CHAPTER 4

CUMULATIVE IMPACTS

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4.0 CUMULATIVE IMPACTS

4.1. PRINCIPLES OF CUMULATIVE IMPACTS ANALYSIS

The approach taken herein to analyze cumulative effects[1] meets the objectives of the National Environmental Policy Act (NEPA) of 1969, Council on Environmental Quality (CEQ) regulations, and CEQ guidance. CEQ regulations (40 Code of Federal Regulations [CFR] 1500-1508) provide the implementing procedures for NEPA. The regulations define "cumulative effects" as:

> . . . the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

CEQ provides guidance on cumulative impacts analysis in *Considering Cumulative Effects Under the National Environmental Policy Act* (CEQ 1997). This guidance further identifies cumulative effects as those environmental effects resulting "from spatial and temporal crowding of environmental perturbations. The effects of human activities will accumulate when a second perturbation occurs at a site before the ecosystem can fully rebound from the effects of the first perturbation." Noting that environmental impacts result from a diversity of sources and processes, this CEQ guidance observes that "no universally accepted framework for cumulative effects analysis exists," while also noting that certain general principles have gained acceptance. One such principle provides that "cumulative effects analysis should be conducted within the context of resource, ecosystem, and community thresholds—levels of stress beyond which the desired condition degrades." Thus, "each resource, ecosystem, and human community must be analyzed in terms of its ability to accommodate additional effects, based on its own time and space parameters." Therefore, cumulative effects analysis normally will encompass a Region of Influence (ROI) or geographic boundaries beyond the immediate area of the proposed action and a timeframe including past actions and foreseeable future actions, to capture these additional effects. Bounding the cumulative effects analysis is a complex undertaking, appropriately limited by practical considerations. Thus, CEQ guidelines observe that it "is not practical to analyze cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful."

For the proposed action to have a cumulatively significant impact on an environmental resource, two conditions must be met. First, the combined effects of all identified past, present, and reasonably foreseeable projects, activities, and processes on a resource, including the effects of the proposed action, must be significant. Second, the proposed action must make a substantial contribution to that significant cumulative impact. Finally, if the effects of the proposed action alone would have a significant impact on an environmental resource within its ROI, then the impacts of the proposed action in combination with all other past, present, and reasonably foreseeable actions would normally be cumulatively significant.

[1] CEQ Regulations provide that the terms "cumulative impacts" and "cumulative effects" are synonymous (40 CFR 1508.8[b]).

Cumulative impacts are those changes to the physical, biological, and socioeconomic environments that would result from a proposed action when added to other past, ongoing, and reasonably foreseeable actions, regardless of what agency of government or person undertakes such other actions (40 CFR 1508.7).

4.1.1. Identifying Region of Influence or Geographical Boundaries for Cumulative Impacts Analysis

The ROI or geographic boundaries for analyses of cumulative impacts can vary for different resources and environmental media. For air quality, the potentially affected air quality regions are the appropriate boundaries for assessment of cumulative impacts from releases of pollutants into the atmosphere. For wide-ranging or migratory wildlife, specifically marine mammals, fish, and sea birds, any impacts of the proposed action might combine with the impacts of other activities or processes within the range of the population. The ROI or geographic boundary for the majority of resources analyzed for cumulative impacts in this Environmental Impact Statement (EIS) is Hood Canal and the Hood Canal watershed.

The cumulative impacts analysis for the Land-Water Interface (LWI) and Service Pier Extension (SPE) projects considers known past, present, and reasonably foreseeable future actions throughout Hood Canal, including Naval Base (NAVBASE) Kitsap Bangor and its 4.5-mile (7.2-kilometer) shoreline on the canal. Although some marine organisms occurring along NAVBASE Kitsap Bangor move beyond Hood Canal, these organisms spend much of their time in Hood Canal; other species are essentially resident. Therefore, cumulative impacts on marine organisms are most likely to result from actions within Hood Canal. Hood Canal (and its watershed) is the most relevant region for defining populations or communities of marine and coastal resources occurring along NAVBASE Kitsap Bangor. Surrounding communities in which actions of NAVBASE Kitsap Bangor are most likely to contribute to cumulative social impacts include Silverdale, Poulsbo, and Bremerton, all of which are on the Kitsap Peninsula and within Kitsap County, as well as Jefferson County on the western shore of Hood Canal across from NAVBASE Kitsap Bangor and Mason County to the south of NAVBASE Kitsap Bangor. An ROI for evaluating the cumulative impacts of the proposed action is defined for each resource in Section 4.3.

4.2. PROJECTS AND OTHER ACTIVITIES ANALYZED FOR CUMULATIVE IMPACTS

4.2.1. Past, Present, and Reasonably Foreseeable Future Actions

Identifiable present effects of past actions are analyzed to the extent they may be additive to impacts of the proposed action. In general, the Navy lists and analyzes the effects of individual past actions only where appropriate; cumulative impacts analysis typically focuses on aggregate effects of past actions. This analysis depends on the availability of data and the relevance of future effects of past, present, and future actions. Although certain data (e.g., extent of forest cover) may be available for extensive periods in the past (i.e., decades), other data (e.g., water quality) may be available only for much shorter periods. Because specific information and data on past projects and actions are usually scarce, the analysis of past effects is often qualitative (CEQ 1997). Analysis will primarily include present and reasonably foreseeable future actions that may have effects additive to the effects of the proposed action. These actions include all likely future development of the region even when foreseeable future action is not planned in sufficient detail to permit complete analysis (CEQ 1997).

Table 4–1 lists the past, present, and reasonably foreseeable future actions at NAVBASE Kitsap Bangor and within the ROI that have had, continue to have, or would be expected to have some impact on the natural and human environment. The projects in this table are limited to those implemented in the last 5 years or those with ongoing contributions to environmental effects. Navy projects were selected based on best available knowledge about proposed future actions as well as a review of available NEPA and permitting documentation for past, current, and future actions. Projects expected to have measurable contributions to impacts within the ROI for a resource area were included in the cumulative analysis. In July 2014, the Navy purchased a bedland easement in Hood Canal. The State of Washington has denied Hood Canal Sand and Gravel's Joint Aquatic Resource Permit Application for their proposed project. Therefore, the construction and operation of Hood Canal Sand and Gravel's pit to pier project is no longer reasonably foreseeable and has been removed from the cumulative impact analysis.

The cumulative analysis considers reasonably foreseeable proposed plans and actions that are focused on shoreline developments in the Hood Canal watershed and that have a potential to result in cumulative impacts on the environment. Figures 4–1 and 4–2 show the locations of the actions which can be shown on these figures (for example, some of the actions are located outside the coverage of the figures, others have many sites, and the locations of some security projects cannot be shown in public documents). 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, the reach from Toandos Peninsula south to Great Bend is referred to as mid-Hood Canal, and the reach from Great Bend to Lynch Cove is referred to as southern Hood Canal. The LWI and SPE project sites are within northern Hood Canal. Cumulative projects were identified through contacts with the Kitsap County, Mason County, and Jefferson County Departments of Community Development, Washington State Department of Transportation (WSDOT), natural resource agencies, and American Indian tribes.

Because the LWI and SPE are independent actions, their environmental impacts are evaluated independently in Chapter 3. The combined impacts of the LWI and SPE are addressed in each resource section in Chapter 3. In this cumulative impacts analysis, the combined impacts of the LWI and SPE are evaluated for their contribution to cumulative impacts with past, present, and reasonably foreseeable future actions.

Overlap in the construction periods for multiple, closely located projects can result in short-term, cumulative impacts that are in addition to standard, longer-term cumulative impacts. Based on current projected schedules, construction of the following projects may overlap with construction of the LWI and SPE: existing EHW (EHW-1) Pile Replacement, the Transit Protection System (TPS) Pier, Magnetic Silencing Facility (MSF) modification, and installation of Electromagnetic Measurement Range Sensor System equipment on NAVBASE Kitsap Bangor. The EHW-1 Pile Replacement and TPS Pier projects would entail substantial pile driving that would be cumulatively considerable with the Proposed Actions. The EHW-1 Pile Replacement project includes removal of degraded piles and vibratory and impact driving of steel replacement piles. The number of new piles entailed in the TPS Pier project has not been determined (project in development stage). Cumulative impacts arising from these potential construction overlaps are addressed in this chapter where appropriate. Construction of the Waterfront Security Enclave project, which is related to the LWI project, has been completed.

Table 4–1. Past, Present, and Reasonably Foreseeable Future Actions in Hood Canal

Project	Project Description	Project Timeframe		
		Past	Present	Future
NAVBASE Kitsap Bangor Waterfront Operations	Waterfront operations include the overall integration of all port operations along the NAVBASE Kitsap Bangor waterfront. Activities include vessel traffic movement and management, personnel clearance and tracking, and ingress/egress within the restricted areas.	X	X	X
NAVBASE Kitsap Bangor Waterfront Facilities Maintenance	Common maintenance activities include pressure washing of waterfront piers to remove bird fecal material, marine fouling organisms (e.g., mussels, algae) and foreign materials (e.g., dirt). Maintenance area includes walkways and approaches to the piers. Other maintenance activities may involve repair and replacement of structures or facilities as needed. Recently completed maintenance actions included pile driving for KB Dock repair (5 piles replaced in 2015).	X	X	X
EHW-1 Maintenance	This multi-year project involves replacing deteriorated piles, the most recent phase, and installation of 29 30-inch (76-centimeter) steel piles. Phased repair of this structure is expected to continue until 2024.	X	X	X
Force Protection and Weapons Security Measures (locations UCNI)	The project involves installation and operation of facilities, including construction of an Auxiliary Reaction Force Facility (14,000 square feet [1,300 square meters]) and an Armored Fighting Vehicle Operational Storage Facility (16,146 square feet [1,500 square meters]); alteration of two buildings for a new armory (2,500 square feet [232 square meters]); and replacement of an Alert Force Garage (2,530 square feet [235 square meters]) including a new paved access road.	X	X	X
Road Improvements	Road clearing and grading are continuous. Loss of vegetation and habitat can be expected from road improvements, including those for the D5 Road and Transfer Facilities and Missile Haul Road.	X	X	X
CSDS-5 Support Facilities	The Navy implemented upgrades to waterfront and shore-based support facilities for its Submarine Development Squadron Five Detachment on NAVBASE Kitsap Bangor. These upgrades were completed in July 2005. Anticipated levels of mission support and the operational tempo of assigned submarines require additional shore-side buildings for administration, operations, industrial, and support functions. Security requirements and operational efficiency dictate consolidation of off-base contractor space onto a contiguous site adjacent to the shore-based support facilities. At the existing Service Pier, the Navy improved barge mooring capacity by replacing an existing research barge with a new research barge and installing new mooring piles to anchor the new research barge. This work occurred in summer of 2013 and involved installation of 18 new piles over a 3-week period.	X		
Mission Support Facilities	Mission support facilities may include activities or projects such as the addition of power booms, captivated camels, and piles for support or attachment; installation of emergency power generation capability; and other activities to support facilities or operations.	X	X	X

Table 4–1. Past, Present, and Reasonably Foreseeable Future Actions in Hood Canal (continued)

Project	Project Description	Project Timeframe		
		Past	Present	Future
Navy Surface Warfare Center Carderock Division (NSWCCD) Detachment Bremerton Command Consolidation	Construction of in-water facilities includes a new access pier (8,800 square feet [820 square meters]), pontoon (21,600 square feet [2,000 square meters]), vessel overwater footprint (13,623 square feet [1,266 square meters]) and associated mooring components and 102 new steel piles. Project tasks also include road improvements to Carlson Spit Access Road, a 23,000 square feet (2,140 square meters) building, and the addition of 100 workers.	X		
Waterfront Security Enclave and Security Barriers	Construction of enclave fencing for the entire NAVBASE Kitsap Bangor Waterfront Restricted Area and construction of an associated parking area and other facilities. Mitigation action is restoring tidal influence to Cattail Lake, thereby increasing intertidal habitat. Construction was completed in June 2013.	X		
NAVBASE Kitsap Bangor Test Pile Program	This project involved installation and removal of up to 29 test and reaction piles on NAVBASE Kitsap Bangor to gather geotechnical and noise data to validate the design concept for the EHW-2 and future projects at the Bangor waterfront. The test pile program required a maximum of 40 work days for completion, with less than 15 days of pile driving. Pile driving was conducted from July 16 through October 31, 2011.	X		
Relocate Nearshore Port Security Barriers	Project moved four mooring buoys and anchoring systems, previously located between EHW-1 and Marginal Wharf and used to moor the nearshore port security barriers when they are not in use. The mooring system was relocated to an area within Naval Restricted Area 1, near Delta pier. The project occurred in 2011. This resulted in minor seafloor disturbance when the anchors were lifted from the seafloor and repositioned.	X		
TRIDENT Second Explosives Handling Wharf (EHW-2)	Construction and Operation. The proposed project would include a new Explosives Handling Wharf; upland road; an abutment where the trestles connect to the shore; and an upland construction staging area. Approximately 20 existing facilities and/or structures in proximity to the proposed structure would be modified or demolished. Four new buildings would be constructed to house the functions of some of the buildings to be demolished or vacated. The primary impacts during project construction include pile-driving noise and its effects on marine biota, turbidity, and air pollutant emissions. Upland construction would result in permanent and temporary vegetation disturbance; loss of 0.20 acre of wetland; wildlife harassment (primarily from construction noise); and disruption of recreational areas during pile-driving. Long-term impacts would include loss and shading of marine habitat, including eelgrass, macroalgae, and the benthic community, and interference with migration of juvenile salmon, some species of which are protected by the ESA. Construction would occur over 4 years, with in-water work subject to timing restrictions. During construction, measures and BMPs will be implemented to avoid or minimize potential impacts on species, marine and upland habitats, cultural resources, land use, recreation, and traffic. A NEPA Record of Decision was signed in 2012.		X	X

Table 4–1. Past, Present, and Reasonably Foreseeable Future Actions in Hood Canal (continued)

Project	Project Description	Project Timeframe		
		Past	Present	Future
TRIDENT Second Explosives Handling Wharf (EHW-2) (continued)	Mitigation. To compensate for unavoidable impacts on aquatic resources and ensure no net loss of these resources, the Navy purchased credits from the Hood Canal in-Lieu Fee Program. To restore temporarily disturbed construction areas, the Navy will implement a revegetation plan for construction laydown areas and temporarily disturbed areas. To improve scientific understanding of marine species, the Navy will fund research studies on: (1) ocean acidification and (2) Hood Canal chum salmon. To improve salmon production and harvest opportunities in Hood Canal, the Navy will fund improvements at three existing fish hatcheries on Hood Canal and replacement of one finfish spawning facility on Hood Canal. To improve shellfish production and harvest opportunities, the Navy will fund: (1) improvements to beach substrate and 3 years of shellfish seeding on 24 acres of beach; (2) 5 years of shellfish seeding on priority shellfish enhancement areas in Hood Canal and adjacent Admiralty Inlet; (3) construction of a shellfish wet lab, education, and training building at Port Gamble; (4) construction of a floating shellfish nursery at Port Gamble; and (5) geoduck surveys and a geoduck pilot research study. In addition, the Navy will fund acquisition and preservation of upland habitat at Port Gamble.			
Swimmer Interdiction Security System In-water Structure and Support Facilities	The Navy has implemented a Swimmer Interdiction Security System to meet special U.S. Government security requirements for military installations in response to the terrorist attacks of September 11, 2001. The system protects waterside Navy assets and sailors, and would remain in operation as long as valuable naval assets were located on NAVBASE Kitsap Bangor. Specially trained marine mammals and their human teammates respond rapidly to security alerts by detecting, classifying, and marking the location of underwater objects or intruders. Humans work aboard small power boats, and marine mammals would be in enclosures. A Draft EIS was made available to the public for comment in December 2008, with a Record of Decision signed in 2009.	X	X	X
Relocate Floats to Delta Pier	This project removed and disposed of an existing wooden float on the south side of the Delta Pier, and relocated two existing concrete floats from the Marginal Wharf to the location of the wooden float at the Delta Pier. Six concrete piles were installed to secure the concrete floats at the Delta Pier. Five creosote-treated piles, which would no longer be required at the Marginal Wharf, were removed. A single concrete pile was installed to secure the end of the floats, which remain at the Marginal Wharf. The result was a net reduction of 741 square feet (69 square meters) in over-water coverage. The project was completed in 2015.	X		
Electromagnetic Measurement Range	The proposed Electromagnetic Measurement Range Sensor System equipment project includes installation of sensor equipment, including an underwater instrument array, data/power cables, a pile-supported platform, an in-water navigation aid, and an upland monitoring system on NAVBASE Kitsap Bangor.			X

Table 4–1. Past, Present, and Reasonably Foreseeable Future Actions in Hood Canal (continued)

