DEPARTMENT OF
NATURAL RESOURCES

OFFICE OF THE
COMMISSIONER OF PUBLIC LANDS
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November 25, 2024

The Honorable Bernard Dean
Chief Clerk of the House
338B Legislative Building
Olympia, WA 98504

The Honorable Sarah Bannister
Secretary of the Senate
312 Legislative Building
Olympia, WA 98504

Dear Chief Clerk Dean and Secretary Bannister:

Please accept the enclosed legislative report on the Geoduck Task Force (Task Force), submitted on behalf of Department of Natural Resources (DNR), as required in Section 310 (22) of ESSB 5187 (Ch. 475, 2023 Laws). The proviso directs DNR to establish and chair the Task Force along with Tribal partners, the Departments of Ecology, Health, Fish and Wildlife, as well as the Puget Sound Partnership, and members of the academic community.

The Task Force was asked to investigate opportunities to reduce negative impacts to tribal treaty and state geoduck harvests while promoting the long-term opportunities to expand or sustain geoduck harvests. This included analysis and recommendations on the feasibility of intervention to enhance Geoduck wildstock, factors that prevent classifying areas for commercial harvest, and increase the number and area of harvestable tracts that are sustainable and cost-effective. The report and recommendations are due to the Commissioner of Public Lands and the Legislature by December 1, 2024.

Should you have any questions, please contact me at 360-486-3469 or Brian.Considine@dnr.wa.gov.

Sincerely,

Brian Considine
Legislative Director
Office of the Commissioner of Public Lands

Enclosure: Legislative Report – 2024 Geoduck Task Force Deliverables

cc: Members of the Senate Agriculture, Water, Natural Resources, and Parks Committee
Members of the House Agriculture & Natural Resources Committee
Members of the Senate Ways and Means Committee
Members of the House Appropriations Committee
Hilary Franz – Commissioner of Public Lands, Department of Natural Resources
Ruth Musgrave – Senior Policy Advisor, Natural Resources, Office of the Governor
Jim Cahill – Senior Budget Advisor, Natural Resources, Office of Financial Management
Lisa Borkowski – Budget Advisor, Natural Resources, Office of Financial Management

Legislative Report on the Geoduck Task Force Deliverables

Section 310 (22) of ESSB 5187 (Ch. 475, 2023 Laws)

Prepared by
Confluence Environmental Company for the
Washington Department of Natural Resources

Office of the Commissioner of Public Lands, Hilary Franz
November 20, 2024

WASHINGTON STATE DEPARTMENT OF
NATURAL RESOURCES

Executive Summary

The following deliverables were developed as part of the Geoduck Task Force (Task Force), convened by the Washington Department of Natural Resources, to fulfill the requirements of the language from the Washington State Legislature's enacted budget for fiscal years 2023-2025 (the proviso):

1. The **Technical Memorandum** identifies important factors impacting wild stock geoduck harvest opportunities. This is the primary document describing work done under the proviso and includes the discussion of major topics such as water quality, harvest restrictions, and management framework. The Technical Memorandum also presents a summary and inventory of the status of priority geoduck tracts impacted by water quality or other issues impacting harvestability.

2. The **Ranking Method Memorandum** specifically addresses the priority focus of wastewater treatment plant outfalls, which are known to negatively impact geoduck resources due to the creation of areas prohibited for shellfish harvesting. The report presents a prioritization framework and scoring of identified wastewater treatment plants affecting geoduck harvest. Where applicable, the report refers to the Technical Memorandum for additional information detailing the regulatory authorities and authorization process for wastewater treatment plants.

3. The **Enhancement Factsheet** reviews considerations for enhancing the wild geoduck population in Puget Sound. The report outlines the opportunities and risks of integrating hatchery-raised individuals into the wild and introduces strategies, including potential pilot-scale projects, that could increase or sustain the number of geoduck available for harvest in the wild stock fishery.

4. The **Geoduck Task Force Roster** identifies individuals who participated in the Task Force and/or the technical subgroups of the Task Force.

These reports work together to synthesize information on the wild stock geoduck fishery and inform potential next steps for increasing or sustaining harvestable geoduck in Washington State. Each report concludes with a series of actionable recommendations. The Technical Memorandum provides general recommendations based on the Task Force and working subgroups discussions. The Ranking Method Memorandum provides a prioritized list of wastewater treatment plant outfalls and affected geoduck tracts with specific recommendations for further work needed to identify viable remedies. Lastly, the Enhancement Factsheet provides recommendations addressing some of the uncertainties and unknowns regarding potential risks of and methods for geoduck population enhancement.

TECHNICAL MEMORANDUM

Factors Affecting Wild Stock Geoduck Harvest Opportunities

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Acronyms and Abbreviations

CSO	Combined sewer overflow
DNR	Washington Department of Natural Resources
DOH	Washington Department of Health
Ecology	Washington Department of Ecology
FDA	U.S. Food and Drug Administration
MLLW	Mean lower low water
NPDES	National Pollutant Discharge Elimination System
NSSP	National Shellfish Sanitation Program
RCW	Revised Code of Washington
ROV	Remotely operated vehicle
SPD	Shellfish Protection District
TAC	Total allowable catch
Task Force	Geoduck Task Force
WAC	Washington Administrative Code
DFW	Washington Department of Fish and Wildlife
WWTP	Wastewater treatment plant

Summary

The Geoduck Task Force, led by the Washington Department of Natural Resources (DNR), was convened in January 2024 as required by the Washington State Legislature's enacted budget for fiscal years 23-25. The proviso language charged the Task Force with considering "opportunities to reduce negative impacts to tribal treaty and state geoduck harvest and promote long-term opportunities to expand or sustain geoduck harvest". The stipulations of the proviso and interests of Task Force members focused the engagement around three primary topics related to geoduck harvest opportunities: 1) water quality, 2) harvest restrictions, and 3) enhancement. This technical memorandum considers and addresses the influence of water quality and harvest restrictions on the geoduck fishery. Additionally, this document summarizes and describes the management of the geoduck fishery and considers the implications of the management framework on harvest.

The commercial wild stock geoduck fishery is jointly managed by DNR, the Washington Department of Fish and Wildlife, and the Puget Sound treaty tribes. Together, the co-managers conduct the necessary surveys, consolidate biomass information, set total allowable catches for the fishery, and develop and execute fisheries management for geoduck. The wild stock geoduck fishery is managed at a regional level, and allowable harvest is agreed upon by co-managers and allocated by region. Within a region, individual tracts are delineated as locations with commercial biomass of geoduck between -70 feet and -18 feet mean lower low water (RCW 77.60.070). To be available for harvest, a given tract must be classified as Approved or Conditionally Approved for shellfish harvesting by the Washington Department of Health (DOH) and be surveyed to have sufficient biomass, relative to original surveys conducted in the 1960s and 1970s.

In Washington State, DOH evaluates and classifies shellfish growing areas as the designated authority responsible for implementing the U.S. Food and Drug Administration (FDA) National Shellfish Sanitation Program (NSSP), Guide for the Control of Molluscan Shellfish. Through the classification process, DOH considers point source and nonpoint source pollution, shoreline conditions, and marine water quality, and either prohibits, restricts, conditionally approves, or approves shellfish harvesting from a given location. The primary examples of point source pollution are wastewater treatment plant (WWTP) outfalls. Shellfish harvesting is prohibited around WWTP outfalls, and these facilities can therefore affect access to geoduck harvest in many locations throughout Puget Sound. This document describes the regulation and authorization process for WWTP outfalls and the associated prohibition of shellfish harvesting in proximity to those outfalls. Additionally, priority geoduck tracts affected by WWTP outfalls are identified. These tracts are further considered in the Ranking Method Memorandum prepared as part of the Task Force process, and WWTPs are prioritized based on the potential for remedies to expand access to geoduck harvest. Nonpoint source pollution can also affect access to geoduck harvest, although impacts are typically limited by the subtidal depth of geoduck tracts. One location (Poverty Bay) was identified as an area where nonpoint pollution is affecting geoduck harvest opportunities; the Poverty Bay Shellfish Protection District is working to improve and maintain water quality in the area.

Throughout Puget Sound, there are also locations that have not gone through the DOH classification process and are therefore unavailable for geoduck harvest. Task Force members identified a series of

priority geoduck tracts in unclassified areas; this document and appendices include information gathered on these locations and discuss a likely pathway to classification. Necessary resources and support for completing the classification process could significantly expand access to geoduck harvest in many locations.

Guiding regulations and conservation measures can also limit geoduck harvest opportunities. The Task Force considered harvest restrictions associated with depth, survey requirements, eelgrass, macroalgae and herring spawning, and the 200-yard rule set forth in RCW 77.60.070, which limits vessel access within 200 yards of the shoreline. These restrictions were recognized, in many ways, to be protective of important nearshore resources and were considered to be appropriate. The Task Force considered and recommends a revision to the 200-yard rule to improve operational flexibility and equality in harvest opportunities between co-managers.

The role of the management framework in defining geoduck harvest opportunities was highlighted during Task Force meetings and discussions. Specific management decisions are made jointly by co-managers and are outside of the scope of this Task Force process. However, this document discusses geoduck fishery management and considers elements of the framework that may drive the availability of geoduck for harvest.

The information presented here is finally synthesized and organized into a series of recommendations specific to noted effects of water quality and harvest restrictions on geoduck harvest opportunities. These recommendations were agreed upon by Task Force members and represent priority goals and interests, based on available options to expand and sustain access to geoduck harvest.

1.0 Introduction

This document has been developed as part of the Geoduck Task Force (Task Force) led by the Washington Department of Natural Resources (DNR), convened in January 2024, to fulfill the requirements of the language from the Washington State Legislature's enacted budget for fiscal years 23-25 (the proviso):

> "*The task force must investigate opportunities to reduce negative impacts to tribal treaty and state geoduck harvest and promote long-term opportunities to expand or sustain geoduck harvest. The task force must provide a report to the commissioner of public lands and the legislature, in compliance with RCW 43.01.036, by December 1, 2024, that includes analysis and recommendations related to the following elements:*
>
> *(i) The feasibility of intervention to enhance the wild stock of geoduck, including reseeding projects;*
>
> *(ii) Factors that are preventing areas from being classified for commercial harvest of wild stock geoduck or factors that are leading to existing wild stock geoduck commercial tract classification downgrade, and recommendations to sustainably and cost-effectively increase the number and area of harvestable tracts, including:*
>
> *(A) Consideration of opportunities and recommendations presented in previous studies and reports;*
>
> *(B) An inventory of wastewater treatment plant and surface water runoff point sources impacting state and tribal geoduck harvesting opportunities within the classified commercial shellfish growing areas in Puget Sound;*
>
> *(C) A ranking of outfalls and point sources identified in (b)(ii)(B) of this subsection prioritized for future correction to mitigate downgraded classification of areas with commercial geoduck harvest opportunity;*
>
> *(D) An inventory of wild stock geoduck tracts that are most impacted by poor water quality or other factors impacting classification;*
>
> *(E) Consideration of the role of sediment load and urban runoff, and pathways to mitigate these impacts; and*
>
> *(F) Recommendations for future actions to improve the harvest quantity of wild stock geoduck and to prioritize areas that can attain improved classification most readily, while considering the influence of outfalls ranked pursuant to (b)(ii)(C) of this subsection."*

Prior to the first Task Force meeting, the facilitation team conducted one-on-one interviews with Task Force members to understand the goals and interests of fishery co-managers, state agencies, and other Task Force representatives for the Task Force effort. The results from the interviews formed the basis for the three Task Force subgroups:

- Water Quality
- Harvest Restrictions
- Geoduck Population Enhancement

Information from Task Force and subgroup meetings has been incorporated into three deliverables as part of the overall Task Force effort: 1) a Technical Memorandum (this document), 2) a Ranking Method Memorandum, and 3) a Wild Stock Geoduck Enhancement Factsheet. Work done under the proviso is primarily documented in this Technical Memorandum, which addresses the following items:

- Section 2.0: Overview of wild stock geoduck fishery management.
- Section 3.0: Summary of primary factors affecting the calculation of harvestable biomass.
- Section 4.0: Investigation of important factors preventing classification of commercial/wild stock geoduck areas as harvestable (e.g., poor water quality) or leading to existing geoduck area downgrade in classification. Where possible, an inventory of affected geoduck tracts is included.
- Section 5.0: Recommendations to sustainably increase the number and area of harvestable tracts.

2.0 Overview of Geoduck Tract Management

The commercial wild stock geoduck fishery is jointly managed by DNR, the Washington Department of Fish and Wildlife (DFW), and the Puget Sound treaty tribes party to United States v. Washington, 873 F. Supp. 1422 W.D. Wash. 1994 and United States v. Washington, 898 F. Supp. 1453 W.D. Wash. 1995. Together, the state agencies and tribes conduct the necessary surveys, consolidate biomass information, set total allowable catches (TACs) for the fishery, and develop and execute broader fisheries management for geoduck. DNR designates state-owned aquatic lands for geoduck harvesting and conducts regular auctions to sell geoduck harvest opportunities to individuals and private entities. DFW's role includes, in part, coordinating with the treaty tribes to develop biological survey information for geoduck tracts, calculation of the harvestable biomass, conducting research, and a range of other tasks for the state. Tract surveys are often conducted in coordination with or by tribal co-managers. DFW's authority also includes licensing and enforcement of the geoduck fishery. Each tribe has authority to manage and enforce harvest by their members. A "low-effect" Habitat Conservation Plan completed in July 2008 provides Endangered Species Act coverage for harvest of geoduck under the current management framework (DNR 2008).

The commercial fishery is managed at a regional level, with individual tracts comprising a management region. The 7 management regions are (1) San Juan Islands, (2) Strait of Juan de Fuca, (3) North Puget Sound, (4) Hood Canal, (5) North Central Sound, (6) South Central Sound, and (7) South Puget Sound. Individual tracts are defined as locations determined through surveys that have commercial biomass (>0.03 pounds per square foot) of geoduck present between the depths of -70 feet and -18 feet mean lower low water (MLLW) (RCW 77.60.070). Tracts must also be in areas classified as Approved or Conditionally Approved by the Washington Department of Health (DOH) for commercial harvest of shellfish. Additionally, anchoring of harvest vessels by state harvesters is limited to locations greater than 200 yards from shore (RCW 77.60.070). This rule does not affect tribal harvesters and does not change tract boundaries; in certain locations, the rule limits the area of a given tract that can be harvested by the state.

Prior to harvesting on any tract, a geoduck survey must first be conducted to determine the approximate density and weight of geoduck present on the tract. These dive surveys involve a number of 900-square-foot transects in which divers are counting "shows" (or the presence of a geoduck siphon) along the transect. Additionally, a subset of geoduck is sampled to determine mean weight per geoduck. This information is extrapolated to a total biomass for the tract using a show factor (the proportion of geoduck that have a visible siphon) and the total area of the tract. The show factor is determined either empirically, using a show plot, or by using a default show factor that is assumed to be conservative. In certain locations, a show plot is established, which is a delineated area of seafloor that has a census of the total number of geoduck present. Divers can then survey the show plot on each day they survey a nearby tract to calculate the percentage of geoduck visible on that day and apply that value to the tract being surveyed.

