INCIDENTAL HARASSMENT AUTHORIZATION APPLICATION

EHW-1 PILE REPLACEMENT AND MAINTENANCE PROJECT
NAVAL BASE KITSAP BANGOR

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

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For:
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EXECUTIVE SUMMARY

The United States Department of the Navy is applying for an Incidental Harassment Authorization (IHA) for the incidental take of marine mammals resulting from the maintenance and repairs to the Explosives Handling Wharf #1 facility, including replacement of 4 structurally unsound piles, on Naval Base Kitsap Bangor between July 16, 2015 and January 15, 2016. Naval Base Kitsap Bangor, located on Hood Canal approximately 20 miles (32 kilometers) west of Seattle, Washington, provides berthing and support services to Navy submarines and other fleet assets. Vibratory and impact pile driving associated with the proposed activities have the potential to affect marine mammals within the waterways adjacent to Naval Base Kitsap Bangor that could result in harassment under the Marine Mammal Protection Act of 1972, as amended.

Five species of marine mammals have a reasonable potential to occur within the waters surrounding Naval Base Kitsap Bangor: the Steller sea lion (*Eumetopias jubatus*), the California sea lion (*Zalophus californianus*), the harbor seal (*Phoca vitulina*), the transient killer whale (*Orcinus orca*), and the harbor porpoise (*Phocoena phocoena*). None of these species are listed under the federal Endangered Species Act. These species are included in the analysis of this application based on the potential for exposure to Level B behavioral harassment from noise associated with vibratory and impact pile driving during project construction. Four additional species previously documented in Hood Canal are not carried forward in the analysis because they are unlikely to be present during project construction; the humpback whale (*Megaptera novaeangliae*), the gray whale (*Eschrichtius robustus*), Southern Resident killer whale, and the Dall’s porpoise (*Phocoenoides dalli).*

The purpose of the project is to maintain the structural integrity of Explosives Handling Wharf #1 facility and ensure its continued functionality to support the operational requirements of the TRIDENT program. The proposed action includes wharf maintenance activities and the replacement of four existing 24-inch hollow prestressed octagonal concrete piles with four new 30-inch concrete filled steel pipe piles. Existing piles will be removed using a pneumatic hammer and a crane. In order to minimize underwater noise impacts on marine species, vibratory pile driving will be the primary method used to install new steel piles. An impact hammer may be used if substrate conditions prevent the advancement of piles to the required depth or to verify the load bearing capacity. An air bubble curtain or other noise attenuating device will be used to reduce noise levels during impact driving. Marine mammal monitoring will be conducted during all pile driving, and work will shut down if marine mammals come within distances (10 meters for pinnipeds and 29 meters for cetaceans) where injury could potentially occur. A maximum of 8 days of pile driving during one in-water work season (July 16, 2015 through January 15, 2016) will be required for pile installation.

The Navy used the National Marine Fisheries Service promulgated thresholds for assessing pile driving impacts to marine mammals. The Navy used the practical spreading loss equation and empirically measured source levels from other similar steel pile driving projects to estimate potential marine mammal exposures to pile driving noise. Predicted exposures are described in detail in Section 6 and summarized in Table ES–1. Level A harassments associated with pile driving activities will be avoided by implementing mitigation measures described in Section 11. The noise modeling predicts that 920 Level B harassments may occur during proposed action. Conservative assumptions (including marine mammal densities and other assumptions) used to estimate the exposures are likely to overestimate the potential number of exposures and their severity.

Pursuant to MMPA Section 101(a)(5)(D), the Navy submits this application to National Marine Fisheries Service for the authorization of incidental, but not intentional, taking of five marine mammal species during pile driving activities for the Explosives Handling Wharf #1 Pile Replacement and Maintenance Project, between July 16, 2015, and January 15, 2016. The taking will be in the form of non-lethal, temporary harassment and is expected to have a negligible impact on these species. In addition, the taking will not have an unmitigable adverse impact on the availability of these species for subsistence use.

Regulations governing the issuance of incidental take under certain circumstances are codified at 50 Code of Federal Regulations Part 216, Subpart I (Sections 216.101 – 216.108). Section 216.104 sets out 14 specific items that must be addressed in requests for take pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act. These 14 items are addressed in Sections 1 through 14 of this Incidental Harassment Authorization application.

Table ES–1. Number of Potential Exposures of Marine Mammals to Level B Harassment Thresholds during the Explosives Handling Wharf #1 Pile Replacement and Maintenance Project

Species	Total
Transient killer whale	12
Harbor porpoise	40
Steller sea lion	48
California sea lion	568
Harbor seal	2,056
Total	2,704

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ACRONYMS AND ABBREVIATIONS

BMP	best management practices
BSS	Beaufort Sea State
°C	Celsius
CFR	Code of Federal Regulations
CV	Coefficient of Variation
dB	Decibel
dBA	Decibel with A-weighting filter
DPS	Distinct Population Segment
DO	Dissolved Oxygen
DoN	Department of the Navy
EEZ	Exclusive Economic Zone
EHW-1	Explosive Handling Wharf #1
ESA	Endangered Species Act
°F	Fahrenheit
Ft	Feet
Hz	Hertz
IHA	Incidental Harassment Authorization
kHz	Kilohertz
kg	Kilogram
km	Kilometer
km^2	Square kilometers
lbs	Pounds
m	Meter
mg/L	Milligrams per Liter
MLLW	Mean Lower Low Water
MMPA	Marine Mammal Protection Act
ms	Millisecond
NAVBASE Kitsap	Naval Base Kitsap
Navy	U.S. Navy
NMFS	National Marine Fisheries Service
Pa	Pascal
PSB	Port Security Barrier
PSU	Practical Salinity Units
PTS	Permanent Threshold Shift
RMS	Root Mean Square
SEL	Sound Exposure Level
SPL	Sound Pressure Level
Sq	Square
TL	Transmission Loss
TS	Threshold Shift
TTS	Temporary Threshold Shift
TRIDENT	Trident Fleet Ballistic Missile
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
°W	West

WA	Washington
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington Department of Ecology
WRA	Waterfront Restricted Area
WSDOT	Washington State Department of Transportation
ZOI	Zone of Influence
μPa	Micropascal

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

Naval Base (NAVBASE) Kitsap Bangor, Washington provides berthing and support services to U.S. Navy submarines and other fleet assets including the TRIDENT Fleet Ballistic Missile (TRIDENT) program. The Explosive Handling Wharf #1 (EHW-1) facility is a U-shaped concrete structure built in 1977 for ordnance handling operations in support of the Trident Submarine squadron home ported at NAVBASE Kitsap Bangor. EHW-1 consists of two 30-meter (100-feet) access trestles and a main pier deck that measures approximately 215 meters (700 feet) in length. The wharf is supported by both 16-inch and 24-inch hollow octagonal pre-cast concrete piles. Additionally, there are steel and timber fender piles on the outboard and inboard edges of the wharf.

The Navy has determined that the EHW-1 structural integrity is compromised due to deterioration of the wharf's piling sub-structure. The purpose of the project is to maintain the structural integrity of the wharf and ensure its continued functionality to support the operational requirements of the TRIDENT program. The project area is shown in Figure 1-1.

Under Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA) of 1972, as amended in 1994, an Incidental Harassment Authorization (IHA) is requested from the National Marine Fisheries Service (NMFS) to the Navy for activities that have the potential to affect small numbers of marine mammals in the waterways adjacent to NAVBASE Kitsap Bangor through behavioral harassment incidental to activities conducted during the project. The proposed project activities that could potentially result in behavioral harassment to marine mammals are the vibratory and impact installation of steel piles. The 14 specific items required for this application, as set out by 50 CFR 216.104 Submission of Requests, are provided for in Chapters 1–14 of this application.

1.2 Proposed Action

The Navy is proposing to perform maintenance and restore the structural integrity of the EHW-1 facility, including replacement of 4 structurally unsound piles. The project will include demolishing and replacing existing piles at Bent 27 of the outboard support of the EHW-1 (Figures 1-2 and 1-3). Additionally, the project includes replacement of structural elements such as decking and pile caps, installation of cathodic protection, repair of a concrete wetwell (small concrete encased sewage lift station), and recoating of the tops of fender piles and steel mooring fittings. Table 1-1 provides a summary of the proposed maintenance and repair activities.

The Proposed Action includes best management practices (BMPs), and minimization measures that will be implemented to avoid or minimize potential environmental impacts as described in Section 2.4.

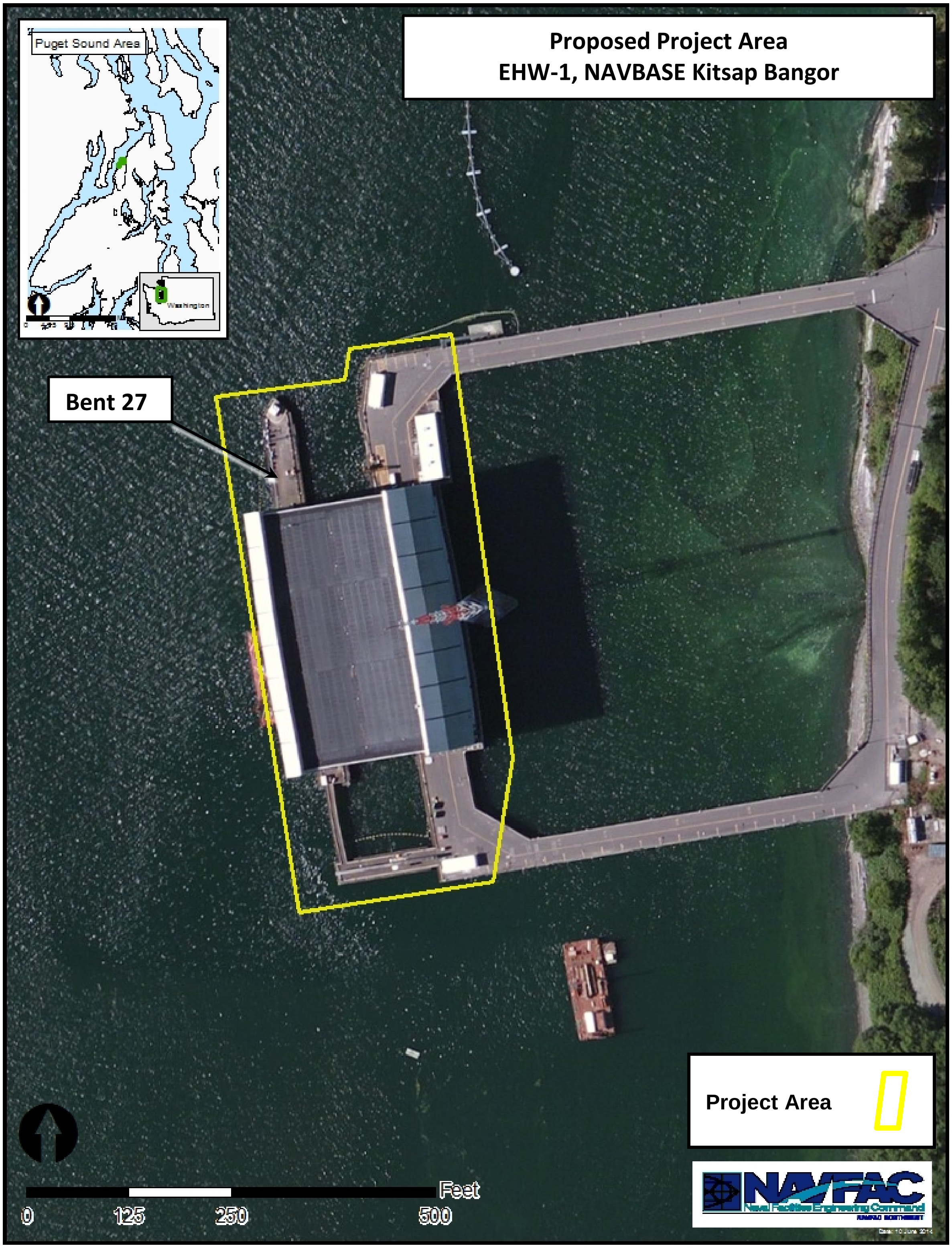

Figure 1-1. Proposed Project Area

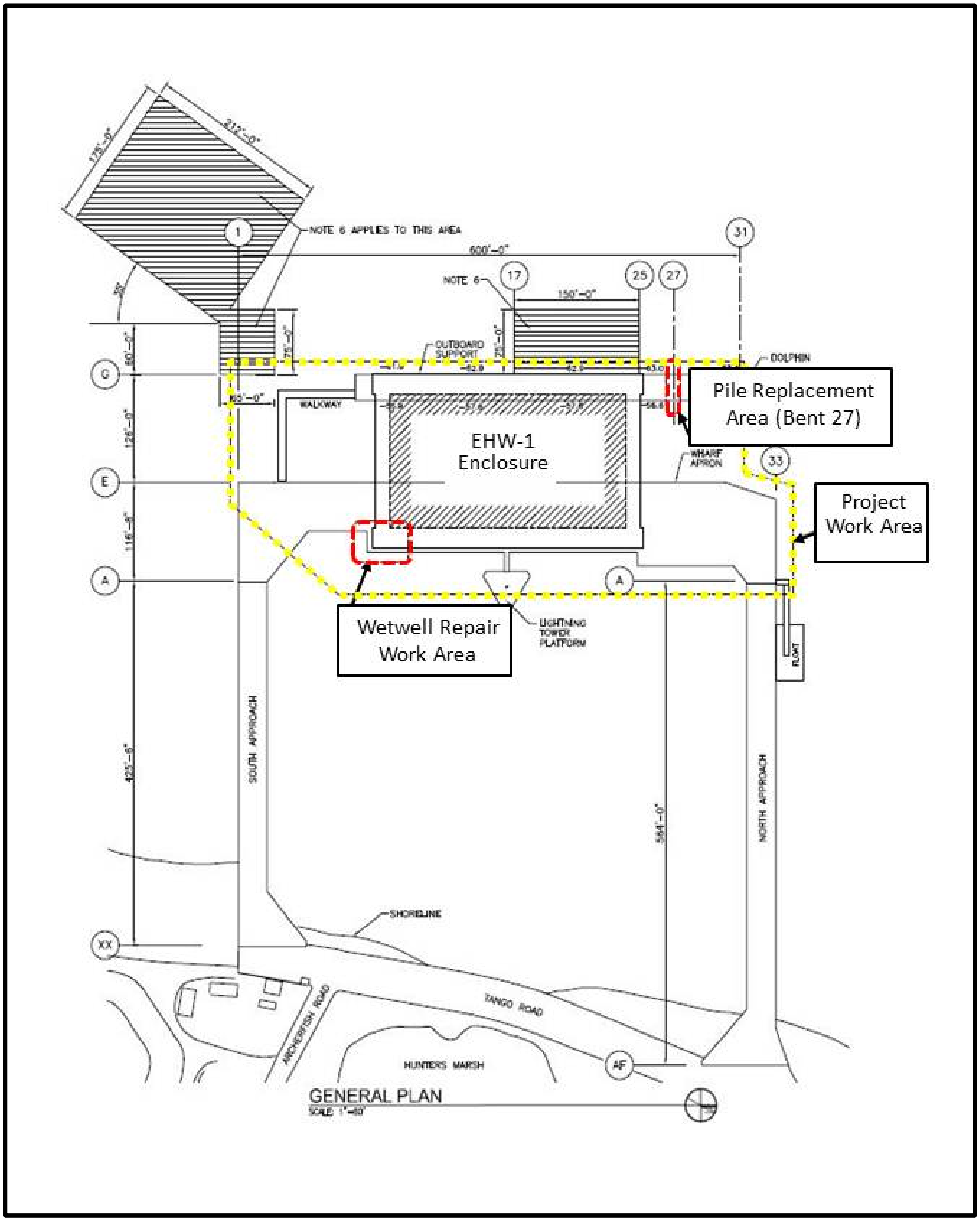

Figure 1-2. EHW-1 Project Work Area

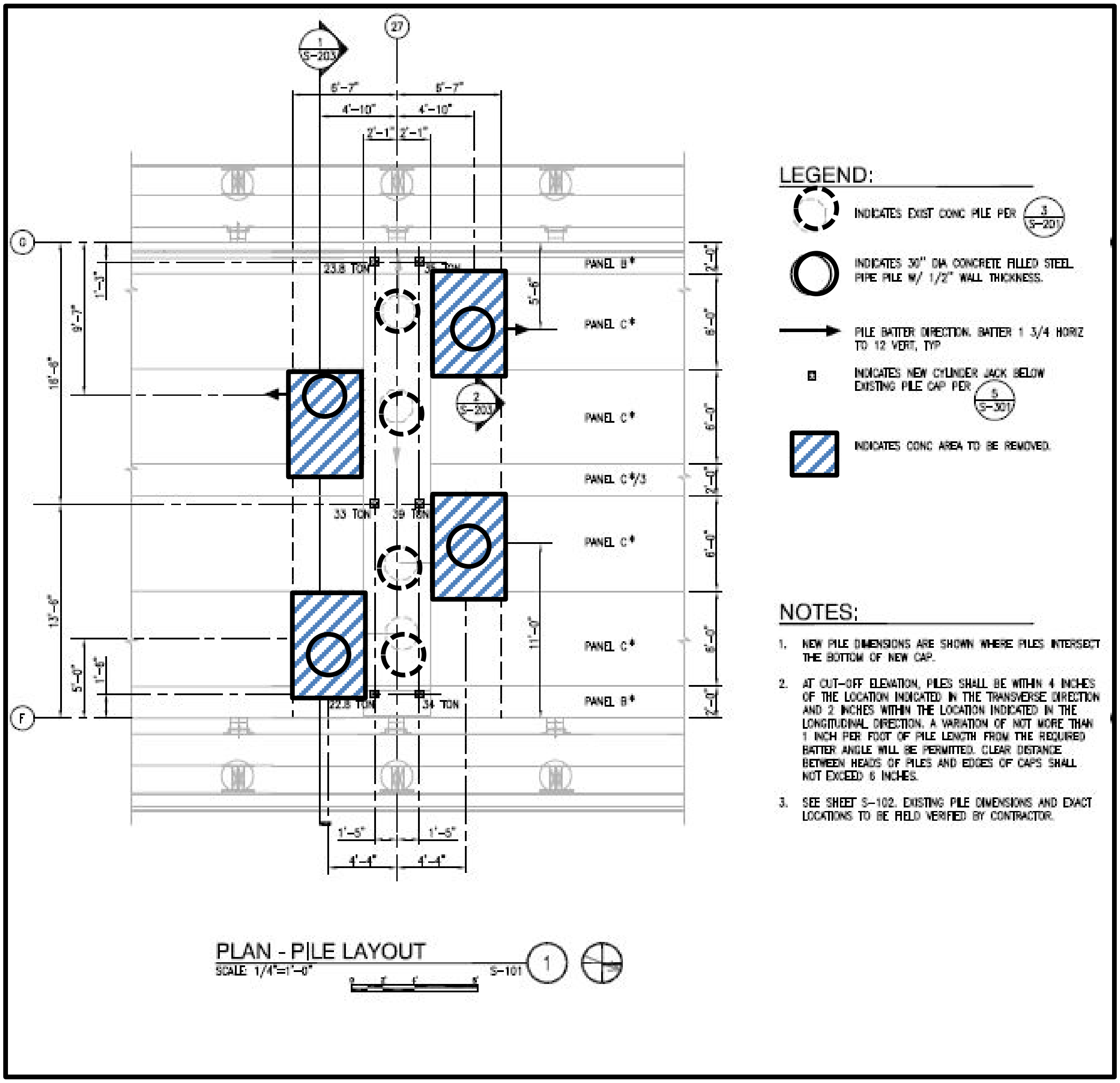

Figure 1-3. EHW-1 Pile Replacement Layout

Table 1-1. EHW-1 Proposed Maintenance and Repair Activities
Demolish four existing 24-inch hollow prestressed octagonal concrete piles to the mudline.
Install four new 30-inch concrete filled steel pipe piles adjacent to the demolished piles.
Demolish and replace four 6'-0" by 4'-3" sections of deck in order to install new piles
Install new concrete pile caps for the newly installed piles
Install cathodic protection system for newly installed piles.
Repair deteriorated concrete of the wetwell on Wharf Apron.
Recoat top portion of 183 steel pipe fender piles.
Recoat 27 steel mooring fittings on the deck of the Wharf.

1.3 General Description Construction Methods

1.3.1 Pile Replacement Construction Methods

This section describes the planned methods of pile removal and installation that would be used to accomplish the work included as part of this Proposed Action. Other repairs at EHW-1 that are planned to occur overwater do not produce noise levels anticipated to result in take of marine mammals. Therefore, the section below describes project activities that could potentially result in behavioral harassment to marine mammals.

1.3.1.1 Pile Removal

Four existing 24-inch hollow prestressed octagonal concrete piles located at Bent-27 will be removed. If possible, piles will be first scored by a diver using a small pneumatic hammer. Each pile will be moved slightly back and forth to break at the score. The broken pile will be removed by a crane. Remaining pile parts will be chipped away with a pneumatic hammer. If there is not room to move a pile, the entire base of the pile will be chipped away with a pneumatic hammer for removal. Rebar strands in the piles will be torched to remove. Concrete debris will be captured as practicable using a debris curtains/sheeting and removed from the project area. Removed piles and/or pile pieces will be placed on a barge for upland disposal in accordance with federal and state requirements. The Navy will evaluate if it would be possible to reclaim or recycle the materials.