Project	Project Description	Project Timeframe		
		Past	Present	Future
Northwest Training Range Complex (NWTRC) EIS, Pacific Ocean	A wide variety of military training activities are conducted in the W-237 operating areas west of Washington, including training exercises in anti-air, anti-surface, and anti-submarine warfare; electronic combat exercises; mine countermeasures training; naval special warfare training; and various support operations. The Navy has developed policies and procedures to preclude harm and to minimize the effects of Navy training on terrestrial and marine species and habitats. This action involves activities at Floral Point, which is within the Region of Influence for this cumulative analysis. The Navy prepared an EIS/OEIS to assess effects of ongoing and potential future training activities in the Northwest Training Range Complex. Training activities are ongoing. The current permits cover training activities until 2015.	X	X	X
NAVSEA NUWC Keyport Range Complex Extension	This project involves an increase in the underwater Hood Canal Military Operating Area, including areas in and outside Hood Canal. The EIS included the Dabob Bay Range Complex and a proposed expansion of the Marine Operating Areas both to the north and south of their existing limits. Training activities are ongoing. Permits expire in 2016.	X	X	X
Northwest Testing and Training (NWTT)	Combined EIS for ranges covered by the Northwest Training Range Complex (NWTRC) and NUWC Keyport; adds the other RDT&E conducted in the Pacific Northwest and pier side maintenance at PSNS, NAVSTA Everett, and NAVBASE Kitsap Bangor waterfront. The project includes pier side sonar testing conducted as part of overhaul, modernization, maintenance, and repair activities at Puget Sound Naval Shipyard in Bremerton, Naval Base Kitsap at Bangor, and Naval Station Everett. The Navy proposes to adjust training and testing activities from current levels to the level needed to support Navy requirements beginning October 2015.			X
Marine Structure Maintenance and Pile Replacement Program	Programmatic EA to cover upcoming marine structure maintenance and pile replacement projects at six NRNW installations for 2018–2023.			X
Service Pier Electrical Upgrades	This project would correct existing power and communications deficiencies, expand power and communications distribution from Substations #4 and #5 to the existing Service Pier, and install a multi-phased emergency industrial power generator to support multiple Command Tenants on NAVBASE Kitsap Bangor. Site preparation would include removal of overhead power lines and communication lines, site clearing and grubbing, installation of erosion controls, grading, excavation, and preparation for construction. The EA is anticipated to be completed in 2017, followed by project implementation.			X
Bangor Transit Protection System (TPS) Pier	This project consists of a new floating pier with finger piers, connected to the shore by a trestle and ramp. Total overwater area is approximately 1.6 acres (0.65 hectare). On-land facilities would include a new operations and headquarters building with a footprint of 9,000 square feet (836 square meters), and parking lots totaling 22,000 square feet (2,045 square meters).			X

Table 4–1. Past, Present, and Reasonably Foreseeable Future Actions in Hood Canal (continued)

Project	Project Description	Project Timeframe		
		Past	Present	Future
Magnetic Silencing Facility (MSF) Modification	The proposed project would provide a berth for U.S. Coast Guard Blocking Vessels at the existing Magnetic Silencing Facility. The Proposed Action includes: installation of steel support structure in two locations with two 10- by 40-foot (3- by 12-meter) open deck mooring camels; installation of four double-bitts on the pier deck; and repair of approximately 25 piles. No new piles would be installed, and no structure will be installed on the sea bottom.			X
Port Gamble Dock	The Olympic Property Group has applied for a permit for a dock at a former mill site in Port Gamble. The proposed dock would be 365 feet (111 meters) in length with an area of about 4,800 square feet (446 square meters), and will include an abutment, pier, truss, and gangway, as well as a primary float, seaplane float, and kayak launching float. The dock would accommodate up to nine boats.			X
Kitsap Memorial State Park	Washington State Parks conducted a slope stabilization project for an approximately 1,000-foot (305-meter) long, creosote-treated bulkhead at Kitsap Memorial State Park in Poulsbo on Hood Canal. The treated wood bulkhead was removed and the shoreline "naturalized" as part of the project. The project was permitted by both an approved shoreline exemption under normal maintenance repair and replacement and an approved Site Development Activity Permit. Naturalization of the shoreline improved nearshore habitat in this stretch of Hood Canal.	X		
Hood Canal Bridge improvements	In 2009, the Washington State Department of Transportation completed upgrades to the Hood Canal Bridge. The project involved reconstruction of the east half of the Hood Canal Bridge to current design standards and improvements to the remainder of the structure. The bridge was redesigned to current wind, wave, and seismic standards. To improve safety and mobility, it now features two 12-foot traffic lanes and 8-foot shoulders. The resulting dependability of the drawspan has reestablished the 600-foot opening for large vessels that pass through the bridge.	X		
Olympic View Marina	Olympic View Marina, LLC, replaced the abandoned Seabeck Marina on Seabeck Bay approximately 7 miles south of NAVBASE Kitsap Bangor on the east side of Hood Canal. The original construction plan included installation of 72,510 square feet (6,740 square meters) of piers, floats, and gangways (approximately 1.66 acres of overwater structures) for the moorage of approximately 200 boats but the replacement was smaller than originally designed. The original design called for 250 steel piles (14- to 20-inch [36- to 51-centimeter]-diameter) and a 600-foot (183-meter) breakwater. This project would result in short-term water quality and noise impacts during construction, as well as long-term shading under the new overwater structures and loss of marine habitats from installation of the breakwater and pier piles. Upland vegetation would be cleared for the on-land structures. In order to permit rebuilding of the marina, the shoreline designation of the old Seabeck Marina in the Kitsap County Shoreline Management Master Program was amended from "conservancy" to "rural" in April 2009. In January 2010, workers began installing piles for the docks. Removal of concrete debris from the beach was completed in October 2010. The breakwater was installed in 2014. Additional moorage slips may be added as demand increases.	X	X	X

Table 4–1. Past, Present, and Reasonably Foreseeable Future Actions in Hood Canal (continued)

Project	Project Description	Project Timeframe		
		Past	Present	Future
Belfair Sewer Line	Mason County is constructing a sewer line in the Belfair area (extreme south end of Hood Canal, approximately 25 miles (40 kilometers) south of NAVBASE Kitsap Bangor, and not shown in Figure 4–1) to replace aging and failing septic systems with a sanitary sewer system. The sewer line would run on both the north and south shores of southern Hood Canal. The project was developed as part of the Mason County Facilities Plan approved in 2002, which received state funding from the 2005 Legislature. The sewer line would not be located directly adjacent to Hood Canal, so construction would have little potential for marine impacts. The first phase of construction has been completed and the wastewater treatment and reclamation plant began operating in July 2012. One purpose of the project is to reduce the impact of failing septic systems to water quality in Hood Canal. The Belfair Sewer Line would help to decrease water quality impacts on Hood Canal by eliminating inadequate septic systems.	X	X	
Pleasant Harbor Marina and Golf Resort	The Statesman Group of Companies proposed a new master-planned development at Pleasant Harbor south of Brinnon. The project locale is on the west side of Hood Canal approximately 9 miles (15 kilometers) southwest of NAVBASE Kitsap Bangor. The development includes resort housing, a hotel, a restaurant, a spa, a clubhouse, a 9-hole golf course and 3-hole practice course, and other resort-type facilities. It would involve refurbishment of an existing 300-slip marina and development of resort facilities along the shoreline. Replacement of the marina docks was completed in early 2013. A supplemental EIS was published in December 2015 (the original EIS was published in November 2007 and a draft supplemental EIS was published in November 2014). The EIS documents address nine issues and impacts: (1) shellfish, (2) water quality, (3) transportation, (4) public services, (5) shorelines, (6) fish and wildlife, (7) rural character, (8) archaeology and cultural resources, and (9) critical areas. Project construction would likely result in short-term water quality and noise impacts. Refurbishing the marina would result in some loss of nearshore marine benthic habitat in the immediate project vicinity. The golf course and upland facilities would require considerable clearing of upland vegetation (estimated at 128 acres [52 hectares]), with a potential for erosion and water quality impacts. Impervious surfaces are predicted to be approximately 12 percent of the total area, or approximately 28 acres (11 hectares).	X	X	X

BMP = best management practice; CSDS-5 = Commander, Submarine Development Squadron 5; EA = environmental assessment; EHW = Explosives Handling Wharf; EIS = environmental impact statement; ESA = Endangered Species Act; KB = Keyport/Bangor; MSF = Magnetic Silencing Facility; NAVSTA = Naval Station; NEPA = National Environmental Policy Act; NRNW = Navy Region Northwest; NSWCCD = Navy Surface Warfare Center Carderock Division; NUWC = Naval Undersea Warfare Center; NWTRC = Northwest Training Range Complex; NWTT = Northwest Testing and Training; OEIS = overseas environmental impact statement; PSNS = Puget Sound Naval Shipyard; ROD = Record of Decision; SEIS = supplemental environmental impact statement; TPS = Transit Protection System; U.S. = United States; WDNR = Washington Department of Natural Resources

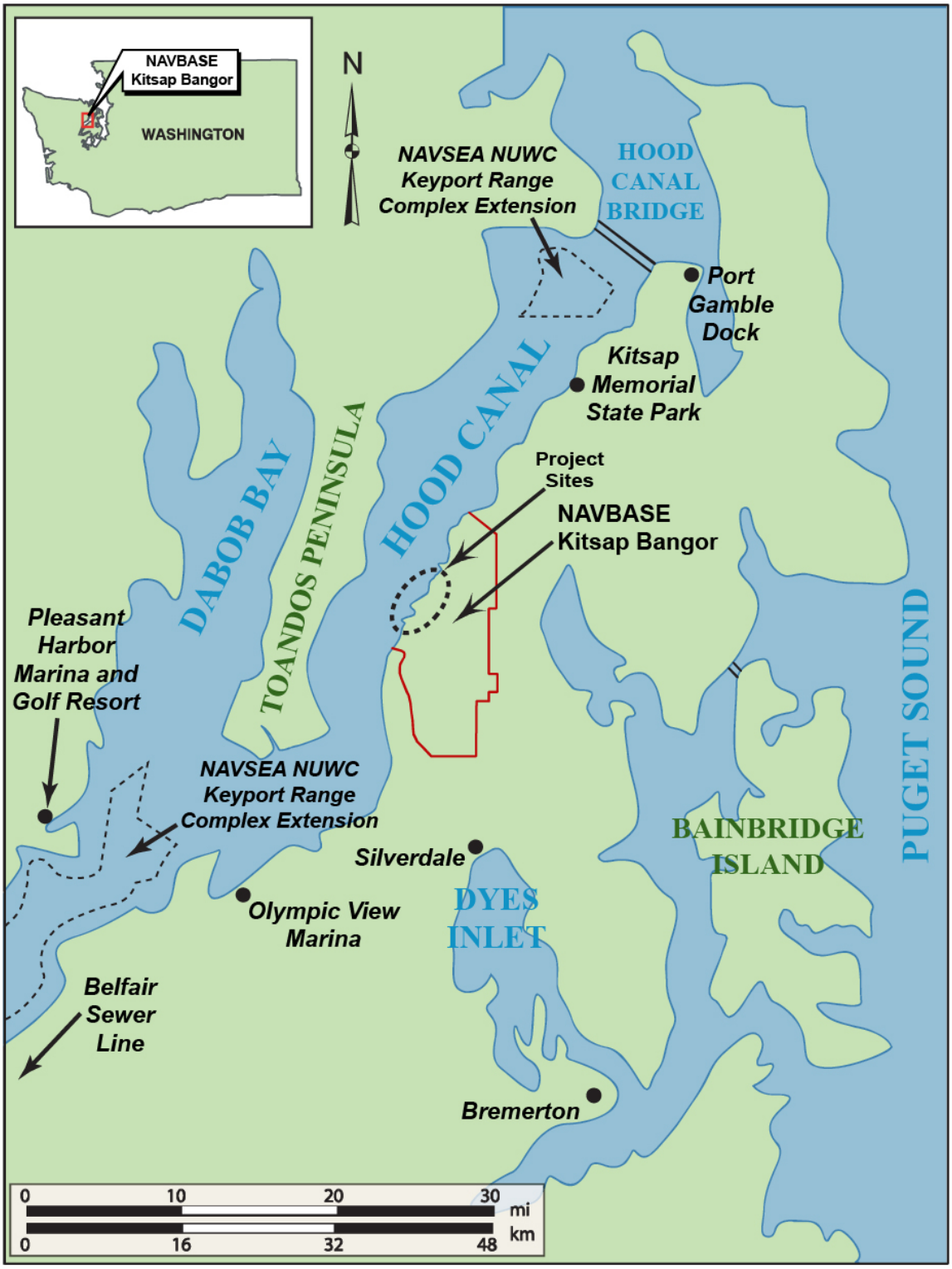

Figure 4–1. Locations of Future Non-Navy Actions and NAVSEA NUWC Keyport Range Complex Extension

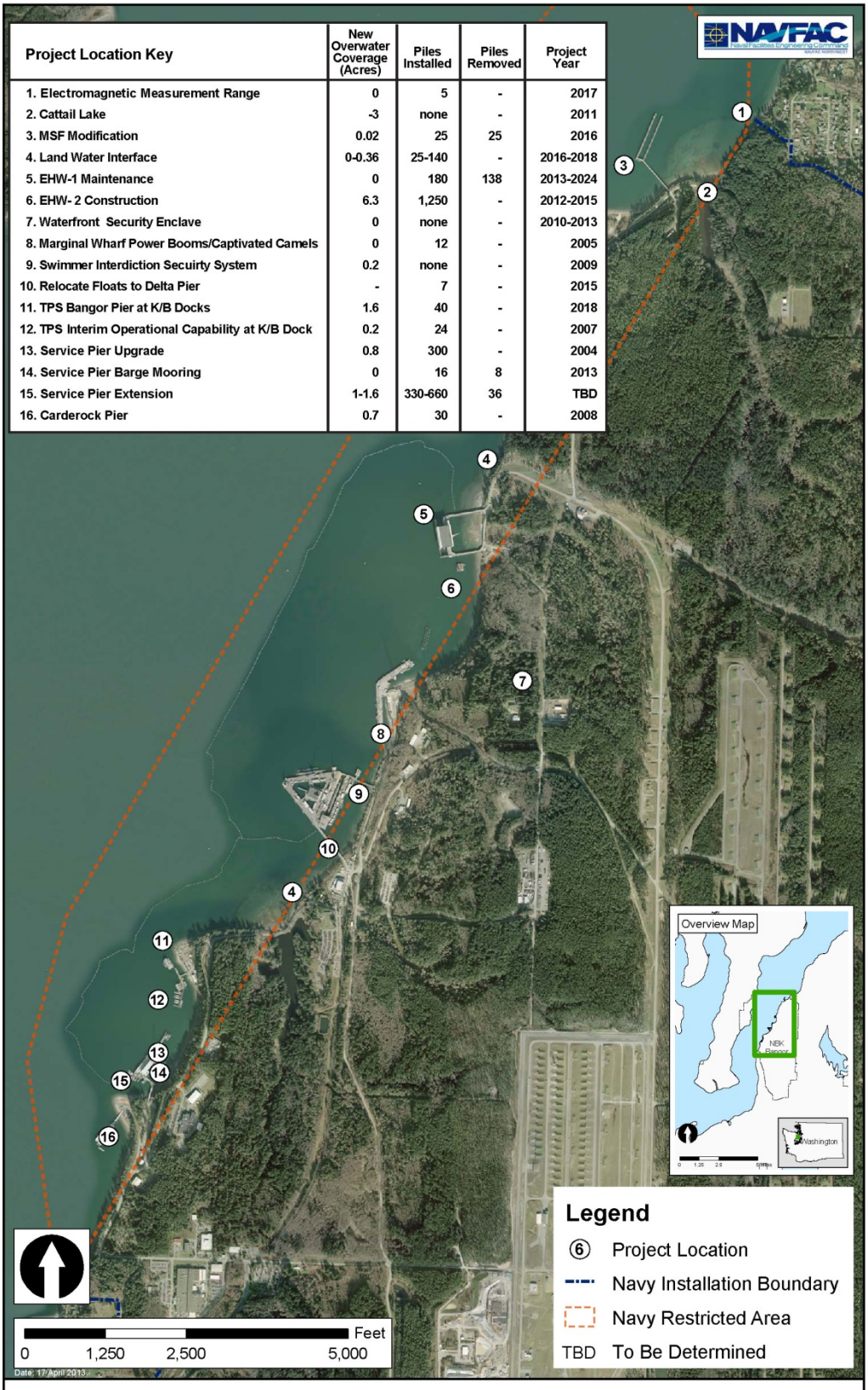

Figure 4–2. Locations of Past, Present, and Future Navy Actions

4.2.1.1. OTHER REGIONAL ACTIVITIES, PROCESSES, AND TRENDS

In addition to the past, present, and planned future projects listed in Table 4–1 other activities, such as shoreline development and improvement of environmental quality in Hood Canal, were considered in the cumulative impact analysis as described in the following sections.

4.2.1.1.1. SHORELINE DEVELOPMENT

Hood Canal and its shorelines are designated as "Shorelines of Statewide Significant" under Washington's Shoreline Management Act (SMA). As stipulated in Washington's SMA, preferred uses for shorelines of statewide importance include the following: (1) recognize and protect the statewide interest over local interest, (2) preserve the natural character of the shoreline, (3) favor long-term over short-term benefits, (4) protect the resources and ecology of the shoreline, (5) increase public access to publicly owned shorelines, and (6) increase shoreline recreational opportunities (Revised Code of Washington [RCW] 90.58.020 and Washington Administrative Code [WAC] 173-26-181).

Development along the shoreline of Hood Canal has been relatively intense. Residential uses predominate, with lot sizes smaller than those in the upland area. Some of these residences have docks. Commercial facilities are scattered along the shoreline; the community of Seabeck, to the south, has a store, a few businesses, a marina, and a retreat center. The Hood Canal Bridge is north of NAVBASE Kitsap Bangor and the project area. Farther south is Scenic Beach State Park. Future general development in the Hood Canal watershed would increase impervious surface and thereby affect vegetation and soils, with potential impacts on water quality in streams and Hood Canal.

The shoreline of Hood Canal has been, and continues to be, subject to development by property owners. Over the past 5 years, an average of 15 shoreline development permit applications (i.e., Joint Aquatic Resources Permit Applications [JARPAs]) per year have been submitted by property owners within the ROI. The permitted actions, such as pier/dock construction, shoreline stabilization, stairways/beach access, shoreline construction, and submarine cable installation, are likely to continue within this region at the same pace (i.e., approximately 15 per year) over the next several years.