Establishment of a show plot can be done by conducting daily surveys for 5 to 15 days, adding markers next to geoduck until no new geoduck are visible. A show plot census can also be determined using disturbance (banging rebar with a hammer at the sediment surface) during sampling to allow geoduck to be counted upon response, potentially reducing the time required for the census. Regardless of the method, show plots can be time consuming and are not always feasible. When a show plot is not close enough or similar enough in environmental condition to a given tract, a default show factor of 75% is used when calculating the total tract biomass. Inaccuracy of the show factor can have significant implications for the calculation of total biomass (e.g., an inappropriate show factor can lead to a tract having a negative biomass after harvest, if the show factor assumed a higher proportion of shows than actual). The use of a default show factor also makes it difficult to compare two surveys of the same tract at different points in time, for instance, to determine a recovery rate. Any difference in geoduck density detected could be due to differences in show factor during the particular days of the two surveys. Total biomass values for individual tracts are summed at a region level and used to calculate the TAC for the given management region. The harvest rate for a specific management region is typically 2.7% of the calculated total surveyed biomass for that region, although only two regions still use a harvest rate that high. The harvest rate varies regionally based on co-manager agreement. More details on the calculation of total biomass and TAC under the current management framework can be found in Bradbury et al. (2000).

The geoduck survey and total biomass calculation can be used to determine the harvestability of a tract. For tracts that have been commercially harvested, the primary determining factor restricting harvest is whether the tract has returned to the pre-harvest density. Sampling on geoduck tracts throughout Puget Sound began in 1967, providing a baseline for comparison. Until a tract returns its originally surveyed density, it is considered to be in recovery and not available for harvest. On tracts where DNR will be harvesting, DFW develops an environmental assessment report to accompany DNR's process for auctioning harvest on the available tracts. At this time, there are tracts in both South Puget Sound and Hood Canal (e.g., Nisqually Reach (13800), Eld Inlet East (17150), and Port Gamble (20000)) that were harvested, recovered, and harvested a second time.

In recent years, new management approaches have been explored due to a better understanding of tract recovery rates and potential unsustainability of the current framework. The current framework assumes that a given tract would recover after approximately 39 years; recent work suggests the average time to recovery (at least in South Puget Sound) is 55 years (Stevick et al. 2021). These values alone indicate a lack of sustainability of the fishery under the current management framework, as that framework assumes a recovery time that is shorter than the actual recovery time determined through field surveys. Recovery rates are also geographically variable throughout Puget Sound. Using the approach of the existing framework, sustainable harvest would necessarily require an assumed recovery rate that is equal to or longer than the actual recovery.

A new strategy, using the Sparkman-Conrad planning tool, uses tract-by-tract management instead of regional management. It considers tract-specific recovery rates when projecting future harvest opportunity and sets current harvest amounts that are projected to be sustainable over a 30-year time frame rather than a fixed harvest rate of 2.7%. Also, a certain amount of reserve biomass is subtracted from the total biomass to calculate the commercially available biomass. This reserve biomass represents geoduck that are not actually "harvestable." Although every individual geoduck is technically harvestable, in aggregate it is not economically feasible to harvest them all. The reserve biomass concept acknowledges this reality and sets tract biomass levels that are truly harvestable. Benefits of this approach include reopening tracts that would have been unavailable under the current framework and allowing for a more tract-specific and flexible approach while maintaining sustainability. However, this approach does require increased survey effort to determine tract-specific recovery rates and likely results in a reduction in total harvest biomass in many locations. This tract-recovery-based model is currently being used in select management regions.

3.0 Factors Driving Harvestable Biomass

The harvestable biomass determined through application of the management framework described in Section 2.0 is affected by a number of primary factors. While the biomass available for harvest is ultimately a result of the combination of a broad suite of data, assumptions, and decisions, the following factors were identified by Task Force members and through review of management documentation as the primary drivers determining the TAC and locations available for harvest:

- Water quality
- Harvest restrictions and access based on statute and management documents
- Stock assessment details:
  - Pre-harvest survey on harvest tract
  - Show factor in place as a multiplier for all population estimates
  - Feedback from divers regarding populations to determine when to close a tract
- Model used to calculate TAC (age-based equilibrium yield model, Sparkman-Conrad model, or other)
- Recovery rate and available information

These factors, among others identified by Task Force members, are considered and discussed in detail in Section 4.0.

4.0 Discussion and Geoduck Tract Inventory: Factors Affecting Harvest Opportunities

The following sections identify and evaluate factors known to affect the available harvest biomass or harvestability of geoduck tracts. Where possible, site-specific information will be provided to discuss issues affecting certain locations. A summary and inventory of the status of priority geoduck tracts impacted by water quality or other issues impacting harvestability is included.

4.1 Water Quality

Water quality issues that are affecting geoduck harvest are divided into three subtopics: 1) point source pollution, 2) nonpoint source pollution, and 3) unclassified areas. Point sources of pollution originate from a single, identifiable source. Nonpoint pollution comes from diffuse sources and typically occurs as a result of rainfall or snowmelt runoff moving over and through land. The following subsections describe how each type of water quality issue is regulated and managed for classification of shellfish growing areas and identifies sites to be prioritized for improvements. This section also investigates important factors preventing classification of commercial and wild stock geoduck areas as harvestable or leading to downgrade in classification of existing geoduck areas. An inventory of wild stock geoduck growing areas that are most impacted by water quality issues is also provided.

4.1.1 Point Source Pollution

Point source pollution affecting geoduck harvest areas within Puget Sound is largely due to wastewater treatment plant (WWTP) outfalls, but harvest areas can also be impacted by combined sewer overflows (CSOs), marinas, and mooring areas. There are three primary state agencies involved in the regulation and authorization of WWTP outfalls or the associated prohibition of shellfish harvesting in proximity to them: the Washington Department of Ecology (Ecology), DNR, and DOH. The authorities of each agency are distinct, with differing underlying objectives. In the context of WWTP outfalls and other point sources of pollution, regulations and rules from all three agencies affect where geoduck may be harvested. Figure 1 provides an overview of the regulatory and authorization authorities and process for permitting of a WWTP outfall and the determination of shellfish growing area classifications around that WWTP outfall.

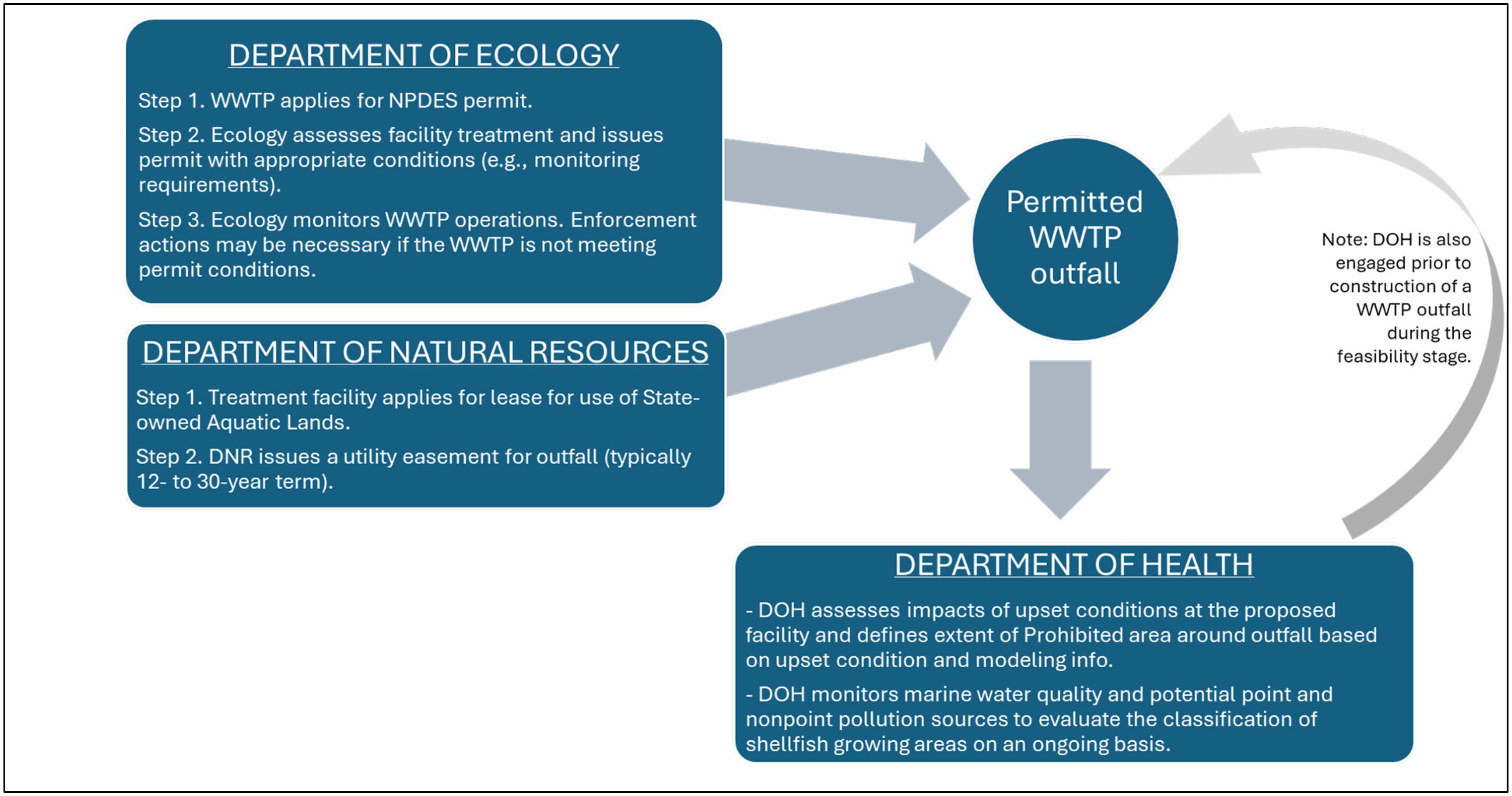

Figure 1. Wastewater treatment plant regulatory and authorization authorities and process

The DOH regulations are based on federal and state public health standards and set limits around where shellfish can be grown and/or harvested commercially. DOH is the designated authority responsible for implementing the FDA NSSP, Guide for the Control of Molluscan Shellfish (also referred to as the NSSP Model Ordinance) (FDA 2023) within Washington. In order to classify an area, DOH requires three main types of information: 1) marine water sampling data, 2) meteorology and hydrography information, and 3) shoreline survey details. The consolidation of this information includes assessment of all point and nonpoint sources of pollution in the vicinity. Through sampling of the marine waters and compilation of available sampling data within the associated watershed, the typical water quality conditions under various flow regimes can be assessed. The classification process requires the collection of a minimum of 30 marine water quality samples; such sampling typically takes 5 years but can be conducted in half that time through coordination between DOH and other agencies or tribes. The sampling data, meteorology and hydrography information, and shoreline survey details are put together into a sanitary survey report that classifies the shellfish growing area into one of the four available classes (Approved, Conditionally Approved, Prohibited, or Restricted). The NSSP Model Ordinance requires a Prohibited area around all WWTP outfalls, which is determined using NSSP Guidance and DOH Policies.

DOH's (2022) Wastewater Treatment Plant Outfall Strategy outlines approaches to improve WWTP treatment, flow, and dispersal to support a classification upgrade or increase opportunity to harvest shellfish based on closure criteria and conditions. The strategy highlights that of the 34,662 acres that are classified as Prohibited in Puget Sound, 63% of that area is due to WWTP outfalls. DOH Policies require a minimum Prohibited area radius of 300 yards from WWTP outfalls, with some limited exceptions. Most Prohibited areas are larger than the minimum, and certain actions may reduce the size of a Prohibited area and increase harvest opportunities. Such actions include:

- Increasing initial dilution by improving outfall diffuser characteristics,
- Improving overall treatment,
- Removing or extending outfalls, or
- Reducing the flow through the system.

It is important to note that the above actions require capital improvements to the treatment facilities and would be limited by both technical feasibility and funding availability. At certain locations, refined hydrographic information, modeling data, or field studies may show that a Prohibited area could be reduced and/or that a Conditionally Approved area could be established. Conditionally Approved areas allow for harvest when specific conditions are met, and such classifications can help to expand access to geoduck resources in certain locations. When hydrographic information or modeling data is not available, field studies, including dye or drogue studies, may be necessary to inform the establishment of a Conditionally Approved area. These studies are time intensive and costly; the dye alone for a single dye study can cost upwards of $25,000. Past studies have required coordination with the FDA for technical and equipment support and a team of DOH staff and other partners. The FDA provides this assistance throughout the country, and scheduling is dependent on FDA availability. Due to these factors, DOH typically conducts one of these studies every several years.

In addition to the classification of shellfish growing areas by DOH, Ecology regulates WWTPs in adherence to the Clean Water Act, the state Water Pollution Control Act, and regulations from the Code of Federal Regulations and Washington Administrative Code (WAC). Specifically, Ecology issues individual National Pollutant Discharge Elimination System (NPDES) wastewater discharge permits for municipalities and industries discharging wastewater to waters of the state. These permits include, among other things, discharge limits for specific pollutants, monitoring and reporting requirements, and operation and maintenance requirements. Permit conditions consider discharge standards established under WAC Chapter 173-221 and surface water quality criteria (WAC Chapter 173-201A). WWTPs that meet all NPDES permit conditions still have a Prohibited shellfish growing area around the outfall based on DOH's analysis. The presence of a Prohibited area is not an indication of insufficient treatment or monitoring at a WWTP.

In December of 2021, Ecology issued The Puget Sound Nutrient General Permit to control nutrients discharged from 58 WWTPs into the marine and estuarine waters of Puget Sound and the Salish Sea. Regulation of this discharge of nutrients may support increased harvest opportunity for geoduck through associated WWTP facility upgrades and improved reliability of the facilities that could ultimately reduce the size of a Prohibited area.

DNR is responsible for managing and granting authorizations for use of State-owned Aquatic Lands under RCW 79.105.030. There are three different aquatic types of authorizations: leases, easements, and licenses. Placement of a WWTP outfall is granted under a utility easement, which generally has a 12- to 30-year term, as determined by the proponent. The placement of a WWTP outfall is based on modeling and feasibility analyses considering water circulation, design needs, and other relevant factors.

Throughout Puget Sound, there are geoduck tracts that are closed or partially closed as a result of their proximity to WWTP outfalls. It should be noted that WWTP outfalls are not the only type of point source pollution; DOH also considers pollution from marinas and boating. However, WWTP outfalls are the primary type of point source pollution affecting harvest of wild stock geoduck. Table 1 includes a list of geoduck tracts that have been identified as priorities by Task Force members and are closed or partially closed by Prohibited areas around WWTP outfalls. Appendix A provides a series of maps showing geoduck tracts and WWTP outfalls throughout the 7 geoduck management regions. Potential actions and priorities associated with the WWTP facilities listed in Table 1 are explored further in the Ranking Method Memorandum developed as part of the Task Force effort.

