is planned.

9.4 Summary of Impacts on Marine Mammal Habitat

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

Construction may have permanent and temporary impacts on benthic invertebrate species, another marine mammal prey source. Direct benthic habitat loss would result from the installation of new structures; however, some of the older existing structures will be removed. Overall, there will be a loss of habitat within the action area, but this small reduction would be minor in comparison to the total available benthic habitat in the Hampton Roads area of the Chesapeake Bay. Furthermore, the areas to be permanently impacted are located along NAVSTA Norfolk's waterfront and are regularly disturbed from maintenance dredging and ship movements (e.g., vessel propeller wakes) during waterfront operations. Therefore, impacts of the project are not likely to have adverse effects on marine mammal foraging habitat in the proposed project area.

10 IMPACTS TO MARINE MAMMALS FROM LOSS OR MODIFICATION OF HABITAT

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

The Proposed Action is not expected to have any habitat-related effects that could cause significant or long-term consequences for populations of marine mammals because all activities will be temporary. The Proposed Action will affect marine mammal habitats indirectly through temporary, localized impacts on prey abundance and availability. The most important impacts on marine fish species consumed by marine mammals will result from potential TTS effects on fish during pile driving. TTS is a behavioral disturbance that is, by definition, temporary, and any impacts to the marine mammal prey base will cease upon completion of construction. As discussed in Section 9, there will be no permanent loss or modification of habitat.

11 MEANS OF EFFECTING THE LEAST PRACTICABLE ADVERSE IMPACTS

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

General best management practices (BMPs), mitigation and minimization measures that may be implemented for all in-water repair and replacement activities, are presented in the following subsections. These BMPs are routinely used by the Navy during marine structure maintenance, repair, and pile replacement activities. BMPs are intended to avoid and minimize potential environmental impacts. BMPs are included in construction contract plans and specifications for individual projects and become requirements that the contractor must implement.

11.1 General Construction Best Management Practices

- The Navy will adhere to performance conditions imposed as part of the Clean Water Act, Section 404, Permit and Section 401, Water Quality Certification. No in-water work will be conducted until the Clean Water Act authorization process has been completed.
- An Environmental Protection Plan will be prepared before the start of construction activities. The plan will identify construction planning elements and recognize spill sources at the sites. The plan will outline BMPs, responsive actions in the event of a spill or release, and notification and reporting procedures. The plan will also outline contractor management elements such as personnel responsibilities, project site security, site inspections, and training.
- No petroleum products, fresh cement, lime, fresh concrete, chemicals, or other toxic or harmful materials will be allowed to enter surface waters.
- Wash water resulting from washdown of equipment or work areas will be contained for proper disposal and will not be discharged.
- Equipment that enters surface water will be maintained to prevent any visible sheen from petroleum products.
- No oil, fuels, or chemicals will be discharged to surface waters, or onto land where there is a potential for re-entry into surface waters. Equipment, such as fuel hoses, oil drums, oil or fuel transfer valves, and fittings, will be checked regularly for leaks. Materials will be maintained and stored properly to prevent spills.
- No cleaning chemicals or solvents will be discharged to ground or surface waters.

11.2 Pile Repair, Removal, and Installation Best Management Practices

11.2.1 General Pile Removal and Replacement

- Removed piles and associated sediments (if any) will typically be contained on a barge. If a barge is not utilized, piles and sediments may be stored in a containment area near the construction sites.
- Piles that break or are already broken below the waterline may be removed by pulling them directly from the sediment with a crane. If this is not possible, piles will be removed with a clamshell bucket. To minimize disturbance to bottom sediments and splintering of piling, the contractor will use the minimum size bucket required to pull out piles based on pile depth and substrate. The clamshell bucket will be emptied of piling and debris on a contained barge before it is lowered into the water. If the bucket contains only sediment, the bucket will remain closed and be lowered to the mud-line and opened to redeposit the sediment. In some cases (depending on access, location, and other factors), piles may be cut below the mud-line.
- Any floating debris generated during removal or installation will be retrieved. Any debris in a containment boom will be removed by the end of the workday or when the boom is removed, whichever occurs first. Retrieved debris will be disposed of at an upland disposal site.
- Whenever activities that generate sawdust, drill tailings, concrete fragments, or wood chips from treated timbers are conducted, tarps or other containment material will be used to prevent debris from entering the water.
- If excavation around piles to be repaired or replaced is necessary, hand tools or a siphon dredge will be used to excavate around piles. If siphon dredges are used, any contaminated sediment must be accounted for as waste and disposed of properly.

11.3 Minimization Measures for Marine Mammals and Other Protected Species

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

11.3.1 Coordination

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

11.3.2 Soft Start

The Navy will utilize a "soft start" procedure to provide a warning and give animals in proximity to pile driving the opportunity to leave the area prior to an impact driver operating at full capacity, thereby exposing fewer animals to loud underwater and airborne sounds. The soft start will be accomplished by providing an initial set of strikes from the impact hammer at reduced energy, followed by a 30-second waiting period, then two subsequent sets. The soft start procedure will be used for impact pile driving at the beginning of each day's in-water pile driving or any time pile driving has ceased for more than 30 minutes.

The reduced energy of an individual hammer cannot be quantified because they vary by individual drivers. Also, the number of strikes will vary at reduced energy because raising the hammer at less than full power and then releasing it results in the hammer "bouncing" as it strikes the pile resulting in multiple "strikes."

11.3.3 Visual Monitoring and Shutdown Procedures

A Marine Mammal Monitoring Plan will be submitted to NMFS for approval prior to commencement of project activities. At a minimum, the plan will include the following: a visual monitoring program, acoustic monitoring program, and reporting activities.

In order to reduce the potential for Level A (PTS onset) or Level B (behavioral) harassment, the following visual monitoring will be implemented, and shutdown procedures will be put into effect if a marine mammal were to approach a shutdown zone for the activity being conducted. Impacts are expected to be insignificant and no injury would be expected, as monitors will ensure the shutdown zone is clear of mammals before the start of in-water noise-generating activities. Proposed monitoring zones are provided in Table 11-1. The minimum monitoring zone is equivalent to the general construction shutdown zone described below.

- For humpback whales, work will stop any time the species is sighted approaching the humpback whale Level A harassment zone. This approach will prevent the need for Level A takes for this species.
- For all impact and vibratory pile driving and drilling, shutdown zones would be as specified in Table 5-2. These shutdown zones will help to reduce injury. They will be monitored at all times as specified in Table 5-2 and work will stop as soon as safely possible if an animal is seen approaching these zones.
- To record takes, the entire Level A (PTS onset) zones beyond the shutdown zones in Table 5-2 and a portion of the Level B (behavioral) harassment zones will be visually monitored.
- In order to prevent injury from physical interaction with construction equipment, a general construction shutdown zone of 10 m (33 ft) will be implemented during all in-water construction activities having the potential to affect marine mammals to ensure marine mammals are not present within this zone. These activities could include but are not limited to barge positioning, dredging, or pile driving. For some sound-generating activities, the potential for Level A (PTS onset) harassment by acoustic injury extends less than 10 m from the source; for these activities, the shutdown zone automatically mitigates/minimizes Level A (PTS onset) harassment.
- Visual monitoring will be conducted by experienced personnel with training in marine mammal detection and the ability to describe relevant behaviors that may occur in proximity to in-water construction activities (or PSOs). If more than one PSO is required, a lead PSO will be designated. The lead PSO must have prior experience as a PSO on a construction project subject to a NMFS incidental take authorization.
- If a marine mammal species for which incidental take has not been authorized is seen approaching or entering the shutdown zone or the disturbance zone during pile driving, the noise-producing activity will cease. If such circumstances recur, the Navy will consult with NMFS concerning the potential need for an additional take authorization.
- Pile driving will cease if any marine mammal is detected in or approaching the Level A shutdown zones as described in Table 5-2. If a marine mammal is observed in the Level B (behavioral) harassment zone or the Level A (PTS onset) harassment zone beyond the shutdown zones, but

not approaching or entering the shutdown zone, a take will be recorded, and the work will be allowed to proceed without cessation.

- All species that enter either the Level A (PTS onset) harassment or Level B (behavioral) harassment zones will be monitored and documented, with the PSO estimating the amount of time the animal spends within the Level A or Level B zone while pile extraction, driving, or drilling activities are underway.
- In the event of a shutdown, pile driving will be halted and delayed until either the animal has voluntarily left and been visually confirmed beyond the shutdown zone or 15 minutes have elapsed without re-detection of the animal.
- Visual monitoring will take place from 30 minutes prior to initiation through 30 minutes post-completion of pile driving. Prior to the start of pile driving, the shutdown zone and disturbance zone will be monitored for 30 minutes to ensure that the zones are clear of marine mammals. Pile driving will only commence once observers have declared the shutdown zone clear of marine mammals.
- Monitoring will be conducted by, at a minimum, a two-person PSO team designated by the construction contractor. Given the configuration of the harassment zones, which vary depending on the pile type/size and the pile driver type (see Figure A-1 through Figure A-10 of Appendix A), it is assumed that one PSO would be sufficient to monitor the zones for impact drivers, and three to four PSOs would be sufficient to monitor the zones for vibratory drivers. However, additional monitors may be added if warranted by the level of marine mammal activity in the area or site conditions. PSOs will be placed at the best vantage point(s) practicable (Figure 11-1) to monitor for marine mammals and implement shutdown/delay procedures when applicable by calling for the shutdown by the pile driver operator.
    - Potential PSO Locations can be found on Figure 11-1 and include:
        - Northernmost Jetty
        - Pier 14
        - Pier 12
        - Pier 11
        - Pier 10
        - Pier 8
        - Pier 2
        - Pier 1
- The PSOs shall have no other job-related tasks and shall only operate as PSOs.
- If the shutdown zone is obscured by fog or poor lighting conditions, pile driving will not be initiated until the entire shutdown zone is visible.

Table 11-1. Marine Mammal Level A (PTS onset) and Level B (Behavioral) Harassment Zones for Monitoring

Pile type, size, and driving method	*Level A (PTS Onset) Harassment*				*Level B (Behavioral) Harassment Distance (m)*
	LF Cetacean Distance (m)	*MF Cetacean Distance (m)*	*HF Cetacean Distance (m)*	*Phocids Distance (m)*	
Vibratory drive 56-inch steel sheet piles, Year 1, Phase I	36	4	53	22	2,500
Vibratory remove 18-inch concrete piles, Year 1, Phase I	10	1	15	7	2,500
Impact drive 18-inch concrete piles, Year 1 Phase I	18	1	21	10	25
Vibratory drive 56-inch and Steel sheet piles, Year 2, Phase II	40	4	59	24	2,500
Vibratory remove 18-inch concrete piles, Year 2, Phase II	16	2	23	10	2,500
Impact drive 18-inch concrete piles, Year 2, Phase II	25	1	29	13	25
Vibratory drive 56-inch steel sheet piles, Year 3, Phase III	49	5	72	30	2,500
Vibratory remove 16-inch composite piles, Year 3, Phase III	7	1	11	5	2,500
Impact drive 18-inch concrete piles, Year 3, Phase III	26	2	49	22	22
Impact drive 16-inch composite piles, Year 3, Phase III	41	1	31	14	25

Key: dB = decibel; HF = high-frequency; LF = low-frequency; m = meters; MF = mid-frequency; m = meter

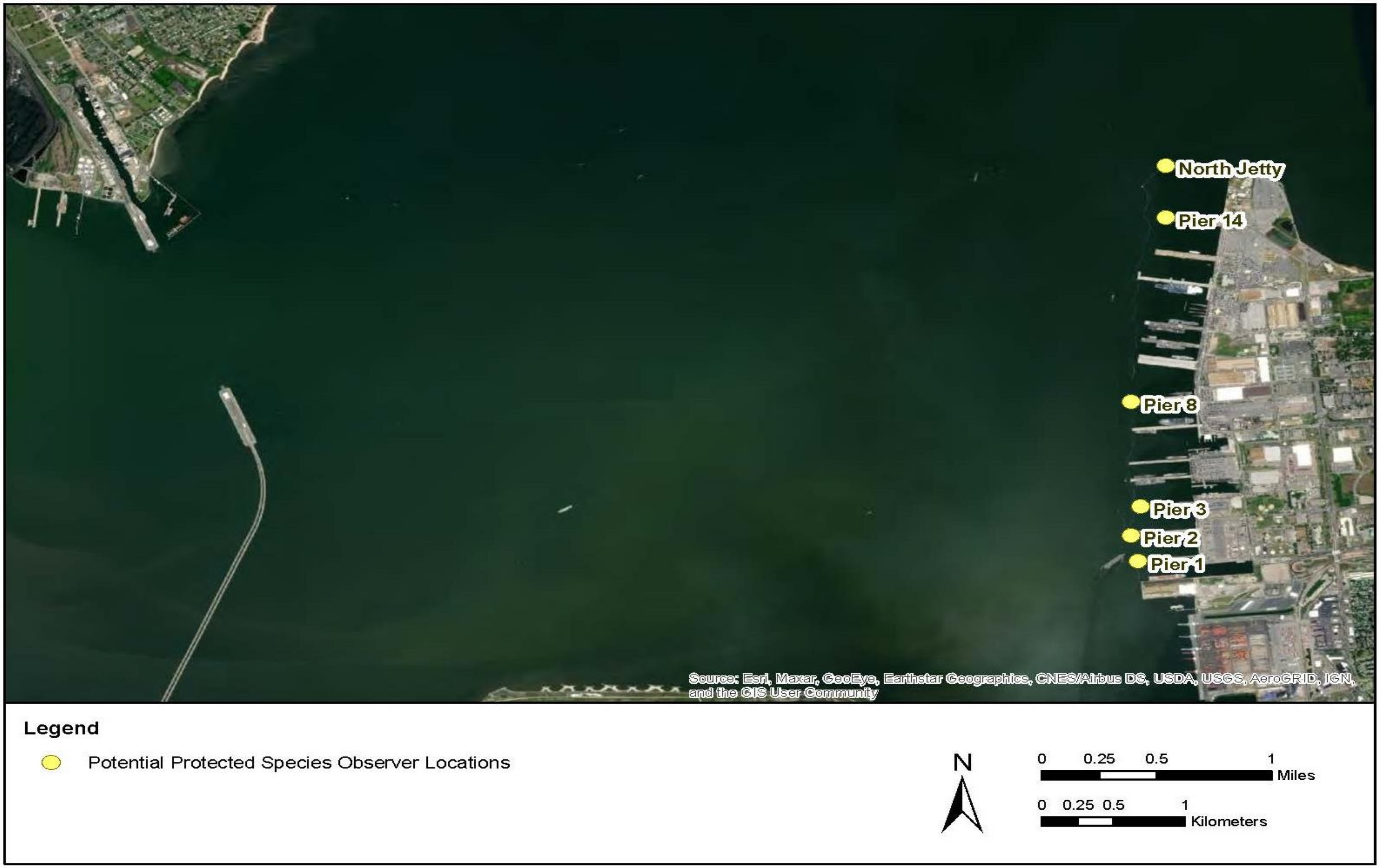

Figure 11-1. Potential PSO Locations

11.3.4 Acoustic Measurements

For details regarding the acoustic monitoring plan, see Section 13.2.

11.3.5 Mitigation Effectiveness

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

Visual detection conditions in the proposed project area are generally excellent. The observers will be positioned in locations that provide the best vantage point(s) for monitoring. Any activity that would result in threshold exceedance at or more than 1,000 m would require a minimum of three PSOs to effectively monitor the entire ROI. As such, proposed mitigation measures are likely to be very effective.

12 ARCTIC PLAN OF COOPERATION

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

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

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

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

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

This section is not applicable. There is no subsistence use of marine mammal species or stocks in the proposed project area at NAVSTA Norfolk.

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.

The Navy intends to complete marine mammal and acoustic monitoring for the proposed project in order to provide a more robust assessment of sound levels from pile driving and marine mammal responses, and to refine avoidance and minimization measures as warranted by the results. A Marine Mammal Monitoring Plan will be developed further and submitted to NMFS for approval in advance of the start of construction of the LOA period.

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 LOA.

13.1 Marine Mammal Monitoring Plan

A Marine Mammal Monitoring Plan will be prepared and submitted to NMFS for approval in advance of the start of construction of the LOA period. Visual monitoring of the Level A (PTS onset) and Level B (behavioral) disturbance zones would occur (Table 11-1). If a marine mammal is observed entering the disturbance zone as described in Chapter 11, an exposure would be recorded, and behaviors documented. All PSOs will be trained in marine mammal identification and behaviors. NMFS requires that the PSOs have no construction-related tasks.

13.1.1 Visual Monitoring

Visual monitoring of the entire Level A and shutdown zones will occur for 100 percent of pile driving activities. The Level B zones will be visually monitored to the extent possible from PSO locations as described in Chapter 11. If a marine mammal is observed entering the Level B zone, an exposure will be recorded and behaviors documented.

13.1.2 Methods of Monitoring

The Navy will monitor the shutdown, Level A, and disturbance zones before, during, and after pile driving activities. Based on NMFS requirements, the Marine Mammal Monitoring Plan will include the following procedures:

- PSOs will be located on land-based features such as docks, piers, or bridges, in order to properly observe the entire shutdown zone(s).
- There would be a minimum of one PSO for each pile driving activity. Depending on the size of the zone associated with the type of noise-generating activity occurring, site conditions, and the level of marine mammal activity, more may be utilized as necessary.

- PSOs will be located at the best vantage point(s) to observe the zone associated with behavioral impact thresholds.
- During all observation periods, PSOs will use binoculars and the naked eye to search continuously for marine mammals.
- Monitoring distances will be measured with range finders.
- Distances to animals will be based on the best estimate of the PSO, relative to known distances to objects in the vicinity of the PSO.
- Bearing to animals will be determined using a compass.
- In-water activities will be curtailed under conditions of fog or poor visibility that might obscure the presence of a marine mammal within the Level A (PTS onset) shutdown zone.
- Pre-Activity Monitoring: The Level A (PTS onset), shutdown and Level B (behavioral) disturbance zones will be monitored for 30 minutes prior to in-water construction/demolition activities. If a marine mammal is present within the shutdown zone, the activity will be delayed until the animal(s) leave the shutdown zone. Activity will resume only after the PSO has determined that, through sighting or by waiting approximately 15 minutes, the animal has moved outside the shutdown zone. If a marine mammal is observed approaching the shutdown zone, the PSO who sighted that animal will notify the shutdown PSO of its presence.
- During Activity Monitoring: If a marine mammal is observed entering the disturbance zone, the activity will be completed without cessation, unless the animal enters or approaches the Level A (PTS onset) 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 Level A (PTS onset) shutdown zone of its own volition or has not been re-sighted for a period of 15 minutes.
- Post-Activity Monitoring: Monitoring of the Level A (PTS onset) shutdown and disturbance zones will continue for 30 minutes following the completion of the activity.

13.1.3 Data Collection

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

- Dates and times (begin and end) of all marine mammal monitoring.
- Dates and times that pile removal/installation or drilling begins and ends.
- Construction activities occurring during each daily observation period, including how many and what type of piles were driven and by what method.
- Total duration of driving time for each pile (vibratory) and number of strikes for each pile (impact).
- Weather conditions (e.g., rain, fog, wind speed, percent cloud cover, visibility).
- Water conditions (e.g., sea state, tidal state [incoming, outgoing, slack, low, and high]).
- Species (genus/species, lowest possible taxonomic level, or unidentified), PSO confidence in identification, estimated numbers of animals/group (min/max/best est.), group composition (if there is a mix of species), and, if possible, sex and age class of marine mammals.

- Marine mammal behavior patterns observed (e.g., feeding, traveling), including bearing and direction of travel and, if possible, the correlation to SPLs and estimated time spent in the harassment zone, and assessment of behavioral response thought to result from the activity.
- Distance from pile removal/installation or drilling activities to marine mammals and distance from the marine mammal to the PSO observation point.
- Locations and times of all marine mammal observations.
- Other human activity in the area.
- Name of PSO and PSO location.
- Number of individuals of each species (differentiated by month, as appropriate) detected within the harassment zone and estimates of number of marine mammals taken by species (a correction factor may be applied to total take numbers, as appropriate).
- Detailed information about any implementation of any mitigation triggered (e.g., shutdowns and delays), a description of specific actions that ensued, and resulting behavior of the animal, if any.
- Description of attempts to distinguish between the number of individual animals taken and the number of incidences of take, such as ability to track groups or individuals.
- Submit all PSO datasheets and/or raw sighting data (as an appendix to the required report).

The Navy will note in behavioral observations, to the extent practicable, if an animal has remained in the area during construction activities. Therefore, it may be possible to identify if the same animal or different individuals are being taken. The Navy will provide information regarding any mitigation (e.g., shutdowns or delays) in reporting as well.

13.2 Hydroacoustic Monitoring Plan

The Navy will implement in situ acoustic monitoring efforts to measure SPLs from in-water construction activities for pile types and methods that have not been previously collected at NAVSTA Norfolk (Table 13-1). The Navy will collect and evaluate acoustic sound recording levels during pile driving activities. Hydrophones would be placed at locations 33 ft from the noise source and, where the potential for Level A (PTS onset) harassment exists, at a second representative monitoring location that is a distance of 20 times the depth of water at the pile location, to the maximum extent practicable. For the 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 most recent NMFS guidance for the collection of source levels. The only exception to the guidance will be if the nearby Federal Navigation Channel could interfere with the distance to depth ratio. If so, this will be noted in an updated plan once a construction contractor is selected and provides potential monitoring locations for the equipment.
- Hydroacoustic monitoring will be conducted for 10 percent of the total number of each pile type (Table 13-1). Monitoring locations will be determined once the construction contractor has been selected. The Contractor will update the monitoring plan to include potential locations for review by NMFS prior to beginning monitoring. The resulting data set will be analyzed to examine and confirm SPLs and rates of TL for each separate in-water construction activity. With NMFS concurrence, these metrics may be used to recalculate the limits of shutdown, Level A (PTS onset), and Level B (behavioral) harassment zones. Locations of hydroacoustic recordings will be collected

via a global positioning system. 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/drill/hammer location. 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.
- Environmental data will 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).
- The chief inspector will supply the acoustics specialist with the substrate composition, hammer/drill model and size, hammer/drill energy settings, depth of the pile being driven or drilling, blows per ft for the piles monitored and any changes to those settings during the monitoring.
- For acoustically monitored construction activities, data from the continuous monitoring locations will be post-processed to obtain the following sound measures:
    - Maximum peak pressure level recorded for all activities, expressed in dB re 1 µPa. This maximum value will originate from the phase of drilling/hammering during which drill/hammer energy was also at maximum (referred to as Level 4).
    - From all activities occurring during the Level 4 phase these additional measures will be made, as appropriate:
        - Mean, median, minimum, and maximum RMS pressure level in dB re 1 µPa.
        - Mean duration of a pile strike (based on the 90 percent energy criterion).
        - Number of hammer strikes.
        - Mean, median, minimum, and maximum single strike sound exposure level (SEL) in dB re μPa^2 second (sec).
    - SEL_{CUM} as defined by the mean single strike SEL + 10*log (number of hammer strikes) in [dB re μPa^2 sec].
    - Median integration time used to calculate SPL_{RMS}.
    - A frequency spectrum (pressure spectral density) in dB re μPa^2 per Hz based on the average of up to eight successive strikes with similar sound. Spectral resolution will be 1 Hz, and the spectrum will cover nominal range from 7 Hz to 20 kHz.
    - Finally, the SEL_{CUM} 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 (SELs-s) values. The sum is taken of the antilog, with $\log_{10}$ taken of result to express in [dB re μPa^2 sec].

Table 13-1. Hydroacoustic Monitoring Summary

Pile Type	*Count*	*Method of Install/Removal*	*Number Monitored*
18-inch concrete	200	Vibratory	20
18-inch concrete	184	Impact	18
56-inch steel sheet	547	Vibratory	55
16-inch composite	178	Vibratory	18
16-inch composite	105	Impact	11

13.3 Reporting

All draft and final monitoring reports will be submitted to PR.ITP.MonitoringReports@noaa.gov as well as to the NMFS biologist who reviews this application.

