**DEPARTMENT OF THE NAVY**
COMMANDER
NAVY REGION MID-ATLANTIC
1510 GILBERT ST.
NORFOLK, VA 23511-2737

IN REPLY REFER TO
5090
EV22/09/RE264

MAR 2 2 2017

Ms. Jolie Harrison
Office of Protected Resources, National Marine Fisheries Service
National Oceanic and Atmospheric Administration
1315 East-West Highway (B-SSMC3 Room 13822)
Silver Spring, MD 20910-3282

Dear Ms. Harrison:

SUBJECT: LETTER OF AUTHORIZATION APPLICATION, PROPOSED DEMOLITION OF PIERS 32 AND 10 AND CONSTRUCTION OF NEW PIER 32, NAVAL SUBMARINE BASE NEW LONDON

This letter supports the Department of the Navy (Navy)'s application for a Letter of Authorization (LOA), pursuant to the Marine Mammal Protection Act of 1972 (MMPA), as amended in 1994, for the proposed demolition of Piers 32 and 10 and construction of new Pier 32 at Naval Submarine Base (SUBASE) New London, located in the towns of Groton and Ledyard, Connecticut. The locations of the projects are displayed in enclosures (1) and (2).

Under the preferred alternative, the Navy proposes to construct a submarine berthing pier that meets all current Navy SSN berthing pier requirements. Pier 32 and Pier 10 were constructed in 1978 and 1959, respectively. Pier 10 has reached and Pier 32 is nearing the end of their life-cycle. The current Pier 32 and Pier 10 would be demolished. The new Pier 32 would be constructed approximately 150 feet to the north of the existing Pier 32. The proposed activities with the potential to affect marine mammals within the river adjacent to SUBASE that could result in harassment under the MMPA are pile installation by vibratory and impact hammer and pile removal by vibratory extraction. The proposed project would also require dredging of approximately 60,000 cubic yards of sediment in two areas of the Thames River federally authorized and Navy-maintained navigation channels near Pier 32 and underneath existing Pier 32 and Pier 10 after demolition. Disposal of the dredged material would be in an existing Confined Aquatic Disposal (CAD) cell in the Thames River, south of the Nautilus Museum. All dredging called for in the project supports safe maneuvering for entry and departure of submarines at SUBASE New London.

The proposed project is expected to begin in October 2018, at the earliest, and would take approximately 3.5 years to complete by March 2022, with in-water construction and demolition occurring during approximately 35 non-consecutive months. The new Pier 32 would be constructed and existing Pier 32 would be demolished prior to the demolition of Pier 10. In the enclosed LOA application (enclosure (1)), the Navy is requesting coverage under an LOA for the duration of the proposed project. Due to mission requirements and operational schedules, the

construction schedule is subject to change. More specific details on activities proposed to occur each year of this project are included in the LOA application (enclosure (1)).

The Navy has prepared the enclosed LOA application pursuant to the MMPA, which prohibits the "take" of marine mammals in U.S. waters. In addition, the Navy has prepared the enclosed Draft Environmental Assessment to evaluate the potential effects of the proposed project on environmental resources, including marine biological resources, in and near the project area (enclosure (2)). Based on the information provided in the enclosures, the Navy has determined that the proposed action may result in incidental taking of harbor seals and gray seals during pile driving/extraction activities associated with the construction/demolition of Pier 32 and demolition of Pier 10 between October 2018 and March 2022. Takes would be predominantly in the form of non-injury, Level B (behavioral) harassment, but may include Level A permanent threshold shift (PTS) harassment, as described in the application. We ask that the NOAA Fisheries Service, therefore, issue an LOA covering the proposed in-water construction and demolition activities from October 1, 2018 through March 31, 2022.

We look forward to working with you on this proposed action. Should you have any questions regarding the proposed action or application package please contact either Mr. Ron Carmichael, Chief of Naval Operations, Energy & Environmental Readiness Division (N45), at (703) 695-5269 or via E-Mail at ronald.carmichael@navy.mil or Ms. Jessica Bassi, Naval Facilities Engineering Command Mid-Atlantic (EV22) at (757) 341-0493 or via E-Mail at jessica.bassi@navy.mil.

Sincerely,

MICHAEL H. JONES
Director, Environmental Planning
and Conservation
By direction of the Commander

Enclosures: 1. LOA Application for the Demolition/Replacement of Pier 32/Demolition of Pier 10 at SUBASE New London, Groton, CT, dated March 2017
2. Draft Environmental Assessment for Demolition/ Replacement of Pier 32/Demolition of Pier 10 at SUBASE New London, Groton, CT, dated March 2017

Copy to: NOAA Fisheries Service (Mr. Ben Laws)
Chief of Naval Operations (N45, Mr. Ronald Carmichael)

# REQUEST FOR LETTER OF AUTHORIZATION UNDER THE MARINE MAMMAL PROTECTION ACT FOR THE DEMOLITION/REPLACEMENT OF PIER 32/DEMOLITION OF PIER 10 AT NAVAL SUBMARINE BASE NEW LONDON GROTON, CONNECTICUT

**Submitted to:**

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

Prepared by:

**Naval Facilities Engineering Command Mid-Atlantic**

Prepared for:

**Naval Submarine Base New London**

March 2017

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# EXECUTIVE SUMMARY

In accordance with the Marine Mammal Protection Act of 1972, as amended, the United States Navy (Navy) is applying for a Letter of Authorization (LOA) for the incidental take of marine mammals from the demolition of Pier 32 and Pier 10 and construction of a new Pier 32 at Naval Submarine Base New London (SUBASE), Groton, Connecticut. Two species of marine mammals may be present in the Thames River near SUBASE: harbor seal (*Phoca vitulina*) and gray seal (*Halichoeris grypus*). Harbor seals and gray seals are more likely to occur at SUBASE from September to May.

Construction of the new Pier 32 would begin in October 2018 and would include the installation of approximately 120 concrete-filled steel pipe piles; 60 by vibratory hammer only and 60 by vibratory and impact hammer. Approximately 60 of the steel piles would be installed in rock sockets drilled into bedrock. In addition, approximately 194 fiberglass-reinforced plastic fender piles would be installed by vibratory and impact hammer. Pile driving would most likely occur from a barge and crane, but the contractor may choose to use a temporary pile-supported work trestle that would be constructed by using an impact hammer to drive approximately 60 steel H-piles and subsequently removing them by vibratory hammer. Therefore, this application includes the analysis of the additional pile driving and removal associated with the temporary trestle.

Construction of Pier 32 may also require an upgrade to the quaywall north of Pier 32 to support a crane weight test area. Because the requirement for the upgrade will not be determined until final design, it has been included in the application due to the potential for this requirement. The quaywall upgrade would include up to approximately eighteen 30-inch diameter concrete-filled steel pipe piles that would be installed into rock sockets. A fender system composed of approximately nine 16-inch diameter plastic piles would also be installed into rock sockets.

Demolition of existing Pier 32 would begin once the new Pier 32 is operational and would include removal by vibratory extraction of approximately 60 steel piles from the temporary work trestle, 120 concrete-encased steel H-piles, and 70 steel H-piles. Fifty-six wood piles would be pulled by attaching a sling to the pile and lifting with a crane. Demolition of Pier 10 would include the removal by vibratory extraction of 24 concrete-encased, steel H-piles and 166 cast-in-place, reinforced concrete piles. Eighty-four steel and 41 wood fender piles would be pulled with a sling.

The project is estimated to require approximately 3.5 years to complete, with in-water construction and demolition occurring during approximately 35 non-consecutive months. The new Pier 32 would be constructed and existing Pier 32 would be demolished prior to the demolition of Pier 10.

During the first and second years of this LOA application, most construction activity would be pile installation by vibratory hammer. Pile installation by impact hammer would begin at the end of the first year and would also occur at the end of the second year and in the third year of construction. Demolition of existing Piers 32 and 10 and the temporary work trestle, if used, would be completed in the fourth year.

The project would also require dredging of 60,000 cubic yards of sediment in two areas of the Thames River navigation channel near Pier 32, the berthing areas alongside the new Pier 32, and underneath existing Pier 32 and Pier 10 after demolition. Disposal of the dredged material would

be in an existing Confined Aquatic Disposal cell in the Thames River federal navigation channel. Dredging would not result in harassment of marine mammals.

The Navy is requesting an LOA for construction and demolition activities that will occur from October 2018 through March 2022.

The Navy used the National Marine Fisheries Service ([NMFS] 2009, 2016) thresholds to estimate the number of Level A and Level B takes by incidental harassment of marine mammals from acoustic sources during construction and demolition, as outlined in Chapter 5. Proxy values for acoustic source levels associated with the proposed activities were estimated from empirically measured source levels from similar activities, while the practical spreading loss equation was used to estimate transmission loss from the source. Acoustic thresholds and maximum distances to the onset of permanent threshold shift (PTS) were calculated in accordance with the NMFS 2016 guidance.

Predicted exposures are described in Chapter 6. Although the potential for Level A (injury in the form of PTS) harassment is recognized, the Navy believes this potential is minimized based on the proposed monitoring and mitigation procedures, and the size and accessibility of the corresponding zones of influence.

An estimated average density of 0.6 seals per square kilometer, 75% of which are harbor seals and 25% of which are gray seals, occurs in the project area during nine months of the year (September through May). Based on the number of in-water, sound-generating workdays in each of the four years, and assuming that seals are present during the activities up to a maximum of 180 workdays per year, authorization is requested for a total of 16 Level A (PTS onset injury) takes, including 12 takes of harbor seals and 4 takes of gray seals, and 657 Level B (behavioral) takes, including 493 takes of harbor seals and 164 takes of gray seals for the entire project.

Pursuant to the Marine Mammal Protection Act Section 101(a)(5)(D), the Navy submits this LOA application to NMFS for the incidental taking of harbor seals and gray seals during pile driving/extraction activities associated with the construction/demolition of Pier 32 and demolition of Pier 10 between October 2018 and March 2022. Takes would be predominantly in the form of non-injury, Level B (behavioral) harassment, but may include Level A (PTS) harassment, as described above. The estimated number of takes is expected to have a negligible impact on these species.

# TABLE OF CONTENTS


EXECUTIVE SUMMARY ....... ES-1
1 INTRODUCTION AND DESCRIPTION OF ACTIVITIES ....... 1-1
1.1 Introduction ....... 1-1
1.2 Description of Activities ....... 1-5
1.2.1 Construction of New Pier 32 ....... 1-5
1.2.2 Demolition and Removal of Pier 32 and Pier 10 ....... 1-6
1.2.3 Dredging of Pier Areas and Navigation Channel ....... 1-6
2 DATES, DURATION, AND LOCATION OF ACTIVITIES ....... 2-1
2.1 Dates of Construction ....... 2-1
2.2 Duration of Activities ....... 2-1
2.2.1 Construction ....... 2-1
2.2.2 Demolition ....... 2-2
2.3 Project Area Description ....... 2-9
2.3.1 Bathymetric Setting ....... 2-9
2.3.2 Tides, Circulation, Temperature, and Salinity ....... 2-9
2.3.3 Substrates and Habitats ....... 2-10
2.3.4 Ambient Sound ....... 2-10
3 MARINE MAMMAL SPECIES AND NUMBERS ....... 3-1
4 AFFECTED SPECIES STATUS AND DISTRIBUTION ....... 4-1
4.1 Harbor Seals ....... 4-1
4.1.1 Status ....... 4-2
4.1.2 Numbers ....... 4-2
4.1.3 Distribution ....... 4-2
4.1.4 Vocalization and Hearing ....... 4-3
4.2 Gray Seals ....... 4-3
4.2.1 Status ....... 4-3
4.2.2 Numbers ....... 4-3
4.2.3 Distribution ....... 4-3
4.2.4 Vocalization and Hearing ....... 4-4
5 TYPE OF INCIDENTAL TAKE AUTHORIZATION REQUESTED ....... 5-1
6 NUMBERS AND SPECIES TAKEN ....... 6-1
7 IMPACTS ON MARINE MAMMAL SPECIES OR STOCKS ....... 7-1
7.1 Level A Harassment Impacts ....... 7-2
7.2 Level B Harassment Impacts ....... 7-2
8 IMPACTS ON SUBSISTENCE USE ....... 8-1

9 IMPACTS ON MARINE MAMMAL HABITAT AND THE LIKELIHOOD OF RESTORATION ....... 9-1

10 IMPACTS ON MARINE MAMMALS FROM LOSS OR MODIFICATION OF HABITAT ....... 10-1

11 MEANS OF EFFECTTING THE LEAST PRACTICABLE ADVERSE IMPACTS – STANDARD OPERATING PROCEDURES AND MITIGATION MEASURES ....... 11-1

11.1 General Construction BMPs ....... 11-1

11.2 Pile Removal and Installation Impact Minimization for Marine Mammals ....... 11-2

11.2.1 Marine Mammal Observer Training ....... 11-2

11.2.2 Monitoring of the Level A Injury Zone (Shutdown Zone) ....... 11-3

11.2.3 Monitoring of the Level B Harassment Zone ....... 11-4

12 MINIMIZATION OF ADVERSE IMPACTS ON SUBSISTENCE USE ....... 12-1

13 MONITORING AND REPORTING EFFORTS ....... 13-1

13.1 Monitoring Plan ....... 13-1

13.1.1 Visual Marine Mammal Observations ....... 13-1

13.1.2 Methods of Monitoring ....... 13-2

13.1.3 Data Collection ....... 13-3

13.1.4 Interagency Notification ....... 13-3

13.2 Reporting ....... 13-4

14 RESEARCH EFFORTS ....... 14-1

15 LITERATURE CITED ....... 15-1

16 LIST OF PREPARERS ....... 16-1

APPENDIX A ACOUSTIC CALCULATIONS USING NMFS OPTIONAL USER SPREADSHEETS ....... A-1

# LIST OF FIGURES

Figure 1-1. General Location of U.S. Naval Submarine Base New London and Proposed Action ....... 1-2

Figure 1-2. Location of the Proposed Action at Pier 32 ....... 1-3

Figure 1-3. Location of the Proposed Action at Pier 10 ....... 1-4

Figure 6-1. Predicted Underwater SPLs (dB re 1µPa) Associated with Vibratory Pile Installation at New Pier 32 ....... 6-6

Figure 6-2. Predicted Underwater SPLs (dB re 1µPa) Associated with Impact Pile Driving at New Pier 32 ....... 6-7

Figure 6-3. Predicted Underwater SPLs (dB re 1µPa) Associated with Vibratory Pile Extraction at Existing Pier 32 ....... 6-8

Figure 6-4. Predicted Underwater SPLs (dB re 1µPa) Associated with Vibratory Pile Extraction at Existing Pier 10 ....... 6-9

# LIST OF TABLES

**Table 2-1. First Year Pile Installation Activity (October 2018 – September 2019)............................................2-4**

**Table 2-2. Second Year Pile Installation Activity (October 2019 – September 2020)........................................2-6**

**Table 2-3. Third Year Pile Installation Activity (October 2020 – September 2021)..........................................2-7**

**Table 2-4. Fourth Year Pile Removal Activity (October 2021 – March 2022) ...................................................2-8**

**Table 3-1. Species Potentially Occurring in the Project Area ................................................................................3-2**

**Table 4-1. Marine Mammals Likely to be Affected by the Proposed Action.....................................................4-1**

**Table 5-1. Marine Mammal Injury and Disturbance Thresholds for Underwater Sounds .............................5-2**

**Table 6-1. Underwater Sound Pressure Levels from Similar In-situ Monitored Construction Activities ..........................................................................................................6-3**

**Table 6-2. Calculated Areas of ZOIs and Maximum Distances Corresponding to MMPA Thresholds for Underwater Sound................................................................................6-5**

**Table 6-3. Maximum Number of Takes by Type ..................................................................................6-11**

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| BMPs | best management practices |
| CAD | confined aquatic disposal |
| CALTRANS | California Department of Transportation |
| CV | coefficient of variation |
| cy | cubic yard(s) |
| dB | decibels |
| dB peak/pk | instantaneous peak sound pressure level |
| dB re 1 μPa | dB referenced to a pressure of 1 microPascal |
| dB re 1 $\mu Pa^2$-s | dB referenced to a pressure of 1 microPascal squared per second |
| ESA | Endangered Species Act |
| F | Fahrenheit |
| FEAD | Facilities Engineering and Acquisition Department |
| FR | Federal Register |
| ft | feet |
| Hz | hertz |
| kHz | kilohertz |
| km | kilometer |
| $km^2$ | square kilometer |
| LOA | Letter of Authorization |
| $L_E$ | sound exposure level, cumulative 24 hour |
| $L_{pk, flat}$ | peak sound pressure level (unweighted) |
| m | meter(s) |
| μPa | micropascal |
| MMOs | marine mammal observers |
| mg/L | milligrams per Liter |
| mi | mile(s) |
| MLLW | mean lower low water |
| MMPA | Marine Mammal Protection Act |
| NA | not applicable |
| NAVFAC | Naval Facilities Engineering Command |
| ND | no data |
| NMFS | National Marine Fisheries Service |
| NMSDD | Navy Marine Species Density Database |
| NOAA | National Oceanic and Atmospheric Administration |
| PAHs | polycyclic aromatic hydrocarbons |
| PCBs | polychlorinated biphenyls |
| ppt | parts per thousand |
| PTS | permanent threshold shift |
| rms | root mean squared |
| SEL | sound exposure level |
| $SEL_{cum}$ | cumulative sound exposure level |
| SPL | sound pressure level |
| SUBASE | Naval Submarine Base New London |
| TL | transmission loss |
| TTS | temporary threshold shift |

| | |
|---|---|
| U.S.C. | United States Code |
| USACE | United States Army Corps of Engineers |
| WFA | weighting factor adjustments |
| WSDOT | Washington State Department of Transportation |
| ZOI(s) | zone(s) of influence |

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# 1 INTRODUCTION AND DESCRIPTION OF ACTIVITIES

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

## 1.1 Introduction

Pursuant to the Marine Mammal Protection Act (MMPA) Section 101(a)(5)(D), the United States Navy (Navy) submits this application to National Marine Fisheries Service (NMFS) for a Letter of Authorization (LOA) for the incidental taking of marine mammal species during pile driving and removal activities associated with the proposed demolition/replacement of Pier 32 and demolition of Pier 10 at Naval Submarine Base New London (SUBASE) between October 2018 and March 2022. Code of Federal Regulations 50 216.104 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 first 14 chapters of this application.

SUBASE is located in the towns of Groton and Ledyard in New London County, Connecticut and occupies approximately 687 acres along the east bank of the Thames River, six miles (mi) north of the river's mouth at Long Island Sound (Figure 1-1). SUBASE supports shore commands to provide a Base Operations Support infrastructure to the operating forces of the Navy and other naval organizations and tenants; and to program and budget for resources to support Base Operations Support requirements. SUBASE ensures and enhances national security by providing the facilities, delivering the services, and creating the environment for the Fleet, Fighter, and Family to deploy combat-ready submarines and their crews and train professional submariners.

Recent Global Shore Infrastructure Plans and Regional Shore Infrastructure Plans identified a requirement for 11 adequate submarine berths at SUBASE. There are currently six adequate berths available via Piers 6, 17, and 31, leaving a shortfall of five adequate berths. The remaining submarine berthing piers (8, 10, 12, 32, and 33) are classified as inadequate because of their narrow width and short length compared to current SSN (hull classification) berthing design standards (Unified Facilities Criteria 4-152-01, Design Standards for Piers and Wharves [Department of Defense 2017]).

The Proposed Action is to demolish Pier 32 and Pier 10, and replace them with a new Pier 32 that meets all current Navy SSN pier standards to accommodate Virginia Class submarines. The Proposed Action includes:

- Construction of a new, larger Pier 32 to be located approximately 150 feet (ft) north of the current location (Figure 1-2).
- Upgrade of the quaywall, north of Pier 32, may be required to accommodate a crane weight test area (Figure 1-2). This will not be determined until final design, so it is included in this application due to the potential for this requirement.
- Demolition of existing Pier 32 (Figure 1-2) and Pier 10 (Figure 1-3).