The rate of development in the area has been and will be influenced by zoning and land use designations. Kitsap County has zoned land uses adjacent to the base designated as Rural Residential (maximum of one dwelling unit per 5 acres [2 hectares]) (Kitsap County Department of Community Development 2010). Small unincorporated communities close to the base include Vinland on the northern boundary, Olympic View to the south, and Silverdale to the southeast. The Vinland and Olympic View communities are predominantly designated as Rural Residential. The land uses of the nearby Silverdale community are mostly designated as Urban Industrial and Urban Low-Density Residential (one to nine dwellings per acre [0.4 hectare]). The residential areas only allow for single family dwellings and, coupled with the low density designation, would allow for slow development rates in those areas with an expected overall county growth rate of less than 9 percent over a 7-year period. This rate is down from 22 percent over the previous decade. The largest incorporated city near the base is Poulsbo, about 2 miles (3.2 kilometers) east of the base.

Approximately 27 percent of the Hood Canal shoreline is modified with bulkheads, riprap, or other structures (Puget Sound Partnership 2008); approximately 25 percent of the Kitsap County shoreline is modified (Judd 2010). In comparison, an estimated 6 percent of the NAVBASE Kitsap Bangor shoreline is modified (Judd 2010).

4.2.1.1.2. AGENCY PLANS FOR IMPROVING ENVIRONMENTAL CONDITIONS IN HOOD CANAL

As described in previous chapters, there are several water quality parameters of concern in Hood Canal, including low dissolved oxygen (DO) levels and high nutrients, particularly in the southern part of the canal. The area of concern for low DO levels is south of the Bangor waterfront. Because of these water quality problems and concern for salmon and the overall environmental health of Hood Canal, several government entities and community groups have joined together to plan and develop programs to improve environmental conditions in Hood Canal. The primary action plan was developed by the Hood Canal Coordinating Council (HCCC), a consortium of county governments, tribes, and other groups that was formed to help recover summer-run chum salmon populations in Hood Canal and the eastern Strait of Juan de Fuca and to restore native plant communities along adjacent shorelines. In 2014 the HCCC published the *Hood Canal Integrated Watershed Plan – Five-Year Strategic Priorities.* The plan includes five focal components: shellfish, commercial shellfishing, forests, forestry, and salmon. Future actions taken under this plan are expected to improve habitat and water quality conditions in Hood Canal and its watershed, with potential benefits to fish and wildlife species occurring in these areas.

Recommended key actions in the HCCC's plan include updating Kitsap County's Shoreline Master Plan (which was completed in 2014) and critical areas ordinances, conducting a nearshore assessment (conducted in 2009–2010), adopting the Kitsap County draft shoreline environmental designations (designated in 2013), and continuing to monitor the Big Beef Creek summer-run chum salmon reintroduction project (HCCC 2005). Under its Marine Riparian Initiative, the HCCC worked with several existing entities and programs to develop a coordinated approach to revegetating marine shorelines (HCCC undated). This initiative involved training Master Gardeners, Water Watchers, and other volunteer groups to provide site-specific planting plans for landowners to address soil and slope stability, sediment control, wildlife, microclimate, shade, nutrient input for detrital food webs, fish prey production, habitat/large woody debris structure, water quality, human health and safety, and aesthetics.

The Kitsap County Health District (2005) has also identified part of Upper Hood Canal as a restoration area. The goals of the Upper Hood Canal Restoration Project are to protect public health and the environment by identifying and correcting sources of fecal coliform contamination from failing onsite sewage systems and inadequate animal waste management, obtaining water quality data, and educating Upper Hood Canal residents about the low DO problem and actions they can take to reduce bacteria and nutrient concentrations in Hood Canal. The restoration area extends approximately 20 miles (32 kilometers) along the eastern shore of Hood Canal from Olympic View Road in the north to the Kitsap County–Mason County line in the south. Most of this area lies directly south of NAVBASE Kitsap Bangor, but a portion lies along the western edge of the southern part of the base. Of particular concern are low DO levels resulting from algal blooms, which are triggered by increases in nutrients from failing onsite sewage systems, inadequate animal waste management (i.e., hobby farms), and stormwater flowing into Hood

Canal. This work is continuing as part of the District's Water Pollution Identification & Correction program (Kitsap Public Health District 2016). Actions taken under this program are expected to improve water quality conditions in western Kitsap County including the Hood Canal watershed, with potential benefits to fish and wildlife species occurring in these areas.

The Navy and Washington Department of Natural Resources (WDNR) signed a restrictive easement on July 7, 2014. The Navy paid $720,000 for the easement, which precludes construction in the easement area. The easement covers 4,804 acres (1,944 hectares) of aquatic land, which extends from the Hood Canal Bridge to just south of the Hamma Hamma River Delta. The easement covers a strip of land, from 18 feet (5.5 meters) below MLLW down to 70 feet (21 meters) below MLLW. The restrictive easement will prevent construction and development in the footprint of the easement. It will not affect public access, privately owned lands, recreational uses, aquaculture, or geoduck harvest. All 4,804 acres overlay designated critical habitat for ESA-listed salmonid species. The restrictive easement area also protects large tracts of wild stock geoduck and extensive eelgrass habitat. The easement will protect the area for 55 years. WDNR will continue to manage the land under its aquatic lands program.

Under the Readiness and Environmental Protection Integration Program, the Navy has established a multi-year agreement with The Trust for Public Lands, WDNR, and Jefferson Land Trust. To date, the Navy and its partners have purchased protective easements on 5,149 acres (2,084 hectares) of upland and shoreline properties around Hood Canal, including protection of approximately 2 miles (3 kilometers) of the riparian corridor along the Dosewallips River. The Dosewallips transaction completed the protection of the riparian corridor from the shoreline of Hood Canal to the Olympic National Forest. Beyond the riparian corridor which is protected by an easement and managed by Washington State Parks, the Navy purchased a restrictive easement to maintain 3,607 acres (1,460) of working forest as a buffer and permanently protect these lands from development. Within the Dabob Bay Natural Area, the Navy and WDNR have partnered on transactions which protect 122 acres (49 hectares). These areas provide protection for designated critical habitat for ESA-listed salmonid species. Additional Readiness and Environmental Protection Integration Program transactions are underway within the agreement area around Hood Canal.

4.2.1.1.3. PUGET SOUND TREND DATA (INCLUDING HOOD CANAL)

Trend data in the Puget Sound region have been summarized in the *2007 Puget Sound Update—Ninth Report of the Puget Sound Assessment and Monitoring Program* (PSAT 2007a) and the *2012 State of the Sound* (Puget Sound Partnership 2012). [2007 information is used for some indicators (e.g., birds) that were not fully developed at the time the 2012 report was published.] These trends were used, where applicable, in Section 4.3, to help indicate the cumulative impacts of past, present, and future actions. Some of the relevant trends include the following:

- A decrease in marine birds (particularly scoters, loons, and grebes) and increase in California sea lions and harbor seals;
- A decline in native eelgrass in Hood Canal;
- An increase in the size and duration of phytoplankton blooms and a corresponding decrease in overall DO levels;

- A decrease in some fish stocks (salmon, rockfish, spiny dogfish, Pacific cod, and hake);
- Increased shoreline sediment erosion due to shoreline armoring and in-water structures; and
- An overall decline in fecal coliform levels.

4.2.1.1.4. HABITATS OF MIGRATORY MARINE ANIMALS

Migratory or wide-ranging marine animals that may be present in the project area may be affected by natural events and anthropogenic activities in areas far removed from Hood Canal waters — on breeding grounds, migration routes, wintering areas, or other habitats within a species' range. Events and activities that affect the habitats and populations of these marine species outside Hood Canal include the following:

- Disease;
- Natural toxins;
- Weather and climatic influences;
- Natural predation;
- Fishing;
- Hunting;
- Ocean pollution;
- Habitat modification or destruction;
- Commercial shipping, fishing, and other vessel traffic; and
- Whaling for scientific purposes.

4.3. CUMULATIVE IMPACTS ANALYSIS

This section presents an assessment of the cumulative environmental impacts of the LWI and SPE when combined with past, present, and reasonably foreseeable actions. The purpose of the cumulative impacts analysis is to identify and describe impacts of the Proposed Actions that may be insubstantial by themselves but would be considered substantial in combination with the impacts of other actions and trends. The impacts of other actions are assessed using available information, and trends in environmental conditions are derived from the *2007 Puget Sound Update—Ninth Report of the Puget Sound Assessment and Monitoring Program* (PSAT 2007a) and *2012 State of the Sound* (Puget Sound Partnership 2012).

Since the information available on past, present, and reasonably foreseeable actions varies in quality and level of detail, impacts of these actions were quantified where feasible based on available data; otherwise, professional judgment and experience were used to make a qualitative assessment of impacts. In some cases, there may be a combination of both quantitative and qualitative analysis. Where this is the case, professional judgment was used to evaluate the impact based on the combined information.

Several major sources of quantitative information were available, particularly concerning past and present Navy actions. Among these were NEPA and Endangered Species Act (ESA) documentation, including environmental impact statements, environmental assessments, and biological assessments.

As noted in Section 4.2.1 above, the combined impacts of the LWI and SPE are described for each resource in Chapter 3. In this assessment of cumulative impacts, the combined contribution of the LWI and SPE Proposed Actions to cumulative impacts is described for each resource. For each of the Proposed Actions, the action alternatives would contribute to the same types of cumulative impacts, but the magnitude of these contributions would differ between alternatives. Ranges are presented for these contributions when quantifiable impacts differ between alternatives. The primary difference in impacts between the LWI action alternatives is that Alternative 2 entails construction of a pile-supported pier, resulting in more pile driving and generally greater impacts on marine habitats and species than Alternative 3, which would not involve pier construction. The primary difference in impacts between the SPE alternatives is that Alternative 3 (Long Pier Alternative) would result in greater overwater coverage, habitat displacement, and pile driving.

Regardless of the alternatives selected, the proposed Mitigation Action Plan (Appendix C) was designed and will be implemented to compensate for the impacts on marine habitats and species, so that the Proposed Actions will make no net contribution to cumulative impacts. Effects of this mitigation for specific resources are delineated in the following sections.

Potential cumulative impacts include that construction and operation of the LWI and SPE would contribute to regional cumulative impacts on marine resources such as shallow-water habitat, including loss of eelgrass, macroalgae, and habitat for juvenile salmon and other fish and invertebrate species. However, through the implementation of proposed compensatory aquatic mitigation actions in the Mitigation Action Plan (Appendix C), the project's contribution to cumulative impacts would not be significant.

The other construction impacts of the Proposed Actions, such as air and water quality effects, would be minor and highly localized and, thus, would not contribute significantly to cumulative impacts in the region.

Impacts on upland habitats and species from LWI and SPE would be moderate, and all but 7.2 acres (2.9 hectares) would be revegetated; approximately 4.9 acres (2 hectares) would be revegetated, so there would be little contribution to cumulative upland impacts. During construction, marine vessel traffic from LWI and SPE would roughly double the frequency of openings of the Hood Canal Bridge from other actions, an adverse impact on travelers on SR-104. Bridge openings would be scheduled to avoid peak traffic hours to the extent possible. The multiple projects would have cumulative positive economic benefits.

It is also possible that construction of the LWI and SPE would overlap in time with construction of other waterfront structures on NAVBASE Kitsap Bangor. In this case, pile driving for the multiple projects could result in cumulative noise impacts. As a result, more individuals of marine species (fish, marine mammals, and marine birds) would be affected, but it is unlikely that population-level effects due to cumulative sound levels would be greater than those of the

LWI and SPE projects alone. Noise impacts on nearby residential and recreational areas also would increase slightly due to the separated locations of the multiple construction projects. It is not expected that there would be major marine construction projects outside of NAVBASE Kitsap Bangor that would overlap with the other Navy projects and cause cumulative noise impacts. Concurrent construction of multiple projects would exacerbate traffic impacts on base roads and delays at the gates entering the base, with increased impacts on traffic on adjacent regional roadways.

4.3.1. Marine Water Resources

4.3.1.1. HYDROGRAPHY

The ROI for hydrography is defined as Hood Canal. Hydrographic processes in Hood Canal mix, disperse, and redistribute the watershed loadings such that marine water and sediment quality conditions at different locations within Hood Canal reflect the magnitude and relative contributions of inputs from multiple sources within the ROI.

The overall hydrography of Hood Canal probably has not changed much over time, except for localized changes in water movement around manmade, in-water structures. Past and present placement of in-water structures during construction (e.g., anchors, piles, floats, boat ramps) for Navy actions such as Marginal Wharf, Service Pier, Keyport/Bangor (KB) Dock, Delta Pier, and EHW-1 has impacted or is impacting the circulation and pattern of currents by creating eddies and increasing or decreasing current velocity in the vicinity of these structures. Particularly during peak tides, the flow patterns around piles become more turbulent as the water mass is forced against the piles, thus deflecting the linear flow laterally and downward. This produces a decrease in velocities of the water column downcurrent of the piles, but an overall increase in the turbulence and mixing in the water mass. These effects are localized and do not affect regional circulation patterns, tidal flows, or longshore sediment supply and transport processes within Hood Canal.

The impacts of past and present actions on hydrographic conditions in Hood Canal are described in Section 3.1.1 for existing conditions. Similar to the proposed LWI and SPE projects, other past, present, and future actions that construct and operate structures in the intertidal and subtidal nearshore areas of Hood Canal have or will result in localized and temporary disturbances of bottom sediments, with the potential for altering bathymetry, flow patterns, and littoral transport processes.

From a regional perspective, Puget Sound has approximately 2,500 miles (4,000 kilometers) of shoreline, consisting in large part of beaches and coastal bluffs that are subject to continual erosion (Shipman 2010). Erosion of bluffs ("feeder bluffs") is considered an important source for the sediment supply to Puget Sound beaches (Johannessen 2010). The Puget Sound shoreline is becoming progressively hardened (i.e., covered with artificial structures) to prevent erosion of the shoreline and protect upland infrastructure. An estimated 25 percent of the West Kitsap county shoreline is armored (Judd 2010). Shoreline armoring is believed to affect the natural coastal sediment supply and transport processes and potentially contribute to beach narrowing, sediment coarsening, and loss of upper intertidal habitat (Ruggiero 2010).

Several waterfront facilities, such as Carderock Pier, Keyport Bangor Docks, Delta Pier, Marginal Wharf, and EHW-1, currently exist at NAVBASE Kitsap Bangor. These structures are separated by expanses of uninterrupted shoreline and open water between them. Depending on the direction and intensity of the local winds, individual structures offer varying amounts of fetch for the generation of wind waves, as well as protection from the effects of those waves. In most cases, the pier facilities are constructed on a foundation of solid piles configured in a manner that serves to disrupt well-organized wave fields approaching the shoreline from open water. This acts to reduce the amount of energy reaching shallow subtidal and intertidal zones adjacent to each pier facility and the capacity of the waves to re-suspend and transport unconsolidated seafloor sediments. Evidence from bathymetric surveys and aerial photographs confirms the presence of sediment deposits along portions of the shoreline, some of which are co-located with the pier facilities, suggesting that the piles in the pier foundations promote a depositional environment and the accretion of unconsolidated material in the form of shallow subtidal shoals and broadening intertidal beaches (Morris et al. 2009). However, in some cases, the co-occurrence of shoreline structures and shoals may be coincidental. For example, an aerial photograph of EHW-1 taken shortly after the structure was constructed shows the presence of a shoal immediately inshore of the wharf, indicating that the shoal was present at the time the wharf was constructed (Prinslow et al. 1979, Plate 1). Other localized areas of shoaling, such as immediately north of Keyport-Bangor Point, are related to sediment discharge from the adjacent wetland (Devil's Hole) and the presence of headlands that deflect tidal currents and waves.

Future shoreline development and placement of in-water structures, including EHW-2 and the Olympic View Marina, would likely add to existing erosion and accretion of shoreline sediments. Washington State Parks recently completed naturalization of 1,000 feet (305 meters) of bulkheaded shoreline at Kitsap Memorial Park (description in Table 4–1), reducing hard surfaces along the Hood Canal shoreline. The Kitsap County Nearshore Assessment, West Kitsap Addendum (Judd 2010) determined that of the 35 littoral cells associated with the West Kitsap County shoreline, 20 (57 percent) had low impacts on shoreline processes while seven (20 percent) had high impacts. The NAVBASE Kitsap Bangor waterfront is ranked low for disturbance for dominant processes, which include sediment erosion and transport, but moderate to high disturbance for controlling factors including disturbance to wave energy, disturbance to slope, and frequency of disturbance. For the littoral cells adjacent to the NAVBASE Kitsap Bangor waterfront, scores for these controlling factors generally were above the mean value for West Kitsap County shoreline, indicating a relatively higher level of disturbance. The high military activity in the area may have contributed to the elevated scores.

Cumulatively, the LWI and SPE would contribute to regional changes in nearshore sediment dynamics. Specifically, construction of the abutments for the LWI project could result in small decreases in the sediment supply to the littoral cell. However, the north and south abutments would only be 72 feet (22 meters) long, and would lie above the mean high water (MHW) line, although the abutment stair landings (12 square feet [1 square meter] at each abutment) and a portion of riprap would be below the mean higher high water (MHHW) line. The portions of the bluffs that would be disturbed by the LWI abutments do not exhibit characteristics of feeder bluffs (e.g., presence of recent landslide scarps, bluff toe erosion, abundant sand/gravel in bluff, etc.; Johannessen 2010; MacLennan and Johannessen 2014). Therefore, the proportional change in the regional sediment supply associated with construction of the abutments is expected to be small. Further, the pile-supported LWI (Alternative 2), observation posts (LWI Alternative 3),

and SPE structures could intercept a portion of the longshore sediment supply to the shoreline downdrift from the NAVBASE Kitsap Bangor waterfront. The LWI and SPE structures (all alternatives) would attenuate some of the energy of surface waves associated with storm events approaching the project site from the north and south. This reduction in wave energy in areas shoreward of the barriers would reduce the frequency and magnitude of sediment resuspension events and promote conditions more conducive to long-term retention of sediments and accumulation of fine-grained sediment in the form of a shoal area or comparatively broader intertidal area (Kelty and Bliven 2003). While the structures could have a minor effect on the frequency and magnitude of storm-related wave events that provide sufficient energy to resuspend bottom sediments in nearshore areas of the project sites, this is not expected to result in substantial, long-term reductions in the longshore sediment transport rates (cbec 2013).