1.3.1.2 Pile Installation

Because impact driving of steel piles can produce underwater noise levels that have been known to cause fish kills, vibratory hammers will be used to install four 30-inch concrete filled steel piles adjacent to the demolished piles (Figure 1-4). The vibratory hammer will install the new piles to a point of refusal or within approximately 5 ft of the final tip elevation (approximately -110 ft MLLW). The vibratory hammer process for pile installation begins by placing a choker cable around a pile and lifting it into vertical position with a crane. The pile is then lowered into position and set in place at the mudline. The pile is held steady while the vibratory driver installs the pile to the required tip elevation. In some substrates, a vibratory driver may be unable to advance a pile until it reaches the required depth. In these cases, an impact hammer will be used to entirely advance the pile to the required depth.

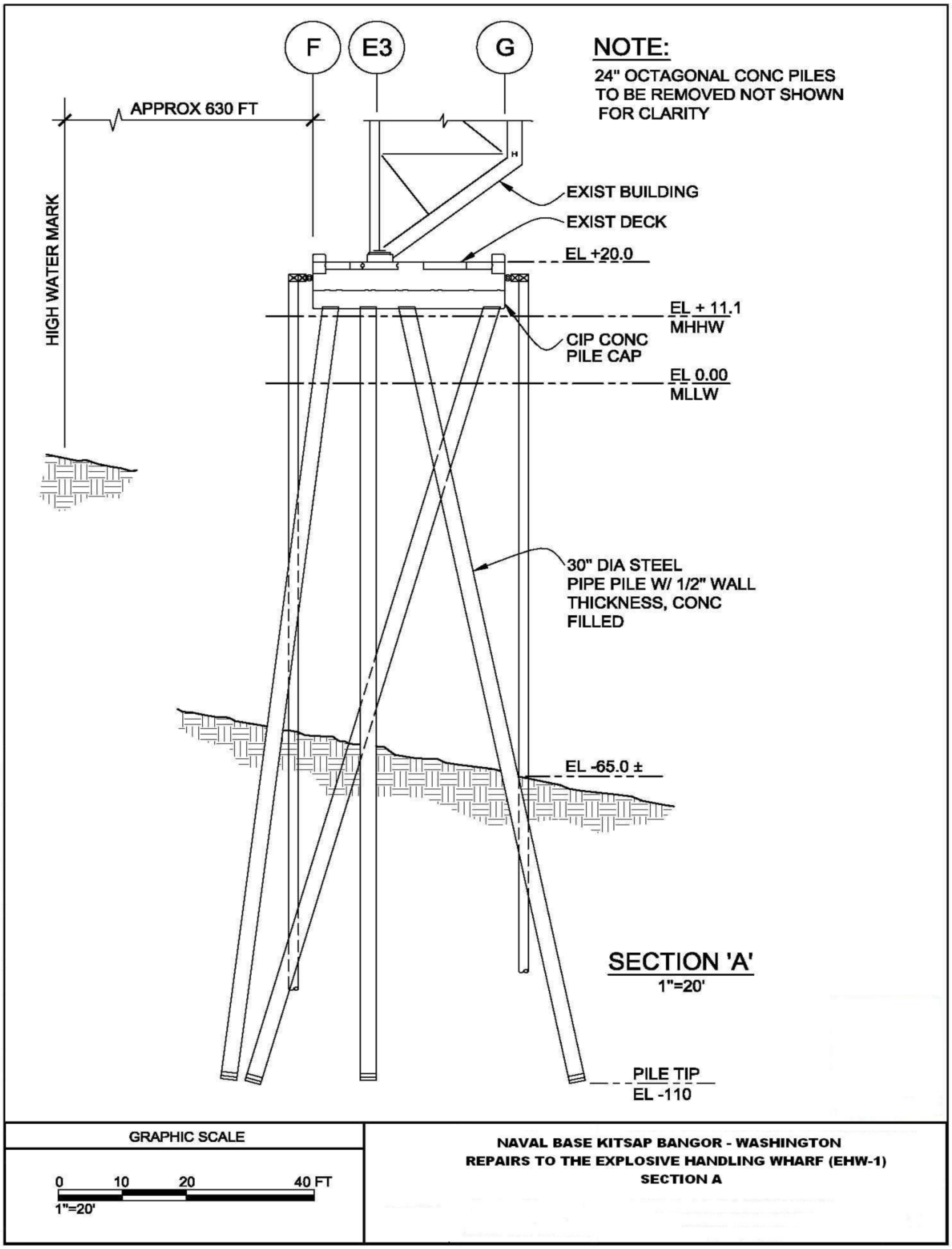

Figure 1-4. EHW-1 Pile Replacement Configuration

Based on the Navy's experience replacing piles during previous repair cycles at the EHW-1 facility, the Navy feels that use of a vibratory hammer will be sufficient; the impact hammer has yet to be required to accomplish installation. Impact pile driving is anticipated to verify the load bearing capacity (proofing1) of the new piles. An impact hammer is typically required to strike a pile a number of times the last few feet to ensure it has met load bearing specifications. To minimize noise levels, a bubble curtain or other noise attenuation device will be employed for all steel impact pile strikes. A bubble curtain is usually a ring or series of stacked rings that are placed around a pile along the pile's entire length. The rings are made of tubing which has small puncture holes through which compressed air is pumped. As the compressed air bubbles flow from the tubing, they create an air barrier which impedes the sound produced during pile driving.

To provide a general estimate of daily steel pile impact driving durations, Navy geotechnical and engineering staff used information from past projects using diesel hammers to estimate pile strikes and average strike rates needed to install 24- to 36-inch steel piles. For steel piles that are "proofed" an average of 400 strikes per pile were estimated. For piles that cannot be advanced with a vibratory driver and, therefore will be fully impact driven, 2,000 strikes per pile were estimated to fully drive a pile. This estimate assumes an average estimated strike rate of 44 strikes per minute (or almost a strike every second and a half) resulting in an estimate of approximately 9 minutes of impact driving for each pile proofed or approximately 45 minutes for each pile fully impact driven. Actual strike numbers and average strike rates will vary due to substrate conditions and the type and energy of impact hammers will likely vary. Past projects at EHW-1 have not required full impact driving. Therefore, steel impact pile driving is estimated to occur from approximately 36 minutes to a maximum of 3 hours over the entire project duration. A maximum number of 8 days will be required to install the 4 piles.

1.3.2 Barges

Barges will be used as platforms for conducting work activities and to haul materials and equipment to and from work sites. Barges will be moored with spuds or anchors and not allowed to ground.

1.3.3 Project Staging

No staging sites have been identified. If staging areas for equipment and materials are identified at a future date, they will occur in currently developed lots or managed fields, unless otherwise approved by the project biologist.

1.3.4 Future Maintenance

Maintenance of EHW-1 will not change as a result of repairs associated with the Proposed Action.

1.4 Best Management Practices, Mitigation and Minimization Measures

The Proposed Action includes best management practices (BMPs) for construction and other measures that will be implemented to minimize or avoid potential environmental impacts. Chapter 11 presents the measures to be implemented to reduce or avoid environmental impacts

1 "Proofing" is driving the pile the last few feet into the substrate to determine the capacity of the pile. The capacity is established by measuring the resistance of the pile to a hammer that has a piston with a known weight and stroke (distance the hammer rises and falls) so that the energy on top of the pile can be calculated. The blow count in "blows per inch" is measured to verify resistance, and pile compression capacities are calculated.

from the implementation of the proposed action. Additional minimization measures have been added to protect marine mammals and ESA-listed species, such as use of vibratory installation of piles where possible, implementation of noise attenuation, and marine mammal monitoring as described in Chapter 11 of this application.

Best management practices and minimization measures are included in construction contract plans and specifications for individual projects and must be agreed upon by the contractor prior to any construction activities. A signed contract represents a legal agreement between the contractor and the Navy. Failure to follow the prescribed BMP mitigation and minimization measures constitutes a contract violation.

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 Duration of Activities

No work will begin on the proposed action until all required permits and approvals are in place. Construction would occur when the wharf is not in operational use and would not disrupt operations at EHW-1. Construction associated with the Proposed Action is expected to begin on July 16, 2015. In-water work will comply with timing restrictions (or in-water work windows) by the Washington Department of Fish and Wildlife (WDFW) to avoid conducting activities when bull trout and juvenile salmon and steelhead are most likely to be present. The allowable time frame for in-water work at NAVBASE Kitsap Bangor is July 16 through January 15.

All in-water impact pile driving will occur during daylight hours except from July 16 to September 23, when impact pile driving will only occur starting 2 hours after sunrise and ending 2 hours before sunset to protect foraging marbled murrelets during the nesting season.

While sequencing of all proposed repair work has not been scheduled, work would likely proceed with removal of deck segments occurring first, followed by installation of the new concrete filled steel piles and pile caps. Only after the new piles have been installed and the pile caps have fully cured and reached design compressive strength, would removal of the existing concrete piles begin.

2.2 Region of Activity

NAVBASE Kitsap Bangor is located north of the city of Silverdale in Kitsap County on the eastern shoreline of northern Hood Canal (Figure 2-1). Hood Canal is a long, narrow fjord-like basin of western Puget Sound. Throughout its 67-mile length, the width of the canal varies from 1 to 2 miles and exhibits strong depth/elevation gradients and irregular seafloor topography in many areas. The width of the canal is approximately 1.5 miles at the project site, 2.2 miles at the northern end of NAVBASE Kitsap Bangor, and constricts to approximately 1.1 miles near the southern end near Hazel Point. Although no official boundaries exist along the waterway, the northeastern section of the canal extending from the mouth of the canal at Admiralty Inlet to the southern tip of Toandos Peninsula is referred to as northern Hood Canal.

Within northern Hood Canal, nearshore development is limited with NAVBASE Kitsap Bangor representing the only industrial waterfront. There are many nearshore structures in the southern portion of Hood Canal, primarily smaller docks. A few docks and a small pier occur at Seabeck, more than 8 miles (13 kilometers) south, and the Hood Canal Bridge, approximately 7 miles (11 kilometers) north of installation. The remainder of the northern Hood Canal shoreline is generally undeveloped.

The NAVBASE Kitsap Bangor waterfront occupies approximately 4.3 miles (7 kilometers) of the approximately 67-mile (108-kilometer) long eastern shoreline of Hood Canal. The entirety of NAVBASE Kitsap Bangor waterfront is restricted from general public access (Naval Restricted Areas 1 and 2 per 33 CFR 334.1220) (Figure 2-2). The project is located in the Washington Department of Ecology Water Resource Inventory Area 15 and U.S. Geological Service Hydrologic Unit Code 17110018, Hood Canal.

EHW-1 is located along the northern waterfront of NAVBASE Kitsap Bangor and is one of eight pile supported structures at the installation.

2.3 Activity Area Description

2.3.1 Marine and Bathymetric Setting

The Hood Canal is a long, narrow, fjord-like basin of western Puget Sound. Oriented northeast to southwest, the portion of the canal from Admiralty Inlet to a large bend, called the Great Bend, at Skokomish, Washington, is 52 miles long. East of the Great Bend, the canal extends an additional 15 miles to the headwaters at Belfair. Throughout its 67-mile length, the width of the canal varies from 1 to 2 miles and exhibits strong depth/elevation gradients and irregular seafloor topography in many areas. Although no official boundaries exist along the waterway, the northeastern section of the canal extending from the mouth of the canal at Admiralty Inlet to the southern tip of Toandos Peninsula is referred to as northern Hood Canal.

In northern Hood Canal, water depths in the center of the waterway near Admiralty Inlet vary between 300 and 420 feet (ft). As the canal extends southwestward toward the Olympic Mountain Range and Thorndyke Bay, water depths shoal to approximately 160 ft over a moraine deposit. This deposit forms a sill across the short axis of the canal in the vicinity of Thorndyke Bay, which limits seawater exchange with the rest of Puget Sound. The Bangor waterfront on NAVBASE Kitsap occupies approximately 5 miles of the shoreline within northern Hood Canal (1.7% of the entire Hood Canal coastline) and lies just south of the sill feature. Water depths along the Bangor waterfront are provided in Figure 2–3. The width of the canal ranges from 2.2 miles at the northern end of NAVBASE Kitsap Bangor to approximately 1.1 miles near the southern end near Hazel Point. The farthest direct line of site from the project site is 8.4 miles to the north and 4.2 miles to the south (see Figure 2-3).

2.3.2 Tides, Circulation, and Currents

The tides in Hood Canal are mixed, diurnal-semidiurnal with a range directly dependent upon the phase and alignment of the lunar and solar gravitational influences on the regional tides (URS 1994; Morris et al. 2008). The astronomic influences (tides) on water level within Puget Sound, including Hood Canal, result in one flood and one ebb tidal event with a small to moderate range (1 to 6 ft) and a second flood and second ebb with a larger range (8 to 16 ft) during a 24-hour and 50-minute tidal day. As a result, higher-high, lower-high, higher-low, and lower-low water levels are recorded within each tide day.

Since the tides within Hood Canal are mixed diurnal-semidiurnal, this body of water is subject to one major flushing event per tide day when approximately 1.1326 x 109 cubic yards (or 3% of the total canal volume) is exchanged over a 6-hour period. Due to the wide range of tidal heights that can occur in this body of water, the actual seawater exchange volume for Hood Canal ranges from 1% during a minor tide to 4% during a major tide.

Despite considerable tidally driven seawater influx within the basin, some studies have estimated water residence time in the southern and middle portions of Hood Canal can be up to one year due to the natural limitation on seawater exchange (i.e., bathymetry) (Warner et al. 2001; Warner 2007). However, at NAVBASE Kitsap Bangor, the majority of the daily volume of seawater exchange flows directly across the waterfront area. As a result, the degree of flushing that occurs is relatively high and the characteristics of this seawater more closely track the physical, chemical, and biological conditions of Puget Sound than southern Hood Canal.

2.3.3 Circulation and Currents

Tidal currents and resulting circulation patterns within Hood Canal are complex due to the configuration of the basin, as well as the mixed diurnal-semidiurnal tidal regime. Current measurements obtained from the reaches of northern Hood Canal in the summer of 2007 indicate that tidal phase and range have a significant impact to the velocity of currents associated with the flood and ebb tides (Morris et al. 2008). The larger tidal ranges promote higher velocity currents and increased flushing of the basin, while small to moderate tidal ranges yield a diminished tidal current regime and limit the volume of seawater exchange between Hood Canal and connecting waters of Puget Sound. Seawater that enters the canal from Admiralty Inlet during an incoming flood tide tends to be cooler, more saline, and well-oxygenated relative to the Hood Canal waters. As a result, the incoming water has a tendency to sink to the bottom of the canal as it flows over the sill and move south during each flood tide, while the lower density Hood Canal water tends to remain in the upper water column.

Current flow (speed and direction) along the Bangor waterfront is primarily a function of tidal action based on the phase and range of each tide within the mixed diurnal-semidiurnal regime, and current velocities in the shallower water areas (less than 50 ft) around the project area are variable and complex. The magnitude or instantaneous velocity of these fluctuating water column currents ranges from 0 to 0.88 foot per second (ft/sec) within the 30- to 65-foot water depth interval. However, current flow in any one direction is short-lived and inconsistent in magnitude, with relatively few periods of time when sufficient energy (0.7 ft/sec) exists to exceed the threshold for re-suspending deposits of unconsolidated material on the seafloor (Boggs 1995). Statistical summaries show that time-averaged net flow is within the 0.07 to 0.10 ft/sec range in the upper water column and less than 0.03 ft/sec in proximity to the seafloor.

The nearshore current observations at NAVBASE Kitsap Bangor piers and wharves in the summer of 2006 suggest that tidal currents were inconsistent with water level (tide) measurements. Rather than the typical relationship where maximum current corresponds to mid-flood or mid-ebb in the water level record, maximum flow velocities recorded along the waterfront aligned with water levels at the high and low tide. Furthermore, the direction of nearshore flow often ran counter to expectations in a normal system, with flood tide coinciding with northeastward currents and ebb tide resulting in southwesterly currents (Morris et al. 2008).

2.3.4 Sea State

Apart from larger impacts associated with large-scale changes in weather and ocean circulation in the Pacific Basin, seasonal variability in Hood Canal circulation can occur in the winter, when strong meteorological events (e.g., storms, high winds) are more prevalent. Regardless of direction, winds with velocities in excess of 25 knots occur relatively infrequently in the Puget Sound region (Morris et al. 2008). The typically light winds afforded by the surrounding highlands (Olympic and Cascade Mountain Ranges) coupled with the fetch-limited environment of Hood Canal result in relatively calm wind conditions throughout most of the year. However, the northern and middle sections of Hood Canal are oriented in the southwest to northeast direction. Therefore, organized coastal storm events that reach land in the late autumn and winter months, as well as fair weather systems in the spring and summer exhibiting wind speeds in excess of 20 knots, have the capability to generate substantial wind waves due to increased fetch and/or alter normal tidal flow within the basin. However, much of the Bangor waterfront area is afforded some protection by the coastline of both Kitsap and Toandos Peninsulas.

However, the Project Area is afforded some protection by the coastline of both Kitsap and Toandos Peninsulas (see Figure 2-3). Using a maximum fetch of 8.4 miles between the Project Area and the north shore of Thorndyke Bay to the north-northeast, estimates indicate that a 20-knot sustained wind has the capability to generate average wave heights of 1.9 feet (Beaufort Sea State [BSS] of 2) and a 30-knot wind event could produce wave heights of 3.1 feet (BSS = 3) (CERC 1984). The maximum fetch to the southwest is one-half that to the northeast (4.2 miles), which could yield average waves of 1.3 feet in height (BSS = 2) in a 20-knot wind and 1.9 feet (BSS =2) in a 30 knot wind. Maximum wave heights in these weather conditions could be 67 percent higher than average estimates reported above. Thus, a weather event capable of generating waves with an average height of 3.1 feet (BSS = 3) could also yield waves with maximum heights of 5.1 feet (BSS = 4) (CERC 1984).

2.3.5 Water Temperature

Water temperatures in the Strait of Juan de Fuca and Puget Sound typically range from 44 to 46 degrees Fahrenheit (°F) throughout the winter months (mid-December through mid-March). Surface waters slowly warm throughout the spring and summer due to increased solar heating, reaching temperatures of 50°F in mid-May or early June to a maximum temperature of 54°F during the month of August. Beginning in September, water temperatures begin to decrease over time, falling 6 to 8°F over the next 3 months due to decreasing levels of solar radiation. Occasionally, anomalies in this pattern of heating and cooling are detected in the data record, but are often short in duration (1 to 2 weeks). Monthly mean water temperatures along the Bangor waterfront on NAVBASE Kitsap in 2005–2006 are summarized in Table 2–1. Similar water temperature patterns were measured in 2007–2008 (Hafner and Dolan 2009). Nearshore areas (water depths range from 1 to 60 meters) are susceptible to greater temperature variations due to seasonal fluxes in solar radiation input.

Table 2–1. Monthly Mean Surface Water Temperatures (°C/°F)

Sampling Month	Nearshore Temperature	Offshore Temperature
July 2005	14.3°C (57.8°F)	11.6°C (52.9°F)
August 2005	13.8°C (56.8°F)	13.5°C (56.3°F)
September 2005	14.9°C (58.8°F)	11.6°C (52.9°F)
January 2006	8.2°C (46.8°F)	---
February 2006	8.1°C (46.6°F)	---
March 2006	8.5°C (47.3°F)	8.3°C (46.9°F)
April 2006	9.6°C (49.3°F)	9.3°C (48.7°F)
May 2006	10.9°C (51.6°F)	11.0°C (51.8°F)
June 2006	13.2°C (55.8°F)	---

Source: Phillips et al. 2009
°C = degrees Celsius; °F = degrees Fahrenheit
Data are from 13 nearshore and 4 offshore stations along the Bangor waterfront on NAVBASE Kitsap.
--- No data were collected at this depth during this sampling month.

2.3.6 Water Quality

The federal Clean Water Act requires that all states restore their waters to be "fishable and swimmable." Section 303(d) of the Clean Water Act established a process to identify and clean up polluted waters. Every two years, all states are required to perform a water quality assessment of the quality of surface waters in the state, including all the rivers, lakes, and marine waters where data available. Ecology compiles its own water quality data, and invites other groups to submit water quality data they have collected.

Waters whose beneficial uses – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants are placed in the “polluted water” category (Category 5) on the water quality assessment. Categories range from Category 1, waters that meet tested standards for clean waters, to Category 5, waters that fall short of state surface water quality standards and are not expected to improve within the next two years. The 303(d) list is comprised of those waters that have been designated as Category 5, impaired.

Waters placed on the 303(d) list require the preparation of a water cleanup plan, like a total maximum daily load (TMDL). The TMDL identifies how much pollution needs to be reduced or eliminated to achieve clean water. It identifies the maximum amount of a pollutant to be allowed to be released into a water body so that the beneficial uses of the water are not impaired.