Table 1. Priority geoduck tracts within Prohibited areas affected by point source pollution

Geoduck Tract	Facility	Outfall Location	DOH Growing Area	Reason for DOH Prohibited Area
South Central Sound Management Region				
Brownsville (07200), Battle Point North (07050), Keyport (06910)	Central Kitsap Treatment	47.6766° N, 122.6013° W	Port Orchard Passage	WWTP Outfall
Hood Canal Management Region				
Snake Rock (19100), Port Ludlow (19150), Colvos Rock (19200)	Olympic Water & Sewer Inc	47.9361° N, 122.6756° W	Hood Canal #1	WWTP Outfall, Marina / Boating
South Puget Sound Management Region				
Three Tree Point (09800)	Miller Creek WWTP	47.4417° N, 122.3644° W	Three Tree Point	WWTP Outfall
Normandy Park (09850)	Midway Sewer District	47.4033° N, 122.3367° W	Poverty Bay	WWTP Outfall, Marina / Boating
Redondo (10380)	Redondo WWTP	47.34941° N, 122.3380° W	Poverty Bay	The classification change is based on the unpredictable impact from the Redondo WWTP
Dumas Bay (10400)	Lakota WWTP	47.3358° N, 122.3817° W	Poverty Bay	WWTP Outfall
Steilacoom (10750)	Chambers Creek WWTP	47.1949° N, 122.5839° W	Ketron Island	WWTP Outfall
Taylor Bay (14300)	Taylor Bay STP	47.1823° N, 122.7795° W	West Key Peninsula	WWTP Outfall

4.1.2 Nonpoint Source Pollution

The impact from nonpoint source pollution on subtidal geoduck tracts is typically limited due to the depth and subtidal location of commercial tracts. There is typically substantial pollution source dilution available for inland nonpoint pollution sources, limiting impacts to geoduck resources within subtidal marine areas. Classification downgrade of a geoduck tract due to nonpoint source pollution results from the failure of a marine water quality station to meet NSSP water quality standards. Although uncommon, nonpoint source pollution can impact geoduck harvest when large flows from streams push high levels of bacteria from agriculture, urban runoff, or other sources out to subtidal zones.

DOH's shellfish growing area classification process for closures due to nonpoint source pollution considers evaluation of marine water quality, shoreline surveys, and meteorological information. Shoreline surveys evaluate the potential factors that impact marine water quality and examine septic systems, agricultural activities, wild animals, industrial facilities, WWTPs, and marinas. For nonpoint source pollution, DOH focuses on shoreline drainages to understand what is occurring in the watershed and how it impacts the marine area. When there is a failure to meet water quality standards at a marine water quality station, DOH considers seasonal data and rainfall events, which may lead to a conditional approval of harvest. The closure is based on a statistical evaluation of a minimum of the last 30 samples from the station. The size of the closure is based on neighboring marine water sampling station locations or, potentially, other hydrographic information.

When a classification downgrade related to nonpoint pollution occurs, there is an avenue available to address and find solutions to fix the issues. RCW 90.72 states that local government must form a Shellfish Protection District (SPD) to implement shellfish protection programs if there is a downgrade of the growing area. SPDs may comprise participants from businesses, tribes, industry representatives, governmental organizations, and citizens; funding typically comes through grants or taxes levied to residents within the area. These groups are formed with the goal of developing locally driven efforts and implementing methods to improve water quality. These programs address topics such as funding sources, pollution control strategies, education and outreach, and tools for correcting pollution sources. For impacted geoduck tracts, county health departments and SPDs work with state and local entities to design and implement projects such as pollution identification and correction, stormwater management, and community education to improve water quality for geoduck harvest. RCW 90.72 also authorizes the voluntary formation of SPDs in instances where there is not a downgrade of a growing area mandating formation.

In the context of commercial geoduck harvest, only one area has been identified to date that received a DOH growing area classification downgrade from Approved to Conditionally Approved based on nonpoint source pollution: Poverty Bay. The Poverty Bay geoduck tracts impacted by nonpoint source pollution are located on the eastern shoreline of Puget Sound between Des Moines Marina and the mouth of Redondo Creek. The subtidal water quality monitoring stations failed the NSSP standard in 2017 due to high bacteria loads from tributaries during rainfall events in the summer. In response to the classification downgrade, King County formed the Poverty Bay Technical Committee and initiated the bacterial Pollution Identification and Correction field monitoring program. The Poverty Bay Shellfish Protection District is working with local jurisdictions to identify and improve pollution in the watershed by conducting site investigations to screen for bacteria sources, remedying known failures of septic systems, and ensuring administration of stormwater management programs. DOH created a re-opening standard based on bacteria load modeling of contributing creeks, establishing a specific load for the growing area to get re-classified as Approved. The Conditionally Approved growing area classification remains in Poverty Bay due to failure to meet the bacteria load threshold from last year's samples in 2023. The Poverty Bay Shellfish Protection District is continuing their work with cities, tribes, sewer districts, and agencies to implement successful actions in the watershed for improving and maintaining water quality.

In certain locations affected by nonpoint source pollution, it can be possible to classify the growing area as Restricted to allow for relay of shellfish. As defined under the Model Ordinance, "relay" refers specifically to the movement of shellfish from a Restricted or Conditionally Restricted area to an Approved or Conditionally Approved area for subsequent harvest after depuration (FDA 2023).

Restricted growing areas typically have no available water quality information or poor water quality, based on established marine water quality stations. Relay of shellfish from a Restricted area to an Approved area can be allowed by DOH upon request. Shellfish moved from a Restricted to Approved area can be harvested from that Approved area once 60 days has passed or a validation study has been completed. Restricted areas have currently been established in Washington as part of the scallop fishery around the San Juans and in limited locations for the harvest of oysters or clams. Relay has not been conducted for geoduck. Establishing relay practices for geoduck, where geoduck would be moved and then harvested, would likely require studies to understand the feasibility and tradeoffs given the level of effort.

4.1.3 Unclassified Areas

Outside of locations where DOH has classified shellfish growing areas as Approved, Conditionally Approved, Prohibited, or Restricted, there are locations that are unclassified. Unclassified areas include both those denoted as such in DOH's growing area mapping, as well as areas that have no associated denotation (refer to boxes in Figure 2). Areas that are denoted as unclassified may have some water quality or other information available, but the process to classify the area was not completed.

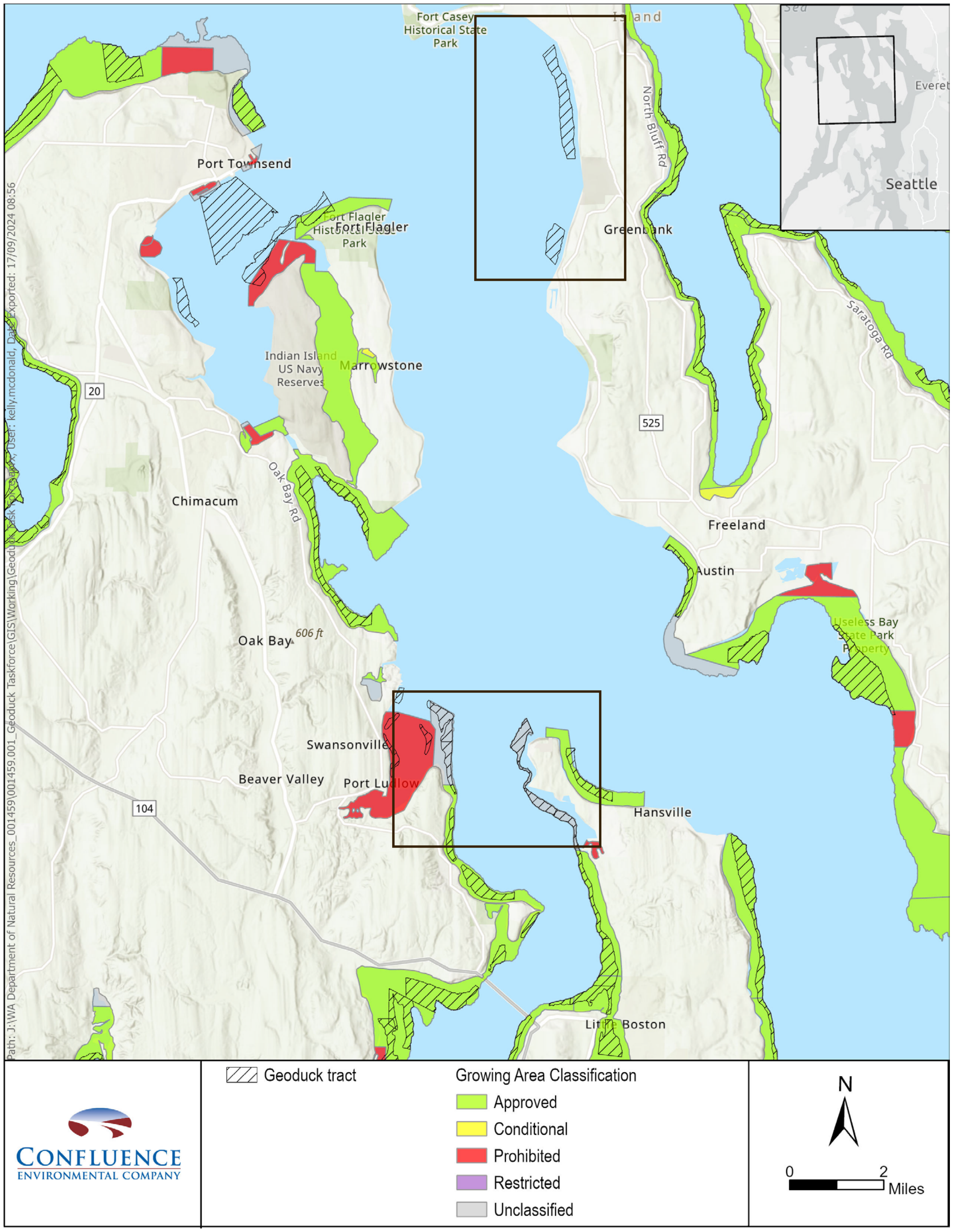

Figure 2. Example unclassified areas

In the context of water quality impacts on unclassified areas, it is worth noting the impact of CSOs. Throughout the state of Washington, there are several communities where CSOs can potentially result in the discharge of combined stormwater and sewage to receiving waters, especially during a storm event. King County and the City of Seattle own and operate the largest combined sewer system in the state, with over 100 CSO outfalls in the metro Seattle area (Figure 3). In the context of wild stock geoduck harvest, these CSO outfalls limit the ability of DOH to classify a commercial shellfish growing area. The classification process requires there to be predictability in the system so that a discharge of untreated waters would be known. Uncontrolled CSOs do not offer the necessary predictability. Geoduck tracts between Edmonds and Fauntleroy are affected by the King County and Seattle CSO systems.

Throughout Puget Sound, there are many geoduck tracts that are within unclassified areas and are therefore currently unavailable for commercial harvest. Making these tracts available for harvest would require DOH to go through the classification process. Additionally, geoduck density and biomass survey information would need to be collected in order to calculate the biomass available for harvest at the tract. These processes can be lengthy and require sufficient capacity to complete. Based on the interests of Task Force members, priority geoduck tracts were identified and the following information on those tracts was collected and reviewed to highlight unclassified areas with a relatively straightforward process to classification that may offer high value geoduck resources:

- **Tract acreage.** Acreage at depths between -18 feet and -70 feet MLLW available for geoduck harvest.
- **Available geoduck density.** Based on recent survey information, would the tract likely offer a high density of geoduck for harvest?
- **Proximity to WWTP outfall or other point source pollution.** Would the classification process likely result in a Prohibited or Conditionally Approved classification (based solely on distance from nearby point sources, and recognizing that DOH would still need to conduct a full evaluation of these areas to determine classification)?
- **Timeline to classification.** In some locations, DOH has partial information necessary for the completion of the classification process. Would the available information help to expedite the classification timeline?
- **Solution identified.** Has work already identified a solution that could address any water quality issues to allow the area to be classified as Approved?
- **Ancillary benefits.** Are there benefits beyond expanded geoduck harvest that would be realized through efforts to classify the area?

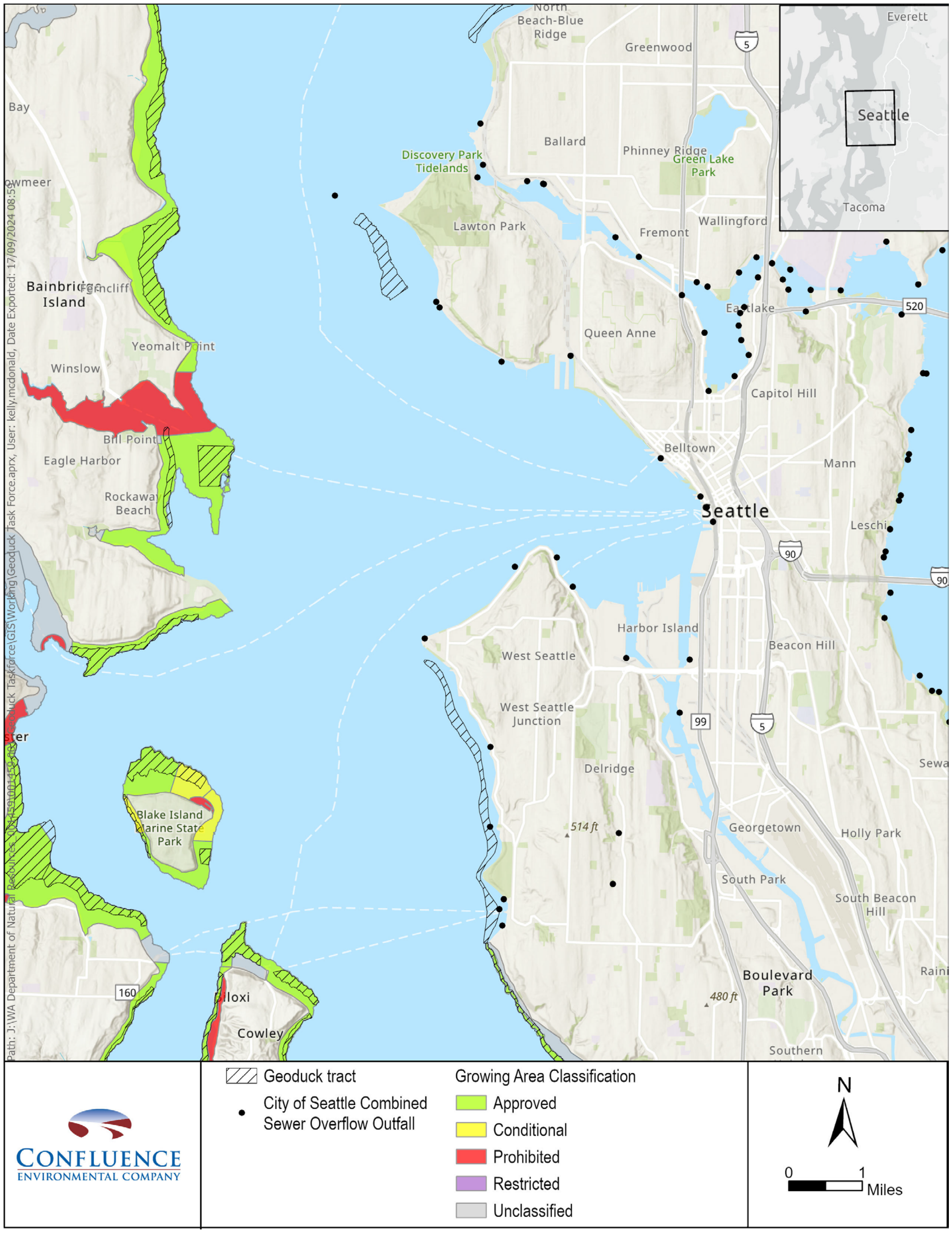

Figure 3. Combined sewer overflow outfalls along the City of Seattle waterfront

The following sections provide a discussion of the potential classification pathway(s) for a subset of unclassified geoduck tracts identified as priorities by Task Force members. While the discussions are location specific, the information considered and potential pathway to classification could be applied to other unclassified tracts. The full list of priority unclassified tracts, including the information bulleted above, is available in Appendix B.