13.3.1 Annual Reports

The Navy will submit an annual report within 90 days after each activity year, starting November 30, 2025, (for the first annual report) or from the date when the previous annual report ended. Annual reports will detail the monitoring protocols, summarize the data recorded during monitoring, and estimate the number of marine mammals that may have been harassed during the period of the report. Annual reports will also include results from acoustic monitoring detailed in Section 13.2 of the LOA application. NMFS would provide comments on the annual reports. The Navy will address NMFS comments and submit revisions within 30 days of receipt. If no comments are received on the draft from NMFS within 30 days, the annual report will be considered completed.

13.3.2 Final Report

A comprehensive summary report will be prepared and submitted to NMFS within 90 days after the closure of the LOA permit period. The final report will synthesize the data recorded during all monitoring and estimate the number of marine mammals that may have been harassed through the entire project. The results will be summarized in graphical form and include summary statistics and time histories of sound values based upon the data from the activities monitored during the LOA period. NMFS would provide comments on the annual reports. The Navy will address NMFS comments and submit revisions within 30 days of receipt. If no comments are received on the draft from NMFS within 30 days, the annual report will be considered completed.

13.3.3 Reporting Requirements

13.3.3.1 Marine Mammals

The marine mammal report will contain the informational elements described in the Monitoring Plan and, at minimum, will include:

1. Dates and times (begin and end) of all marine mammal monitoring;
2. Construction activities occurring during each daily observation period, including:

- The number and type of piles that were driven and the method (e.g., impact, vibratory, rotary, down-the-hole [DTH]),
- Total duration of driving time for each pile (vibratory driving) and number of strikes for each pile (impact driving), and
- For DTH excavation, duration of operation for both impulsive and non-pulse components;

3. PSO locations during marine mammal monitoring;
4. Environmental conditions during monitoring periods (at beginning and end of PSO shift and whenever conditions change significantly), including Beaufort sea state and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon, and estimated observable distance;
5. Upon observation of a marine mammal, the following information:
   - Name of PSO who sighted the animal(s) and PSO location and activity at time of sighting;
   - Time of sighting;
   - Identification of the animal(s) (e.g., genus/species, lowest possible taxonomic level, or unidentified), PSO confidence in identification, and the composition of the group if there is a mix of species;
   - Distance and location of each observed marine mammal relative to the pile being driven for each sighting;
   - Estimated number of animals (min/max/best estimate);
   - Estimated number of animals by cohort (i.e., adults, juveniles, neonates, group composition);
   - Animal's closest point of approach and estimated time spent within the harassment zone;
   - Description of any marine mammal behavioral observations (e.g., observed behaviors such as feeding or traveling), including an assessment of behavioral responses thought to have resulted from the activity (e.g., no response or changes in behavioral state such as ceasing feeding, changing direction, flushing, or breaching);
6. Number of marine mammals detected within the harassment zones, by species; and
7. Detailed information about implementation of any mitigation (e.g., shutdowns and delays), a description of specific actions that ensued, and resulting changes in behavior of the animal(s), if any.

The Navy will submit all PSO datasheets and/or raw sighting data with the draft report.

13.3.3.2 Hydroacoustic Monitoring

The hydroacoustic monitoring report will contain the informational elements described in the hydroacoustic monitoring plan and, at minimum, will include:

1. Hydrophone equipment and methods: recording device, sampling rate, distance (m) from the pile where recordings were made; depth of water and recording device(s);
2. Type and size of pile being driven, substrate type, method of driving during recordings (e.g., hammer model and energy), and total pile driving duration;
3. Whether a sound attenuation device is used and, if so, a detailed description of the device used and the duration of its use per pile;
4. For impact pile driving and/or DTH excavation (DTH mono-hammer and cluster drill) (per pile), number of strikes and strike rate; depth of substrate to penetrate; pulse duration and mean,

median, and maximum sound levels (dB re 1 µPa): RMS SPL (SPL_{RMS}); SEL_{CUM}, peak SPL (SPL_{PEAK}), and SELs-s;

5. For vibratory driving/removal and/or DTH excavation (DTH mono-hammer and cluster drill) (per pile), duration of driving per pile; mean, median, and maximum sound levels (dB re 1 µPa): SPL_{RMS}, SEL_{CUM} (and timeframe over which the sound is averaged);
6. One-third octave band spectrum and power spectral density plot; and
7. General daily site conditions:
   - Date and time of activities.
   - Water conditions (e.g., sea state, tidal state).
   - Weather conditions (e.g., percent cover, visibility).

14 RESEARCH EFFORTS

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

The U.S. Navy is one of the world's leading organizations in assessing the effects of human activities in the marine environment, including marine mammals. From 2004 through 2013, the Navy has funded over $240 million specifically for marine mammal research. More recently, the Navy funded more than $40 million from fiscal year 2019 to 2020. Navy scientists work cooperatively with other government researchers and scientists, universities, industry, and non-governmental conservation organizations in collecting, evaluating, and modeling information on marine resources. They also develop approaches to ensure that these resources are minimally impacted by existing and future Navy operations. It is imperative that the Navy’s research and development (R&D) efforts related to marine mammals are conducted in an open, transparent manner with validated study needs and requirements. The goal of the Navy’s R&D program is to enable collection and publication of scientifically valid research as well as development of techniques and tools for Navy, academic, and commercial use. Historically, R&D programs are funded and developed by the Navy’s Chief of Naval Operations Energy and Environmental Readiness and Office of Naval Research, Code 322 Marine Mammals and Biology Program. Primary focus of these programs is understanding the effects of sound on marine mammals, including physiological, behavioral, ecological, and population-level effects.

The Office of Naval Research’s current Marine Mammals and Biology Program research concentration areas include: (1) monitoring and detection; (2) integrated ecosystem research, including sensing and tag development; (3) effects of sound on marine life (e.g., hearing, behavioral response studies, physiology [diving and stress], and population consequences of acoustic disturbance); and (4) models and databases for environmental compliance.

The Naval Facilities Engineering Systems Command’s Living Marine Resources Program aims to improve the best available science regarding the potential impacts to marine species from Navy activities, demonstrate and validate basic research projects that are ready for applied research investment, and broaden the use of or improve the technology and methods available to the U.S. Navy marine species monitoring program. Key investment areas of the Living Marine Resources Program include:

- Data to support risk threshold criteria;
- Data processing and analysis tools;
- Monitoring technology demonstrations;
- Standards and metrics; and
- Emergent topics.

The following marine mammal monitoring activities and contracted studies have been or are currently being conducted by the Navy in the vicinity of NAVSTA Norfolk. To better understand marine mammal presence and habitat use in the region, the Navy has funded and coordinated the following recent major efforts:

- Mid-Atlantic Humpback Whale Monitoring, Virginia Beach, Virginia (Aschettino et al., 2015, 2016, 2017, 2018).
- Seal Tagging and Tracking in Virginia (Ampela et al., 2019).

- Haul-out Counts and Photo-Identification of Pinnipeds in Chesapeake Bay and Eastern Shore, Virginia (Jones et al., 2018).
- Haul-out Counts and Photo-Identification of Pinnipeds in Chesapeake Bay, Virginia (Rees et al., 2016).
- Occurrence, Distribution, and Density of Marine Mammals Near Naval Station Norfolk and Virginia Beach (Engelhaupt et al., 2014, 2015, 2016).

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

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Appendix A

Acoustic Transmission Loss Modeling

UNDERWATER ACOUSTIC TRANSMISSION LOSS MODELING

FOR THE

REPAIR/REPLACEMENT OF THE Q8 BULKHEAD

AT

NAVAL STATION NORFOLK

NORFOLK, VIRGINIA

REVISED JANUARY 2024

UNDERWATER ACOUSTIC TRANSMISSION LOSS MODELING FOR THE REPAIR/REPLACEMENT OF THE Q8 BULKHEAD

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ACRONYMS AND ABBREVIATIONS

ANSI	American National Standards Institute
dB	decibel(s)
C	Celsius
dB re 1 µPa^2-sec	dB referenced to a pressure of 1 microPascal squared per second (measures underwater sound level exposure)
dB_{pk}	peak pressure
dB SEL_{cum}	cumulative sound exposure level
DPS	Distinct Population Segment
ESA	Endangered Species Act
FRP	Fiber Reinforced Polymer
GIS	geographical information systems
HDPE	High Density Polyethylene
dB peak	instantaneous peak sound pressure level in decibels (can apply to either airborne or underwater sound)
kHz	kilohertz
MMPA	Marine Mammal Protection Act
NAVSTA	Naval Station
Navy	Department of the Navy
NMFS	National Marine Fisheries Service
PTS	permanent threshold shifts
rms	root mean square
SEL	sound exposure level
SPL	sound pressure level
PTS	permanent threshold shift
TTS	temporary threshold shift
µPa	microPascal(s)
WFA	Weighting Factor Adjustment

1.0 OVERVIEW

The United States Department of the Navy (Navy) proposes to repair and replace the Q8 Bulkhead at Naval Station (NAVSTA) Norfolk in Norfolk, Virginia (**Figure 1)**. The proposed repair and replacement of the Q8 Bulkhead is required because the existing tongue and groove sheet piles have numerous holes between the sheets which have allowed for migration of retained fill into the waterway, which has contributed to the formation of sinkholes on the landward side of the bulkhead. Furthermore, over-dredging of sub-aqueous river bottom in front of the toe of the existing sheets has decreased bottom tip embedment of the sheets to such an extent that a significant percentage of the design factor of safety against catastrophic bulkhead failure has been lost, and the sheets are effectively overloaded beyond acceptable Design Code limits. Landward of the existing bulkhead, pavement will be removed and disposed of at an off-site disposal area. Excavation beneath the existing pavement would occur to expose the existing concrete relieving platform for inspection, to facilitate removal and replacement of existing stormwater outfall pipes and catch basins, and to accommodate installation of a new tie-back rod system. These excavated materials will be stockpiled for re-use.

Upon completion of the replacement of stormwater outfall pipes, pile extraction and installation activities would begin, in phases. Phase I of construction will occur between Piers 12-14 and includes vibratory extraction of 139, 18-inch square pre-stressed concrete fender piles; vibratory installation of 183, 56-inch steel sheet piles; and impact installation of 109, 18-inch square pre-stressed concrete fender piles. Phase I construction is currently scheduled to begin in Sept 2023 with an estimated completion date of Sept 2024. Phase II will occur between Piers 11-12 and includes vibratory extraction of 61, 18-inch square pre-stressed concrete fender piles; vibratory installation of 81, 56-inch steel sheet piles; and impact installation of 49, 18-inch square pre-stressed concrete fender piles. Phase II construction is currently scheduled to begin in Sept 2024 with an estimated completion date of Sept 2025. Finally, Phase III of construction will occur north of Pier 14 and includes vibratory extraction of 178 16-inch composite fender piles; vibratory installation of 283 56-inch steel sheet piles; impact installation of 105, 16-inch composite fender piles; and impact installation of 26, 18-inch square pre-stressed concrete fender piles. Phase III construction is currently scheduled to begin in Sept 2025 with an estimated completion date of Sept 2026.

Figures 2 and 3 identify the structure footprints to be demolished, constructed, and what will remain. All sheet piles will be installed approximately one foot in front of the existing concrete sheet plie, which will remain in place. The interstitial space between the new and existing sheet pile will be filled with a cementitious flowable fill and a continuous reinforced concrete cap will be installed along the top of the new steel sheet pile bulkhead.

The repairs/replacement of the bulkhead are needed because the existing bulkhead has failed in multiple locations, creating sinkholes and creating unsafe conditions. The repairs/replacement are needed to ensure full functionality of the bulkheads and prevent further erosion to the installation waterfront. Without the repairs, the Navy's mission would be compromised.

The acoustic model herein analyzes pile extraction and driving associated with the activities described above to develop a rigorous, defensible model of underwater transmission loss from project activities for the purpose of mapping harassment zones within which "takes" of marine mammals, as defined under the Marine Mammal Protection Act (MMPA), can be anticipated. The Acoustic Transmission Loss

Modeling effort will also support the analysis of project effects on Endangered Species Act (ESA)-listed fish and sea turtle species and Essential Fish Habitat.

The key components of this analysis include (1) the definition of acoustic source levels; (2) mathematical models and assumptions for acoustic transmission loss from the source; (3) the application of thresholds for different levels of effect on marine mammals and other species to determine the distances within which those thresholds are exceeded; (4) mapping the resulting model of acoustic transmission loss onto the project area using geographical information systems (GIS) to quantify the areas of harassment zones; and (5) use of appropriate density data to calculate the number of takes that may occur within the harassment zones.

The approach is consistent with that used in recent Navy applications for Incidental Harassment Authorizations and Letter of Authorizations for similar construction activities at Navy installations in the Mid-Atlantic Region. A glossary of acoustical terms is provided in Section 7 at the end of the plan.

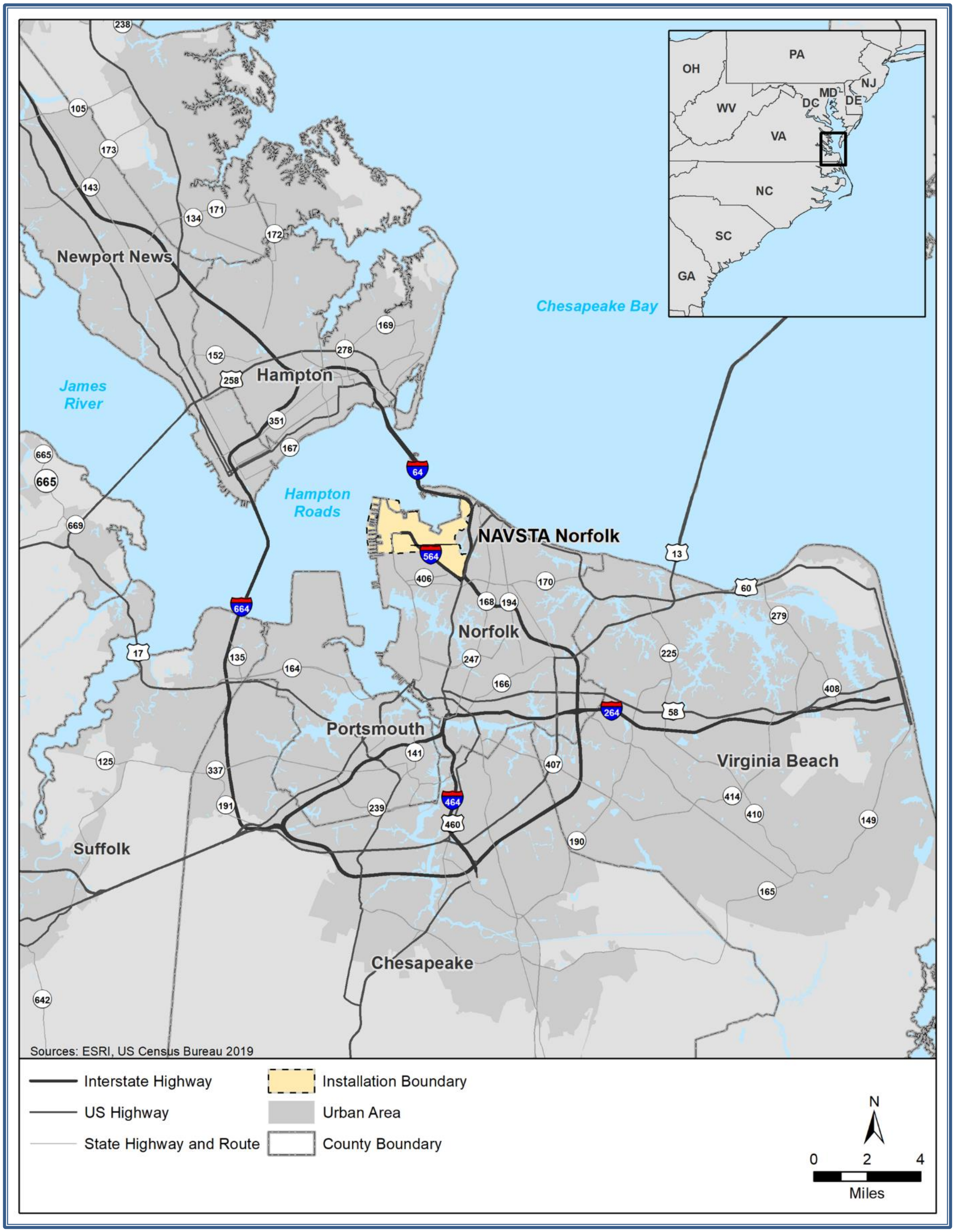

Figure 1. Project Location Map

1

2 **Figure 2. Proposed Construction and Demolition**

2.0 Species to be Assessed

Species proposed to be assessed for impacts from acoustic sources are listed in **Table 1**. The list includes all ESA-listed or otherwise protected marine mammal, sea turtle, and fish species determined to have a reasonable possibility of presence within the project's acoustic harassment zones where exposure to underwater sound could result in a "take" by harassment under the MMPA or ESA. The list includes all species that have the potential to occur within the water bodies of or vicinity of the project area (Elizabeth River and Hampton Roads). Potential presence of species is based on Marine Mammal Stock Assessment Reports in the Atlantic (Waring et al. 2016) and recent applications/authorizations for construction projects at NAVSTA Norfolk (Request for Letter of Authorization for Incidental Harassment of Marine Mammals for NAVSTA Norfolk Marine Structure Maintenance, Pile Replacement, and Select Waterfront Improvements (Navy 2020; NMFS 2021b); Request for Incidental Harassment Authorization Under the MMPA for the Demolition and Construction of Pier 3 at NAVSTA Norfolk (Navy 2022a); and Request for Letter of Authorization Under the MMPA for the Demolition and Reconstruction of Pier 3 at NAVSTA Norfolk (Navy 2022b). The Navy's Marine Species Density Database (Navy 2017) was also reviewed. Further analysis will determine which of these species can be screened out based on extremely low density and discountable likelihood of take.

Table 1. Species to be Assessed for Impacts from Acoustic Sources

Common Name	Scientific Name	Regulatory Authority
Marine Mammals		
Humpback whale	*Megaptera novaeangliae*	MMPA
Common bottlenose dolphin	*Tursiops truncatus*	MMPA
Harbor porpoise	*Harbor porpoise*	MMPA
Harbor seal	*Phoca vitulina*	MMPA
Gray seal	*Halichoerus grypus*	MMPA
Sea Turtles		
Leatherback (E)	*Dermochelys coriacea*	ESA
Loggerhead (Northwest Atlantic Ocean DPS) (T)	*Caretta caretta*	ESA
Green (North Atlantic DPS) (T)	*Chelonia mydas*	ESA
Kemp's ridley (E)	*Lepidochelys kempii*	ESA
Fishes		
Atlantic sturgeon (E)	*Acipenser oxyrinchus*	ESA
Shortnose sturgeon (E)	*Acipenser brevirostrum*	ESA

Legend: T = Threatened, E = Endangered, MMPA = Marine Mammal Protection Act, ESA = Endangered Species Act; DPS = Distinct Population Segment.

3.0 Acoustic Source Levels

Replacing the Q8 Bulkhead will require demolition and construction activities. In-water demolition activities will involve removal of piles and in-water construction includes installation of piles. The types and numbers of piles to be removed and constructed under the Proposed Action are shown in **Table 2**. In order to estimate sound source levels for pile driving activities proposed for this project, available documentation for projects that are most similar to the Proposed Action in terms of the type and size of pile, method of installation, and substrate conditions, were reviewed to identify the most relevant proxy sound source levels (**Table 4).** The most appropriate proxies are provided based on consistency with other NAVFAC MIDLANT pile driving projects.

Table 2. Repair/Replacement of Q8 Bulkhead - Pile Installation and Removal Activity

Facility	Method of Pile Driving/Extraction	Pile Type	Pile Size	Number of Sheets (pairs)/Piles	Impact Pile Driving (Strikes / Pile) [1]	Vibratory Pile Driving/Extracting (Minutes to drive a single pile) [2]	Maximum number of piles installed each day	Average Water Depth	Total Number of Days of In-Water Construction
Phase I Construction, Piers 12-14	Vibratory Install	ASTM A572, Grade 50 Steel Sheet Pile	56-inch Wide	183 piles (bulkhead)	NA	24 minutes	6	35 feet	31 days
	Vibratory Extract	Pre-stressed Concrete Fender Piles	18-inch square	139 piles (fender)	NA	14 minutes	6	35 feet	24 days
	Impact Install	Pre-stressed Concrete Fender Piles	18-inch square	109 piles (fender)	307	NA	6	35 feet	19 days
Phase II Construction, Piers 11-12	Vibratory Install	ASTM A572, Grade 50 Steel Sheet Pile	56-inch Wide	81 piles (bulkhead)	NA	28 minutes	6	24 feet	15 days
	Vibratory Extract	Pre-stressed Concrete Fender Piles	18-inch square	61 piles (fender)	NA	26 minutes	6	24 feet	11 days
	Impact Install	Pre-stressed Concrete Fender Piles	18-inch square	49 piles (fender)	499	NA	6	24 feet	11 days
Phase III Construction, North of Pier 14	Vibratory Install	ASTM A572, Grade 50 Steel Sheet Pile	56-inch Wide	283 piles (bulkhead)	NA	38 minutes	6	19 feet	48 days
	Vibratory Extract	Composite (HDPE or FRP) Fender Piles[1]	16-inch diameter	178 piles (fender)	NA	20 minutes	6	19 feet	30 days
	Impact Install	Composite (HDPE or FRP) Fender Piles	16-inch diameter	105 piles (fender)	540	NA	6	19 feet	18 days
	Impact Install	Pre-stressed Concrete Fender Piles	18-inch square	26 piles (fender)	540	NA	6	19 feet	5 days

1 **Notes**: HDPE = High Density Polyethylene (plastic); FRP = Fiber Reinforced Polymer (fiberglass); NA = not applicable.

1. Pile installation hours and number of strikes per pile are based on previous experience. The actual driving time/strikes depend on the actual method of installation. Method of installation and hammer size will be the responsibility of the installation contractor.
2. Pile extraction hours are based on previous experience. The actual extraction time and the actual method of pile extraction depends on the contractor and condition of piles.

3.1 Concurrent Activities

In order to maintain project schedules and work efficiently, it is likely that multiple pieces of equipment would operate at the same time within the bulkhead areas. According to recent guidance provided by NMFS, when two noise sources have overlapping sound fields, there is potential for higher sound levels than for non-overlapping sources because the isopleth of one sound source encompasses the sound source of another isopleth. In such instances, the sources are considered additive and combined using the rules of decibel addition. For addition of two simultaneous sources, the difference between the two sound source levels is calculated, and if that difference is between 0 and 1 dB, 3 dB are added to the higher sound source levels; if the difference is between 2 or 3 dB, 2 dB are added to the highest sound source levels; if the difference is between 4 to 9 dB, 1 dB is added to the highest sound source levels; and with differences of 10 or more decibels, there is no addition (NMFS, unpublished and Table 5, below).

For simultaneous usage of three or more continuous sound sources, the three overlapping sources with the highest sound source levels are identified. Of the three highest sound source levels, the lower two are combined using the above rules, then the combination of the lower two is combined with the highest of the three. For example, with overlapping isopleths from 24-, 36-, and 42-inch diameter steel pipe piles with sound source levels of 161, 167, and 168 dB RMS respectively, the 24- and 36-inch would be added together; given that 167 – 161 = 6 dB, then 1 dB is added to the highest of the two sound source levels (167 dB), for a combined noise level of 168 dB. Next, the newly calculated 168 dB is added to the 42-inch steel pile with sound source levels of 168 dB. Since 168 – 168 = 0 dB, 3 dB is added to the highest value, or 171 dB in total for the combination of 24-, 36-, and 42-inch steel pipe piles (NMFS unpublished).