NAVBASE Kitsap Bangor is located within an area of Hood Canal classified as “Class AA,” defined as “water quality that markedly and uniformly exceeds the requirements for all or substantially all uses” (WDOE 2005). Dissolved Oxygen (DO) levels within the Hood Canal are known to reach very low levels in the summer months and early fall months (a.k.a. hypoxia). This is especially true in the southern Hood Canal where natural and man-made environments combine to create conditions that can be potentially lethal to some underwater species. Water segments of Hood Canal adjacent to and north of NAVBASE Kitsap Bangor are designated Category 5, impaired waters, for exceedances of dissolved oxygen (WDOE 2014a). Areas of Hood Canal near the base have also been listed as Category 2, waters of concern, for isolated exceedances of bacteria (fecal coliform) and pH.

2.3.7 Stratification and Salinity

The waters of Hood Canal near NAVBASE Kitsap Bangor reflect a stratified water column with less saline surface water overlying cooler saline water with depth. The salinity of the upper water layer is sensitive to the amount of freshwater input and may become more diluted during heavy precipitation (URS 1994). Variances due to seasonal changes (such as freshwater input, wind-induced mixing, and solar heating) are common (URS 1994).

Freshwater input into Hood Canal comes from creeks, rivers, groundwater (including artesian wells [deep underground aquifer]), and stormwater outfalls. The freshwater inputs affect the salinity in Hood Canal. Artesian wells also contribute to freshwater inputs, with estimated flows of 2,000 to 2,500 gallons per minute (Washington Department of Ecology [WDOE] 1981). Overland flow from much of the western portion of NAVBASE Kitsap Bangor is routed to Hood Canal through a series of stormwater outfalls. Saltwater and freshwater mixing zones exist at the mouths of each of these streams and outfalls (URS 1994).

During water quality surveys from 2005 through 2008, average surface water salinity levels along the NAVBASE Kitsap Bangor waterfront ranged from 24 to 34 practical salinity units (PSU) (Phillips et al. 2009) Salinity measurements with depth reflected a stratified water column, with less saline surface water overlying cooler saline water at depth. The transition between the lower salinity surface waters and higher salinity subsurface waters occurred at a depth of about 33 feet (Phillips et al. 2009). The lowest surface water salinity (18.47 PSU) was measured in February 2007 when freshwater (low salinity) input may have been high due to winter storms and runoff (Hafner and Dolan 2009). The range of salinity along the NAVBASE Kitsap Bangor waterfront is typical for marine waters in Puget Sound (Newton et al. 1998, 2002).

2.3.8 Sediments

Existing sediment information is based on results from sampling near the Project Area during 2007 (Hammermeister and Hafner 2009); sampling locations are shown in Figure 2-4. Sediment quality at the project site is generally good; levels of contaminants meet applicable state standards. Marine sediments are composed of gravelly sands with some cobbles in the intertidal zone, transitioning to silty sands in the subtidal zone (Hammermeister and Hafner 2009).

Subsurface coring studies conducted in 1994 found the presence of glacial till approximately 6 feet below mud line in the intertidal zone, increasing to over 10 feet in the subtidal zone (URS 1994). The composition of sediment samples from the Project Area ranged from 65 to 100 percent for sand, less than 1 to 7 percent for gravel, 2 to 32 percent silt, and 2 to 11 percent clay.

2.3.9 Ambient Sound

2.3.9.1 Ambient Underwater Sound

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

Human-generated sound is a significant contributor to the ambient acoustic environment along the NAVBASE Kitsap Bangor waterfront. Normal port activities include vessel traffic from large ships, support vessels and security boats, and loading and maintenance operations, which all generate underwater sound (Urick 1983). Other sources of human-generated underwater sound not specific to the installation include sounds from echo sounders on commercial and recreational vessels, industrial ship noise, and noise from recreational boat engines. Ship and small boat noise comes from propellers and other on-board rotating equipment.

The underwater acoustic environment at EHW-1 will vary depending on the amount of anthropogenic activity, weather conditions, and tidal currents. Anthropogenic noise may dominate the ambient soundscape when operational activities are occurring. At other times with less anthropogenic activity, ambient sound is likely to be dominated by sound from natural sources.

Underwater ambient sound was recorded and measured at NAVBASE Kitsap Bangor during previous Navy activities. In 2009, the average broadband (100 Hz–20 kHz) sound level near Marginal Wharf on NAVBASE Kitsap Bangor was 114 dB re 1µPa rms (Slater 2009). Below 300 Hz, noise from industrial activity dominated the spectrum, with a maximum level of 110 dB rms in the 125 Hz band. From 300 Hz to 5 kHz, average received levels ranged between 83 and

99 dB rms. Wind-driven wave sound dominated the background sound between 5 and 10 kHz; above 10 kHz, the sound levels were relatively even at all frequencies.

Similar sound levels were recorded near EHW-1 during the Test Pile Program at NAVBASE Kitsap Bangor in 2011. Average sound levels ranged from 112.4 dB rms at mid depth to 114.3 dB rms at deep depth (Illingworth & Rodkin 2012). These measurements were made during normal port activities, but did not include noise from construction and pile driving projects. Small-scale geographic variations in ambient sound are to be expected based on land shadowing and other environmental factors, but for analysis purposes, the average sound level at EHW-1 was assumed to be 114 dB rms.

Ambient sound measurements from NAVBASE Kitsap Bangor are well within the range of levels reported for a number of sites within the greater Puget Sound region (95 – 135 dB rms; Veirs and Veirs 2005; Carlson et al. 2005). Nearshore broadband measurements near ferry terminals in Puget Sound resulted in median sound levels (50% cumulative distribution function) between 104 and 130 dB rms (WSDOT 2012).

2.3.9.2 Ambient Airborne Sound

Airborne sound at the Bangor waterfront is produced by common industrial equipment, including trucks, cranes, compressors, generators, pumps, and other equipment that might typically be employed along industrial waterfronts; and airborne sound is produced by other sounds such as sea lions. Sound levels are highly variable based on the types and operational states of equipment at the recording location, and sound levels may even vary within a single installation, with some piers/wharfs very loud and others relatively quiet. Data from airborne ambient sound measurements are currently only available for a short time at NAVBASE Kitsap Bangor.

Airborne sound was measured at Delta Pier within the waterfront industrial area at NAVBASE Kitsap Bangor during a two-day period in October 2010. During this period, daytime sound levels ranged from 60 dBA to 104 dBA, with average values of approximately 64 dBA. Evening and nighttime levels ranged from 64 to 96 dBA, with an average level of approximately 64 dBA. Thus, daytime maximum levels were higher than nighttime maximum levels, but average nighttime and daytime levels were similar (U.S. Department of the Navy 2010). Measurements, taken during the Navy's Test Pile Program located near EHW-1, indicated an average airborne ambient sound level of 55 dBA (Illingworth & Rodkin 2012). Maximum sound levels from the 2010 recordings were produced by a combination of sources including heavy trucks, forklifts, cranes, marine vessels, mechanized tools and equipment, and other sound-generating industrial/military activities. Maximum sound levels were intermittent in nature and not present at all times. Based on the sound levels measured at the highly industrial location at Delta Pier, the Navy estimated that maximum airborne sound levels at pier locations with a high level of industrial activity may reach as high as 104 dBA due to trucks, forklifts, cranes, and other industrial activities. Sound levels will vary by time and location, but average background sound levels are expected to range from approximately 55 dBA (average from Test Pile Program at NAVBASE Kitsap Bangor) to 64 dBA (average levels measured at Delta Pier at NAVBASE Kitsap Bangor (Illingworth & Rodkin 2012).

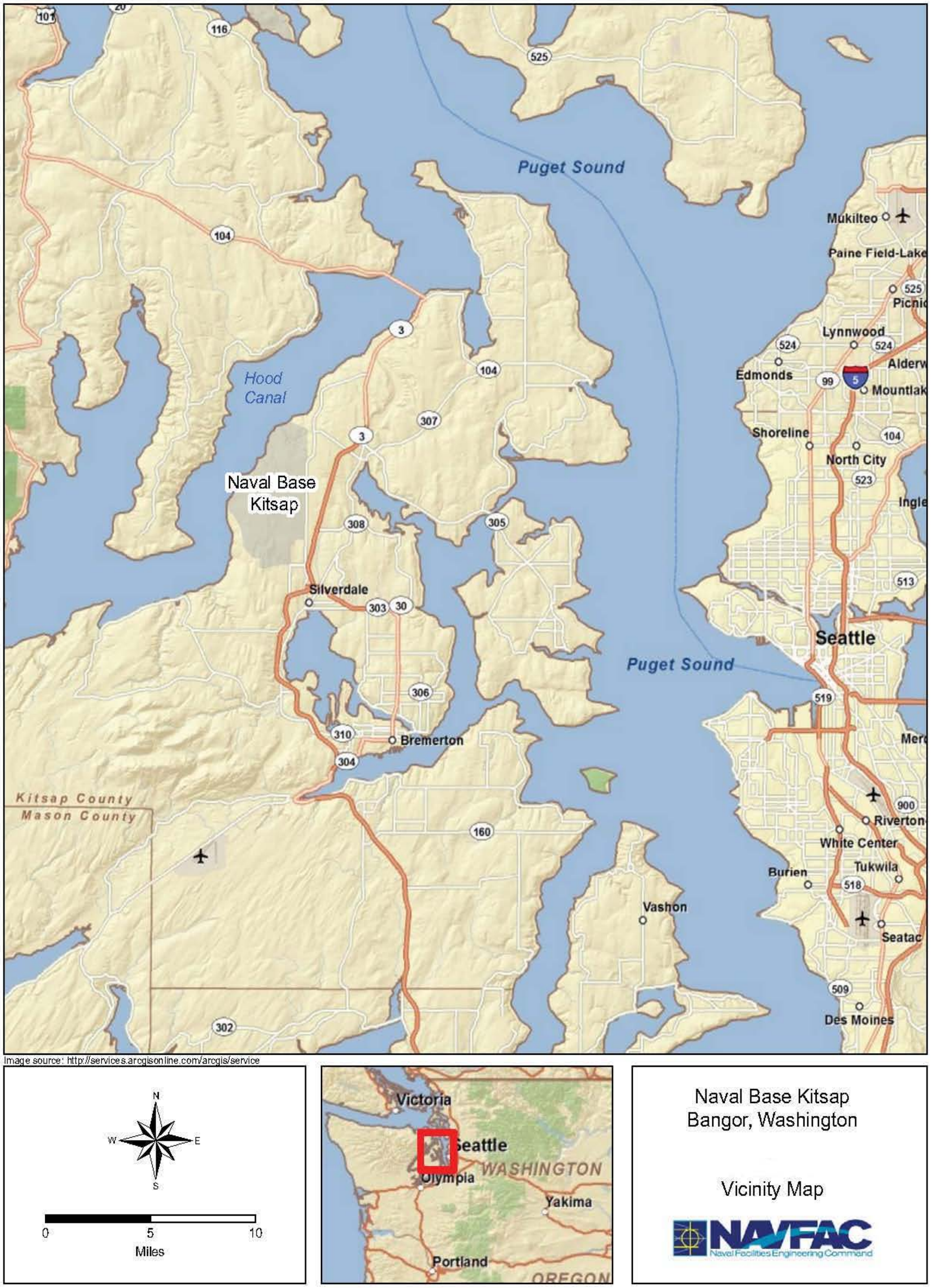

Figure 2-1. NAVBASE Kitsap Bangor Vicinity Map

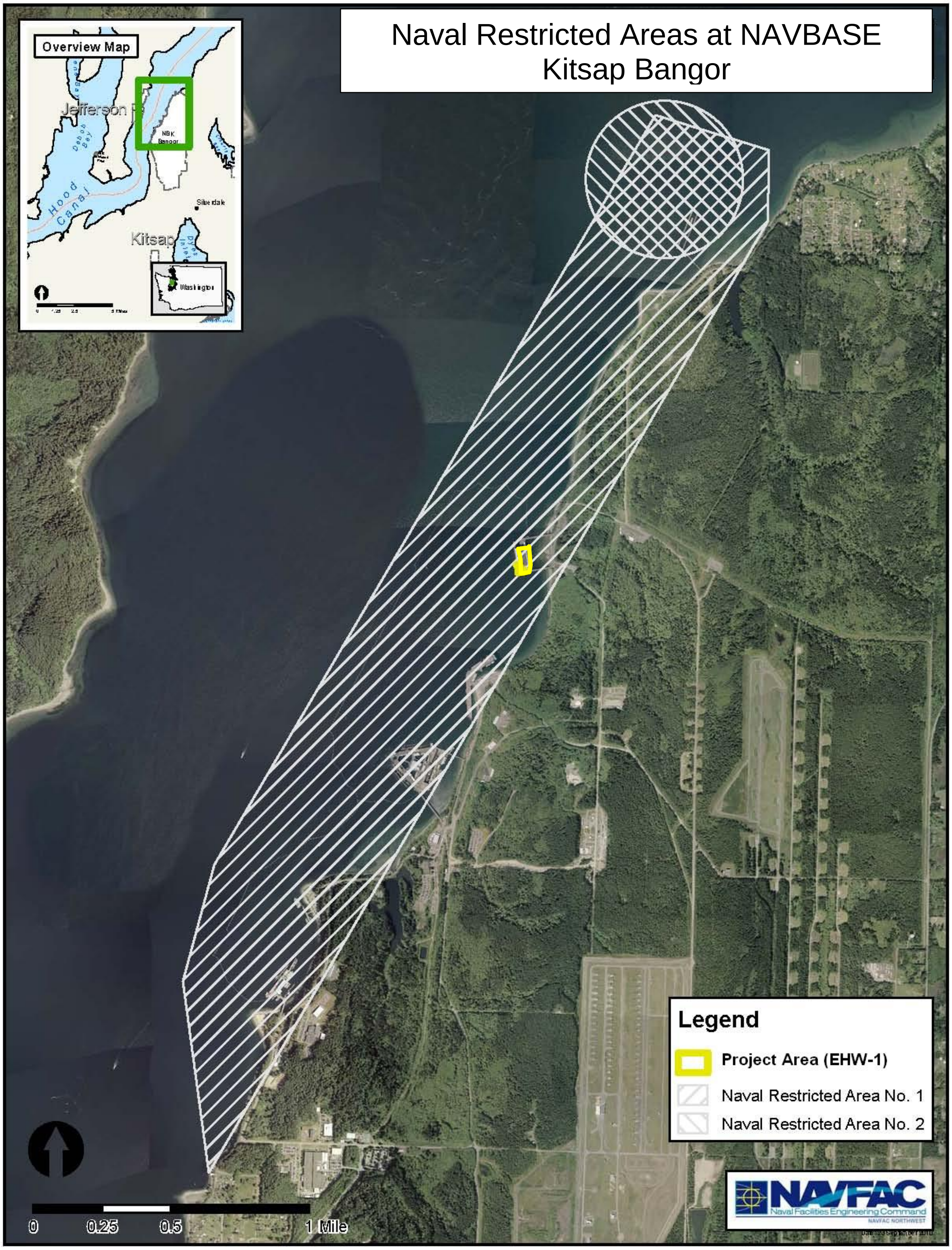

Figure 2-2. Restricted Areas at NAVBASE Kitsap Bangor

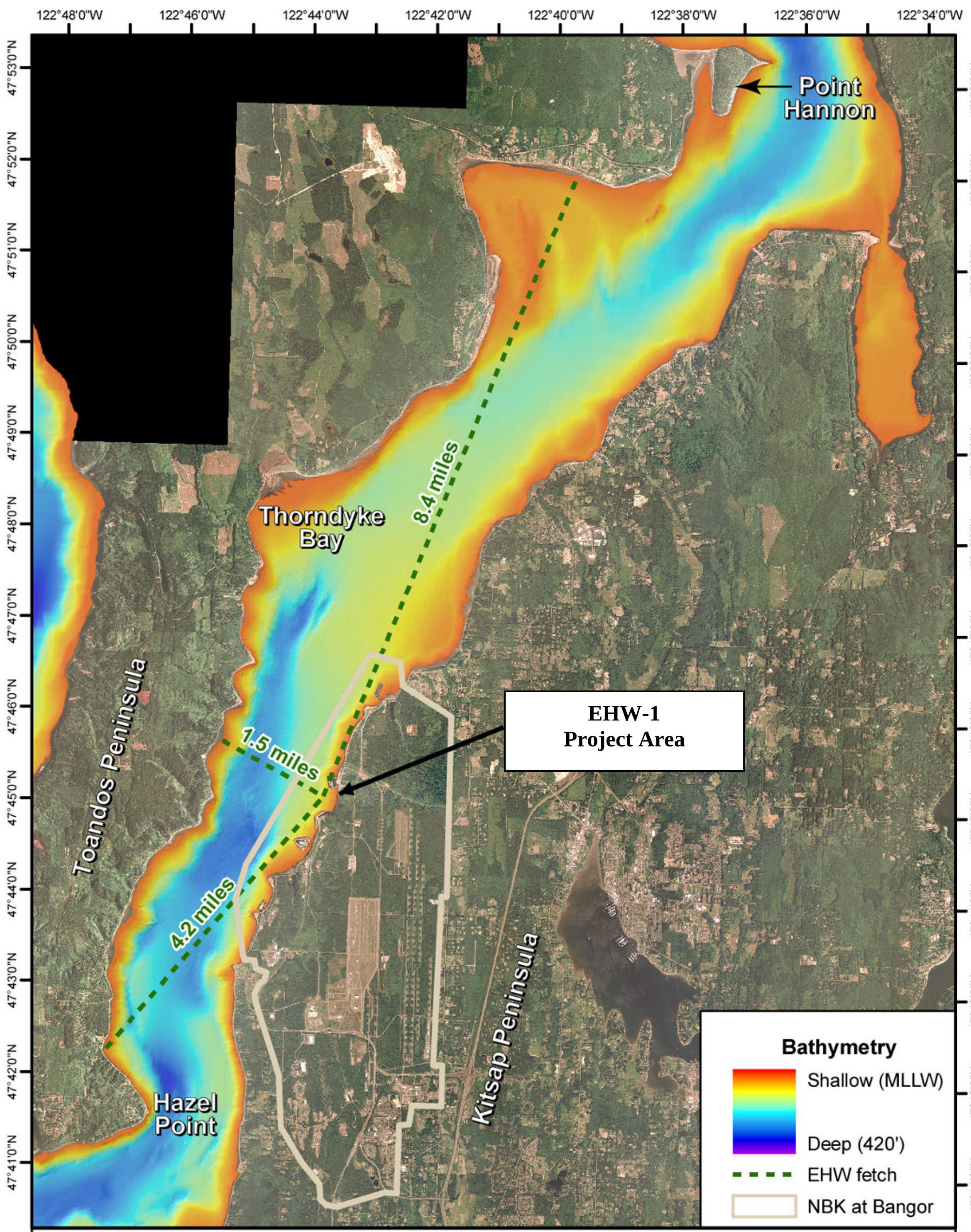

Figure 2-3. EHW-1 Bathymetry & Maximum Fetch

0 1 2
Miles

NOTE:
Coordinate System: WA State Plane (North)
Horizontal Datum: NAD83
Vertical Datum: MHW
Units: feet
DEM provided by University of Washington

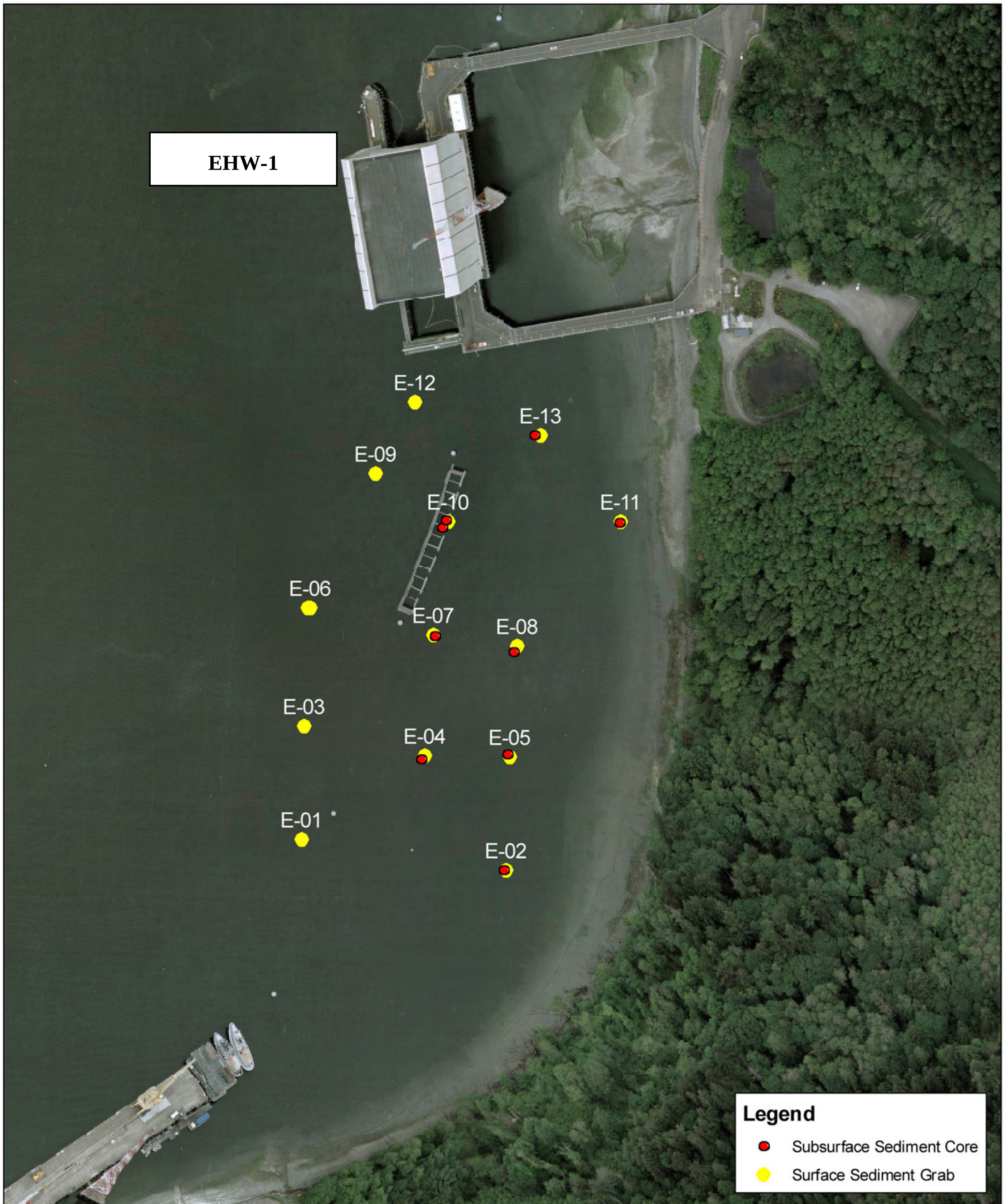

Figure 2-4. Sediment Sampling Locations

Projection: Lambert Conformal Conic
Datum: NAD 83

Feet 0 75 150 300 450 600

Source: Hammermeister and Hafner 2009

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3 Marine Mammal Species and Numbers

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

Five marine mammal species managed by NMFS have a reasonable potential to occur within Hood Canal (Table 3-1). A reasonable potential was defined as species with any regular occurrence in Hood Canal since 1995. None of these species are listed under the ESA. Stock abundance and ESA status of these species is listed in Table 3–1. Section 3.1 provides a description of each of the species analyzed and their population abundance. Section 4 contains a description of the status, distribution, and seasonal distribution (when applicable) and site-specific occurrence information for each species.