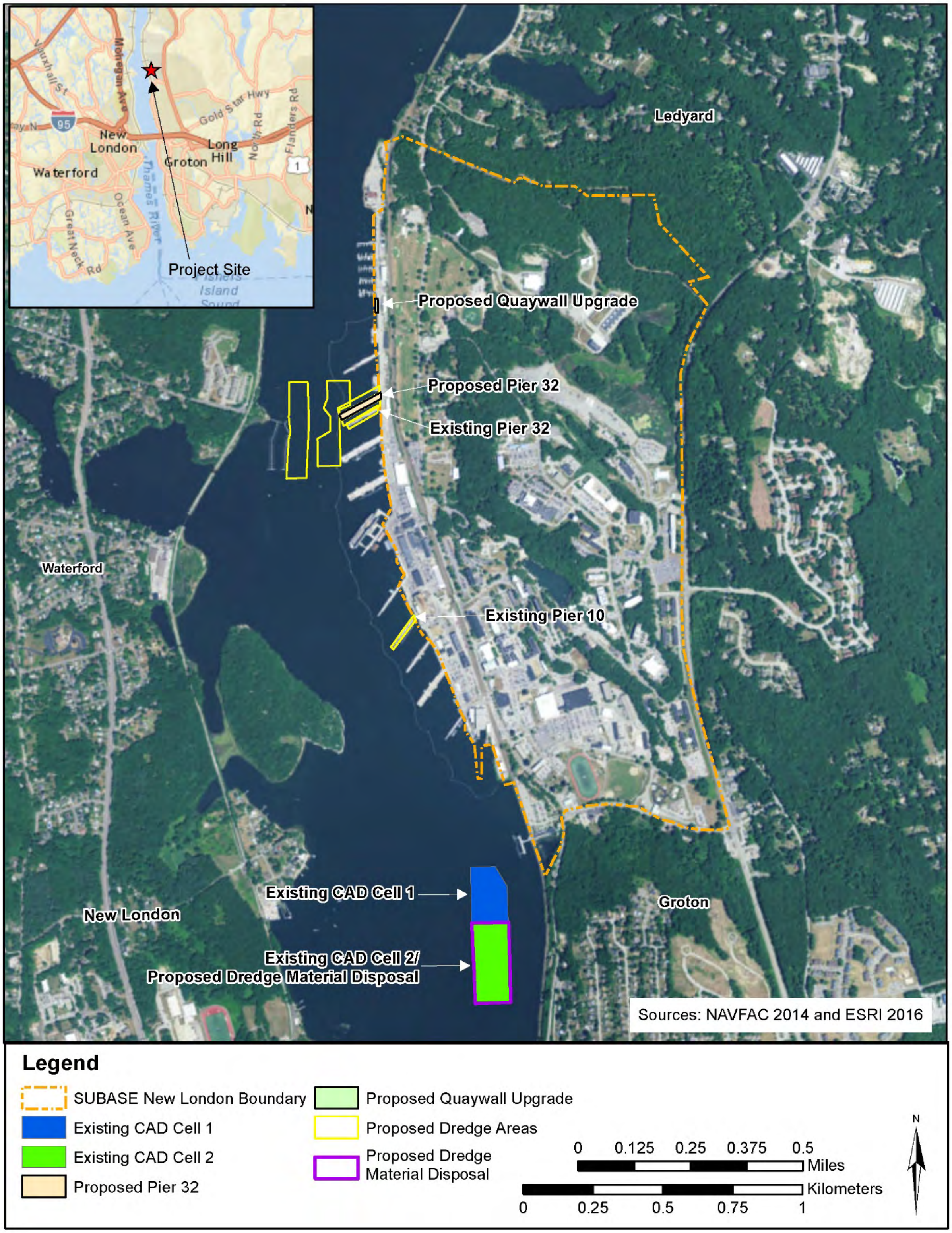


**Figure 1-1. General Location of U.S. Naval Submarine Base New London and Proposed Action**

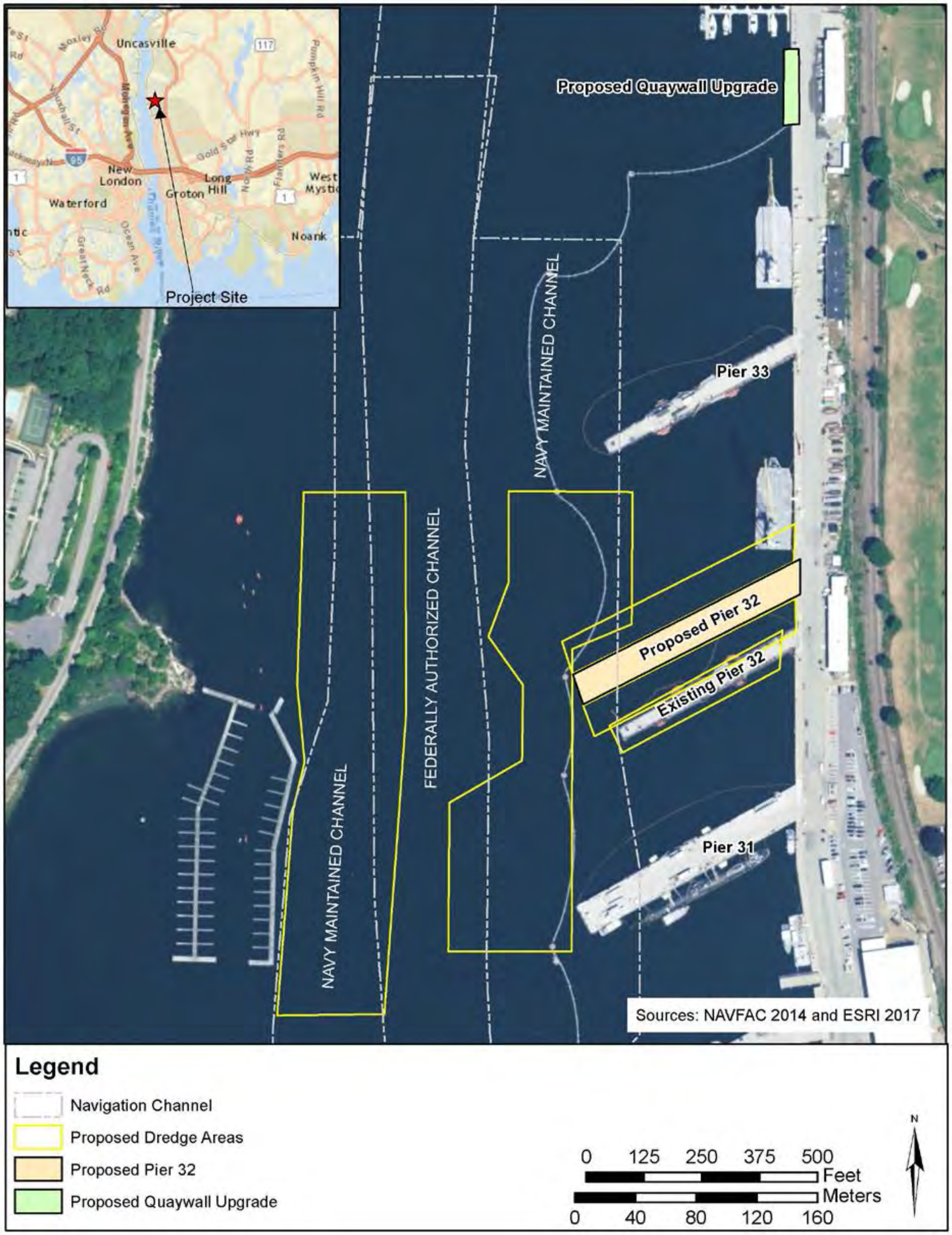


**Figure 1-2. Location of the Proposed Action at Pier 32**


**Figure 1-3. Location of the Proposed Action at Pier 10**

- Dredging of the sediment mounds beneath the existing Pier 32 (approximately 9,400 cubic yards [cy]) and the existing Pier 10 (approximately 10,000 cy) to a depth of 36 ft below mean lower low water (-36 ft MLLW) plus 2 ft of over dredge[1]. Any remaining timber piles beneath the existing piers would be pulled with a strap. Dredging of the berthing areas alongside the proposed new Pier 32 (approximately 74,000 sq ft) to a depth of -38 feet MLLW plus 2 feet of over dredge.
- Dredging of two additional areas (approximately 10,200 cy and 31,100 cy) in the Thames River navigation channel to a depth of -36 ft MLLW plus 2 ft of over dredge (Figure 1-2).
- Disposal of dredged material in an existing Confined Aquatic Disposal (CAD) cell (CAD cell 2) located in the Thames River federal navigation channel south of SUBASE (Figure 1-1).

The in-water construction and demolition activities are anticipated to begin in October 2018 and take approximately 35 non-consecutive months to complete. The requested effective date of the LOA is October 2018.

Section 1.2 describes the proposed activities to be conducted in detail. The proposed activities with the potential to affect marine mammals within the river adjacent to SUBASE that could result in harassment under the MMPA of 1972, as amended in 1994, are pile installation by vibratory and impact hammer and pile removal by vibratory extraction. Chapter 1 provides an overview of the entire project, and Chapter 2 provides more specific details on activities proposed to occur each year of this LOA.

## 1.2 Description of Activities

### *1.2.1 Construction of New Pier 32*

Pile driving would most likely be conducted using a barge and crane. However, the contractor may choose to use a temporary pile-supported work trestle that would be constructed by driving approximately 60 steel 14-inch diameter H-piles.

Structural support piles for Pier 32 would consist of approximately 120 concrete-filled steel pipe piles measuring 36 inches in diameter. The piles would be driven between 40 ft below the mudline near the shore and 150 ft below the mudline at the end of the pier. Fender piles would also be installed and would consist of approximately 194 fiberglass-reinforced plastic piles measuring 16 inches in diameter.

Special construction features would include drilling rock sockets into bedrock in an estimated 60 places to hold the piles. A rotary drill using a rock core barrel and rock muck bucket would be used inside of the steel pipe piles to drill a minimum of 2 ft down into bedrock to create the rock socket that would be filled with concrete. Underwater noise from the rock drill as it is operated inside a steel pipe would be much less than that produced by vibratory and impact pile driving of the steel pipes (Martin et al. 2012). Sediment would be lifted out and re-deposited within 10 ft of the pipe pile during rock socket drilling.

Impact and vibratory hammers would be used for installing piles where rock sockets are not required. Based on previous construction projects at SUBASE, it is estimated that an average of one 36-inch pile per week (with driving on multiple days) and two plastic piles per day would be

[1] Additional dredge depth that allows for varying degrees of accuracy of different types of dredging equipment.

installed. The per-pile drive time for each pile type and method will vary based on environmental conditions (including substrate) where each pile is driven. Impact or vibratory pile driving may result in harassment of marine mammals.

Construction of Pier 32 may also require upgrade of the quaywall north of Pier 32 to provide the reinforcement needed to support a crane weight test area. Because there is potential that a work trestle would be used and the requirement for the upgrade will not be determined until final design, the pile driving is included in the analyzed activities. The quaywall upgrade would include up to approximately eighteen 30-inch diameter concrete-filled steel pipe piles that would be installed into rock sockets driven into bedrock adjacent and parallel to the existing steel sheet pile wall. Pile caps and a concrete deck would be installed above the piles. A fender system composed of approximately nine 16-inch diameter plastic piles would also be installed into rock sockets approximately 2 ft in front of the new deck.

### *1.2.2 Demolition and Removal of Pier 32 and Pier 10*

When the new Pier 32 is operational, the existing Pier 32 would be demolished using a floating crane and a series of barges. Pier 10 would be demolished after the demolition of existing Pier 32. The concrete decks of the piers would be cut into pieces and placed on the barges. Demolition debris would be sorted and removed by barge and recycled to the maximum extent practicable. Any residual waste would be disposed of offsite in accordance with applicable federal, state, and local regulations. Once the decks are removed, the steel H piles and pipe piles that support the existing pier would be pulled using a vibratory extraction method (hammer). The vibratory hammer would be attached to the pile head with a clamp. Once attached, vibration would be applied to the pile that would liquefy the adjacent sediment allowing the pile to be removed.

Demolition of existing Pier 32 would include the removal by vibratory driver-extractor (hammer) of approximately 60 steel piles from the temporary work trestle, 120 concrete-encased steel H-piles, and 70 steel H-piles. Fifty-six wood piles would be pulled with a sling. Demolition of Pier 10 would include the removal by vibratory hammer of 24 concrete-encased, steel H-piles and 166 cast-in-place, reinforced concrete piles. Eight-four steel fender piles and 41 wood piles would be pulled with a sling. A total of 440 piles would be removed by vibratory hammer for both piers and the work trestle.

### *1.2.3 Dredging of Pier Areas and Navigation Channel*

The Proposed Action would also include dredging of approximately 60,000 cy of sediment in two areas of the Thames River navigation channel near Pier 32, the berthing areas alongside the new Pier 32, and underneath existing Pier 32 and Pier 10 after demolition (Figure 1-2 and Figure 1-3). All dredging for the Proposed Action would support safe maneuvering for entry and departure of submarines at the proposed new Pier 32 and existing Piers 8, 12, 17, and 31. The proposed design dredge depth in all areas to be dredged is -36 ft relative to MLLW plus 2 ft of over dredge.

Dredging would be conducted in two phases. Dredging of the new Pier 32 area and the northern portion of the channel dredge areas would be conducted in the first construction year. The footprints of the demolished Pier 32 and Pier 10 and the southern portions of the channel dredge areas would be dredged after demolition of the existing piers in the fourth year of construction. Dredging would occur only during the period between October 1 and January 31 to avoid

potential impacts on shellfish and fisheries resources in the area. Each dredging and disposal phase would take approximately 2 weeks to complete.

After the demolition of Pier 32, any remnant timber piles present underneath existing Pier 32 would be pulled with a strap. The sediment mound that has formed beneath the pier would be dredged (approximately 9,400 cy) to the design depth. Dredging would also be required immediately west of Piers 31 and 32 (approximately 10,200 cy) and along the eastern edge (approximately 31,100 cy) of the navigation channel to achieve the required minimum depths to maneuver the submarines. Once the existing Pier 10 and any remnant timber piles are removed, the sediment mound beneath the old pier would be dredged (approximately 10,000 cy).

The dredged material would be disposed, in accordance with federal and state requirements, in an existing CAD cell (CAD cell 2 shown in Figure 1-1), and the CAD cell would be capped/covered with the cleaner portion of the dredged material.

Since dredging and disposal activities would be slow moving and conspicuous to marine mammals, they pose negligible risks of physical injury. An environmental bucket would be used for dredging to minimize turbidity compared with the turbidity generated by hydraulic dredging. Noise emitted by dredging equipment is broadband, with most energy below 1 kilohertz (kHz), and would be similar to that generated by vessels and maritime industrial activities that regularly operate within the action area (Clarke et al. 2002; Todd et al. 2015). Short-term effects on the behavior of animals passing through the immediate area (e.g., avoidance, partial masking of calls between individuals) are possible but would be localized, temporary events unlikely to rise to the level of harassment under the MMPA.

Dredging operations would not result in physical injury or generate noise that would result in injury or harassment of marine mammals; therefore, dredging is not included as an activity expected to result in incidental takes.

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# 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 of Construction

Pile installation for the new Pier 32 and pile removal associated with the demolition of the existing Piers 32 and 10 is expected to take a total of approximately 3.5 years. Construction and demolition activities are expected to begin in October 2018 and proceed to completion in March 2022.

## 2.2 Duration of Activities

In-water activities expected to result in incidental takes of marine mammals would occur during approximately 35 non-consecutive months of the project beginning in October 2018. The estimated duration of pile installation and removal, including duration of the vibratory and impact hammer activities, is provided in the following tables (Table 2-1 through 2-4) for each year of construction and demolition. Also included in the tables are the durations for wood piles and steel fender piles to be pulled by a crane using a sling or strap attached to the pile. The durations of proposed pile driving/removal activities are primarily derived from information provided by Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Public Works Department, Facilities Engineering and Acquisition Department (FEAD) Design Manager and the record of pile driving activities documented during the construction of SUBASE Pier 31 (American Bridge 2010-2011). The proposed new Pier 32 would be comparable to Pier 31 in design and location and would have similar sub-surface geological conditions along this reach of the Thames River.

### *2.2.1 Construction*

During the first, second, and third year of construction of Pier 32, vibratory, drilling, or impact hammer methods would be used for pile installation. The majority of the pile installation activity would be by vibratory hammer.

Construction of the new pier may require a temporary work trestle supported by approximately 60 steel 14-inch H-piles driven with an impact hammer. Support piles for Pier 32 (approximately 120 concrete-encased steel, 36-inch diameter) would be installed in 24 groups of 5, each group comprising a bent[2] (60 each 100 ft and 60 each 180 ft long), beginning near the quaywall and moving westerly to the outer end of the pier. As experienced during the construction of Pier 31, it is assumed that all of the piles from Bent 1 through Bent 12 (approximately sixty 100-ft piles) would be installed by vibratory hammer and anchored by drilled rock sockets. Bents 13 through 24 (approximately sixty 180-ft piles) would be installed primarily by vibratory hammer with impact hammer only being used to install the final 20 to 40 ft of each pile (American Bridge 2016). The type/size of impact hammer that would be used to complete the work would be determined by the contractor selected to perform the work. However, it is likely that a diesel

[2] A bent is a structural support placed at intervals perpendicular to the pier length and would consist of concrete and steel structure supported by 5 piles at each bent.

impact hammer would be used. These hammers work by dropping a weight on top of the pile repeatedly to drive it into the substrate; diesel combustion is used to repeatedly lift the weight and allow it to fall onto the pile to drive it.

Depending on the lengths of the piles and whether rock sockets are required, pile installation would take up to 2 weeks per bent (5 piles per bent) for shorter piles and 5 weeks per bent for longer piles.

The use of vibratory hammers would be intermittent and interspersed with the welding and painting of additional pipe sections, drilling of rock sockets, and the repositioning of work barges. In total, vibratory hammer operations would occur for an average of 20 minutes per pile for short piles and approximately 30 minutes per pile for longer piles. Where impact hammer driving is required to achieve deeper depths, an entire bent of piles would be installed to the maximum depth achievable with a vibratory hammer, and then the piles would be finished with the impact hammer. Each bent would be completed before construction begins on the next bent. This method maximizes efficiency and minimizes the duration of impact hammer operation.

Given the sub-surface conditions, as evidenced during the construction of first half of Pier 31, no impact hammers would be used for installation of the first 60 piles (36-inch by 100 ft). It is possible that the construction contractor may choose to conduct vibratory and impact hammering on the same days, depending on the logistics of switching hammers. However, for this analysis, the worst-case (maximum number of takes) assumptions are made that vibratory and impact hammering would occur on different days and would occur on up to the maximum number of workdays (180) during the nine months of the year (September to May) when seals are most likely to be present.

As discussed in Chapter 1, upgrade of the quaywall is still yet to be determined, but is included in this application. Installation of the piles for the quaywall upgrade (approximately 18 concrete-filled 30-inch steel pipe piles) would occur concurrently with pile installation for Pier 32. Drilling into rock sockets would take an average of approximately 4 hours of drilling each and an installation rate of 0.5 piles per day. The approximately nine 16-inch diameter plastic fender piles would also be drilled into rock sockets.

Based on this construction methodology and data recorded for SUBASE Pier 31, impact hammering of steel piles, which generates the loudest sound, would only occur on a total of approximately 39 days (23 days in the first year, 16 days in the second year). The average number of pile strikes per day would be approximately 2,500 for the 36-inch concrete-encased steel piles for new Pier 32, or approximately 4,000 strikes for the 14-inch steel H-piles used for the temporary trestle. To provide a worst case for the maximum number of Level A (acoustic injury) takes, the impact hammering of steel piles is assumed to occur during the nine months of the year (September to May) when seals are most likely to be present.

Plastic piles, the installation of which generates much lower sound levels than steel piles, would be installed by impact hammer for approximately 26 days during the third year.

### 2.2.2 Demolition

Demolition of Pier 32 is scheduled to begin in the fourth and final year of construction, beginning with removal of the deck. Demolition is estimated to take a total of approximately eight months, including four months for removal of the deck and four months of in-water pile

extraction. Vibratory extraction methods would be used to remove the existing piles during pier demolition. Approximately two piles per day would be removed.

Pier 10 would be demolished after demolition of Pier 32. Demolition would take approximately six months, including approximately two months of in-water pile removal work. Support piles would be removed using the same method described for Pier 32. Pier 10 demolition is anticipated to begin and be completed in the fourth year.

The following tables (Table 2-1 through 2-4) provide a breakdown of average estimated pile installation and removal durations by construction year. Actual durations may vary due to conditions encountered during construction.