Table 3 below shows the potential concurrent scenarios associated with the Q8 Bulkhead replacement. At most, three pieces of equipment could be used at one time. There are anticipated to be scenarios where two vibratory hammers could operate simultaneously; where two vibratory hammers and an impact hammer could operate simultaneously; and one vibratory hammer and one impact hammer could operate simultaneously. In accordance with NMFS' guidance, in a situation where an impact and vibratory hammer are used concurrently, the largest zone generated by either the vibratory hammer or impact hammer would be used. Based on the guidance provided by NMFS, Table 6 lists the revised proxy source levels for these concurrent activities.

Table 3. Potential Concurrent Activity Scenarios

Project Phase	Activity/Scenario	Piles per Day	Total Pile Driving Days	Total Pieces of Equipment
Phase I	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles	12	15	Vibratory extraction (1); vibratory hammer (1)
Phase I Phase II Phase III	Vibratory extract 18-inch concrete piles; vibratory install 56-inch steel sheet piles; impact install 18-inch concrete piles[1]	18	19	Vibratory extraction (1); vibratory hammer (1); impact hammer (1)
Phase I Phase II	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles[1]	12	4	Vibratory extraction (1); vibratory hammer (1)
Phase II	Vibratory install 56-inch steel sheet piles and impact install 18-inch concrete piles	18	11	Vibratory hammer (1); impact hammer (1)
Phase III	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles	12	31	Vibratory extraction (1); vibratory hammer (1)
Phase III	Vibratory install 56-inch steel sheet piles and impact install 16-inch composite piles	12	15	Vibratory hammer (1); impact hammer (1)

Notes. 1: could occur in either phase listed.

Table 4. Underwater Proxy Source Levels for Individual Activities

Pile Size, Type	Installation Method	Sound Pressure Levels (SPL) or Sound Exposure Level (SEL) at 10 meters distance			Source
		Average Peak SPL, dB re 1 μPa	Average Root Mean Square SPL, dB re 1 μPa	Average SEL, dB re 1 μPa^2-sec	
56-inch steel sheet pile	Vibratory[1]	NA	168	NA	Illingworth and Rodkin 2017[1]
18-inch pre-stressed concrete pile	Impact	185	170	160	CALTRANS 2020[2]
	Vibratory	185	162	157	CALTRANS 2020[3]
16-inch plastic	Impact	184	169	157	e4sciences 2023[4]
	Vibratory	NA	158	NA	Illingworth and Rodkin 2017

Notes: [1]- A proxy value for vibratory driving 56-inch sheet piles was not found so data for 48-inch steel shell piles was used (highest avg from Table 3).
[2]- Data for 18-inch concrete piles (Table 2-4 of CALTRANS 2020).
[3]- Data on vibratory extraction of concrete piles is not available. Please see p. 28479 of 84 FR 28474 where it was suggested that proxy source sound levels for timber piles be used as they are expected to have similar sound levels.
[4] Data for 16-inch composite piles (Table 10 of e4sciences 2023).
Legend: dB=decibels; rms = root mean square, SEL = sound exposure level; dB re 1 μPa = dB referenced to a pressure of 1 microPascal, measures underwater SPL. dB re 1 μPa^2-sec = dB referenced to a pressure of 1 microPascal squared per second. Single strike SEL are the proxy source levels presented for impact pile driving and are used to calculate distances to permanent threshold shift (PTS). NA = Not applicable

4.0 ACOUSTIC TRANSMISSION LOSS MODELS

4.1 MODEL FOR LEVEL A (PTS) HARASSMENT OF MARINE MAMMALS

Acoustic transmission loss modeling for cumulative sound exposure that may result in Level A harassment to marine mammals was conducted using National Marine Fisheries Service (NMFS) marine mammal acoustic technical guidance (*Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing—Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts, April 2018*) (NMFS 2018a). This guidance provides acoustic thresholds for the onset of permanent threshold shift (PTS), which would be considered Level A harassment under the MMPA. PTS from pile driving activities will be calculated for marine mammals in the project area using the *Optional User Spreadsheet* (herein referred to as NMFS spreadsheet) provided on the NMFS website (NMFS 2020a).

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

The NMFS spreadsheet generates threshold distances to PTS for the situation in which an animal remains stationary for the entire 24-hour duration of activity. Although PTS is unlikely to occur due to likely animal avoidance during pile driver operations (Russell et al. 2016), some animals could habituate to the noise source and continue to occupy the area. The NMFS spreadsheet therefore provides a boundary condition for the maximum distance at which PTS could occur. In order to properly calculate the distances to PTS, number of pile strikes per pile for impact pile driving and duration (in minutes) for vibratory pile driving each day is required for the analysis. See **Table 2** for pile installation activity that was used in the NMFS spreadsheet.

4.2 MODEL FOR LEVEL B (BEHAVIORAL) HARASSMENT OF MARINE MAMMALS

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

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

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

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

Where

TL is the transmission loss in dB,

R1 is the distance of the modeled SPL from the driven pile, and

R2 is the distance (usually 10 meters) from the driven pile of the initial measurement.

This formula was used to estimate the distances to critical threshold levels that bound the harassment zones for MMPA Level B (Behavioral) harassment due to underwater sound.

In modeling transmission loss from the proposed project area, the conventional assumption would be made that acoustic propagation from the source is impeded by natural and relatively dense manmade features that extend into the water, resulting in acoustic shadows behind such features.

4.3 Model for Fish

The transmission loss (TL) formula below was used for determining distance to thresholds for ESA-listed fish species:

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

To calculate distance to thresholds (see Chapter 5), number of pile strikes per pile are required for the project. **Table 2** provides pile installation activity for the project.

4.4 Model for Sea Turtles

The hearing capabilities of sea turtles are poorly known and there is very little available information on the effects of noise on sea turtles, especially to determine impacts from natural and anthropogenic, sound sources (i.e., pile driving noise; Popper et al. 2014). Methods for analyzing acoustic impacts to sea turtles will be consistent with the Navy's Criteria and Thresholds for U.S. Navy Acoustic and Explosives Effects Analysis (Phase III) (Navy 2017).

The same transmission loss formula used for fish (above) was used to determine distance to thresholds for ESA-listed sea turtles. To calculate distance to thresholds (see Chapter 5), number of pile strikes per pile are required for the project. **Table 2** provides pile installation activity for the project.

5.0 Sound Exposure Criteria and Thresholds

5.1 Marine Mammals

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

As introduced in Chapter 4, NMFS finalized the acoustic threshold levels for determining the onset of PTS in marine mammals in response to underwater impulsive and non-impulsive/continuous sound sources (NMFS 2018b). The criteria use cumulative SEL metrics (dB SEL_{cum}) and peak pressure (dB_{pk}) rather than the dB rms metric. NMFS equates the onset of PTS, which is a form of auditory injury, with Level A harassment under the MMPA and "harm" under the ESA. Level B harassment is considered to occur when marine mammals are exposed to impulsive underwater sounds > 160 decibels referenced to a pressure of 1 microPascal (dB rms re 1 µPa) from impact pile driving and to non-impulsive underwater sounds > 120 dB rms re 1 µPa (**Table 4**). The application of the 120 dB rms threshold is considered precautionary (NMFS 2009, 74 Federal Register 41684) as it can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. Behavioral harassment may or may not result in a stress response.

Acoustic disturbance levels from vibratory or impact pile driving have the potential to exceed the harassment levels defined in **Table** 6 for both non-impulsive/continuous and impulsive sound levels. This table incorporates PTS thresholds in combination with prior existing thresholds for Level B exposure.

Table 5. PTS and Behavioral Disturbance Threshold Criteria for Underwater Noise

Marine Mammals	Vibratory Pile Driving Noise (non-impulsive sounds) (re 1 µPa)		Impact Pile Driving Noise (impulsive sounds) (re 1 µPa)	
	PTS Onset (Level A) Threshold	Level B Disturbance Threshold	PTS Onset (Level A) Threshold[1]	Level B Disturbance Threshold
Low-Frequency Cetaceans	199 dB SEL_{CUM}[2]	120 dB rms	219 dB Peak[3] 183 dB SEL_{CUM}[2]	160 dB rms
Mid-Frequency Cetaceans	198 dB SEL_{CUM}[2]	120 dB rms	230 dB Peak[3] 185 dB SEL_{CUM}[2]	160 dB rms
High-Frequency Cetaceans	173 dB SEL_{CUM}[2]	120 dB rms	202 dB Peak[3] 155 dB SEL_{CUM}[2]	160 dB rms
Phocidae (true seals)	201 dB SEL_{CUM}[2]	120 dB rms	218 dB Peak[3] 185 dB SEL_{CUM}[2]	160 dB rms

Notes:
[1] Dual metric acoustic thresholds for impulsive sounds. Whichever results in the largest isopleth for calculating PTS onset is used in the analysis.
[2] Cumulative SEL over 24 hours.
[3] Flat weighted or unweighted peak sound pressure within the generalized hearing range.
Legend: µPa = micropascal; dB = decibel; PTS = permanent threshold shift; rms = root mean square; SEL = sound exposure level.

5.2 CONCURRENT ACTIVITIES

Simultaneous use of pile drivers, and hammers could result in increased SPLs and harassment zone sizes given the proximity of the structure sites and the rules of decibel addition (Table 6). Revised proxy source levels based on this guidance are provided in Table 7.

Table 6. Rules for Combining Sound Levels

Difference in Sound Source Level (dB)	Rule
0 or 1 dB	Add 3 dB to the higher source level
2 or 3 dB	Add 2 dB to the higher source level
4 to 9 dB	Add 1 dB to the higher source level

Source: Egger, 2021; NMFS 2021.
Key: dB = decibel.

Table 7. Revised Proxys for Concurrent Activity Scenarios

Equipment	RMS	Vibratory Install	Revised Proxy
Vibratory extract (18-inch concrete)	162	168 (56-inch sheet piles)	169

The above revised proxy source level of 169 dB would be applied to all activities that have multiple uses of vibratory hammers. For this project, that would always be vibratory removal of 18-inch concrete piles and vibratory installation of 56-inch steel sheet piles. When these activities could also occur concurrently with impact pile driving of either 18-inch concrete piles or 16-inch composite piles, the Level A and Level B harassment zones would be determined by the largest zone generated by either hammer type.

During construction the Contractor needs flexibility to be able to complete the project and not be stuck to a certain number of concurrent days or a certain production rate. The production rate can fluctuate on a daily basis from a variety of factors such as weather, equipment failures, or even in equipment availability. The production rate in Table 3 is an estimate; however, Navy would prefer to not be locked into a set number of concurrent days to reflect the reality of construction.

Table 8. Injury and Disturbance Zones for Underwater Marine Mammals – Impact Pile Driving

		Injury (PTS Onset) Level A					Behavioral Disturbance Level B All Species	
			LF Cetacean	MF Cetacean	HF Cetacean	Phocid		
Structure	**Pile Size and Type**	**Total Pile Driving Days**	**Maximum Distance to 183 dB SELcum Threshold (m)/Area (sq km)**	**Maximum Distance to 185 dB SELcum Threshold (m)/Area (sq km)**	**Maximum Distance to 155 dB SELcum Threshold (m)/Area (sq km)**	**Maximum Distance to 185 dB SELcum Threshold (m)/Area (sq km)**	**Maximum Distance to 160 dB RMS SPL Threshold (m)**	**Area within 160 dB RMS SPL Threshold (sq km)**
Phase I Construction, Piers 12-14	18-inch pre-stressed square concrete	19	43.9/0.003027	1.6/0.000004	52.3/0.004341	23.5/0.000867	46.4	0.003382
Phase II Construction, Piers 11-12	18-inch pre-stressed square concrete	11	60.8/0.005807	2.2/0.000008	72.4/0.008234	32.5/0.001659	46.4	0.001003
Phase III Construction, North of Pier 14	16-inch composite	18	40.4/0.002542	1.4/0.000003	48.1/0.003608	21.6/0.000722	39.8	0.002489
Phase III Construction, North of Pier 14	18-inch pre-stressed square concrete	5	64/0.006434	2.3/0.000008	76.3/0.009145	34.3/0.001848	46.4	0.003382

Notes: [1]Distance to behavioral disturbance thresholds calculated using practical spreading loss model.
Legend*:* PTS= permanent threshold shift; dB RMS= decibel root mean square; m = meters; sq m = square meters.

Table 9. Injury and Disturbance Zones for Underwater Marine Mammals – Vibratory Pile Driving/Extraction

Structure	Pile Size	Total Pile Driving Days	Injury (PTS Onset) Level A				Behavioral Disturbance Level B All Species	
			LF Cetacean	MF Cetacean	HF Cetacean	Phocid		
			Maximum Distance to 199 dB SELcum Threshold (m)/Area (sq m)	Maximum Distance to 198 dB SELcum Threshold (m)/Area (sq m)	Maximum Distance to 173 dB SELcum Threshold (m)/Area (sq m)	Maximum Distance to 201 dB SELcum Threshold (m)/Area (sq m)	Maximum Distance to 120 dB RMS SPL Threshold (m)	Area within 120 dB RMS SPL Threshold (sq km)
Phase I Construction, Piers 12-14	56-inch steel sheet	31	35.9/0.002048	3.2/0.000019	53.0/0.004447	21.8/0.000761	15,849	92.963287
	18-inch pre-stressed square concrete	14	10.0/0.000165	0.9/0.000002	14.7/0.00035	6.1/0.000063	6,310	43.397949
Phase II Construction, Piers 11-12	56-inch steel sheet	265	39.7/0.00251	3.5/0.000023	58.7/0.005463	24.2/0.000941	15,849	93.523935
	18-inch pre-stressed square concrete	98	15.1/0.000372	1.3/0.000004	22.3/0.000801	9.2/0.000142	6,310	44.318491
Phase III Construction, North of Pier 14	56-inch steel sheet	3	48.7/0.003699	4.3/0.000027	72.0/0.008104	29.6/0.00136	15,849	85.931194
	16-inch composite	2	6.8/0.00007	0.6/0.0000004	10.1/0.000156	4.2/0.000026	3,415	11.505933

Notes: [1]Distance to behavioral disturbance thresholds calculated using practical spreading loss model; [2]Pre-drilling.
Legend: PTS= permanent threshold shift; dB RMS= decibel root mean square; m = meters; sq m = square meters.

Table 10. Injury and Disturbance Zones for Underwater Marine Mammals – Concurrent Activities									
Activity	***Project Phase and Pile Location***	***Concurrent Scenario***	***Piles Per Day***	***Total Pile Driving Days***	***Level A (PTS Onset) Harassment***				***Level B (Behavioral) Harassment All Species***
					LF Cetaceans	***MF Cetaceans***	***HF Cetaceans***	***Phocids***	
					Maximum Distance to 199 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)	***Maximum Distance to 198 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)***	***Maximum Distance to 173 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)***	***Maximum Distance to 201 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)***	***Maximum Distance to 120 dB RMS SPL Threshold(m)/Area of Harassment Zone (km^2)***
Vibratory Pile Extraction (1) and Vibratory Pile Installation (1)	Phase I Piers 12-14	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles[1]	12	15	46.3 / 0.003407	4.1 / 0.000031	68.5 / 0.00743	28.2 / 0.001274	18,478 / 96.014966
Vibratory Pile Extraction (1), Vibratory Pile Installation (1), and Impact Installation (1)	Phase I Piers 12-14, Piers 11-12, and North of Pier 14	Vibratory extract 18-inch concrete piles; vibratory install 56-inch steel sheet piles; impact install 18-inch concrete piles[1, 2, 3]	18	19	60.7 / 0.017332	5.4 / 0.000137	89.8 / 0.037634	36.9 / 0.006398	18,478 / 103.001094
Vibratory Pile Extraction (1) and Vibratory	Phase II Piers 11-12	Vibratory extract 18-inch concrete piles and vibratory install	12	4	46.3 / 0.003397	4.1 / 0.00003	68.5 / 0.016154	28.2 / 0.001268	18,478 / 93.295658

Table 10. Injury and Disturbance Zones for Underwater Marine Mammals – Concurrent Activities									
					Level A (PTS Onset) Harassment				***Level B (Behavioral) Harassment All Species***
					LF Cetaceans	***MF Cetaceans***	***HF Cetaceans***	***Phocids***	
Activity	***Project Phase and Pile Location***	***Concurrent Scenario***	***Piles Per Day***	***Total Pile Driving Days***	***Maximum Distance to 199 dB SELcum Threshold (m)/Area of Harassment Zone (km²)***	***Maximum Distance to 198 dB SELcum Threshold (m)/Area of Harassment Zone (km²)***	***Maximum Distance to 173 dB SELcum Threshold (m)/Area of Harassment Zone (km²)***	***Maximum Distance to 201 dB SELcum Threshold (m)/Area of Harassment Zone (km²)***	***Maximum Distance to 120 dB RMS SPL Threshold(m)/Area of Harassment Zone (km²)***
Pile Installation (1)		56-inch steel sheet piles[1]							
Vibratory Pile Installation (1) and Impact Installation (1)	Phase II Piers 11-12 and North of Pier 14	Vibratory install 56-inch steel sheet piles and impact install 18-inch concrete piles[3]	18	11	48.7 / 0.007384	4.3 / 0.000054	72 / 0.016154	29.6 / 0.002712	15,849 / 100.588184
Vibratory Pile Extraction (1) and Vibratory Pile Installation (1)	Phase III North of Pier 14	Vibratory extract 18-inch concrete piles and vibratory install 56-inch steel sheet piles[1]	12	31	46.3 / 0.003273	4.1 / 0.000019	68.5 / 0.007233	28.2 / 0.001192	18,478 / 97.877432
Vibratory Pile Installation (1)	Phase III North of Pier 14	Vibratory install 56-inch steel sheet piles and impact install 16-	12	15	48.7 / 0.003627	4.3 / 0.000021	72 / 0.007996	29.6 / 0.001316	15,849 / 85.07705

Table 10. Injury and Disturbance Zones for Underwater Marine Mammals – Concurrent Activities

Activity	***Project Phase and Pile Location***	***Concurrent Scenario***	***Piles Per Day***	***Total Pile Driving Days***	***Level A (PTS Onset) Harassment***				***Level B (Behavioral) Harassment All Species***
					LF Cetaceans	***MF Cetaceans***	***HF Cetaceans***	***Phocids***	
					Maximum Distance to 199 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)	***Maximum Distance to 198 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)***	***Maximum Distance to 173 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)***	***Maximum Distance to 201 dB SELcum Threshold (m)/Area of Harassment Zone (km^2)***	***Maximum Distance to 120 dB RMS SPL Threshold(m)/Area of Harassment Zone (km^2)***
and Impact Installation (1)		inch composite piles[3]							

Notes: 1. Shorter duration of driving/extraction per pile for multiple vibratory hammers was used as once that is complete, activity would no longer be concurrent.
2. Greatest number of strikes per pile possible was used as a conservative estimate to compare potential Level A and B harassment zones of impact and vibratory activity.
3. Larger zone between impact and vibratory activity was used to determine the maximum distance to the thresholds.

5.3 FISH

Criteria and thresholds to estimate impacts from sound produced by impact pile driving activities are presented below in **Table** 11. Consistent with Popper et al. 2014, dual metric sound exposure criteria are utilized. It is assumed that a specified effect would occur when either metric (cumulative SEL or peak SPLs) is met or exceeded. Guidelines were developed for mortality and the lowest level where injury was found (recoverable injury). In addition, Popper et al. (2014) developed guidance for the onset of TTS. **Table 5** lists the impact pile driving guidance for the lowest level where injury was found and the onset of TTS.

In addition, if the received SEL from an individual pile strike is below a certain level, then the accumulated energy from multiple strikes would not contribute to injury, regardless of how many pile strikes occur. This SEL is referred to as "effective quiet", and is assumed to be 150 dB (referenced to a pressure of 1 microPascal squared per second [re: 1 µPa2-sec]). Effective quiet establishes a limit on the maximum distance from the pile where injury to fishes is expected – the distance at which the single strike SEL attenuates to 150 dB. Beyond this distance, no physical injury is expected, regardless of the number of pile strikes. Underwater sound would likely cause behavioral changes to fish, which can vary from impaired startle response, freeze response, and increased swimming speed to avoidance (Lafrate et al. 2016)

In summary, based on the best available information for other fish species, underwater noise at or above the levels presented in **Table 11** have the potential to cause injury or behavioral modification to fish. See Appendix A for calculated distances to thresholds during pile driving activities.

Table 11. Fish Impact Pile Driving Injury Guidance

Fish Hearing Group	Onset of Mortality		Onset of Injury		Temporary Threshold Shift
	SEL_{cum}	SPL_{peak}[2]	SEL_{cum}	SPL_{peak}[2]	
No swim bladder (particle motion detection)	> 219 dB	> 213 dB	> 216 dB	> 213 dB	NC
Swim bladder not involved in hearing (particle motion detection)	210 dB	> 207 dB	203 dB	> 207 dB	> 186 dB cumulative SEL[3]
Swim bladder involved in hearing (primarily pressure detection)	207 dB	> 207 dB	203 dB	> 207 dB	186 dB cumulative SEL[3]
Eggs and larvae	> 210 dB	> 207 dB	Not quantified	Not quantified	Not quantified

Source: Popper, et al. 2014

Notes: [1] No vibratory criteria have been established

[2] Peak levels are relative to 1 micropascal (µPa) and cumulative SEL levels are relative to 1 micropascal squared (µPa2) per second.

[3] Cumulative SEL over 24 hours.

Legend: > = greater than; NC = effects from exposure to sound produced by impact pile driving is considered to be unlikely, therefore no criteria are reported; dB = decibel; SEL = sound exposure level; TTS = temporary threshold shift.

Table 12. Maximum Distances to Fish Sound Thresholds from Impact Pile Driving

Section	Pile Count and Size/Type[1]	Total Pile Driving Days[2]	Fishes Without a Swim Bladder					Fishes with a Swim Bladder not Involved in Hearing; Eggs and Larvae					Fishes with a Swim Bladder Involved in Hearing				
			Onset of Mortality		Onset of Injury		TTS	Onset of Mortality[3]		Onset of Injury		TTS	Onset of Mortality		Onset of Injury		TTS
			> 219 SEL_{cum}	> 213 SPL_{peak}	> 216 SEL_{cum}	> 213 SPL_{peak}	>186 SEL_{cum}	210 SEL_{cum}	> 207 SPL_{peak}	203 SEL_{cum}	> 207 SPL_{peak}	186 SEL_{cum}	207 SEL_{cum}	> 207 SPL_{peak}	203 SEL_{cum}	>207 SPL_{peak}	186 SEL_{cum}
Phase I, Impact Install	109, 18-inch pre-stressed concrete pile	19	0 m	0 m	0 m	0 m	11 m	0 m	0 m	1 m	0 m	11 m	0 m	0 m	1 m	0 m	11 m
Phase II, Impact Install	49, 18-inch pre-stressed concrete pile	11	0 m	0 m	0 m	0 m	15 m	0 m	0 m	1 m	0 m	15 m	0 m	0 m	1 m	0 m	15 m
Phase III, Impact Install	105, 16-inch composite pile	18	0 m	0 m	0 m	0 m	26 m	1 m	0 m	2 m	0 m	26 m	1 m	0 m	2 m	0 m	26 m
	26, 18-inch pre-stressed concrete pile	5	0 m	0 m	0 m	0 m	18 m	1 m	0 m	1 m	0 m	18 m	1 m	0 m	1 m	0 m	18 m

Source: Popper et al. 2014

Notes: [1] Due to the lack of studies on fish supporting injury or behavioral disturbance from vibratory pile driving methods, the range of effects on fish focuses on impact pile driving.

[2] Distances are based on maximum number of pile strikes per day for any given pile type installed (See Table 2)

[3] Onset of mortality in eggs and larvae is the same as fishes with swim bladder not involved in hearing; onset of injury and TTS are not quantified for eggs and larvae (see Table 4).

Legend: m = meters; SELcum = Cumulative sound exposure level (decibel referenced to 1 micropascal squared seconds [dB re 1 µPa2-s]); SPLpeak = Peak sound pressure level (decibel referenced to 1 micropascal [dB re 1 µPa]); > indicates that the given effect would occur above the reported threshold; TTS = Temporary Threshold Shift).