Colvos Rocks East and Tala Point

The Colvos Rocks East (19300) and Tala Point (19350) geoduck tracts (Figure 4) were historically classified as Approved by DOH but removed from active classification based on lack of interest in shellfish harvesting in those locations. Should there be co-manager interest in harvesting geoduck from these tracts, the locations could be Conditionally Approved upon request. Sampling at historic marine water quality stations would be necessary prior to a change in classification. With support from tribes and other stakeholders, the required minimum 30 samples can be collected in as little as 2.5 years. Geoduck survey information collected in 2019 suggests that the tracts have moderate geoduck density and are currently in recovery.

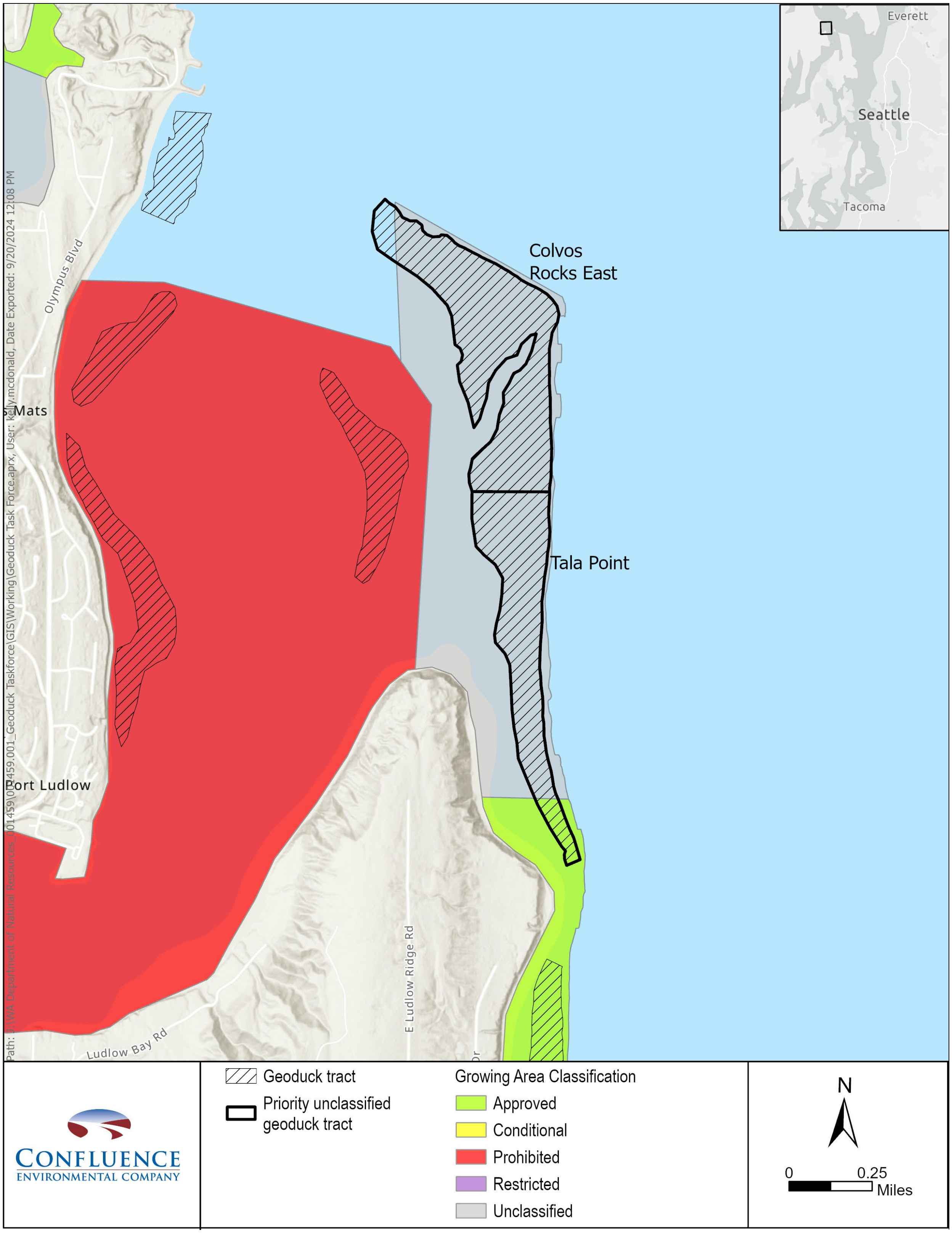

Figure 4. Colvos Rocks East and Tala Point tracts

Weist Windmill and Big Hunter

The Weist Windmill (16950) and Big Hunter (16900) tracts (Figure 5) are located adjacent to the Eld Inlet Growing Area in South Puget Sound. Part of each tract is currently located in an Approved area; classification of the unclassified area would expand the harvest opportunities within each tract. All required marine water quality sampling has already been conducted. Because the unclassified area is part of a growing area that has already been classified, an addendum to the existing sanitary survey conducted by DOH is the only additional piece necessary to complete the classification. It is estimated that the classification process would take 6 months. Both tracts have been surveyed for geoduck biomass and density recently (Big Hunter in 2016 and Weist Windmill in 2018) and are recovering quickly from past harvest within the Approved areas. Additional surveys are scheduled for 2026 (Big Hunter) and 2028 (Weist Windmill). If the necessary classification steps were completed, the entirety of each tract would be available for harvest based on survey results and co-manager agreement. Continued protection of water quality in this location in support of shellfish harvesting would potentially provide an ancillary benefit to eelgrass and kelp restoration efforts in the vicinity. Expansion of the Approved area would also support identified goals of the Puget Sound Partnership to increase shellfish harvesting opportunities in Puget Sound by 500 acres per year (Puget Sound Partnership 2020).

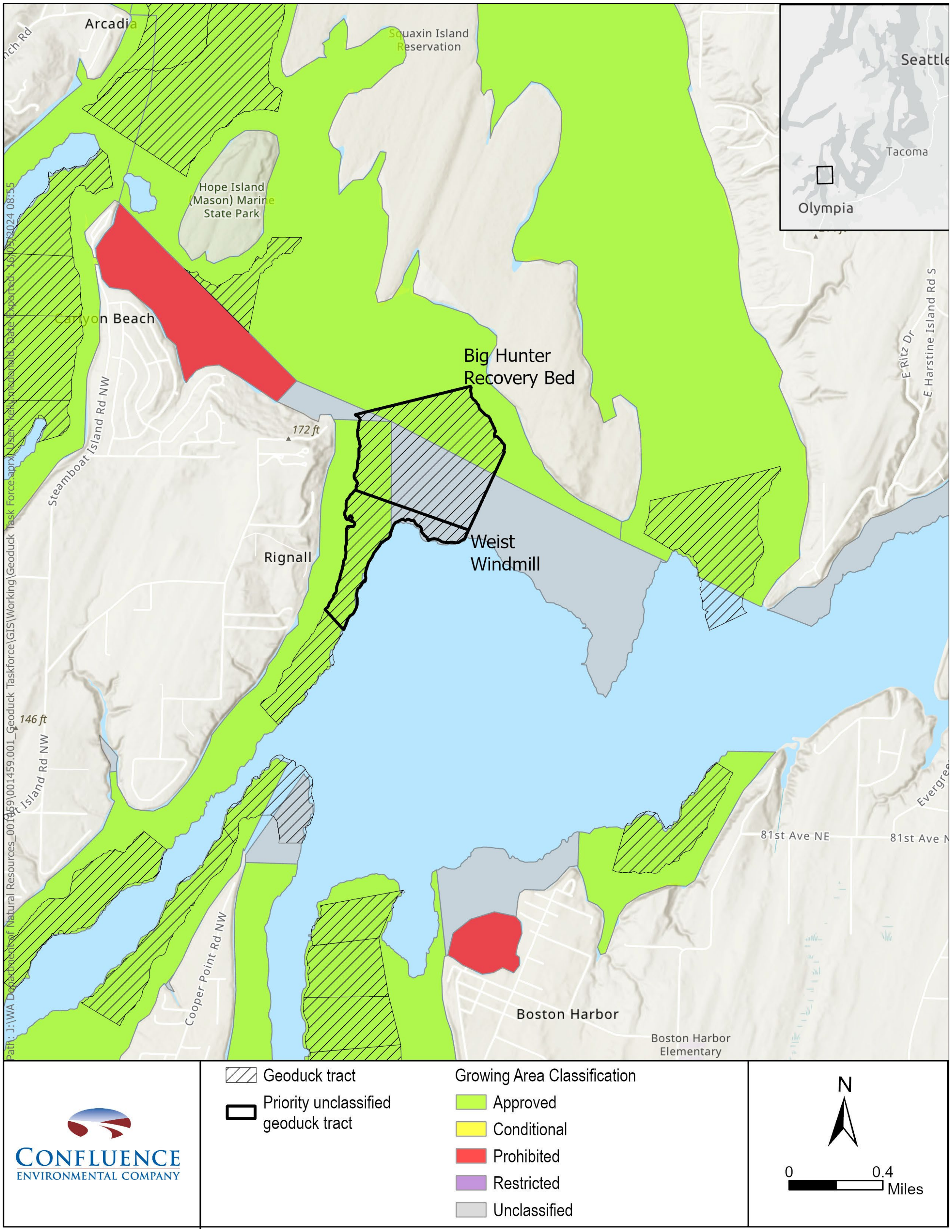

Figure 5. Weist Windmill and Big Hunter tracts

Foulweather, Foulweather 1, Foulweather 2, and Foulweather Bluff

The Foulweather area tracts are located along the western shores of Foulweather Bluff at the northern tip of the Kitsap Peninsula (Figure 6). Recent survey efforts have redrawn the tract boundaries and may not match the tracts as shown in Figure 6. The geoduck density in this location is considered to be moderate to high based on recent (2019) surveys, and co-managers have requested that DOH consider classification of these locations to allow for harvest. At this time, approximately 4 of the 30 required marine water quality samples have been collected, and the shoreline survey is expected to begin within the next year (approximately 2025). It is estimated that the additional steps necessary for classification could be completed in 4 years. Classification of the unclassified growing areas around Foulweather Bluff could potentially open upwards of 200 acres for geoduck harvest. Approval of these locations for harvest would also support the identified goal of the Puget Sound Partnership to increase shellfish harvesting opportunities in Puget Sound by at least 500 acres per year (Puget Sound Partnership 2020).

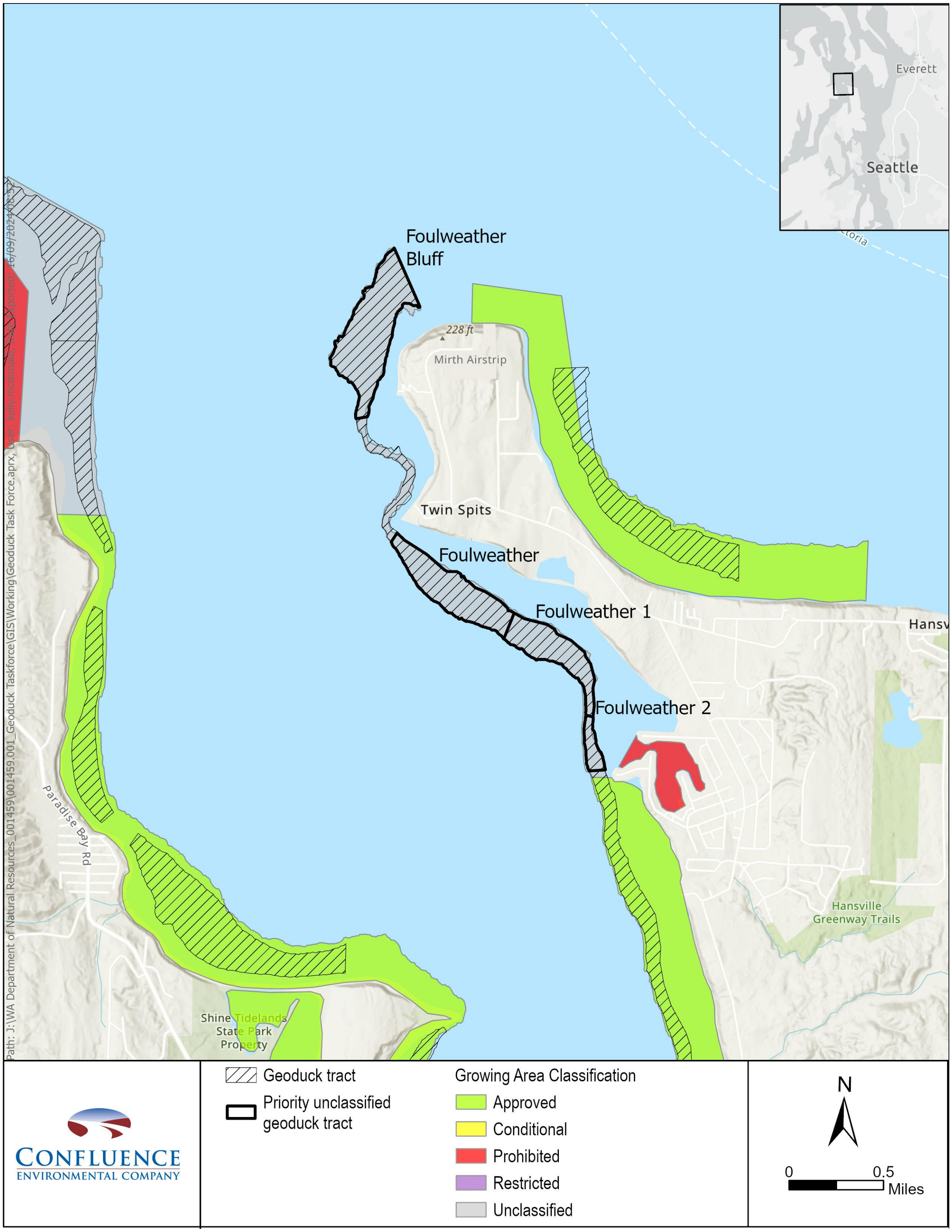

Figure 6. Foulweather area tracts

Richmond Beach and West Point

The Richmond Beach (6100) and West Point (8800) tracts are located offshore of the City of Seattle. Both tracts are potentially affected by WWTP outfalls, including the West Point WWTP outfall, Brightwater WWTP outfall, and Edmonds WWTP outfall (refer to Figure 7). Additionally, the Seattle and King County CSO systems affect the water quality in the vicinity of these tracts and the predictability of potential water quality issues. The West Point tract is proximal to the West Point WWTP outfall and would, most likely, be within the required Prohibited area around the outfall. Methods outlined in the DOH outfall strategy report (as summarized in Section 4.1.1) could be explored to limit the size of the Prohibited area. However, the size of the West Point WWTP (designed and permitted for approximately 215 million gallons per day) would likely make solutions cost prohibitive.