**Table 2-1. First Year Pile Installation Activity (October 2018 – September 2019)**

| Activity | Pile Count[a] | Pile Type | Method Of Installation | Piles Installed Per Work Day[b] | Total Pile Driving Days | Average Hammer/Drill Operation (Seconds/ Strikes Per Pile)[c, d] | Average Hammer/Drill Operation (Seconds/ Strikes Per Day) | Calendar Months[b] |
|---|---|---|---|---|---|---|---|---|
| Pier 32 Construction (pile installation) | 60 | 14-inch steel H-piles for temporary work trestle | Impact hammer | 4 | 15[e] | 1,000 strikes | 4,000 strikes | 3 weeks |
| | 60 | 36-inch x 100-ft concrete-filled, steel pipe piles | Vibratory hammer and rock socket drilling | 0.5 | 120 | 1,200 seconds | 600 seconds | 6 |
| | 20[f] | 36-inch x 180-ft concrete-filled, steel pipe piles | Vibratory hammer | 0.2[g] | 100 | 1,800[h] seconds | 360 seconds | 5 |
| | 20 | 36-inch x 180-ft concrete-filled, steel pipe piles | Impact hammer to drive last 20-40 ft[i] | 2.5[i] | 8[e] | 1,000 strikes | 2,500 strikes[j] | 2 weeks |
| Quaywall Upgrade (pile installation) | 18 | 30-inch x 100-ft concrete-filled, steel pipe piles | Rock socket drilling | 0.5 | 36 | 15,000 seconds | 7,500 seconds | Concurrent with Pier 32 |
| | 9 | 16-inch fiberglass reinforced, plastic piles | Rock socket drilling | 0.5 | 18 | 7,500 seconds | 3,750 seconds | |

a. Pile count total based on Design Plans for comparable SUBASE Pier 31

b. Estimate provided by NAVFAC Mid-Atlantic Public Works Department, FEAD Design Manager based on data from previous similar projects (NAVFAC Mid-Atlantic 2016); assumes 5 work days per week

c. Estimate from American Bridge Pile Driving Records for SUBASE Pier 31 Replacement (2010-2011) and American Bridge (2016)

d. Vibratory hammer measured in seconds per pile

e. Impact hammering is assumed to occur during nine months of the year (September to May) when seals are present. Vibratory hammering can occur at any time of year but for the purpose of Level B (behavioral) take calculations is assumed to occur on different days than impact hammering.

f. Total of approximately 20 out of estimated 60, 36-inch, 180-ft piles would be installed in the first year by vibratory hammer and finished by impact hammer

g. Assumes that each pile would be installed in increments of 20% (0.2) per work day to allow for the welding, painting, and curing of pile sections and joins and repositioning of barges, resulting in a total installation rate of 1 pile per week
h. Estimated seconds per pile from American Bridge Pile Driving Records for SUBASE Pier 31 construction 2010-2011 (average duration of 30 minutes recorded for installation of the longer piles).
i. Based on method of pile finishing recorded for Pier 31. Piles 180 ft long were installed in a bent (groups of 5) to maximum depths achievable via vibratory means then the last 20-40 ft finished with an impact hammer. Each bent would be completed before moving to the next bent
j. Estimated 2.5 piles per work day and 2,500 strikes per day calculated from American Bridge Pile Driving Records for SUBASE Pier 31 Replacement 2010-2011 based on the number of days an impact hammer was used for pile driving, restrikes, and pile dynamic analysis tests

**Table 2-2. Second Year Pile Installation Activity (October 2019 – September 2020)**

| Activity | Pile Count[a] | Pile Type | Method Of Installation | Piles Installed Per Work Day[b] | Total Pile Driving Days | Average Hammer Operation (Seconds /Strikes Per Pile)[c, d] | Average Hammer Operation (Seconds/ Strikes Per Day) | Calendar Months[b] |
|---|---|---|---|---|---|---|---|---|
| Pier 32 Construction (pile installation) | 40 | 36-inch x 180-ft concrete-filled, steel pipe piles | Vibratory hammer | 0.2[e] | 200[f] | 1,800 seconds[g] | 360 seconds | 10 |
| | 40[h] | 36-inch x 180-ft concrete-filled, steel pipe piles | Impact hammer to drive last 20-40 ft[i] | 2.5[i] | 16[f] | 1,000 strikes | 2,500 strikes[j] | 3.5 weeks |

a. Pile count total based on Design Plans for comparable SUBASE Pier 31
b. Estimate provided by NAVFAC Mid-Atlantic Public Works Department, FEAD Design Manager based on data from previous similar projects (NAVFAC Mid-Atlantic 2016); assumes 5 work days per week
c. Estimate from American Bridge Pile Driving Records for SUBASE Pier 31 Replacement (2010-2011) and American Bridge (2016)
d. Vibratory hammer measured in seconds per pile and impact hammer measured in strikes per pile
e. Assumes that each pile would be installed in increments of 20% (0.2) per work day to allow for the welding, painting, and curing of pile sections and joins and repositioning or barges, resulting in a total installation rate of 1 pile per week
f. Impact hammering is assumed to occur during nine months of the year (September to May) when seals are present. Vibratory hammering can occur at any time of year but for the purpose of Level B (behavioral) take calculations is assumed to occur on different days than impact hammering.
g. Seconds per pile from American Bridge Pile Driving Records for SUBASE Pier 31 Replacement 2010-2011 (average duration of 30 minutes recorded for installation of the longer piles)
h. Total of approximately 40 of 60, 36-inch, 180-ft piles would be finished by impact hammer in the second year
i. Based on method of pile finishing recorded for Pier 31. Piles in a bent (groups of 5) were installed to maximum depths achievable via vibratory means then the last 20-40 ft finished with an impact hammer. Each bent would be completed before moving to the next bent.
j. Estimated 2.5 piles per work day and 2,500 strikes per day calculated from American Bridge Pile Driving Records for SUBASE Pier 31 Replacement 2010-2011 based on the number of days an impact hammer was used for pile driving, restrikes, and pile dynamic analysis tests

**Table 2-3. Third Year Pile Installation Activity (October 2020 – September 2021)**

| Activity | Pile Count[a] | Pile Type | Method Of Installation | Piles Installed Per Work Day[b] | Total Pile Driving Days | Average Hammer Operation (Seconds/ Strikes Per Pile)[c,d,e] | Average Hammer Operation (Seconds/ Strikes Per Day) | Calendar Months[b] |
|---|---|---|---|---|---|---|---|---|
| Pier 32 Construction (pile installation) | 194 | 16-inch fiberglass reinforced, plastic piles | Vibratory hammer | 2 | 97 | 1,200 seconds | 2,400 seconds | 5 |
| | 64 | 16-inch fiberglass reinforced, plastic piles | Impact hammer to drive last 20-40 ft[f] | 2.5[g] | 26 | 1,000 strikes | 2,500 strikes[g] | 1.5 |
| 4 months to complete new Pier 32 deck | | | | | | | | |
| After new Pier 32 is operational, additional 4 months for demolition of old Pier 32 deck | | | | | | | | |

a. Pile count total based on Design Plans for comparable SUBASE Pier 31
b. Estimate provided by NAVFAC Mid-Atlantic Public Works Department, FEAD Design Manager based on data from previous similar projects (NAVFAC Mid-Atlantic 2016); assumes 5 work days per week
c. Extrapolated from pile logs from comparable SUBASE Pier 31 construction
d. Estimate from American Bridge Pile Driving Records for SUBASE Pier 31 Replacement (2010-2011) and American Bridge (2016)
e. Vibratory hammer measured in seconds per pile
f. Estimated that one third (64) of the 194 plastic piles will be installed to maximum depths achievable via vibratory means then the last 20-40 ft finished with an impact hammer
g. Estimated 2.5 piles per work day and 2,500 strikes per day assumed based on American Bridge Pile Driving Records for SUBASE Pier 31 Replacement 2010-2011 including pile driving, restrikes, and pile dynamic analysis tests

**Table 2-4. Fourth Year Pile Removal Activity (October 2021 – March 2022)**

| Activity | Pile Count[a] | Pile Type | Method Of Removal | Piles Removed Per Work Day[b] | Total Pile Driving Days | Average Hammer Operation (Seconds Per Pile)[c] | Average Hammer Operation (Seconds Per Day) | Calendar Months[b] |
|---|---|---|---|---|---|---|---|---|
| Pier 32 Demolition (pile removal) | 60 | 14-inch steel piles temp. work trestle | Vibratory hammer | 5 | 14 | 1,200 seconds | 2,400 seconds | 3 weeks |
| | 24 | 33-inch concrete-encased Steel H-piles | Vibratory hammer | 2 | 12 | 1,200 seconds | 2,400 seconds | 3.5 |
| | 96 | 24-inch concrete-encased Steel H-piles | Vibratory hammer | 2 | 48 | 1,200 seconds | 2,400 seconds | |
| | 70 | 14-inch steel H-piles | Vibratory hammer | 5 | 14 | 1,200 seconds | 2,400 seconds | |
| | 56 | wooden piles | Pulled by crane & sling | 5 to 10 | 0 | 0 | 0 | |
| 4 months for demolition of Pier 10 deck | | | | | | | | |
| Pier 10 Demolition (pile removal) | 24 | 24-inch concrete-encase steel H-piles | Vibratory hammer | 9.5 | 2.5 | 1,200 seconds | 11,400 seconds | 0.5 |
| | 166 | 24-inch cast-in-place reinforced concrete piles | Vibratory hammer | 9.5 | 17.5 | 1,200 seconds | 11,400 seconds | 0.5 |
| | 84 | steel fender piles | Pulled by crane & sling | 12.5 | 0 | 0 | 0 | 0.25 |
| | 41 | wood piles | Pulled by crane & sling | 12.5 | 0 | 0 | 0 | 0.25 |

a. Pile count based on Waterfront Facilities Inspections and Assessments May 10, 2010
b. Estimate provided by NAVFAC Mid-Atlantic Public Works Department, FEAD Design Manager based on data from previous similar projects (NAVFAC Mid-Atlantic 2016); assumes 5 work days per week
c. Estimate from American Bridge Pile Driving Records (2010-2011) and American Bridge (2016)

## 2.3 Project Area Description

SUBASE is located in the towns of Groton and Ledyard in New London County, Connecticut. SUBASE occupies approximately 687 acres along the east bank of the Thames River, 6 mi north of the river's mouth at Long Island Sound (Figure 1-1). The Thames River is the easternmost of Connecticut's three major rivers and is formed by the confluence of the Shetucket and Yantic rivers in Norwich, from which it flows south for 12 mi to New London Harbor. The Thames River discharges freshwater and sediment from the interior of eastern Connecticut into Long Island Sound. It is the main drainage of the Thames River Major Drainage Basin, which encompasses approximately 3,900 square mi of eastern Connecticut and central Massachusetts (USACE 2015). The lower Thames River and New London Harbor sustains a variety of military, commercial, and recreational vessel usage. New London Harbor provides protection to a number of these vessels from the deeper, more open waters of Long Island Sound and the Atlantic Ocean.

### *2.3.1 Bathymetric Setting*

The central portions of the Thames River have been shaped by historic dredging to support navigation to Norwich Harbor. A basin exists in Norwich Harbor at the confluence of the Yantic and Shetucket Rivers with a maximum depth of -47 ft. The basin is maintained to -25 ft and the river, from the basin to the turning basin at Smith Cove and the SUBASE, is maintained to -25 ft and 200 ft wide. Outside the dredged channel, depths from 1 to 7 ft are typical. Below Smith Cove the channel has been dredged to -42 ft to support submarine navigation from Long Island Sound and ranges from 400 to 1,000 ft in width (Navy 1995). A bathymetric survey was conducted along Pier 32 and the adjacent portion of the Thames River in May 2012. The results of the survey identified areas where a depth of -36 ft was not achieved. These are the areas identified for dredging as part of the Proposed Action.

### *2.3.2 Tides, Circulation, Temperature, and Salinity*

The Thames River is subject to a semi-diurnal tide, with an average range of 2.5 ft in the vicinity of the SUBASE. Due to a shallow gradient, the flood tide progresses up the river at a relatively quick rate. High tide arrives in the vicinity of the SUBASE in less than one minute relative to the National Ocean Service station at the State Pier in New London. Low tide occurs in the vicinity of the SUBASE 10 minutes after it occurs at the State Pier.

Currents in the Thames River are primarily tidally driven except at or near the surface where the freshwater river discharge can be strong enough to offset the flood tide flow at times. Water in the upper feet of the river exhibit downstream flow, while water in the bottom feet exhibit upstream flow. The tidal current amplitude increases from the mouth of the river northward to the northern reaches of the river owing to a smaller cross-sectional area in the upper reaches. In general, the upper feet show a similar flood and ebb magnitude, indicating that the flooding period is approximately the same as the ebbing period. For bottom waters, the ebb period is longer and thus the mean amplitude must be lower to conserve water mass (Navy 1995).

Water temperature values measured during a 12-year period in the Thames River near Mohegan, Connecticut ranged from a minimum of 32° Fahrenheit (F) to a maximum of 82° F with a mean temperature of 53.8° F in the mixing water (i.e., surficial zone) of the river. Within the saltwater wedge, the water temperatures measured during the same 12-year period at the Mohegan station

ranged from a minimum of 33.8° F to a maximum of 69.8° F with a mean of 53.2° F. Prevailing summer winds are from the south and southwest, while winter brings prevailing winds from the northwest (Navy 1995).

During nearshore surveys conducted in the Thames River at SUBASE in 2015, water temperature values were measured and ranged from approximately 33° F in winter to 77° F in summer. Water temperature measurements in spring indicated warming surface temperatures and stratification, with a 43°F difference from surface to bottom (Tetra Tech 2016).

The project area is located approximately 6 mi from the mouth of the Thames River. Due to tidal influence and concurrent freshwater discharge within the basin, a zone of lesser density mixing water forms above a saltwater wedge. Seawater salinities are typically recorded within the area of the piers below the zone of mixing salinity. The wedge of higher salinity bottom water surrounding the piers and CAD cell areas normally has salinity in the range of 30 to 32 practical salinity units (Tetra Tech 2016). The mixing zone between saline bottom water and surface water normally has lower salinity in the range of 8 to 24 practical salinity units (Tetra Tech 2016).

### 2.3.3 Substrates and Habitats

The sediments found in the Thames River vary along the longitudinal length of the river and along the cross section of the bottom in relation to the distance from shore. Course gravel and bedrock exists along the riverbank and near stormwater outfall locations along the waterfront of SUBASE. Sediments in the berthing areas contain predominately fine-grained material with higher sand fractions being encountered in the shallower sediments. Within the navigation channel, sediments are composed predominantly of silt and clay (90 percent or greater) with less than 5 percent sand (CardnoTEC 2014a,b).

The Thames River has historically been an industrial river, and as such, has shown elevated levels of metals, Polycyclic Aromatic Hydrocarbons (PAHs), pesticides, and Polychlorinated Biphenyls (PCBs). Testing of sediments in the vicinity of the pier areas and other regions have shown varying concentrations of metals, PAHs, PCBs, and other chemicals above background (i.e., naturally occurring) concentrations. Sediment testing related to this project has revealed that the sediments in the pier areas and on the surface of the navigation channel contain elevated concentrations of these contaminants (CardnoTEC 2014a,b).

### 2.3.4 Ambient Sound

Data on ambient underwater sound levels in the Thames River are unavailable. Vessel traffic is extensive in the river, especially south of the project area (south of Interstate 95 and the Amtrak bridges) in the highly developed downtown areas of Groton and New London. Large vessels, ferries in particular, frequently transit between the lower part of the river and destinations within Long Island Sound and elsewhere. Vessel noise within the river is likely to frequently exceed the 120 decibel (dB) threshold for behavioral harassment from continuous sound (Richardson et al. 1995), but data are not available to support use of a higher threshold.

# 3 MARINE MAMMAL SPECIES AND NUMBERS

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

Due to the likely presence of marine mammals in vicinity of the SUBASE, underwater sound generated by pile driving and extraction activities associated with the Proposed Action are anticipated to result in the harassment of marine mammals. Pile driving can also generate airborne noise that could potentially result in disturbance to marine mammals (pinnipeds) that are hauled out. Due to the absence of haul outs in the project area, the potential for acoustic harassment by airborne sound is considered negligible and is not analyzed.

Based on the number of piers and high density of pilings along the shoreline and discussion with NMFS (Laws 2016), the Navy concluded that underwater sound transmission through these structures would be impeded similar to the interruption of sound transmission by natural projections of the shoreline. Using this assumption, the resulting acoustic zone of influence (ZOI) for marine mammal injury and disturbance would be limited to the middle reaches of the Thames River, extending no farther south than the Amtrak Bridge, approximately 3 mi upstream from the mouth of the river. The ZOIs are depicted and discussed in detail in Chapter 6.

Occurrence information for marine mammal species with a reasonable likelihood of occurrence within the maximum project ZOI in the Thames River is summarized in Table 3-1. The Navy's Marine Species Density Database (NMSDD) has density estimates for harbor and gray seals, as well as several other species of marine mammals that occur in Long Island Sound. The NMSDD density estimates for harbor seals and gray seals are the same, 0.0703/square kilometer ($km^2$ [0.4 square mi]) during fall, winter, and spring, and 0.0174/$km^2$ (0.4 square mi) during summer months. These estimates, however, are based on broad-scale oceanic surveys, which have not extended up the Thames River.

Marine mammal surveys were conducted in fall 2014 and winter, spring, and summer of 2015 as part of a nearshore biological survey at SUBASE. No marine mammals were observed (Tetra Tech 2016). A two-year detailed, systematic survey of marine mammals in the Thames River began in January 2017. Survey results are not yet available. Harbor seals (*Phoca vitulina*) have been sighted in the Thames River near the SUBASE by Navy personnel. NMFS (Laws 2016) noted that given the recent increase of gray seals (*Halichoeris grypus*) in New England waters, by the time of proposed construction (2018), there would be a reasonable possibility that they would co-occur with, and would not always be distinguishable from, harbor seals. Both gray and harbor seals have rookeries in Long Island Sound.

Based on the sighting information of personnel at the SUBASE, the Navy believes the extrapolation of NMSDD species and density estimates to the middle part of the Thames River would underestimate the density of harbor seals and probable gray seals in the project ZOIs, while overestimating the density of other marine mammal species whose presence in the river has never been established. Therefore, the Navy will place greater emphasis on the observations of personnel at SUBASE in estimating the density of seals. Based on the repeated sightings of two seals at SUBASE occurring approximately 2 times each week, the average presence of seals (harbor or gray) is estimated to be 4 per week or 0.6 per day from September through May. The majority (75 percent) of these are likely to be harbor seals. There are no areas (haul outs) where seals are known to be concentrated nor have there been contemporary sightings of larger

numbers of seals along this stretch of the river, and the animals seen at SUBASE likely move up and down as well as across the river from SUBASE. Given that the Thames River is about 500 m (1,640 ft) wide at SUBASE, and similarly developed areas extend about 1 km (3,280 ft) up and down the river, the Navy believes it is reasonable to extrapolate the observations at SUBASE to an area of about 1 $km^2$ for the purpose of estimating density. This would result in an average density of 0.45 harbor and 0.15 gray seals per $km^2$ within the project ZOIs from September through May.

**Table 3-1. Species Potentially Occurring in the Project Area**

| Species | Stock | Stock Abundance[1] | Relative Occurrence in Project Area | Season(s) of Occurrence | Density in the Project Area[2] | Status Under ESA and MMPA |
|---|---|---|---|---|---|---|
| harbor seal *Phoca vitulina* | Western North Atlantic | 70,142 (CV = 0.29) | Common | Spring, fall, winter | 0.45/$km^2$ | Not listed under ESA or considered strategic or depleted under MMPA |
| gray seal *Halichoerus grypus* | Western North Atlantic | Insufficient data | Common | Spring, fall, winter | 0.15/$km^2$ | Not listed under ESA or considered strategic or depleted under MMPA |

*Sources*: [1]Stock abundances from Waring et al. 2015a; [2]Density estimates based on incidental sightings by SUBASE personnel

*Notes*: CV = coefficient of variation; 95 percent confidence interval; ESA = Endangered Species Act

# 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.*

Harbor seals (*Phoca vitulina*) are regularly observed in the vicinity of SUBASE. Gray seals (*Halichoerus grypus*) could co-occur with, and are not always distinguishable from, harbor seals, and therefore, are assumed to occur in the vicinity of SUBASE as well.

Many other marine mammal species occur outside of the project area beyond the mouth of the Thames River in Long Island Sound, including but not limited to fin whale (*Balaeonoptera physalus*), humpback whale (*Megaptera novaeangliae*), short-beaked common dolphin (*Delphinus delphis*), common bottlenose dolphin (*Tursiops truncatus*), Atlantic white-sided dolphin (*Lagaeonorhynchus acutus*), harbor porpoise (*Phocoena phocoena*), and harp seal (*Pagophilus groenlandicus*). These species are not known, and are unlikely to occur 6 mi up the Thames River near SUBASE, and they will not be considered further in this application.

The project area is likely used for foraging by transient individual harbor seals and gray seals (Table 4-1). Pile driving and removal could potentially harass those few pinnipeds that are in the water close to the project site, whether their heads are above or below the surface.

**Table 4-1. Marine Mammals Likely to be Affected by the Proposed Action**

| Species | Status of Stock | Distribution | Population Size | Typical Habitats |
|---|---|---|---|---|
| Harbor seal (*Phoca vitulina*) | MMPA | On the East Coast, found from the Canadian Arctic to southern New England, New York, and occasionally to the Carolinas. | 75,000-100,000 in New England | Temperate coastal habitats and use rocks, reefs, beach, and drifting glacial ice as haul-out and pupping sites. When hunting, they use the entire water column –from the surface to the sea floor. |
| Gray seal (*Halichoerus grypus)* | MMPA | Western North Atlantic stock located in eastern Canada and the northeastern United States. | 331,000 in western North Atlantic | Coastal waters, islands, sandbars, ice shelves, and icebergs. When hunting, they use the entire water column –from the surface to the sea floor. |

*Note*: MMPA = protected under the Marine Mammal Protection Act.

## 4.1 Harbor Seals

The harbor seal is a common species of seal that is distributed in the cold temperate waters of the North Atlantic and North Pacific. Males and females are not sexually dimorphic, and therefore, it is difficult to tell the sexes apart. The color of harbor seals varies from light grey to dark brown with various black spots. Males and females are approximately 4.9 ft and 220 pounds and the maximum lifespan is about 35 years (Waring et al. 2015a).

Harbor seals use terrestrial habitat “haul-out sites” throughout the year, particularly during the pupping and molting periods. In northern New England, they typically haul out on tidal ledges. In southern New England, harbor seals favor rocky ledges, isolated rocks, and small nearshore islands as haul-out sites (Kenney 2014). Haul-out behavior is strongly influenced by tide stage, air temperature, time of day, wind speed, and precipitation. Human disturbance can also affect

haul-out behavior although harbor seals appear to acclimate to some human activity (Waring et al. 2015a).

### 4.1.1 Status

Harbor seals are not listed as endangered or threatened under the Endangered Species Act (ESA) or as depleted under the MMPA. They are not considered a strategic stock under the MMPA because human caused mortality in the species is low relative to the stock size. The potential biological removal for the western north Atlantic stock of harbor seals is 2,006 (MMPA Sec. 3. 16 United States Code [U.S.C.] 1362; Waring et al. 2015a).

### 4.1.2 Numbers

In 2001, the harbor seal population was estimated to be approximately 100,000 individuals. However, the most recent survey, conducted in 2012, yielded an estimate of approximately 75,000 seals. Four possibilities were attributed to the observed decline in harbor seal populations between study periods: (1) the 2012 estimate may be biased by erroneous assumptions about seal distribution since the 2012 study area was based on sample areas as opposed to the entire coast; (2) the correction factor was different in the two surveys, being 2.54 in 2001 and 2.33 in 2012; (3) not all seals were in the study area during the survey period; and, (4) the population is no longer growing and has, in fact, declined due to increased competition with increasing gray seal populations (Waring et al. 2015b).

The Western North Atlantic Stock (containing the Gulf of Maine) report published by the National Oceanic and Atmospheric Administration (NOAA) states that the minimum population estimate for harbor seals is 66,884 based on corrected available counts along the Maine coast in 2012. A population trend analysis has not been conducted for this stock. The statistical power to detect a trend in abundance for this stock is poor due to the relatively imprecise abundance estimates and long survey interval (Waring et al. 2015a).