Conclusions regarding the cumulative effect of existing in-water infrastructure at NAVBASE Kitsap Bangor on longshore sediment supply, based on assessments of historical changes in the shoreline, are inconsistent. Golder Associates (2010) concluded that while the sediment supply rate in the vicinity of the Bangor waterfront is low, the presence of existing pile-supported structures at the NAVBASE Kitsap Bangor waterfront has not caused appreciable changes in the morphology of the shoreline. In contrast, MacLennan and Johannessen (2014) concluded that apparent changes in the NAVBASE Kitsap Bangor shoreline have been substantial. These changes were attributable to several factors, including northward shifts in the positions of spits due to the natural effects of prevailing winds and waves, erosion in areas of feeder bluffs, sediment accumulation near Devil's Hole, and inaccuracies in the historical mapping. However, in some areas, such as north of EHW-1, MacLennan and Johannessen (2014) attributed the absence of shoreline recession to the wave dampening effects of in-water structures.

A substantial portion (34 percent) of the Puget Sound and Northern Straits shoreline has been modified, resulting in regional alterations of beach habitat and changes in sediment deposition and erosion patterns (Johannessen and MacLellan 2007). As discussed in Section 3.1, the effects of in-water structures associated with the LWI and SPE projects (all alternatives) alone on sediment transport processes would be minor. However, these projects would contribute cumulatively to changes in sediment supply within Hood Canal, as well as long-term changes in sediment deposition and erosion patterns within NAVBASE Kitsap Bangor, similar to those noted by MacLennan and Johannessen (2014). Outside of NAVBASE Kitsap Bangor, the scale of these changes related to the cumulative contributions of the LWI and SPE projects may not be discernable from future changes related to natural processes.

4.3.1.2. WATER QUALITY

The ROI for marine water quality is defined as Hood Canal and its watershed. The evaluation for the ROI for water quality also considered several different scales of ROI for use in the cumulative analysis. Sub-basins and drift cells were considered as smaller, more discrete ROI, and the larger Puget Sound region was considered as a larger scale. Based on the available information on management of water quality, planning, recovery efforts, and trend data, the Hood Canal Basin was determined to be an appropriate ROI for water quality. This ROI is large enough to capture projects contributing to water quality impacts and also has available water quality management plans and data. Watershed drainage represents an important source for freshwater and sediments, as well as human-derived pollutants associated with the watershed

runoff that contributes to contaminant loading of Hood Canal. Hydrographic processes in Hood Canal mix, disperse, and redistribute the watershed loadings such that marine water conditions at different locations within the canal reflect the magnitude and relative contributions of inputs from multiple sources within the ROI.

The impacts of past and present actions on water quality are described in Section 3.1.1 for existing conditions. Water quality in Hood Canal has been and is being impacted by past and present in-water and upland actions and would potentially be impacted by future actions. Specific impacts include: (1) stormwater and urban runoff; (2) nutrient and pollutant loading from leaking or ineffective septic systems; (3) incidental spills associated with boat operations, such as fueling, or other activities conducted on piers, wharves, and floats; (4) sediment disturbance and turbidity from in-water construction activities; and (5) contaminant loadings attributable to the use over time of materials such as treated wood piles. These sources include inputs of pollutants to Hood Canal that are periodic (e.g., fuel, oil, and other contaminants) and continuous (e.g., leaching septic tanks and runoff), impacting water quality parameters such as turbidity, pH, DO, biochemical oxygen demand (BOD), and chemical contaminant and fecal bacteria levels.

Most development in the Hood Canal watershed (except NAVBASE Kitsap Bangor) uses septic systems, and many older systems have failed over time (Hood Canal Dissolved Oxygen Program [HCDOP] 2005). Fecal coliform bacteria and nutrients are periodically discharged into Hood Canal through stormwater runoff from areas with inadequate septic systems. Though fecal coliform bacteria are not harmful to humans, the presence of fecal coliform indicates the possible presence of pathogenic viruses or bacteria. Fecal coliform bacteria can also be absorbed and concentrated in shellfish making them unsuitable for human consumption.

Nutrients are a larger problem because they can cause algae to bloom. When algal blooms occur, they cause DO to be rapidly used up during bacterial decomposition of decaying organic matter. A rapid loss of DO can result in fish kills. Animal wastes from hobby farms or sites where animals are bred are also a source of nutrients. These sources have long been recognized as primary contributors to the low DO conditions in Hood Canal (HCDOP 2005). Efforts have been made to eliminate the use of septic systems or to repair failing systems to the extent possible, particularly in nearshore areas, and to control point sources such as hobby farms. However, in the Hood Canal watershed, some future development would continue to use septic systems because sewers are not available in many areas.

Fecal coliform levels in the vicinity of NAVBASE Kitsap Bangor typically are low (below State standards), and they have remained relatively stable during the past decade (Puget Sound Partnership 2010). Since 1994, the Washington Department of Health (WDOH) has upgraded twice the number of shellfish growing areas (indicating reduced fecal coliform contamination at the beds) than they have downgraded (indicating increased fecal coliform contamination at the beds). Fecal coliform contamination at shellfish growing sites in northern Hood Canal has been negligible (Puget Sound Partnership 2010). Construction of new sewer lines in southern Hood Canal and other actions (e.g., future phases of the Belfair Sewer Line; also see Section 4.2.1.1.2) should contribute in the future to lower coliform levels in southern and mid-Hood Canal.

Although fecal coliform levels are expected to decrease, the *State of the Sound Report* (Puget Sound Action Team [PSAT] 2007b) concluded that the overall trend is for continued deterioration of water quality in Hood Canal due to a rise in toxic contaminants and a lowering of DO levels, which are regarded as water quality parameters of major concern. Various waters in Puget Sound are listed as impaired by Washington Department of Ecology (WDOE), including southern Hood Canal (PSAT 2007b).

Most of the future actions would have no impact or variable (sometimes minimal) short-term impacts on marine water quality, and some future actions would be designed to minimize impacts and/or improve water quality. For example, all new piers, including the proposed LWI and SPE structures, would use concrete or steel piles, which, unlike the creosote-treated piles used in the past, would not have the potential for leaching hydrocarbon compounds into the water. The same would be the case for the Port Security Barriers (PSBs) and associated anchors. Several proposed projects (e.g., future phases of the Belfair Sewer Line) and actions (e.g., initiatives reflected in Hood Canal agency plans) would be implemented specifically to improve water quality in Hood Canal (Section 4.2.1.1.2). Additionally, per Clean Water Act (CWA) Section 303(d), a Total Maximum Daily Load (TMDL) is expected to be implemented in the future to evaluate the sources contributing to low DO levels in the vicinity of NAVBASE Kitsap Bangor and potential loading allocations that would result in consistent compliance with state standards for DO.

Construction of the proposed LWI and SPE projects would not be expected to contribute to or exacerbate cumulative water quality impacts because project-related changes would be localized and would not overlap in space with those of other cumulative projects. Even if the construction periods for the proposed projects and the TPS and MSF projects were to overlap in time, their water quality impacts would be localized, with little potential to overlap in space. Thus, cumulative water quality impacts would not occur.

The proposed LWI and SPE projects would result in only small increases in boat traffic with minor potential for contributing cumulatively to increased risks of vessel-related spills. Therefore, it is not expected that operations associated with the proposed projects would result in cumulative water quality impacts that would affect important species such as fish, marine mammals, and marine birds in Hood Canal (Sections 4.3.3, 4.3.4, and 4.3.5, respectively). Similarly, the other project alternatives would not contribute to significant cumulative impacts on water quality.

4.3.1.3. SEDIMENT

The ROI for marine sediments is defined as Hood Canal and its watershed. Similar to marine water quality, watershed drainage represents an important source of suspended materials and sediments, as well as human-derived pollutants that contribute to the contaminant loading of Hood Canal. Hydrographic processes in Hood Canal mix, disperse, and redistribute the watershed loadings such that marine sediment quality conditions at different locations within Hood Canal reflect the magnitude and relative contributions of inputs from multiple sources within the ROI. The impacts of past and present actions are described in Section 3.1.1 for existing sediment conditions.

Past, present, and future actions involving in-water construction, including associated pile driving and dredging, in Hood Canal have caused, are causing, or would cause short-term disturbances to sediment. Disturbed sediment creates plumes of turbid water that carry fine-grained material downcurrent from the disturbed area. Thus, it is assumed that there have been some very slight changes in the ratio of fine- to coarse-grained sediment in localized areas over time.

Future actions (Navy and non-Navy) would potentially disturb bottom sediments over an area of approximately 7.9 additional acres (3.2 hectares), for a total estimated area of 34.6 acres (14 hectares). Additional area has been affected by past non-Navy actions, such as dock and bulkhead construction and operations. Together the LWI and SPE would impact up to 2 acres (0.8 hectare), for a total of up to 36.6 acres (approximately 15 hectares) in which in-water structures have affected or will affect bottom sediments.

Many of the in-water projects including marinas, boat ramps, and Navy piers have resulted in an increased use of boats in the nearshore area. Boats that operate in these areas have the potential to disturb sediments from propeller wash, which could result in slight changes in the ratio of fine- to coarse-grained sediment in localized areas. However, the cumulative impacts of in-water construction and propeller wash have been inconsequential when compared with movement of sediment by tides and currents.

Sediment quality has also been impacted by development over time. In some locations, chemicals discharged into Hood Canal via stormwater runoff, streams, and other sources have accumulated in sediments and been absorbed in the tissues of marine organisms. In general, however, levels of chemical contaminants and toxicity in Hood Canal sediments are low (WDOE 2007). Sediment quality in the vicinity of the proposed projects is generally good (Hammermeister et al. 2009). The organic content of sediment is low, and levels of measured contaminants, such as metals, butyltins, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and pesticides, are below thresholds specified in sediment quality standards. Although past, present, and future actions have had, continue to have, or would be expected to have sediment quality impacts, as described above, the proposed projects would not contribute substantively to cumulative impacts on sediment quality in Hood Canal. As discussed in Section 3.1.2, impacts on sediment quality from the construction and operational phases of the proposed projects would be limited to temporary and localized impacts from construction activities or accidental spills. However, these are not expected to contribute to substantial cumulative impacts on sediment quality. Similarly, the other project alternatives would not contribute to significant cumulative impacts on sediment quality.

4.3.2. Marine Vegetation and Invertebrates

4.3.2.1. MARINE VEGETATION

The ROI for evaluating cumulative impacts on marine vegetation is defined as Hood Canal. Recent regional surveys indicate decreasing eelgrass in Hood Canal (PSAT 2007a), so the potential for the projects to contribute to these impacts is important. Therefore, Hood Canal is relevant for determining cumulative impacts on marine vegetation and eelgrass in particular. Marine vegetation in Hood Canal would not be affected by actions outside Hood Canal.

The impacts of past and present actions on marine vegetation are described in Section 3.2.1.1 for existing conditions. Marine vegetation in Hood Canal has been, is being, or would be disturbed by past, present, and future placement of in-water structures such as piles and anchors, dredging, underwater fills, and construction of overwater structures. These impacts include temporary or permanent loss of vegetation, reduced productivity, and changes in the type or abundance of vegetation. Recent trend data indicate that some of the more sensitive and important vegetation for critical habitat in Hood Canal, such as eelgrass, has decreased over time. According to the most recent survey data available (Gaeckle et al. 2011), there is strong evidence of eelgrass (*Zostera marina*) decline in the Hood Canal Region. This region had the highest proportion of significant negative results for the four eelgrass parameters tested (site-level area, deep edge depth, shallow edge depth, and 5-year area trends). According to the report, roughly 85 percent of the cumulative tests that were significant indicated that the *Z. marina* area is declining or the seagrass bed is receding at the shallow or deep edge (i.e., a significant shallow or deep depth change that causes bed size reduction) in this region. The *2012 State of the Sound* report (Puget Sound Partnership 2012) attributes Hood Canal eelgrass losses to eutrophication, which has contributed to macroalgae blooms and stressed eelgrass beds.

Currently, there are approximately 37.7 acres (15 hectares) of eelgrass extending in a strip along the intertidal/nearshore zone of the Bangor waterfront. Based on the known extent of current eelgrass beds, an estimated 5.2 acres (2.1 hectares) of eelgrass may have been lost over time due to placement of in-water structures such as piles and anchors, nearshore vessel activities, or displacement by the invasive brown alga, *Sargassum muticum*. Approximately 24.7 acres (10 hectares) of overwater shading have been created by past actions on NAVBASE Kitsap Bangor (Table 4–2). The overwater shading reduces the productivity of marine vegetation such as eelgrass and macroalgae. Information is not readily available to quantify the amount of shading and eelgrass loss attributable to all past and present non-Navy actions in Hood Canal, although that area is likely to be similar to or greater than the area affected by past and present Navy actions.

Ongoing action for NAVBASE Kitsap Bangor EHW-2 and for the future actions (TPS pier and MSF modification) would result in approximately 7.9 acres (3.2 hectares) of new shading and the loss of less than 0.1 acre (0.04 hectare) of eelgrass. These actions have been designed to avoid eelgrass beds to the extent possible. To compensate for unavoidable impacts on aquatic resources from EHW-2, the Navy purchased aquatic habitat credits from the Hood Canal in-Lieu Fee Program. Other future non-Navy actions involving the placement of piles and anchors and resultant shading would also reduce the amount of eelgrass and macroalgae. Future actions impacting eelgrass would require mitigation (in compliance with the U.S. Army Corps of Engineers (USACE) rule on compensatory mitigation for losses of aquatic resources) such that there would be no net loss of these resources. It is estimated that up to 12 acres (4.8 hectares) of overwater structures would be created by the actions described in Table 4–1. As described in Section 3.2.2, macroalgae are generally less sensitive to the effects of shading due to lower light requirements.

Table 4–2. Cumulative Loss of Marine Vegetation on NAVBASE Kitsap Bangor in acres (hectares)

Parameter	Total Overwater Shading Area	Eelgrass Loss[1]	Macroalgae Loss[2]
Past Navy Waterfront Construction and/or *Sargassum* invasion	24.7 (10)	5.2 (2.1)	Not determined
EHW-2[3]	6.3 (2.5)	0.09 (0.04)	0.13 (0.05)
Land/Water Interface[4]	0.12–0.34 (0.047–0.14)	0.013–0.024 (0.0054–0.01)	0.05–0.078 (0.02–0.032)
Bangor TPS Pier	1.6 (0.65)	TBD	TBD
Service Pier Extension[4]	1.0–1.6 (0.41–0.65)	0	0
MSF Modification	0.02 (0.07)	0	0
Non-Navy Future Hood Canal Projects	1.7 (0.67)	Not determined	Not determined
Total	**up to 36.3 (14.7)**	**5.3 plus undetermined amount**	**0.14 plus undetermined amount**

EHW = Explosives Handling Wharf; MSF = Magnetic Silencing Facility; TBD = to be determined; TPS = Transit Protection System

1. For the purposes of cumulative impact assessment, eelgrass loss is the known area of flora under fully shading proposed structures (EHW-2), the area in the steel plate anchor and pile footprints (LWI Alternative 2), or the area under PSB mooring anchor footprints and PSB foot and buoy disturbance footprints (LWI Alternative 3).
2. For the purposes of cumulative impact assessment, macroalgae loss is the known area under the proposed structure (EHW-2), or the area under the steel plate anchor and pile footprints (LWI Alternative 2), or area under PSB mooring anchor footprints and PSB foot disturbance footprints (LWI Alternative 3). Total macroalgae areas were estimated for LWI.
3. Impacts on eelgrass and other marine vegetation from the EHW-2 project were mitigated through purchase of aquatic habitat credits from the Hood Canal In-Lieu Fee Program.
4. Impacts on eelgrass and other marine vegetation from the proposed project would be mitigated as part of the Mitigation Action Plan. The SPE is located outside of marine vegetation depths at NAVBASE Kitsap Bangor and would not contribute to marine vegetation losses during operation.

The estimated combined impact of past Navy actions, future non-Navy actions, and the LWI and SPE projects and other future Navy actions is up to 36.6 acres (14.8 hectares) of overwater structures, as well as a related loss of eelgrass and macroalgae. That is, actions that have contributed to past declines can be expected to contribute to future declines of eelgrass in Hood Canal (PSAT 2007a). Hood Canal currently supports approximately 550 acres (223 hectares) of eelgrass; northern Hood Canal (north of the tip of Toandos Peninsula) supports approximately 220 acres (89 hectares) (Simenstad et al. 2008). Cumulative impacts on eelgrass beds would affect the functions of these habitats, including primary productivity, habitat for invertebrates and epiphytic algae, and feeding and refuge for juvenile fish (including ESA-protected salmonids and their forage species) (Section 4.3.3). The impacts of the LWI on marine vegetation, including eelgrass, would be mitigated as part of the Mitigation Action Plan described in Appendix C. The SPE would not contribute to marine vegetation loss. Therefore, construction and operation of the LWI and SPE projects would not make a long-term net contribution to cumulative impacts on marine vegetation.

4.3.2.2. BENTHIC COMMUNITIES

The ROI for evaluating cumulative impacts on benthic communities and shellfish is defined as Hood Canal. Regional surveys indicate a reduction in abundance and diversity for the benthic community in Hood Canal (PSAT 2007a), so the Proposed Actions' contributions to these impacts are important. Therefore, Hood Canal is relevant for determining cumulative impacts on benthic communities and shellfish. Benthic communities and shellfish in Hood Canal would not be affected by actions outside of Hood Canal.