The Richmond Beach tract is a high value tract, noted as having a high density and quality of geoduck. Significant work has been conducted to explore the necessary steps to classify this tract. Given the highly urbanized environment in proximity to the tract (both residential and commercial) and the impact of wastewater outfalls, an assessment of trace metals in geoduck collected from the Richmond Beach tract was conducted in 2009, in collaboration between the Suquamish Tribe and DOH (Ostrom et al. 2009; Washington DOH 2009). Results suggest that consuming geoduck from Richmond Beach would not expose consumers to harmful levels of contaminants. Subsequent coordination between the Suquamish Tribe, DOH, and King County Department of Natural Resources and Parks, Wastewater Treatment Division, has sought to identify the necessary remedies limiting classification of the Richmond Beach tract. As shown on Figure 7, there are multiple emergency overflows or outfalls in proximity to the Richmond Beach tract. Specifically, Lift Stations 4 and 12 managed by the Shoreline Sewer District discharge within or just north of the Richmond Beach tract (refer to locations highlighted in red on Figure 8). Available information suggests that these lift stations have not discharged sewage (i.e., had overflow events) since 2009, when upgrades to the Hidden Lake Pump Station (located along the Richmond Beach shoreline) were completed. However, Lift Stations 4 and 12 do not currently have the necessary equipment to meter discharge, limiting the ability of the sewer district to respond in emergency situations to avoid or minimize the discharge of sewage. Upgrades to the monitoring and telemetry equipment at the lift stations could provide DOH with the necessary information to complete the classification process. Current review standards used by Ecology now require lift stations to have the necessary telemetry and alarms to alert operators of problems (WAC 173-240-040); upon upgrading, these lift stations would be required to have this equipment. Depending on the upset condition considered (i.e., the reasonable worst-case discharge), the Richmond Beach tract may still be affected by Prohibited areas around these outfalls. With the necessary predictability available at the proximal outfalls, reactivation of the marine water quality sampling stations in the vicinity of Richmond Beach would provide the necessary information to complete the classification process. Collection of the 30 required marine water quality samples would take between 2.5 and 5 years, depending on agency coordination.

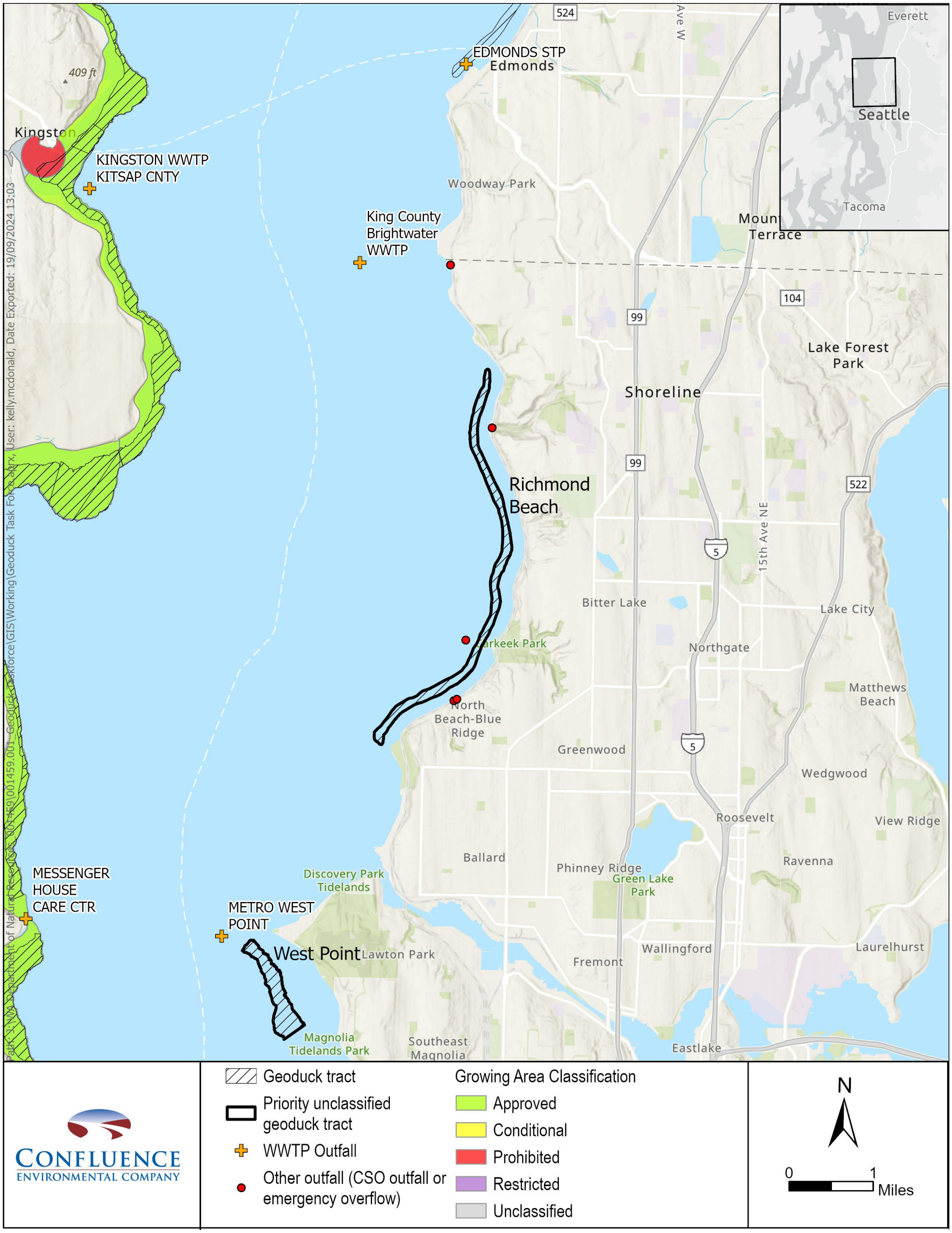

Figure 7. Richmond Beach and West Point tracts and nearby outfalls

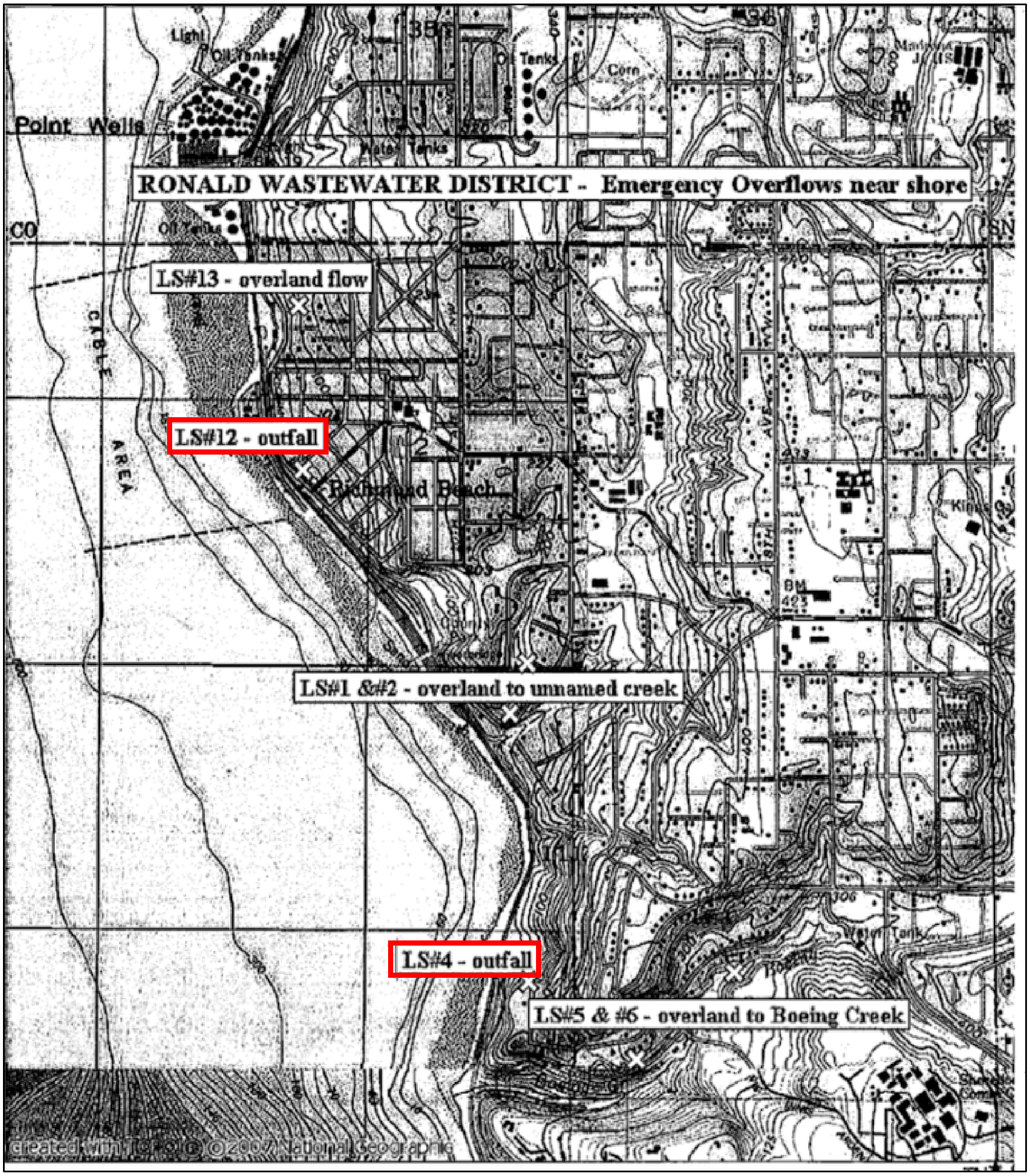

Figure 8. Lift stations managed by the Shoreline (Ronald) Sewer District

4.2 Harvest Restrictions

Geoduck harvest in Puget Sound is restricted by a variety of rules outside of water quality. The following sections describe those restrictions and discuss recommendations associated with these restrictions that may improve or expand geoduck harvest opportunities.

4.2.1 Depth Restrictions

Geoduck harvest is currently restricted to depths between -70 and -18 feet MLLW (RCW 77.60.070). Discussions with subgroup participants and Task Force members indicated that relaxing the depth restrictions would be unlikely to significantly increase harvestable biomass. The rationale for not exploring these additional harvest opportunities was based on both the lower geoduck density outside of the currently harvestable depths and diver safety considerations. Diver safety dramatically declines as depth increases and is therefore an important consideration when weighing the value of harvest opportunities deeper than -70 feet MLLW. Environmental considerations at shallower depths were also cited as a potential concern. Therefore, the Task Force deprioritized the topic of exploring geoduck harvest areas deeper than -70 feet MLLW and shallower than -18 feet MLLW.

4.2.2 Surveys/Resurveys

Geoduck occur throughout the Salish Sea from the low intertidal zone to at least 360 feet of water depth. Commercial tracts have been identified based on dive surveys. A geoduck tract includes inshore, offshore, and side boundaries for a site where geoduck densities are considered to be of commercial density. Geoduck distribution is patchy, likely in part due to the seabed substrates.

DFW began using SCUBA diving to identify and assess commercial geoduck tracts starting in 1967. Geoduck surveys assess the abundance of geoduck on a commercial tract to establish the total geoduck biomass and harvestable allowance. The current management framework requires a geoduck tract to be resurveyed before it can be harvested again to ensure that it has returned to pre-harvest density. Increasing the frequency of resurveys on existing tracts may also refine the estimates for geoduck abundance or establish the rate of recovery. Additional survey information on tracts is likely to support site-specific approaches to management and provide data to better understand population dynamics throughout Puget Sound. Additional survey efforts could also help to expand available information on locations that were deemed to not have commercial density based on 1970s surveys. In some locations, the initial surveys were low resolution and could be refined to better characterize potential geoduck resources. Newer technologies (e.g., remotely operated vehicles [ROVs], underwater cameras) could be cost effective for these exploratory surveys; identified promising areas would be subsequently surveyed using divers to get an accurate estimate.

4.2.3 Eelgrass Restrictions

Eelgrass restrictions placed on geoduck tracts are based on data from site-specific surveys that are a part of pre-harvest requirements. Current regulations restrict geoduck harvest from occurring within 2 vertical feet of an eelgrass bed. In most locations, this restriction is used to modify the tract boundary so that the tract excludes areas that are not harvestable due to the proximity to eelgrass. In discussions, Task Force and subgroup members recognized the value of eelgrass resources and agreed that geoduck harvest should not occur in eelgrass. Currently, the presence of an eelgrass bed along part of a tract boundary results in a modification of the tract boundary along the entirety of the shoreward edge. The concept of introducing flexibility to allow for harvest along sections of a tract where eelgrass does not occur was introduced as a way to expand harvest opportunities. Task Force and subgroup members indicated that the current restriction (defining the shallow limit of the tract boundary based on any presence of eelgrass along the tract) was appropriate due to potential sedimentation impacts associated with harvest. Consistency of the tract boundary was also important for diver communication and coordination. Therefore, exploring additional harvest opportunities by introducing flexibility around eelgrass restrictions is not considered to be a priority.

4.2.4 Macroalgae/Herring Spawning Restrictions

Wildstock geoduck harvest can potentially adversely affect Pacific herring (*Clupea pallasii*) spawning populations by disturbing sensitive macroalgal habitat. Pacific herring spawn in shallow, vegetated areas and attach their eggs to submerged aquatic vegetation. Where Pacific herring spawning has been documented, geoduck harvest must be deeper than -25 feet MLLW outside of the herring spawning season (January through April). During the herring spawning season, harvest at tracts in documented spawning locations must be deeper than -35 feet MLLW. The presence of habitat is based on herring spawning locations documented by DFW. The restriction depths of -25 feet MLLW and -35 feet MLLW were collectively decided by co-managers approximately 25 years ago to establish a precautionary measure to protect herring spawning from potential impacts of habitat disturbance from geoduck harvest; however, there is a lack of depth data to support these determinations.