### 4.1.3 Distribution

In the western North Atlantic, harbor seals are distributed from the eastern Canadian Arctic and Greenland south to southern New England and New York, and can occur as far south as the Carolinas. Surveys conducted by the Navy have indicated that harbor seals are regularly present during cold months in Virginia on the Chesapeake Bay Bridge Tunnel islands. Although the stock structure of the western North Atlantic population is unknown, it is thought that harbor seals found along the eastern United States and Canadian coasts represent one population. In United States waters, breeding and pupping normally occurs in waters north of the New Hampshire/Maine border (Waring et al. 2015a).

Harbor seals are year-round inhabitants of the coastal waters of eastern Canada and Maine, and occur seasonally along the southern New England and New York coasts from September through late May. A general southward movement from the Bay of Fundy to southern New England waters occurs in autumn and early winter. A northward movement from southern New England to Maine and eastern Canada occurs prior to the pupping season, which takes place from mid-May through June. The overall geographic range throughout coastal New England has not changed significantly during the last century. Harbor seal populations have increased in Connecticut since the 1980s and are common in Long Island Sound from September through June (Medic 2005). Incidental sightings of two seals moving through the waterfront at SUBASE

have been reported by SUBASE personnel approximately two times per week from September through May.

#### 4.1.4 Vocalization and Hearing

Pinnipeds produce sounds both in air and water that range in frequency from approximately 100 hertz (Hz) to 12 kHz, and it is believed that these sounds only serve social functions such as mother-pup recognition and reproduction (Miller 1991). Source levels for pinniped vocalizations range from approximately 95 to 190 dB re 1 µPa at 1m in water. Vocalization frequency ranges from 90 Hz to 16 kHz in water and from 100 to 1,000 Hz in air (Richardson et al. 1995).

Functional hearing limits for Phocid seals, including harbor and gray seals, are estimated to be 75 Hz to 30 kHz in air and 50 Hz to 86 kHz in water (Finneran 2016; Kastak and Schusterman 1999; Kastelein et al. 2009a; Kastelein et al. 2009b; Møhl 1968a, b; Reichmuth 2008; Terhune and Ronald 1971, 1972).

### 4.2 Gray Seals

Gray seals have a wide variety of coloring. Males tend to have a dark brown-gray to black coat with a few light patches. Females are generally light gray-tan, lighter on the chest, with dark spots and patches. Adult males, and some older adult females to a lesser extent, have a characteristically long nose with wide nostrils. Adult gray seals can weigh between 550 and 880 pounds and measure between 7.5 ft and 10 ft in length (Waring et al. 2015a) with the males being larger than females. Gray seals have been known to dive to depths up to 1,000 ft for as long as 20 minutes.

#### 4.2.1 Status

Gray seals are not listed as endangered or threatened under the ESA or as depleted under the MMPA. They are not considered a strategic stock under the MMPA because human caused mortality in the species is low relative to the stock size. The potential biological removal is unknown for the species (MMPA Sec. 3. 16 U.S.C. 1362; Waring et al. 2015a).

#### 4.2.2 Numbers

Current estimates of the total western Atlantic gray seal population are not available; although estimates of portions of the Canadian stock are available for select time periods. Using this data, the combined 2012 total population of gray seals in Canada is estimated to be 331,000. Present data are insufficient to calculate the minimum population estimate for United States waters; however, the stock size appears to be increasing (Waring et al. 2015a).

#### 4.2.3 Distribution

Gray seals are divided into three somewhat isolated stocks:

- Western north Atlantic located in eastern Canada and the northeastern United States
- Eastern north Atlantic that includes Great Britain, Iceland, Norway, the Faroe Islands, and Russia
- Baltic Sea

Breeding seals are found across the North Atlantic in coastal areas from Massachusetts to the Baltic Sea. Young seals often disperse widely, sometimes going over 1,000 mi (1,610 kilometers

[km]) from their natal grounds. For example, young seals born in the eastern United States and Canada are sometimes seen in New Jersey waters (NOAA Fisheries 2015). The western North Atlantic stock is equivalent to the eastern Canada population, and ranges from New York to Labrador (Waring et al. 2015a). Gray seal populations have increased in Connecticut since the 1980s and are common in Long Island Sound from September through June (Medic 2005).

#### 4.2.4 Vocalization and Hearing

The discussion of harbor seals in Section 4.1.4 also applies to gray seals.

# 5 TYPE OF INCIDENTAL 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.*

The Navy's description of construction and demolition, as presented in Chapters 1 and 2 and summarized in Chapter 6, identifies the number and size of piles along with the expected methods of installation and removal during the period of in-water acoustic disturbance activities. This application requests incidental take authorization for a 3.5-year period beginning October 2018.

Under the 1994 Amendments to the MMPA, harassment is statutorily defined as, any act of pursuit, torment, or annoyance which:

- **(Level A Harassment)** has the potential to injure a marine mammal or marine mammal stock in the wild; or,
- **(Level B Harassment)** 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 but which does not have the potential to injure a marine mammal or marine mammal stock in the wild (NMFS 2013).

Noise activities that may adversely affect marine mammals were previously evaluated using generic underwater sound exposure thresholds (70 Federal Register [FR] 1871). For underwater noise, NMFS' previous threshold criterion for determining exposure to injury ("harm" as defined under ESA) was 180 dB root mean squared (rms) referenced to a pressure of 1 microPascal (dB re 1µPa) for cetaceans and 190 dB rms re 1µPa for pinnipeds. NMFS identified different thresholds for behavioral disturbance ("harassment" under ESA) for vibratory pile driving versus impact pile driving. For all marine mammals the behavioral harassment threshold for impact pile driving is 160 dB rms and the threshold for vibratory pile driving (non-impulsive noise) is 120 dB rms.

On August 5, 2016, NMFS finalized the acoustic threshold levels for determining the onset of permanent threshold shift (PTS) in marine mammals in response to underwater impulsive and non-impulsive sound sources (NMFS 2016). The new criteria use cumulative sound exposure level metrics ($SEL_{cum}$) and instantaneous peak SPL ($dB_{pk}$) 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. Temporary threshold shifts (TTS) in hearing ability resulting from noise exposure, along with non-injury behavioral disturbances, are considered Level B harassment under the MMPA. Both forms of harassment constitute "incidental take" under these statutes. Under the new acoustic guidance (NMFS 2016), Level A and Level B Harassment are further defined as:

- **(Level A Harassment)** would result from non-serious injury or permanent (hearing) threshold shift; or
- **(Level B Harassment**) would result from behavioral disturbance or temporary (hearing) threshold shift.

Only PTS was addressed in the final acoustic guidance (NMFS 2016). Per 81 FR 51693, NMFS does not currently recommend calculations of TTS exposures separate from assessments of Level B harassment using the prior existing thresholds for enumerating Level B (behavioral) takes. Therefore, distances to TTS thresholds were not estimated, and the ZOIs for sound producing activities resulting in Level B (non-injury behavioral) harassment for seals both under and above water were calculated using the prior thresholds, recognizing that TTS is possible within the Level B ZOI.

The Navy requests the issuance of an LOA for Level A and Level B harassment pursuant to Section 101 (a) (5) of the MMPA for incidental takes by harassment of the two species of marine mammals, the harbor seal and the gray seal, during construction and demolition activities. Acoustic disturbance levels from vibratory or impact pile installation and vibratory pile extraction have the potential to exceed the harassment levels defined in Table 5-1 for both impulsive and non-impulsive/continuous sound levels. This table incorporates PTS thresholds in combination with prior existing thresholds for Level B exposure.

**Table 5-1. Marine Mammal Injury and Disturbance Thresholds for Underwater Sounds**

| | **UNDERWATER SOUNDS** | | | | |
|---|---|---|---|---|---|
| | **Impulsive (i.e., Impact Pile Driving)** | | | **Non-Impulsive, Continuous (i.e., Vibratory Pile Driving)** | |
| | $L_{pk}$, flat (re 1 µPa) | $L_E$, $SEL_{cum}$ (24-hr) (re 1 µPa$^2$s) | Impulsive (re 1 µPa) | $SEL_{cum}$ (24-hr) (re 1 µPa$^2$-s) | Non-impulsive (re 1 µPa) |
| **Marine Mammal Hearing Group** | ***Level A Harassment PTS Onset Thresholds (received level)*** | | ***Level B Harassment (Behavioral)*** | ***Level A Harassment (PTS)*** | ***Level B Harassment (Behavioral)*** |
| Phocid pinnipeds (underwater) (true seals) | 218 dB | 185 dB | 160 dB | 201 dB | 120 dB |

*Notes*: $L_{pk}$ flat - The subscript "flat" indicates peak sound pressure should be flat weighted or unweighted within the generalized hearing group.
$L_E$ - cumulative sound exposure and indicating designated marine mammal auditory weighting function is for the recommended accumulation period of 24 hours.
re 1 µPa$^2$s = referenced to a pressure of 1 microPascal squared per second.
*Sources*: NMFS 2009, 2016.

Under the new guidance, dual metric acoustic thresholds for impulsive sound have been provided for onset of PTS. It is recommended that the threshold that results in the largest isopleth be used for calculating PTS onset. In this LOA, PTS was calculated using the $SEL_{cum}$ metric as it takes into account both received level and duration that contribute to noise-induced hearing loss. Typically, the metric is normalized to a single second of sound exposure but the intention is for the metric to account for accumulated exposure over the duration of the activity within a 24-hour period (NMFS 2016).

The Navy has prepared an underwater acoustic transmission loss model for the proposed project area and has identified the areas surrounding sound producing activities within which sound levels would result in Level A harassment and Level B harassment (Refer to Chapter 6). The Navy proposes to monitor these areas during activities that produce sound levels that could result

in marine mammal harassment. If a marine mammal enters the Level B area, it will be noted as a take authorized in the LOA. Sound-producing activities will cease when a marine mammal enters the corresponding Level A (onset PTS) area 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 likelihood of Level A acoustic exposures, it is possible that an animal could be present undetected within the Level A ZOI during the impact driving of steel piles. Therefore, the Navy requests authorization for potential Level A takes associated with this activity. A standard shutdown zone of 10 meters (m) (33 ft) will also be applied to prevent non-acoustic injury to marine mammals from all potentially hazardous in-water activities occurring at the piers.

Assuming presence during nine months of the year (September through May), based on sightings at SUBASE, 0.6 seals/$km^2$, either harbor (0.45) or gray (0.15), would enter the mapped ZOIs for acoustic harassment each workday of in-water acoustic disturbance activities. The extent of the ZOI for the onset of PTS during impact driving the 36-inch concrete-filled steel piles and 14-inch steel H-piles would extend to threshold distances of 984 m (3,228 ft) and 536 m (1,758 ft), respectively (refer to Chapter 6). These activities would only occur on 23 days during the first year (20 36-inch piles and 60 14-inch piles) and during 16 days in the second year (40 36-inch piles). For the whole project, this indicates the potential for 12 Level A (Injury, PTS) takes of harbor seals (75% of takes) and 4 Level A (Injury, PTS) takes of gray seals (25% of takes). As noted above, the likelihood of Level A takes will be minimized by implementing shutdown procedures. Other sound-producing activities have very small Level A ZOIs (less than 10 m [33 ft]), which would be easily monitored to ensure that injuries do not occur.

Sound-generating activities resulting in Level B harassment would occur during all years and, depending on the activity, would extend up to 631 m (2,070 ft) to 4,642 m (15,226 ft) from the source (refer to Chapter 6). Within the nine-month season when seals are present, these activities would occur on 157 days during the first year, 164 days during the second year, 97 days during the third year, and 108 days during the fourth year. For the whole project, this indicates an estimated 493 Level B (behavioral) takes of harbor seals and 164 Level B (behavioral) takes of gray seals.

The Navy's impact minimization and mitigation procedures are presented in Chapter 11.

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# 6 NUMBERS AND SPECIES TAKEN

*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.*

Pier construction and demolition would include the use of impact and vibratory hammers for pile installation and the use of a vibratory hammer for pile extraction. To estimate sound source levels for each of these activities, sound monitoring data from a number of sources were reviewed, including the Caltrans (2015) *Compendium of Pile Driving Sound Data*; monitoring reports prepared by the Washington State Department of Transportation (WSDOT); and relevant monitoring results reported by the Navy and other applicants, as published online by NOAA Fisheries in support of MMPA Incidental Take Authorizations.

Results from comparable projects similar to the Proposed Action in terms of the type and size of pile, method of installation or removal, water depths, and substrate conditions are provided in Table 6-1. For impact pile driving, where data from individual piles were available, weighted averages based on the number of strikes per pile were calculated to provide reasonable proxy values for the Proposed Action; otherwise, the average per pile value was used. For vibratory driving and extraction, the average per pile value was used. Decibels were converted to pressure in Pascals prior to averaging, then converted back to dB. Acoustic measurements from the vibratory installation of small steel piles were used in lieu of data from extraction because a) no data on vibratory extraction of small piles were found; and b) sound levels from vibratory installation and extraction are expected to be similar.

Based on this review, the following source levels are assumed for the underwater noise produced by construction activities:

- Impact driving of 14-inch steel H-piles for the temporary trestle is assumed to generate a peak SPL of 208 dB re 1μPa, an rms SPL of 187 dB re 1μPa, and a single-strike SEL of 177 dB re 1μ$Pa^2$-sec at 10 m (33 ft).
- Impact driving of 36-inch steel piles, would be assumed to generate an instantaneous peak SPL ($dB_{pk)}$ of 209 dB, an rms SPL of 198 dB, and a SEL of 183 dB at the 10 m (33 ft) distance.
- Vibratory driving of 36-inch steel piles would generate 168 dB rms and 168 dB SEL at 10 m (33 ft). For a continuous source such as vibratory driving or extraction, the $dB_{pk}$ values are not of concern.
- Vibratory and impact driving of the 16-inch plastic piles, for which no data specific to that size and composition are available, are assumed to be similar to available data on13-inch plastic piles: 166 $dB_{pk}$ and 153 dB rms. No SEL measurements were made, but the SEL at 10 m (33 ft) can be assumed to be at least 9 dB less than the rms value (based on in-water impact pile-driving data summarized by Caltrans 2015), which would put the SEL value for the plastic piles at 144 dB.

- Demolition activities at both piers involving steel H-pile removal with a vibratory driver-extractor are assumed to have rms and SEL values of 158 dB based on a relatively large set of measurements from the vibratory installation of 14-inch H-piles (Table 6-1). This was considered a valid proxy for the Proposed Action because, among the studies reviewed, the pile type was the most similar, and the measured sound levels were intermediate between those obtained from smaller and larger piles. Other underwater noise-generating activities during demolition, e.g., use of underwater cutting tools, are assumed to generate the same or lower SPLs.
- Drilling the rock sockets is assumed to be an intermittent, non-impulsive, broadband noise source, similar to vibratory pile driving, but using a rotary drill inside a pipe or casing, which is expected to reduce sound levels below those of typical pile driving (Martin et al. 2012). Measurements made during a pile drilling project in 1-5 m (3-16 ft) depths at Santa Rosa Island, CA, by Dazey et al. (2012) appear to provide reasonable proxy source levels for the proposed activities. Dazey et al. (2012) reported average rms source levels ranging from 151 to 157 dB re 1µPa, normalized to a distance of 1 m (3 ft) from the pile, during activities that included casing removal and installation as well as drilling, with an average of 154 dB re 1µPa during 62 days that spanned all related drilling activities during a single season. Using the 154 dB at 1 m (3 ft) source level and assuming practical spreading loss, received sound levels would diminish to less than the behavioral effects threshold (120 dB re 1µPa) at a distance of 185 m. Following NMFS (2016) acoustic guidance and using the *Optional User Spreadsheet* (NOAA Fisheries 2016) indicates a distance of 2.9 m (9.5 ft) to the onset Level A (PTS) threshold for the longest duration drilling activity. As a result, sound levels and ZOIs associated with drilling would be significantly less than those occurring contemporaneously from pile driving during Pier 32 construction (Table 2-1). Since the ZOIs for drilling would be contained within those of other activities, they are not analyzed further.

**Table 6-1. Underwater Sound Pressure Levels from Similar In-situ Monitored Construction Activities**

| Project and Location | Pile Size, Type (number) | Installation Method | Water Depth | Sound Pressure Levels (SPL) or Sound Exposure Level (SEL) at 10 m (33 ft) Distance: Range of Average Peak SPL, dB re 1 µPa | Range of Average Root Mean Square SPL, dB re 1 µPa | Range of Average SEL, dB re 1 µPa²-sec |
|---|---|---|---|---|---|---|
| Hazel Avenue Bridge Replacement, Sacramento County, CA[1] | 14-inch steel H-pile[a] | Impact | 1 – 5 m (3 – 16 ft) | 208 | 187[b] | 177 |
| Test Pile Program Bangor Naval Base, WA[2] | 36-inch Steel Pipe (4) | Impact | 14.3-22 m (47-72 ft) | ND | 187-198 | 175-186 |
| Naval Base Point Loma Fuel Pier Replacement, San Diego, CA[3] | 36-inch Steel Pipe (7) | Impact | 2.4-17 m (8-56 ft) | ND | 194-200 | 179-184 |
| Anacortes Ferry Terminal, WA[4] | 36-inch Steel Pipe (7) | Impact | 12.8 m (42 ft) | 205-211 | 189-194 | 183-186 |
| Mukilteo Ferry Terminal, WA[5] | 36-inch Steel Pipe (2) | Impact | 7.3 m (24 ft) | 202-207 | 187-191 | 180-184 |
| Weighted Average for 36-inch Steel Pipe Impact Driving | | | | 209 | 198 | 183 |
| Napa River Bridge, CA[1] | 13-inch Plastic (4) | Impact | 10 m (33 ft) | 166 | 153 | ND |
| Test Pile Program Bangor Naval Base[2] | 36-inch Steel Pipe (3) | Vibratory | 13.7-14.6 m (45-48 ft) | ND | 168-169 | 168-169 |
| Naval Base Point Loma Fuel Pier Replacement, San Diego, CA[3] | 36-inch Steel Pipe (7) | Vibratory | 2.4-17 m (8-56 ft) | ND | 159-174 | 159-174 |
| Anacortes Ferry Terminal, WA[4] | 36-inch Steel Pipe (2) | Vibratory | 12.8 m (42 ft) | ND | 168-170 | 168-170 |
| Average for 36-inch Steel Pipe Vibratory Driving | | | | | 168 | 168 |
| Mad River Slough, CA[1] | 13-inch Steel Pipe (4) | Vibratory | 4.5-5.5 m (15-18 ft) | N/A | 150-156 | 150-156 |
| Stockton Marina, CA[1] | 16-inch Steel Shell (4) | Vibratory | 5-6 m (16-20 ft) | N/A | 153-163 | 153-163 |
| EHW-1 Pile Replacement, Bangor Naval Base, WA[6] | 16-inch Steel Pipe (8) | Vibratory | 18-24 m (60-80 ft) | N/A | 155-168 | 155-168 |
| Parsons Slough Sill, Moss Landing, CA[1] | 12-inch Steel H-pile (4) | Vibratory | 5-6 m (16-20 ft) | N/A | 141-143 | 142-145 |
| Port of Anchorage, AK[1] | 14-inch Steel H-pile (10) | Vibratory | 9-17 m (30-56 ft) | N/A | 147-168* | 147-168* |
| Average for 14-inch Steel H-Pile Vibratory Installation (Apply to Extraction) | | | | | 158 | 158 |

*Notes:* *Total of 26 measurements were made during installation of 10 piles. Repeat measurements of the same pile at the same distance were averaged. Sound measurements were from a variety of distances, so source levels at 10 m were estimated assuming an attenuation rate of 15 log (measurement distance/10). ND = No data; N/A = Not applicable. dB=decibels. NA = not applicable because peak levels are far below applicable thresholds. 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.

[a]Pile source levels from install of temporary work trestle. [b]rms values were not reported for this project, so rms dB were assumed to be 10 dB larger than the SEL value, resulting in an rms value of 187 dB for 14-inch H-piles, which is consistent with general guidance provided in same document (CALTRANS 2015, see screening tool in Appendix IV).

*Sources*: [1]CALTRANS 2015; [2] Illingworth and Rodkin 2012; [3]NAVFAC SW 2014; [4]WSDOT 2012; [5]WSDOT 2007; [6]NAVFAC 2012.

Two methods for calculating acoustic impacts were used. As discussed in Chapter 5, the new acoustic guidance only addresses methods for calculating the onset of PTS and thus the Navy utilized the *Optional User Spreadsheet* provided by NMFS to calculate PTS from pile driving and vibratory extraction activities on pinnipeds in the project area (NOAA Fisheries 2016). The spreadsheet results are included in Appendix A. For impact pile driving, the single strike SEL/pulse equivalent was used and for vibratory pile driving the rms SPL source level was used. Per the NMFS Spreadsheet, default Weighting Factor Adjustments (WFA) were used for calculating PTS from both vibratory and impact pile driving, using 2.5 kHz and 2.0 KHz, respectively. These WFAs are acknowledged by NMFS as conservative.

Distance to thresholds for assessing non-injury (behavioral) Level B takes were calculated using the general formula for acoustic transmission loss (TL) below. Distances calculated were based on previously approved assumptions of "practical spreading" for sound transmission loss with distance from the sources as well as numerous pile-supported piers blocking sound along the waterfront that limit the distance of sound transmission in the Thames River.

TL is in dB as a function of distance from the source, which is as follows:

$TL = B * \log10 (R_1/R_2) + C * (R_1-R_2)$, where

B = logarithmic (predominantly spreading) loss

C = linear (scattering and absorption) loss

$R_1$ = receiver distance

$R_2$ = range at which the source measurement was made (usually 10 m [33 ft] for pile driving)

The B term has a value of 10 for cylindrical spreading and 20 for spherical spreading. An intermediate "practical spreading" value of 15 is generally accepted by NOAA for use in pile driving applications and has been used in most Navy projects that involve pile driving. The C term is dependent on frequency, temperature, and depth, but is small and will conservatively be assumed to equal zero for pile driving. This analysis uses the practical spreading loss equation, which with the conservative assumption that C = 0, simplifies to $TL = 15 \log (R_1/R_2)$.