Table 3-1. Marine Mammals Potentially Present within Hood Canal

Species and Stock	Stock Abundance[1]	ESA Status
Killer Whale (*Orcinus orca*) West Coast Transient	243[2]	None
Harbor Porpoise *(Phocoena phocoena)* Washington Inland Waters	10,682[3] (CV=0.38)	None
Steller Sea Lion (*Eumetopias jubatus*) Eastern United States/DPS	63,160-78,198[2]	None
California Sea Lion (*Zalophus californianus*) United States	296,750[4]	None
Harbor Seal (*Phoca vitulina*) Hood Canal	3,055 in 1999[5]	None

Sources:
1. NMFS marine mammal stock assessment reports at: http://www.nmfs.noaa.gov/pr/sars/species.htm.
2. Allen and Angliss 2014. West Coast Transient estimate is considered a minimum estimate.
3. J. Laake, unpublished data as cited in Carretta et al. 2014.
4. Carretta et al. SAR 2011 as presented in Carretta et al. 2014.
5. Derived from Jeffries et al. 2003 and London et al. 2012.

CV = coefficient of variation; DPS = Distinct Population Segment

Four rare species documented in Hood Canal are not carried forward in the analysis because they are unlikely to be present during project construction; humpback whale, gray whale, Southern Resident killer whale, and Dall's porpoise. The rationale for exclusion of each species is outlined below.

- Humpback whales are occasionally present in small numbers in Puget Sound, but few records exist for Hood Canal. A humpback whale was sighted in Hood Canal several times in January and February 2012 and again in 2015 (Orca Network 2012, 2015). Review of the 2012 sightings information indicated they were of one individual (Calambokidis 2012, personal communication). Prior to the 2012 sightings, there were no confirmed reports of humpback whales entering Hood Canal (Calambokidis 2012, personal communication). Only a few records of humpback whales near Hood Canal (but north of the Hood Canal Bridge) are in the Orca Network database.

- Gray whales have been sighted in Hood Canal upstream from the Hood Canal Bridge on only six occasions since 1999, including a stranded whale at Belfair State Park (Calambokidis 2013, personal communication). The most recent report in Hood Canal was of characteristic "blows" (air exhaled through the whale's blowhole) in the waters near Lilliwaup in November 2010 (Calambokidis 2013, personal communication).
- The Southern Resident killer whale stock is resident in the inland waters of Washington State and British Columbia; however, it has not been seen in Hood Canal since 1995 (19 years ago).
- Dall's porpoises may occasionally occur in Hood Canal (Jeffries 2006, personal communication); one was observed in deeper water in the vicinity of NAVBASE Kitsap Bangor in summer 2008 during boat-based surveys of the naval base waterfront (Tannenbaum et al. 2009). No other records of occurrence in Hood Canal were found in a review of databases and other records.

3.1 Species Abundance

3.1.1 Killer Whale, West Coast Transient Stock

A recent mark-recapture estimate that does not include the "outer coast" subpopulation or whales from California for the west coast transient population resulted in an estimate of 243 (95% probability interval = 180-339) in 2006 (DFO 2009, as cited in Allen and Angliss 2014). This estimate applies to the population of west coast transient whales that occur in the inside waters of southeastern Alaska, British Columbia, and northern Washington. Because the California transient numbers have not been updated since the publication in 1997, the total number of transient killer whales reported above should be considered as a minimum count for the west coast transient stock (Allen and Angliss 2014).

3.1.2 Harbor Porpoise

Aerial surveys of the inside waters of Washington and southern British Columbia were conducted during August of 2002 and 2003 (J. Laake, unpublished data as cited in Carretta et al. 2014). These aerial surveys included the Strait of Juan de Fuca, the San Juan Islands, the Gulf Islands, and the Strait of Georgia, which includes waters inhabited by the Washington Inland Waters stock of harbor porpoise, as well as, harbor porpoises from British Columbia. An average of the 2002 and 2003 estimates of abundance in U.S. waters resulted in an uncorrected abundance of 3,123 (CV=0.10) harbor porpoises in Washington inland waters (J. Laake, unpublished data as cited in Carretta et al. 2014). When corrected for availability and perception bias, using a correction factor of 3.42 (1/g(0); g(0)=0.292, CV=0.366) (Laake et al. 1997, as cited in Carretta et al. 2014), the estimated abundance for the Washington Inland Waters stock of harbor porpoise in 2002/2003 is 10,682 (CV=0.38) animals (J. Laake, unpublished data as cited in Carretta et al. 2014). However, because the most recent abundance estimate is greater than 8 years old, there is no current estimate of abundance available (Carretta et al. 2014).

3.1.3 Steller Sea Lion

The Eastern stock was estimated by NMFS in the Recovery Plan for the Steller Sea Lion to number between 45,000 to 51,000 animals (NMFS 2008). This stock has been increasing approximately 3% per year over the entire range since the late 1970s (NMFS 2012a). The most recent population estimate for the Eastern stock ranges from 58,334 to 72,223 (Allen and Angliss 2014).

3.1.4 California Sea Lion

The current population estimate for the U.S. stock of California sea lions is 296,750 (Carretta et al. 2011 SAR as presented in Carretta et al. 2014). The entire population cannot be counted because all age and sex classes are not ashore at the same time during field surveys. In lieu of counting all sea lions, pups are counted during the breeding season (because this is the only age class that is ashore in its entirety), and the number of births is estimated from the pup count. The size of the population is then estimated from the number of births and the proportion of pups in the population (Carretta et al. 2011 SAR as presented in Carretta et al. 2014).

3.1.5 Harbor Seal

The most recent abundance estimate for harbor seals in Hood Canal is greater than 8 years old; therefore, there is no current estimate of abundance (Carretta et al. 2014). However, harbor seals are the most numerous pinniped in the inland marine waters of Washington. A population estimate for harbor seal in Hood Canal of 1,088 (711 X 1.53; CV = 0.15) was derived from data collected in 1999 by aerial surveys and a correction factor from Huber et al. (2001) to account for animals in the water (Jeffries et al. 2003, as presented in Carretta et al. 2014). More recent tagging information resulted in an updated haul out correction factor for harbor seals in Hood Canal. Tagging data collected by London et al (2012) during the same time of year (month) and time of day as the original 1999 aerial surveys, estimated 20% of harbor seals in Hood Canal were hauled. Therefore, the aerial surveys represented only 20% of the population. Using this information, the 1999 Hood Canal population estimate was updated to approximately 3,555 animals. The density estimate used in this application assumed a uniformed distribution of the 3,555 harbor seals in Hood Canal divided by the area of Hood Canal (358.44 sq. km) for an estimate of 9.92 individuals/sq. km. However, harbor seals are not uniformly distributed in Hood Canal because major haulouts are located on the western side of the Canal and in Dabob Bay. In addition, all individuals will not be in the water at one time (London et al. 2012). In Hood Canal, the number of harbor seals hauled out varies by season, tidal height, time of day, and year (London et al. 2012). Variation by year was associated with significant predatory events by transient killer whales (see 4.1.3). Therefore, the actual number of harbor seals likely to be exposed was reduced to 80% of the total estimated population, resulting in a density of 7.93 animals/ sq km.

3.2 Estimates of Site-Specific Occurrence

Estimating potential marine mammal occurrence over time and space can be challenging. Prior Navy marine mammal IHA applications for construction projects in Hood Canal relied on density estimates for some or all species exposure estimates. Analyses based on species density assume that marine mammals are uniformly distributed within a given area at any given point in time. This assumption is rarely true for marine mammal species in Hood Canal because many of the species are not resident, but occasionally or seasonally present. Additionally, most species are not distributed evenly but occur clumped in groups. Distribution of individuals or groups does not occur uniformly in space but is biased by areas of greater importance, such as areas of high prey abundance, haulout sites, or areas with lower predation risk, etc. For example, density estimates near haulouts or foraging location would be expected to be a function of distance from the attracting haulout and number of animals utilizing the haulout or foraging location.

To characterize potential species occurrence, this application utilized density information available for Puget Sound and recent research and survey information conducted on-site or in Puget Sound. The Navy also discussed species occurrence with local species experts and reviewed incidental sighting reports from the OrcaNetwork for verified or reasonably verified species presence, as well as information on seasonal, intermittent, or unusual species occurrences. Based on a review of this information, the Navy separated species into three groups to predict numbers present during the in-water work period:

1. Species with rare or infrequent occurrence in Hood Canal.
2. Species with routine occurrence, but no site-specific survey information.
3. Species with site-specific survey information.

In the case of species with rare or infrequent occurrence in all or part of Hood Canal, the Navy reviewed historical temporal and spatial distribution to predict potential numbers of animals during the in-water work period. One species, transient killer whale, fit this category (Table 3-2). Transient killer whales have been seen in Hood Canal twice, in 2003 and 2005, over the last 11 years (see Section 4.1.3). Therefore, there is a low likelihood the animals would be present during the potential 8 days pile driving will occur at the EHW-1 project site. Therefore, a methodology that assumes at any point in time these animals are present or uniformly distributed, either in time or space, would have little chance of predicting actual occurrence. Because the whales could occur, if they did occur, we assumed an average pod size predicted for Puget Sound, 6 animals (see Section 4.1.3), would be present.

Table 3-2. Analysis Method (Bolded) and Estimated Density Where Applicable

	Rare/Infrequent Occurrence	Routine Occurrence W/out Site-specific Data	Site-specific Survey Information Available.
Killer Whale	**Yes/Historical**	No	No
Harbor Porpoise	No	**Yes/Density 0.149 animals/sq km[1]**	No
Steller Sea Lion	No	No	**Yes**
California Sea Lion	No	No	**Yes**

Harbor Seal	No	**Yes/Density** 9.92 **animals/sq km**[2]	**No**

[1]See Section 4.2.3. In-water work season is the period from July 16-January 15.
[2]London et al. 2012.

For harbor porpoises that have routine occurrence, this application assumes that individuals are relatively uniformly distributed and uses densities within the in-water work period to estimate number of individuals potentially present.

Harbor seals along the NAVBASE Kitsap Bangor waterfront presented a unique challenge for estimating abundance in this application. Harbor seal haulouts at NAVBASE Kitsap Bangor were unknown, and have not been surveyed. Recent information indicates harbor seals are hauling out in small numbers at Service Pier and Marginal Wharf. Because no surveys have been conducted specific to these locations and prior IHA applications have successfully used the density for take calculations, this application also uses a density estimation method for harbor seals along the Bangor waterfront. The estimated density of harbor seals in Hood Canal is explained in Section 3.1.5. For assessing impacts to harbor seals in the water from underwater noise, the density value, 9.92 (Table 3-2), was multiplied by 0.8 since a portion of the population would be expected to be hauled out and not exposed to underwater sound sources. Therefore, the density estimate used in this application is 7.93 animals/sq km.

Finally, in locations where a reasonable assessment of marine mammal occurrence can be determined from on-site surveys, survey numbers and trends are used as the best predictor of abundance during the in-water work period. For this application, survey information is available for California sea lions and Steller sea lions hauled out at NAVBASE Kitsap Bangor. Prior NAVBASE Kitsap Bangor applications considered the best descriptor of probable occurrence to be the average of the maximum count of each sea lion species over the months when pile driving work would be conducted (e.g. average monthly maximum for the months when pile driving will occur). For this application, pile driving will occur for a maximum of 8-days, so all months within the in-water work window were not averaged because all pile driving work could occur during the month with the highest number of individuals present. Therefore, the month with the highest average monthly maximum over all survey years was used. For Steller sea lions, the month with the highest monthly average was November with 5.7 Steller sea lions. Therefore, rounding to the nearest whole number, 6 Steller sea lions were assumed to be present on any day when pile driving would occur. For California sea lions, November was also the month with the highest monthly average at 70.5 California sea lions. Rounding to the nearest whole number, 71 California sea lions were assumed to be present on any day when pile driving would occur.

Descriptions of all Navy survey efforts at NAVBASE Kitsap Bangor are described in Appendix A.

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4 Affected Species Status and Distribution

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

Marine mammal species managed by NMFS that potentially occur in the project area and may be affected by the proposed action belong to two taxonomic groups: cetaceans (killer whale and, harbor porpoise) and pinnipeds (Steller sea lions, California sea lions, and harbor seals). This section includes information on each species' stock status, abundance, and distribution (including seasonal information if available). Some of these sections contain direct excerpts from most current stock assessment reports developed by NMFS.

4.1 Killer Whale, West Coast Transient Stock

4.1.1 Status and Management

Among the genetically distinct assemblages of killer whales in the northeastern Pacific, the West Coast Transient stock, which occurs from California to southeastern Alaska, is one of two stocks that may occur in the Study Area. The other is the Southern Resident Killer whale population is addressed separately. Killer whales belonging to the West Coast Transient stock are protected under the MMPA, but not listed under the ESA.

4.1.2 Distribution

The geographical range of the West Coast Transient stock of killer whales includes waters from California through southeastern Alaska with a preference for coastal waters of southern Alaska and British Columbia (Krahn et al. 2002). Transient killer whales in the Pacific Northwest spend most of their time along the outer coast of British Columbia and Washington, but visit inland waters in search of harbor seals, sea lions, and other prey. Transients may occur in inland waters in any month (Orca Network 2012), but several studies have shown peaks in occurrences: Morton (1990) found bimodal peaks in spring (March) and fall (September to November) for transients on the northeastern coast of British Columbia, and Baird and Dill (1995) found some transient groups frequenting the vicinity of harbor seal haulouts around southern Vancouver Island during August and September, which is the peak period for pupping through post-weaning of harbor seal pups. However, not all transient groups were seasonal in these studies and their movements appear to be unpredictable.

The number of West Coast Transient killer whales in Washington inland waters at any one time was considered likely to be fewer than 20 individuals (Wiles 2004). Recent research suggests that the transient killer whales use of inland waters from 2004 through 2010 has increased and the trend is likely due to increasing prey abundance (Houghton et al. in review). Many of the West Coast Transients in Washington inland waters have been catalogued by photo identification. However, unlike the Southern Resident stock, re-sighting uniquely identified individuals is less frequent.

4.1.3 Site Specific Occurrence

Transient killer whales were observed in Hood Canal in 2003 and 2005, but have not been observed since. Killer whales were historically documented in Hood Canal by sound recordings in 1958 (Ford 1991), a photograph from 1973, sound recordings in 1995 (Unger 1997), and also anecdotal accounts of historical use.

West Coast Transient killer whales most often travel in small pods of up to four individuals (Baird and Dill, 1996). Houghton (pers. comm. 2012) reported that the group size most often observed in the Salish Sea was four whales for 2004–2010, is larger than the size most often observed from 1987-1993, and that group size appeared to be increasing from 2004–2010. According to Houghton unpublished data, the most commonly observed group size in Puget Sound (Puget Sound definition is as defined in Section 2 – waters east of Admiralty Inlet [including Hood Canal] through South Puget Sound and up to Skagit Bay) from 2004 to 2010 is 6 whales (mode=6, mean=6.88) (Houghton pers. comm. 2012). Occasionally larger groups may occur (OrcaNetwork 2012). Houghton noted that a group of up to 27 animals was observed in Puget Sound in 2010 (Houghton pers. comm. 2012).

4.2 Harbor Porpoise

4.2.1 Status and Management

Harbor porpoises are protected under the MMPA, but not listed under the ESA. NMFS conservatively recognizes two stocks in Washington waters: the Oregon/Washington Coast stock and the Washington Inland Waters stock (Carretta et al. 2013, as presented in Carretta et al. 2014). Individuals from the Washington Inland Waters stock are expected to occur in Puget Sound.

4.2.2 Distribution

In Washington Inland waters, harbor porpoise are known to occur in the Strait of Juan de Fuca and the San Juan Island area year-round (Calambokidis and Baird 1994; Osmek et al. 1995; Carretta et al. 2012). Harbor porpoises were historically one of the most commonly observed marine mammals in Puget Sound (Scheffer and Slipp 1948); however, there was a significant decline in sightings beginning in the 1940s (Everitt et al. 1979; Calambokidis et al. 1992), but recent increased sightings may indicate a return to the area. Only a few sightings were reported between the 1970s and 1980s (Calambokidis et al. 1992; Osmek et al. 1995; Raum-Suryan and Harvey 1998), and no harbor porpoise sightings were recorded during multiple ship and aerial surveys conducted in Puget Sound (including Hood Canal) in 1991 and 1994 (Calambokidis et al. 1992; Osmek et al. 1995). Incidental sightings of marine mammals during aerial bird surveys conducted as part of the PSAMP detected few harbor porpoises in Puget Sound between 1992 and 1999 (Nysewander et al. 2005). However these sightings may be negatively biased due to the low elevation of the plane which may have caused an avoidance behavior. The apparent decline in harbor porpoises observed since the 1940s may be due to by-catch from gill net fisheries coupled with the sharp decline of the herring fishery. Since 1999, PSAMP data and stranding data documented increasing numbers of harbor porpoise in Puget Sound, indicating that the species may be returning to the area (Nysewander 2008; WDFW 2008; Jeffries 2013).

4.2.3 Site Specific Occurrence

Sightings in Hood Canal north of the Hood Canal Bridge have increased in recent years (Calambokidis pers. comm. 2010). The Navy conducted nearshore marine mammal boat surveys of the Bangor waterfront area from July to September 2008 and from November to May 2010 and vessel line-transect surveys in Hood Canal and Dabob Bay from September through October

2011 for the Test Pile Program (see Appendix A). Based on observations during track line transect surveys, harbor porpoises were seen commonly during surveys with the number of individuals sighted in the deeper water of Hood Canal ranging from 0 to 11 individuals, with an average of approximately six animals sighted per day (Navy 2012). The maximum group size per sighting was six individuals (mean 1.8) (Navy 2012). In comparison, Baird (2003) reported a group size range of 1 to 8 individuals in Canadian waters.

Density of harbor porpoises was estimated from the 2011 trackline surveys based on guidance from other line transect surveys conducted for harbor porpoises using similar monitoring parameters (i.e., boat speed, number of observers, etc.) (Barlow 1988; Calambokidis et al. 1993; Carretta et al. 2001), the Navy determined the effective strip width for the surveys to be one kilometer or a perpendicular distance of 500 meters from the transect to the left or right of the vessel. The effective strip width was set at the distance at which the detection probability for harbor porpoises was equivalent to one, which assumes that all individuals on a transect are detected. Only the sightings occurring within the effective strip width were used in the density calculation. Based on the data collected during the line transect surveys conducted as part of the Test Pile Program, a total of 38 individual harbor porpoises were sighted within the required perpendicular distance from the survey vessel. The total trackline length of all the surveys conducted during the Test Pile Program (September and October) was 471.2 km (Navy 2012). By multiplying the trackline length of the surveys by the effective strip width, in this case one kilometer, the total area surveyed during the surveys was 471.2 square kilometers. Dividing the number of individual harbor porpoises sighted (38) by the area surveyed (471.2 sq. km) results in a density of 0.0806 harbor porpoises per sq. km. To account for availability bias [g(0)] or the animals which are unavailable to be detected because they are submerged, the Navy utilized a g(0) value of 0.54, derived from other similar line transect surveys (Barlow 1988; Calambokidis et al. 1993; Carretta et al. 2001). This resulted in a corrected density of 0.149 harbor porpoises per sq. km. Density estimates for harbor porpoise are considered year-round estimates (Navy 2014b).