5.4 SEA TURTLES

Unweighted peak pressure thresholds for TTS and PTS were developed for sea turtles based on auditory sensitivity in marine mammals (Navy 2017, 2018) (**Table 12**). Popper et al. (2014) recommended applying SEL-based impact thresholds developed for fishes without a swim bladder to sea turtles, which was adjusted based on an 11 dB difference found between the SEL-based non-impulsive TTS threshold and the SEL-based impulsive TTS thresholds for marine mammals. Sea turtles are expected to avoid exposure to underwater root mean square (rms) SPL of 175 dB re 1 µPa or greater (Navy 2017). This threshold is considered the behavioral threshold. The adjusted weighted SELs and behavioral threshold for sea turtles from pile driving noise are shown in **Table 12.** See Appendix A for calculated distances to thresholds during pile driving activities.

Table 13. PTS, TTS, and Behavior Thresholds for Sea Turtles Exposed to Impulsive and Non-Impulsive Sounds

Non-Impulsive		Impulsive				
TTS (weighted SPL Threshold re µPa2-s)	PTS (weighted SPL Threshold re µPa2-s)	TTS (weighted SPL Threshold re µPa2-s)	TTS Peak SPL (unweighted SPL Threshold re 1 µPa)	PTS (weighted SPL Threshold re µPa2-s	PTS (unweighted SPL Threshold re µPa)	Behavioral (weighted re µPa2-s)
200 dB SEL	220 dB SEL	189 dB SEL	226 dB Peak	204 dB SEL	232 dB Peak	175 dB RMS

Legend: PTS = permanent threshold shift, TTS = temporary threshold shift, SEL = sound exposure level, SPL = sound pressure level, SEL $_{cum}$ = cumulative SEL over 24 hours, NA = Not Applicable.

Table 14. Maximum Range to Sea Turtle Sound Thresholds from Impact Pile Driving

Section	Pile Count and Size/Type	Total Pile Driving Days	PTS Weighted (SELcum) Threshold 204 dB re µPa^2-s	TTS Weighted (SELcum) Threshold 189 dB re µPa^2-s	Behavior Unweighted (rms) Threshold 175 dB re 1 µPa
Phase I, Impact Install	109, 18-inch pre-stressed concrete pile	19	0 m	0 m	3 m
Phase II, Impact Install	49, 18-inch pre-stressed concrete pile	11	0 m	0 m	3 m
Phase III, Impact Install	105, 16-inch composite pile	18	0 m	0 m	2 m
	26, 18-inch pre-stressed concrete pile	5	0 m	0 m	3 m

Legend: dB re 1 µPa = dB referenced to a pressure of 1 microPascal; dB re 1 µPa2-s = dB referenced to a pressure of 1 microPascal squared per second; m = meter; PTS = permanent threshold shift; rms = root mean square pressure level; SELcum = cumulative sound exposure level

Table 15. Maximum Range to Sea Turtle Sound Thresholds from Vibratory Pile Driving/Extracting or Drilling

Section	Pile Count and Size/Type	Total Pile Driving Days	PTS Weighted (SELcum) Threshold 220 dB re μPa^2-s	TTS Weighted (SELcum) Threshold 200 dB re μPa^2-s	Behavior Unweighted (rms) Threshold 175 dB re 1 μPa
Phase I, Vibratory Install	183, 56-inch steel sheet	31	0 m	0 m	51 m
Phase I, Vibratory Extract	139, 18-inch pre-stressed concrete	14	0 m	0 m	20 m
Phase II, Vibratory Install	81, 56-inch steel sheet	15	0 m	0 m	51 m
Phase II, Vibratory Extract	61, 18-inch pre-stressed concrete	11	0 m	0 m	20 m
Phase III, Vibratory Install	283, 56-inch steel sheet	48	0 m	1 m	51 m
Phase III, Vibratory Extract	178, 16-inch composite	30	0 m	0 m	11 m

Legend: dB re 1 μPa = dB referenced to a pressure of 1 microPascal; dB re 1 μPa2-s = dB referenced to a pressure of 1 microPascal squared per second; m = meter; PTS = permanent threshold shift; rms = root mean square pressure level; SELcum = cumulative sound exposure level

5.5 GIS Mapping of HARASSMENT ZONES

To create a GIS map of the modeled harassment zones, the following were implemented: (1) use of a high-resolution ArcGIS aerial image of the project area so that the shoreline boundaries of harassment zones can be accurately drawn; (2) define a modeled sound source location that provides a reasonable approximation for project activities with the greatest potential for effects; (3) the application of rules for sound propagation and acoustic shadowing along bearing angles that intersect shoreline obstructions; and (4) the translation of the TL Model into a graphical depiction of diminishing sound pressure isopleths as a function of the sound source level and TL over distance.

The calculations are made in an Excel workbook, which is used to create a multi-ring buffer of isopleths (i.e., sound contours) diminishing in 1 dB increments from the sound source location. The sound contours are created in GIS and clipped to the boundary of the respective harassment zones and then displayed on a map. The graphical outputs will be modified based on different source levels.

5.6 Description of Take Calculation

Consistent with other Navy projects, take estimates associated with pile installation activity are typically calculated using the following general formula:

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

For species where density estimates are not available or not accurate for the inshore area of NAVSTA Norfolk, the methods used in the LOA application for the Pier 3 replacement at NAVSTA Norfolk, which is currently under review with NMFS, will be applied.

6.0 PROPOSED MITIGATION APPROACH FOR MARINE MAMMALS

Calculated distances to the underwater marine mammal auditory (PTS onset) SEL thresholds and behavioral disturbance thresholds for the four hearing groups are provided below for proposed vibratory and impact construction at the Q8 Bulkhead (Tables 8 - 10). Figures depicting the harassment zones are contained in Appendix A.

Modeled areas of noise depicted in the figures are considered conservative. Sound may be truncated from encountered land masses, anthropogenic structures, and depth. Adjusted maximum distances are provided for the behavioral disturbance thresholds where the extent of noise reaches land prior to reaching the calculated radial distances to the threshold. Areas encompassed within the threshold harassment zones were calculated using the location of a representative pile. Sound source locations were chosen to model the greatest possible affected areas.

7.0 GLOSSARY

Table 16. Glossary of Acoustical Terms

Term	Definition
Decibel (dB)	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for water is 1 microPascal (µPa) and for air is 20 µPa (approximate threshold of human audibility).
Sound Pressure Level (SPL)	Sound pressure is the force per unit area, usually expressed in microPascals where 1 Pascal equals 1 Newton exerted over an area of 1 square meter. The SPL is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressure exerted by the sound to a reference sound pressure. SPL is the quantity that is directly measured by a sound level meter.
Frequency, hertz (Hz)	Frequency is expressed in terms of oscillations, or cycles, per second. Cycles per second are commonly referred to as hertz (Hz). Typical human hearing ranges from 20 Hz to 20 kHz.
Peak Sound Pressure, dB re 1 microPascal (µPa)	Peak sound pressure is based on the largest absolute value of the instantaneous sound pressure over the frequency range from 20 Hz to 20 kHz. This pressure is expressed in this application as dB re 1 µPa.
Root Mean Square (rms), dB re 1µPa	The rms level is the square root of the mean of the squared pressure level(s) as measured over a specified time period. For pulses, the rms has been defined as the average of the squared pressures over the time that comprise that portion of waveform containing 90 % of the sound energy for one impact pile driving impulse.
Sound Exposure Level (SEL), dB re 1 µPa^2 sec	Sound exposure level is a measure of energy. Specifically, it is the dB level of the time integral of the squared-instantaneous sound pressure, normalized to a 1-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.
Frequency Spectrum, dB over frequency range	The amplitude of sound at various frequencies, usually shown as a graphical plot of the mean square pressure per unit frequency (µPa^2/Hz) over a frequency range (e.g., 10 Hz to 10 kHz in this application).
Ambient Noise Level	The background sound level, which is a composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.

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Appendix A

MARINE MAMMAL HARASSMENT ZONE FIGURES

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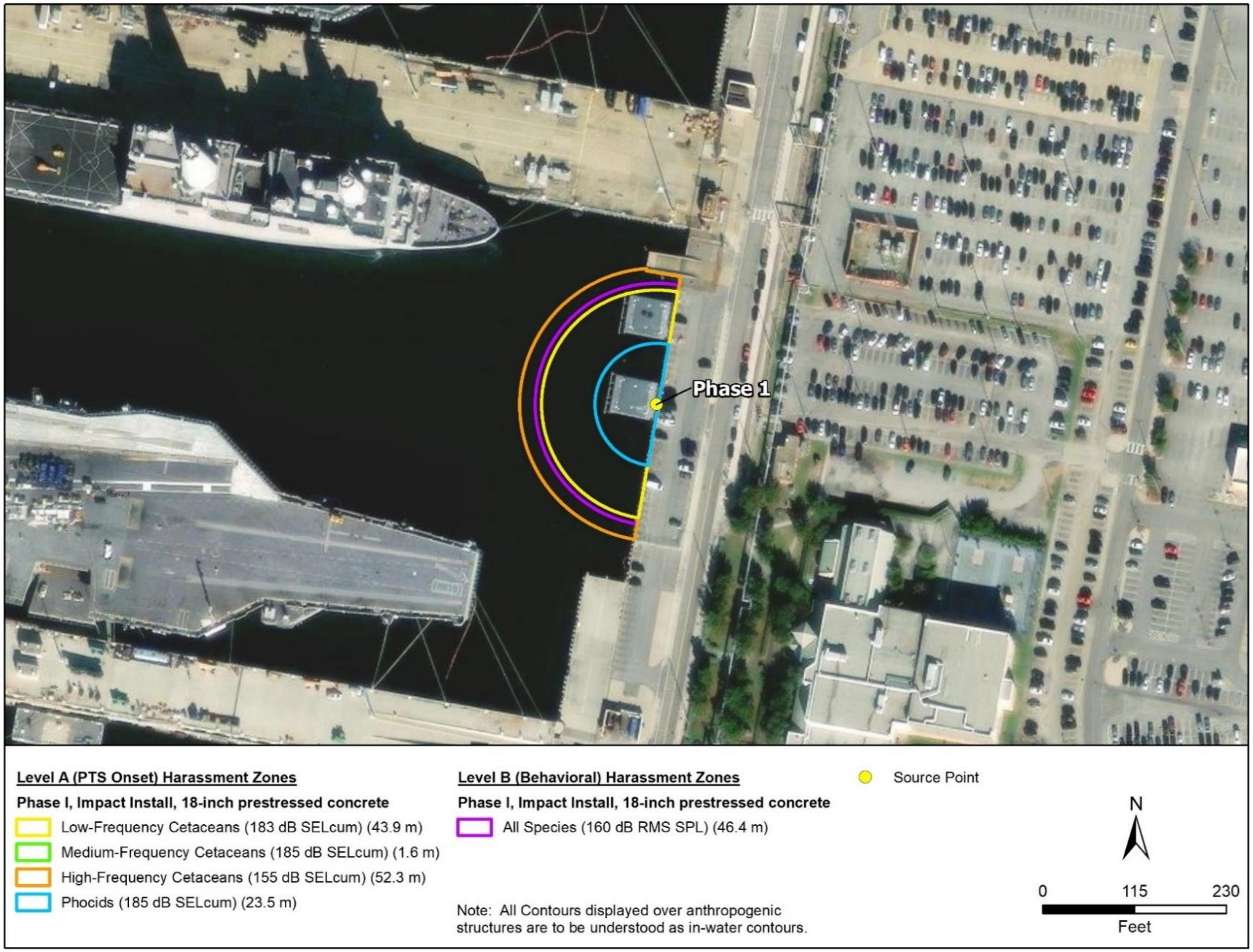


Figure A-1. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Impact Pile Driving 18-inch Concrete Fender Piles, Phase I

Note: Basemap aerial imaging has changed with updates, however source point is the same as previous applicable versions.

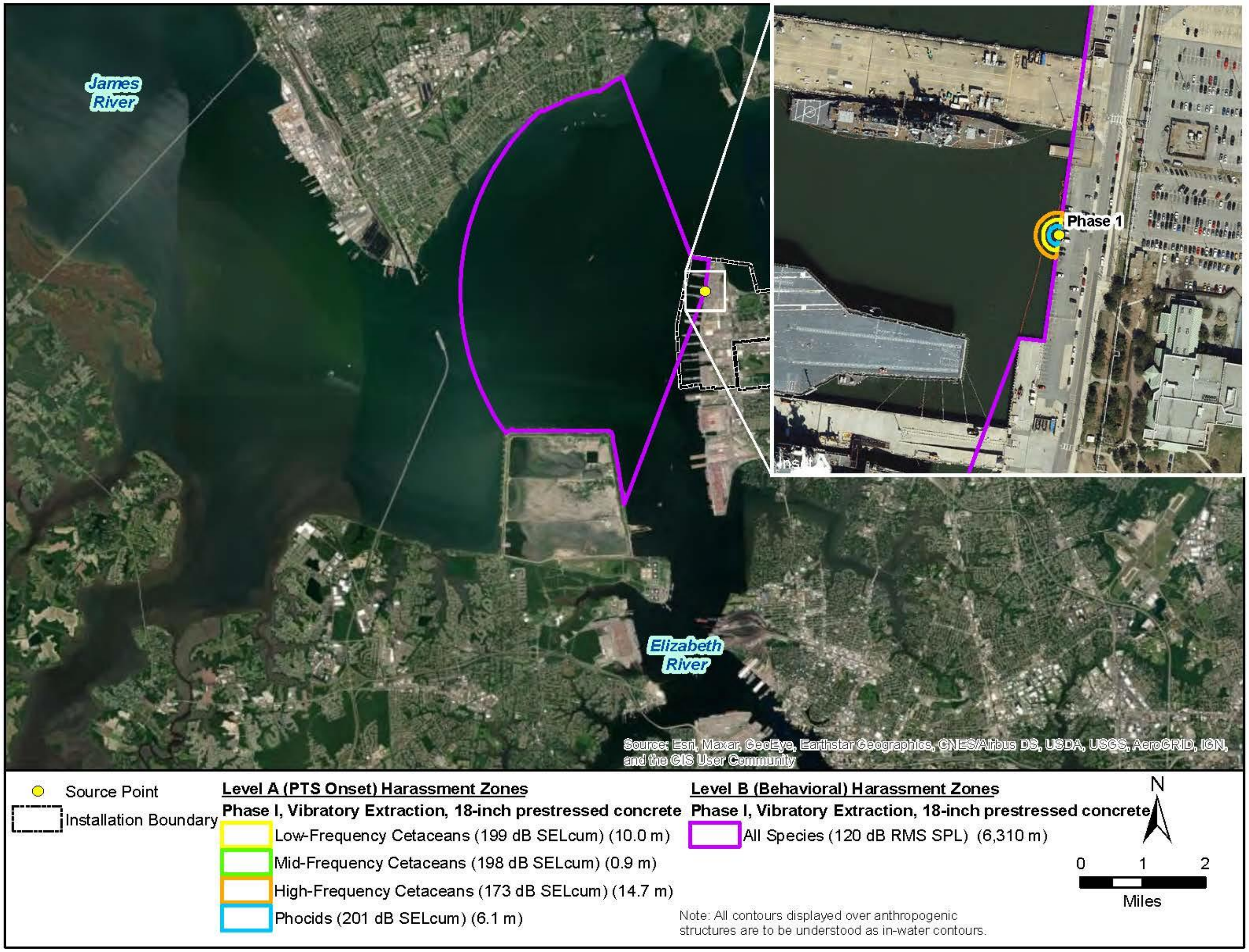


Figure A-2. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Vibratory Extraction of 18-Inch Concrete Fender Piles, Phase I

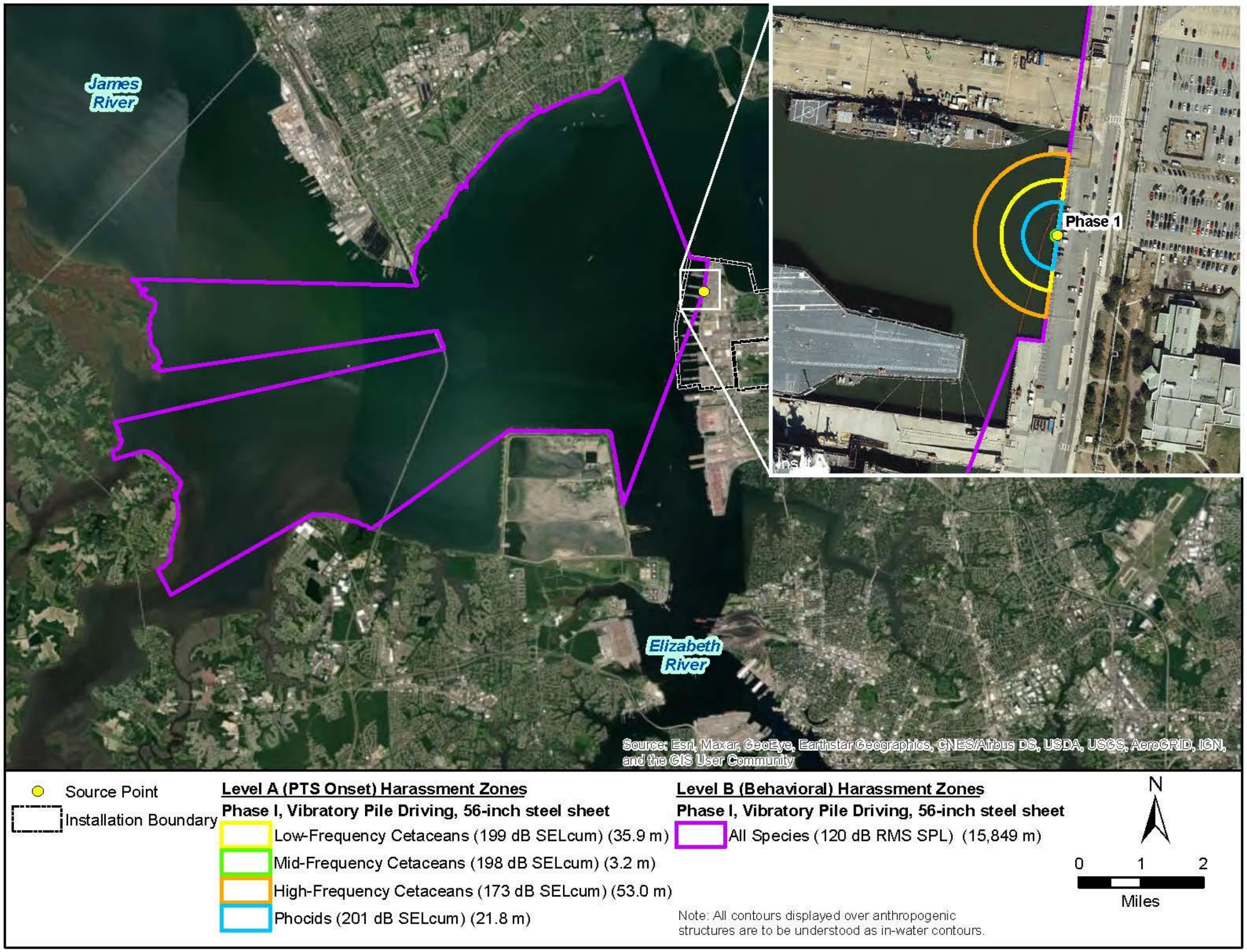


Figure A-3. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Vibratory Pile Driving 56-inch Steel Sheet Piles, Phase I

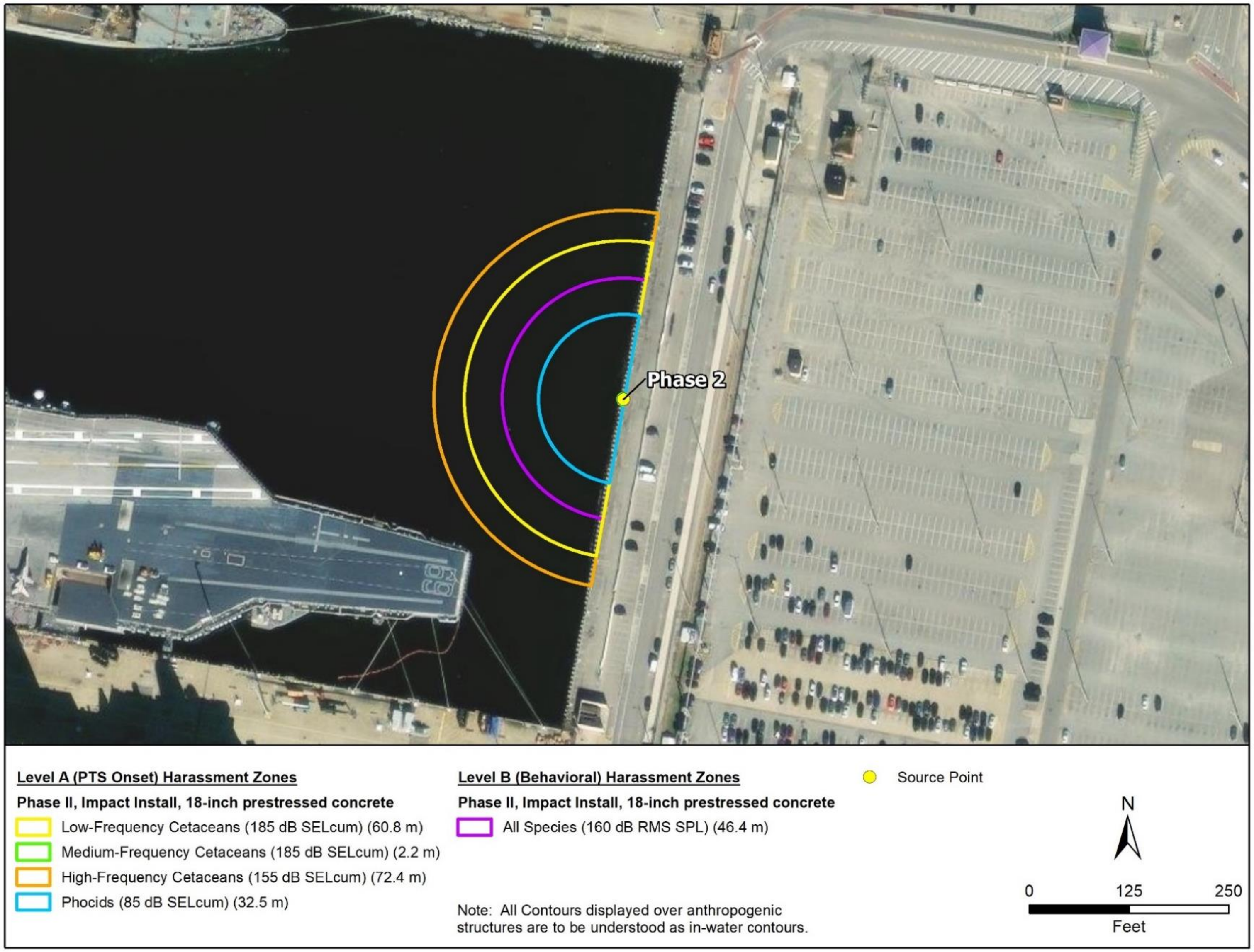


Figure A-4. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Impact Pile Driving 18-inch Concrete Fender Piles, Phase II

Note: Basemap aerial imaging has changed with updates, however source point is the same as previous applicable versions.