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

In modeling transmission loss from the project area, the conventional assumption would be made that acoustic propagation from the source is impeded by natural and manmade features that extend into the water, resulting in acoustic shadows behind such features. While not solid structures, given the density of structural pilings under the many pile-supported piers located south of Piers 32 and 10, coupled with the docking of submarines at these piers, the piers are presumed to disrupt sound propagation southward in the river.

Pile driving can also generate airborne noise that could potentially result in disturbance to marine mammals (pinnipeds) that are hauled out. Due to the absence of haul outs in the project area, the potential for acoustic harassment by airborne sound is considered negligible and is not analyzed.

The Navy identified the ZOIs for sound producing activities within which sound levels would result in Level A and Level B harassment for seals (Table 6-2). The ZOIs for the loudest sound-producing activities are depicted in Figures 6-1 through 6-4. As illustrated in the figures, the density of pilings associated with multiple piers along the shoreline is presumed to act as a barrier to sound transmission in certain directions.

**Table 6-2. Calculated Areas of ZOIs and Maximum Distances Corresponding to MMPA Thresholds for Underwater Sound**

| LOA Year | Activity Description | Source Level, dB @ 10m (rms and SEL) | Figure | Maximum Distance (m)/Area of ZOI (km$^2$) (ft/mi$^2$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | *Impulsive Noise (Impact Pile Driving)* | | *Non-impulsive, continuous noise (Vibratory Pile Extraction/Driving* | |
| | | | | Level A – 185 dB[a] | Level B – 160 dB[b] | Level A – 201 dB[a] | Level B – 120 dB[b] |
| Year 1 | New Pier: Temporary Work Trestle: Impact Driving 14-inch steel H piles | 177[a]/187[b] | 6-1 | 536/0.4468 (1,758/.1725) | 631/0.5468 (2,070/0.2110) | N/A | N/A |
| | New Pier: Vibratory and Drilling Installation 36-inch concrete-filled steel piles (100-180 ft long) | 168 | 6-1 | N/A | N/A | <4/<0.0001 (13/<0.0001) | 4,642/2.2002 (15,226/0.8495) |
| | New Pier: Impact Driving 36-inch concrete-filled steel piles, last 20-40 ft | 183[a]/198[b] | 6-2 | 984/0.886 (3,228/.3421) | 3,415/2.037 (11,201/0.7722) | N/A | N/A |
| Year 2 | New Pier: Vibratory Installation 36-inch concrete-filled steel piles (180 ft long) | 168 | 6-1 | N/A | N/A | <4/<0.0001 (13/<0.0001) | 4,642/2.2002 (15,226 /0.8495) |
| | New Pier: Impact Driving 36-in concrete-filled steel piles, last 20-40 ft | 183[a]/198[b] | 6-2 | 984/0.8886 (3,228/0.3431) | 3,415/2.037 (11,201/0.7722) | N/A | N/A |
| Year 3 | New Pier: Vibratory Driving 16-inch plastic piles | 153 | 6-1 | N/A | N/A | 0.9/<0.0001 (2.95/<0.0001) | 1,585/1.1584 (5,199 /0.4473) |
| | New Pier: Impact Driving 16-inch plastic piles | 144[a]/153[b] | 6-1 | 2.5/<0.0001 (8.2/<0.0001) | 1/<0.0001 (3/<0.0001) | N/A | N/A |
| Year 4 | Existing Pier 32: Vibratory Extraction | 158 | 6-3 | N/A | N/A | 2/<0.0001 (7/<0.0001) | 3,415/1.8372 (11,201/0.7093) |
| | Existing Pier 10: Vibratory Extraction | 158 | 6-4 | N/A | N/A | 5.6/<0.0001 (18 /<0.0001) | 3,415/2.9002 (11,201 /0.7093) |

*Notes*: Level A (PTS) Calculated using NOAA Fisheries 2016 (See Appendix A).
[a]dB = SEL re 1 µPa$^2$-sec; [b]dB =root mean square SPL in decibels re 1µPa . km$^2$ = square kilometers; mi$^2$ = square miles
Source levels in rms and SEL were the same value for all except as noted for impact pile driving, in which case the rms value is used to calculate the Level B ZOIs, and the SEL value is used to calculate the Level A (onset PTS) ZOI

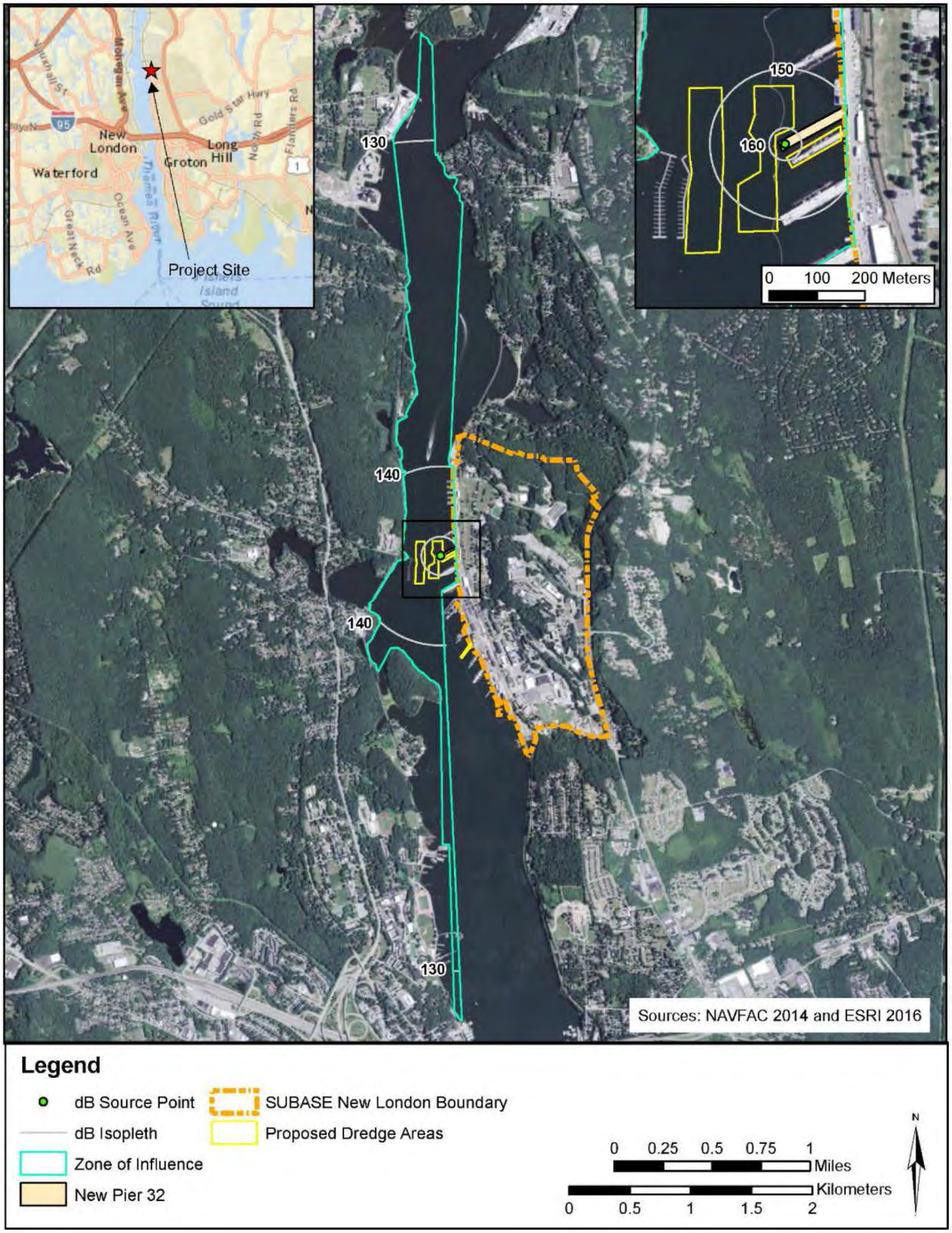


**Figure 6-1. Predicted Underwater SPLs (dB re 1μPa) Associated with Vibratory Pile Installation at New Pier 32**

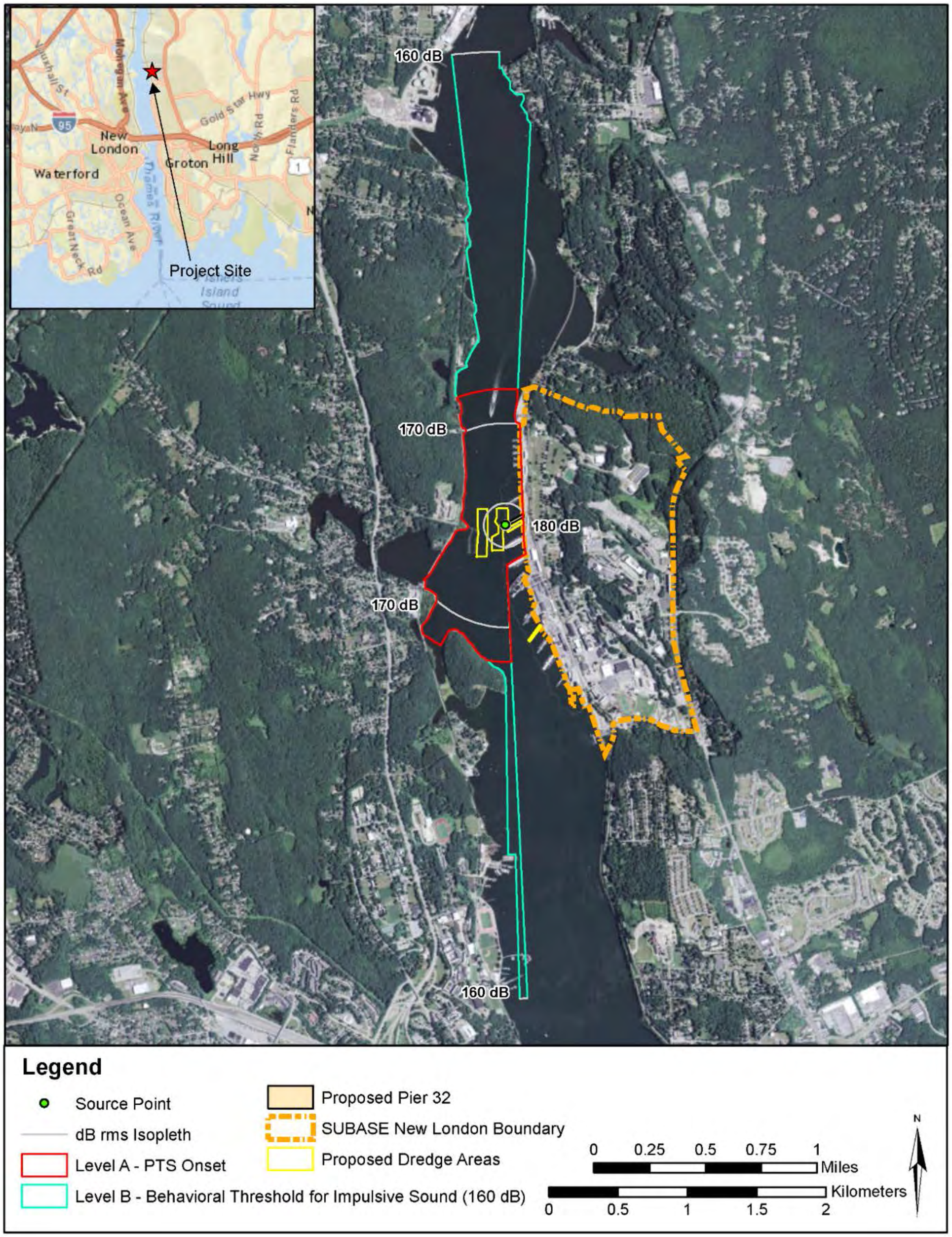


**Figure 6-2. Predicted Underwater SPLs (dB re 1µPa) Associated with Impact Pile Driving at New Pier 32**

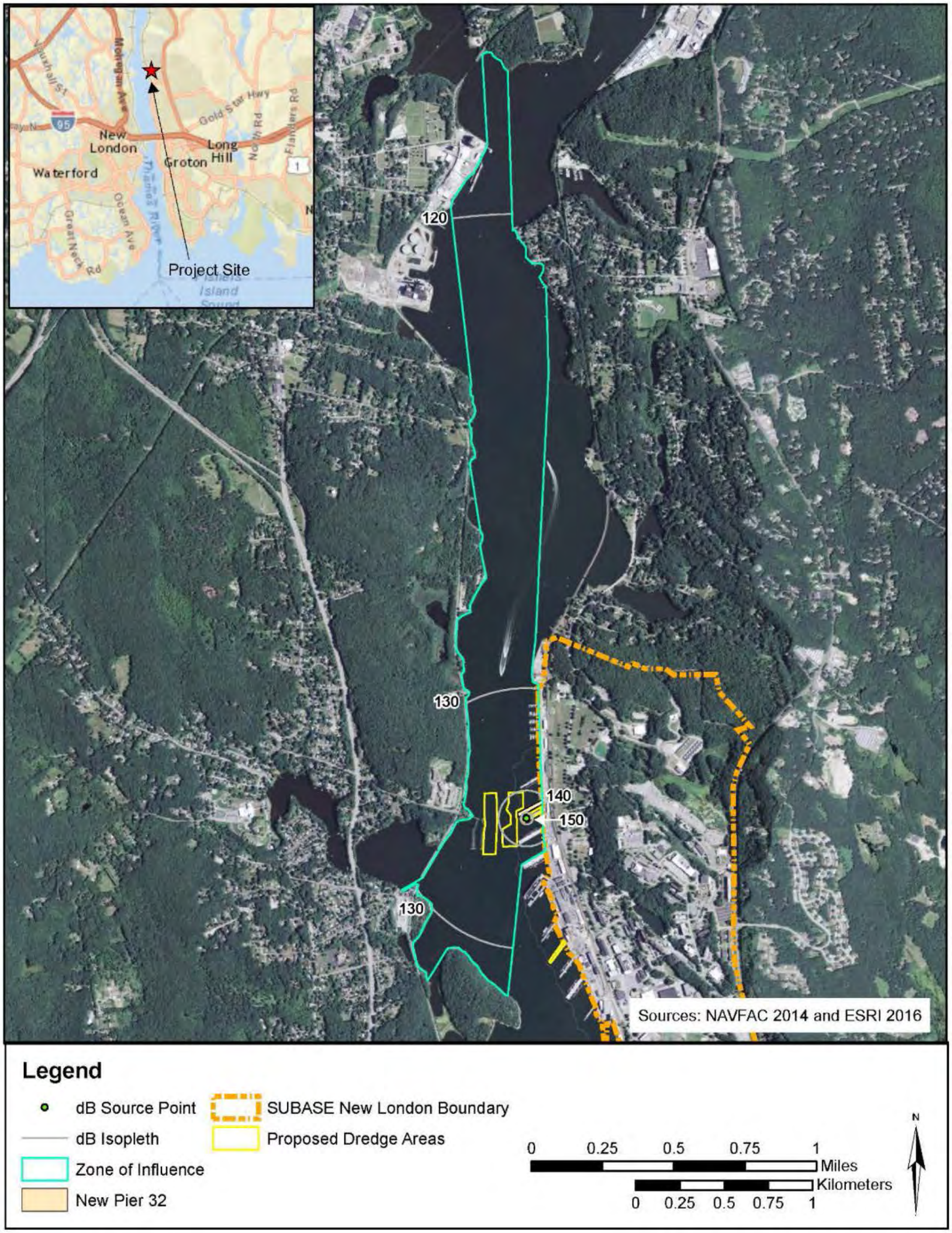


**Figure 6-3. Predicted Underwater SPLs (dB re 1μPa) Associated with Vibratory Pile Extraction at Existing Pier 32**

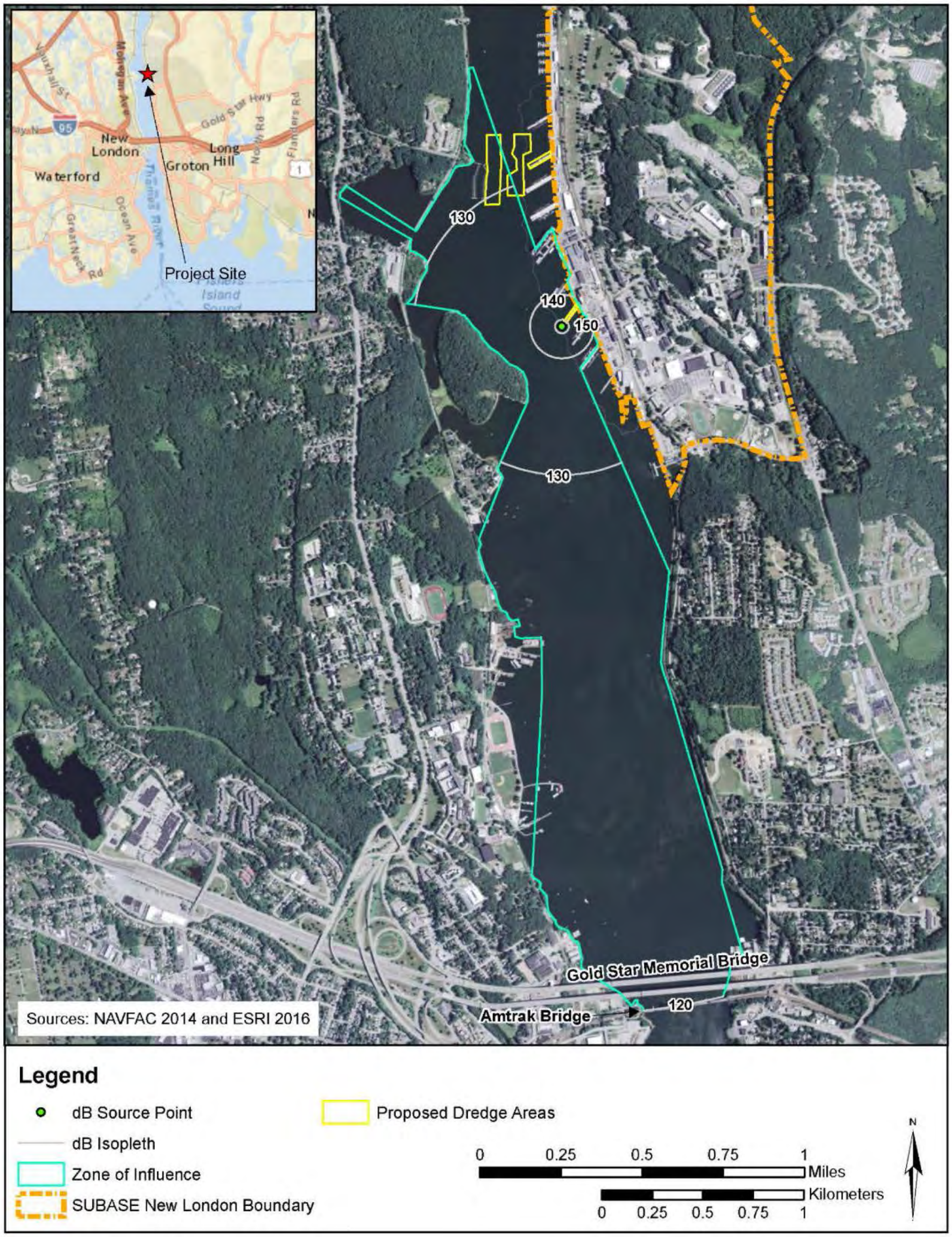


**Figure 6-4. Predicted Underwater SPLs (dB re 1μPa) Associated with Vibratory Pile Extraction at Existing Pier 10**

Take calculations and assumptions are as follows:

- Number of takes per activity = density (average number of seals per $km^2$) * area of ZOI ($km^2$) * number of days, rounded to the nearest whole number.
- Seal density in the project area is estimated as 0.6/$km^2$ from September through May (zero from June through August), consisting of 75% harbor seals (0.45/ $km^2$) and 25% gray seals (0.15/ $km^2$).
- Assumes as a worst case that activities will occur up to a maximum of 180 workdays (5 days per week) when seals are present (September through May) during each full construction year.
- Assumes vibratory and impact hammer pile driving would not occur on the same days.
- Level A and Level B takes are calculated separately based on the respective ZOIs for each type of activity, providing a maximum estimate for each type of take which corresponds to the authorization requested under the MMPA.
- A marine mammal is considered to be taken only once per day, and Level A takes would represent individuals that also have experienced Level B harassment.
- Assumes impact hammering of 16-inch fiberglass reinforced, plastic piles results in no takes based on low source levels and ZOIs less than 10 m (Table 6-2).
- Assumes that the effective implementation of a 10 m shutdown zone will prevent non-acoustic injuries and will prevent animals from entering acoustic harassment ZOIs that extend less than 10 m from the source.

The maximum extent of the potential injury ZOI (for impact pile driving of steel piles) is 984 m (3,228 ft) from the source for 36-inch concrete-filled steel piles and 536 m (1,758 ft) for 14-inch steel H-piles; other potential acoustic injury ZOIs for vibratory pile extraction and installation are only 1 to 5.6 m (3 to 18 ft) from the source (Table 6-2). Seals within about 10 m (33 ft) of in-water construction or demolition may also be at risk of injury from interaction with construction equipment. These potential injury ZOIs and the 10 m (33 ft) standoff distance would be monitored during all in-water construction/demolition activities, and the activities would be halted if a marine mammal were to approach within these distances. Given the dimensions of these injury ZOIs and good visibility for monitoring the construction and demolition areas from the adjacent piers, these procedures have a high likelihood of success, and no injury takes are anticipated except possibly during steel pile impact driving. Furthermore, conservative assumptions (including marine mammal densities) used to estimate the exposures have likely overestimated the potential number of exposures and their severity.