Based on an overlay analysis conducted in GIS, about 58 geoduck tracts are impacted by mapped herring spawning areas, with 34 tracts containing between 1 and 20 acres of overlap and 3 tracts having over 20 acres of overlap, totaling 267 acres; this intersection comprises less than 1% of total geoduck harvest tracts. Current restrictions based on macroalgae and herring spawning habitat limit where or when harvest can occur but do not limit the total harvestable biomass. Geoduck resources within harvestable tracts remain in the total harvestable commercial biomass.

Ongoing work is being conducted to explore interactions between geoduck harvest and herring spawning habitat. During the summer of 2024, DFW administered a pilot study to analyze geoduck harvest impacts to macroalgae and spawning substrate for Pacific herring. The study was conducted on the Wollochet Harbor East tract in South Puget Sound. DFW divers surveyed areas of the tract in June and after the initial harvest period to estimate percent cover of macroalgae species by cover or type, percent cover of other potential spawning substrate (such as polychaete worm tubes), number of geoduck siphons, and to note the predominant substrate type within quadrats along a transect. Although results have not been made available yet, this study may provide information for reevaluating herring spawn protections.

Additional work and studies may be conducted to better understand the depth at which herring spawn to evaluate the interaction between the geoduck fishery and preferred macroalgae habitat. Task Force subgroup members indicated interest in exploring methods for a consistent survey method for macroalgae and mapping herring spawning habitat to understand where they occur more accurately and how to best protect the habitat during harvest. Due to ongoing work and discussions on this topic, no recommendations on macroalgae and herring spawning restrictions will be made at this time.

4.2.5 200-yard Rule

RCW 77.60.070 states, "…Vessels conducting harvest operations must remain seaward of a line two hundred yards seaward from and parallel to the line of ordinary high tide," which means anchoring cannot occur within 200 yards parallel to the ordinary high water mark. In certain locations where the bathymetry is steep, a large portion of a geoduck tract (between -18 feet and -70 feet MLLW) can be within 200 yards of the shoreline.

The language of the rule was intended to allow divers (but not vessels) to approach closer than 200 yards, but safety and equipment constraints have meant that, in practice, the language limits both divers and vessels from being within 200 yards of the shoreline. This rule applies only to state harvesters; tribal harvesters are not subject to the rule and can harvest to the shoreward edge of a tract (-18 feet MLLW or as otherwise determined), regardless of the distance to shore. Due to this rule, the state is also excluded entirely from some tracts located entirely within 200 yards of shore. This rule and its application to state harvesters alone impacts harvest opportunities for both state and tribal harvesters; in certain locations, tribal harvesters are limited to locations that the state cannot harvest, regardless of resource quality and other considerations (e.g., depth, as some tracts the state is precluded from entirely are bathymetrically steep, making harvest challenging or impossible). Based on Task Force and subgroup discussions, it is recommended that a legislative change to the language of the statute be explored. Proposed language would read, "Vessels conducting harvest operations must remain seaward of *eighteen feet below mean lower low water (0.0 feet) or the shallowest edge of the harvest area, whichever is deeper*."

The Environmental Impact Statement that governs the geoduck fishery already has noise standards independent of the 200-yard rule, specifically a 50-decibel maximum measured at the shore. This standard would be maintained even if vessels anchored closer to shore than 200 yards. Due to the way sound travels across water, increased proximity is unlikely to significantly increase noise compared to the existing harvest. State harvest only occurs Monday through Friday (excluding holidays) and during daylight hours (8 am to 4 pm).

The proposed change would be primarily operational and would not increase the overall biomass of geoduck available for harvest. Nonetheless, it could provide more flexibility and equality in harvest opportunities, where the existing rule limits tribal or state harvesters from accessing certain resources.

4.3 Management Framework

This section provides a discussion of the current management framework and the mechanics of determining harvest opportunities. It should be noted that specific decisions about management and harvest of geoduck tracts are under the purview of co-managers. The information presented here focuses on elements of the management framework that are key to determining available harvest opportunities and is intended to provide context within the scope of the Task Force effort.

4.3.1 Stock Assessment

To support fishery management, the assessment of geoduck biomass and density is conducted as briefly described in Section 2.0. The calculation of available biomass is dependent on a number of key assumptions and pieces of information. Average density, average weight, and tract area data from surveys are the basis for calculation of tract biomass. A harvest rate is applied to the sum of all tract biomasses in a region or subregion to calculate the TAC. Based on discussions with the Task Force, the concept of the show factor was raised as an element of the calculation with significant impact on the total biomass. The show factor is intended to represent the portion of geoduck that is not visible during a survey. There are multiple methods for determining the tract-specific show factor in the field (refer to Section 2.0). If a specific show factor cannot be determined, a default of 75% is used. There is error associated with the show factor, whether it is determined in the field (e.g., dynamic environmental conditions may affect show during a survey) or the default is used. This error is not currently incorporated into the error associated with the final population estimate, requiring an alternate decision-making framework used by co-managers to close a tract other than the 65% drawdown target identified in co-management plans. If the show factor is not representative of actual geoduck density, the population can be over or underestimated, leading to harvest in excess of the target proportion or reduced harvest opportunity, respectively. Additional investigation into methods to determine the show factor could greatly improve biomass estimates and management decision-making. There is potential for the application of newer technologies (e.g., ROVs, sonar) to support accuracy and efficiency of survey efforts and show factor determination.

4.3.2 Lower Than Predicted Recovery/Recruitment Rates

As described briefly in Section 2.0, the current management framework assumes, on average, a given tract would return to pre-harvest density (i.e., recover) after approximately 39 years. Recent work suggests recovery is highly variable by location. In South Puget Sound, the average time recovery is 55 years (Stevick et al. 2021). The discrepancy between these values suggests that recruitment and/or survival are not occurring at the assumed rates. There is also a high degree of spatial variability in recruitment and recovery rates (both at large and small scales) that impacts the suitability of a region-wide management framework. Research has addressed basic questions about geoduck population structure and dynamics, but there are still a number of unknowns and uncertainties around the factors affecting geoduck recruitment and survival. These factors, and the potential for geoduck population enhancement efforts to address some of the recovery challenges, are addressed further in the Wild Stock Geoduck Enhancement Factsheet.

4.3.3 Management Strategies

The management strategy used for the geoduck fishery ultimately determines the biomass available for harvest, based on surveys supporting the stock assessment and calculation of total biomass. Any framework used in fishery management relies on key assumptions to set harvest rates that protect the population while also allowing for harvest. As described in Section 2.0, there are multiple management frameworks under consideration by co-managers of the geoduck fishery. Although outside of the scope of the Task Force discussion, it is important to note the interplay between priorities identified here and the framework used to manage the fishery. Where possible, implementation of Task Force recommendations should consider the implications and interactions with the overarching management framework to ensure harvest of geoduck at a sustainable rate.

5.0 Recommendations

This section summarizes the general recommendations presented within this document based on the Task Force and working subgroups discussions. Additional recommendations specific to currently classified areas affected by WWTP outfalls are available in the Ranking Method Memorandum (*citation to be added once finalized)*. The Task Force recommends the following efforts and changes to increase harvest opportunities for wild stock geoduck:

- Provide additional resources, as needed, to evaluate Prohibited areas associated with WWTP outfalls to determine if conditional approval of portions of the area would be possible. A Conditionally Approved classification would allow for harvest under certain predetermined conditions. Creating Conditionally Approved areas may require dye or drogue studies to provide the necessary time of travel information. Improved data and information from the WWTP could also inform refinements to the Prohibited and Conditionally Approved area boundaries.
- Fund and implement a systematic in-depth review of WWTP outfalls and the associated Prohibited areas affecting geoduck resources to identify site-specific WWTP or outfall improvements to increase harvestable area. This process should include participation by WWTP operators, wastewater engineers, and resource agencies to determine options and feasibility. Options presented in DOH's Wastewater Treatment Plant Outfall Strategy report could act as a starting place for the process.
- Expand harvest opportunities in currently unclassified areas by:
    - Providing funding for the Shoreline Sewer District to upgrade monitoring and telemetry equipment to improve predictability and enable classification of the Richmond Beach tract.
    - Reinitiating marine water quality sampling at stations near the Colvos Rocks East and Tala Point tracts to allow for the tracts to be Conditionally Approved, based on co-manager interest.
    - Increasing capacity for the marine water quality sampling necessary to classify a shellfish growing area through partnerships and funding, as available. Additional support can halve the time required for DOH alone to conduct sampling (from 5 years to 2.5 years).
    - Prioritizing classification efforts for tracts that are outside WWTP closure zones or affected by other known point sources of pollution.
- Provide funding for studies and pilot projects, as appropriate, to better understand the feasibility of transplanting and/or short-term relay of geoduck outside of areas that are classified as Prohibited.

- Investigate enacting a statutory amendment to the 200-yard rule: "Vessels conducting harvest operations must remain seaward of ~~a line two hundred yards seaward from and parallel to the line of ordinary high tide~~ eighteen feet below mean lower low water (0.0 feet) or the shallowest edge of the harvest area, whichever is deeper."

- Provide funding for targeted geoduck surveys:

  - In locations where geoduck tract boundaries have been modified due to the presence of WWTP outfalls to better understand geoduck resources in the area.

  - Of areas that have not been surveyed for 10 or more years and in new areas that have not yet been surveyed (e.g., in Strait of Juan de Fuca region).

  - In support of a pilot project or investigation to explore using newer methods or technologies (e.g., ROV or sonar).

  - For collaborative agency/tribal/academic research into developing a new or updated show plot method that will consider environmental conditions compared to show.

6.0 References

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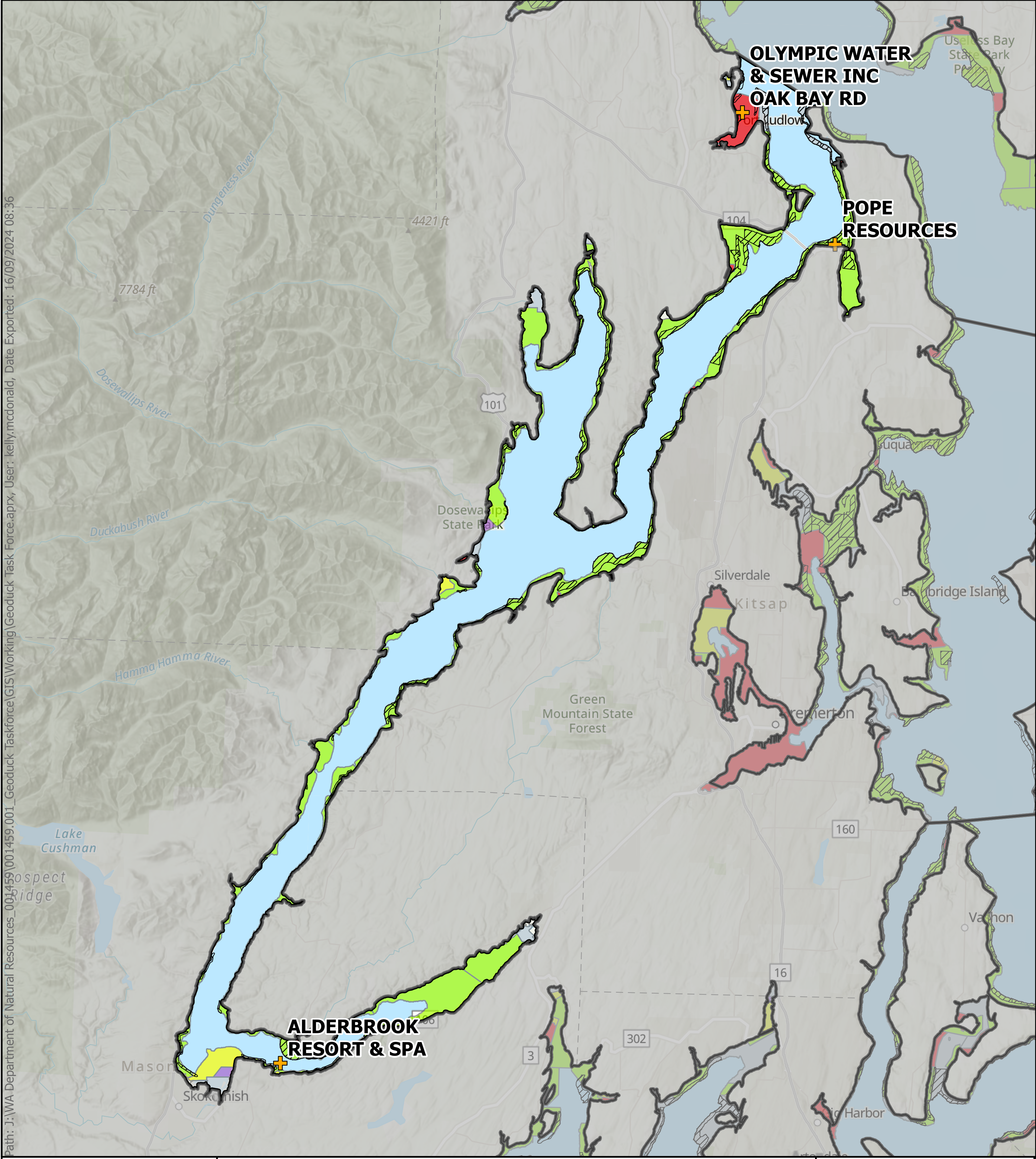
Appendix A