4.3 Steller Sea Lion

4.3.1 Status and Management

In the North Pacific, NMFS has designated two Steller sea lion stocks: (1) the western U.S. stock consisting of populations at and west of Cape Suckling, Alaska (144 degrees W longitude); and (2) the Eastern U.S. stock, consisting of populations east of Cape Suckling, Alaska. The western U.S. stock is listed as depleted under the MMPA and endangered under the ESA. Although there is evidence of mixing between the two stocks (Jemison et al. 2013), animals from the western U.S. stock are not present in Puget Sound. Individuals that occur in Puget Sound are of the Eastern DPS (Allen and Angliss 2014). The Eastern distinct population segment (stock) was recently (April 2012) removed from listing under the ESA because it was stable or increasing throughout the northern portion of its range (Southeast Alaska and British Columbia) and stable or increasing slowly in the central portion of its range (Oregon through northern California) (77 FR 23209, NMFS 2012a). Critical habitat has been designated for the Steller sea lion (58 FR 45269); however, there is no designated critical habitat for the species in Washington State.

4.3.2 Distribution

The eastern stock of Steller sea lions are found along the coasts of southeast Alaska to northern California where they occur at rookeries and numerous haulout locations along the coastline (Jeffries et al. 2000; Scordino 2006; NMFS 2012b).Along the northern Washington coast, up to 25 pups are born annually (Jeffries 2013a). Male Steller sea lions often disperse widely outside of the breeding season from breeding rookeries in northern California (St. George Reef) and southern Oregon (Rogue Reef), (Scordino, 2006; Wright et al. 2010). Based on mark recapture sighting studies, males migrate back into these Oregon and California locations from winter feeding areas in Washington, British Columbia, and Alaska (Scordino 2006).

In Washington, Steller sea lions use haulout sites primarily along the outer coast from the Columbia River to Cape Flattery, as well as along the Vancouver Island side of the Strait of Juan de Fuca (Jeffries et al. 2000). A major winter haulout is located in the Strait of Juan de Fuca at Race Rocks, British Columbia, Canada (Canadian side of the Strait of Juan de Fuca) (Edgell and Demarchi 2012). Numbers vary seasonally in Washington with peak numbers present during the fall and winter months and a decline in the summer months that corresponds to the breeding season at coastal rookeries (approximately late May to early June) (Jeffries et al. 2000). In the Puget Sound, Jeffries (pers. comm. 2012) identified five winter haulout sites used by adult and subadult (immature or pre-breeding animals) Steller sea lions, ranging from immediately south of Port Townsend (near Admiralty Inlet) to Olympia in southern Puget Sound (see Figure 4-1). Numbers of animals observed at these sites ranged from a few to less than 100. In addition, Steller sea lions opportunistically haul out on various navigational buoys in Admiralty Inlet south through southern Puget Sound near Olympia (Jeffries 2012). One or two animals occur on these buoys.

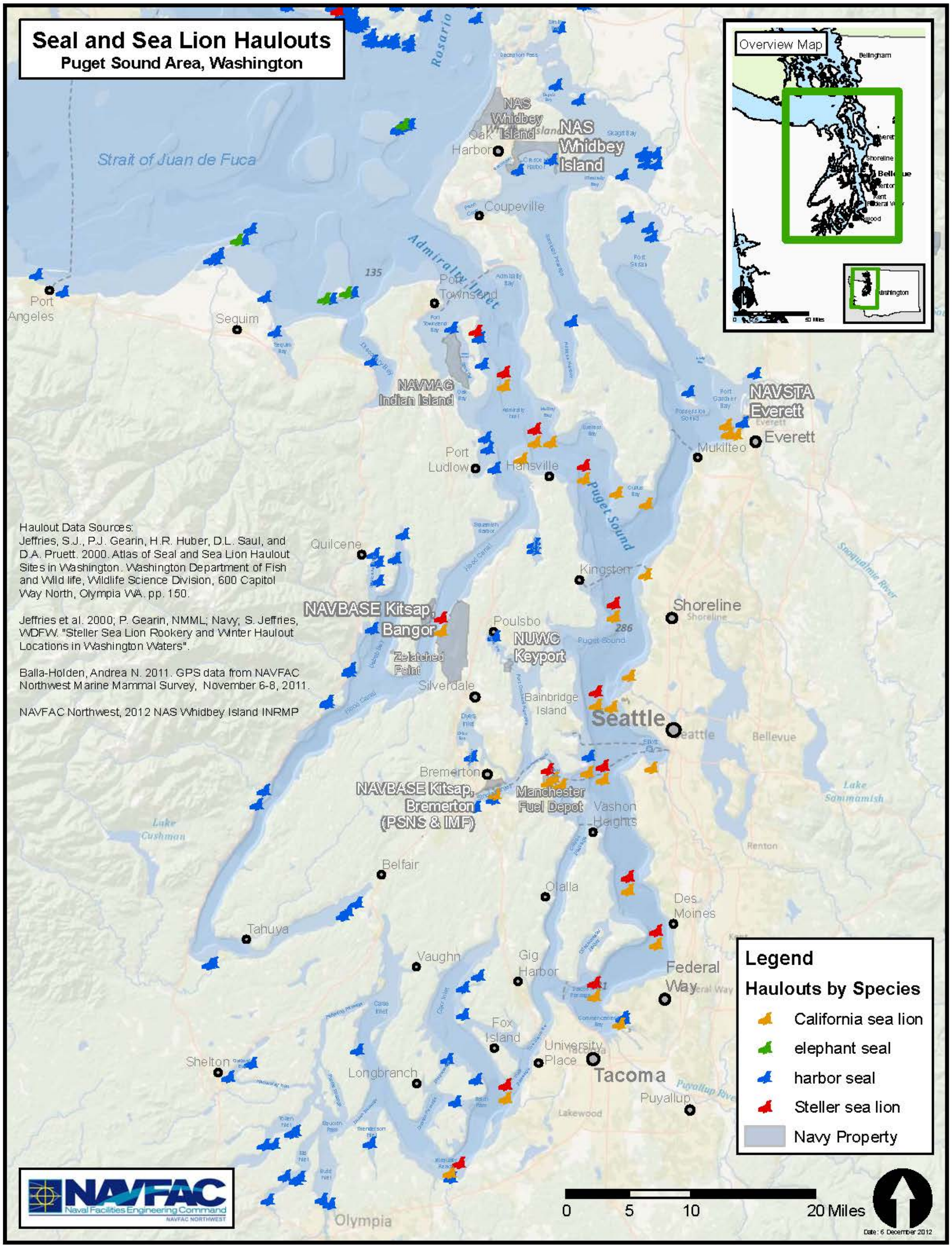

Figure 4-1. Pinniped Haulouts in the Puget Sound Area

4.3.3 Site Specific Occurrence

Steller sea lions have been seasonally documented at NAVBASE Kitsap Bangor in Hood Canal since 2008 with up to 11 individuals observed hauled out on submarines at Delta Pier (Figure 4-2) (Navy 2014a). Surveys at NAVBASE Kitsap Bangor indicate Steller sea lions typically arrive in October and depart by the end of May, although two Steller sea lions were seen in September in two different survey years (Navy 2014a).

4.4 California Sea Lion

4.4.1 Status and Management

California sea lions are protected under the MMPA and are not listed under the ESA. NMFS has defined one stock for California sea lions (U.S. Stock), with five genetically distinct geographic populations: (1) Pacific Temperate, (2) Pacific Subtropical, (3) Southern Gulf of California, (4) Central Gulf of California, and (5) Northern Gulf of California. The Pacific Temperate population includes rookeries within U.S. waters and the Coronados Islands just south of the U.S./Mexico border. Animals from the Pacific Temperate population range north into Canadian waters, and movement of animals between U.S. waters and Baja California waters has been documented (Carretta et al. 2013, as presented in Carretta et al. 2014).

4.4.2 Distribution

During the summer, California sea lions breed on islands from the Gulf of California to the Channel Islands and seldom travel more than about 31 miles (50 km) from the islands. The primary rookeries are located on the California Channel Islands of San Miguel, San Nicolas, Santa Barbara, and San Clemente. Their distribution shifts to the northwest in fall and to the southeast during winter and spring, probably in response to changes in prey availability. In the nonbreeding season, adult and subadult males migrate northward along the coast to central and northern California, Oregon, Washington, and Vancouver Island, and return south in the spring. They are occasionally sighted hundreds of miles offshore. Primarily male California sea lions migrate into northwest waters with most adult females with pups remaining in waters near their breeding rookeries off the coasts of California and Mexico. Females and juveniles tend to stay closer to the rookeries. California sea lions also enter bays, harbors, and river mouths and often haul out on man-made structures such as piers, jetties, offshore buoys, and oil platforms.

4.4.3 Site Specific Occurrence

Jeffries et al. (2000) and Jeffries (pers. comm. 2012) identified dedicated, regular haulouts used by adult and subadult California sea lions in Washington inland waters (Figure 4-1). Main haulouts occur at NAVBASE Kitsap Bangor, NAVBASE Kitsap Bremerton, and NAVSTA Everett, as well as in Rich Passage near Manchester, Seattle (Shilshole Bay), south Puget Sound (Commencement Bay, Budd Inlet), and numerous navigation buoys south of Whidbey Island to Olympia in south Puget Sound (Jeffries et al. 2000; Jeffries pers. comm. 2012) (Figure 4-1). Additionally, Race Rocks, British Columbia, Canada (Canadian side of the Strait of Juan de Fuca) has been identified as a major winter haulout for California sea lions (Edgell and Demarchi 2012).

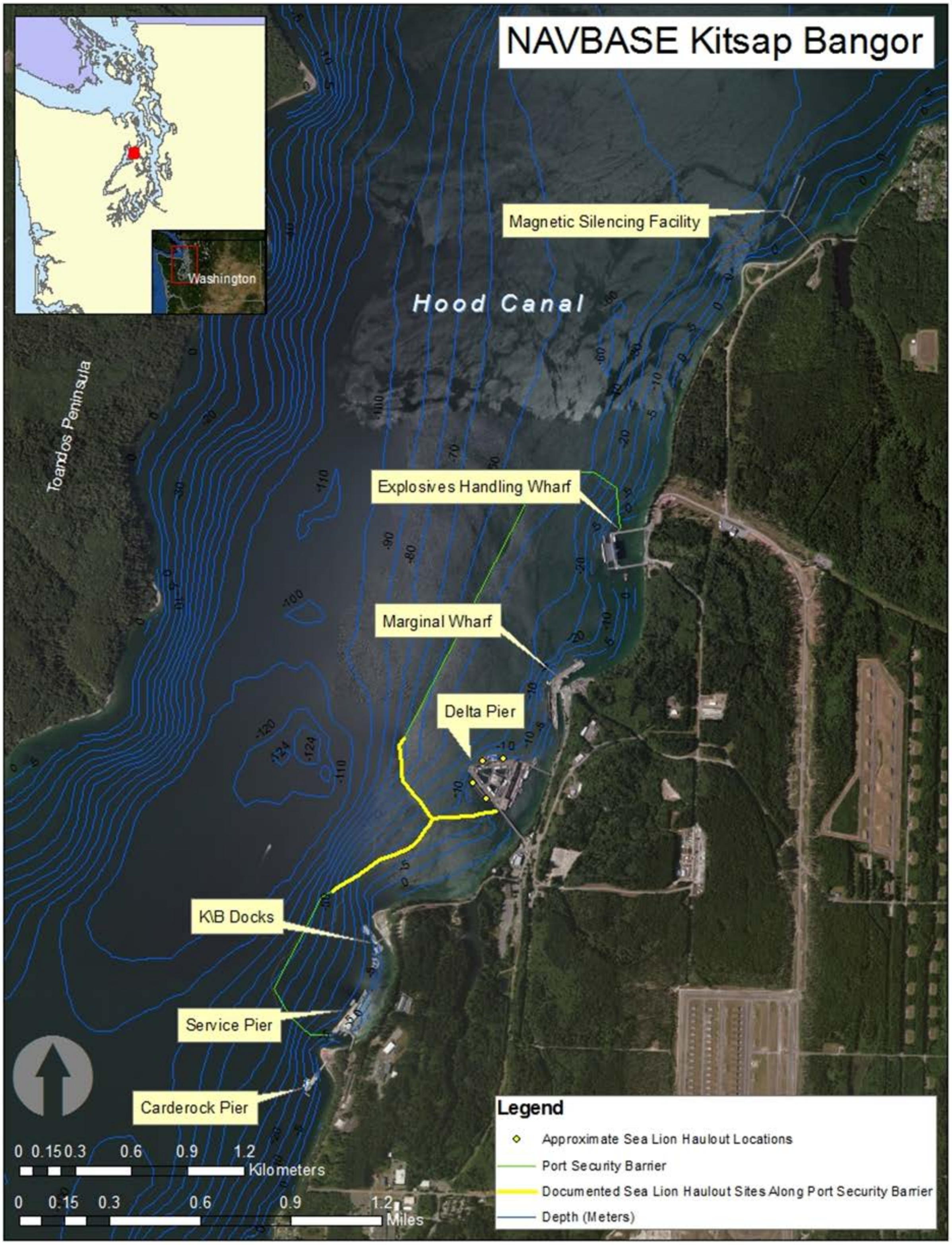

Figure 4-2. Sea Lion Haulouts at NAVBASE Kitsap Bangor

The Navy conducts surveys at its installations with sea lions in Puget Sound (see Appendix A for additional information). Haulouts are located at NAVBASE Kitsap Bangor where up to 122 California sea lions, respectively, have been observed hauled out on the Port Security Barrier (PSB) floats and on docked submarines (Navy 2014a). Numbers of animals typically peak in October or November. Figure 4-2 depicts the areas on the PSBs and submarines where California sea lions typically haul out.

During summer months and associated breeding periods, the inland waters would not be considered a high-use area by California sea lions, as they would be returning to rookeries in California waters. However, surveys at Bangor indicate that a few individuals are present through mid-June and have arrived as early as August with at least one individual remaining in July (Navy 2014a).

4.5 Harbor Seal

4.5.1 Status and Management

Harbor seals are not listed as depleted under the MMPA and they are not listed under the ESA. Within Washington inland waters, 3 stocks of harbor seals are recognized:

1. Southern Puget Sound (south of the Tacoma Narrows Bridge)
2. Washington Northern Inland Waters (including Puget Sound north of the Tacoma Narrows Bridge, the San Juan Islands, and the Strait of Juan de Fuca)
3. Hood Canal (Carretta et al. 2014).

4.5.2 Distribution

Harbor seals are a coastal species, rarely found more than 12 mi. (20 km) from shore, and frequently occupy bays, estuaries, and inlets (Baird 2001). Individual seals have been observed several miles upstream in coastal rivers (Baird 2001). Ideal harbor seal habitat includes haulout sites, shelter during the breeding periods, and sufficient food (Bjørge 2002). Haulout areas can include intertidal and subtidal rock outcrops, sandbars, sandy beaches, peat banks in salt marshes, and manmade structures such as log booms, docks, and recreational floats (Wilson 1978; Prescott 1982; Schneider and Payne 1983, Gilbert and Guldager 1998; Jeffries et al. 2000; Lambourn et al. 2010). Harbor seals do not make extensive pelagic migrations, though some long distance movement of tagged animals in Alaska (108 mi. [174 km]) and along the U.S. west coast (up to 342 mi. [550 km]) have been recorded (Brown and Mate 1983; Womble and Gende 2013). Harbor seals have also displayed strong fidelity to haulout sites.

Harbor seals are the most common, widely distributed marine mammal found in Washington marine waters and are frequently observed in the nearshore marine environment. They occur year-round and breed in Washington. Numerous harbor seal haulouts occur in Washington inland waters (Figure 4-1). Haulouts include intertidal and subtidal rock outcrops, beaches, reefs, sandbars, log booms, and floats. Numbers of individuals at haulouts range from a few to between 100 and 500 individuals (Jeffries et al. 2000).

4.5.3 Site Specific Occurrence

Harbor seals occur year-round throughout the nearshore waters of Puget Sound (Table 4-3). Haulouts occur throughout Hood Canal primarily on the west side. The nearest haulout identified by Jeffries is at the mouth of the Dosewallips River 10 miles southwest of the NAVBASE Kitsap Bangor waterfront. Surveys conducted from 2007 to 2010 at NAVBASE Kitsap Bangor, observed harbor seals in the water every month of surveys (Agness and Tannenbaum 2009; Tannenbaum et al. 2009, 2011). Harbor seals were routinely seen during marine mammal monitoring for construction projects, at or near EHW-1 (Test Pile Project, EHW-2 construction, and prior EHW-1 repairs (Navy 2012: Hart Crowser 2013). Small numbers of harbor seals have been documented hauling out on the PSB floats, the wavescreen at Carderock Pier, buoys, barges, marine vessels, and logs (Agness and Tanenbaum 2009; Tannenbaum et al. 2009, 2011). Most documented occurrences of harbor seals hauling out along the Bangor waterfront were on the Port Security Barrier floats and on manmade floating structures near KB Dock and Delta Pier. On two occasions, four to six individuals were observed hauled out near Delta Pier.

Past IHA applications for NAVBASE Kitsap Bangor indicated a couple of observations of harbor seal births or neonates. In 2014 the Navy's knowledge of harbor seal births increased due to increased pinniped surveys on the waterfront and increased contact with waterfront personnel who have had lengthy careers at Bangor. Known harbor seal births include one on the Carderock wave screen in August 2011 and at least one on a small 10x10 floating dock at EHW-2 in fall 2013, as reported by EHW-2 construction crew, and afterbirth on a float at Magnetic Silencing Facility with an unknown date. In addition, Navy biologists learned that harbor seal pupping has occurred on a section of the Service Pier for the past 13 years according to the Port Operations vessel crews.

While the density in Hood Canal is 9.92 individuals/sq km, not animals will be in the water. Therefore, the number of harbor seals likely to be exposed will be based on the number in the water. Because the density is based on animals at haulouts primarily on the west side of Hood Canal, and harbor seals are nearshore oriented, we would expect the density not be uniform, but highest near the major haulouts on the west side of Hood canal and decreasing waterward. However, density along the Bangor waterfront will also be influenced by animals that haulout and likely routinely remain in proximity of the Bangor shoreline. Therefore, the actual number of harbor seals likely to be exposed was reduced to 80% of the total estimated population, resulting in a density of 7.93 animals/ sq km.

5 Take Authorization Requested

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

5.1 Take Authorization Request

Under Section 101 (a)(5)(D) of the MMPA, the Navy requests an IHA for the take of marine mammals incidental to noise generated during vibratory and impact pile driving during pile replacement activities described in this application at EHW-1 in the Hood Canal Basin of Puget Sound, Washington. The Navy requests an IHA for a period of 1 year: July 16, 2015, through January 15, 2016.

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

5.2 Method of Incidental Taking

This authorization request considers noise from vibratory and impact pile installation as outlined in Section 1 that has the potential to disturb or displace marine mammals resulting in Level B harassment as defined above. No additional exposures are anticipated from concrete pile removal or airborne sounds because the areas of exposure are subsumed by concurrent extent of the ensonified underwater areas. The proposed action is not anticipated to affect the prey base or significantly affect other habitat features of marine mammals that would meet the definition of take. No additional exposures are anticipated from airborne sounds because the area of airborne exposure is subsumed by concurrent extent of the ensonified underwater areas.

Level A harassment is not anticipated given the methods of installation and measures designed to minimize the possibility of injury to marine mammals. First, vibratory pile drivers will be the primary method of steel pile installation. Vibratory pile drivers have relatively low sound levels (<180 dB re 1µPa at 10 meters) compared to impact drivers and are not expected to cause injury to marine mammals. Second, impact driving of steel piles will not occur without a noise attenuation measure (such as a bubble curtain or other attenuating device) in place, and all pile driving will either not start or be halted if marine mammals approach the Level A injury zone (“shutdown zone”).

Section 6 contains detailed results of modeled potential exposures for each marine mammal species.

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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, and the number of times such takings by each type of taking are likely to occur.

6.1 Introduction

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

During repairs at EHW-1, impact pile driving of steel piles is expected to result in Level B exposure of marine mammals as defined under the MMPA. Effects of other activities are discussed in Section 7. Level A harassment of cetaceans and pinnipeds is not expected to occur; therefore, the noise related impacts discussed in this IHA are entirely Level B harassment. The methods for estimating the number and types of exposure are described in the sections below:

Exposure of each species was determined at each project location by:

- Estimating the area of impact where noise levels exceed acoustic thresholds for marine mammals (Section 6.2 and 6.3)
- Evaluating potential presence of each species at each project area (based on historical occurrence, density, or by site-specific survey as outlined in Section 6.4)
- Estimating potential Level B harassment exposures by multiplying the density or number, as applicable, of each marine mammal species in the area exposed by their probable duration during construction (Section 6.5)

Each of the 3 items above is discussed in the sections following.

6.2 Area of Impact Estimation

6.2.1 Description of Noise Sources

Ambient sound is a composite of sounds from multiple sources, including environmental events, biological sources, and anthropogenic activities. Physical noise sources include waves at the surface, precipitation, earthquakes, ice, and atmospheric noise, among other events. Biological sources include marine mammals, fish, and invertebrates. Anthropogenic sounds are produced by vessels (small and large), dredging, aircraft overflights, construction activities, geophysical explorations, commercial and military sonars, and other activities.