The estimated numbers of instances of acoustic harassment (takes) by year, species, source (impulsive or non-impulsive) and severity (Level A or Level B) are shown in Table 6-3. Total Level A takes are estimated as 12 harbor seals and 4 gray seals (total 16), and Level B takes are estimated as 493 harbor seals and 164 gray seals (total 657) (Table 6-3).

## Table 6-3. Maximum Number of Takes by Type

| LOA Year | Marine Mammals | UNDERWATER VIBRATORY PILE DRIVING CRITERIA (E.G., NON-PULSED/CONTINUOUS SOUNDS) | | UNDERWATER IMPACT[1] PILE DRIVING CRITERIA (E.G., PULSED SOUNDS) | | TOTAL TAKES (LEVEL A + LEVEL B)) |
|---|---|---|---|---|---|---|
| | | Level A Injury Threshold 201 dB[2] | Level B Disturbance Threshold 120 dB[3] rms | Level A Injury Threshold [1]185 dB[2] | Level B Disturbance Threshold 160 dB[3] rms | |
| Year 1 | Harbor seal | 0 | 155 | 6 | 11 | 172 |
| | Gray seal | 0 | 52 | 2 | 3 | 57 |
| | Total all species | 0 | 207 | 8 | 14 | 229 |
| Year 2 | Harbor seal | 0 | 162 | 6 | 15 | 183 |
| | Gray seal | 0 | 54 | 2 | 5 | 61 |
| | Total all species | 0 | 216 | 8 | 20 | 244 |
| Year 3 | Harbor seal | 0 | 51 | 0 | 0 | 51 |
| | Gray seal | 0 | 17 | 0 | 0 | 17 |
| | Total all species | 0 | 68 | 0 | 0 | 68 |
| Year 4 (6 months) | Harbor seal | 0 | 99 | 0 | 0 | 99 |
| | Gray seal | 0 | 33 | 0 | 0 | 33 |
| | Total all species | 0 | 132 | 0 | 0 | 132 |
| Project Total | Harbor seal | 0 | 467 | 12 | 26 | 505 |
| | Gray seal | 0 | 156 | 4 | 8 | 168 |
| | Total all species | 0 | 623 | 16 | 34 | 673 |

*Notes*: [1]An animal within the Level A ZOI on a given day is counted as a Level A take and would not be counted as a Level B take on the same day.
[2] dB re 1 µPa$^2$-sec;
[3] dB re 1µPa rms

# 7 IMPACTS ON MARINE MAMMAL SPECIES OR STOCKS

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

The effects of pile driving and extraction noise on marine mammals depend on several factors, including:

- Type, depth, intensity, and duration of pile driving/extraction sound
- Species
- Size of the animal and proximity to the source
- Social and behavioral context of the animal
- Depth of the water column
- Substrate of the habitat
- Sound propagation properties of the environment

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

Given the variable distribution of hard (including manmade structures) and soft substrates, variable depths, and lack of precise geo-spatial data for the project area, it is not feasible to attempt to model the influence of all of these factors, and the acoustic transmission loss model used to assess noise impacts from the Proposed Action relies on the simplifying assumption of a constant logarithmic rate of transmission loss from the source.

Behavioral impacts may occur, but the type and severity of these effects are difficult to define due to individual differences in response and limited studies addressing the behavioral effects of sounds on marine mammals. The behavioral responses most likely to occur during the Proposed Action are habituation and temporary relocation (Ridgway et al. 1997; Finneran et al. 2003; Wartzok et al. 2003). The time required to drive each pile would be short, and given the absence of haul-out sites and only transient occurrence of seals in the project area, anticipated behavioral disturbances are expected to be discreet and brief. Injurious impacts to marine mammal species are possible as a result of physiological responses to both the type and strength of the acoustic signature (Viada et al. 2008).

## 7.1 Level A Harassment Impacts

As introduced in Chapter 5, NMFS's new acoustic threshold levels for determining the onset of PTS in marine mammals in response to underwater impulsive and non-impulsive sound sources was finalized in 2016. The onset of PTS (or permanent hearing loss) is a form of auditory injury and is considered Level A harassment under the MMPA. Because the ears are the most sensitive organ to pressure, they are the organs most sensitive to injury (Ketten 2000). Direct tissue responses to impact/impulsive sound stimulation may range from mechanical vibration or compression with no resulting injury to tissue trauma (injury). 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; cause hemorrhaging; and cause leakage of cerebrospinal fluid into the middle ear (Ketten 2004).

The likelihood of Level A exposures during the project would be minimized due to the best management practices (BMPs) and mitigation measures outlined in Chapter 11. As described above, physiological responses of marine mammals to impulsive sound stimulation range from non-injurious vibration or compression of tissue to injurious tissue trauma and permanent hearing loss. BMPs and mitigation measures would minimize but cannot totally eliminate the possibility of such occurrences during this project. The Navy is aware of how important such mitigations are and understands the risks of injury associated with impulsive sounds. To further reduce the potential of Level A exposure, marine mammal monitoring would be implemented. Observers would be in place during in-water work (specifically pile driving and extraction) and established shutdown protocols would be in place based on Level A ZOIs. Refer to Chapter 13 for details on the monitoring process.

## 7.2 Level B Harassment Impacts

Behavioral responses to sound are highly variable. The magnitude of each potential behavioral change ultimately determines the severity of the response. A number of factors may influence an animal's response to noise, including its previous experience, its auditory sensitivity, its biological and social status (including age and sex), and its behavioral state and activity at the time of exposure (National Research Council 2003, 2005).

As introduced in Chapter 5, the onset of TTS is a form of Level B harassment under the MMPA. TTS is a reversible exposure to noise in which physiological mechanisms of the ear are fatigued (i.e., diminished sensitivity of inner ear and residual middle-ear muscular activity, displacement of certain inner ear membranes). The magnitude of TTS normally decreases over time following cessation of noise exposure (Southall et al. 2007). TTS experiments conducted on pinnipeds observed aggression at the noise apparatus as well as avoidance of the area where food had previously been made available prior to noise exposure. Maximum TTS was shown to occur approximately 2 minutes following exposure or averaging approximately 6 – 10 minutes following exposure (Kastak et al 1999). Further, underwater noise may partially or entirely interfere with the way in which marine mammals receive acoustic signals. This interference is termed "auditory masking" and can affect a marine mammal's ability to communicate, forage, navigate, or social interaction (Southall et al. 2007). Masking does not happen at the noise source but instead occurs at the receiver that is located some distance away. Masking occurs when the ability to detect or recognize a sound of interest is degraded by the presence of another sound

(the masker) and hence understanding the frequency in which a marine mammal hears is essential. Combined hearing measurements from multiple individuals can be used to create species audiograms that are useful to determine the masking potential of different types of noise (Erbe et al 2016).

Studies of marine mammal responses to pile driving (both impact and vibratory methods) are limited. Marine mammal monitoring at the Port of Anchorage marine terminal redevelopment project in Anchorage, 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) (Integrated Concepts & Research Corporation 2009). Small numbers of cetaceans (beluga whales, harbor porpoise) and pinnipeds (harbor seals, Steller sea lions) were observed. This study also noted that the background noise levels at this port are typically relatively high (~125 dB rms). This background noise is due to both strong tidal currents and marine traffic from shipping vessels at the Port of Anchorage. Such high background noise levels could help habituate marine mammals to non-impulsive sounds from vibratory pile driving in their environment.

Responses to impact pile driving are expected to be more acute than response to vibratory driving. 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 impulsive sound sources (typically seismic guns or acoustic harassment devices) have been varied, but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds 2002; also see reviews in Gordon et al. 2003; Wartzok et al. 2003; and Nowacek et al. 2007). Observations of marine mammals a Naval Base Kitsap Bangor in Silverdale, Washington 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 were more likely to change direction while traveling during construction. Further, pinnipeds were more likely to dive and sink when closer to pile driving activity (HDR 2012). Harbor seals have been observed to temporarily avoid areas within 15 mi of active pile driving starting from predicted received levels of between 166 and 178 dB re 1 μPa (Russell et al. 2016).

Marine mammals exposed to pile driving and extraction sound over the course of the Proposed Action would likely avoid affected areas if they experience noise-related discomfort. As described above, individual responses to pile driving noise are expected to be variable. Some individuals may occupy the project area during pile driving without apparent discomfort while others may be displaced with undetermined long-term effects. Avoidance of the affected area during pile driving and extraction operations would reduce or eliminate the likelihood of injury impacts, but may also reduce access to foraging areas. Given the duration of the project, there is a potential for displacement of marine mammals from the affected area due to these behavioral disturbances during the in-water work period. Since pile driving and extraction would only occur during daylight hours, marine mammals transiting or foraging in the project area at night will not be affected.

Given the relatively low density of marine mammals found in the Thames River near SUBASE, it is unlikely that the area is used extensively for foraging by a discrete population of animals. Effects of pile driving and extraction activities may be experienced by individual marine mammals, but would not cause population-level impacts or affect the status of the stocks of these two species.

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# 8 IMPACTS ON SUBSISTENCE USE

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

Potential marine mammal impacts resulting from the Proposed Action will be limited to populations for which there is no known historic or current subsistence use. Therefore, impacts on the availability of species or stocks for subsistence use are not considered.

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# 9 IMPACTS ON 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.*

Activities associated with the Proposed Action are expected to result in removal of a small amount of low quality habitat, disturb sediments, and disturb benthic and forage fish communities on a temporary, highly localized scale. The relatively high amount of vessel traffic in the confined space of the SUBASE and the transition to the federal navigation channel has resulted in a determination that the project area encompasses relatively low quality habitat for most marine species.

Pile installation and removal, deployment of anchors and/or spuds from barges, and dredging activities would have direct, temporary adverse effects on benthic habitat by direct removal or disturbance of the benthic substrate. Excavation and disturbance of sediment at Pier 32, Pier 10, and in the Thames River navigation channel would result in mortality for many of the smaller benthic organisms residing on the river bottom in those specific locations. Following project activities, re-colonization of the substrate within the disturbed areas is expected via larval recruitment and emigration of benthic organisms from the surrounding area.

Disposal of dredged material in the CAD cell would have a direct impact to the benthos as a result of burial and suffocation. Most, if not all, sessile marine invertebrates are not expected to survive burial. Some motile marine organisms would be buried and unable to survive, while others such as burrowing specialists, may survive. Survival rates would depend primarily on burial depth. From 2010 through 2012, biannual benthic sampling of the CAD cell area was conducted to assess the timeframe for recovery of benthic populations of the CAD cells, in accordance with Water Quality Certificate conditions for the 2010 waterfront maintenance dredging project at the SUBASE. The sampling results of the CAD cell were compared to sampling results of an undisturbed reference site located upriver. The degree of similarity of population and community structures was assessed. The results of the three year survey program indicated that a progressive recovery to a stable benthic population was occurring at the CAD cell. As demonstrated by the biannual benthic survey, benthic assemblages are anticipated to recover within three to five years after the completion of the project, and disposal impacts would not be significant (CardnoTEC 2015).

Project activities would temporarily disturb benthic and water column habitats and change bottom topography to a minor degree, but effects on prey availability and foraging conditions for marine mammals would be temporary and limited to the immediate area of pier demolition/construction, dredging, and disposal. The new surfaces of piles and exposed concrete on the new pier would likely result in establishment of fouling communities on the new structures, and may attract fish and benthic organisms resulting in small scale shifts in prey distribution.

Water quality impacts from pile removal/installation, dredging, and dredged material disposal include physical and chemical impacts. Changes to the water turbidity, water chemistry, and dissolved oxygen are expected during pile removal and dredging.

The impacts to water quality that are expected during dredging, dredged material disposal, and pile removal/installation would be temporary and would diminish with the cessation of these activities. According to the results of a project specific sediment dispersion model, resuspended sediments from dredging would stay in the water column for two or more tidal cycles (NAVFAC Mid-Atlantic 2015). The dredge plume would drop below ambient suspended sediment concentrations of 5 milligrams per liter (mg/L) within 24 hours of cessation of dredging. The suspended sediment concentration of the dredge plume is predicted to be less than 25 mg/L in all impacted areas outside of the navigation channel. Within the navigation channel, temporal increases in suspended sediment concentration up to 50 mg/L are anticipated for Pier 32 and up to 75 mg/L for Pier 10 (NAVFAC Mid-Atlantic 2015). Suspended sediment plumes would be localized, rapidly dispersed by tidal currents, and also unlikely to affect marine mammals that normally experience variable turbidity (Todd et al. 2015).

Using proper operational controls such as controlling bucket speeds and preventing barge overflow, the impacts would be minimized and the anticipated changes to the water quality of the marine system would return to pre-project conditions. No appreciable or permanent changes to the salinity regime, tidal cycle, or current patterns are anticipated.

There are no known haul outs within the vicinity of the Proposed Action. Therefore, effects to haul outs are not analyzed as part of this application. The Proposed Action would have no impact on available habitat in the general region.

# 10 IMPACTS ON 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 individual or populations of marine mammals because of the relatively small footprint and temporary nature of the project impacts. Information provided in Chapter 9 (Impacts on Marine Mammal Habitat and the Likelihood of Restoration) indicates there may be temporary impacts, but those impacts would be limited to the immediate area. Impacts will cease upon the completion of activities associated with the Proposed Action.

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# 11 MEANS OF EFFECTTING THE LEAST PRACTICABLE ADVERSE IMPACTS – STANDARD OPERATING PROCEDURES AND MITIGATION MEASURES

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

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

This chapter summarizes BMPs and mitigation measures that will be implemented during in-water construction activities to reduce environmental impacts. Mitigation measures are designed to help reduce or avoid potential impacts on marine resources. BMPs and minimization measures would be included in the construction contract plans and specifications and must be agreed upon by the contractor prior to any construction activities. Upon signing the contract, it becomes a legal agreement between the contractor and the Navy. Failure to follow the prescribed BMPs and minimization measures is a contract violation.

This project is in the planning phase and a contractor has not been selected to complete work on the project. The equipment used to remove and install pier piles would be determined by the contractor who is awarded the project. Instead of specifying the type of hammer and exact mitigation measures, the Navy will ensure that in-water noise-producing activities will cease when a marine mammal enters the ZOI where prolonged exposure would lead to Level A (injury) harassment.

## 11.1 General Construction BMPs

- All work shall adhere to performance requirements of the Clean Water Act, Section 404 permit and Section 401 Water Quality Certification. No in-water work shall begin until after issuance of regulatory authorizations.
- No petroleum products, lime, chemicals, or other toxic or harmful materials shall be allowed to enter surface waters. Equipment that enters surface waters shall be maintained to prevent any visible sheen from petroleum products. Fuel hoses, oil drums, oil or fuel transfer valves, fittings, etc. shall be checked regularly for leaks, and be maintained and stored properly to prevent spills.
- Wash water resulting from wash down of equipment or work areas shall be contained for proper disposal, and shall not be discharged unless authorized.
- All equipment would utilize vegetable or biodegradable oil and would be inspected daily for leaks

- Pile driving and extraction will only be conducted during daylight hours in weather conditions suitable for visual monitoring of marine mammals.
- The project shall utilize soft start techniques for impact pile driving. The Navy shall conduct an initial set of three strikes from the impact hammer at 40 percent energy, followed by a 1-minute waiting period, then two subsequent three strike sets. Soft start shall be required for any impact driving, including at the beginning of the day, and at any time following a cessation of pile driving of thirty minutes or longer.
  - Whenever there has been downtime of 30 minutes or more without impact driving, the contractor shall initiate impact driving with soft-start procedures described above.

## 11.2 Pile Removal and Installation Impact Minimization for Marine Mammals

The following impact minimization and monitoring measures shall be implemented during pile driving to avoid marine mammal exposure to Level A injurious noise levels generated from impact pile driving and to reduce to the lowest extent practicable exposure to Level B noise levels.

During all in-water construction and demolition activities there is a 10 m (33 ft) shutdown zone to protect animals from physical injury. For some sound-generating activities the potential for Level A harassment by acoustic injury extends less than 10 m (33 ft) from the source (see Table 6-2), and for these activities, the physical injury shutdown zone automatically protects against Level A acoustic harassment. The threshold distances for Level A and Level B takes for harbor seals and gray seals from other activities are provided in Table 6-2 and are as follows:

1. During impact driving of 14-inch steel H-piles, the Level A take zone shall extend from the 10 m (33 ft) shutdown zone out to 536 m (1,758 ft), and the Level B take zone shall extend out to 631 m (2,070 ft).
2. During vibratory installation of 36-inch concrete-filled steel piles, the Level B take zone shall extend from the 10 m (33 ft) shutdown zone out to 4,642 m (15,226 ft or 2.9 mi).
3. During impact driving of 36-inch concrete-filled steel piles, the Level A take zone shall extend from the 10 m (33 ft) shutdown zone out to 984 m (3,228 ft), and the Level B take zone shall extend out to 3,415 m (11,201 ft or 2.1 mi).
4. During vibratory installation of 16-inch plastic piles, the Level B take zone shall extend from the 10 m (33 ft) shutdown zone out to 1,585 m (5,199 ft).
5. During vibratory extraction of all piles at Pier 10, the Level B take zone shall extend from the 10 m (33 ft) shutdown zone out to 3,415 m (11,201 ft or 2.1 mi).

Monitoring of these zones will be conducted by trained marine mammal observers (MMOs). Training and monitoring procedures are summarized below and more detail on monitoring protocols is provided in Chapter 13.

### *11.2.1 Marine Mammal Observer Training*

- MMOs will meet the qualification requirements described in Section 13.1.2 (Visual Marine Mammal Observations).

- Construction crews and barge operators will receive a general environmental awareness briefing prior to the start of repair and maintenance activities. This training is designed to improve the effectiveness of visual observations for protected species and provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures.

### 11.2.2 Monitoring of the Level A Injury Zone (Shutdown Zone)

- Monitoring of shutdown and Level A zones shall be conducted during all impact driving activity.
- During impact driving of steel piles, monitoring will be conducted by a two-person MMO team designated by the construction contractor. For each of the three main activities (demolition of Pier 32, construction of new Pier 32, and demolition of Pier 10), MMOs will be placed at the best vantage point(s) practicable (e.g., from a small boat, construction barges, on shore, elevated perch, or any other suitable location) to monitor for harbor and gray seals and implement shutdown/delay procedures when applicable by calling for the shutdown to equipment operators. The MMOs shall have no other construction-related tasks while conducting monitoring and shall be trained on the observation zones, species identification, how to observe, and how to fill out the data sheets by the Navy Natural Resources Manager prior to any pile driving activities.
- MMOs will monitor the entire shutdown zone for impact driving of steel pipes before, during, and after pile driving using binoculars and/or spotting scopes. The MMOs shall be separated and spread out, looking in opposite directions across the ZOIs. The shutdown zone for impact pile driving was calculated based on acoustic modeling at a notional pile location. The maximum extent of the potential injury ZOI for impact pile driving of 36-inch steel piles is 984 m (3,228 ft) from the source, whereas the maximum extent of the potential injury ZOI for impact driving of 14-inch steel H-piles is 536 m (1,758 ft). A small boat would be used to monitor the farthest extent of these ZOIs.
- The shutdown zone for impact driving of steel pipes shall be viewed for 15 minutes prior to in-water construction activities. If a marine mammal is observed in the shutdown zone, in-water activities shall be delayed until the animal(s) leaves the shutdown zone. Activity shall resume only after the construction MMO has determined, through re-sighting or by waiting approximately 15 minutes, that the animal(s) has moved outside the shutdown zone. The construction MMO(s) shall notify the foreman/point of contact when construction activities can commence. Observation of the shutdown zone will continue for 30 minutes following the completion of pile driving.
- The 10 m (33 ft) standoff distance would be monitored by a single MMO during all in-water pile installation/extraction activities, and the activities would be halted if a marine mammal were to approach within this distance. This measure allows for a physical buffer zone between protected marine mammals and construction equipment. The construction MMO will verify required monitoring distance using GPS device and have full visibility of the

shutdown zone regardless of the type of driving taking place, and will be able to immediately report a marine mammal observation and initiate shutdown procedures.

- For in-water heavy machinery work other than pile driving (using, e.g., standard barges, tug boats), if a marine mammal comes within 10 m (33 ft), operations shall cease and vessels shall reduce speed to the minimum level required to maintain steerage and safe working conditions.
- Shutdown shall occur if a species, for which authorization has not been granted or for which the authorized numbers of takes have been met, approaches or is observed within the Level B harassment zone. The Navy shall then contact NMFS immediately.

### 11.2.3 Monitoring of the Level B Harassment Zone

- Monitoring will be conducted by a two-person marine MMO team designated by the construction contractor using the following approach. For each of the three main activities (construction of new Pier 32, demolition of existing Pier 32, and demolition of Pier 10) having the potential to cause Level B acoustic harassment, the following approach will be implemented to estimate the number of Level B takes of marine mammals occurring during that activity.
    - The Level B zone shall be monitored during two-thirds of all pile driving days.
    - On two consecutive days not more than one week prior to the initiation of the demolition or construction activity, and on the first two consecutive days of in-water demolition or construction, two MMOs trained as described above and in Section 13.1.2 will systematically survey the entirety of the maximum Level B ZOI from a small boat captained by an individual who is not one of the MMOs. Each survey will continue throughout the daylight hours to maximize the possibility of detecting resting or transient animals and of differentiating multiple sightings of the same individual from the occurrence of multiple individuals.
    - The number, species, and locations of all marine mammals seen will be documented using NMFS-approved sighting forms. One-day surveys of the entire ZOI will be repeated at least monthly for as long as the activity continues. In conjunction with the monitoring of shutdown zones, all incidental sightings of marine mammals within Level B ZOIs will also be documented. The results of these monitoring efforts will be used to estimate the average number of individuals occurring per day in the ZOI during the activity, which will be multiplied by the number of days of in-water sound-generating activities to estimate the total number of harassment takes.