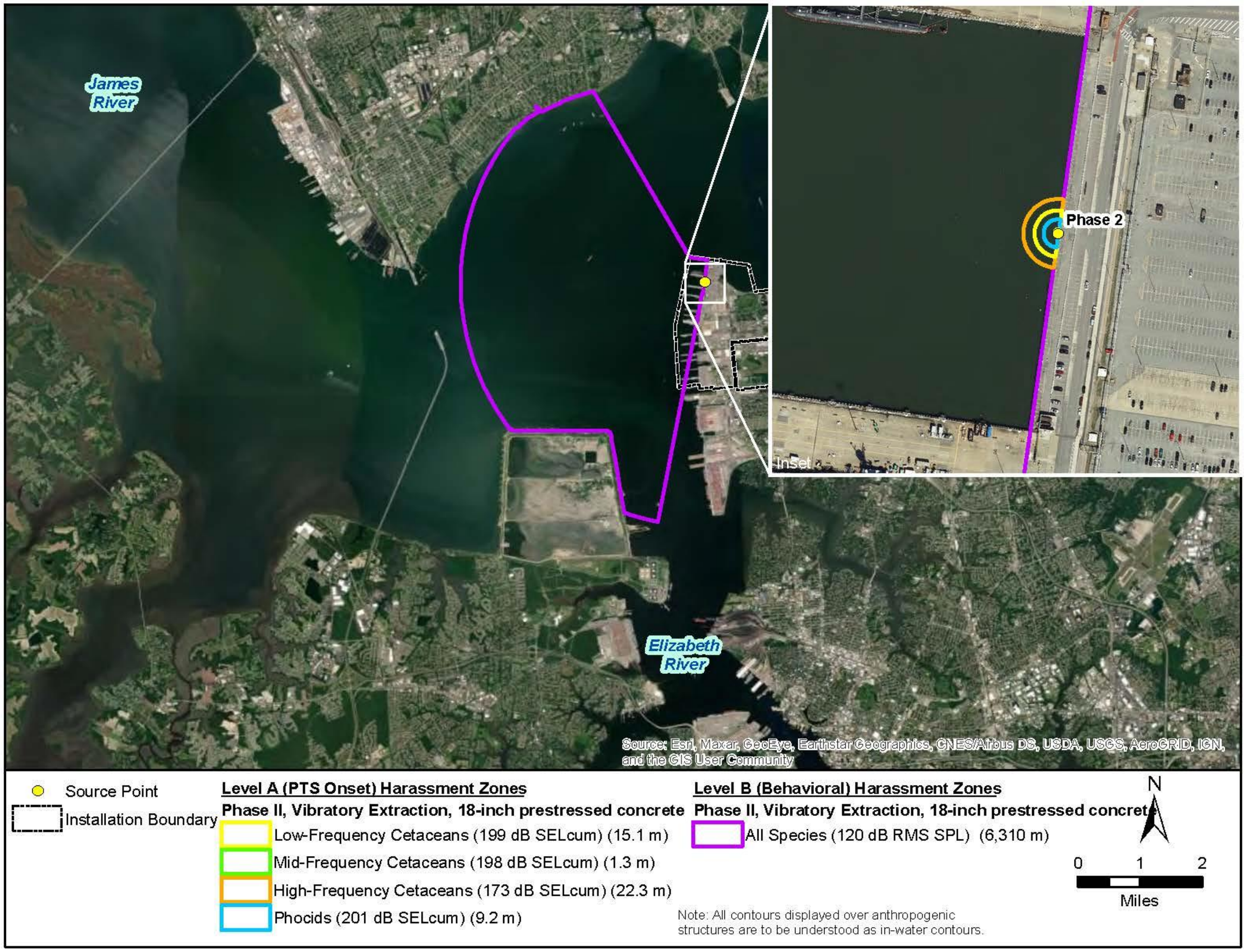


Figure A-5. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Vibratory Extraction of 18-Inch Concrete Fender Piles, Phase II

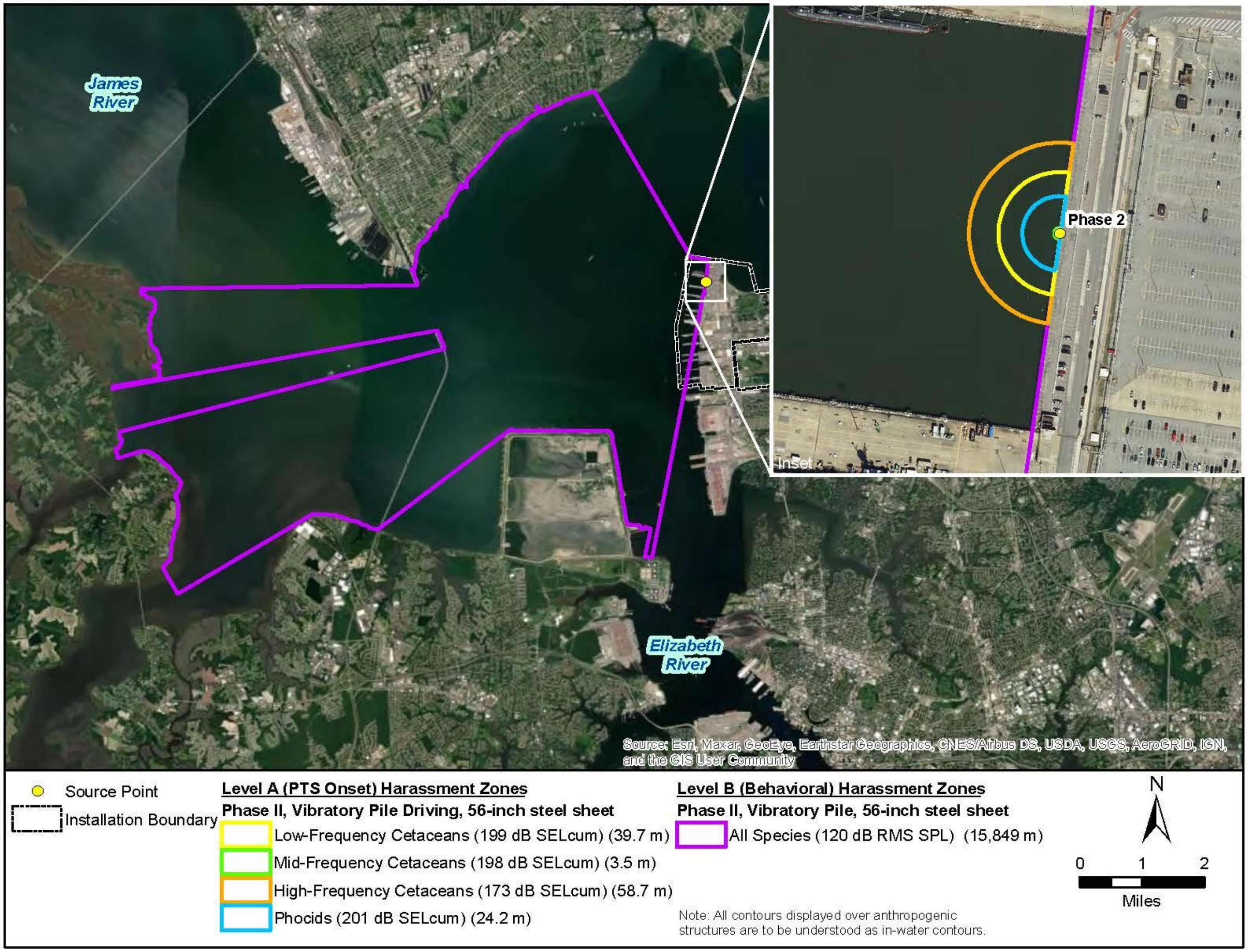
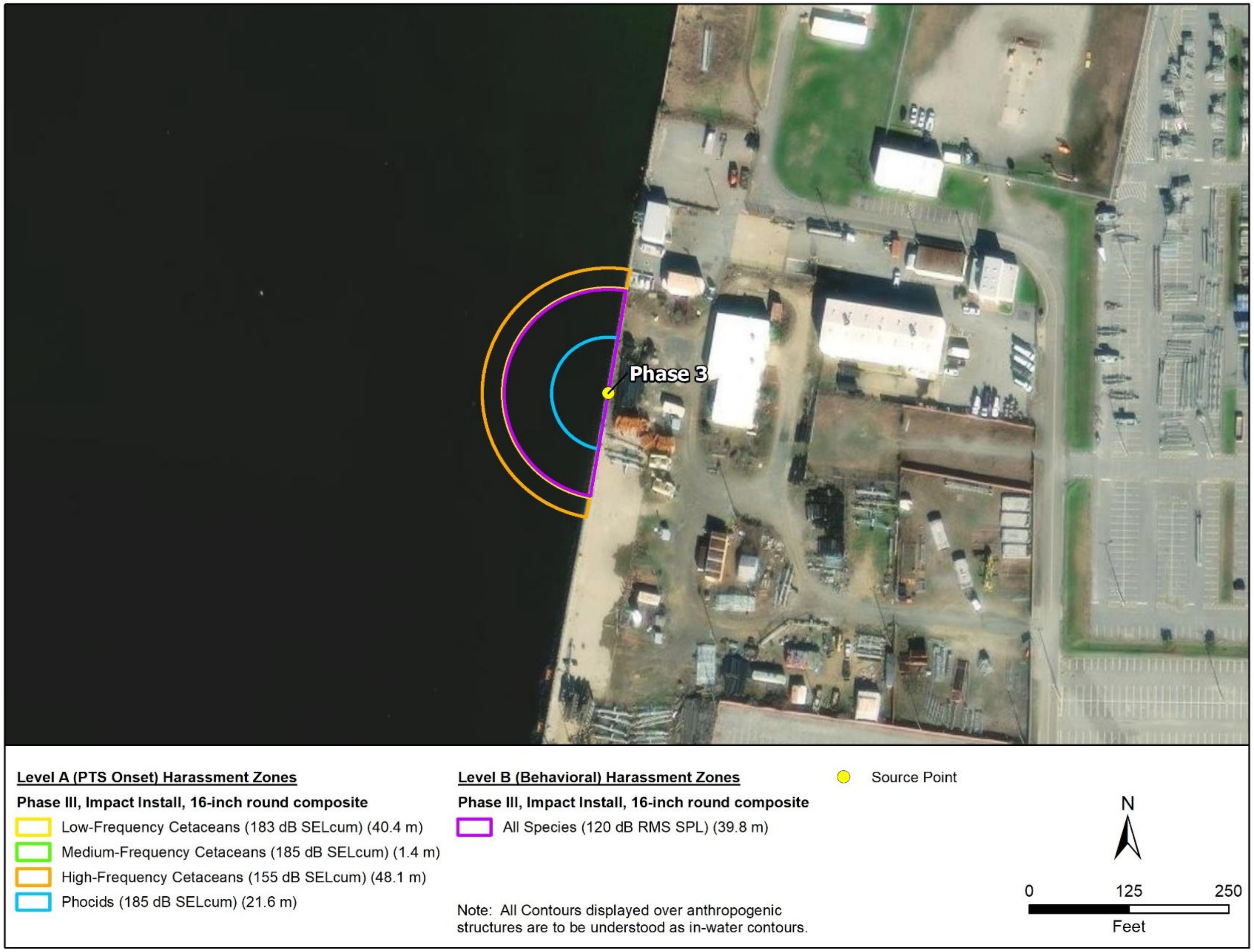


Figure A-6. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Vibratory Pile Driving 56-inch Steel Sheet Piles, Phase II



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2 **Figure A-7. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Impact Pile Driving at 16-inch Composite Fender Piles, Phase**
3 **III**

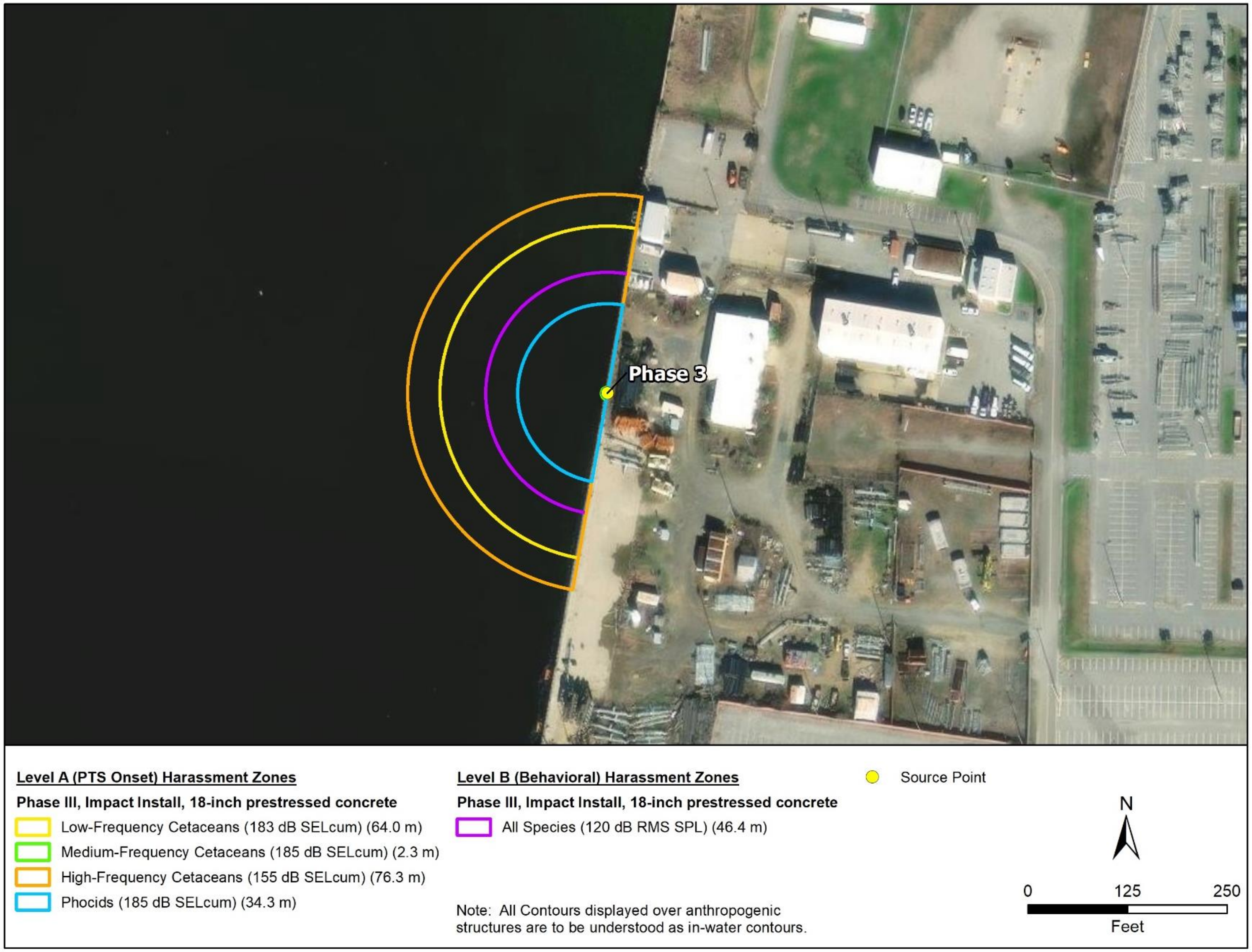


Figure A-8. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Impact Pile Driving 18-inch Concrete Fender Piles, Phase III

Note: Basemap aerial imaging has changed with updates, however source point is the same as previous applicable versions.

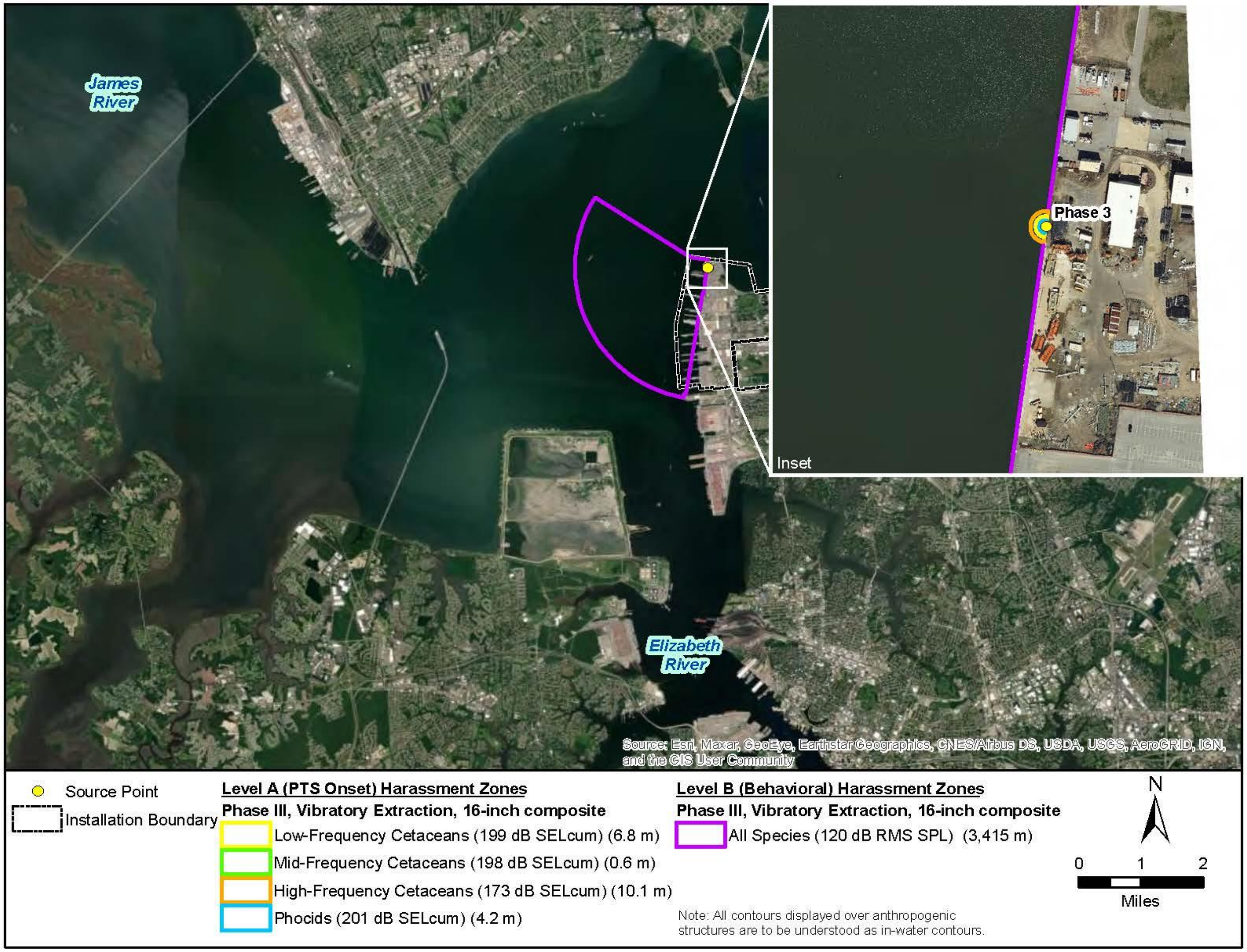


Figure A-9. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Vibratory Extraction of 18-Inch Composite Fender Piles, Phase III

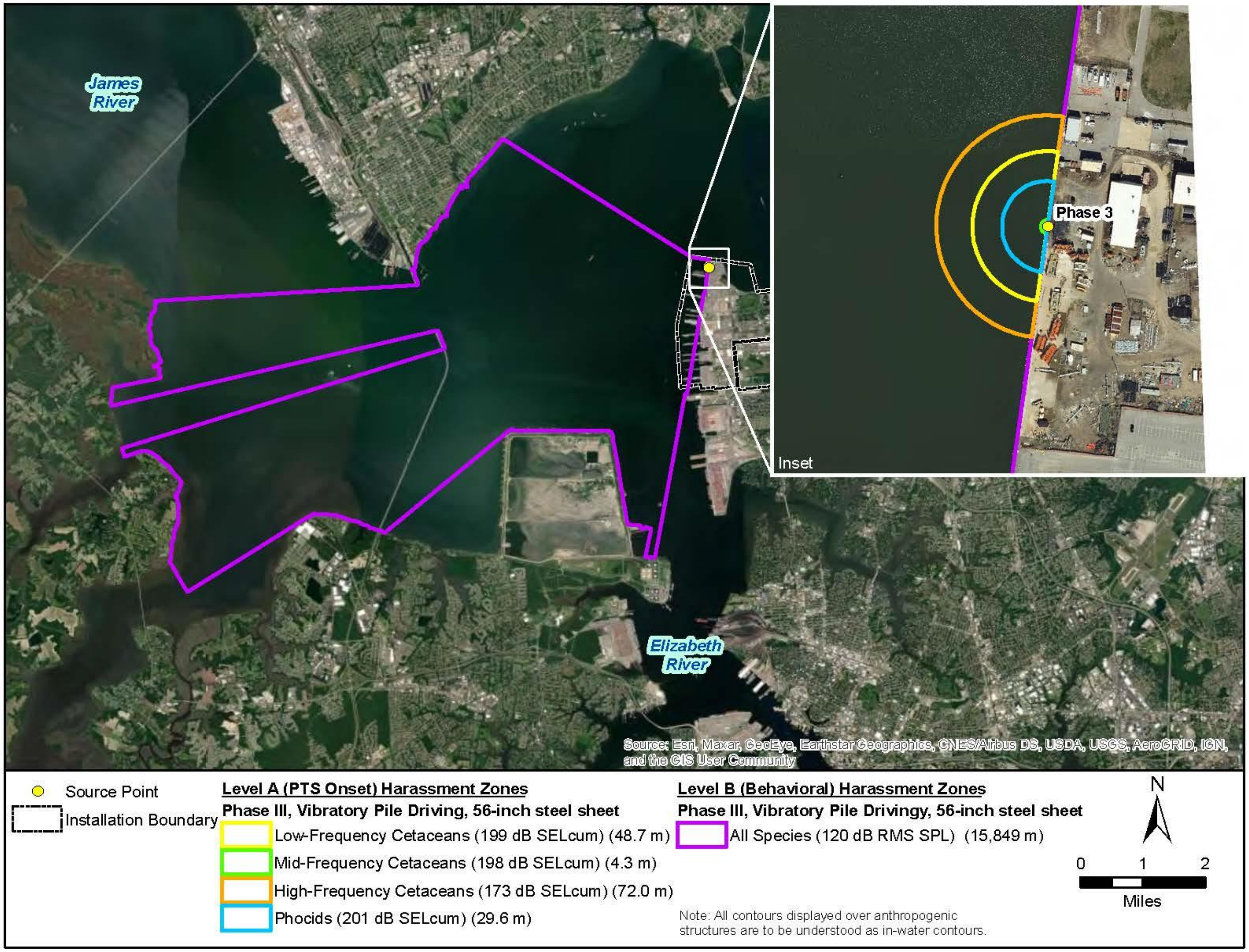


Figure A-10. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Vibratory Pile Driving 56-inch Steel Sheet Piles, Phase III