The impacts of past and present actions on benthic communities are described Section 3.2.1.1 for existing conditions. Past, present, and future Navy and non-Navy actions, including marinas, residential docks, boat ramps, and piers involving placement of piles and anchors have resulted or would result in the direct loss of the benthic soft-bottom habitat. This habitat is replaced by hard surfaces represented by piles and anchors and, as a result, the types of benthic organisms have changed and are changing in these localized areas. Hard surfaces create sites for colonization by species adapted to these surfaces, such as mussels and sea anemones. Thus, the cumulative impact of in-water structures has been to replace native soft-bottom habitat with hard-surface habitat over time. This has adversely impacted some species (including prey species for juvenile salmonids) while benefiting others. It is estimated that approximately 2.4 acres (0.97 hectare) of benthic soft-bottom habitat has been lost and converted to hard-surface habitat due to placement of in-water structures along the Bangor waterfront to date.

The overwater portion of structures has also increased shading and nighttime lighting impacts on the benthic community. Shading can impact the abundance of some benthic organisms and lighting can increase predation rates. Shading and loss/alteration of soft-bottom habitat has impacted the type and abundance of benthic organisms that occur in the vicinity of these structures. In addition, in-water structures at the NAVBASE Kitsap Bangor have resulted in accretion of sediments in protected areas created by these structures and possibly erosion in areas downdrift of the structures. The areas of accretion would favor benthic species typical of coarse sediments. Any areas of erosion would result in adverse impacts on sediment-dwelling species. These changes would adversely affect foraging by juvenile salmon, which prefer species typical of fine-grained sediments and eelgrass beds.

The recent trend for the benthic community in Hood Canal is a reduction in abundance and diversity (PSAT 2007a). This trend is strongest in southern Hood Canal and in deeper waters and includes decreases in the native Olympia oyster, which occurs intertidally in Hood Canal but has not been detected in surveys along the Bangor waterfront. Stress-sensitive species (i.e., those species that cannot tolerate poor water quality conditions such as low DO levels or high toxicant concentrations in sediments) are more abundant in northern Hood Canal, which includes NAVBASE Kitsap Bangor, than in southern Hood Canal. Low DO levels are considered a likely cause of this trend, but other contributing factors such as sediment contamination are being investigated (PSAT 2007a).

Future in-water structures would similarly result in a direct loss of soft-bottom habitat. Specifically, approximately 0.2 acre (0.08 hectare) of soft-bottom habitat would be replaced with hard surfaces for EHW-2, less than 0.002 acre (0.0067 hectare) combined for the Commander, Submarine Development Squadron Five (CSDS-5) Support Facilities barge replacement and

Electromagnetic Measurement Range, and up to 0.18 acre (0.074 hectare) of soft bottom would be filled with steel plate anchors, piles, or other structures for the LWI and SPE projects. The EHW-2 project includes several measures to mitigate for project impacts on benthic species. To improve shellfish production and harvest opportunities, the Navy will fund improvements to beach substrate and 3 years of shellfish seeding on 24 acres of beach; 5 years of shellfish seeding on priority shellfish enhancement areas in Hood Canal and adjacent Admiralty Inlet; construction of a shellfish wet lab, education, and training building at Port Gamble; construction of a floating shellfish nursery at Port Gamble; and surveys of geoduck and a geoduck pilot research study. Projects other than LWI would not affect tribal shellfish areas.

Future non-Navy actions are estimated to result in a loss of less than 0.01 acre (0.004 hectare) of soft-bottom habitat, based on reviews of available information for those projects. Washington State Parks recently completed naturalization of 1,000 feet (305 meters) of bulkheaded shoreline at Kitsap Memorial Park (description in Table 4–1), reducing hard surfaces along the Hood Canal shoreline.

The conversion of soft-bottom habitat to hard surfaces from past, present, and foreseeable future actions would total approximately 2.6 acres (1 hectare) from Navy actions, not including LWI and SPE, and an unquantified amount from past non-Navy actions. Non-Navy anticipated construction would convert an additional 0.01 acre (0.004 hectare). The Proposed Actions (LWI and SPE projects) would convert up to 0.18 acre (0.074 hectare) of soft bottom, putting the total impacts from all future actions at about 2.8 acres (1.1 hectares). The trend for Hood Canal as a whole is for decreasing abundance and diversity of the soft-bottom benthic community, although this trend is more pronounced in southern Hood Canal than in the NAVBASE Kitsap Bangor area. Considering all factors, the up to 0.18 acre (0.074 hectare) of benthic habitat impacted by the Proposed Actions would contribute to cumulative impacts on the benthic community in Hood Canal. However, this contribution would be compensated for by the Mitigation Action Plan described in Appendix C.

4.3.2.3. PLANKTON

The ROI for evaluating cumulative impacts on plankton is defined as Hood Canal. Recent regional surveys indicate an increasing trend in phytoplankton blooms in Hood Canal (PSAT 2007a). Therefore, Hood Canal is relevant for determining cumulative impacts on plankton. Plankton in Hood Canal would not be substantially affected by actions outside of Hood Canal.

The impacts of past and present actions on plankton are described in Section 3.2.1.1 for existing conditions. Plankton populations have been largely unaffected by past and present in-water development in the ROI, and future in-water development is also unlikely to adversely impact plankton. When piers are constructed, slight changes in plankton abundance and community type may occur from disturbance to the water column, increased nighttime lighting, overwater shading, and an increase in plankton filter feeders that colonize new underwater structures. However, since plankton are not sessile and tides and currents continually move the water column, residence times under structures is typically short. Thus, slight increases in predation or disturbances to the water column from in-water structures would have little impact on plankton given the available habitat for these species in Hood Canal.

Plankton have been impacted by upland developments that contribute sources of nutrients to Hood Canal. For example, upland projects that use fertilizers are likely to produce stormwater runoff that contains nutrients such as nitrogen and phosphorus. Other sources include failing septic systems and runoff from sites where animals are raised. Projects that contribute nutrients to Hood Canal cause plankton blooms close to the source of the nutrient input. While these nutrients favor plankton productivity, blooms reduce the available DO in the water and adversely impact other marine organisms. In Hood Canal, there has been an increasing trend in phytoplankton blooms, primarily due to changes in nutrient levels, mostly in southern Hood Canal. Blooms of plankton are lasting longer and occurring more frequently (PSAT 2007a).

Cumulative impacts on plankton attributable to past, present, and foreseeable future actions include the creation of sites for plankton filter feeders, nighttime artificial lighting, and shading, all of which reduce plankton productivity. The Proposed Actions would have similar impacts, although the proposed nighttime artificial lighting for both the LWI and SPE would be on only as needed and would not be continuous. Because the area affected by other actions is such a small part of the available habitat in Hood Canal, impacts and cumulative impacts to plankton from the projects would be inconsequential.

4.3.3. Fish

The ROI for evaluating cumulative impacts on marine fish is defined as Hood Canal. Depending on the species, there is varying potential for actions elsewhere in Hood Canal to impact fish affected by LWI and SPE. Resident Hood Canal fish species are unlikely to be affected by actions outside of Hood Canal. Those species that are the most transitory would be Hood Canal salmonids, whereas resident species are more restricted in their movement. Juvenile salmonids originating from Hood Canal streams migrate northward along the shoreline. In general, on exiting Hood Canal these fish turn west toward the Strait of Juan de Fuca and the Pacific Ocean and do not enter the waters of Puget Sound proper. Migratory fish such as salmon move beyond Hood Canal, but the potential for human actions to affect these fish as they move between the mouth of Hood Canal and the Pacific Ocean is considered low. The contribution of effects on fish occurring in the ocean to cumulative impacts of the projects cannot be determined based existing data, but it is acknowledged there is a relationship.

4.3.3.1. SALMONIDS

The impacts of past and present actions on marine fish are described in Section 3.3.1.1 for existing conditions. Past actions have adversely impacted populations of salmonids (salmon, steelhead, and trout, including threatened and endangered species) in Hood Canal and tributaries through loss of foraging and refuge habitat in shallow areas, reduced function of migratory corridors, loss and degradation of spawning habitat in streams, interference with migration, adverse impacts on forage fish habitat and spawning, contamination of water and sediments, and depletion of DO. Another factor that has resulted in adverse impacts on salmonid abundance is the overharvest by fisheries. This impact has been greatest on native stocks. Practically all chum salmon and most Chinook salmon spawning in Hood Canal stream systems are derived from naturalized hatchery stock. Populations of pink salmon, coho salmon, bull trout, and steelhead are also in decline. The net result is that several Hood Canal salmonid species have been listed as threatened under the ESA. Existing Navy structures have affected salmonid and forage fish habitat, and similar to in-water

structures throughout Puget Sound have probably impeded and continue to impede juvenile salmon migration to some degree (Salo et al. 1980; Simenstad et al. 1999; Nightingale and Simenstad 2001a; and Southard et al. 2006) (as discussed in Section 3.3.2.2.2 for physical habitat and barriers during operations). Current and future waterfront projects along NAVBASE Kitsap Bangor would be designed and implemented to minimize impacts on salmonid habitat and migration and on forage fish. Design aspects include large spacing between piles (e.g., 20 feet [6 meters] for the larger piers), increased structure height-over-water in nearshore waters, and building materials (e.g., grating) that allow for light transmission.

The *State of the Sound Report* (PSAT 2007b) described several trends that may be indicative of cumulative impacts on the growth and development of salmonids. There was an increasing trend for toxics to be concentrated in the tissues of Puget Sound Chinook and coho salmon. These salmon have been found to have in their bodies 2 to 6 times the PCBs and 5 to 17 times the polybrominated diphenyl ethers (PBDEs) of other West Coast salmon populations. As of the 2012 State of the Sound report (Puget Sound Partnership 2012), concentrations of PBDEs in multiple fish species appeared to be dropping but PAHs and PCBs showed no progress overall toward the 2020 goal. However, PCBs in adult coho salmon returning to Puget Sound rivers were below thresholds. Wild salmon stocks declined from 93 to 81 healthy stocks between 1992 and 2002, and 7 stocks became extinct during that same period. Commercial, tribal, and sport fishing contribute to impacts on fish stocks in Puget Sound in general.

Future Navy and non-Navy actions could have some of the same impacts as described above for past actions, notably habitat loss or alteration and the decreased function of migratory corridors. However, federal or federally funded actions that have occurred since legislation was enacted, such as the ESA and NEPA, have been considering and are required to (1) consider environmental impacts on threatened and endangered species, (2) prepare analysis (including a biological assessment), and (3) consult with federal regulatory agencies to minimize project impacts. Future actions are also required to go through this same process. Future actions on NAVBASE Kitsap Bangor will be designed and implemented to minimize impacts on salmonids. For the proposed projects, these measures include designs that minimize impacts on intertidal and shallow subtidal habitats to the maximum extent practicable, limiting in-water work to the maximum extent practicable, observing work windows (except for non-pile-driving work for the LWI project), taking measures to reduce construction-related noise, and implementing habitat mitigation. The above processes and actions will help to ensure that impacts of projects are below levels that would endanger the continued existence of these species.

Currently, efforts are being made to reverse the decline of fish populations by regulating development and restoring fish habitat. Numerous salmon preservation and restoration groups have proposed and constructed habitat restoration projects in Hood Canal. Most of these projects are on the east and south sides of the canal. The majority of Hood Canal salmonid-bearing river systems also occur in the southern portion of the canal. Efforts to reduce construction impacts to salmonids and other fish have resulted in a schedule of in-water work periods that all projects must adhere to, as authorized by state (Washington Department of Fish and Wildlife [WDFW]) or federal (USACE) regulatory authorities. The work windows help minimize adverse impacts migrating and spawning fish.

Past, present, and future development projects have had, continue to have, or would be expected to have the potential to result in many of the impacts described above for salmonids and add to declining population trends. Although there are ongoing and future actions and plans to improve conditions for salmonids in Hood Canal (described above), impacts of the projects would result in short-term increases in underwater noise and turbidity; long-term increases in nearshore migrational barriers; and degradation of some nearshore physical habitats and biological communities, thereby contributing to cumulative impacts on these species. The contribution of the proposed projects to cumulative impacts on nearshore habitat would be compensated for by the Mitigation Action Plan described in Appendix C.

Because the LWI and SPE construction may overlap with construction of the EHW-1 Pile Replacement, TPS Pier, MSF modification, and installation of Electromagnetic Measurement Range Sensor System equipment on NAVBASE Kitsap Bangor, salmonids (which are migratory) would be exposed to pile-driving noise and increased turbidity levels within a short period. Concurrent pile driving between LWI or SPE and these other projects would result in 3 decibels (dB) higher noise levels in some locations, as described above for LWI and SPE combined (Appendix D). The greatest potential for higher cumulative noise levels would occur between the north LWI and EHW-1, and SPE and the TPS Pier, where the area in which cumulative impacts on salmonids could occur would be extended beyond that affected by LWI and SPE combined (Appendix D). Proposed Navy projects include several measures to mitigate for impacts on salmonids. These would improve scientific understanding, the Navy will provide funding for research studies on: (1) ocean acidification and (2) Hood Canal chum salmon. They would also improve salmon production and harvest opportunities in Hood Canal, the Navy will fund improvements at three existing fish hatcheries on Hood Canal and replacement of one finfish spawning facility on Hood Canal.

Observing the in-water work window would avoid construction-related impacts on 95 percent of juvenile salmonids, except for the impacts of non-pile-driving work. It is likely there would still be adverse impacts on salmonids from pile driving. As described in Appendix D, the main effect of concurrent pile driving would be to extend the area over which fish and other marine biota are exposed to pile-driving noise by up to 1.3 miles (2.1 kilometers). Following the completion of construction activities, increased noise levels at a given location would generally not occur. However, if two closely located pile-driving projects occurred at the same time, underwater noise levels could increase by as much as 3 dB at sites roughly equidistant between the multiple pile-driving rigs (Appendix D). If the actual construction schedules for these projects overlapped for less than two construction seasons, or did not overlap, cumulative impacts would be reduced accordingly.

4.3.3.2. OTHER MARINE FISH SPECIES

Prior to the 1980s, in-water construction of docks, piers, and boat ramps in Hood Canal impacted fish species presence and abundance (including threatened and endangered species). Underwater noise from pile driving, for example, can cause fish mortality as well as changes in fish behavior. Since the 1980s, in-water construction has been limited to work windows that minimize adverse impacts on migrating juvenile salmonids. Even so, underwater construction noise continues to adversely impact the abundance and occurrence of some fish close to construction activities.

Navy and non-Navy actions involving placement of in-water structures have changed and would continue to change fish habitat in and around these structures. In-water structures can impact fish in several ways: (1) increasing the presence of predators that prey on juvenile fish; (2) posing a barrier to fish movement, particularly juvenile fish; (3) causing direct loss of marine vegetation such as eelgrass, which is important habitat for forage fish and other species; and (4) creating shade that reduces the productivity of aquatic vegetation and benthic organisms, which are preyed on by fish.

Water quality has been and is being impacted by past and present actions and could be impacted by potential future development. In particular, DO levels in Hood Canal are chronically impacted by nutrient levels from development activities that have increased over time. Nutrients can cause algal blooms that deplete DO and result in fish kills (Section 3.3.2.2.2). Many of the other types of past and ongoing impacts described above for salmonids also apply to other marine species.

Trend data have shown a decrease in some fish species such as rockfish (including threatened and endangered species), spiny dogfish, Pacific cod, and hake, as well as increased toxics in the tissues of some species such as Chinook salmon (PSAT 2007a). Commercial, tribal, and sport fishing contribute to impacts on fish stocks in Puget Sound in general.

Future Navy and non-Navy actions could have impacts similar to those described above for past actions. Impacts on fish populations are expected to be reduced by (1) the protective measures taken to minimize impacts during construction activities, (2) the design elements that reduce long-term impacts on nearby habitats, and (3) the strengthened environmental planning and design of recent and future actions. Future actions, including Navy actions, will be designed and implemented to minimize impacts on fish and their habitat. In addition, many of the habitat restoration projects discussed above for salmonids would also benefit non-salmonid fish species.

Past, present, and future development actions have had, continue to have, or would be expected to result in many of the impacts on marine fish described above and thus to add to declining population trends. Although ongoing and future actions and plans are intended to improve conditions for marine fish species in Hood Canal (described above), impacts of the Proposed Actions would result in short-term increases in underwater noise and turbidity (as described above for salmonids), and long-term degradation of some nearshore physical habitats and biological communities, thereby contributing to cumulative impacts on these species. It is not possible to specify the significance of this contribution for the impacted species, except that it would occur at a time of downward trends for these populations. All construction-related actions on NAVBASE Kitsap Bangor are designed and implemented to minimize impacts on marine fish species to the maximum extent practicable. These measures include minimizing the disturbance of highly productive intertidal and shallow subtidal habitats, limiting in-water work, observing work windows, and taking measures to reduce construction-related noise. Although these actions do not necessarily mean that the Proposed Actions and all future actions would have no impact on marine fish species, such actions would help to ensure that the impacts of projects were below levels that would endanger the continued existence of these species. Cumulative impacts from a possible overlap between the construction periods for the LWI and SPE with EHW-1 Pile Replacement, TPS Pier, MSF modification, and Electromagnetic Measurement Range projects would be similar to those described above for salmonids (Section 3.3.2.2.2).

4.3.4. Marine Mammals

The ROI for evaluating cumulative impacts on marine mammals is defined as Hood Canal. Depending on the species, there is a varying potential for actions elsewhere in Hood Canal to affect marine mammals affected by the LWI and SPE projects. Resident harbor seals are unlikely to be affected by actions outside Hood Canal. Other marine mammal species (sea lion species and cetaceans) are migratory or wide-ranging and may be affected by these actions. The contribution of effects on marine mammals occurring in the ocean and inland waters outside of Hood Canal to cumulative impacts of the proposed projects is difficult to define, but it is acknowledged that there is a relationship.