The sounds produced by pile driving fall into two sound types: impulsive and non-impulsive (defined below). Impact pile driving produces impulsive sounds, while vibratory pile driving produces non-impulsive sounds. The distinction between these two general sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing (Ward 1997 as cited in Southall et al. 2007).

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

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

In some environments, the duration of both impulsive and non-impulsive sounds can be extended due to reverberations. Appendix B provides additional information on the fundamentals of underwater sound and a review of pile driving sound pressure levels from similar pile sizes and type as those proposed for installation at EHW-1.

6.2.2 Vocalization and Hearing of Marine Mammals

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

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

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

NMFS reviewed studies of hearing sensitivity of marine mammals and developed draft guidance when assessing the effects of anthropogenic sound on the auditory function of marine mammals The guidance uses measured or estimated hearing ranges to determine the sound level where marine mammals experience a temporary shift in a hearing threshold (Temporary Threshold Shift [TTS]) and a permanent shift (Permanent Threshold Shift [PTS]) (NOAA 2013). As of June 2014 this guidance has not been finalized by NMFS. The guidance places marine mammals into the following functional hearing groups based on their generalized hearing sensitivities: high-frequency cetaceans, mid-frequency cetaceans, low-frequency cetaceans (mysticetes), phocid pinnipeds (true seals), and otariid pinnipeds (sea lions and fur seals). Table 6-1 is summarizes information for vocalization and hearing capabilities for marine mammal species potentially present in Puget Sound. Species assessed in this application are bolded.

Table 6-1. Hearing and Vocalization Ranges for Marine Mammal Functional Hearing Groups and Species Potentially Within Puget Sound

Functional Hearing Group (FHG)	Species	FHG Sound Production[a]		FHG General Hearing Ability Frequency Range[a]
		Frequency Range	Source Level (dB re 1 µPa @ 1 m)	
High-Frequency Cetaceans	**Harbor porpoise**, Dall's porpoise	100 Hz to 200 kHz [b,c,d]	120 to 205	200 Hz to 180 kHz [o,p]
Mid-Frequency Cetaceans	**Killer whale**	100 Hz to >100kHz [b,c,e,f,g]	118 to 236	150 Hz to 160 kHz[p]
Low-Frequency Cetaceans	Gray whale, Humpback whale, Minke whale	10 Hz to 20 kHz [c,h,i]	129 to 195	7 Hz to 22 kHz[p]
Phocidae	Northern Elephant Seal, **Harbor seal**	100 Hz to 120 kHz [c,j,k,l]	103 to 180	In-water: 75 Hz to 75 kHz In-air: 75 Hz to 30 kHz [p,q,r]
Otariidae	**California sea lion** **Steller sea lion**	30 Hz to 10 kHz [c,l,m,n]	120 to 196	In-water: 50 Hz to 50 kHz In-air: 50 Hz to 75 kHz [p,q,r]

aSound production levels and ranges and functional hearing ranges are generalized composites for all members of the functional hearing groups, regardless of their presence in the area. These frequency ranges and source levels include social sounds for all groups and echolocation sounds for mid- and high-frequency groups. In-air vocalizations were not included for pinniped groups.
Sound production data adapted and derived from: bMarten, 2000; cRichardson, et al., 1995; dVilladsgaard, et al., 2007; eMøhl, et al., 2003; fPhilips, et al., 2003; gRasmussen, et al., 2006; hAburto, et al., 1997; iWürsig, et al., 1980; jHanggi & Schusterman, 1994; kRossong & Terhune, 2009; lSchusterman, et al., 1970; mHughes, et al., 2011; nVerboom & Kastelein, 1995
Hearing data adapted and derived from: oKastelein, et al., 2002; pSouthall et al., 2007; qHemila et al. 2006; rSchusterman 1981
dB re 1 µPa @ 1 m: decibels (dB) referenced to (re) 1 micro (µ) Pascal (Pa) at 1 meter; Hz: Hertz; kHz: kilohertz

6.2.3 Sound Exposure Criteria and Thresholds

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

To date, no studies have been conducted that examine impacts to marine mammals from pile driving sounds from which empirical noise thresholds have been established. Currently NMFS used generic underwater sound exposure thresholds to determine when an activity could result in impacts to a marine mammal defined as Level A (injury) or Level B (disturbance including behavioral and TTS) harassment (NMFS 2005). Cetaceans and pinnipeds exposed to sounds >180 and 190 dB rms re 1 µPa, respectively, are considered to have been taken by Level A harassment (NMFS 2005). Level B harassment occurs when marine mammals are exposed to impulsive underwater sounds > 160 dB rms re 1 µPa from impact pile driving and to non-impulsive underwater sounds 120 dB rms re 1 µPa (NMFS 2005). Thresholds are listed in Table 6-2. As stated above, NMFS has developed new guidance for assessing PTS (Level A) and TTS (Level B) (NOAA 2013); however, this guidance is currently not final. Therefore, this application utilized the existing thresholds.

For airborne noise, NMFS uses generic sound exposure thresholds to determine when an activity in the ocean might result in impacts to a marine mammal (70 FR 1871). Construction-period airborne noise would have little impact to cetaceans because noise from airborne sources would not transmit as well underwater (Richardson et al. 1995); thus, noise would primarily be a problem for hauled-out pinnipeds near the project locations. The National Marine Fisheries Service has identified behavioral harassment threshold criteria for airborne noise generated by pile driving for pinnipeds regulated under the MMPA. Level A injury threshold criteria for airborne noise have not been established. The Level B behavioral harassment threshold for harbor seals is 90 dB rms re 20 µPa (unweighted) and for all other pinnipeds is 100 dB rms re 20 µPa (unweighted) (Table 6-2).

6.2.4 Limitations of Existing Noise Criteria

The application of the 120 dB rms re 1 µPa behavioral threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. The 120 dB rms re 1 µPa threshold level for non-impulsive noise originated from research conducted by Malme et al. (1984, 1988) for California gray whale response to continuous industrial sounds such as drilling operations. (The 120 dB re 1 µPa non-impulsive sound threshold should not be confused with the species-specific 120 dB pulsed sound criterion established for migrating bowhead whales in the Arctic as a result of research in the Beaufort Sea [Richardson et al. 1995; Miller et al. 1999]).

To date, there is no research or data supporting a response by pinnipeds or odontocetes to non-impulsive sounds from vibratory pile driving as low as the 120 dB threshold. Southall et al. (2007) reviewed studies conducted to document behavioral responses of harbor seals and northern elephant seals to non-impulsive sounds under various conditions and concluded that those limited studies suggest that exposures between 90 dB and 140 dB rms re 1µPa generally do not appear to induce strong behavioral responses.

Table 6-2. Injury and Disturbance Thresholds for Underwater and Airborne Sounds

Marine Mammals	Airborne Marine Construction Criteria (impact and vibratory pile driving) (re 20 µPa)[1]	Underwater Vibratory Pile Driving Criteria (non-impulsive sounds) (re 1µPa)		Underwater Impact Pile Driving Criteria (impulsive sounds) (re 1µPa)	
	Disturbance Guideline Threshold (haulout)[2]	Level A Injury Threshold	Level B Disturbance Threshold	Level A Injury Threshold	Level B Disturbance Threshold
Cetaceans (whales, dolphins, porpoises)	Not applicable	180 dB rms	120 dB rms	180 dB rms	160 dB rms
Pinnipeds (seals, sea lions, walrus, except harbor seals)	100 dB rms (unweighted)	190 dB rms	120 dB rms	190 dB rms	160 dB rms
Pinnipeds (harbor seals)	90 dB rms (unweighted)	190 dB rms	120 dB rms	190 dB rms	160 dB rms

1. Airborne disturbance thresholds not specific to pile driver type.
2. Sound level at which pinniped haulout disturbance has been documented. This is not considered an official threshold, but is used as a guideline.

6.2.5 Auditory Masking

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

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

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

Based on the frequency overlap between noise produced by both vibratory and impact pile driving (10 Hz - 1.5 kHz) and recorded vocalizations (Table 6-1), animals that remain in a project area during pile driving may be vulnerable to masking for the duration of pile driving. Energy level of vibratory pile driving are less than half that of impact pile driving; therefore, the potential for masking noise would be limited to a small radius around a pile. The likelihood that vibratory pile driving would mask relevant acoustic signals for marine mammals is negligible. In addition, most marine mammal species that may be subject to masking are transitory within the project areas. The animals most likely to be at risk for vocalization masking are resident pinnipeds (harbor seals and sea lions around local haulout areas). Possible behavioral reactions to vocalization masking include changes to vocal behavior (including cessation of calling), habitat abandonment (long- or short-term), and modifications to the acoustic structure of vocalizations (which may help signalers compensate for masking) (Brumm and Slabbekoorn 2005; Brumm and Zollinger 2011). Given the relatively high sound levels for most marine mammal vocalizations, the Navy has estimated that masking events would occur concurrently within the zones of behavioral harassment estimated for vibratory and impact pile driving (see Section 6.3.2, Underwater Noise from Pile Driving) and are therefore taken into account in the underwater exposure analysis.

6.3 Modeling Noise Impact from Pile Driving

6.3.1 Underwater Sound Propagation

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

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

where TL is the transmission loss in dB, R1 is the distance of the modeled SPL from the driven pile, and R2 is the distance from the driven pile of the initial measurement.

The degree to which underwater noise propagates away from a noise source is dependent on a variety of factors, most notably by the water bathymetry and presence or absence of reflective or absorptive conditions including the sea surface and sediment type.

In the following section, the TL model described above was used to calculate the expected noise propagation from pile driving, using a representative source level to estimate the zone of influence (ZOI) or area exceeding the noise criteria.

6.3.2 Underwater Noise from Pile Driving

The intensity of pile driving sounds is greatly influenced by factors such as the type of piles, hammers, and the physical environment in which the activity takes place. In order to determine reasonable sound pressure levels from pile driving, studies with similar pile type and size, installation method, and subsurface substrate characteristics to the proposed action were evaluated. Data from prior pile driving projects at the NAVBASE Kitsap Bangor waterfront, including one at EHW-1 were reviewed in the analysis. The evaluation is presented in Appendix B and the representative sound pressure levels used in the analysis are presented in Table 6-3.

A bubble curtain[2] will be used to minimize the noise generated by impact driving steel pipe piles. The bubble curtain is expected to attenuate impact pile driving sound levels an average of 8 dB; therefore, 8 dB was subtracted from the values in Table 6-3 prior to modeling. Bubble curtain performance is discussed in Appendix B. If a new method of sound attenuation is developed that has demonstrated an average of at least 8 dB of attenuation, then this method could be employed instead of a bubble curtain for driving steel pile. Vibratory pile driving sound levels can be 20 to 30 or more decibels lower than impact driving sound levels and does not produce high peak amplitudes with fast rise times typical of steel pile driving. Therefore, bubble curtains are not used for vibratory pile driving.

Calculated distances to the underwater marine mammal behavioral noise thresholds and associated areas are provided in Table 6-4. Adjusted maximum distances are provided where the extent of noise reaches land prior to reaching the calculated radial distance to the threshold. The areas, referred to as Zones of Influence (ZOI), only include the area encompassed to the extent of the shoreline. Figures illustrating the extent and area of each ZOI for a pile representing the worst-case extent of noise propagation (furthest from the shore) are presented in Figure 6-1.

Table 6-3. Representative Sound Pressure Levels from Pile Driving Studies

30-inch Steel Pipe Pile	Number of Projects Considered[1]	RMS dB re 1µPa	Peak dB re 1µPa	SEL dB re 1µPa^2-sec
Impact installation	3	195	216	186
Vibratory Installation	2	166	---	---

[1]See Appendix B for studies reviewed.
Notes: Peak and rms relative to 1 µPa; SEL relative to 1 µPa^2-sec

2 Bubble curtains emit a series of bubbles around a pile to introduce a high-impedance boundary through which pile driving noise is attenuated and can be unconfined or confined. A confined bubble curtain uses a flexible or rigid shroud around the bubble curtain to hold air bubbles near the pile. Confined bubble curtains are only implemented when water velocities are greater than 1.6 feet per second (NMFS 2011).

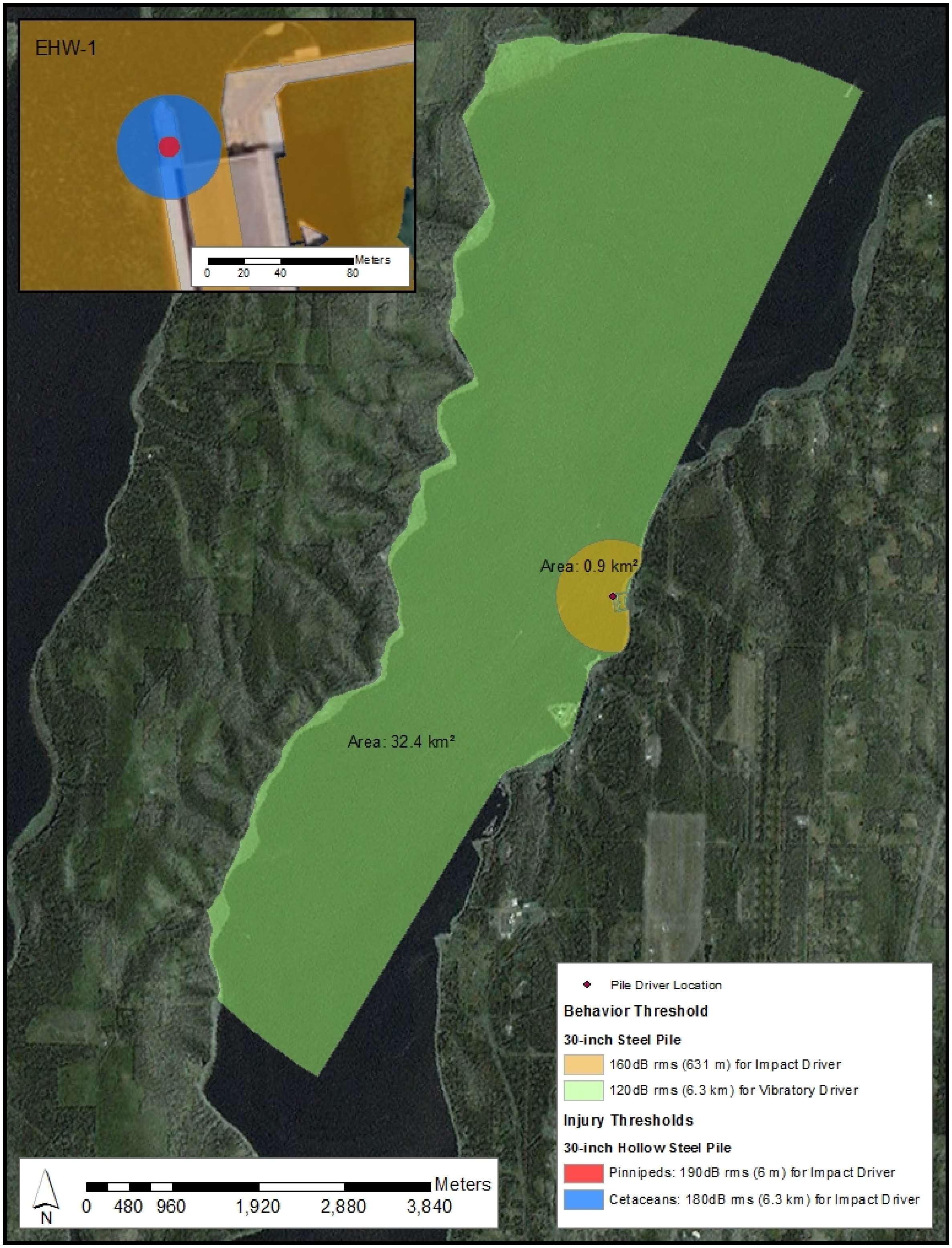

Figure 6-1. Representative View of Affected Areas for Marine Mammals due to Underwater Pile Driving Noise

Table 6-4. Calculated Radial Distance(s) to Underwater Marine Mammal Pile Driving Noise Thresholds and Area Encompassed within Threshold Distance

Installation Method	Injury Pinnipeds (190 dB RMS)	Injury Cetaceans (180 dB RMS)	Behavioral Harassment Cetaceans and Pinnipeds from Impact Driving (160 dB RMS)	Behavioral Harassment Cetaceans and Pinnipeds from Vibratory Installation (120 dB RMS)
Impact	6 m 113 sq m	29 m 2,630 sq m	631 m 0.9 sq km	N/A
Vibratory	N/A	N/A	N/A	6.3 km adjusted max* 32.4 sq km

*Area adjusted because land masses are encountered prior to reaching the calculated area.

6.3.3 Airborne Sound Propagation

Pile driving can generate airborne noise that could potentially result in disturbance to marine mammals (pinnipeds) that are hauled out or at the water's surface. As a result, the Navy analyzed the potential for pinnipeds hauled out or swimming at the surface to be exposed to airborne sound pressure levels that could result in Level B behavioral harassment. The appropriate airborne noise thresholds for behavioral harassment for all pinnipeds, except harbor seals, is 100 dB rms re 20 µPa (unweighted) and for harbor seals is 90 dB rms re 20 µPa (unweighted) (see Table 6-2). Construction noise behaves as point-source and, thus, propagates in a spherical manner with a 6 dB decrease in sound pressure level over water ("hard-site" condition) per doubling of distance (WSDOT 2012). A spherical spreading loss model, assuming average atmospheric conditions, was used to estimate the distance to the 100 dB and 90 dB rms re 20 µPa (unweighted) airborne thresholds. The transmission loss equation is given by:

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

where TL is the transmission loss in dB, R1 is the distance of the modeled SPL from the driven pile, and R2 is the distance from the driven pile of the initial measurement.

The intensity of pile driving sounds is greatly influenced by factors such as the type of piles, hammers, and the physical environment in which the activity takes place. In order to determine reasonable airborne source sound pressure levels, source levels were chosen based on a review of pile driving in-situ recordings (see analysis in Appendix B). Values available from the analysis for steel piles are listed in Table 6-5. An impact pile driving value was not available for 30-inch steel piles; therefore, the 36-inch pile value from the Bangor Test Pile Program, an unweighted Lmax of 112 dB, was used in the calculation. The 30-inch unweighted RMS value of 95 dB Leq was used in the calculations for airborne disturbance from vibratory pile installation.

Table 6-5. Airborne Sound Pressure Levels from Similar In-situ Monitored Construction Activities

Pile Type	Size (diameter in inches) [1]	Installation Method	
		Impact RMS L_{max} (Unweighted) Impact	Vibratory RMS L_{eq} (unweighted) Vibratory
Steel Pipe	24-inch	110[2]	92[2]
	30-inch	---	**95**
	36- inch	**112**	95

Notes: All values relative to 20μPa and at 15 m (50 ft) from pile.
[1]See Attachments 4 and 5 of Appendix B for projects reviewed. [2] Limited data set

The distances to the airborne harassment thresholds were calculated for steel impact and vibratory driving with the airborne transmission loss formula. The calculated and measured distances to the pinniped airborne noise thresholds are shown in Table 6-6. Measured distances to the pinniped thresholds were also available for 30-inch piles from monitoring during the Test Pile Program (Illingworth & Rodkin 2012). These distances are also presented in Table 6-6. The extent of airborne noise from impact pile driving extends the farthest. Because these distances are smaller than those to the behavioral threshold, a separate analysis of Level B take was not conducted for animals in the airborne zone. Animals in the airborne zone would already have been exposed within a Level B underwater zone.

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

Installation Method	Harbor Seal Threshold = 90 dB rms	Steller Sea lions and California Sea Lions Thresholds = 100 dB RMS
Impact	189 m	60 m
Vibratory	Calculated= 27 m Measured mean = 33 m (51 m max)	Calculated = 8 m Measured mean = 10 m (16 m max)

Notes: Calucated values used bolded values in Table 6-5 and transmission loss model in 6.3.3. Measured values reported in Navy 2012 from Bangor Test Pile Program.

6.4 Evaluation of Potential Species Presence

In prior Navy applications, either density data from the Navy's marine mammal base (Navy 2014b) or site-specific survey information has been used to quantify take. However, as described in Chapter 3.2, using a density based analysis for species that occur intermittently does not adequately account for their unique temporal and spatial distributions[3]. For intermittently occurring species, historical occurrence and numbers as well as group size were reviewed to develop a realistic estimate of potential exposure. Therefore, estimates in this application for

3 Previously a density based exposure analysis was required for these species. The analyses often resulted in zero exposure estimates. Therefore, to obtain IHA coverage for potential exposure to these animals, the Navy would typically augmented the requested take by the typical group size of animals. NMFS has subsequently requested that future Navy IHA applications for Puget Sound do not use a density estimate for marine mammal species with a low likelihood of occurrence.

species without a predictable occurrence are based on a historical likelihood of encounter. The following specie was in this category for Hood Canal:

- Transient killer whale.

For species with more frequent occurrence, but no site-specific surveys, density estimates were used for quantification of potential exposure. These species were:

- Harbor porpoise and harbor seal.

For species with installation-specific surveys, survey information was used for quantification of potential exposure. These species were:

- Steller sea lion and California sea lion.