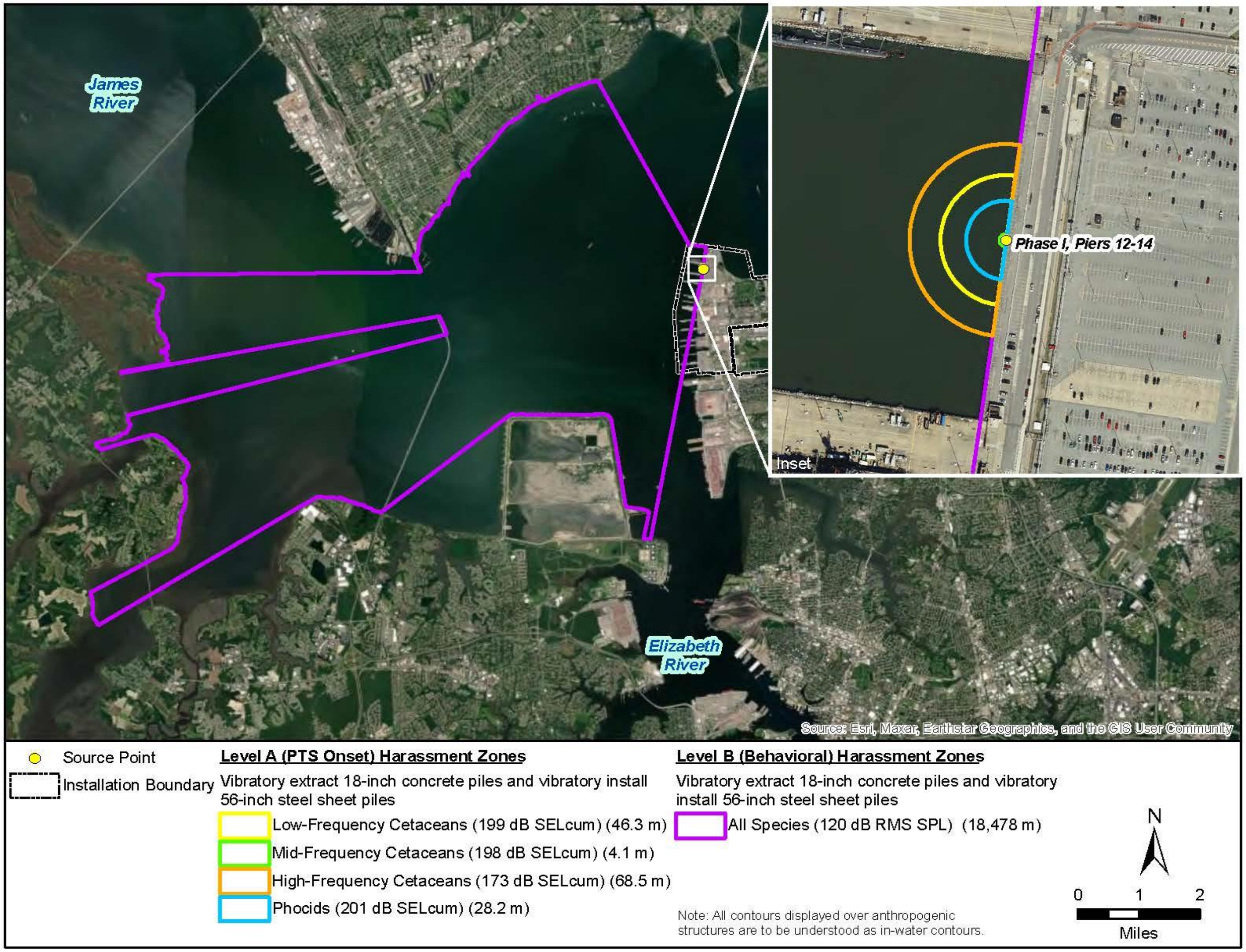


Figure A-11. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities: Vibratory Extraction of 18-inch Concrete Piles and Vibratory Installation of 56-inch Steel Sheet Piles, Phase I

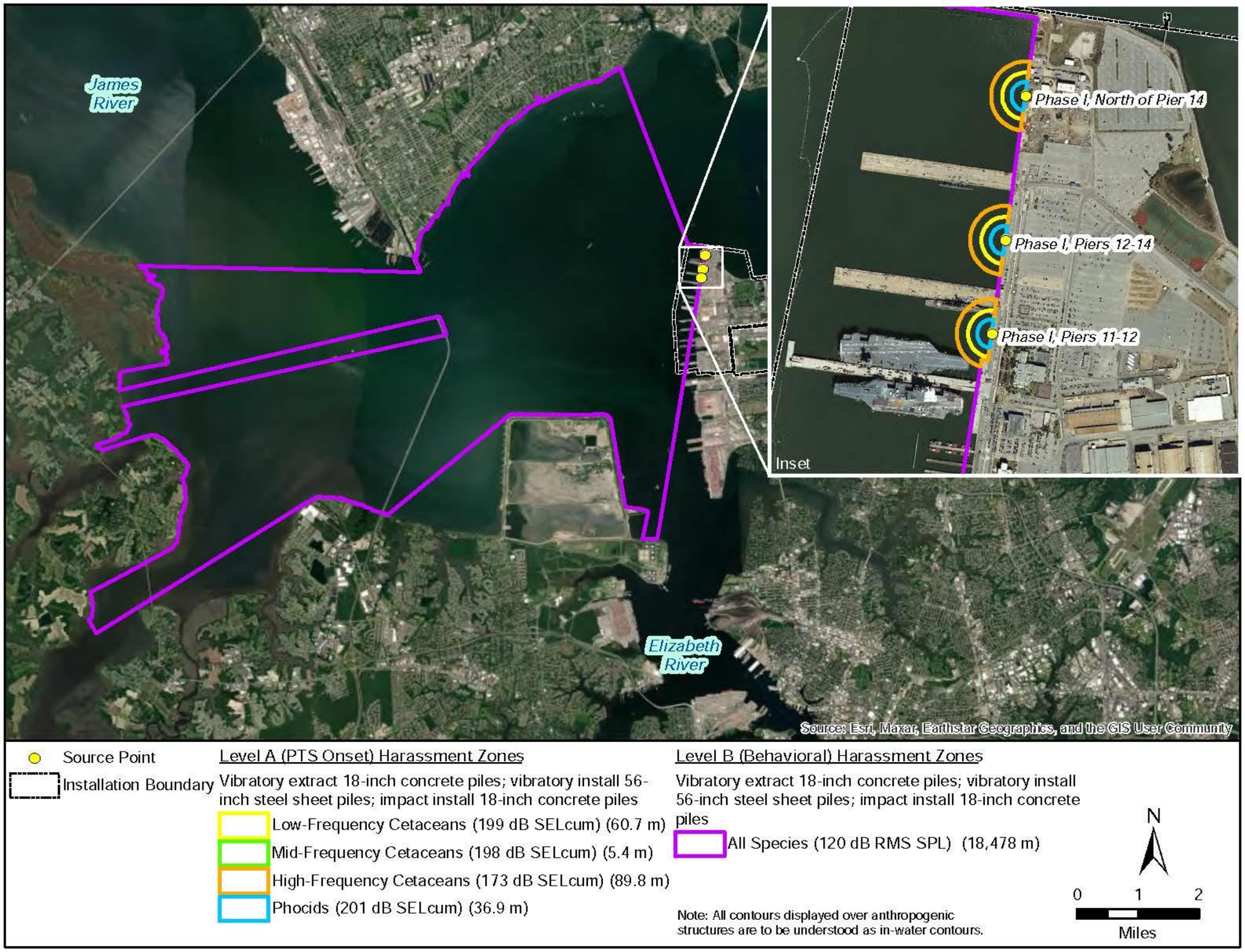


Figure A-12. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities: Vibratory Extraction of 18-inch Concrete Piles, Vibratory Installation of 56-inch Steel Sheet Piles, and Impact Installation of 18-inch Concrete Piles, All Phases

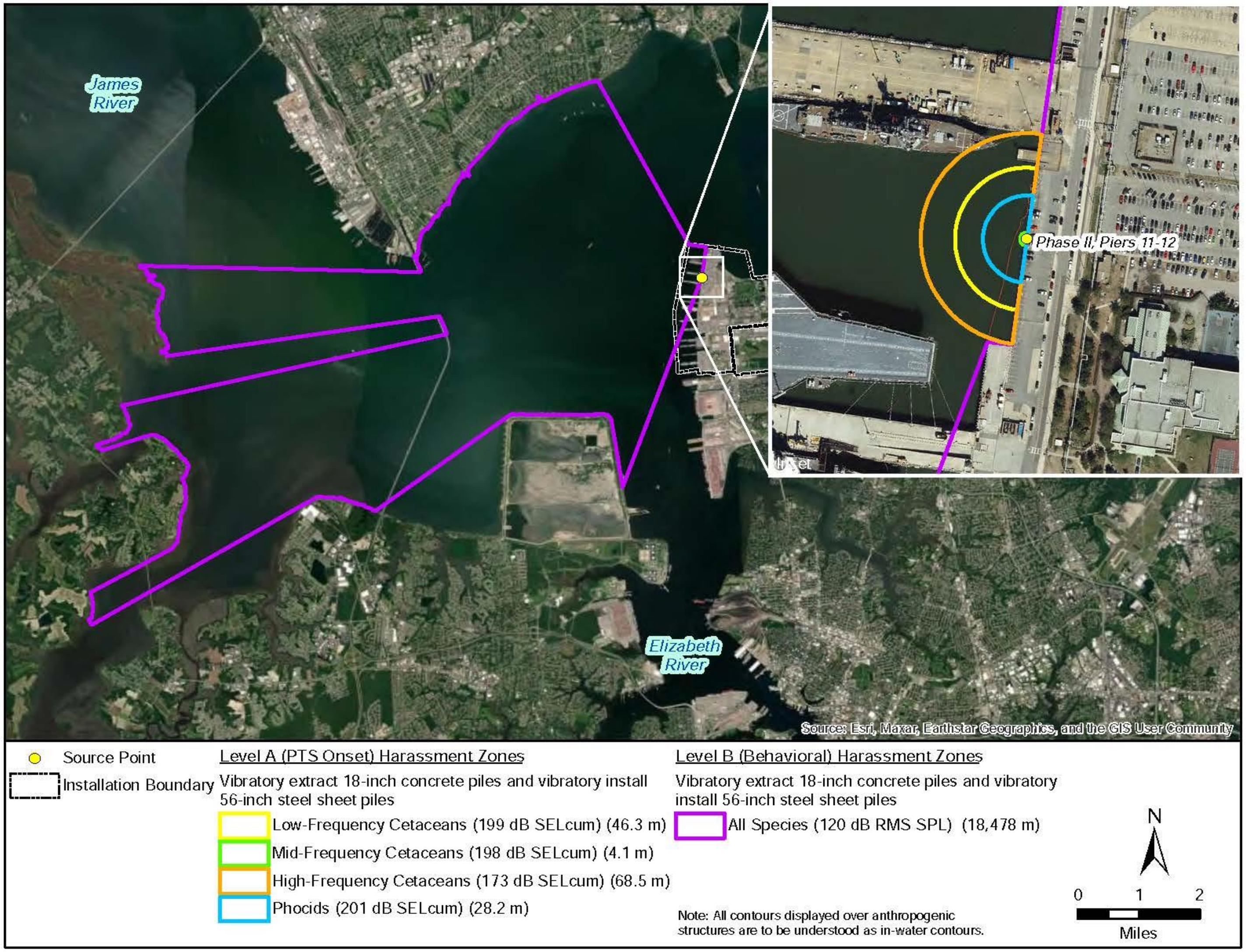


Figure A-13. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities: Vibratory Extraction of 18-inch Concrete Piles and Vibratory Installation of 56-inch Steel Sheet Piles, Phase II

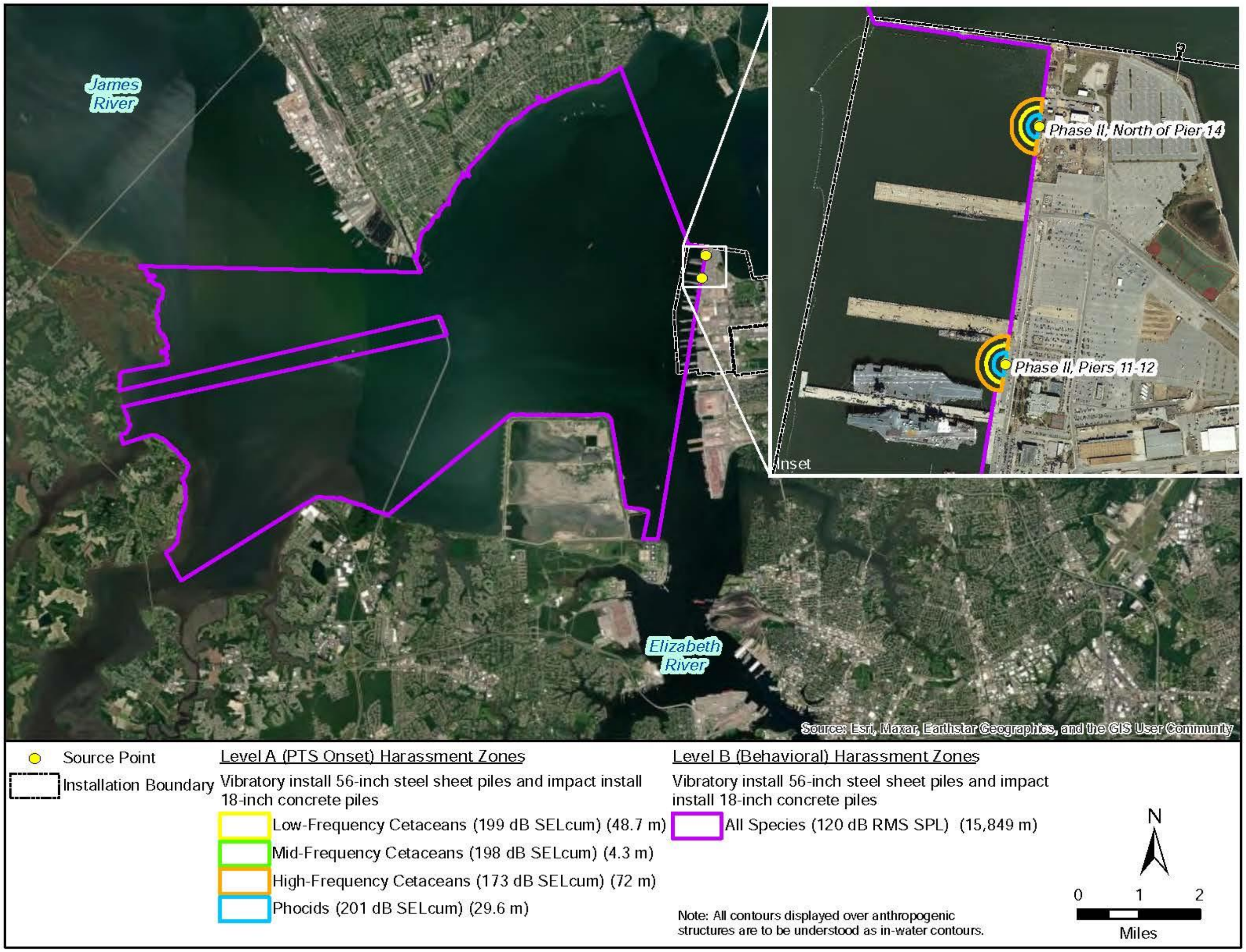


Figure A-14. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities: Vibratory Installation of 56-inch Steel Sheet Piles and Impact Installation of 18-inch Concrete Piles, Phase II and III

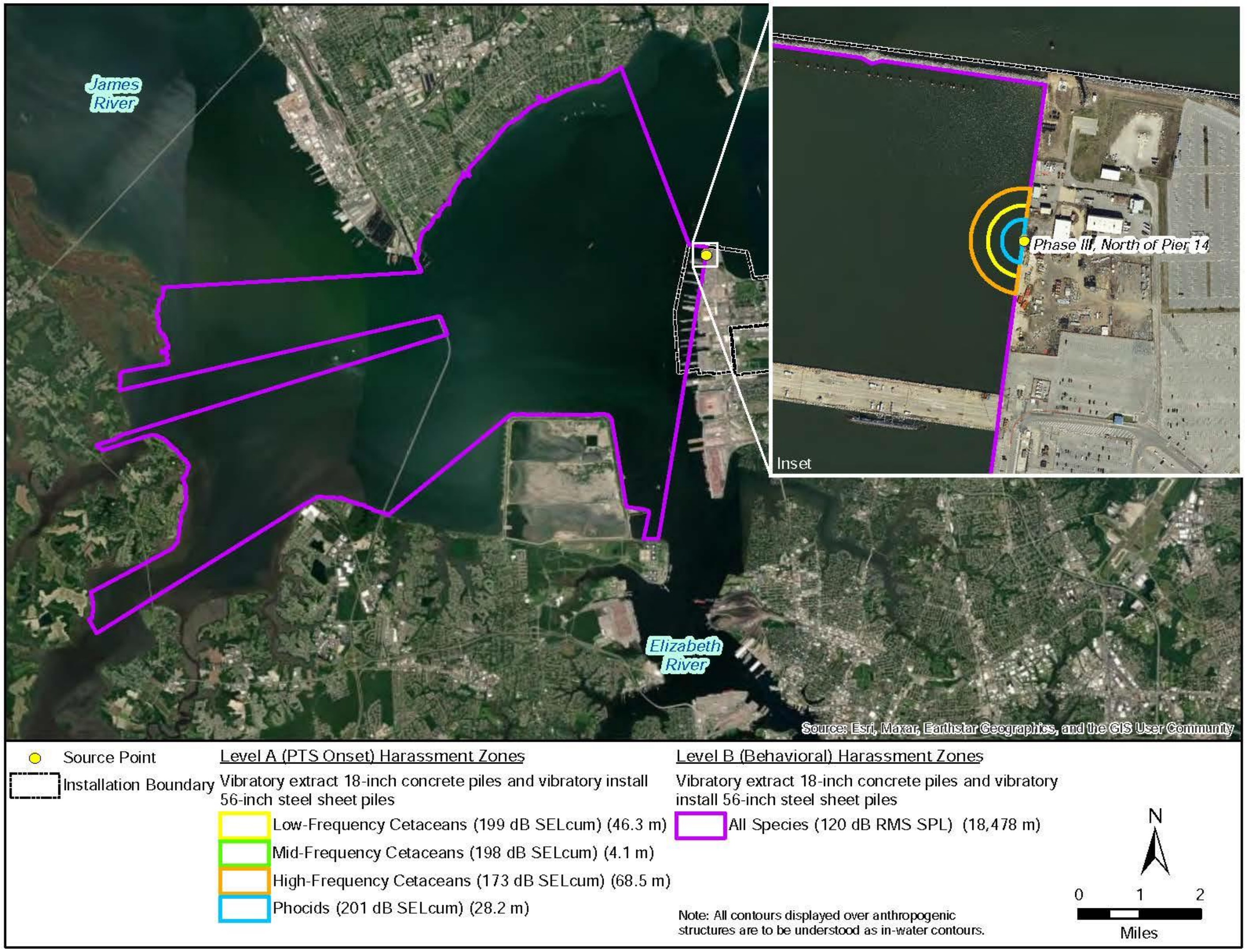
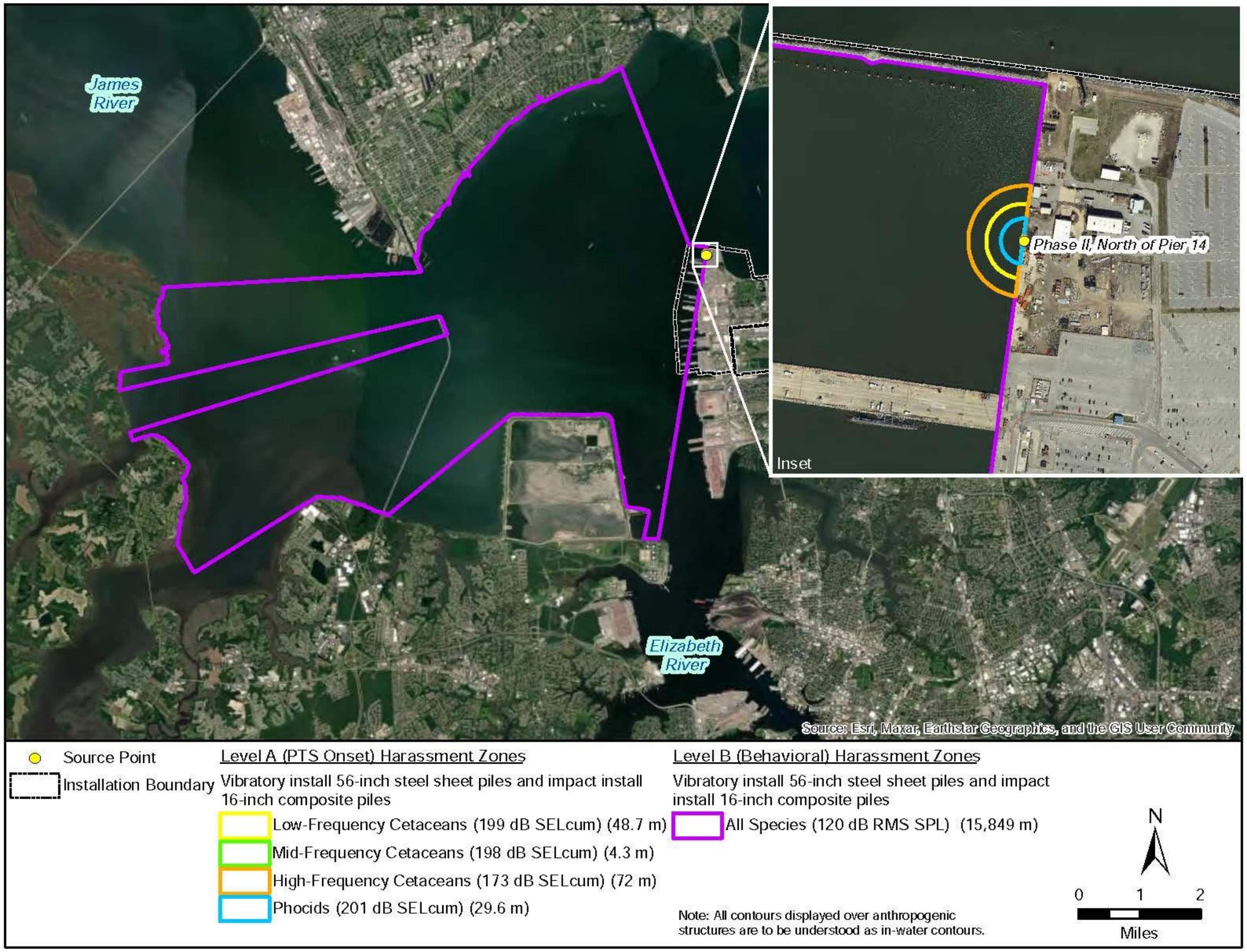


Figure A-15. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities: Vibratory Extraction of 18-inch Concrete Piles and Vibratory Installation of 56-inch Steel Sheet Piles, Phase III



A-16. Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities: Vibratory Installation of 56-inch Steel Sheet Piles and Impact Installation of 16-inch Composite Piles, Phase III

Level A (PTS Onset) and Level B (Behavioral) Harassment Zones from Concurrent Activities:

Appendix B
NMFS SPREADSHEETS

USER SPREADSHEET INTRODUCTION

VERSION: 2.2 (2020)

Companion* User Spreadsheet to:

National Marine Fisheries Service (NMFS): 2018 Revision to: Technical Guidance For Assessing the Effects of Anthropogenic Noise on Marine Mammal Hearing: Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts (Version 2.0)

2018 Revised Technical Guidance web page

***For more information on the optional methodology provided within this User Spreadsheet, see Appendix D of Technical Guidance (2018)**

DISCLAIMER: NMFS has provided this spreadsheet as an optional tool to provide estimated effect distances (i.e., isopleths) where PTS onset thresholds may be exceeded. Results provided by this spreadsheet do not represent the entirety of the comprehensive effects analysis, but rather serve as one tool to help evaluate the effects of a proposed action on marine mammal hearing and make findings required by NOAA's various statutes. Input values are the responsibility of the individual user.

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

INSTRUCTIONS

STEP 1: Determine what spreadsheet is appropriate for activity

HOW TO DETERMINE WHICH TAB TO USE

1) Is the sound source NON-IMPULSIVE or IMPULSIVE? (If it is unclear which category describes your source, consult NOAA)
- a) NON-IMPULSIVE (e.g., drilling, vibratory pile driving, tactical sonar): Go to Question 2
- b) IMPULSIVE (e.g., explosives, impact pile driving, DTH pile driving, seismic): Go to Question 5

2) Is the NON-IMPULSIVE sound source STATIONARY or MOBILE?
- a) STATIONARY: Go to Question 3
- b) MOBILE: Go to Question 4

3) Is the NON-IMPULSIVE, STATIONARY source CONTINUOUS or INTERMITTENT†?
- a) CONTINUOUS: Use Tab A* — RED
- *If source is vibratory pile driving: Use Tab A.1 — BRICK
- b) INTERMITTENT: Use Tab B — YELLOW

† A key distinction between continuous and intermittent sound sources is that intermittent sounds have a more regular (predictable) pattern of bursts of sounds and silent periods (i.e., duty cycle), which continuous sounds do not.