Geoduck Tracts and WWTP Outfalls Map Series



Geoduck tract

Geoduck Management Region

WWTP Outfall

Growing Area Classification

Approved

Conditional

Prohibited

Restricted

Unclassified

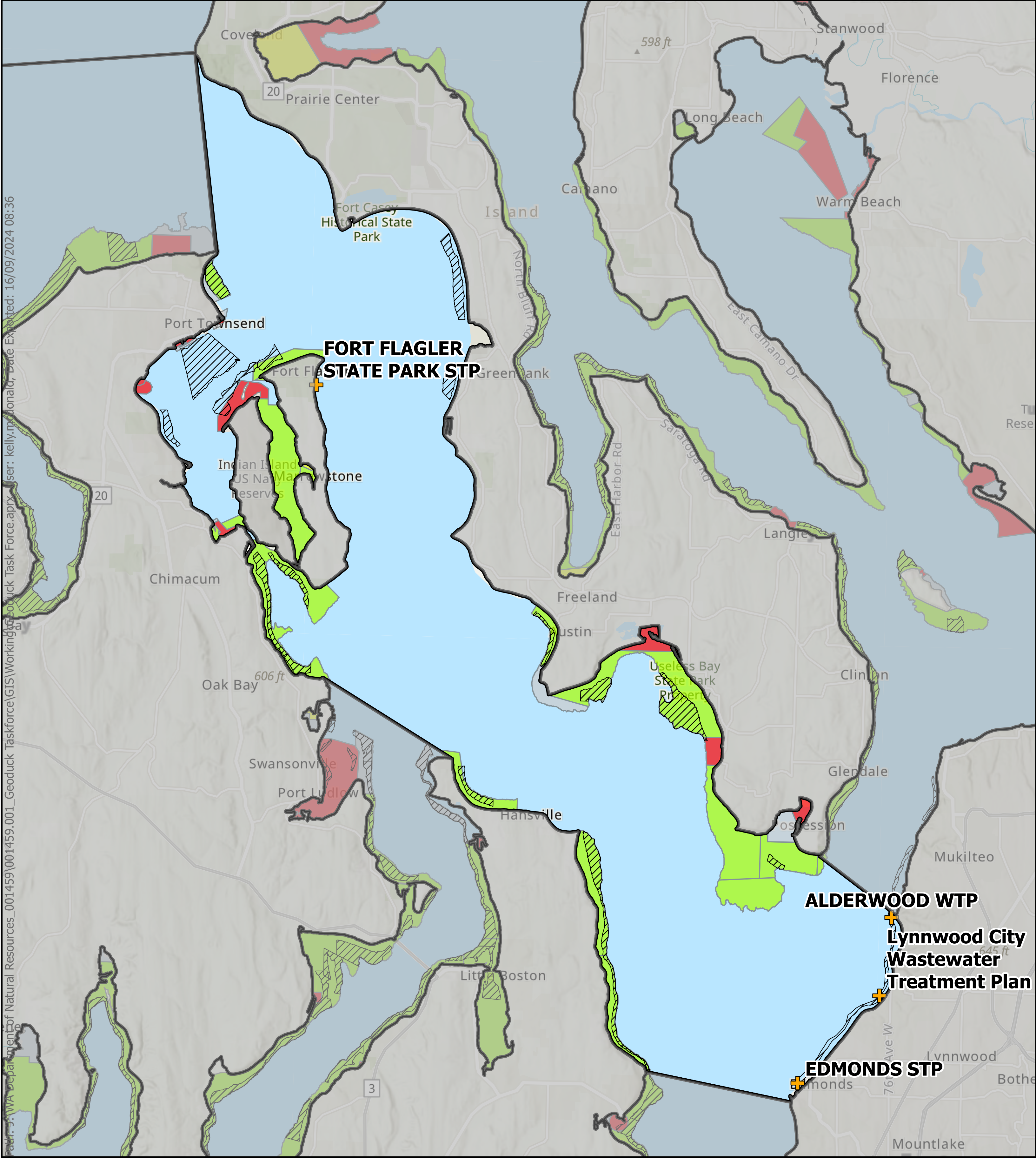
Management Region: Hood Canal

Sheet 1 of 7

N

0 1 2 3 4 5 Miles

CONFLUENCE ENVIRONMENTAL COMPANY



Geoduck tract

Geoduck Management Region

WWTP Outfall

Growing Area Classification

Approved

Conditional

Prohibited

Restricted

Unclassified

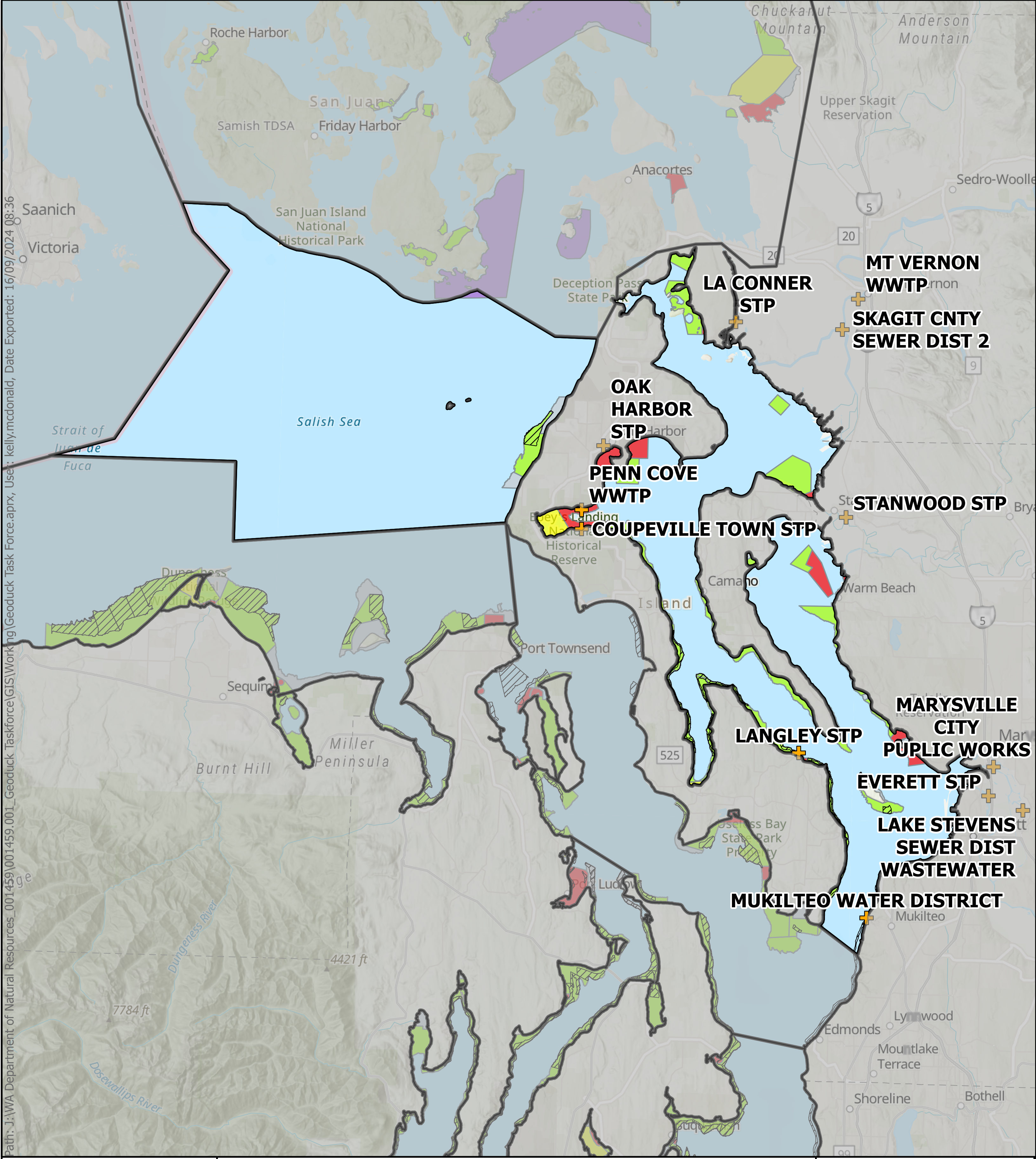
Management Region:
North Central

Sheet 2 of 7

N

0 1 2 3
Miles

CONFLUENCE
ENVIRONMENTAL COMPANY



Geoduck tract

Geoduck Management Region

WWTP Outfall

Growing Area Classification

- Approved
- Conditional
- Prohibited
- Restricted
- Unclassified

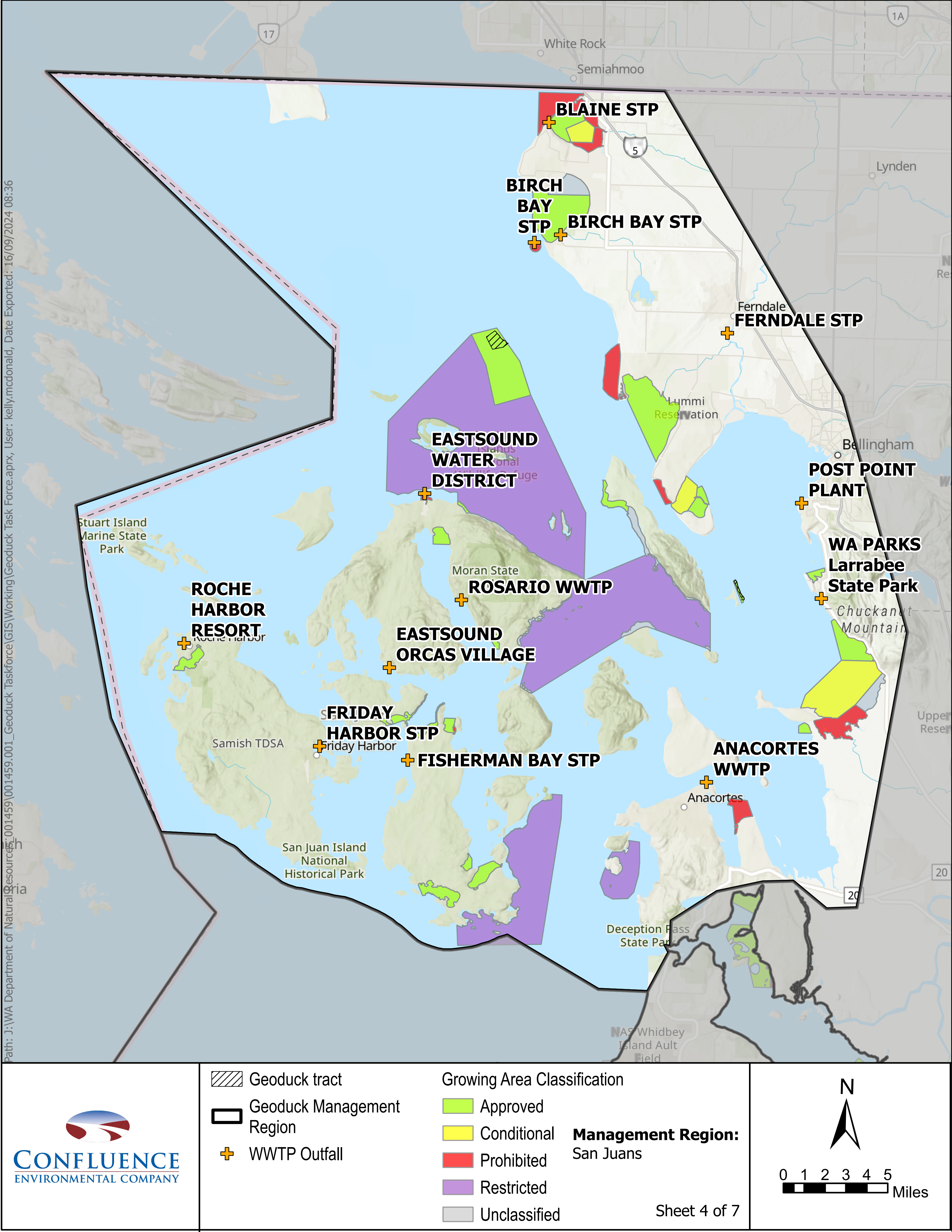
Management Region: North Puget Sound

Sheet 3 of 7

N

0 1 2 3 4 5 6 7 Miles

CONFLUENCE ENVIRONMENTAL COMPANY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BIRCH BAY STP
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FERNDALE STP
EASTSOUND WATER DISTRICT
POST POINT PLANT
WA PARKS Larrabee State Park
ROCHE HARBOR RESORT
ROSARIO WWTP
EASTSOUND ORCAS VILLAGE
FRIDAY HARBOR STP
FISHERMAN BAY STP
ANACORTES WWTP
White Rock
Semiahmoo
Lynden
Ferndale
Lummi Reservation
Bellingham
Stuart Island Marine State Park
Moran State
Chuckanut Mountain
Samish TDSA
Friday Harbor
Anacortes
San Juan Island National Historical Park
Deception Pass State Park
NAS Whidbey Island Ault Field
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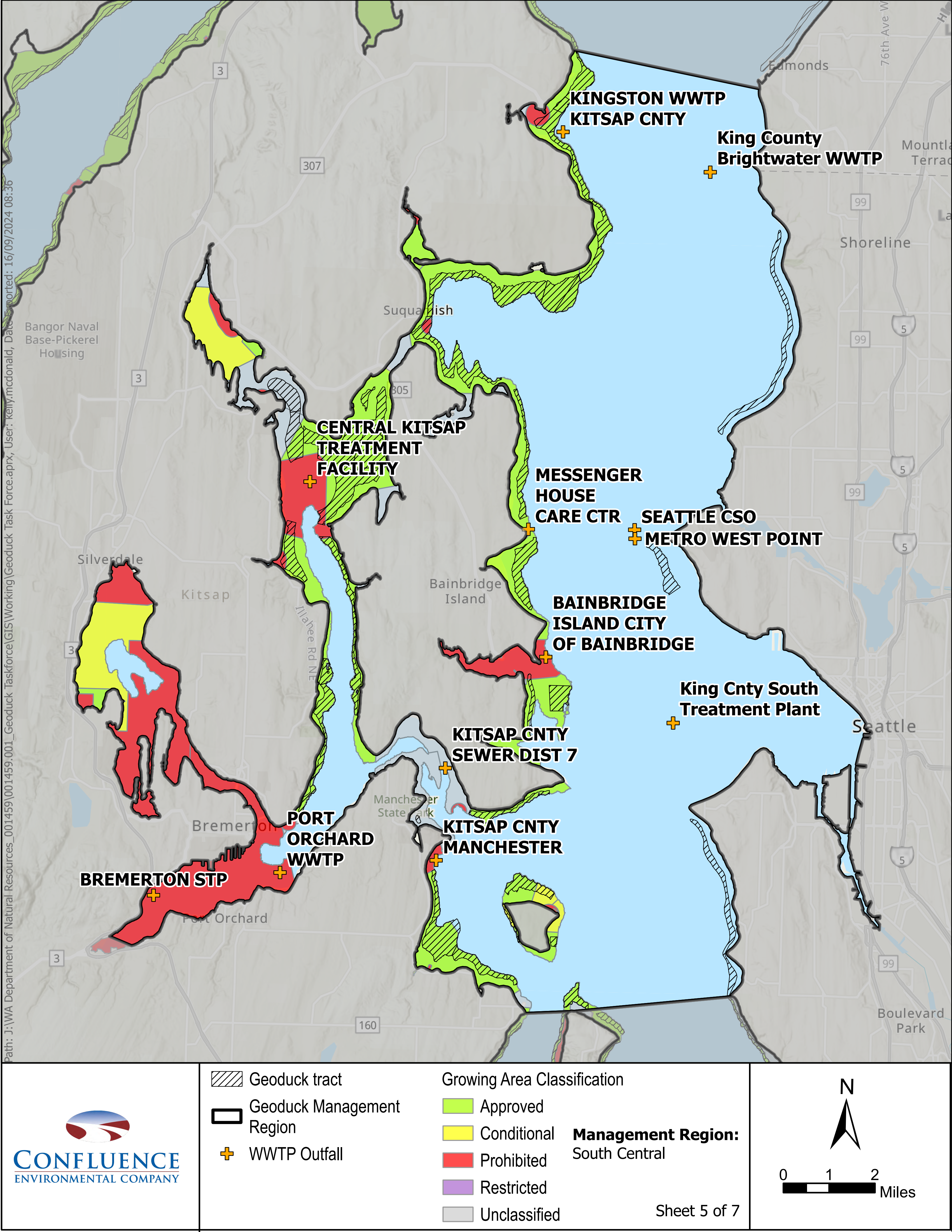
Geoduck tract
Geoduck Management Region
WWTP Outfall
Growing Area Classification
Approved
Conditional
Prohibited
Restricted
Unclassified
Management Region: San Juans
Sheet 4 of 7
N
0 1 2 3 4 5 Miles
CONFLUENCE ENVIRONMENTAL COMPANY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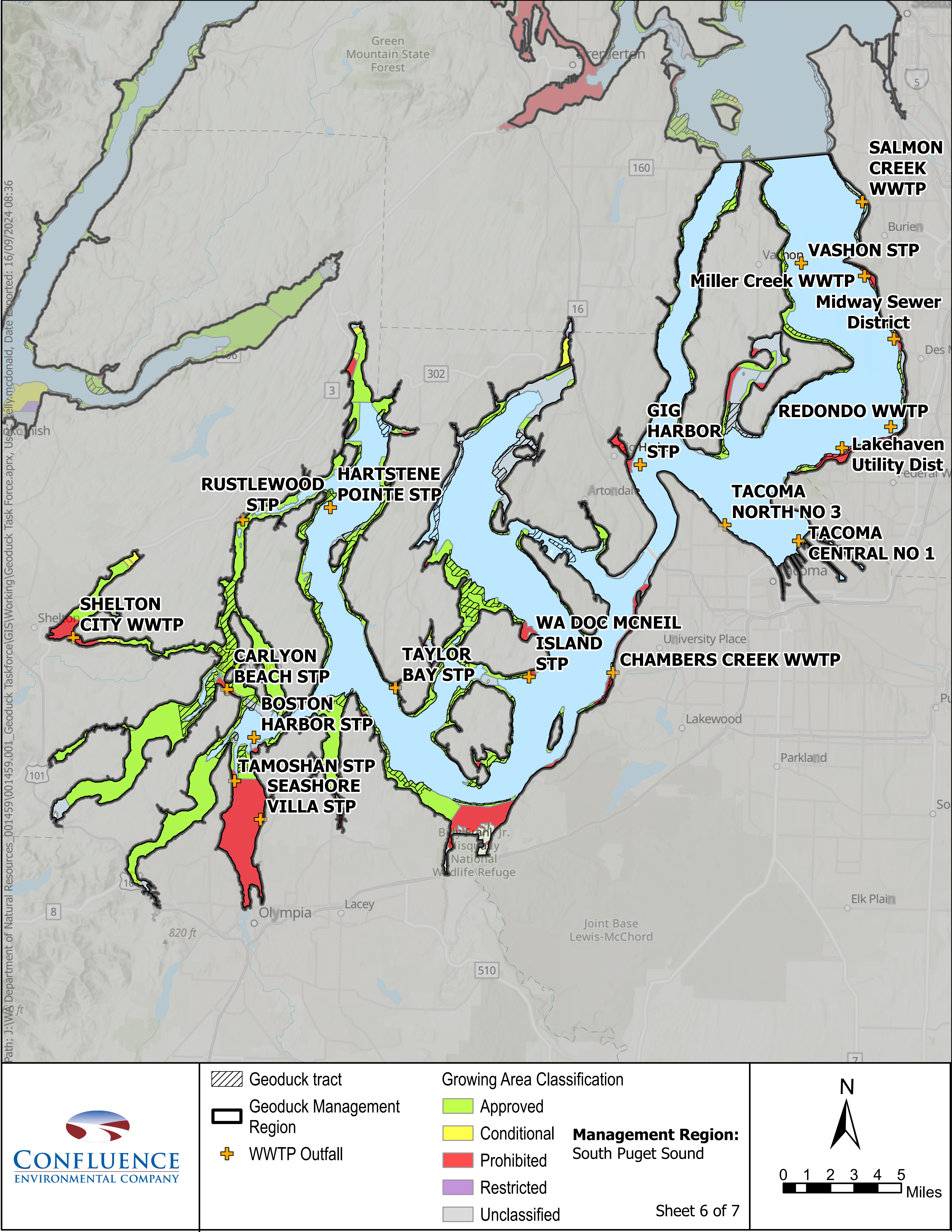
KITSAP CNTY
King County
Brightwater WWTP
Edmonds
Shoreline
Suquamish
Bangor Naval
Base-Pickerel
Housing
CENTRAL KITSAP
TREATMENT
FACILITY
MESSENGER
HOUSE
CARE CTR
SEATTLE CSO
METRO WEST POINT
Silverdale
Kitsap
Bainbridge
Island
Illahee Rd NE
BAINBRIDGE
ISLAND CITY
OF BAINBRIDGE
King Cnty South
Treatment Plant
Seattle
KITSAP CNTY
SEWER DIST 7
Manchester
State Park
PORT
ORCHARD
WWTP
Bremerton
KITSAP CNTY
MANCHESTER
BREMERTON STP
Port Orchard
Boulevard
Park
Geoduck tract
Geoduck Management
Region
WWTP Outfall
Growing Area Classification
Approved
Conditional
Prohibited
Restricted
Unclassified
Management Region:
South Central
Sheet 5 of 7
N
0
1
2
Miles
CONFLUENCE
ENVIRONMENTAL COMPANY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VASHON STP
Miller Creek WWTP
Midway Sewer District
GIG HARBOR STP
REDONDO WWTP
Lakehaven Utility Dist
TACOMA NORTH NO 3
TACOMA CENTRAL NO 1
RUSTLEWOOD STP
HARTSTENE POINTE STP
SHELTON CITY WWTP
CARLYON BEACH STP
BOSTON HARBOR STP
TAMOSHAN STP
SEASHORE VILLA STP
TAYLOR BAY STP
WA DOC MCNEIL ISLAND STP
CHAMBERS CREEK WWTP
Green Mountain State Forest
Bremerton
Burien
Vashon
Des M
Artondale
University Place
Lakewood
Parkland
Elk Plain
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Lacey
Billy Frank Jr. Nisqually National Wildlife Refuge
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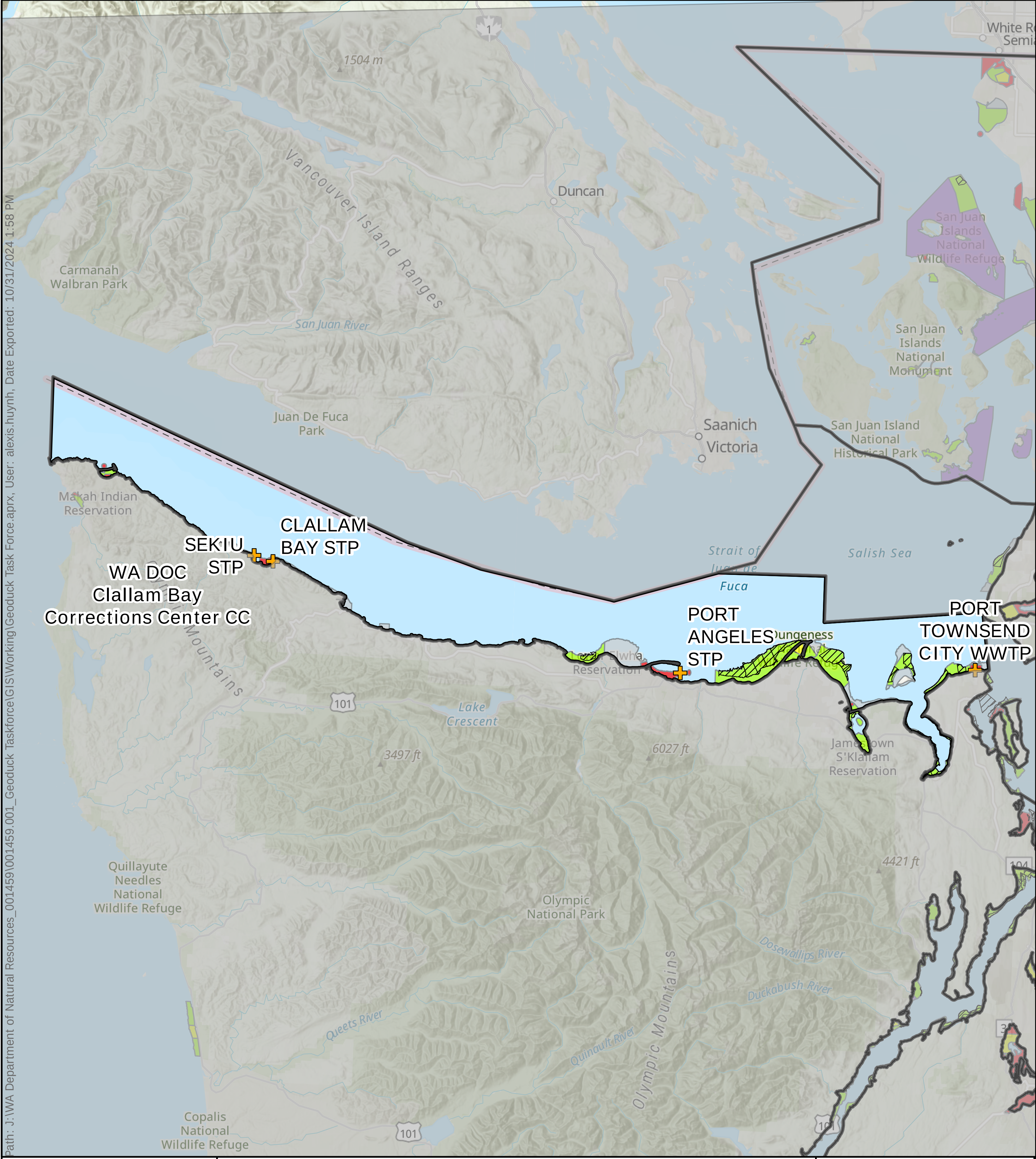
Geoduck tract
Geoduck Management Region
WWTP Outfall
Growing Area Classification
Approved
Conditional
Prohibited
Restricted
Unclassified
Management Region: South Puget Sound
Sheet 6 of 7
N
0 1 2 3 4 5 Miles
CONFLUENCE ENVIRONMENTAL COMPANY



Geoduck tract

Geoduck Management Region

WWTP Outfall

Growing Area Classification

Approved

Conditional

Prohibited

Restricted

Unclassified

Management Region: Strait

Sheet 7 of 7

0 2 4 6 8 10 12 Miles

CONFLUENCE ENVIRONMENTAL COMPANY

Appendix B

Compiled Information On Priority Unclassified Geoduck Tracts

Appendix B: Compiled information on priority unclassified geoduck tracts

Geoduck Tract Name	Geoduck Tract Number	Geoduck Management Region	Tract Acreage	Number of co-managers	Nearby pollution point sources	Ancillary benefits	Available survey information	Steps required for classification	Estimated timeline to classification	Notes
Port Townsend	4100	North Puget Sound	994.5	9			last surveyed in 2017	Shoreline survey, marine water sampling	5 years	