# 12 MINIMIZATION OF ADVERSE IMPACTS ON SUBSISTENCE USE

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

- *(i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;*
- *(ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;*
- *(iii) A description of what measures the applicant has taken an/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and*
- *(iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.*

The proposed activity will take place in the Thames River in southeastern Connecticut, and as detailed in Chapter 8, no activities will take place in or near a traditional Arctic subsistence hunting area. Therefore, there are no relevant subsistence uses of marine mammals implicated by this action, and subsistence uses are not considered in this document.

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# 13 MONITORING AND REPORTING EFFORTS

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

## 13.1 Monitoring Plan

The Navy is committed to demonstrating environmental stewardship while executing its National Defense Mission and complying with the suite of federal environmental laws and regulations. As a complement to the Navy's commitment to avoiding and reducing impacts of the Proposed Action through impact minimization and mitigation measures listed in Chapter 11, Means of Effecting the Least Practicable Adverse Impacts, the Navy will implement the following monitoring efforts. Taken together, mitigation and monitoring comprise the Navy's integrated approach for reducing environmental impacts from the Proposed Action. The Navy's overall monitoring approach will seek to leverage and build on existing research efforts whenever possible. A Marine Mammal Monitoring Plan will be developed further and will entail visual observations. The plan will be submitted to NMFS for approval well in advance of the start of construction.

### *13.1.1 Visual Marine Mammal Observations*

The Navy will collect sightings data and behavioral responses to construction for marine mammal species observed in the region of activity during the period of construction.

All MMOs will have the following qualifications:

- Will be independent observers (i.e., not construction personnel) who are trained biologists.
- Will have the ability to conduct field observations and collect data according to the assigned protocol.
- The team of MMOs will have one member that is designated as lead observer or monitoring coordinator and the lead observer will have had prior experience working as an observer.
- All credentials for assigned MMOs will be submitted to the Navy in advance for approval.
- Experience or training in the field identification of marine mammals, including the identification of behaviors.
- 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.

- Sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations.
- 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 shutdown 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.

### *13.1.2 Methods of Monitoring*

The Navy shall conduct briefings between construction supervisors and crews and the MMO team prior to the start of all pile driving activities, and when new personnel join the work, in order to explain responsibilities, communication procedures, marine mammal monitoring protocol, and operational procedures. All personnel working in the project area shall watch the Navy's Marine Species Awareness Training video. An informal guide shall be included with the monitoring plan to aid in identifying species if they are observed in the vicinity of the project area.

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

- MMOs will be primarily located on boats, docks, and piers at the best vantage point(s) in order to properly see the entire shut down zone(s).
- MMOs will be located at the best vantage point(s) to observe the zone associated with behavioral impact thresholds.
- During all observation periods, MMOs will use high-magnification (25X), as well as standard handheld (7X) binoculars, and the naked eye to search continuously for marine mammals.
- Monitoring distances will be measured with range finders.
- Distances to animals will be based on the best estimate of the MMO, relative to known distances to objects in the vicinity of the MMO.
- Bearings to animals will be determined using a compass.
- Pile driving shall only take place when the shutdown and Level A zones are visible and can be adequately monitored. If conditions (e.g., fog) prevent the visual detection of marine mammals, activities with the potential to result in Level A harassment shall not be initiated. If such conditions arise after the activity has begun, impact pile driving would be halted but vibratory pile driving or extraction would be allowed to continue.
- Pre-Activity Monitoring:
    - The shutdown and buffer zones will be monitored for 15 minutes prior to in-water construction/demolition activities. If a marine mammal is present within the shutdown zone, the activity will be delayed until the animal(s) leave the shutdown

zone. Activity will resume only after the MMO has determined that, through sighting or by waiting approximately 15 minutes, the animal(s) has moved outside the shutdown zone. If a marine mammal is observed approaching the shutdown zone, the MMO who sighted that animal will notify all other MMOs of its presence.

- During Activity Monitoring:
  - If a marine mammal is observed entering the Level B ZOI, that pile segment will be completed without cessation, unless the animal enters or approaches the buffered shutdown zone, at which point all pile driving activities will be halted. If an animal is observed within the shutdown zone during pile driving, then pile driving will be stopped as soon as it is safe to do so. Pile driving can only resume once the animal has left the shutdown zone of its own volition or has not been re-sighted for a period of 15 minutes.
  - All times when the hammer is off but pile driving has not completely stopped will also be monitored.
- Post-Activity Monitoring:
  - Monitoring of the shutdown and buffer zones will continue for 30 minutes following the completion of the activity.

### 13.1.3 Data Collection

The following information shall be recorded on all NMFS-approved sighting forms used by MMOs:

- Date and time that pile driving or removal begins or ends
- Construction activities occurring during each observation period
- Other human activity in the area
- Weather parameters (e.g., wind, temperature, percent cloud cover, and visibility)
- Tide and sea state

If a marine mammal approaches or enters the shutdown zone, the following information will be recorded once shutdown procedures have been implemented:

- Any shutdown procedures implemented
- Species, numbers, and if possible sex and age class of the species (to estimate number of potential incidental takes)
- Behavior patterns observed, including bearing and direction of travel
- Location of the MMO, and distance from the animal(s) to the observer

Data collection forms shall be furnished to the NAVFAC point of contact within a mutually agreeable timeframe.

### 13.1.4 Interagency Notification

If the contractors encounter a marine mammal that is injured, sick, or dead, the installation natural resources manager shall be notified immediately. The Navy will in turn notify the appropriate regulatory agencies.

The Navy will provide the regulatory agencies with information as requested, such as the species or description of the animal(s), the condition of the animal (including carcass condition if the animal is dead), location, the date and time of first discovery, observed behaviors (if alive), and photo or video (if available).

In preservation of biological materials from a dead animal, the MMO has the first responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. MMOs shall not handle dead animals.

## 13.2 Reporting

Monitoring reports will be provided to NMFS in accordance with permit requirements and timelines. The reporting procedures are summarized below:

- A draft report shall be submitted on all monitoring conducted under the LOA within 90 calendar days of the completion of marine mammal monitoring or 60 days prior to the issuance of any subsequent LOA for this project, whichever comes first. A final report will be prepared and submitted within 30 days following resolution of comments on the draft report from NMFS. This report must contain the information elements described in the Marine Mammal Monitoring Plan, and at a minimum, shall include information described in section 13.1.3 of this LOA application.
- Reporting injured or dead marine mammals:
    - In the unanticipated event that the specified activity clearly causes the take of marine mammal(s) in a manner prohibited by the LOA, such as serious injury, or mortality, the Navy will immediately cease the specified activities and report the incident to the Office of Protected Resources (301-427-8401), NMFS, and the Northeast/Greater Atlantic Regional Stranding Coordinator (978-282-8478), NMFS. The report must include the following information:
        1. Time and date of the incident;
        2. Description of the incident;
        3. Environmental conditions (e.g., 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 animals(s); and
        7. Photographs or video footage of the animals(s).
    - Activities shall 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 that the Navy discovers an injured or dead marine mammal, the lead MMO determines that the cause of the injury or death is unknown and the death is relatively recent (e.g., in less than a moderate state of decomposition), the Navy will immediately report the incident to the Office of Protected Resources, NMFS,

and the Northeast/Greater Atlantic Regional Standing Coordinator, NMFS. The Report will include the same information as listed in numbers 1-7 above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with the Navy to determine whether additional mitigation measures or modifications to the activities are appropriate.

- In the event that the Navy discovers an injured or dead marine mammal, and the lead MMO determines that the injury or death is not associated with or related to the activities authorized in the LOA (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), the Navy will report the incident to the Office of Protected Resources, NMFS, and the Northeast/Greater Atlantic Regional Standing Coordinator, NMFS, within 24 hours of the discovery. The Navy will provide photographs or video footage or other documentation of the stranded animal sighting to NMFS.

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# 14 RESEARCH EFFORTS

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

At this time, the Navy does not anticipate any specific research conducted in conjunction with the Proposed Action. A post project report on marine mammal observations and the amount of take that occurred would be provided to NOAA. The post project report will be submitted within 90 days of project completion.

The Navy strives to be a world leader in marine species research and has provided funding over the past five years to universities, research institutions, federal laboratories, private companies, and independent researchers around the world to increase the understanding of marine species physiology and behavior with several projects ongoing in the state of Washington.

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

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

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and outside research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods into Navy activities. For example, at the 4$^{th}$ International Meeting on the Effects of Noise on Aquatic Life, held in Dublin, Ireland in July 2016, there were at least five presentations or posters specific to pile driving, including data gathered during Navy Mid-Atlantic exercises. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential monitoring tool. Overall, the Navy will continue to research and contribute to university/external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include monitoring programs, data sharing with NMFS from research and development efforts, and future research as previously described.

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# 15 LITERATURE CITED

American Bridge. 2010-2011. Pile Driving Records for SUBASE Pier 31 construction. American Bridge. 2010-2011.

American Bridge. 2016. Ken Farrelly, personal communication, regarding SUBASE Pier 31 construction. September 21-22, 2016

California Department of Transportation (Caltrans). 2015. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Available online at: http://www.dot.ca.gov/hq/env/bio/fisheries_bioacoustics.htm. November 2015.

CardnoTEC. 2014a. Sediment Sampling and Testing Results Report Replacement of Pier 32 (P-898), United States Naval Submarine Base New London, Groton, Connecticut. January 2014.

CardnoTEC. 2014b. Sediment Sampling and Testing Results Report Addendum for Pier 10 Demolition and Dredging as part of Replacement of Pier 32 (P-898) Project, United States Naval Submarine Base New London, Groton, Connecticut. November 2014.

CardnoTEC. 2015. Assessing Benthic Invertebrate Population and Community Responses to Waterfront Maintenance Dredging and Confined Aquatic Disposal Cell Creation in the Thames River. Final Report. May 27, 2015.

Clarke D, Dickerson C, Reine K. 2002. Characterization of Underwater Sounds Produced by Dredges Dredging 2002. ASCE. Orlando, Florida, USA. p 64-64. As presented in Central Dredging Association Position Paper. Underwater Sound In Relation To Dredging. The Netherlands. 7 November 2011.

Dazey, E., M. McIntosh, S. Brown, and K.M. Dudzinski. 2012. Assessment of Underwater Anthropogenic Noise Associated with Construction Activities in Bechers Bay, Santa Rosa Island, California. Journal of Environmental Protection; 3: 1286–1294.

Department of Defense. 2017. Unified Facilities Criteria (UFC) 4-152-01, Design: Piers and Wharves. Prepared by Naval Facilities Engineering Command, U.S. Army Corps of Engineers, and Air Force Civil Engineer Center. 24 January.

Erbe, C., Reichmuth, C., Cunningham, K., Klaus, L., & Dooling, R. 2016. Communication masking in marine mammals: a review and research strategy. Marine Pollution Bulletin 103 (2016) 15-38.

Finneran, J., R. Dear, D.A. Carder, and S.H. Ridgway. 2003. Auditory and behavioral responses of California sea lions (*Zalophus californianus*) to single underwater impulses from an arc-gap transducer. *The Journal of the Acoustical Society of America*, *114*(3): 1667-1677.

Finneran, J.J. 2016. Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise. May 2016.

Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M.P. Simmonds, R. Swift, and D. Thompson. 2003. A review of the effects of seismic surveys on marine mammals. *Marine Technology Society Journal*, *37*(4): 16-34.

HDR Inc. 2012. Naval Base Kitsap at Bangor Test Pile Program, Bangor, Washington. Final Marine Mammal Monitoring Report. Prepared for Naval Facilities Engineering Command Northwest, Silverdale, WA. April 2012.

Illingworth and Rodkin. 2012. Naval Base Kitsap Test Pile Program. Acoustic Monitoring Report. April 2012.

Integrated Concepts and Research Corporation. 2009. *Marine mammal monitoring final report, 15 July 2008 through 14 July 2009: Construction and scientific marine mammal monitoring associated with the Port of Anchorage marine terminal redevelopment project*. United States Department of Transportation Maritime Administration, Port of Anchorage.

Kastak, D. & Schusterman, R. J. 1999. In-air and underwater hearing sensitivity of a northern elephant seal (*Mirounga angustirostris*). *Canadian Journal of Zoology*, 77(11), 1751-1758.

Kastak, D. Schusterman, R.J., Southall, B.L., & Reichmuth, C.J. 1999. Underwater temporary threshold shift induced by octave-band noise in three species of pinniped. J. Acoust. Soc. Am., Vol. 106, No. 2, August 1999.

Kastelein, R. A., Wensveen, P., Hoek, L. & Terhune, J. M. 2009a. Underwater hearing sensitivity of harbor seals (*Phoca vitulina*) for narrow noise bands between 0.2 and 80 kHz. *Journal of the Acoustical Society of America*, 126(1), 476–483.

Kastelein, R. A., Wensveen, P. J., Hoek, L., Verboom, W. C. & Terhune, J. M. 2009b. Underwater detection of tonal signals between 0.125 and 100 kHz by harbor seals (*Phoca vitulina*). *Journal of the Acoustical Society of America*, 125(2), 1222-1229.

Kenney, Robert D. 2014. Marine Mammals of Rhode Island, Part 5, Harbor Seal. Rhode Island Natural History Survey. Retrieved from http://rinhs.org/uncategorized/marine-mammals-of-rhode-island-part-5-h. April 17.

Ketten, D.R. 1995. Estimates of blast injury and acoustic trauma zones for marine mammals from underwater explosions. *In* R.A. Kastelein, J.A. Thomas, & P.E. Nachtigall (Eds.), *Sensory systems of aquatic mammals* (pp. 391-407). Woerden, The Netherlands: De Spil Publishers.

Ketten, D.R. 2000. Cetacean ears. In W.W. L. Au, A.N. Popper, & R.R. Fay (Eds.), *Hearing by whales and dolphins* (pp. 43-108). New York: Springer-Verlag.

Ketten, D.R. 2004. Marine mammal auditory systems: a summary of audiometric and anatomical data and implications for underwater acoustic impacts. *Polarforschung*, 72 (2/3), 79-92.

Laws, Ben. 2016. Personal communication, January 21.

Martin, B., A. MacGillivray, J. MacDonnell, J. Vallarta, T. Deveau, G. Warner, and D. Zeddies. 2012. Underwater Acoustic Monitoring of the Tappan Zee Bridge Pile Installation Demonstration Project: Comprehensive Report. JASCO Document 00355, Version 1.1. Technical report for AECOM by JASCO Applied Sciences.

Miller, E. H. 1991. Communication in pinnipeds, with special reference to non-acoustic signaling. D. Renouf (Ed.), The Behaviour of Pinnipeds (pp. 128 – 235). London: Chapman and Hall.

Medic, Heather. 2005. Connecticut Department of Energy and Environmental Protection. Seal Season Is Approaching in Long Island Sound. Connecticut Wildlife. November/December 2005.

Møhl, B. 1968a. Auditory sensitivity of the common seal in air and water. Journal of Auditory Research, 8, 27-38.

Møhl, B. 1968b. Hearing in Seals R. J. Harrison, R. Hubbard, C. Rice and R. J. Schusterman (Eds.), Behavior and Physiology of Pinnipeds (pp. 172-195). New York: Appleton-Century.

Morton, A.B. and H.K. Symonds. 2002. Displacement of *Orcinus orca* (L.) by high amplitude sound in British Columbia, Canada. *ICES Journal of Marine Science 59*: 71-80.

National Marine Fisheries Service (NMFS). 2009. Taking of marine mammals incidental to specified activities; construction of the East Span of the San Francisco-Oakland Bay Bridge. 74 FR 41684.

NMFS. 2013. Protected Resources Glossary. Available online at: http://www.nmfs.noaa.gov/pr/glossary.htm. Accessed on 17 January 2013.

NMFS. 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing, Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. NOAA Technical Memorandum NMFS-OPR-55. July 2016.

National Oceanic and Atmospheric Administration (NOAA) Fisheries. 2015. Gray Seal (*Halichoerus grypus*). Retrieved from : http://www.fisheries.noaa.gov/pr/species/mammals/seals/gray-seal.html. January 15

NOAA Fisheries. 2016. *Optional User Spreadsheet*. NOAA's Marine Mammal Acoustic Technical Guidance. Last updated August 30. http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm.

National Research Council. 2003. Ocean noise and marine mammals. Washington, DC: National Research Council Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals; The National Academies Press.

National Research Council. 2005. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. The National Academies Press, Washington, D.C.

Naval Facilities Engineering Command (NAVFAC). 2010. Waterfront Facilities Inspections and Assessments AT Naval Submarine Base New London Groton, Connecticut Report Number: CR-6551-OCN (REV 1). May, 10, 2010.

NAVFAC. 2012. Naval Base Kitsap at Bangor EHW-1 Pile Replacement Project. Final Acoustic Monitoring Report. Bangor, Washington. 30 April 2012.

NAVFAC Mid-Atlantic. 2015. Sediment Dispersion Modeling of Dredging Related To the Proposed Replacement of Pier 32 and Demolition of Pier 10 United States Naval Submarine Base New London, Groton, Connecticut.

NAVFAC Mid-Atlantic. 2016. Public Works Department. Personal communication with FEAD Design Manager about data from previous similar projects. Email dated July 18, 2016.

NAVFAC Southwest (SW). 2014. Naval Base Point Loma Fuel Pier Replacement Project: Acoustic, Marine Mammal, Green Sea Turtle, and California Least Tern Monitoring Report, Final. August.

United States Navy (Navy). 1995. Final Environmental Impact Statement. Seawolf Class Submarine Homeporting on the East Coast of the United States. June 1995.

Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. *Mammal Review, 37*(2): 81-115.

Reichmuth, C. 2008. Hearing in marine carnivores. *Bioacoustics*, 17, 89-92.

Richardson, W.J., C.R. Greene, C.I. Malme, and D.H. Thomson. 1995. *Marine Mammals and Noise*. Academic Press, NY.

Ridgway, S.H., D.A. Carder, R.R. Smith, T. Kamolnick, C.E. Schlundt, and W.R. Elsberry. 1997. Behavioral responses and temporary shift in masked hearing threshold of bottlenose dolphins, *Tursiops truncatus*, to 1-second tones of 141 to 201 dB re 1 µPa. Technical Report 1751, Revision 1. San Diego, California: Naval Sea Systems Command.

Russell, Debbie J.F., Hastie, Gordon D., Thompson, David, Janik, Vincent M., Hammond, Philip S., Scott-Hayward, Lindesay A.S., Matthiopoulos, Jason, Jones, Esther L., and McConnell, Bernie J. 2016. Avoidance of wind farms by harbour seals is limited to pile driving activities. *Journal of Applied Ecology*. John Wiley & Sons Ltd of behalf of British Ecological Society.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr., C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A., & Tyack, P.L. 2007. Marine mammal noise exposure criteria: Initial Scientific Recommendations. Aquatic Mammals, Volume 33, Number 4, 2007.

Terhune, J. M. & Ronald, K. 1971. The harp seal, *Pagophilus groenlandicus* (Erxleben, 1777) X. The air audiogram. *Canadian Journal of Zoology*, 49, 385-390.

Terhune, J. M. & Ronald, K. 1972. The harp seal, *Pagophilus groenlandicus* (Erxleben, 1777) III. The underwater audiogram. *Canadian Journal of Zoology*, 50, 565-569.

Tetra Tech. 2016. Nearshore Surveys at Naval Submarine Base New London. Final Report. Prepared for NAVFAC Mid-Atlantic, Norfolk, VA by Tetra Tech, Inc., Arlington, VA. April 8, 2016.

Todd, Victoria L.G., Tod, Ian B., Gardiner, Jane C., Morrin, Erica C.N., MacPherson, Nicola A., DiMarzio, Nancy A. and Thomsen, Frank. 2015. A review of impacts of marine dredging activities on marine mammals. ICES Journal of Marine Science.

U.S. Army Corps of Engineers (USACE). 2015. Connecticut River Basins. Available online at: http://www.nae.usace.army.mil/Missions/CivilWorks/RiverBasins/Connecticut.aspx. Update: 12 June 2015. Accessed on 29 March 2016.

Viada, S. T., R. M. Hammer, R. Racca, D. Hannay, M. J. Thompson, B. J. Balcom, and N. W. Phillips. 2008. Review of potential impacts to sea turtles from underwater explosive removal of offshore structures. *Environmental Impact Assessment Review, 28*(4): 267-285.

Waring GT, Josephson E, Maze-Foley K, Rosel, PE, editors. 2015a. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2014. NOAA Tech Memo NMFS NE 231; 361 p. doi: 10.7289/V5TQ5ZH0.

Waring, Gordon T., Robert A. DiGiovanni Jr., Elizabeth Josephson, Stephanie Wood, and James R. Gilbert. 2015b. 2012 Population Estimate for the Harbor Seal (*Phoca vitulina concolor*) in New England Waters. NOAA Technical Memorandum NMFS-NE-235. August 2015.

Wartzok, D., A. N. Popper, J. Gordon and J. Merrill. 2003. Factors affecting the responses of marine mammals to acoustic disturbance. *Marine Technology Society Journal, 37*(4):6-15.

Washington State Department of Transportation (WSDOT). 2007. Underwater sound levels associated with driving steel and concrete piles near the Mukilteo Ferry Terminal. March 2007.

WSDOT. 2012. Underwater Vibratory Sound Levels from a Steel and Plastic on Steel Pile Installation at the Anacortes Ferry Terminal. Prepared by Jim Laughlin. March.