4) Is the NON-IMPULSIVE, MOBILE source CONTINUOUS or INTERMITTENT?
- a) CONTINUOUS: Use Tab C ("safe distance" methodology from Sivle et al. 2014) — BLUE
- b) INTERMITTENT: Use Tab D ("safe distance" methodology from Sivle et al. 2014) — ORANGE

5) Is the IMPULSIVE sound source STATIONARY or MOBILE?
- a) STATIONARY: Use Tab E* — GREEN
- *If source is impact pile driving: Use Tab E.1 — EVRGRN
- *If source is DTH pile driving/installation: Use Tab E.2 — TEAL
- b) MOBILE: Use Tab F ("safe distance" methodology from Sivle et al. 2014) — PURPLE

STEP 2: Within the appropriate tab, fill-in: **SAGE CELLS** specific to the activity
- a) Please provide information used to support values in provided in sage boxes (e.g., surrogate data, direct measurements, etc.)
- b) If information is unavailable to fill-out one or more of the sage boxes, please consult NMFS

STEP 3: Estimated PTS isopleths (meter) will be provided in: **SKY BLUE CELLS** by marine mammal hearing group

STEP 4: When using this spreadsheet to estimate marine mammal takes, please provide a copy of completed tab used to estimate isopleths

ASSUMPTIONS & ADDITIONAL INFORMATION

1) Marine mammals remain stationary during activity
2) Currently, recovery between intermittent sounds is not considered regardless of time between sounds (i.e., all sounds within the accumulation period are counted)

Suggested (Default*) Weighting Factor Adjustments (WFA) for Broadband Sources:

Source	WFA	Example Supporting Sources
Seismic airguns	1 kHz	Breitzke et al. 2008; Tashmukhambetov et al. 2008; Tolstoy et al. 2009
Impact pile driving hammers	2 kHz	Blackwell 2005; Reinhall and Dahl 2011
Vibratory pile driving hammers	2.5 kHz	Blackwell 2005; Dahl et al. 2015
DTH pile driving/installation	2 kHz	Denes et al. 2016; Denes et al. 2019; Reyff and Heyvaert 2019
Drill vessels/platforms	2 kHz	Greene 1987; Blackwell et al. 2004; Blackwell and Greene 2006

* NMFS acknowledges default WFAs are likely conservative

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

Based on NMFS 2018 Revised Technical Guidance

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Technical questions or suggestion on User Spreadsheet: Please contact Amy Scholik-Schlomer (amy.scholik@noaa.gov)

UPDATES (will be posted when change results in the need to recalculate an isopleth; other non-substantive changes may be made periodically but will not result in a version number change)

Original Version	Updated Version	Change	Date posted
1.0	1.1	Sheet A, error with formula for phocid pinniped	Aug. 22, 2016
1.1	2.0	Corresponds to 2.0 version of Revised Technical Guidance (2018). Added sheet specific to vibratory pile driving and explosives and added capabilities to calculate peak sound pressure level isopleths for impulsive sources	July 2018
2.0	2.1	Updated version based on comments from 2018 public comment period. Added Tab for DTH	July 2020
2.0	2.2	Updated version based on comments from 2018 public comment period (late) on seismic surveys from IAGC	December 2020

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

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NAVSTA Norfolk Q8 Bulkhead, Phase I: Vibratory Install 183, 56-inch steel sheet piles
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B30)	168
Number of piles within 24-h period	6
Duration to drive a single pile (minutes)	24
Duration of Sound Production within 24-h period (seconds)	8640
10 Log (duration of sound production)	39.37
Transmission loss coefficient	15
Distance of sound pressure level (L_{rms}) measurement (meters)	10

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

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**35.9**	**3.2**	**53.0**	**21.8**	**1.5**

WEIGHTING FUNCTION CALCULATIONS

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

NOTE: If user decided to override these Adjustment values, they need to make sure to download another copy to ensure the built-in calculations function properly.

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

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

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NAVSTA Norfolk Q8 Bulkhead, Phase I: Vibratory Extract 139, 18-inch prestressed concrete piles
PROJECT/SOURCE INFORMATION	
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B30)	162
Number of piles within 24-h period	6
Duration to drive a single pile (minutes)	14
Duration of Sound Production within 24-h period (seconds)	5040
10 Log (duration of sound production)	37.02
Transmission loss coefficient	15
Distance of sound pressure level (L_{rms}) measurement (meters)	10

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

RESULTANT ISOPLETHS

Hearing Group	**Low-Frequency Cetaceans**	**Mid-Frequency Cetaceans**	**High-Frequency Cetaceans**	**Phocid Pinnipeds**	**Otariid Pinnipeds**
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**10.0**	**0.9**	**14.7**	**6.1**	**0.4**

WEIGHTING FUNCTION CALCULATIONS

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

NOTE: If user decided to override these Adjustment values, they need to make sure to download another copy to ensure the built-in calculations function properly.

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

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

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NAVSTA Norfolk Q8 Bulkhead, Phase II: Vibratory Install 81, 56-inch steel sheet piles
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B30)	168
Number of piles within 24-h period	6
Duration to drive a single pile (minutes)	28
Duration of Sound Production within 24-h period (seconds)	10080
10 Log (duration of sound production)	40.03
Transmission loss coefficient	15
Distance of sound pressure level (L_{rms}) measurement (meters)	10

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

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**39.7**	**3.5**	**58.7**	**24.2**	**1.7**

WEIGHTING FUNCTION CALCULATIONS

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

NOTE: If user decided to override these Adjustment values, they need to make sure to download another copy to ensure the built-in calculations function properly.

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

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

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NAVSTA Norfolk Q8 Bulkhead, Phase II: Vibratory Extract 61, 18-inch prestressed concrete piles
PROJECT/SOURCE INFORMATION	
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B30)	162
Number of piles within 24-h period	6
Duration to drive a single pile (minutes)	26
Duration of Sound Production within 24-h period (seconds)	9360
10 Log (duration of sound production)	39.71
Transmission loss coefficient	15
Distance of sound pressure level (L_{rms}) measurement (meters)	10

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

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**15.1**	**1.3**	**22.3**	**9.2**	**0.6**

WEIGHTING FUNCTION CALCULATIONS

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

NOTE: If user decided to override these Adjustment values, they need to make sure to download another copy to ensure the built-in calculations function properly.

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

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

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NAVSTA Norfolk Q8 Bulkhead, Phase III: Vibratory Install 283, 56-inch steel sheet piles
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B30)	168
Number of piles within 24-h period	6
Duration to drive a single pile (minutes)	38
Duration of Sound Production within 24-h period (seconds)	13680
10 Log (duration of sound production)	41.36
Transmission loss coefficient	15
Distance of sound pressure level (L_{rms}) measurement (meters)	10

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

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**48.7**	**4.3**	**72.0**	**29.6**	**2.1**

WEIGHTING FUNCTION CALCULATIONS

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

NOTE: If user decided to override these Adjustment values, they need to make sure to download another copy to ensure the built-in calculations function properly.

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

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

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NAVSTA Norfolk Q8 Bulkhead, Phase III: Vibratory Extract 178 Composite Fender piles
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B30)	158
Number of piles within 24-h period	6
Duration to drive a single pile (minutes)	20
Duration of Sound Production within 24-h period (seconds)	7200
10 Log (duration of sound production)	38.57
Transmission loss coefficient	15
Distance of sound pressure level (L_{rms}) measurement (meters)	10

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

RESULTANT ISOPLETHS

Hearing Group	**Low-Frequency Cetaceans**	**Mid-Frequency Cetaceans**	**High-Frequency Cetaceans**	**Phocid Pinnipeds**	**Otariid Pinnipeds**
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**6.8**	**0.6**	**10.1**	**4.2**	**0.3**

WEIGHTING FUNCTION CALCULATIONS

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

NOTE: If user decided to override these Adjustment values, they need to make sure to download another copy to ensure the built-in calculations function properly.

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

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

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NAVSTA Norfolk Q8 Bulkhead, Phase I: impact install 18-inch square prestressed concrete piles
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 73), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: METHOD E.1-1 is PREFERRED method when SEL-based source levels are available (because pulse duration is not required). Only use method E.1-2 if SEL-based source levels are not available.

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT) **PREFERRED METHOD (pulse duration not needed)**

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**192.7**

SEL_{cum}

Single Strike SEL_{ss} ($L_{E,p,\ single\ strike}$) specified at "x" meters (Cell B32)	160
Number of strikes per pile	307
Number of piles per day	6
Transmission loss coefficient	15
Distance of single strike SEL_{ss} ($L_{E,p,\ single\ strike}$) measurement (meters)	10

PK

$L_{p,0\text{-}pk}$ specified at "x" meters (Cell G29)		
Distance of $L_{p,0\text{-}pk}$ measurement (meters)*		
$L_{p,0\text{-}pk}$ Source level		#NUM!

RESULTANT ISOPLETHS*

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

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**43.9**	**1.6**	**52.3**	**23.5**	**1.7**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

"NA": PK source level is ≤ to the threshold for that marine mammal hearing group.

E.1-2: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B53)	
Number of piles per day	
Strike (pulse) Duration[Δ] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Transmission loss coefficient	
Distance of sound pressure level (L_{rms}) measurement (meters)	

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

PK

$L_{p,0\text{-}pk}$ specified at "x" meters (Cell G47)		
Distance of $L_{p,0\text{-}pk}$ measurement (meters)*		
$L_{p,0\text{-}pk}$ Source level		#NUM!

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

RESULTANT ISOPLETHS*

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

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

"NA": PK source level is ≤ to the threshold for that marine mammal hearing group.

WEIGHTING FUNCTION CALCULATIONS

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

NOTE: If user decided to override these Adjustment values, they need to make sure to download another copy to ensure the built-in calculations function properly.

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

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

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NAVSTA Norfolk Q8 Bulkhead, Phase I: impact install 18-inch square prestressed concrete piles
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 73), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: METHOD E.1-1 is PREFERRED method when SEL-based source levels are available (because pulse duration is not required). Only use method E.1-2 if SEL-based source levels are not available.

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT) **PREFERRED METHOD (pulse duration not needed)**

Unweighted $SEL_{cum\,(at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**194.8**

SEL_{cum}

Single Strike SEL_{ss} ($L_{E,p,\,single\ strike}$) specified at "x" meters (Cell B32)	160
Number of strikes per pile	499
Number of piles per day	6
Transmission loss coefficient	15
Distance of single strike SEL_{ss} ($L_{E,p,\,single\ strike}$) measurement (meters)	10

PK

$L_{p,0\text{-}pk}$ specified at "x" meters (Cell G29)		
Distance of $L_{p,0\text{-}pk}$ measurement (meters)*		
$L_{p,0\text{-}pk}$ Source level		#NUM!

RESULTANT ISOPLETHS*

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

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**60.8**	**2.2**	**72.4**	**32.5**	**2.4**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

"NA": PK source level is ≤ to the threshold for that marine mammal hearing group.

E.1-2: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B53)	
Number of piles per day	
Strike (pulse) Duration[∆] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Transmission loss coefficient	
Distance of sound pressure level (L_{rms}) measurement (meters)	

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

PK

$L_{p,0\text{-}pk}$ specified at "x" meters (Cell G47)		
Distance of $L_{p,0\text{-}pk}$ measurement (meters)*		
$L_{p,0\text{-}pk}$ Source level		#NUM!

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring

requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

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

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

"NA": PK source level is ≤ to the threshold for that marine mammal hearing group.

WEIGHTING FUNCTION CALCULATIONS

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

NOTE: If user decided to override these Adjustment values, they need to make sure to download another copy to ensure the built-in calculations function properly.

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

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

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NAVSTA Norfolk Q8 Bulkhead, Phase I: impact install 18-inch square prestressed concrete piles
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment (kHz)[¥]	2	

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 73), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: METHOD E.1-1 is PREFERRED method when SEL-based source levels are available (because pulse duration is not required). Only use method E.1-2 if SEL-based source levels are not available.

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT) PREFERRED METHOD (pulse duration not needed)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	192.1

SEL_{cum}

Single Strike SEL_{ss} ($L_{E,p,\ single\ strike}$) specified at "x" meters (Cell B32)	157
Number of strikes per pile	540
Number of piles per day	6
Transmission loss coefficient	15
Distance of single strike SEL_{ss} ($L_{E,p,\ single\ strike}$) measurement (meters)	10

PK

$L_{p,0\text{-}pk}$ specified at "x" meters (Cell G29)		
Distance of $L_{p,0\text{-}pk}$ measurement (meters)*		
$L_{p,0\text{-}pk}$ Source level		#NUM!

RESULTANT ISOPLETHS*

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

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	40.4	1.4	48.1	21.6	1.6
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

"NA": PK source level is ≤ to the threshold for that marine mammal hearing group.

E.1-2: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B53)	
Number of piles per day	
Strike (pulse) Duration[∆] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Transmission loss coefficient	
Distance of sound pressure level (L_{rms}) measurement (meters)	

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

PK

$L_{p,0\text{-}pk}$ specified at "x" meters (Cell G47)		
Distance of $L_{p,0\text{-}pk}$ measurement (meters)*		
$L_{p,0\text{-}pk}$ Source level		#NUM!

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

RESULTANT ISOPLETHS*

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

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

"NA": PK source level is ≤ to the threshold for that marine mammal hearing group.

WEIGHTING FUNCTION CALCULATIONS

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

NOTE: If user decided to override these Adjustment values, they need to make sure to download another copy to ensure the built-in calculations function properly.

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

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

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NAVSTA Norfolk Q8 Bulkhead, Phase I: impact install 18-inch square prestressed concrete piles
PROJECT/SOURCE INFORMATION	

Please include any assumptions

PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment (kHz)[¥]	2	

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 73), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: METHOD E.1-1 is PREFERRED method when SEL-based source levels are available (because pulse duration is not required). Only use method E.1-2 if SEL-based source levels are not available.

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT) **PREFERRED METHOD (pulse duration not needed)**

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**195.1**

SEL_{cum}

Single Strike SEL_{ss} ($L_{E,p,\ single\ strike}$) specified at "x" meters (Cell B32)	160
Number of strikes per pile	540
Number of piles per day	6
Transmission loss coefficient	15
Distance of single strike SEL_{ss} ($L_{E,p,\ single\ strike}$) measurement (meters)	10

PK

$L_{p,0\text{-}pk}$ specified at "x" meters (Cell G29)		
Distance of $L_{p,0\text{-}pk}$ measurement (meters)*		
$L_{p,0\text{-}pk}$ Source level		#NUM!

RESULTANT ISOPLETHS*

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

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**64.0**	**2.3**	**76.3**	**34.3**	**2.5**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**

"NA": PK source level is ≤ to the threshold for that marine mammal hearing group.

E.1-2: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B53)	
Number of piles per day	
Strike (pulse) Duration[∆] (seconds)	
Number of strikes per pile	
Duration of Sound Production (seconds)	0
10 Log (duration of sound production)	#NUM!
Transmission loss coefficient	
Distance of sound pressure level (L_{rms}) measurement (meters)	

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

PK

$L_{p,0\text{-}pk}$ specified at "x" meters (Cell G47)		
Distance of $L_{p,0\text{-}pk}$ measurement (meters)*		
$L_{p,0\text{-}pk}$ Source level		#NUM!

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

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

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

"NA": PK source level is ≤ to the threshold for that marine mammal hearing group.

WEIGHTING FUNCTION CALCULATIONS

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

NOTE: If user decided to override these Adjustment values, they need to make sure to download another copy to ensure the built-in calculations function properly.

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

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Appendix B

Sample Marine Mammal Observation Forms

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Project name: ____________________ Lead observer: ______ ____________________ Page ______ of _______

Project location : ____________________ Lead observer contact info: ____________________ Date: ______________

Effort Info					Sighting Info*				
Event	Time of Event (start and end)	Observer* Name and Location	Visibility Info (e.g. wind, glare, swell)	Construction Activity (Including Number and Type of Piles)	Species	Distance to Animal (from Observer) and Closest Point of Approach to the Activity	# of Animals Group Size (min/max/best) # of Calves	Animal Movement Relative to Pile Driving Equipment/ Time in Harassment Zone	Behavior Change/ Response to Activity/ Shutdown Info
Start Monitoring – End Monitoring Soft Start – Vibratory – Impact Sighting – Delay – Shutdown	: :					m	/ / ___ calves	toward or away parallel none Time in Harassment Zone:	
Start Monitoring – End Monitoring Soft Start – Vibratory – Impact Sighting – Delay – Shutdown	: :					m	/ / ___ calves	toward or away parallel none Behavior Code: ________	
Start Monitoring – End Monitoring Soft Start – Vibratory – Impact Sighting – Delay – Shutdown	: :					m	/ / ___ calves	toward or away parallel none Behavior Code: ________	
Start Monitoring – End Monitoring Soft Start – Vibratory – Impact Sighting – Delay – Shutdown	: :					m	/ / ___ calves	toward or away parallel none Behavior Code: ________	

*Note location of observer and any marine mammal sightings with date/time on project map

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Appendix C

Marine Mammal Monitoring Plan

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MMPA PERMIT VISUAL AND HYDROACOUSTIC MONITORING PLAN FOR THE REPAIR AND REPLACEMENT OF THE Q8 BULKHEAD

AT

NAVAL STATION NORFOLK
NORFOLK, VIRGINIA

September 2023

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Appendix B: Acoustic Modeling Results (Tables and Figures)
Appendix C: Data Collection Sheets
Appendix D: Issued Authorization (To be added to the plan once received from NMFS)

Acronyms and Abbreviations

Acronym	***Definition***
dBrms	Decibels Root Mean Square Referenced
ft.	Feet
LOA	Letter of Authorization
m	Meters
MMPA	Marine Mammal Protection Act
NAVSTA	Naval Station
Navy	U.S. Department of the Navy
NMFS	National Marine Fisheries Service
NRM	Installation Natural Resources Manager
PSO	Protected Species Observers
RMS	Root-Mean-Square Sound Pressure Levels
SEL	Sound Exposure Levels
SME	Subject Matter Expert
VA	Virginia

Chapter 1. Introduction

1.1 Purpose of the Marine Mammal and Acoustic Monitoring Plan

The purpose of this Marine Mammal and Acoustic Monitoring Plan (Plan) is to detail the protocols for marine mammal and acoustic monitoring activities associated with the repair and replacement of the Q8 Bulkhead at Naval Station (NAVSTA) Norfolk (Figure 1-1. In accordance with the Marine Mammal Protection Act (MMPA) of 1972, as amended, an application for Letter of Authorization (LOA) will be submitted to National Marine Fisheries Service (NMFS) on 15 September 2023. Incidental take of humpback whale (*Megaptera novaeangliae*), bottlenose dolphin (*Tursiops truncatus*), harbor porpoise (*Phocoena phocoena*), harbor seal (*Phoca vitulina*), and gray seal (*Halichoerus grypus*) are anticipated as a result of the proposed project.).

The proposed project includes the repair and replacement of the Q8 Bulkhead at NAVSTA Norfolk, located in Norfolk, VA, as well as various upgrades and improvements to nearby bulkheads and wharves. The proposed project will occur in phases over a period of five years, from January 1, 2025 through December 31, 2029. Vibratory and impact pile driving and drilling activities associated with proposed activities have the potential to affect marine mammals within marine waters adjacent to these Navy installations and could result in harassment under the MMPA.

The purpose of monitoring is:

1. To minimize the potential for Level A (PTS onset) harassment of marine mammals by implementing shutdown zones whenever a marine mammal is within a distance as specified by the application and subsequent authorizations;
2. To determine the numbers and species of marine mammals that occur within established Level A (PTS onset) and Level B (behavioral) harassment zones, and to document any differences in species, numbers, or effects relative to project-related in-water activities; and
3. To empirically measure sound source levels for different types of piles and installation/removal methods, as detailed in the application and subsequent authorizations.

Once approved by NMFS, this Plan will not be modified without NMFS' approval. The LOA and this corresponding Plan are valid for take incidental to the specified activities at NAVSTA Norfolk from January 2025 through December 2029.

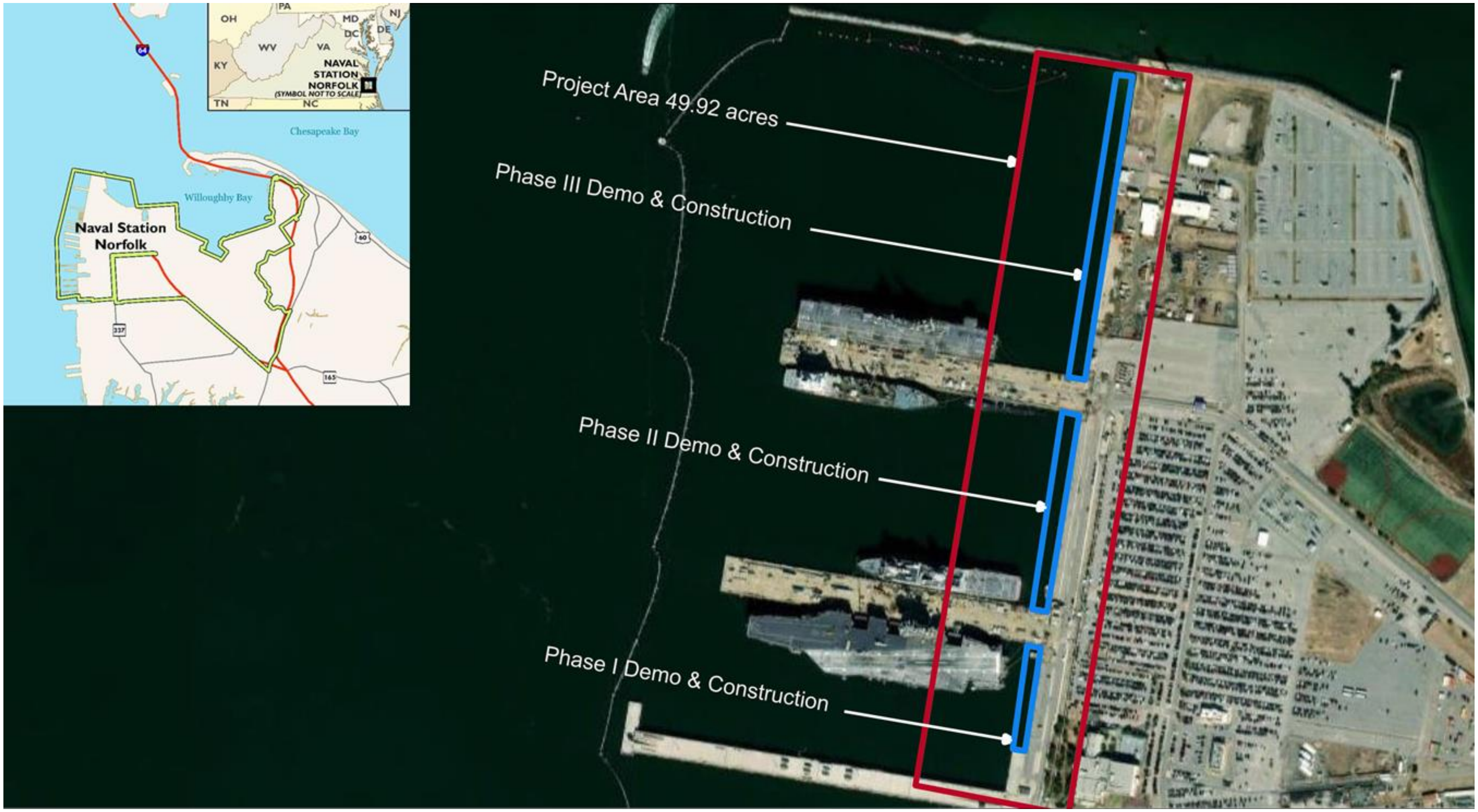

Figure 1-1 Project Site

1.2 Summary of Activities to be monitored for Marine Mammals

All relevant in-water construction and demolition activities that have the potential to result in Level A and Level B harassment of marine mammals, including installation of piles via vibratory and impact pile driving, pre-drilling, and removal of piles via vibratory hammers, shall be monitored.