Construction of some past, present, and future shoreline projects has involved, is involving, and would involve activities such as pile driving or dredging that generate high levels of noise. While these impacts are usually temporary, they may be of an intensity to cause short-term behavioral impacts on marine mammals (e.g., avoidance or changes in feeding behavior). These higher noise levels can constitute harassment (a type of "take") of marine mammals under the ESA and Marine Mammal Protection Act (MMPA). Operations on the NAVBASE Kitsap Bangor waterfront, including Delta Pier and KB Docks, as well as non-Navy actions, have resulted in increased human presence, noise, boat movement, and other activities.

Future in-water projects by the Navy (EHW-1 Pile Replacement, TPS Pier, MSF modification, and Electromagnetic Measurement Range platform construction, in addition to the proposed LWI and SPE projects) and non-Navy projects would increase the number of in-water structures, and increase human activity levels (e.g., visual disturbance from increased boat operations). In-water facilities themselves tend to have minimal impacts on marine mammals and may provide some benefits. While harbor seals infrequently utilize manmade structures on the Bangor waterfront, these same facilities may be used as haul-outs for other species such as California sea lions. Marine mammals that frequent the Bangor waterfront have demonstrated their ability to habituate to current high levels of human activity and the net effect is expected to be minimal relative to the large range of these species within inland waters.

Past, present, and future development have contributed and would contribute to a continuing increase in concentrations of toxic materials and PCBs in waters such as Hood Canal (PSAT 2007a; Puget Sound Partnership 2012). There are numerous sources and pathways for toxics to enter the environment and food of marine mammals. For example, toxics may enter marine waters through the following: surface water runoff, aerial deposition, wastewater discharges, combined sewer overflows, groundwater discharge, leaching from contaminated bottom sediments, direct spills into marine waters, and migrating biota such as salmon. These contaminants are affecting the health of marine mammals. For example, the levels of contaminants in harbor seals have increased dramatically over the past 20 years (PSAT 2007a; Puget Sound Partnership 2010). Because marine mammals are highly mobile, the noise impacts of the Proposed Actions could be cumulative with noise impacts on marine mammals from other actions and activities in the Hood Canal region. However, the fact that the noise impacts would be temporary would reduce the magnitude of cumulative effects. Because other impacts on marine mammals from the Proposed Actions and other projects are expected to be minimal, other cumulative impacts on marine mammals are considered unlikely.

The greatest potential for cumulative impacts on marine mammals would be simultaneous exposure to pile-driving noise (underwater and airborne) from the Navy's current and future waterfront construction projects at NAVBASE Kitsap Bangor (EHW-1 Pile Replacement, LWI, SPE, TPS Pier, and Electromagnetic Measurement Range projects). Overlapping construction projects involving pile driving would likely impact more marine mammals (through behavioral harassment and possible temporary hearing impacts) than any project alone. As described in Appendix D, the main effect of concurrent pile driving would be to extend by approximately 1.3 miles (2.1 kilometers) the area over which marine mammals and other marine biota are exposed to pile-driving noise. Increased noise levels at a given location would generally not occur; however, if two closely located pile-driving projects such as EHW-1 and LWI, or SPE and TPS Pier, occurred at the same time, noise levels could increase by as much as 3 dB at sites roughly equidistant between the multiple pile-driving rigs (Appendix D). The overlap in construction is based on currently projected schedules for the multiple projects and is subject to change (likely resulting in reduction in the period of overlap). Cumulative impacts would be reduced through the implementation of impact minimization measures including soft starts and noise attenuating devices (e.g., bubble curtains) for pile driving, and implementation of marine mammal monitoring with shutdown zones to preclude injury.

4.3.5. Marine Birds

The ROI for evaluating cumulative impacts on marine birds is defined as Hood Canal. Depending on the species, there is a varying potential for actions elsewhere in Hood Canal to affect marine birds affected by the LWI and SPE projects. Resident species are unlikely to be affected by actions outside Hood Canal. Migratory or wide-ranging marine bird species, however, may be affected by such actions. The contribution of effects on marine birds occurring in other inland waters and the ocean to cumulative impacts of the LWI and SPE projects is difficult to define, but it is acknowledged that there is a relationship.

Construction and operation of past and present waterfront projects, such as Delta Pier and KB Docks, as well as any future Navy or non-Navy actions, have resulted or would result in increased human presence, noise, boat movement, and other activities, driving away some water-dependent wildlife such as marine birds from these areas. Marine birds typically avoid areas with continuous activity or periodic loud noise. Often, however, birds will return to these areas when human presence is lower or there is less activity. There may also be some benefits, as some birds may use these in-water structures for roosting or nesting.

Trend data for Hood Canal indicate that marine bird species have been on the decline. Of the 30 most common marine birds, 19 have experienced declining populations of 20 percent or more over the past 20 years. Exact causes for the declines are mostly unknown, but possible reasons include increased predation, habitat loss, changing migration patterns, decreases in forage fish populations, hunting, and disturbance to breeding grounds in the Arctic (PSAT 2007a). In the Puget Sound region, the population of the marbled murrelet, a species listed as threatened under the Federal ESA, declined more than 20 percent between the 1970s and 1990s but has been fairly stable in recent years (PSAT 2007a). The principal reason for the earlier decline was loss of nesting habitat (old-growth forest).

Future in-water Navy projects (EHW-1 Pile Replacement, TPS pier, MSF modification, and Electromagnetic Measurement Range platform construction, in addition to LWI and SPE) and non-Navy projects would increase the number of in-water structures, and increase human activity levels (e.g., visual disturbance from increased boat operations). In-water facilities themselves tend to have minimal impacts on marine birds and may provide some benefits. Many marine birds perch on, or shelter near, manmade structures on the Bangor waterfront. Marine birds that frequent the Bangor waterfront have demonstrated their ability to habituate to current high levels of human activity and the net effect is expected to be minimal relative to the large range of these species within inland waters.

Past, present, and future development projects have had, continue to have, or would be expected to have many of the same impacts on marine birds described above and add to past or current declining population trends. Because marine birds are highly mobile, noise impacts of the Proposed Actions could be cumulative with noise impacts from other actions and activities in the Hood Canal region. However, since noise impacts of the proposed projects on marine birds would be temporary the magnitude of cumulative effects would tend to be reduced. Because other impacts on marine birds from LWI, SPE, and other projects are expected to be minimal (as described above and in Section 3.5.2), other cumulative impacts on marine birds are considered unlikely.

The greatest potential for cumulative impacts on marine birds would be simultaneous exposure to pile-driving noise (underwater and airborne) from the Navy's current and future waterfront construction projects at NAVBASE Kitsap Bangor (EHW-1 Pile Replacement, LWI, SPE, TPS Pier, and Electromagnetic Measurement Range). This is likely to impact more marine birds (as modeled through behavioral harassment only) than any project alone. As described in Appendix D, the main effect of concurrent pile driving would be to extend by approximately 1.3 miles (2.1 kilometers) the area over which marine birds and other marine biota would be exposed to pile-driving noise. Increased noise levels at a given location would generally not occur; however, if two closely located pile-driving projects such as EHW-1 and LWI, or SPE and TPS Pier, occurred at the same time, noise levels could increase by as much as 3 dB at sites roughly equidistant between the multiple pile-driving rigs (Appendix D). The overlap in construction is based on currently projected schedules for the multiple projects and is subject to change (likely resulting in reduction in the period of overlap). Cumulative impacts would be reduced through the implementation of impact minimization measures, including noise attenuating devices (e.g., bubble curtains) for impact pile driving, and implementation of marbled murrelet monitoring with shutdown zones to preclude injury.

4.3.6. Terrestrial Biological Resources

4.3.6.1. VEGETATION

The ROI for evaluating cumulative impacts on native vegetation is defined as the Hood Canal watershed. Overall, native upland vegetation in the vicinity of Hood Canal has decreased in extent due to shoreline and upland development. The contribution of such development in the Hood Canal watershed is relevant for determining cumulative impacts on vegetation. Native vegetation in the watershed would not be affected by actions outside Hood Canal.

On NAVBASE Kitsap Bangor, past and present development has resulted or is resulting in the loss of approximately 1,100 acres (445 hectares) of forested area to development and 300 acres (121 hectares) to grassland/shrubland habitat. Similarly, past and present non-Navy actions have contributed or are contributing to vegetation loss or conversion due to residential and commercial development in the general area. Since the 1960s approximately 1,000 acres (405 hectares) on NAVBASE Kitsap Bangor have been replanted with native species, although the long-term impact of these replantings on vegetation resources at the base has not been quantified. The vegetation community on NAVBASE Kitsap Bangor and the surrounding area provides habitat for a variety of wildlife species, as well as other functions, such as shading and a source of woody debris for fish habitat in streams.

The overall trend in the project area has been a decrease in vegetation as land has been developed, and has been a noted problem along the shoreline areas of Hood Canal. To mitigate the loss of vegetation from shoreline development along Hood Canal, the HCCC has been supporting projects that increase shoreline vegetation, initiating for example a Marine Riparian Initiative to reestablish more native vegetation and eradicate noxious weeds (discussed in Section 4.2.1.2.2, Agency Plans for Improving Environmental Conditions in Hood Canal).

Future Navy and non-Navy actions would also result in loss of vegetation. Based on review of information on other future Navy projects, and available information on past, present, and future non-Navy actions, it is estimated that future Navy and non-Navy actions would result in a loss of approximately 296 and 167 acres (120 and 68 hectares) of vegetation, respectively. Construction of the LWI and SPE projects combined would permanently remove approximately 7.2 acres (2.9 hectares) of second-growth forest and native and invasive shrub habitat. An additional 4.9 acres (2 hectares) of temporarily disturbed area would be revegetated with native plant species. As there are no rare, threatened, or endangered plant species on NAVBASE Kitsap Bangor, there would be no cumulative impact from the Proposed Actions on ESA-listed plant species.

The Proposed Actions would at most contribute less than 0.1 percent to the total area of vegetation cleared on NAVBASE Kitsap Bangor by past, present, and future Navy actions. While the Proposed Actions would cause some loss of vegetation, given the amount and location of this loss there would be little impact on wildlife habitat or the vegetative community on NAVBASE Kitsap Bangor (there is an abundance of vegetation in the immediate vicinity of the proposed projects and on NAVBASE Kitsap Bangor), and even less in the broader Hood Canal region. Therefore, the proposed projects would make a minimal contribution to cumulative impacts on vegetation.

4.3.6.2. WILDLIFE

The ROI for evaluating cumulative impacts on terrestrial wildlife is defined as Hood Canal. Depending on the species, there is a varying potential for actions elsewhere in Hood Canal to affect wildlife species affected by the LWI and SPE projects. Resident species are unlikely to be affected by actions outside Hood Canal, although migratory birds or other wide-ranging wildlife species may be affected by such actions. The contribution of effects on migratory or wide-ranging species to cumulative impacts of the proposed projects is difficult to define, but it is acknowledged that there is a relationship.

Approximately 1,400 acres (567 hectares) of forested wildlife habitat have been or are being lost and/or impacted by past and present development on NAVBASE Kitsap Bangor. These projects and future projects have resulted in or would result in the removal of mostly second- and third-growth forested habitat; this forested area has been replaced by buildings, parking lots, or grassland that is not considered optimum wildlife habitat. Over time, the loss of wildlife habitat and increased human activity have resulted in fewer native species and occasional replacement by non-native wildlife species that are more adapted to an urban environment. In addition, forest fragmentation due to roads, buildings, fences, and other development can restrict wildlife movement within a contiguous habitat. Similar loss of wildlife habitat has occurred throughout the Hood Canal region due to past and present non-Navy development.

There is a general trend toward loss or conversion of wildlife habitat due to development, although the pace of this conversion is slower in the Hood Canal region because the canal region is less urbanized. There are large, rather undeveloped areas, such as NAVBASE Kitsap Bangor, outside the urban areas of Kitsap County, and development is on rather large lots (i.e., lots greater than 5 acres [2 hectares]). Further, as a result of explosives safety requirements, future base activities will continue to restrict the development of land around NAVBASE Kitsap Bangor.

With future growth of developed areas in the region, more wildlife habitat is expected to be converted or lost. Approximately 296 acres (120 hectares) and 167 acres (68 hectares) of wildlife habitat would be lost due to future Navy and non-Navy actions, respectively (Section 4.3.6.1). An additional 111 acres (45 hectares) of forest habitat would be isolated from contiguous habitat and the marine shoreline by security barriers, although this vegetation would not be cleared. The loss or conversion of habitat and loss of access to habitat would impact wildlife as discussed above. Construction of the LWI and SPE projects combined would permanently remove approximately 7.2 acres (2.9 hectares) of wildlife habitat. An additional 4.9 acres (2 hectares) of temporarily disturbed habitat would be revegetated with native plant species. Even with revegetation, however, the impact is considered long-term and there would be some loss of wildlife habitat. The proposed projects would contribute less than 2 percent to the area of wildlife habitat lost to development on NAVBASE Kitsap Bangor, and given the amount and location of this loss, would have little impact on wildlife habitat or movement. There is an abundance of wildlife habitat in the immediate vicinity of the Proposed Actions and on NAVBASE Kitsap Bangor. Therefore, the Proposed Actions would make a minimal contribution to cumulative impacts on wildlife.

Upland wildlife would be exposed to construction noise from multiple projects on NAVBASE Kitsap Bangor. The most important example would be pile-driving noise from the EHW-1 Pile Replacement, LWI, SPE, TPS Pier, and Electromagnetic Measurement Range projects, as described in Appendix D and Section 3.9. Pile driving for these projects may overlap for a presently unknown number of construction seasons. The main effect of concurrent pile driving would be to extend the area over which biota were exposed to pile-driving noise. Noise levels at a given location would not generally increase; increases of up to 3 dB would occur only infrequently at a location equidistant between two construction sites (e.g., the North LWI and EHW-1) when pile driving at those sites was concurrent. This could affect sensitive wildlife receptors located along the eastern shore of Hood Canal.

4.3.6.3. WETLANDS

The ROI for evaluating cumulative impacts on wetlands is defined as the Hood Canal watershed. Overall, wetlands in the vicinity of Hood Canal have decreased in extent due to shoreline and upland development (Todd et al. 2006). The contribution of such actions in the Hood Canal watershed is relevant for determining cumulative impacts on wetlands. Wetlands in the watershed would not be affected by actions outside of Hood Canal.

Existing records are not adequate to fully estimate how much wetland was or is being lost or impacted by past and present development on NAVBASE Kitsap Bangor and in the surrounding area. There are approximately 254 acres (103 hectares) of wetlands on NAVBASE Kitsap Bangor and several in the immediate vicinity of the Proposed Actions. Wetlands and their buffers provide valuable functions such as flood storage, wildlife habitat, and improved water quality, and these functions have been lost due to the filling and disturbance of wetlands.

Wetlands are now protected, and regulations on filling or disturbance require replacement of wetland or buffer area and function. The goal of many federal agencies, including the Navy, is no net loss of wetlands, particularly high-quality wetlands. Therefore, the trend is toward either a gain in wetland area or maintenance of the existing amounts (no net loss) of wetland and wetland function. Future Navy or non-Navy actions may result in loss of wetland area, but mitigation would be required in accordance with the requirements of CWA Section 404. Thus, future actions would not result in an overall loss of wetland area over the long term.

As discussed above, neither the LWI nor SPE would result in a loss of wetland. Therefore, the Proposed Actions would not add to the cumulative wetland impacts of past, present, and other future actions.

4.3.7. Geology, Soils, and Water Resources

The ROI for evaluating cumulative impacts on geology, soils, and water resources is defined as the Hood Canal watershed within and in the vicinity of NAVBASE Kitsap Bangor. Major contributors to cumulative impacts on this area include land clearing and soil disturbance, particularly on geologically hazardous slopes; erosion; sedimentation and contamination in water bodies; creation of impervious surfaces, and groundwater recharge.

4.3.7.1. GEOLOGY AND SOILS

Land clearing and disturbance to soils from past, present, and future Navy actions and non-Navy actions have resulted, are resulting, or would result in the loss of soil due to erosion caused by wind and rain. Soil loss can affect the ability of vegetation to become established, and eroded soils can be carried into surface water by stormwater runoff and thus impact water quality. Some past non-Navy development has also adversely impacted geologically hazardous areas such as steep slopes by increasing stormwater runoff and/or overburdening the tops of slopes with structures, which has led to slope failures. However, geologically hazardous areas are now managed more carefully by following the guidance or standards of local governments or agencies (e.g., Kitsap County Code for Geologically Hazardous Areas) and applying construction best management practices (BMPs) for sloped surfaces. Standard stormwater

construction BMPs have also reduced the amount of soil erosion that occurs during land disturbing activities.

There are no trend data indicating whether soil is being lost at an increasing rate in the Hood Canal region. However, it is assumed that the rate of soil loss has decreased over time because of better management techniques for protecting disturbed or hazardous soils and controlling stormwater runoff.

Future Navy and non-Navy actions would result in disturbance from land clearing, and there would be some soil lost due to wind or rain erosion. However, given that construction BMPs would largely control erosion, no significant soil loss is expected. Future development is expected to have less of an adverse impact on geologically hazardous areas due to the implementation of full geotechnical and engineering investigations or simple avoidance of these areas.

Past, present, and future Navy actions, including the proposed projects, have disturbed or would disturb approximately 1,500 acres (607 hectares) of soil on NAVBASE Kitsap Bangor. Construction of the LWI and SPE would contribute to cumulative impacts by temporarily disturbing a total of approximately 4.9 acres (2 hectares) of onshore land during construction. It is anticipated that there would be little loss of soil and no mass wasting activities during construction because soil types are not highly erosive or unstable (with the exception of the abutment locations), rather gentle slopes are represented, and erosion-control BMPs would be used. Further, these areas would be stabilized and revegetated following construction. LWI and SPE combined would create approximately 7.1 acres (2.9 hectares) of new impervious surface, with stormwater controls implemented to minimize impacts. The increased contribution of land clearing for the LWI and SPE projects would be a small fraction of the total amount of existing and proposed cleared land on NAVBASE Kitsap Bangor. While the Proposed Actions would add to the total amount of disturbed land, when combined with other Navy and non-Navy actions, the cumulative impact in terms of soil disturbance would be negligible.