6.5 Estimating Potential Level B Harassment Exposures

To quantitatively assess exposure of marine mammals to noise levels from pile driving over the NMFS thresholds, one of three methods were used depending on a species spatial and temporal occurrence at a project location. As described above for transient killer whales that have a rare and unpredictable occurrence, the likelihood of presence was reviewed based on the information in Chapter 3, the extent of the areas calculated in Section 6.3.2, and the potential maximum duration of work days with pile driving. Transient killer whales are not anticipated to linger in the affected area for multiple days. Because pile driving work is estimated to occur intermittently over a maximum period of 8 days, overlap with transient killer whales, if present would be sporadic. Therefore, the duration of occurrence for transient killer whales was set to 2 days, equivalent to a transit by a project site going one direction and then back. The calculation for species with rare or infrequent occurrence was:

(1) Exposure estimate = Probable abundance during construction × Probable duration during construction

where; Probable abundance = maximum expected group size = 6.

Probable duration = 2 days for transient killer whales.

For species with a regular occurrence at a project location, but no site specific abundance (e.g. harbor porpoises and harbor seals), density estimates were used to determine the number of animals potentially exposed over the pile driving duration, measured in number of days of pile driving. The density estimates presented in Table 3-2 were used in the analysis. The maximum density value for each species during the in-water work window at each site was used in the take assessment calculation. The equation for species likely to occur with only density estimates and no site-specific abundance was:

(2) Exposure estimate = (N × ZOI) × maximum days of pile driving

where; N = density estimate for each species
ZOI = area where pile driving noise exceeds the threshold value

and, N X ZOI is round up to a whole number.

For species with site-specific surveys available, exposures were estimated by:

(3) Exposure estimate = Abundance × maximum days of pile driving where: Abundance = average monthly maximum over the time period when pile driving will occur.

To be conservative, average monthly maximum counts were averaged over the time period of pile driving that had the highest maximum count of animals present.[4] For example, if pile driving was estimated to occur for 60 days, then the average monthly maximum count for the two months with the highest number of animals present would be used in Equation 3. For this analysis, the project will only drive piles for a maximum of 8 days total for 4 piles. Therefore, the month with the highest average number of animals present was used in the analysis. For Steller sea lions and California sea lions, November was the month with the highest average number of animals, with an average monthly maximum of 6 and 71 animals, respectively. All of the pinniped derived estimates assumed that pinnipeds would be in the water 100 percent of the time during pile driving activities for underwater calculations. This approach is conservative because pinnipeds spend a large portion of their time hauled out.

The method for calculating potential exposures to impact and vibratory pile driving noise for each threshold includes the following assumptions:

- For formulas #2 and #3, each species will be present in the project area each day during construction. The timeframe for takings would be one potential take (Level B harassment exposure) per individual, per 24 hours.
- All pilings installed will have an **underwater** noise disturbance distance equal to the piling that causes the greatest noise disturbance (i.e., the piling furthest from shore) installed with the method that has the largest ZOI. The largest ZOI will be produced by vibratory driving. The ZOI for an impact hammer will be encompassed by the larger ZOI from the vibratory driver. Vibratory driving was assumed to occur on any day of pile driving.
- All pilings installed will have an **airborne** noise disturbance distance equal to the piling that causes the greatest noise disturbance (i.e., the piling furthest from shore) installed with impact pile driving because it has the largest ZOI. The ZOI for a vibratory hammer will be encompassed by the larger ZOI from the impact driver. Impact pile driving was assumed to occur on 4 days of pile driving. Based on the distance to the airborne threshold presented in Table 6-6, exposures of pinnipeds to airborne noise would be included in the larger underwater ZOIs from vibratory or impact driving. Therefore, potential exposure to airborne noise from pile driving was not included in the take calculations.
- Days of pile driving were based on the estimated work days using a slow production rate (e.g., providing the maximum number of potential exposures): 1 pile vibratory or impact driven per day for a total of 8 driving days. Note that this rate is not meant to indicate the

4 Prior IHA applications have used an average monthly maximum over the duration of the entire in-water work period. This analysis was accurate for work periods that spanned most or all of an in-water work window. However, pile driving for the EHW-1 project in this application is short in duration with a maximum of 8 days, which will only span a portion of the in-water work window. Therefore, averaging months with zero counts and months with peak counts, would underestimate number of animals exposed if pile driving was conducted only during the month with peak counts. Therefore, this application uses the average monthly maximum for the month when peak abundance occurs.

project will not proceed at a faster rate. The rates listed in this bullet are used solely to assess the number of days pile driving could occur if production was delayed due to difficult access, equipment failure, safety, etc. In a real construction situation, pile driving production rates would be maximized when possible.

- The practical spreading loss model was used to determine the ZOI.

The ZOIs for larger areas exceeding a threshold are not circular and will be truncated by land masses, such as points of land along the NAVBASE Kitsap Bangor shoreline and the Toandos Peninsula on the opposite shoreline.

The exposure assessment methodology estimates the numbers of individuals potentially exposed to the effects of pile driving noise exceeding NMFS established Level B thresholds. Of significant note is that successful implementation of mitigation methods (i.e., visual monitoring and the use of shutdown zones) results in no Level A exposure. Therefore, Level A exposures are not calculated. Results from acoustic impact exposure assessments should be regarded as conservative overestimates that are strongly influenced by limited marine mammal data and the assumption that marine mammals will be present during pile driving.

6.6 Exposure Estimates

Exposure estimates for each species are discussed in the following sections and presented in Table 6-7. Estimates were made using the assumptions in the bullets as described in Section 6.5. Reporting will provide details of how many actual and extrapolated animals of each species are exposed to noise levels considered potential Level B harassment at each location.

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

Table 6-7. Total Underwater Level B Exposure Estimates by Species

Species	Total
Transient killer whale	12
Harbor porpoise	40
Steller sea lion	48
California sea lion	568
Harbor seal	2,056

6.6.1 Killer Whale, West Coast Transient Stock

Transient killer whales have occurred twice in Hood Canal since 2003 with the last occurrence 9 years ago in 2005 (see Section 4.1.3). Because the extent of noise from impact pile driving is calculated to only extend 631 m from pile driving, most of which is within the Waterfront

Restricted Area (WRA), and impact pile driving is likely to occur for less than 3 hours, it is unlikely killer whales will be exposed to impact pile driving noise. If transient killer whales were present, they could encounter noise levels above the Level B behavioral threshold from vibratory pile driving. Therefore, exposure is only anticipated for vibratory pile driving. Using formula #1 with the average group size estimated for Puget Sound of 6 animals, and an estimated duration of killer whales of 2 days, 12 potential exposures of transient killer whales are estimated. Based on this analysis, the Navy requests Level B incidental takes for behavioral harassment of 12 transient killer whales. Animals of any age or sex could be exposed. Any exposures are anticipated to be short in duration as animals transit through the ZOI during vibratory pile driving. Because vibratory pile driving will only occur for 4 hours or less over the entire project, only very limited exposure of transient killer whales to Level B disturbance from pile driving noise is anticipated as animals transit the area. Animals of any age or sex could be exposed.

6.6.2 Harbor Porpoise

In Washington inland waters, harbor porpoises are most abundant in the Strait of Juan de Fuca, San Juan Island area, and Admiralty Inlet. However, harbor porpoises may be present in Puget Sound year-round typically in groups of 1 to 5 individuals. As described above for transient killer whales, harbor porpoises are not likely to be within the 631 m zone above the behavioral threshold for impact pile driving. Based on the Navy's analysis using a density estimate specific to Hood Canal, 0.149, an affected area of 32.4 sq km, and a maximum of 8 days of vibratory pile driving, a maximum estimate of 40 harbor porpoises of the Washington inland waters stock could be exposed to sound levels considered Level B. If harbor porpoises are present during pile driving, only very limited exposure of harbor porpoises to Level B disturbance from pile driving noise is anticipated as animals transit the area. Animals of any age or sex could be exposed.

6.6.3 Steller Sea Lion

Steller sea lions occur seasonally at NAVBASE Kitsap Bangor primarily from October through May and surveys have been conducted at haulout locations. Therefore, formula #3 in Section 6.5 was used to calculate potential exposures of Steller sea lions. The month with the highest average maximum haulout count, November with an average monthly maximum of 6 individuals, was used in the equation. The Navy assumed Steller sea lions could swim into the behavioral harassment zone each day during pile driving. Therefore, the Navy is requesting 6 exposures per day for an estimated 8 days of pile driving, resulting in a total of 48 potential Level B harassment exposures. This rationale is based on a worst case assumption that all days of pile driving would occur during the month with the greatest abundance of animals and all animals would be in the water each day during pile driving. If project work occurs when Steller sea lions are less likely to be present, then actual exposures would be less. Additionally, if daily pile driving duration is short, exposure would be expected to be less because some animals would remain hauled out for the duration of pile driving.

Potential exposures are expected to be limited to subadult or adult males. Animals could be exposed when traveling, resting, and foraging.

6.6.4 California Sea Lion

California sea lions are routinely seen hauled out from August through June on the PSB floats and submarines at NAVBASE, Bangor. Surveys indicate there are 0 to 122 animals hauled out each day during the in-water work period. November 2013 had the highest average monthly maximum with 71 individuals hauled out. For the analysis, an assumption was made that all animals hauled out would swim into the behavioral harassment zone each day during pile driving. Using formula #3, the monthly maximum number of animal, 71, and 8 potential days of pile driving 568 potential Level B behavioral exposures to California sea lions were calculated. This rationale is based on a worst case assumption that all days of pile driving would occur during the month with the greatest abundance of animals and all animals would be in the water each day during pile driving. If project work occurs when California sea lions are less likely to be present, then actual exposures would be less. Additionally, if daily pile driving duration is short, exposure would be expected to be less because some animals would remain hauled out for the duration of pile driving.

Based on the Navy's analysis, a maximum estimate of 568 California sea lions of the U.S. stock could be exposed to sound levels considered Level B behavioral harassment from underwater sound incidental to pile driving. Since primarily only male California sea lions migrate into the Study Area (Jeffries et al. 2000), all exposures are expected to be sub-adult or adult males. Animals could be exposed when traveling, resting, and foraging.

6.6.5 Harbor Seal

Harbor seals are routinely seen year-round primarily in the water at NAVBASE Kitsap Bangor, and occasionally hauled out on PSB floats, work floats, the wave-screen at the Service Pier, and Marginal Wharf. Because these animals have not been specifically surveyed, the exact number of animals likely to be present is unknown. Because multiple animals are routinely seen in the water and no dedicated harbor seal haulout numbers are documented, the density formula presented in Section 6.5 was used to calculate potential harbor seal exposure to pile driving noise. This formula has been used successfully in prior IHA at the Bangor waterfront (EHW-1, EHW-2 construction year 1 and year 2, and Barge Mooring). In these applications, the number of predicted harbor seals exposed to pile driving noises did not exceed the number seen while monitoring plus the number extrapolated for unseen animals. Therefore, this application is also using this methodology to estimate harbor seal exposure. However, prior IHA applications for the Bangor waterfront used a lower density than the current estimate that is based on more recent scientific data regarding harbor seal haul out behavior in Hood Canal (London et al. 2012). Using formula #2 with an estimated 8 days of pile driving and a ZOI of 32.4 square kilometers, and an adjusted density of 7.93 animals per square kilometer to account for animals out of water, a maximum estimate of 2,056 harbor seals of the Washington inland waters stock could be exposed to sound levels considered Level B harassment from underwater sound incidental to pile driving. However, based on the short duration of pile driving during this project (a maximum of 3 hours) and number of harbor seals seen during past monitoring efforts for prior Bangor waterfront projects conducting pile driving, fewer harbor seals will be exposed to Level B disturbance than the 2,056 estimated.

Harbor seal pupping has been reported and seal pups have been observed at NAVBASE Kitsap Bangor. Therefore, neonates may be present during pile driving occurring during the pupping season (June through October for Hood Canal). Otherwise, exposures during the in-water work window would potentially occur to juveniles, subadults, and adults of any sex within the disturbance ZOIs while pile driving is occurring. Animals could be exposed when traveling, resting, and foraging.

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7 Impacts to Marine Mammal Species or Stocks

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

7.1 Potential Effects of Pile Driving on Marine Mammals

7.1.1 Potential Effects Resulting from Underwater Noise

The effects of pile driving noise on marine mammals are dependent on several factors, including the species, size of the animal, and proximity to the source; the depth, intensity, and duration of the pile driving sound; the depth of the water column; the substrate of the habitat; the distance between the pile and the animal; and the sound propagation properties of the environment. Impacts to marine mammals from pile driving activities are expected to result primarily from acoustic pathways. As such, the degree of effect is intrinsically related to the received level and duration of the sound exposure, which are in turn influenced by the distance between the animal and the source. In general, sound exposure should be less intense farther away from the source. 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) will absorb or 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.

Potential impacts to marine species can be caused by physiological responses to both the type and strength of the acoustic signature (Viada et al. 2008). Behavioral impacts may also occur, though the type and severity of these effects are more difficult to define due to limited studies addressing the behavioral effects of impulsive sounds on marine mammals. Potential effects from impulsive sound sources can range from Level B effects such as brief behavioral disturbance, tactile perception, and physical discomfort, to Level A impacts, which may include slight injury of the internal organs and the auditory system, and possible death of the animal (Yelverton et al. 1973; O'Keefe and Young 1984; Ketten 1995; U.S. Department of the Navy 2001).

Physiological Responses

Direct tissue responses to impact/impulsive sound stimulation may range from mechanical vibration or compression with no resulting injury to tissue trauma (injury). Because the ears are the most sensitive organ to pressure, they are the organs most sensitive to injury (Ketten 2000). Sound-related trauma can be lethal or sub-lethal. Lethal impacts are those that result in immediate death or serious debilitation in or near an intense source (Ketten 1995). Sub-lethal damage to the ear from a pressure wave can rupture the tympanum, fracture the ossicles, and damage the cochlea; cause hemorrhage, and cause leakage of cerebrospinal fluid into the middle ear (Ketten 2004). Sub-lethal impacts also include hearing loss, which is caused by exposure to perceptible sounds. Moderate injury implies partial hearing loss. Permanent hearing loss (also called permanent threshold shift or PTS) can occur when the hair cells of the ear are damaged by a very loud event, as well as by prolonged exposure to noise. Instances of temporary threshold shifts and/or auditory fatigue are well documented in marine mammal literature as being one of the primary avenues of acoustic impact. Temporary loss of hearing sensitivity has been documented in controlled settings using captive marine mammals exposed to strong sound exposure levels at various frequencies (Ridgway et al. 1997; Kastak et al. 1999; Finneran et al. 2005). While injuries to other sensitive organs are possible, they are less likely since pile driving impacts are almost entirely acoustically mediated, versus explosive sounds which also include a shock wave that can result in damage. Based on the analysis in Chapter 6, no Level A harassment is expected to result from project activities because mitigation measures outlined in Chapter 11 will be implemented.

Behavioral Responses

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

Controlled experiments with captive marine mammals showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway et al. 1997; Finneran et al. 2003). Observed responses of wild marine mammals to loud pulsed sound sources (typically seismic guns or acoustic harassment devices and including pile driving) have been varied, but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds 2002; also see reviews in Gordon et al. 2004; Wartzok et al. 2003; and Nowacek et al. 2007). Some studies of acoustic harassment and acoustic deterrence devices have found habituation in resident populations of seals and harbor porpoises (see review in Southall et al. 2007). Blackwell et al. (2004) found that ringed seals exposed to underwater pile driving sounds in the 153–160 dB rms range tolerated this noise level and did not seem unwilling to dive. One individual was as close as 63 meters from the pile driving. Responses of two pinniped species to impact pile driving at the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project were mixed (Caltrans 2001; Thorson and Reyff 2006; Thorson 2010). Harbor seals were observed in the water at distances of approximately 400–500 meters from the pile driving activity and exhibited no alarm responses, although several showed alert reactions, and none of the seals appeared to remain in the area. One of these harbor seals was even seen to swim to within 150 meters of the pile driving barge during pile driving. Several sea lions, however, were observed at distances of 500–1,000 meters swimming rapidly and porpoising away from pile driving activities. The reasons for these differences are not known, although Kastak and

Schusterman (1998) reported that sea lions are more sensitive than harbor seals to underwater noise at low frequencies.

Observations of marine mammals on NAVBASE Kitsap Bangor during the Test Pile Project concluded that pinniped (harbor seal and California sea lion) foraging behaviors decreased slightly during construction periods involving impact and vibratory pile driving, and both pinnipeds and harbor porpoise were more likely to change direction while traveling during construction (Navy 2012). Pinnipeds were more likely to dive and sink when closer to pile driving activity, and a greater variety of other behaviors (including fighting, foraging, hauling out, milling, playing, and vocalizing) were observed with increasing distance from pile driving. Relatively few observations of cetacean behaviors were obtained during pile driving, and all were outside the WRA. Most harbor porpoises were observed swimming or traveling through the project area and no obvious behavioral changes were associated with pile driving.

During the first year of EHW-2 construction monitoring (the July 16, 2012 through February 15, 2013 in-water work window), only California sea lions and harbor seals were detected within the shutdown and behavioral disturbance zones (Primary Surveys) and outside the WRA (Outside Boat Surveys). The sample size for California sea lions was too small during pile driving to identify any trends in responses to construction (Hart Crowser 2013). Harbor seals engaged in a variety of behaviors during pile driving, including swimming, diving, sinking, and looking. They were equally likely to swim, dive, or sink as their ultimate behavior if they were inside the 464-meter behavioral disturbance zone and most likely to dive if they were outside the WRA. However, observation effort within the WRA was more intense than effort outside WRA (as explained in Appendix A). Harbor porpoises were only observed outside the WRA, where the predominant behavior during construction (vibratory pile driving) was swimming or traveling through the project area. During pre-construction monitoring, marine mammal observers also reported harbor porpoise foraging. Marine mammal observers did not detect adverse reactions to TPP or EHW-2 construction activities consistent with distress, injury, or high speed withdrawal from the area, nor did they report obvious changes in less acute behaviors.

Marine mammal monitoring at the Port of Anchorage marine terminal redevelopment project 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 and Research Corporation 2009). Most marine mammals observed during the two lengthy construction seasons were beluga whales. Harbor seals, harbor porpoises, and Steller sea lions were observed in smaller numbers. Background noise levels at this port are typically at 125 dB.

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

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

7.1.2 Potential Effects Resulting from Airborne Noise

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

Based on these observations, marine mammals in the impact zones may exhibit temporary behavioral reactions to airborne pile driving noise. These exposures may have a temporary effect on individual or groups of animals, but this level of exposure is very unlikely to result in population-level impacts.

7.2 Conclusions Regarding Impacts to Species or Stocks

Individual marine mammals may be exposed to sound pressure levels during pile driving, which may result in Level B behavioral harassment. Marine mammals that are exposed (harassed) may change their normal behavior patterns (i.e., swimming speed, foraging habits, etc.) or be temporarily displaced from the area of construction. Any exposures will likely have only a minor effect on individuals and no effect on the population. The sound generated from vibratory pile driving is non-impulsive, which is not known to cause injury to marine mammals. Mitigation is expected to avoid most potential adverse underwater impacts to marine mammals from impact pile driving. In addition, the duration of impact pile driving will be 4 hours or less over a maximum 4-day period. The maximum level of exposure (defined as acoustic harassment) is presented in Chapter 6. This level of effect is not anticipated to have any adverse impact to population recruitment or survival.

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8 Impact to Subsistence Use

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

8.1 Subsistence Harvests by Northwest Treaty Indian Tribes

Historically, Pacific Northwest treaty Indian tribes were known to utilize (hunt) several species of marine mammals including, but not limited to: harbor seals, Steller sea lions, northern fur seals, gray whales, and humpback whales (Norberg pers. comm. 2007). Several Pacific Northwest treaty Indian tribes have promulgated[5] tribal regulations allowing tribal members to exercise treaty rights for subsistence harvest of California sea lions and harbor seals (Carretta et al. 2007). There are no known active ceremonial and/or subsistence hunts for marine mammals in Puget Sound, including Hood Canal, or the San Juan Islands (Norberg pers. comm. 2007). Carretta et al. (2007) estimated annual subsistence takes of zero to two California sea lions. No data are available for the number of annual harbor seal subsistence takes (Carretta et al. 2011). In addition, no northern fur seals, gray whales, or humpback whales are anticipated to be affected by project activities; therefore, the project will have no effect to those species.

8.2 Summary

Potential impacts resulting from the proposed action will be limited to individuals of marine mammal species located in the marine waters near EHW-1 will be limited to Level B harassment. Therefore, no impacts to the availability of species or stocks for subsistence use were found.

[5] To make known by open declaration; publish; proclaim formally; or put into operation (a law, decree of a court, etc.).

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9 Impacts to the Marine Mammal Habitat and the Likelihood of Restoration

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

Impacts to habitat from the project are expected to be temporary and include increased human activity and noise levels, impacts to water quality, and changes in prey availability near the project site. Impacts will not result in permanent impacts to habitats used directly by marine mammals.

9.1 Effects from Human Activity and Noise

Existing human activity and underwater noise levels, primarily due to industrial activity and small vessel traffic, could increase above baseline temporarily during pile repair and replacement activities.

Marine mammals in proposed project location and surrounding areas encounter vessel traffic associated with both Navy and non-navy activities. At Navy installations, vessels are used in day-to-day activities including security along the waterfront at NAVBASE Kitsap Bangor. Several studies have linked vessels with behavioral changes in killer whales in Pacific Northwest inland waters (Kruse 1991; Kriete 2002; Williams et al. 2002; Bain et al. 2006), although it is not well understood whether the presence and activity of the vessels, the vessel noise produced, or a combination of these factors produces the changes. The probability and significance of vessel and marine mammal interactions is dependent upon several factors including numbers, types, and speeds of vessels; the regularity, duration, and spatial extent of activities; and the presence/absence and density of marine mammals.