In-water construction and demolition activities under this Plan must comply with all mitigation and minimization measures as detailed in Chapter 11 and Chapter 13 of the application (Appendix A) and subsequent authorization:

In-water activities expected to result in incidental takes of marine mammals would occur from January 2025 through December 2029. The estimated duration of noise generating activities for the first year of construction covered under the requested LOA is provided Table 1-1.

Table 1-1 In-Water Pile Driving and Drilling Activities Occurring During LOA Timeline

Facility	*Method of Pile Driving/Extraction*	*Pile Type*	*Pile Size*	*Number of Sheets (pairs)/ Piles*	*Impact Pile Driving (Strike/ Pile)* [1]	*Vibratory Pile Driving/Extracting (Minutes to drive a single pile)* [2]	*Maximum number of piles installed each day*	*Average Water Depth*	*Total Number of Days of In-Water Construction*
Phase I Construction, Piers 12–14	Vibratory Install	ASTM A572, Grade 50 Steel Sheet Pile	56-inch Wide	183 piles (bulkhead)	NA	24 minutes	6	35 ft	31 days[3]
	Vibratory Extract	Pre-stressed Concrete Fender Piles	18-inch square	139 piles (fender)	NA	14 minutes	6	35 ft	24 days
	Impact Install	Pre-stressed Concrete Fender Piles	18-inch square	109 piles (fender)	307	NA	6	35 ft	19 days[3]
Phase II Construction, Piers 11–12	Vibratory Install	ASTM A572, Grade 50 Steel Sheet Pile	56-inch Wide	81 piles (bulkhead)	NA	28 minutes	6	24 ft	15 days[3]
	Vibratory Extract	Pre-stressed Concrete Fender Piles	18-inch square	61 piles (fender)	NA	26 minutes	6	24 ft	11 days
	Impact Install	Pre-stressed Concrete Fender Piles	18-inch square	49 piles (fender)	499	NA	6	24 ft	11 days[3]

Facility	Method of Pile Driving/Extraction	Pile Type	Pile Size	Number of Sheets (pairs)/ Piles	Impact Pile Driving (Strike/ Pile) [1]	Vibratory Pile Driving/Extracting (Minutes to drive a single pile) [2]	Maximum number of piles installed each day	Average Water Depth	Total Number of Days of In-Water Construction
Phase III Construction, North of Pier 14	Vibratory Install	ASTM A572, Grade 50 Steel Sheet Pile	56-inch Wide	283 piles (bulkhead)	NA	38 minutes	6	19 ft	48 days[3]
	Vibratory Extract	Composite (HDPE or FRP) Fender Piles[1]	16-inch diameter	178 piles (fender)	NA	20 minutes	6	19 ft	30 days
	Impact Install	Composite (HDPE or FRP) Fender Piles	16-inch diameter	105 piles (fender)	540	NA	6	19 ft	18 days[3]
	Impact Install	Pre-stressed Concrete Fender Piles	18-inch square	26 piles (fender)	540	NA	6	19 ft	5 days[3]

Key: FRP = fiber reinforced polymer (fiberglass); ft = feet; HDPE = high-density polyethylene (plastic); NA = not applicable.

Notes:

1. Pile installation hours and number of strikes per pile are based on previous experience. The actual driving time/strikes depend on the actual method of installation. Method of installation and hammer size will be the responsibility of the installation contractor.
2. Pile extraction hours are based on previous experience. The actual extraction time and the actual method of pile extraction depends on the contractor and condition of piles.
3. Denotes activities that may occur concurrently.

1.3 Mitigation Measures

The following mitigation measures, as specified in the submitted application and anticipated authorization, shall be implemented during in-water noise generating activities to minimize Level A and Level B harassment.

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

2. **Soft Start**: The contractor shall utilize a “soft start” procedure to provide a warning and/or give animals in proximity to pile driving the opportunity to leave the area prior to an impact driver operating at full capacity. The soft start shall be accomplished by providing an initial set of strikes from the impact hammer at reduced energy, followed by a 30-second waiting period, then two subsequent sets. The soft start procedure shall be used for impact pile driving at the beginning of each day’s in-water pile driving or any time pile driving has ceased for more than 30 minutes.

   The reduced energy of an individual hammer cannot be quantified because they vary by individual drivers. Also, the number of strikes will vary at reduced energy because raising the hammer at less than full power and then releasing it results in the hammer “bouncing” as it strikes the pile resulting in multiple “strikes.”

3. **Visual Monitoring and Shutdown Procedures**: The Contractor shall submit a Marine Mammal and Hydroacoustic Monitoring Plan to NAVSTA Norfolk environmental office for approval prior to commencement of in water project activities. At a minimum, the plans must include the following:

   The monitoring shall be implemented and shutdown procedures shall be put into effect if a marine mammal were to approach the shutdown zone for the activity being conducted. Impacts are expected to be insignificant and no injury would be expected, as monitors must ensure the shutdown zone is clear of mammals before the start of in-water noise generating activities. Proposed monitoring zones are provided in Table 11-1 of the submitted application (Appendix A). The minimum monitoring zone is equivalent to the general construction shutdown zone described below.

   - For humpback whales, work must stop any time the species is sighted approaching the humpback whale Level A ZOIs. This approach will prevent the need for Level A takes for this species.
   - For all impact and vibratory pile driving and drilling, a shutdown zone of 150 meters shall be implemented to reduce injury. This 150 m shutdown zone shall be monitored at all times and work must stop as soon as safely possible if an animal is seen approaching this zone.
   - The entire Level A (PTS onset) zones beyond 150 m and a portion of the Level B (behavioral) harassment zones shall be visually monitored.
   - In order to prevent injury from physical interaction with construction equipment, a general construction shutdown zone of 10 m or 33 ft. shall be implemented during all in-water construction activities having the potential to affect marine mammals to ensure marine mammals are not present within this zone. These activities could include but are

not limited to 1) barge positioning, 2) dredging, or 3) pile driving. For some sound-generating activities, the potential for Level A (PTS onset) harassment by acoustic injury extends less than 10 m from the source, and for these activities, the shutdown zone automatically mitigates/minimizes Level A (PTS onset) harassment.

- Visual monitoring shall be conducted by experienced personnel with training in marine mammal detection and the ability to describe relevant behaviors that may occur in proximity to in-water construction activities (hereafter "Protected Species Observers" [PSOs]).
- If a marine mammal species for which incidental take has not been authorized is seen approaching or entering the shutdown zone or the disturbance zone during pile driving, the noise producing activity must cease. If such circumstances recur, the Navy will consult with NMFS concerning the potential need for an additional take authorization.
- Pile driving must cease if any marine mammal is detected in or approaching the Level A shutdown zone of 150 m (i.e. Level A [PTS onset] harassment zone]). If a marine mammal is observed in the Level B (behavioral) harassment zone or the Level A (PTS onset) harassment zone beyond 150 meters, but not approaching or entering the shutdown zone, a take shall be recorded, and the work shall be allowed to proceed without cessation.
- All species that enter either the Level A (PTS onset) harassment or Level B (behavioral) harassment zones shall be monitored and documented, with the PSO estimating the amount of time the animal spends within the Level A or Level B zone while pile driving is underway.
- In the event of a shutdown, pile driving shall be halted and delayed until either the animal has voluntarily left and been visually confirmed beyond the shutdown zone or 15 minutes have elapsed without re-detection of the animal.
- Visual monitoring must take place from 30 minutes prior to initiation through 30 minutes post-completion of pile driving. Prior to the start of pile driving, the shutdown zone and disturbance zone shall be monitored for 30 minutes to ensure that the zones are clear of marine mammals. Pile driving will only commence once observers have declared the shutdown zone clear of marine mammals.
- Monitoring shall be conducted by, at a minimum, a two-person PSO team designated by the construction contractor. Given the configuration of the ZOIs, which vary depending on the pile type/size and the pile driver type (see **Error! Reference source not found.** through A-31 of Appendix B), it is assumed that two PSOs would be sufficient to monitor the ZOIs for impact drivers, and three to four PSOs would be sufficient to monitor the ZOIs for vibratory drivers. However, additional monitors may be added if warranted by the level of marine mammal activity in the area. PSOs shall be placed at the best vantage point(s) practicable (Figure 1-2) to monitor for marine mammals and implement shutdown/delay procedures when applicable by calling for the shutdown by the pile driver operator.

Figure 1-2 Potential Protected Species Observer Locations

Chapter 2. Monitoring Zones

2.1 Level A and Level B Harassment Monitoring Shutdown Zones
Level A and Level B harassment monitoring zones are shown in Appendix B (Figures A-1 to A-31). These zones are based on maximum potential distances as shown in Appendix B (Tables A-1 to A-3). These harassment zones may be truncated as they take into account the natural and manmade barriers to sound transmission along the shoreline.

2.2 Observer Monitoring Locations
To effectively monitor the Level A and Level B harassment zones, PSOs shall be positioned at the best practicable vantage points, taking into consideration security, safety, and space limitations. Potential PSO locations are shown on Figure 1-2. The actual number of PSOs may vary depending on the construction activity and the size of the Level A and Level B harassment zones for the activity.

Chapter 3. Visual Monitoring Protocols
The visual monitoring components of this Plan take into consideration the logistical, environmental, and security requirements for working in the project area. The distances to the Level A and Level B harassment boundaries are used to determine monitoring locations for the activities associated with this Plan.

3.1 Protected Species Observer Qualifications
The PSOs must meet NMFS qualifications for PSOs: either be biologists with prior training and experience to meet the qualifications in conducting marine mammal monitoring, professional PSOs with certification (i.e., Protected Species Observer), recognized membership in a professional organization (i.e., Marine Mammal Observer Association), or may substitute education (undergraduate degree in biological science or related field) or training for experience. The PSO (or lead PSO if multiple PSOs required) must have had prior experience working as a PSO on construction projects.

All PSOs shall be independent observers (i.e., not construction personnel) who have the ability to correctly identify the marine mammal species and accurately describe the relevant species-specific behaviors that may occur in proximity to in-water construction activities.

Additional qualifications and protocols of PSOs include the following:
- Must have the ability to conduct field observations and collect data according to the assigned protocol.
- Where a team of multiple PSOs are required, one observer shall be designated as lead observer throughout the duration of the project. The lead PSO must have had prior experience working as an observer on construction projects.
- All credentials for assigned PSOs shall be submitted to the Navy for approval
- All PSOs working on this project must attend a training brief by the Installation Natural Resources Manager (NRM) that will include the following:
    - Navy’s Marine Species Awareness Training video shall be shown
    - ZOIs that must be monitored and locations where PSOs must be stationed
    - Species for takes have been authorized
    - Monitoring and data collection protocols
    - Reporting protocols to ensure take limit is not exceeded
    - Reporting protocols to NMFS in accordance with the issued authorization
- Must have experience or training in the field identification of marine mammals, including the identification of behaviors

- Must have visual acuity in both eyes (correction is permissible) sufficient for discernment of moving targets at the water's surface with ability to estimate target size and distance. Use of binoculars may be necessary to correctly identify the target.
- Must have sufficient training, orientation, or experience with the construction operation to provide for personal safety during observation periods.
- Must have writing skills sufficient to prepare a report of observations including but not limited to the number and species of marine mammals observed, dates and times when in-water construction activities were conducted, dates and times when in-water construction activities were suspended to avoid potential incidental injury from construction sound of marine mammals observed within a defined zone, and marine mammal behavior.
- Ability to communicate orally, by radio or in person, with project personnel to provide real-time information on marine mammals observed in the area as necessary.

3.2 Visual Monitoring

Based on the requirements identified in the submitted LOA and anticipated authorization a minimum of two PSOs would be utilized for impact pile driving activities and 3-4 PSOs would be used for vibratory driving and drilling activities. Additional PSOs may be necessary depending on the size of the Level A and Level B harassment zones for the specific activity that is occurring. These PSOs could potentially be stationed at Pier-1, Pier-2 Pier-3, Pier-8, Pier-14, or The North Jetty, depending on the size of the zones in order to best monitor each ZOI. PSOs will be required to be stationed on elevated platform(s) with the exception of the north jetty, which does not allow access for a lift.

3.2.1 Equipment

The following equipment shall be required to conduct visual monitoring:

- Laser rangefinders used to measure distances to known objects as reference points for distances to marine mammals observed in the water
- Portable marine radios for the observers to communicated with the lead PSO, construction contractor and other observers
- Hearing protection for all personnel near the sound source. Depending on observer locations relative to the sound source, and the subsequent airborne source levels, a noise-reducing headset with capabilities to connect to a radio may be used
- Cellular phones (one per PSO location), and the contact information for the lead observer, other observers, and construction contractor
- Nautical charts
- Daily tide table for the project area
- Watch or chronometer
- Standard handheld binoculars and, if needed, high magnification binoculars
- Monitoring plan, Level A and B harassment zone figures, and/or other relevant permit requirement specifications in sealed transparent plastic cover
- Data collection sheets with plastic cover (waterproof paper recommended)
- Marine mammal identification guides (waterproof paper recommended)
- Clipboard
- Pen/Pencil (capable of writing in rain)
- Elevated platform(s)

3.3 Visual Monitoring Methods

Prior to the start of all in-water noise generating activities, briefings shall be conducted between the Navy, the construction contractor, and the PSO team. Briefings shall be conducted any time new personnel join the work. These briefings will explain responsibilities, communication procedures, visual monitoring protocols, and operational procedures. All PSOs must attend the training brief described above in Section 3.1.

The PSOs are tasked with collecting marine mammal sighting data, including behaviors noted for pre-, during-, and post-pile driving periods. All observations of marine mammals shall be logged, with locations within the Level A or Level B harassment zone or shutdown zone noted. An assessment of take must occur if an animal or group of animals enters any of the Level A or Level B harassment zones during project-related activities. The efficacy of visual detection depends on factors such as the PSOs ability to detect the animal, the environmental conditions (visibility and sea state), and monitoring platforms. Pre-, during-, and post- noise generating activity visual survey protocols are described below.

3.3.1 Visual Survey Protocols

The following survey protocols shall be implemented prior to the start of noise generating activities:

3.3.1.1 Pre-Activity Monitoring

- The Level A (PTS onset) and Level B (behavioral) harassment zones and the shutdown zone shall be monitored for 30 minutes prior to in-water construction/demolition activities. If a marine mammal is present within the shutdown zone, the activity shall be delayed until the animal(s) leave the shutdown zone. Activity will resume only after the PSO has determined that, through sighting or by waiting approximately 15 minutes, the animal has moved outside the shutdown zone. If a marine mammal is observed approaching the shutdown zone, the PSO who sighted that animal must notify the shutdown PSO of its presence.

3.3.1.2 During-Activity monitoring

- During Activity Monitoring: If a marine mammal is observed entering the Level B (behavioral) zone, that activity shall be completed without cessation, unless the animal enters or approaches the Level A (PTS onset) shutdown zone, at which point all pile driving activities shall be halted. If an animal is observed within the shutdown zone during pile driving, then pile driving shall be stopped as soon as it is safe to do so. Pile driving can only resume once the animal has left the Level A (PTS onset) shutdown zone of its own volition or has not been re-sighted for a period of 15 minutes.

3.3.1.3 Post-Activity Monitoring

- Post-Activity Monitoring: Monitoring of the Level A (PTS onset) shutdown and Level B (behavioral) harassment zones must continue for 30 minutes following the completion of the activity.

3.4 Data Collection

PSOs must use approved sighting forms (Appendix C). At a minimum, the following information shall be collected on the sighting forms:

- Date and time that noise generating activities begin and end
- Construction activities occurring during each observation period

- Weather parameters identified in the acoustic monitoring (i.e., 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
- Estimated amount of time an animal spends within the Level A or Level B harassment zones while noise generating activities are underway
- Locations of all marine mammal observations
- Other human activity in the area

To the extent practicable, PSOs must 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.

The Lead PSO shall be responsible for consistency in data collection and shall consult with NAVFAC and the Installation NRM to ensure consistency and oversight on the data collection. The Contractor and/or Lead PSO must update the NRM monthly to keep the NRM abreast of the current take estimate; ensuring authorized takes are not exceeded. Should the project "take" 80% of the authorized takes for a species, the NRM shall be immediately notified. The NRM will in turn notify the Region SME in order to coordinate additional takes with NMFS.

Chapter 4. Hydroacoustic Monitoring Plan

This section comprises the hydroacoustic monitoring plan for the repair and replacement of the Q8 bulkhead. The submitted application and anticipated authorization stipulate the number and types of piles and activities that the project must collect acoustic data for.

4.1 Objectives

The purpose of hydroacoustic monitoring, or sound source verification (SSV), is to characterize underwater noise from pile driving activities during various types of pile driving, extraction, and drilling associated with this project. Data collected shall be reported to NMFS, as required by the issued authorization. Data collected can also be used in future environmental planning and consultation documents.

4.2 Survey Locations

Monitoring shall include two underwater positions and shall be conducted in accordance with NMFS guidance (NMFS 2012). One underwater location shall be at the standard 10 meters from the sound source, while the other positions shall be located at a distance of at least 20x water depth at the pile. **(Once the contractor is onboard and if they determine that this distance interferes with shipping lanes or vessel traffic, or if there is other reasons why this criteria cannot be achieved, the Plan must offer an alternate site as close to the criteria as possible for NMFS' approval).**

4.3 Temporal Considerations

Measurements shall be collected as detailed in the submitted application (Table 13-1 of Appendix A) for each pile type during the entire pile-driving/extracting/drilling event, but during data analysis, only the periods of maximum hammer energy shall be characterized. Maximum hammer energy is characterized by removing starts (ramp up of hammer energy) and stops (ramp down of hammer energy) from data being analyzed.

4.4 Monitoring Equipment Proposed for Use

The recording equipment shall be capable of recording the minimum bandwidth required per NMFS 2012 guidelines. For this project, the specific equipment that shall be used for acoustic monitoring is yet to be determined, as the construction contractor has not been selected. Once they are onboard, they will provide equipment specifications for NMFS' approval.

4.5 Data Processing

Acoustic monitoring must include the measurement of peak sound pressures, root-mean-square sound pressure levels (RMS) and sound exposure levels (SEL). Different data processing is required to characterize source levels for vibratory pile driving than for impact driving. For vibratory pile driving, characterize overall dBrms levels by taking 10 sec averages across the whole event and averaging all the 10 sec periods. Averaging 10 sec periods will likely capture the variation in sound levels over the pile-driving event. For impact pile driving, characterize overall dBrms levels by integrating sound for each waveform across 90% of the acoustic energy in each wavy (using the 5-95 percentiles to establish the 90% criterion) and averaging across all waves in the pile-driving event.

The underwater acoustic recordings or measured data shall be analyzed to provide peak, RMS, and SEL sound pressure levels along with narrow or 1/3rd octave band frequency spectra.

Chapter 5. Interagency Notification for Injured or Dead Marine Mammals

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by the issued authorization, such as a serious injury, or mortality, the contractor must immediately cease the specified activities and report the incident to the NMFS Office of Protected Resources and Greater Atlantic Region Stranding Coordinator (866-755-6622). The report must include the following information:

1. Time and date of the incident
2. Description of the incident
3. Environmental conditions (i.e., wind speed and direction, Beaufort sea state, cloud cover, and visibility)
4. Description of all marine mammal observations and active sound source use in the 24 hours preceding the incident
5. Species identification or description of the animal(s) involved
6. Fate of the animal(s)
7. Photographs or video footage of the animal(s)

Activities must not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with the Navy to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. The Navy may not resume their activities until notified by NMFS.

In the event the contractor discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition), the Navy must immediately report the incident to the Office of Protected Resources, NMFS, and the Greater Atlantic Coast Region Stranding Coordinator. The report must include the same information identified above. Activities may continue while NMFS reviews the circumstances of the incident. NFMS will work with the Navy to determine whether additional mitigation measures or modifications to the activities are appropriate.

In the event the contractor discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the specified activities (i.e., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), the Navy must report the incident to the Office of Protected Resources, and the Greater Atlantic Coast Region Stranding Coordinator within 24 hours of the discovery.

All incidences of injured or dead marine mammals must be coordinated with Region SME and OPNAV N4i, in addition to the agency notifications above. The Installation NRM should reach out to the Region SME with all of the details of the report. The Region SME will coordinate with OPNAV N45.

Chapter 6. Reporting

Monitoring reports shall be provided to NMFS in accordance with the issued authorization. Reports shall be submitted to the Navy 30 days before the due date to NMFS for internal Navy review. The reporting procedures are summarized below.

6.1 Annual Reports

A draft report for all visual and acoustic monitoring for the first year, and subsequent years, must be submitted to NMFS. The draft report shall be submitted to the Navy 60 calendar days before the report is due to NMFS in order for the navy to review and request any necessary changes be made to the document. The LOA will be requesting coverage beginning on January 1, 2025; therefore, the first draft report under must be submitted to NMFS by November 1, 2025.

This report must contain the informational elements from the application, including, but not limited to:

1. Dates and times (begin and end) of all marine mammal monitoring
2. Construction activities occurring during each daily observation period, including how many and what type of piles were driven or removed and by what method (i.e., impact or vibratory)
3. Weather parameters and water conditions during each monitoring period (e.g., wind speed, percent cover, visibility, sea state)
4. The number of marine mammals observed, by species, relative to the pile location and if pile driving or removal was occurring at time of sighting
5. Age and sex class, if possible, of all marine mammals observed
6. PSO locations during marine mammal monitoring
7. Distances and bearings of each marine mammal observed to the plie being driven or removed for each sighting (if pile driving or removal was occurring at time of sighting).
8. Description of any marine mammal behavior patterns during observation, including direction of travel
9. Number of individuals of each species (differentiated by month as appropriate) detected within the monitoring zone, and estimates of number of marine mammals take, by species (a correction factor may be applied to total take numbers, as appropriate)
10. Detailed information about any implementation of any mitigation triggered (e.g., shutdowns and delays), a description of specific actions that ensued, and resulting behavior of the animal, if any.
11. Description of attempt to distinguish between the number of individual animals taken and the number of incidences of take, such as ability to track groups or individuals

Annual reports must also include results from all acoustic monitoring conducted during the reporting period, in accordance with the details in Chapter 4 of this Plan.

NMFS will provide comments within thirty days of receipt of the annual report and the Navy will address the comments and submit revisions within thirty days after receiving NMFS comments. If no comment is received from NMFS within thirty days, the annual report is considered final/completed.

6.2 Final Report

A draft report on all monitoring conducted under the authorization must be submitted within ninety calendar days of the completion of the project or sixty days prior to the issuance of any subsequent authorizations for this project, whichever comes first. A final report shall be prepared and submitted within thirty days following resolution of comments on the draft report from NMFS. This report must contain the informational elements from the application, including, but not limited to:

1. Dates and times (begin and end) of all marine mammal monitoring
2. Construction activities occurring during each daily observation period, including how many and what type of piles were driven or removed and by what method (i.e., impact or vibratory)
3. Weather parameters and water conditions during each monitoring period (e.g., wind speed, percent cover, visibility, sea state)
4. The number of marine mammals observed, by species, relative to the pile location and if pile driving or removal was occurring at time of sighting
5. Age and sex class, if possible, of all marine mammals observed
6. PSO locations during marine mammal monitoring
7. Distances and bearings of each marine mammal observed to the plie being driven or removed for each sighting (if pile driving or removal was occurring at time of sighting).
8. Description of any marine mammal behavior patterns during observation, including direction of travel
9. Number of individuals of each species (differentiated by month as appropriate) detected within the monitoring zone, and estimates of number of marine mammals take, by species (a correction factor may be applied to total take numbers, as appropriate)
10. Detailed information about any implementation of any mitigation triggered (e.g., shutdowns and delays), a description of specific actions that ensued, and resulting behavior of the animal, if any.
11. Description of attempt to distinguish between the number of individual animals taken and the number of incidences of take, such as ability to track groups or individuals.

Literature Cited

NMFS 2012. Guidance Document: Data Collection Methods to Characterize Impact and Vibratory Pile Driving Source Levels Relevant to Marine Mammals. Memo from NMFS Northwest Region and Northwest Fisheries Science Center to Interested Parties. January 31, 2012.