4.3.7.2. WATER RESOURCES

Development in the region has created impervious surfaces, such as roads, buildings, and parking lots, and has considerably impacted surface water and groundwater. Past, present, and future Navy actions and non-Navy actions have produced, are producing, or would produce impervious surfaces that impact surface water by increasing stormwater runoff and often concentrating runoff into peak discharges. The higher volumes of runoff entering surface water during storms can erode stream banks and channels, disturb fish habitat, and degrade water quality by increasing turbidity. Runoff from impervious surfaces can entrain and carry sediment and contaminants such as fuel or oil into receiving waters, where it adversely impacts water quality. Impervious surfaces also impact groundwater by limiting the rate of groundwater recharge, which is an important consideration for drinking water supplies that rely on groundwater. Thus, impervious surfaces may have a detrimental impact on aquifer recharge areas. Based on review of aerial photographs of existing structures, it is estimated that past and present Navy actions on NAVBASE Kitsap Bangor have resulted or are resulting in the creation of approximately 909 acres (368 hectares) of impervious surface.

Regionally, the amount of impervious surface has increased over time, and this trend is expected to continue. For example, between 1991 and 2001 there was an increase of 10.4 percent in the Puget Sound region, and by 2001 approximately 7.3 percent of the region below 1,000 feet (305 meters) of elevation was covered with impervious surfaces (PSAT 2007b). Between 2001 and 2006, developed lands increased by about 3 percent with nearly two-thirds of that increase being impervious surfaces (Puget Sound Partnership 2010). According to the *State of the Sound Report*, there is a substantial decline in biological function when a watershed nears 10 percent impervious surface (PSAT 2007b). While the trend is for the amount of impervious surface to increase, the rate at which this is occurring in Kitsap County is rather slow relative to other counties in the Puget Sound region.

Based on current projections, it is estimated that future Navy actions would create approximately 55 acres (22 hectares) of impervious surface, and non-Navy actions would create 30 acres (12 hectares). The added impervious surface would have the same potential to impact surface and groundwater as described in Section 3.7.2. However, there are requirements for controlling runoff from impervious surface, and most development would have to include implementation of runoff detention and/or treatment measures. Projects in areas of aquifer recharge may also be required to implement measures to ensure that groundwater recharge is not adversely impacted. Thus, impervious surfaces created by future projects are less likely than past actions to adversely impact surface and groundwater.

Construction of the LWI and SPE projects would contribute to cumulative impacts, although not substantially, by creating approximately 7.1 acres (2.9 hectares) of impervious surface on the upland portion of the project sites. Stormwater runoff from these uncovered areas would be controlled by being collected, detained, and treated prior to discharge. Since stormwater runoff from uncovered areas would be controlled, the only impact on surface water would be the additional treatment volume. In terms of groundwater recharge loss, the impervious surface in upland areas would have a negligible impact on groundwater supply and quality because the proposed sites are in a groundwater discharge zone, which is not utilized as a water source.

While the proposed projects would add slightly to the total amount of impervious surface attributable to Navy and non-Navy actions, the cumulative impact on surface water would be negligible given additional measures to control and treat stormwater runoff. No additional impacts on groundwater are expected.

4.3.8. Land Use and Recreation

The ROI for evaluating cumulative impacts on land use and recreation is defined as the surrounding communities in which actions on NAVBASE Kitsap Bangor are most likely to contribute to cumulative impacts. This includes portions of Kitsap Peninsula and Kitsap County in the NAVBASE Kitsap Bangor vicinity, as well as Hood Canal and Jefferson County on the western shore of Hood Canal across from NAVBASE Kitsap Bangor.

Land development from past and present actions has converted or is converting many areas of the natural environment to land uses ranging from rural to urban and industrial. For example, NAVBASE Kitsap Bangor has changed from its rural residential, agricultural, and heavily forested beginnings to its present use as the base of operations and support for the TRIDENT

Fleet Ballistic Missile (TRIDENT) submarine program, with approximately 20 percent of the property developed. Recreational facilities (e.g., parks and trails) have also been developed in association with land development.

Land development and changes in land use could have impacts on various resources including noise, air quality, water quality, socioeconomics, utilities, aesthetics, and energy use, and transportation as discussed in the respective sections in this chapter. Changes in land use could also create issues related to compatibility with adjacent land uses. Land use laws, planning policies, and project reviews are intended to minimize or eliminate such compatibility issues.

The trend is for development to continue converting natural areas to residences, businesses, and other developed uses. Recreational facilities would also be developed as population and demand for public recreation increased. Future Navy and non-Navy actions would also convert undeveloped land to developed use, with impacts similar to those discussed above.

The LWI and SPE projects would not change the land/water use designations at the immediate project site, but would add to the density and location of the developed areas attributable to past, present, and other future Navy and non-Navy actions. That contribution, however, would be minimal, less than 1 percent of the extent of existing developed areas on NAVBASE Kitsap Bangor. Thus, despite temporary impacts from construction noise, the Proposed Actions would make a minimal contribution to cumulative impacts on land use and recreation.

4.3.9. Airborne Acoustic Environment

The ROI for evaluating cumulative impacts on the airborne acoustic environment includes the waterfront and woodland areas near the project site, extending to the Vinland neighborhood just north of the NAVBASE Kitsap Bangor northern property boundary, the Olympic View neighborhood just south of the southern base boundary, the waterfront industrial area encompassing Delta Pier and Marginal Wharf, and shoreline properties on the west side of Hood Canal, west and northwest of the project sites.

Most past, present, and future actions have generated, are generating, or would generate some type of noise, either from a facility itself, from vehicles traveling to and from a site, or from humans. Noise is typically a nuisance factor for sensitive receptors such as residences, hospitals, or parks, where quiet conditions are important. This is particularly true during evening hours. Close proximity to high sound levels can result in physiological problems or hearing damage. Over time the trend has been for noise levels to increase as development has occurred, particularly during daytime hours when activity levels are highest. Noise levels tend to be fairly low outside the urban areas of Kitsap County due to development on large lots (greater than 5 acres [2 hectares]) and a general lack of industrial activity. However, some industrial areas, such as the NAVBASE Kitsap Bangor waterfront, generate higher noise levels.

Future Navy and non-Navy actions would also generate noise. The type of noise and noise levels produced would be dependent on the specific project. The impact of these noise sources would depend on their location relative to sensitive receptors, but it is likely that some of these future actions would produce nuisance noise. There are requirements to limit the level of noise produced by residential, commercial, or industrial land uses. Thus, some future development would have

requirements to provide soundproofing measures. The proposed projects would generate noise from equipment, industrial activities, vessel movement, and human activities. The highest noise levels would be generated by pile driving during construction. Impact hammer pile-driving would generate average (i.e., root mean square [RMS]) noise levels of 109 A-weighted decibel (dBA) re 20 µPa at a distance of 50 feet (15 meters), while vibratory pile driving would generate RMS noise levels of 95 dBA re 20 µPa at 50 feet (15 meters). Residential areas near Olympic View, Thorndyke Bay, and to a lesser extent Suquamish Harbor on the western shore of Hood Canal, would experience increased noise levels during pile driving, as would recreational users on Hood Canal or the western shores of Hood Canal. Combined noise impacts of multiple Navy projects on the communities of Olympic View and Vinland, and nearby schools are not expected to be significant due to the attenuating effects of intervening distance, topography and vegetation. The cumulative impacts of pile-driving noise on fish, mammals, and marine birds are discussed in Sections 4.3.3, 4.3.4, and 4.3.5, respectively. In the long term, noise produced by operation of LWI and SPE would not increase over what is currently generated by EHW-1 and other facilities on the Bangor waterfront.

LWI and SPE construction activities may overlap with EHW-1 Pile Replacement, TPS Pier, and Electromagnetic Measurement Range projects. As discussed in Appendix D this could result in cumulative noise impacts during the period of overlap. As discussed above for LWI and SPE combined, one effect of this temporal overlap in pile driving would be to extend the affected area affected by individual projects. Since the north LWI and SPE projects would be at the northern and southern boundaries of the noise-generating projects (e.g., the Electromagnetic Measurement Range would not generate significant airborne noise), the affected area would not be extended by these multiple projects. Noise level increases of up to 3 dB would occur only for the infrequent case of a location approximately equidistant between two construction sites when pile driving at those sites was concurrent. These areas would be along the NAVBASE Kitsap Bangor waterfront and would not affect off-base areas. In all other cases, noise levels at a given location would be predominated by the closer pile-driving activity. (The intervening headland between the EHW/LWI and SPE sites would reduce the potential for additive noise levels from the multiple projects.) General construction noise for each of the two projects would also overlap, but these noise levels would be similar to existing levels along this industrial waterfront and thus much lower than the levels from pile driving. Therefore, the resulting cumulative noise impacts from general construction are expected to be minimal. If the actual period of construction overlap for the two projects is less than currently projected, resulting cumulative impacts would be reduced accordingly.

After construction, operational noise levels would not change for the LWI, and for the SPE, would be typical of the industrial NAVBASE Kitsap Bangor waterfront. Therefore operations for LWI and SPE would not contribute to cumulative noise impacts.

4.3.10. Aesthetics and Visual Quality

The ROI for evaluating cumulative impacts on aesthetics and visual quality is defined as the surrounding areas in which actions on NAVBASE Kitsap Bangor are most likely to contribute to cumulative visual impacts. This includes Hood Canal, portions of the residential areas on Kitsap Peninsula, and Jefferson County on the western shore of Hood Canal across from NAVBASE Kitsap Bangor. The SPE project is closest to a residential area (Olympic View) while the LWI is

further north and buffered by distance, existing dense vegetation, and a spit of vegetated land to the south.

Visual conditions have been or are being altered by past and present actions as development changes portions of the natural environment to a built environment. However, much of the area around Hood Canal has retained its natural and rural visual quality because of large-lot residential development, an abundance of forested land, and unobstructed views of Hood Canal and the Olympic Mountains. Approximately 68 percent of NAVBASE Kitsap Bangor is forested, thereby helping to retain the natural visual quality at the base.

The trend is for development to continue, which would alter visual resources. Since development in the county tends to be slow and continues to occur on larger lots in many areas, visual resources will change, but at a slow pace. Distant views to the west would not likely be blocked by new development because of the height and proximity to the Olympic Mountains. Future Navy and non-Navy actions would continue the trend of converting land from natural or undeveloped conditions to built conditions. Thus, visual resources would change to more urbanized views. Navy policies (e.g., TRIDENT Joint Venture 1975) recommend using existing developed areas and maintaining natural areas in their existing condition as much as is practicable, and would help minimize impacts on visual quality on NAVBASE Kitsap Bangor. During the period of potential concurrent construction of the proposed projects and the EHW-1 Pile Replacement, TPS Pier, MSF modification, and Electromagnetic Measurement Range projects, a cumulative aesthetic impact on views from Hood Canal would be expected.

While the LWI and SPE would contribute to a change in visual conditions along the waterfront, they would be visually compatible with adjacent facilities and not alter the existing visual resources substantively as previously discussed. Nevertheless, the LWI and SPE projects would make a minor contribution to the cumulative aesthetic impacts of past, present, and other future actions. LWI Alternative 2 would make a greater contribution to cumulative visual impacts than LWI Alternative 3, based on the pier included for the former compared to no pier for the latter alternative. SPE Alternative 3 would make a slightly greater contribution to cumulative visual impacts than SPE Alternative 2.

4.3.11. Socioeconomics

The ROI for evaluating cumulative impacts on socioeconomics is defined as the surrounding communities in which actions of NAVBASE Kitsap Bangor are most likely to contribute to cumulative socioeconomic impacts (e.g., Silverdale, Poulsbo, and Bremerton, all of which are located on the Kitsap Peninsula and within Kitsap County) as well as Jefferson County on the western shore of Hood Canal across from NAVBASE Kitsap Bangor.

Socioeconomic conditions have been or are being profoundly changed by past and present development. For example, NAVBASE Kitsap Bangor has become one of the primary employers in Kitsap County. Development of the TRIDENT base and other military installations has increased the population, long-term employment opportunities, and income of Kitsap County, as well as the demand for housing and various public services (e.g., police, fire, emergency and medical services, and schools). It is estimated that nearly 47,000 personnel (military personnel, civilians, and contractors) work for the military in Kitsap County.

Population, housing, and economic activity are increasing at a moderate rate in Kitsap County (Section 3.11). These changes are attributable to development, population in-migration, changes in economic conditions, and changes in social and political factors. Future Navy and non-Navy actions would generate employment and income. Projects that prompt in-migration would increase the demand for housing and public and social services. However, these conditions would vary over time based on the changing conditions discussed above.

Construction of the LWI and SPE would employ up to approximately 1,566 people for the duration of the construction period. Construction of the EHW-1 Pile Replacement, TPS Pier, MSF modification, and Electromagnetic Measurement Range projects would employ approximately 190 people. During the period of potential construction overlap between these projects, the cumulative socioeconomic effect would be correspondingly increased over what it would be for the LWI and SPE projects alone (Section 3.11.2.2).

In the long term, the LWI and SPE projects would not result in a notable change in staffing or employment.

The temporary loss of access to shellfish beds during construction of the LWI could result in a short-term socioeconomic impact, lasting on the order of a few years during construction and recovery of shellfish beds, since tribal shellfishing is an important subsistence and commercial resource. Over the long term, impacts due to the presence of permanent structures could result in a loss of an estimated $2,208 per year in commercial fishery sales. Mitigation for impacts to tribal resources would be determined through ongoing consultations between the Navy and the affected American Indian tribes. An MOA between the Navy and the Skokomish Indian Tribe was signed on March 3, 2016, and government-to-government consultation with the Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Lower Elwha Klallam Tribe is in progress. Tribal treaty mitigation is discussed further in Section 3.14 and in Appendix C.

4.3.12. Environmental Justice and Protection of Children

The ROI for evaluating cumulative impacts on environmental justice is defined as the surrounding communities in which actions of NAVBASE Kitsap Bangor are most likely to contribute to cumulative socioeconomic impacts (i.e., Silverdale, Poulsbo, and Bremerton, all of which are located on the Kitsap Peninsula and within Kitsap County) as well as Jefferson County on the western shore of Hood Canal across from NAVBASE Kitsap Bangor.

Because the LWI and SPE projects together would not have disproportionate impacts on minority or low-income populations, or on children, they would not contribute to cumulative impacts of these types when considered in conjunction with past, present, and reasonably foreseeable actions.

4.3.13. Cultural Resources

The ROI for evaluating cumulative impacts on cultural resources is defined as NAVBASE Kitsap Bangor facilities. Cultural resources are unique as well as finite in nature, so that an adverse impact on a single historic property affects the complement of historic properties within the ROI.

The trend associated with cultural resources is ongoing identification and preservation of resources. Federal laws and regulations have been established to protect and preserve archaeological and cultural resources. Future Navy or non-Navy actions that involve earth disturbance have some potential for disturbing archaeological resources, and it is possible that such disturbance could go unrecognized and unrecorded. Future Navy actions that involve alterations to National Register of Historic Places (NRHP)-eligible buildings or structures, the construction of new buildings or structures, or square footage reductions all have the potential for direct or indirect impacts on historic properties. However, the Navy would comply with Section 106 of the National Historic Preservation Act (NHPA) for both the LWI and SPE projects, and other reasonably foreseeable further actions within the ROI. This includes mitigation of adverse impacts that could not be avoided or minimized, thereby addressing the cumulative impact of those actions.

Other projects such as those along the waterfront, including the EHW-2 and EHW Security Facility, in conjunction with the proposed projects, could result in cumulative impacts on the historical integrity of the existing EHW or the Delta Pier, although these are unlikely to be significant impacts and would not adversely affect the NRHP eligibility of either historic property. Otherwise, the Proposed Actions would not result in cumulative impacts on other NRHP-eligible architectural or archaeological cultural resources. Other projects involving ground disturbance such as road improvements or building construction have the potential to encounter previously unknown archaeological resources. In all cases, the Navy would comply with Section 106 of the NHPA by identifying the presence of historic properties, evaluating their NRHP eligibility, assessing impacts, and consulting with the State Historic Preservation Officer (SHPO) and Tribes on the mitigation of any adverse impacts, and would take the same action if any unanticipated archaeological resources are discovered. With these procedures in place, the Proposed Actions would not add to the cumulative impacts on archaeological or architectural resources.

4.3.14. American Indian Traditional Resources and Tribal Treaty Rights

The ROI for evaluating cumulative impacts on American Indian traditional resources and treaty rights consists of areas in which affected tribes have been granted treaty rights, including NAVBASE Kitsap Bangor. The Navy has an active consultation process in place, with emphasis on protection and avoidance of areas of traditional cultural importance, as well as access to the resources found on the installation. Through this ongoing process, the Navy will take all feasible measures to keep traditional resources on NAVBASE Kitsap Bangor protected and accessible.

American Indian traditional resources in the ROI, such as traditional use areas (e.g., cedar growth for bark gathering), subsistence resources (e.g., fish [salmon] and shellfish [oysters and clams]), and special places (religious and traditional), have been impacted over time as a result of land development and population growth that resulted in increased use of natural resources such as fish and shellfish. Traditional use areas and subsistence resources are known to be outside of as well as inside the project area. Impacts on traditional resources include loss of access to traditional use areas, conversion of a traditional area or special place to another land use, and reduction in the abundance of tribal resources for economic, subsistence, or ceremonial/religious uses. Ocean acidification and resulting adverse effects on calcification will continue to be a cumulative stressor on shellfish populations in the area.