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

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

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

9.2 Effects on Water Quality

Temporary and localized reduction in water quality will occur as a result of in-water construction activities. Most of this effect will occur during the installation and removal of piles when bottom sediments are disturbed. Effects to turbidity and sedimentation are expected to be short-term and not result in any measurable effects to marine mammals. During pile repair and replacement activities, suspension of anoxic sediment could result in temporary, minor, localized reduced dissolved oxygen in the water column. However, if decreases occur, they would be minimal and localized and are not anticipated to result in levels that would be significant for marine mammals.

9.3 Impacts on Prey Base (Fish)

Pile driving will impact marine habitats used by fish. Marine habitats used by fish species that occur in the project area include nearshore intertidal and subtidal habitats, including piles used for structure and cover. The greatest impact to prey species during pile repair and replacement will result from behavioral disturbance due to pile driving noise. Secondary impacts include benthic habitat displacement, re-suspension of sediments, and injury from underwater noise. The prey base for pinniped species in the project area includes a wide variety of fish such as Pacific hake, Pacific herring, and Pacific salmon. Harbor porpoise likely feed on schooling forage fish, such as Pacific herring, smelts, and squid. Transient killer whales in the Puget Sound prey on pinnipeds.

9.3.1 Underwater Noise Effects on Fish

The greatest impact to marine fish during construction will occur during impact pile driving because pile driving will exceed the established underwater noise behavior guidance and injury thresholds for fish. However, most piles will be installed with a vibratory driver or they will be concrete or timber, which have lower amplitude sound levels and have not been associated with fish kills.

During steel impact pile driving, the associated underwater noise levels will have the potential to cause injury and could result in behavioral responses, including project area avoidance. To reduce potential effects to salmonids, including juvenile ESA-listed salmonids, the project will adhere to the in-water work window. A bubble curtain, or other noise attenuating device, will be deployed to reduce the underwater noise levels and associated impacts to underwater organisms during impact pile driving of steel piles. To further minimize the underwater noise impacts, vibratory pile drivers will be used to the maximum extent practicable to drive steel piles. An impact hammer will be primarily used to verify load bearing capacity or where piles cannot be advanced further with a vibratory driver due to hard substrate conditions. Additionally, impact driving of steel piles will occur intermittently throughout any one day and will cease at night further limiting potential for adverse effects from cumulative exposure.

Fish within the areas where noise exceeds the behavioral guidance (150 dB rms re 1μPa) may display a startle response during initial stages of pile driving and will potentially avoid the immediate project vicinity during pile driving and other construction activities. However, field observation investigations of juvenile salmonid behavior near pile driving projects (Feist 1991; Feist et al. 1992), found little evidence that normally nearshore out-migrating salmonids move farther offshore to avoid the general project area. In fact, some studies indicate that construction site behavioral responses, including site avoidance, may be as strongly tied to visual stimuli as to underwater sound (Feist 1991; Feist et al. 1992; Ruggerone et al. 2008). Therefore, it is possible that salmonids, and likely other species, may alter their normal behaviors including startle response and avoidance of the immediate project site.

Thus, prey availability for marine mammal predators within an undetermined portion of the areas near EHW-1 could be reduced temporarily in localized areas during pile driving. However, with the minimization measures that will be implemented, the effect to the overall marine mammal fish forage base will be minimal and will not rise to the level of MMPA take.

9.3.2 Effects on Fish Habitats/Abundance

Pile repair and replacement activities will adversely affect some habitat conditions for marine fish, including forage fish, in the project area. Positioning and anchoring the construction barges and removing/driving piles will locally increase turbidity, disturb benthic habitats, and disturb forage fish in the immediate pile vicinity. Additionally, removal of marine vegetation and attached biota will occur. Construction could bury benthic organisms with limited mobility under sediment. Increased turbidity could make it difficult for predators to locate prey. All of these actions will be temporary with sediments settling back soon after the cessation of activities, and will be localized to the immediate area around piles. Foraging and refuge habitat quality for prey species will be temporarily degraded over localized areas. The effect is expected to be insignificant to the forage base for marine mammals. All affected areas are expected to recover quickly and no new overwater structures are being built that will permanently degrade or alter habitat.

Impacts to salmonid and forage fish populations, including ESA-listed species, will be minimized by adhering to the in-water work period designated. The work period is designated when out-migrating juvenile salmonids are least likely to occur. Some limited fish habitat degradation is expected during construction, but the impacts to fish species and their habitats will be temporary and localized and not affect the overall prey base for marine mammals.

9.4 Likelihood of Habitat Restoration

All impacts to marine mammal habitat are expected to be limited to the duration of pile extraction and installation during the in-water work window each year. In-water activities associated with the proposed action are not likely to have a permanent, adverse effect on any marine habitat or population of fish species.

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10 Impacts to Marine Mammals from Loss or Modification of Habitat

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

The proposed repair project 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 all activities will be temporary and all piles removed or replaced are within the existing footprint of the current structure. Information provided in Chapter 9 indicates there may be temporary impacts, but those impacts will be limited to the immediate area surrounding the structure being repaired. Impacts will cease upon the completion of repairs.

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11 Means of Effecting the Least Practicable Adverse Impacts

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

The Navy will employ the Best Management Practices (BMPs) and minimization measures listed in this section to avoid and minimize impacts to marine mammals, their habitats, and forage species. Best management practices, mitigation and minimization measures are included in construction contract plans and specifications and must be agreed upon by the contractor prior to any construction activities. A signed contract represents a legal agreement between the contractor and the Navy. Failure to follow the prescribed BMPs and minimization measures constitutes a contract violation.

11.1 General Construction Best Management Practices

- All work will adhere to performance requirements of the Clean Water Act, Section 404 permit and Section 401 Water Quality Certification. No in-water work will begin until after issuance of regulatory authorizations.
- The construction contractor is responsible for preparation of an environmental protection plan. The plan will be submitted and implemented prior to the commencement of any construction activities and is a binding component of the overall contract. The plan shall identify construction elements and recognize spill sources at the site. The plan shall outline BMP, responsive actions in the event of a spill or release, and notification and reporting procedures. The plan shall also outline contractor management elements such as personnel responsibilities, project site security, site inspections, and training.
- No petroleum products, fresh cement, lime, fresh concrete, chemicals, or other toxic or harmful materials shall be allowed to enter surface waters.
- Washwater resulting from washdown of equipment or work areas shall be contained for proper disposal and shall not be discharged unless authorized.
- Equipment that enters surface waters shall be maintained to prevent any visible sheen from petroleum products.
- No oil, fuels, or chemicals shall be discharged to surface waters, or onto land where there is a potential for re-entry into surface waters to occur. Fuel hoses, oil drums, oil or fuel transfer valves, fittings, etc. shall be checked regularly for leaks and will be maintained and stored properly to prevent spills.
- No cleaning solvents or chemicals used for tools or equipment cleaning shall be discharged to ground or surface waters.
- Construction materials will not be stored where high tides, wave action, or upland runoff could cause materials to enter surface waters.
- Barge operations will be restricted to tidal elevations adequate to prevent grounding of a barge.

- Where eelgrass is present in the work area, the Navy shall provide the contractor with plan sheets showing eelgrass boundaries. The following restrictions shall apply to areas designated as having eelgrass:
    - No derrick spudding or anchoring will occur.
    - No scouring of sediments or significant sediment contamination will occur within eelgrass beds.

11.2 Pile Removal and Installation Best Management Practices

- Removed piles and associated sediments (if any) shall be contained on a barge. If a barge is not utilized, piles and sediments may be stored in a containment area near the construction site.
- Pilings that break or are already broken below the waterline may be removed by wrapping the piles with a cable or chain and pulling them directly from the sediment with a crane. If this is not possible, pilings will be removed with a clamshell bucket. To minimize disturbance to bottom sediments and splintering of piling, the contractor will use the minimum size bucket required to pull out piling based on pile depth and substrate. The clamshell bucket will be emptied of piling and debris on a contained barge before it is lowered into the water. If the bucket contains only sediment, the bucket will remain closed and be lowered to the mudline and opened to redeposit the sediment. In some cases (depending on access, location, etc.), piles may be cut below the mudline and the resulting hole backfilled with clean sediment.
- Any floating debris generated during installation will be retrieved. Any debris in a containment boom will be removed by the end of the work day or when the boom is removed, whichever occurs first. Retrieved debris will be disposed of at an upland disposal site.
- If steel piles are filled with concrete, the tube used to fill steel piles with concrete will be placed toward the bottom of the pile to prevent splashing and overflow.
- Whenever activities that generate sawdust, drill tailings, or wood chips from treated timbers are conducted, tarps or other containment material will be used to prevent debris from entering the water.
- Ammoniacal copper zinc arsenate-treated wood will be treated using established standards.
- All piles, lumber, and other materials treated with preservatives shall be sufficiently cured to minimize leaching into the water or sediment.
- If excavation around piles to be repaired or replaced is necessary, hand tools or a siphon dredge will be used to excavate around piles to be replaced.

11.3 Timing Restrictions

- To minimize the number of fish exposed to underwater noise and other construction disturbance, in-water work will occur during the July 16 through January 15 in-water work window when juvenile ESA-listed salmonids are least likely to be present.

- All in-water construction activities will occur during daylight hours (sunrise to sunset) except from July 16 to September 23 when impact pile driving will only occur starting 2 hours after sunrise and ending 2 hours before sunset, to protect foraging marbled murrelets during the nesting season (April 15-September 23). Sunrise and sunset are to be determined based on the National Oceanic and Atmospheric Administration (NOAA) data which can be found at http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html.
- Non in-water construction activities could occur between 7:00 AM and 10:00 PM during any time of the year.

11.4 Minimization Measures for Marine Mammals

The following mitigation measures will 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 disturbance noise levels.

11.4.1 Coordination

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

11.4.2 Acoustic Minimization Measures

- Vibratory installation will be used to the extent possible to drive steel piles to minimize high sound pressure levels associated with impact pile driving.
- A bubble curtain or other noise attenuation device will be employed during impact installation or proofing of steel piles where water depths are greater than 0.67 meters (2 feet) (see Section 2.3.6). A noise attenuation device is not required during vibratory pile driving.
- If a bubble curtain or similar measure is used, it will distribute air bubbles around 100 percent of the piling perimeter for the full depth of the water column. Any other attenuation measure must provide 100 percent coverage in the water column for the full depth of the pile. The lowest bubble ring shall be in contact with the mudline for the full circumference of the ring. The weights attached to the bottom ring shall ensure 100 percent mudline contact. No parts of the ring or other objects shall prevent full mudline contact.
- A performance test of the noise attenuation device shall be conducted prior to initial use for impact pile driving. If a bubble curtain or similar measure is utilized, the performance test shall confirm the calculated pressures and flow rates at each manifold ring. The contractor shall also train personnel in the proper balancing of air flow to the bubblers. The contractor shall submit an inspection/performance report to the Navy for approval within 72 hours following the performance test. Corrections to the noise attenuation device to meet the performance stands shall occur prior to use for impact driving.

11.4.3 Soft Start

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

- A soft start procedure will be used at the beginning of each day's in-water pile driving or any time pile driving has ceased for more than 30 minutes.
- For impact pile driving, the following soft-start procedures will be conducted:
  - The contractor will provide an initial set of strikes from the impact hammer at reduced energy, followed by a 30-second waiting period, then two subsequent sets. (The reduced energy of an individual hammer cannot be quantified because they vary by individual drivers. Also, the number of strikes will vary at reduced energy because raising the hammer at less than full power and then releasing it results in the hammer "bouncing" as it strikes the pile resulting in multiple "strikes").
- For vibratory pile driving, the following soft-start procedures would be conducted:[6]
  - If a variable moment driver can be used, the contractor will initiate noise from vibratory drivers for 15 seconds at reduced energy followed by a 30-second waiting period. The procedure shall be repeated two additional times. If unsafe working conditions during soft starts are reported by the contractor and verified by an independent safety inspection, the Navy may elect to discontinue vibratory driver soft starts. The Navy will inform NFMS HQ if the soft start procedure is discontinued.
  - If use of a variable moment driver is infeasible and the model of vibratory driver was not specifically designed for soft start procedures then the Navy will not employ vibratory soft start procedure due to historical personnel safety concerns.

11.4.4 Visual Monitoring and Shutdown Procedures

A proposed marine mammal monitoring plan is located in Appendix C and will be approved by NMFS prior to commencement of in-water project work. The plan includes the following:

For all impact and vibratory pile driving, a shutdown and disturbance zone will be monitored.

- Monitoring will take place from 15 minutes prior to initiation through 30 minutes post-completion of pile driving.
- For pile driving, the shutdown zone shall include all areas where the underwater sound pressure levels are anticipated to equal or exceed the Level A (injury) criteria for marine mammals. The shutdown zone will always be a minimum of 10 meters (33 feet) to

[6] In 2013, vibratory pile driving during construction of a deep wharf, the Explosives Handling Wharf #2 (EHW-2) located at NAVBASE Kitsap Bangor, resulted in discontinuation of the soft-start procedure due to crane failure from excess wear due to the soft-start procedure. The Marine Mammal Commission has stated that the soft-start is a viable, effective component of a mitigation plan designed to effect the least practicable impact on marine mammals. In response to this concern, NMFS formed a working group with the Navy in April 2014 to address the soft-start procedures. At this time the EHW-2 project is the only project where the procedure has been waived.

prevent injury from physical interaction of marine mammals with construction equipment.

- The disturbance zone shall include all areas where the underwater or airborne sound pressure levels are anticipated to equal or exceed the Level B (disturbance) criteria for marine mammals during impact pile driving. However, due to the extreme area of this zone, this zone may be reduced to a practicable monitoring area in final approved monitoring plans.
- Visual monitoring will be conducted by qualified, trained marine mammal observers (hereafter "observer"). An observer is a biologist with prior training and experience conducting marine mammal monitoring or surveys, and who has the ability to identify marine mammal species and describe relevant behaviors that may occur in proximity to in-water construction activities.
- Trained observers will be placed at the best vantage point(s) practicable (e.g. from a small boat, construction barges, on shore, or any other suitable location) to monitor for marine mammals and implement shutdown/delay procedures when applicable by calling for the shutdown to the pile driver operator.
- If the shutdown zone is obscured by fog or poor lighting conditions, pile driving will not be initiated until the entire shutdown zone is visible (i.e., the entire shutdown zone and surrounding waters within the WRA must be visible to the naked eye).
- Prior to the start of pile driving, the shutdown zone will be monitored for 15 minutes to ensure that the shutdown zone is clear of marine mammals. Pile driving will only commence once observers have declared the shutdown zone clear of marine mammals.
- If a marine mammal is observed in the disturbance zone, but not approaching or entering the shutdown zone, a "take" will be recorded and the work will be allowed to proceed without cessation. Marine mammal behavior will be monitored and documented.
- If a marine mammal approaches or enters a shutdown zone during pile impact or vibratory driving, work will be halted and delayed until either the animal has voluntarily left and been visually confirmed beyond the shutdown zone or 15 minutes have passed without re-detection of the animal.

11.4.5 Data Collection

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

- Date and time that pile removal or installation begins and ends
- Construction activities occurring during each observation period
- Weather parameters identified in the acoustic monitoring (e.g. percent cover, visibility)
- Water conditions (e.g. sea state, tidal state [incoming, outgoing, slack, low, and high])
- Species, numbers, and, if possible, sex and age class of marine mammals
- Marine mammal behavior patterns observed, including bearing and direction of travel, and, if possible, the correlation to sound pressure levels

- Distance from pile removal and installation activities to marine mammals and distance from the marine mammal to the observation point
- Locations of all marine mammal observations
- Other human activity in the area.

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

11.4.6 Mitigation Effectiveness

All observers utilized for mitigation activities will be experienced biologists with training in marine mammal detection and behavior. Due to their specialized training, the Navy expects that visual mitigation will be highly effective. The observers will be positioned in locations, which provide the best vantage point(s) for monitoring. This will probably be an elevated position in order to provide a better range of viewing angles. In addition, the small radius of the shutdown zone makes the likelihood of detecting a marine mammal in this zone extremely high.

12 Effects on Arctic Subsistence Hunting and Plan of Cooperation

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

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

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

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

(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.

Subsistence use is the traditional exploitation of marine mammals by native peoples for their own consumption. This project does not occur in traditional Arctic subsistence hunting areas. Additionally, based on the discussions in Chapter 8, proposed activities will produce no adverse effects on the availability of species or stocks for subsistence use.

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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 the 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 will 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 Coordination

During the in-water work period covered by the IHA, the Navy will update NMFS on the progress of the project bimonthly (September 15, November 15, and January 15).

13.2 Monitoring Plans

In order to reduce impacts to marine mammals to the lowest extent practicable, a marine mammal monitoring plan will be implemented. A proposed monitoring plan is included in Appendix C.

13.3 Reporting

A draft project monitoring report will be submitted to NMFS within 90 work days of the completion of required monitoring. The report will detail the monitoring protocol, summarize the data recorded during monitoring, and estimate the number of marine mammals that may have been harassed. Final reports will be prepared and submitted to NMFS within 30 days following receipt of comments on the draft reports from the 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.

To minimize the likelihood that impacts will occur to the species, stocks, and subsistence use of marine mammals, all construction activities will be conducted in accordance with all federal, state, and local regulations, and minimization measures specified in Chapter 11 will be implemented to protect marine mammals. The Navy will coordinate all activities with the relevant federal and state agencies, including but not limited to NMFS, USFWS, U.S. Coast Guard, USACE, and WDFW.

The Navy is one of the world's leading organizations in assessing the effects of human activities on the marine environment including marine mammals. Navy scientists work cooperatively with other government researchers and scientists, universities, industry, and non-governmental conservation organizations in collecting, evaluating, and modeling information on marine resources. They also develop approaches to ensure that these resources are minimally impacted by existing and future Navy activities.

The Navy will share field data and behavioral observations on all marine mammals that occur in the project areas with NMFS and other agencies upon request. Results of the monitoring effort will be provided to NMFS in summary reports (Section 13.3). The Navy strives to be a world leader in marine species research and has provided more than $100 million 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 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, and
- Developing tools to model and estimate potential effects of sound.

The Navy has sponsored several workshops and ongoing surveys 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.

The following Puget Sound marine mammal monitoring activities and contracted studies are being conducted by the Navy outside of and in addition to the Navy’s commitments to the NMFS under existing permits. In order to better understand marine mammal presence and habitat use in the Puget Sound Region, the Navy has funded and coordinated four major efforts:

- **Puget Sound Pinniped Haulout Surveys at Specific Naval Installations:** Biologists located at NAVBASE Kitsap Bremerton, Bangor, and NAVSTA Everett conduct counts of seals and sea lions hauled out on Navy assets (e.g., submarines) and on floating security fences. In the case of NAVBASE Kitsap Bangor and NAVSTA Everett, counts are conducted daily (excluding weekends) when. For NAVBASE Kitsap Bremerton counts are collected during a monthly water quality sampling program. All animals are identified to species where possible. This information aides in determination of seasonal use of each site and trends in the number of animals. Currently, there are efforts underway to increase the frequency of the surveys at NAVBASE Kitsap Bremerton and expand to additional Navy areas such as Manchester, Whidbey Island, and Indian Island.
- **Opportunistic Marine Mammal Vessel Surveys in Hood Canal and Dabob Bay:** The Navy conducted an opportunistic marine mammal density survey in Hood Canal and Dabob Bay during September and October 2011 and again in October 2012. In Hood Canal, the surveys followed a double saw-tooth pattern to achieve uniform coverage of the entire Bangor waterfront. Transects generally covered the area from Hazel Point on the south end of the Toandos Peninsula to Thorndyke Bay. Surveys in adjacent Dabob Bay represented a different pattern and generally followed more closely to the shoreline while completing a circular route through the bay. A large exclusion zone surrounding a Navy ship moored temporarily in Dabob Bay made it difficult to perform zigzag transects across the bay; therefore, early attempts at surveys in Dabob did not follow a zigzag pattern, and switching to this survey pattern later in the project would have made density information collected during early “loop pattern” surveys incompatible with later data. Therefore, the loop pattern was followed during all subsequent baseline surveys in the bay. These surveys had a dual purpose of collecting marine mammal and marbled murrelet (bird species) data, and shoreline surveys tended to yield more marbled murrelet sightings.
- **Aerial Pinniped Haul-out Surveys:** The Navy funded and contracted WDFW to conduct aerial surveys of pinniped haul-outs in all of Puget Sound and the Strait of Juan de Fuca out to Cape Flattery. NMFS NWR funded the San Juan Islands Region. Collectively this information will be used to revise and update the 2000 Atlas of Seal and Seal Lion Haulouts in Washington State. The surveys began in 2013 and continue until spring 2014. The survey area does not cover the outer coast of Washington, only the inland waters.
- **Aerial Cetacean Surveys in Puget Sound (Admiralty Inlet and south):** The Navy has contracted aerial surveys of cetaceans in Puget Sound in order to better understand seasonality and distribution with the goal of improved density values. These surveys began in late 2013, with the survey frequency still being established.

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

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