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# 16 LIST OF PREPARERS

**U.S. Navy**
Cara Hotchkin
Marine Resources Specialist
NAVFAC Atlantic

Jacqueline Bort Thornton
Marine Resources Specialist
NAVFAC Atlantic

Jessica Bassi
Natural Resources Specialist
Environmental Planning and Conservation
NAVFAC Mid-Atlantic

Angela Peyton
Environmental Planner, EV21
NAVFAC Mid-Atlantic

Tracey P. McKenzie
Naval Submarine Base New London
PWD Environmental Division

**Cardno**
Michael Dungan, Principal/Senior Ecologist, Cardno
M.S. and Ph.D., Ecology and Evolutionary Biology
B.A., Zoology
Years of Experience: 34

Erika Fuery, Environmental Scientist, Cardno
M.A. Environmental Science
B.A. Field Biology/Environmental Science
Years of Experience: 16

Kathy Hall, Senior Project Manager, Cardno
B.A. Earth and Environmental Science
Years of Experience: 20

Jennifer Weitkamp, Environmental Planner, Cardno
B.S. Fisheries
Years of Experience: 22

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# Appendix A
# Acoustic Calculations Using NMFS Optional User Spreadsheets

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

**VERSION: 1.1 (Aug-16)**

KEY

| | |
|---|---|
| (gray) | **Action Proponent Provided Information** |
| (peach) | **NMFS Provided Information (Acoustic Guidance)** |
| (blue) | **Resultant Isopleth** |

**STEP 1: GENERAL PROJECT INFORMATION**

| | |
|---|---|
| **PROJECT TITLE** | Demolition/Construction of Pier 32/Demolition of Pier 10 at Naval Submarine Base New London, Groton, Connecticut |
| **PROJECT/SOURCE INFORMATION**<br>Please include any assumptions | YEAR 1 (Pier 32 Construction): Construction of Temporary Work Trestle - Install via impact hammer 60 14-inch steel H-piles |
| **PROJECT CONTACT** | |

**STEP 2: WEIGHTING FACTOR ADJUSTMENT**

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

| | |
|---|---|
| **Weighting Factor Adjustment (kHz)**[¥] | 2 |

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 64), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

**STEP 3: SOURCE-SPECIFIC INFORMATION**

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

**E.1-2: ALTERNATIVE METHOD (SINGLE STRIKE EQUIVALENT)**

| | |
|---|---|
| **Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = $SEL_{ss}$ + 10 Log (# strikes)** | **213.0** |

| | |
|---|---|
| **Source Level (Single Strike/shot SEL)** | 177 |
| **Number of strikes in 1 h OR Number of strikes per pile** | 1000 |
| **Activity Duration (h) within 24-h period OR Number of piles per day** | 4 |
| **Propagation (xLogR)** | 15 |
| **Distance of single strike SEL measurement (meters)**[+] | 10 |

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

**RESULTANT ISOPLETHS***

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

| **Hearing Group** | **Low-Frequency Cetaceans** | **Mid-Frequency Cetaceans** | **High-Frequency Cetaceans** | **Phocid Pinnipeds** | **Otariid Pinnipeds** |
|---|---|---|---|---|---|
| **$SEL_{cum}$ Threshold** | 183 | 185 | 155 | 185 | 203 |
| **PTS Isopleth to threshold (meters)** | **1,001.8** | **35.6** | **1,193.3** | **536.1** | **39.0** |

**WEIGHTING FUNCTION CALCULATIONS**

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

# A: STATIONARY SOURCE: Non-Impulsive, Continuous

**VERSION: 1.1 (Aug-16)**

KEY

| | |
|---|---|
| (gray) | **Action Proponent Provided Information** |
| (peach) | **NMFS Provided Information (Acoustic Guidance)** |
| (blue) | **Resultant Isopleth** |

**STEP 1: GENERAL PROJECT INFORMATION**

| | |
|---|---|
| **PROJECT TITLE** | Demolition/Construction of Pier 32/Demolition of Pier 10 at Naval Submarine Base New London, Groton, Connecticut |
| **PROJECT/SOURCE INFORMATION**<br>Please include any assumptions | YEAR 1 (Pier 32 Construction): Install via vibratory hammer and rock socket drilling 60 36-inch x 100-ft concrete filled steel pipe piles. |
| **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 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

**STEP 3: SOURCE-SPECIFIC INFORMATION**

| | |
|---|---|
| **Source Level (RMS SPL)** | 168 |
| **Activity Duration (hours) within 24-h period** | 0.1667 |
| **Activity Duration (seconds)** | 600 |
| **10 Log (duration)** | 27.78 |
| **Propagation (xLogR)** | 15 |
| **Distance of source level measurement (meters)[+]** | 10 |

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

**RESULTANT ISOPLETHS**

| Hearing Group | Low-Frequency Cetaceans | Mid-Frequency Cetaceans | High-Frequency Cetaceans | Phocid Pinnipeds | Otariid Pinnipeds |
|---|---|---|---|---|---|
| **$SEL_{cum}$ Threshold** | 199 | 198 | 173 | 201 | 219 |
| **PTS Isopleth to threshold (meters)** | **6.1** | **0.5** | **9.0** | **3.7** | **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** |

# A: STATIONARY SOURCE: Non-Impulsive, Continuous

**VERSION: 1.1 (Aug-16)**

KEY

| | |
|---|---|
| (gray) | **Action Proponent Provided Information** |
| (peach) | **NMFS Provided Information (Acoustic Guidance)** |
| (blue) | **Resultant Isopleth** |

**STEP 1: GENERAL PROJECT INFORMATION**

| | |
|---|---|
| **PROJECT TITLE** | Demolition/Construction of Pier 32/Demolition of Pier 10 at Naval Submarine Base New London, Groton, Connecticut |
| **PROJECT/SOURCE INFORMATION**<br>Please include any assumptions | YEAR 1 (Pier 32 Construction): Install via vibratory hammer 20 36-inch x 180-ft concrete-filled steel pipe piles. |
| **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 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

**STEP 3: SOURCE-SPECIFIC INFORMATION**

| | |
|---|---|
| **Source Level (RMS SPL)** | 168 |
| **Activity Duration (hours) within 24-h period** | 0.1 |
| **Activity Duration (seconds)** | 360 |
| **10 Log (duration)** | 25.56 |
| **Propagation (xLogR)** | 15 |
| **Distance of source level measurement (meters)[+]** | 10 |

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

**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)** | **4.3** | **0.4** | **6.4** | **2.6** | **0.2** |

**WEIGHTING FUNCTION CALCULATIONS**

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

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

**VERSION: 1.1 (Aug-16)**

KEY

| | |
|---|---|
| (gray) | **Action Proponent Provided Information** |
| (peach) | **NMFS Provided Information (Acoustic Guidance)** |
| (blue) | **Resultant Isopleth** |

**STEP 1: GENERAL PROJECT INFORMATION**

| | |
|---|---|
| **PROJECT TITLE** | Demolition/Construction of Pier 32/Demolition of Pier 10 at Naval Submarine Base New London, Groton, Connecticut |
| **PROJECT/SOURCE INFORMATION**<br>Please include any assumptions | YEAR 1 (Pier 32 Construction): Install via impact hammer 20 36-inch x 180-ft concrete-filled steel pipe piles (to drive the last 20-40 ft). |
| **PROJECT CONTACT** | |

**STEP 2: WEIGHTING FACTOR ADJUSTMENT**

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

| | |
|---|---|
| **Weighting Factor Adjustment (kHz)¥** | 2 |

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 64), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

**STEP 3: SOURCE-SPECIFIC INFORMATION**

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

**E.1-2: ALTERNATIVE METHOD (SINGLE STRIKE EQUIVALENT)**

| | |
|---|---|
| **Unweighted $SEL_{cum\ (at\ measured\ distance)} = SEL_{ss}$ + 10 Log (# strikes)** | **217.0** |

| | |
|---|---|
| **Source Level (Single Strike/shot SEL)** | 183 |
| **Number of strikes in 1 h OR Number of strikes per pile** | 1000 |
| **Activity Duration (h) within 24-h period OR Number of piles per day** | 2.5 |
| **Propagation (xLogR)** | 15 |
| **Distance of single strike SEL measurement (meters)⁺** | 10 |

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

**RESULTANT ISOPLETHS***

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

| Hearing Group | Low-Frequency Cetaceans | Mid-Frequency Cetaceans | High-Frequency Cetaceans | Phocid Pinnipeds | Otariid Pinnipeds |
|---|---|---|---|---|---|
| **$SEL_{cum}$ Threshold** | 183 | 185 | 155 | 185 | 203 |
| **PTS Isopleth to threshold (meters)** | **1,839.5** | **65.4** | **2,191.1** | **984.4** | **71.7** |

**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)† | **-0.01** | **-19.74** | **-26.87** | **-2.08** | **-1.15** |

# A: STATIONARY SOURCE: Non-Impulsive, Continuous

**VERSION: 1.1 (Aug-16)**

KEY

| | |
|---|---|
| | Action Proponent Provided Information |
| | NMFS Provided Information (Acoustic Guidance) |
| | Resultant Isopleth |

**STEP 1: GENERAL PROJECT INFORMATION**

| | |
|---|---|
| **PROJECT TITLE** | Demolition/Construction of Pier 32/Demolition of Pier 10 at Naval Submarine Base New London, Groton, Connecticut |
| **PROJECT/SOURCE INFORMATION** (Please include any assumptions) | YEAR 1 (Quaywall Upgrade): Install via rock socket drilling 18 30-inch x 100-ft concrete-filled steel pipe piles |
| **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 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

**STEP 3: SOURCE-SPECIFIC INFORMATION**

| | |
|---|---|
| **Source Level (RMS SPL)** | 154 |
| **Activity Duration (hours) within 24-h period** | 2.1 |
| **Activity Duration (seconds)** | 7560 |
| **10 Log (duration)** | 38.79 |
| **Propagation (xLogR)** | 15 |
| **Distance of source level measurement (meters)**[+] | 10 |

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

**RESULTANT ISOPLETHS**

| Hearing Group | Low-Frequency Cetaceans | Mid-Frequency Cetaceans | High-Frequency Cetaceans | Phocid Pinnipeds | Otariid Pinnipeds |
|---|---|---|---|---|---|
| $SEL_{cum}$ Threshold | 199 | 198 | 173 | 201 | 219 |
| PTS Isopleth to threshold (meters) | **3.8** | **0.3** | **5.7** | **2.3** | **0.2** |

**WEIGHTING FUNCTION CALCULATIONS**

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

# A: STATIONARY SOURCE: Non-Impulsive, Continuous

**VERSION: 1.1 (Aug-16)**

KEY

| | |
|---|---|
| (gray) | **Action Proponent Provided Information** |
| (peach) | **NMFS Provided Information (Acoustic Guidance)** |
| (blue) | **Resultant Isopleth** |

**STEP 1: GENERAL PROJECT INFORMATION**

| | |
|---|---|
| **PROJECT TITLE** | Demolition/Construction of Pier 32/Demolition of Pier 10 at Naval Submarine Base New London, Groton, Connecticut |
| **PROJECT/SOURCE INFORMATION**<br>Please include any assumptions | YEAR 1 (Quaywall Upgrade): Install via rock socket drilling 9 16-inch fiberglass reinforced plastic piles |
| **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 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

**STEP 3: SOURCE-SPECIFIC INFORMATION**

| | |
|---|---|
| **Source Level (RMS SPL)** | 154 |
| **Activity Duration (hours) within 24-h period** | 1.04 |
| **Activity Duration (seconds)** | 3744 |
| **10 Log (duration)** | 35.73 |
| **Propagation (xLogR)** | 15 |
| **Distance of source level measurement (meters)[+]** | 10 |

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

**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)** | **2.4** | **0.2** | **3.5** | **1.5** | **0.1** |

**WEIGHTING FUNCTION CALCULATIONS**

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

# A: STATIONARY SOURCE: Non-Impulsive, Continuous

**VERSION: 1.1 (Aug-16)**

KEY

| | |
|---|---|
| | **Action Proponent Provided Information** |
| | **NMFS Provided Information (Acoustic Guidance)** |
| | **Resultant Isopleth** |

**STEP 1: GENERAL PROJECT INFORMATION**

| | |
|---|---|
| **PROJECT TITLE** | Demolition/Construction of Pier 32/Demolition of Pier 10 at Naval Submarine Base New London, Groton, Connecticut |
| **PROJECT/SOURCE INFORMATION**<br>Please include any assumptions | YEAR 2 (Pier 32 Construction): Install via vibratory hammer 40 36-inch x 180-ft concrete-filled steel pipe piles |
| **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 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

**STEP 3: SOURCE-SPECIFIC INFORMATION**

| | |
|---|---|
| **Source Level (RMS SPL)** | 168 |
| **Activity Duration (hours) within 24-h period** | 0.1 |
| **Activity Duration (seconds)** | 360 |
| **10 Log (duration)** | 25.56 |
| **Propagation (xLogR)** | 15 |
| **Distance of source level measurement (meters)**[+] | 10 |

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

**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) | **4.3** | **0.4** | **6.4** | **2.6** | **0.2** |

**WEIGHTING FUNCTION CALCULATIONS**

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

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

**VERSION: 1.1 (Aug-16)**

KEY

| | |
|---|---|
| | **Action Proponent Provided Information** |
| | **NMFS Provided Information (Acoustic Guidance)** |
| | **Resultant Isopleth** |

**STEP 1: GENERAL PROJECT INFORMATION**

| | |
|---|---|
| **PROJECT TITLE** | Demolition/Construction of Pier 32/Demolition of Pier 10 at Naval Submarine Base New London, Groton, Connecticut |
| **PROJECT/SOURCE INFORMATION**<br>Please include any assumptions | YEAR 2 (Pier 32 Construction): - Installing via impact hammer 36-inch x 180-ft concrete filled steel pipe piles (to drive last 20 - 40 feet). |
| **PROJECT CONTACT** | |

**STEP 2: WEIGHTING FACTOR ADJUSTMENT**

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

| | | |
|---|---|---|
| **Weighting Factor Adjustment (kHz)[¥]** | 2 | |

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 64), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

**STEP 3: SOURCE-SPECIFIC INFORMATION**

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

**E.1-2: ALTERNATIVE METHOD (SINGLE STRIKE EQUIVALENT)**

| | |
|---|---|
| **Unweighted $SEL_{cum\ (at\ measured\ distance)} = SEL_{ss}$ + 10 Log (# strikes)** | **217.0** |

| | |
|---|---|
| **Source Level (Single Strike/shot SEL)** | 183 |
| **Number of strikes in 1 h OR Number of strikes per pile** | 1000 |
| **Activity Duration (h) within 24-h period OR Number of piles per day** | 2.5 |
| **Propagation (xLogR)** | 15 |
| **Distance of single strike SEL measurement (meters)[+]** | 10 |

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

**RESULTANT ISOPLETHS***

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

| **Hearing Group** | **Low-Frequency Cetaceans** | **Mid-Frequency Cetaceans** | **High-Frequency Cetaceans** | **Phocid Pinnipeds** | **Otariid Pinnipeds** |
|---|---|---|---|---|---|
| **$SEL_{cum}$ Threshold** | 183 | 185 | 155 | 185 | 203 |
| **PTS Isopleth to threshold (meters)** | **1,839.5** | **65.4** | **2,191.1** | **984.4** | **71.7** |

**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)†** | **-0.01** | **-19.74** | **-26.87** | **-2.08** | **-1.15** |

# A: STATIONARY SOURCE: Non-Impulsive, Continuous

**VERSION: 1.1 (Aug-16)**

| KEY | |
|---|---|
| (gray) | **Action Proponent Provided Information** |
| (peach) | **NMFS Provided Information (Acoustic Guidance)** |
| (blue) | **Resultant Isopleth** |

**STEP 1: GENERAL PROJECT INFORMATION**

| | |
|---|---|
| **PROJECT TITLE** | Demolition/Construction of Pier 32/Demolition of Pier 10 at Naval Submarine Base New London, Groton, Connecticut |
| **PROJECT/SOURCE INFORMATION** | YEAR 3 (Pier 32 Construction): Install via vibratory hammer 194 16-inch fiberglass reinforced plastic piles. Note: no data specific to this pile size were available. Used source levels for 13-inch plastic piles per study plan. |
| 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 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

**STEP 3: SOURCE-SPECIFIC INFORMATION**

| | |
|---|---|
| **Source Level (RMS SPL)** | 153 |
| **Activity Duration (hours) within 24-h period** | 0.6667 |
| **Activity Duration (seconds)** | 2400 |
| **10 Log (duration)** | 33.80 |
| **Propagation (xLogR)** | 15 |
| **Distance of source level measurement (meters)[+]** | 10 |

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

| 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 |

**RESULTANT ISOPLETHS**

| Hearing Group | Low-Frequency Cetaceans | Mid-Frequency Cetaceans | High-Frequency Cetaceans | Phocid Pinnipeds | Otariid Pinnipeds |
|---|---|---|---|---|---|
| **$SEL_{cum}$ Threshold** | 199 | 198 | 173 | 201 | 219 |
| **PTS Isopleth to threshold (meters)** | **1.5** | **0.1** | **2.3** | **0.9** | **0.1** |

**WEIGHTING FUNCTION CALCULATIONS**

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

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

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

**VERSION: 1.1 (Aug-16)**

KEY

| | |
|---|---|
| (gray) | **Action Proponent Provided Information** |
| (peach) | **NMFS Provided Information (Acoustic Guidance)** |
| (blue) | **Resultant Isopleth** |

**STEP 1: GENERAL PROJECT INFORMATION**

| | |
|---|---|
| **PROJECT TITLE** | Demolition/Construction of Pier 32/Demolition of Pier 10 at Naval Submarine Base New London, Groton, Connecticut |
| **PROJECT/SOURCE INFORMATION** (Please include any assumptions) | YEAR 3 (Pier 32 Construction): Install via impact hammer 64 16-inch fiberglass reinforced plastic piles (to drive last 20-40 ft) |
| **PROJECT CONTACT** | |

**STEP 2: WEIGHTING FACTOR ADJUSTMENT**

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

| | |
|---|---|
| **Weighting Factor Adjustment (kHz)[¥]** | 2 |

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 64), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

**STEP 3: SOURCE-SPECIFIC INFORMATION**

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

**E.1-2: ALTERNATIVE METHOD (SINGLE STRIKE EQUIVALENT)**

| | |
|---|---|
| **Unweighted $SEL_{cum\ (at\ measured\ distance)} = SEL_{ss}$ + 10 Log (# strikes)** | **178.0** |

| | |
|---|---|
| **Source Level (Single Strike/shot SEL)** | 144 |
| **Number of strikes in 1 h OR Number of strikes per pile** | 1000 |
| **Activity Duration (h) within 24-h period OR Number of piles per day** | 2.5 |
| **Propagation (xLogR)** | 15 |
| **Distance of single strike SEL measurement (meters)[+]** | 10 |

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

**RESULTANT ISOPLETHS***

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

| 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)** | **4.6** | **0.2** | **5.5** | **2.5** | **0.2** |

**WEIGHTING FUNCTION CALCULATIONS**

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

# A: STATIONARY SOURCE: Non-Impulsive, Continuous

**VERSION: 1.1 (Aug-16)**

KEY

| | |
|---|---|
| (gray) | Action Proponent Provided Information |
| (peach) | NMFS Provided Information (Acoustic Guidance) |
| (blue) | Resultant Isopleth |

**STEP 1: GENERAL PROJECT INFORMATION**

| | |
|---|---|
| **PROJECT TITLE** | Demolition/Construction of Pier 32/Demolition of Pier 10 at Naval Submarine Base New London, Groton, Connecticut |
| **PROJECT/SOURCE INFORMATION**<br>Please include any assumptions | YEAR 4 (Pier 32 Demolition-Pile removal): Vibratory extraction of 190 piles conisting of 60 14-inch steel piles from the temporary work trestle; 24 33-inch concrete encased steel H-piles; 96 24-inch concrete encased steel H-piles; and 70 14-inch steel H-piles. |
| **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 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

**STEP 3: SOURCE-SPECIFIC INFORMATION**

| | |
|---|---|
| **Source Level (RMS SPL)** | 158 |
| **Activity Duration (hours) within 24-h period** | 0.6667 |
| **Activity Duration (seconds)** | 2400 |
| **10 Log (duration)** | 33.80 |
| **Propagation (xLogR)** | 15 |
| **Distance of source level measurement (meters)⁺** | 10 |

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

**RESULTANT ISOPLETHS**

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

**WEIGHTING FUNCTION CALCULATIONS**

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

# A: STATIONARY SOURCE: Non-Impulsive, Continuous

**VERSION: 1.1 (Aug-16)**

KEY

| | |
|---|---|
| (gray) | Action Proponent Provided Information |
| (peach) | NMFS Provided Information (Acoustic Guidance) |
| (blue) | Resultant Isopleth |

**STEP 1: GENERAL PROJECT INFORMATION**

| | |
|---|---|
| **PROJECT TITLE** | Demolition/Construction of Pier 32/Demolition of Pier 10 at Naval Submarine Base New London, Groton, Connecticut |
| **PROJECT/SOURCE INFORMATION**<br>Please include any assumptions | YEAR 4 (Pier 10 Demo): Vibratory Extract-24 14-inch steel H-piles encased in concrete (creating 24-inch pile) and 166 cast in place reinforced concrete piles (***Note: There are no data on sound from vibratory extraction of concrete piles. Therefore a conservative assumption is made that sound is the same as for extracting concrete piles as it is for steel H-piles***). |
| **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 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

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

**STEP 3: SOURCE-SPECIFIC INFORMATION**

| | |
|---|---|
| **Source Level (RMS SPL)** | 158 |
| **Activity Duration (hours) within 24-h period** | 3.1667 |
| **Activity Duration (seconds)** | 11400 |
| **10 Log (duration)** | 40.57 |
| **Propagation (xLogR)** | 15 |
| **Distance of source level measurement (meters)**[+] | 10 |

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

**RESULTANT ISOPLETHS**

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

**WEIGHTING FUNCTION CALCULATIONS**

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