The trend associated with American Indian traditional resources is ongoing identification and preservation of resources. Federal laws and regulations have been established to protect and preserve traditional cultural resources. In addition, American Indian tribes have been proactive in acquiring traditional areas and preserving cultural resources, including subsistence resources. Most cultural resources on the base that are considered American Indian traditional use areas, subsistence resources, and special places have been identified and will be avoided whenever possible. Access to these resources is also allowed for American Indian tribes with treaty rights.

The Navy will continue to consult with affected American Indian tribes regarding the Proposed Actions and other future Navy projects at the Bangor waterfront (Table 4–1). Past, present, and future Navy activities have the potential to affect protected tribal treaty rights and resources on Bangor, including access to shellfish (oysters and clams). These projects could have impacts on tribal treaty rights and traditional resources similar to those identified for the Proposed Actions. The LWI Proposed Action would affect access to Usual and Accustomed (U&A) shellfish beds, and construction noise and visual effects would influence the setting and integrity of these harvest sites, which would also be affected in the long term by the presence of the LWI structure. Construction vessels for both projects and operational transits of submarines could interfere with tribal fishing vessels, resulting in impacts to access and harvest. The Proposed Actions could have a minimal impact on fisheries via barrier effects on juvenile and adult migratory fish, including salmon. Shellfish harvest impacts are expected to be short term and minor, temporarily affecting access to between 0.64 and 0.68 acre (0.26 and 0.28 hectare) of the approximately 18-acre (7-hectare) tribal shellfish harvesting area.

The impacts of the Proposed Actions would contribute to cumulative effects on traditional resources and treaty rights in the region, which are acknowledged above. These contributions would be offset through implementation of appropriate mitigation measures determined through ongoing consultations between the Navy and affected American Indian tribes. An MOA between the Navy and the Skokomish Indian Tribe was signed on March 3, 2016, and government-to-government consultation with the Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Lower Elwha Klallam Tribe is in progress. Tribal treaty mitigation is discussed further in Section 3.14 and in Appendix C.

4.3.15. Traffic

The ROI for ground transportation includes those streets and intersections that would be used by both automobile and truck traffic to gain access to and from the LWI and SPE, as well as those streets that would be used by construction traffic (e.g., transport of equipment and commuting workers). The streets most likely to be affected by cumulative project-related auto and truck traffic include NW Trigger Avenue and NW Luoto Road (referred to as Trident Avenue outside of base boundaries). The ROI for marine vessel traffic is defined as Hood Canal.

Vehicle circulation patterns have changed and traffic volumes have increased in Kitsap County along with increases in population and increased employment for past and present actions, particularly projects on NAVBASE Kitsap Bangor and other Navy installations. Growth is inevitably accompanied by increased vehicle traffic and consequent impacts on road travel such as intersection delay, lowered levels of service, and decreased safety. The trend in Kitsap County, which parallels the national trend, is for people to own more vehicles and drive more

vehicle miles. Recent increases in gas prices have caused some people to look for other transportation options (e.g., mass transit) or to alter their driving habits. Marine vessel traffic levels have increased throughout the years to accommodate growth in the region.

Future Navy and non-Navy actions would generate additional traffic with impacts similar to those discussed above. Transportation agencies have attempted to keep up with increased traffic, but in many areas traffic volumes exceed the capacity of roads or intersections. Kitsap County has adequate capacity on most of its roads and intersections. However, in the more urbanized areas there are capacity problems on some road segments.

The proposed LWI and its future operation on NAVBASE Kitsap Bangor following completion of the construction activities would not generate additional traffic. Hence, the impacts of this proposed project on the major access roadways, internal base roadway network, and intersections post construction would be negligible.

The proposed SPE and its future operation, including support facilities, on NAVBASE Kitsap Bangor following completion of the construction activities would not result in a notable increase in staffing or employment at NAVBASE Kitsap Bangor. Access to and from the proposed main parking lot that is a component of the SPE Proposed Action would be via Sturgeon Street and controlled by a stop sign. The proposed parking lot would be 7 acres (2.8 hectares) and contain about 420 parking spaces.

Analysis of the added traffic following construction of the SPE site under the highest peak hour traffic demand conditions indicated the following:

- Trigger & Sturgeon (AM Peak) — level of service (LOS) C/20.5 seconds (decline from LOS B), and
- Trigger & Escolar (PM Peak) — LOS D/51.6 seconds (approaching LOS E).

Recent traffic counts of average daily traffic entering or leaving the base on Trigger Avenue or Luoto Road totaled 23,721 trips (All Traffic Data Services 2008). Traffic volumes on these two thoroughfares are expected to increase 10 percent by 2018, although such an increase would contribute only negligibly to the cumulative impacts of past, present, and other future actions along these major access roadways.

The construction periods for the LWI and SPE projects would not overlap. However, construction of these projects has the potential to overlap with construction of the EHW-1 Pile Replacement, TPS Pier, MSF modification, and Electro-magnetic Measurement Range projects. Any overlap of the construction period for the LWI and SPE with that for any of the other projects would tend to increase the traffic impacts. During the overlap periods, the combined impact on base roads used by construction traffic would be approximately two times higher than increase for just the LWI and SPE projects alone (see Section 3.15.2.2 for individual LWI and SPE impacts). However, this would still represent a minor contribution to cumulative traffic impacts both on and off base. Future Navy and non-Navy projects along the shoreline could increase marine vessel traffic levels within Hood Canal. As discussed above, construction of the LWI and SPE projects is not expected to overlap with one another, but would overlap with other Navy construction projects. During these periods of overlap, the frequency and duration of

related openings of the Hood Canal Bridge would be greater than for the LWI or SPE projects alone. The increase in the number of openings caused by LWI and SPE would contribute to the cumulative impact of bridge openings on vehicular traffic. Notices to Mariners and other measures described in Section 3.15.1.2 would prevent adverse impacts to marine navigation. Operation of the LWI and SPE (which would result in an average of two additional bridge openings per month) would not notably increase marine traffic or delays due to bridge openings over the long term.

4.3.16. Air Quality

The ROI for air quality is the Puget Sound Clean Air Agency (PSCAA) region, which encompasses localities in Kitsap County or the Hood Canal region, as the PSCAA is delegated by the state of Washington to regulate the state's Clean Air Act (CAA). Since short-term construction air quality impacts from the LWI and SPE projects would be limited to the Kitsap County or Hood Canal region only, the cumulative air quality impacts are addressed in terms of contributions to the PSCAA region.

Existing air quality has been, is being, or would potentially be impacted by past, present, and future actions to varying degrees, depending on the project. For example, residences and facilities such as parks have had little impact on air quality, while vehicles and industrial operations may produce a number of emissions, including volatile organic compounds (VOCs), nitrogen oxides, particulates, or other emissions.

The trend for air quality is fairly stable, since point sources have been targeted by regulations and are limited in their emissions. Also, outside urban areas of the county, air emission sources such as woodstoves are fairly spread out due to development of large lots, and any impacts are localized. The Hood Canal region is rated as good (the highest rating) in air quality (PSCAA 2013a), is in compliance with all air quality standards, and is currently in an attainment area for all pollutants. Kitsap County is in attainment for all National Ambient Air Quality Standards (NAAQS). The most recent emissions inventory for the PSCAA shows that a rather low percentage of total emissions is associated with stationary and mobile sources in Kitsap County. Past development and subsequent operation of emission sources in Kitsap County have not contributed to exceedances of the NAAQS, and the region is in attainment for all applicable air quality standards.

Future Navy and non-Navy actions that produced sizeable air emissions would be required to install abatement measures to limit emissions and would be required to comply with permit conditions on the amount of air pollutants generated. Thus, it is not anticipated that future actions would result in violations of air quality standards. Planned future development in Kitsap County is consistent with or below the emissions estimates contained in the State Implementation Plan. The Proposed Actions would generate short-term and minimal long-term air emissions, such as VOCs, carbon monoxide, nitrogen oxide, and particulates from boats, vehicles, and equipment. However, the impacts would be localized and individual emissions of these criteria pollutants would be well below the air quality standard compliance levels.

Emissions from the Proposed Actions are not expected add to the cumulative impacts on existing air quality of all past, present, and reasonably foreseeable actions. This is because existing levels of criteria pollutants and greenhouse gas emissions are low, emissions from the Proposed

Actions would be localized, future point sources would be required to control emissions, and the level and the type of development that would occur in the reasonably foreseeable future would not produce substantial emissions.

4.3.16.1. GREENHOUSE GASES

It is generally accepted in the scientific community that human-generated emissions of greenhouse gases (GHGs) over the past century have led to increasing global air temperatures. GHGs, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases, have a propensity to trap heat in the atmosphere. CO_2 is the predominant greenhouse gas emitted by human activities, primarily from the combustion of fossil fuels such as coal, oil, and natural gas. The observed increase in average global air temperatures since the mid-twentieth century is very likely a result of increased atmospheric concentrations of GHGs (Intergovernmental Panel for Climate Change 2007). This phenomenon is commonly referred to as "global warming." Global warming due to GHG emissions induces climate change through the complex interaction of increased temperature with various natural processes such as ocean and atmospheric circulation. Effects of climate change in turn create complex feedback loops, such as loss of reflective snow and ice cover, which increase the rate of climate change. Scientists are now in general agreement that climate change is occurring (American Meteorological Society 2007), and that current trends are very likely to continue unless worldwide emissions and atmospheric concentrations of CO_2 and other GHGs are substantially reduced (Ledley et al. 1999; Energy Information Administration 2008).

4.3.16.1.1. CLIMATE CHANGE

The effects of climate change may not be readily apparent in all geographic areas, including the immediate project region, since the effects occur on a global scale. Among the effects are rising air and ground temperatures, loss of sea ice, sea level rise, loss of protection from fall storms, and retreat of the permafrost boundaries. Sea ice has retreated by about 14 percent since 1978 and thinned by 60 percent since the 1960s, resulting in widespread effects on marine ecosystems, coastal climates, and human settlements. Recent warming has been accompanied by increases in forest disturbances, including insect infestations. The relationship of the proposed projects to sea level rise is discussed in Section 3.1.

Effects of climate change on marine mammals and other marine organisms are poorly understood due to lack of integrated baseline data (Burek et al. 2008). This lack of data on health, diseases, and toxic effects in marine mammals severely limits abilities to predict the effects of climate change on the health of these species. The overall health of an individual animal is the result of complex interactions among immune status, body condition, pathogens and their pathogenicity, toxicant exposure, and the various environmental conditions that interact with these factors. Climate change could affect these interactions in several ways. There may be direct effects from loss of the sea ice habitat, elevations of water levels and air temperature, and increased occurrence of severe weather. Some of the indirect effects of climate change on animal health will likely include alterations in pathogen transmission due to a variety of factors, effects on body condition due to shifts in the prey base/food web, changes in toxicant exposures, and factors associated with increased human habitation in the Arctic (e.g., chemical and pathogen pollution in the runoff due to human and domestic-animal wastes and chemicals and

increased ship traffic with the attendant increased risks of ship strike, oil spills, ballast pollution, and possibly acoustic injury). The extent to which climate change will impact marine mammal health will also vary among species, with some species more sensitive to these factors than others. Baseline data on marine mammal health parameters along with matched data on the population and climate change trends are needed to document these changes (Burek et al. 2008).

4.3.16.1.2. OCEAN ACIDIFICATION AND CUMULATIVE EFFECTS

It has been suggested that the continued emission of CO_2 is causing seawater to become more acidic as CO_2 from the atmosphere dissolves in the oceans; for example, ocean acidification from increased CO_2 is a recognized phenomenon (Cicerone et al. 2004; Feely et al. 2004; Sabine et al. 2004). Scientists estimate that the oceans are now about 25 percent more acidic than they were at the start of the industrial revolution about 300 years ago. The negative effects of ocean acidification are likely to be felt on biological processes such as calcification (Orr et al. 2005; Kleypas and Eakin 2007). Ocean acidification from CO_2 and reduced ventilation also may result in decreases in sound absorption for frequencies lower than 10 kilohertz (kHz) (Hester et al. 2008). This would result in increases in ambient noise levels in ocean environments and enhanced propagation of anthropogenic sound. While this phenomenon is under study (Hester et al. 2008), the effects of CO_2 emissions on ocean acidity and the resultant potential for enhanced sound propagation remain indeterminate due to incomplete information.

The potential effects of proposed GHG emissions are by nature global and cumulative impacts, as individual sources of GHG emissions are not large enough to have an appreciable effect on climate change. Therefore, an appreciable impact on global climate change would only occur when proposed GHG emissions combined with GHG emissions from other manmade activities on a global scale.

Currently there are no formally adopted or published NEPA thresholds of significance for GHG emissions. Formulating such thresholds is problematic, as it is difficult to determine what level of proposed emissions would substantially contribute to global climate change. Therefore, in the absence of an adopted or science-based NEPA significance threshold for GHGs, this EIS compares GHG emissions that would occur from the combined projects of the LWI and SPE to the U.S. GHG baseline inventory of 2012 (USEPA 2014b) to determine the relative increase in proposed GHG emissions (Table 4–3).

The combined GHG emissions associated with the proposed projects would be extremely low (0.00006 percent of the U.S. inventory), emissions would be localized, and emission controls on future point sources would be required. Therefore, the effect would be that the level and the type of development for the reasonably foreseeable future would not produce substantial emissions or have an appreciable contribution to cumulative GHG impacts.

Table 4–3. Combined GHG Emissions of LWI and SPE (Worst Case Alternatives)

Phase/Activity	Total GHG Emissions (metric tons)			
	N_2O	CH_4	CO_2	CO_2e
LWI (Alternative 2)	**0.10**	**0.11**	**1,944.2**	**1,977.5**
SPE (Alternative 3)	**0.36**	**0.20**	**2,019.4**	**2,135.5**
Total Emissions	**0.46**	**0.31**	**3,963.6**	**4,113.1**
U.S. 2012 Annual GHG Emissions (10^6 metric tons)[1]				**6,526**
Proposed Emissions as a percent of U.S. GHG Emissions				**0.00006**

CH_4 = methane; CO_2 = carbon dioxide; CO_2e = carbon dioxide equivalent; N_2O = nitrous oxide

1. Source: USEPA 2014b

4.3.16.2. NAVY STEWARDSHIP AND ENERGY CONSERVATION

In response to concerns over climate change, the Navy has initiated broad programs to reduce energy consumption and shift energy demand to renewable and alternative fuels to an extent consistent with its national security mission, thereby reducing emissions of CO_2 and other GHGs. A number of shore installation and fleet programs have substantially reduced the generation of GHGs, primarily through the conservation of fossil fuels and electricity.

Ashore, the Navy has aggressively encouraged its installations to reduce energy use, both through facility competitions and through investments in solar, wind, and geothermal technologies. Since 1985, the Navy has sponsored a worldwide energy management program that has reduced its energy use by more than 29 percent (NAVFAC Public Affairs 2005). At Pearl Harbor, for example, the installation of approximately 2,800 energy-efficient light fixtures has reduced electricity use by about 758 megawatt-hours per year, equal to 448 tons per year of CO_2 emissions (NAVFAC Public Affairs 2008). New air conditioning chillers also installed at this facility will save another 252 megawatt-hours of electricity per year, equal to about 149 tons per year of CO_2 emissions. Implementing similar energy conservation measures at Navy shore installations worldwide has substantially decreased the Navy's carbon footprint, and the Navy continues to identify new energy conservation measures.

Developed in the 1990s by the U.S. Green Building Council (USGBC), LEED is a certification system for environmentally friendly construction, indicating the project meets or exceeds government mandates as well as industry standards. Buildings can achieve certified, silver, gold or platinum designation of LEED compliance. The Navy requires all construction and major renovation projects to be compliant to LEED silver standards or better. Federal mandates for environmental certification are one of the reasons for the Navy's rule requiring LEED certification of silver or better on all new construction.

The process of getting a building LEED certified is not easy. The intent to apply for certification begins with design of the building by identifying performance goals required by the LEED system. Once these requirements are met, and a design is generated that conforms to these goals, the actual construction of the building must also be tailored to meet these needs. The USGBC reviews the documented evidence of conformance to determine if the building satisfies the requirements for certification. The Navy's requirement for LEED silver certification of all new

buildings and major construction renovation projects represents its continued commitment to environmentally friendly endeavors.

Energy conservation aboard Navy vessels at sea also has achieved substantial reductions in fuel consumption, and thus emissions of GHGs. Naval Sea Systems Command has established an Energy Conservation Awards Program to reward leading fuel conservers among underway surface ships with special recognition and cash incentives. During the first half of 2009, this program reduced the Navy's fuel consumption by about 682,000 barrels, or about 346,000 tons of CO_2 emissions (Navy News Service 2009).

The Navy also is researching and implementing new technologies that may result in substantial additional fuel savings. For example, the new amphibious assault ship *Makin Island*, using a new hybrid power propulsion system, saved an estimated 900,000 gallons of fuel (equal to about 11,000 tons of CO_2) on its initial voyage from the Gulf of Mexico to San Diego. As new Navy ships are placed into service and older ships are retired, the overall fuel efficiency of the Navy's fleet will substantially increase (Biello 2009).

Further, the Navy also is investigating new hull-cleaning technologies that could substantially reduce drag from fouling of vessel hulls by marine organisms, potentially saving millions of gallons of fuel per year. Finally, the Navy has successfully tested the use of biofuels with camelina oil to power aircraft. The Green Hornet biofuel program is the first aviation test program to test and evaluate the performance of a 50/50 biofuel blend in supersonic (above mach 1) operations — a critical test point to successfully clear the F/A-18 E/F for biofuel operations through its entire flight envelope (Navy News Service 2010). Camelina jet biofuel produces 80 percent lower carbon emissions than conventional jet fuels (Biello 2009).

These examples illustrate the Navy's leadership role in achieving large-scale energy reductions that will substantially contribute to a long-term national effort to mitigate global climate change.