X-bed	4200	North Puget Sound	16	9	Potentially impacted by the Prohibited area around the Port Townsend Paper Company outfall		last surveyed in 2017	Shoreline survey, marine water sampling	5 years	
Kala point	4250	North Puget Sound	124.5	9			last surveyed in 2017, low density	Shoreline survey, marine water sampling	5 years	400K pounds harvested in 80's, negative recovery; removed from commercial biomass in 2019
Crane point	4300	North Puget Sound	65	9	Potentially impacted by the Naval Magazine Indian Island WWTP outfall; also nearby hazardous waste site		Post-harvest survey 1988	Reevaluation of the nearby hazardous waste site, evaluation of the Naval Magazine Indian Island WWTP, shoreline survey, marine water sampling	5 years	
Walan 1 & 2	4350	North Puget Sound	181.9	9	Portion of tract in the Prohibited area at the north end of Indian Island (prohibited due to seal haulouts on Rat Island and superfund site on Indian Island)		last surveyed in 2017	Reevaluation of the Prohibited area (including superfund site), potentially sampling shellfish for contaminants of concern, shoreline survey, marine water quality sampling	5 years	2.4 million pounds harvested during 70's and 80's, negative recovery; removed from commercial biomass in 2019
Kilisut 2	4400	North Puget Sound	67.4	9	Potentially impacted by Prohibited area conditions at Rat Island and superfund site on Indian Island		last surveyed in 2017, low density	Reevaluate Prohibited area conditions at Rat Island, marine water quality sampling	5 years	Removed from commercial biomass in 2019
Admiralty Bay	5000	Central Puget Sound	366.3	9			1970 DFW 6 transects, low density	Shoreline survey, marine water sampling	5 years	ROV exploration could provide helpful information
Richmond Beach	6100	Central Puget Sound	304.5	5	WWTPs and emergency overflow/outfalls between Seattle and Edmonds		High density, quality, and ease of digging based on 2015 aging sample collection	CSO improvements, reactivate marine water quality sampling, portion may remain closed due to West Point WWTP	Undetermined	Necessary CSO improvements identified through coordination between the Suquamish Tribe, DOH, and King County DNRP
Lagoon Point	5100	Central Puget Sound	139.3	9			1970 DFW 1 transect, low density	Shoreline survey, marine water sampling	5 years	ROV exploration could provide helpful information
Keyport North	6950	South Central Puget Sound	171.9	5	Keyport Naval Base		Low density	Shoreline survey, marine water sampling, sampling and analysis of shellfish tissue for the chemicals of concern	5 years	
West Point	8800	South Puget Sound	152.2	5	West Point WWTP		1970 DFW 8 transects moderate density.	Undetermined	Undetermined	ROV exploration could provide helpful information
Rosehilla	10250	South Puget Sound	381.9	5			2024 DFW survey, high density	Complete shoreline survey and marine water quality sampling (~16 of 30 samples collected)	3 years	
Weist Windmill	16950	South Puget Sound	62.1	5			2018 DFW	Addendum to the sanitary survey for the Eld Inlet Shellfish Growing Area	6 months	Recovering quickly from harvest. Next survey 2028
Big Hunter	16900	South Puget Sound	173.2	5		Overlap with DNR eelgrass and kelp restoration priorities	2016 DFW	Addendum to the sanitary survey for the Eld Inlet Shellfish Growing Area	6 months	Recovering quickly from harvest. Next survey 2026.
Foulweather	19650	Hood Canal	73.9	7			2019 NRC for PGS	Shoreline survey (scheduled 2025), complete marine water quality sampling (~4 of 30 samples collected)	4 years	

Appendix B: Compiled information on priority unclassified geoduck tracts

Geoduck Tract Name	Geoduck Tract Number	Geoduck Management Region	Tract Acreage	Number of co-managers	Nearby pollution point sources	Ancillary benefits	Available survey information	Steps required for classification	Estimated timeline to classification	Notes
Foulweather 1	19700	Hood Canal	54	7			2019 NRC for PGS	Shoreline survey (scheduled 2025), complete marine water quality sampling (~4 of 30 samples collected)	4 years	
Foulweather 2	19750	Hood Canal	12.2	7			2014 HC for PGS	Shoreline survey (scheduled 2025), complete marine water quality sampling (~4 of 30 samples collected)	4 years	
Foulweather Bluff	19550	Hood Canal	109.5	7			2014 HC for PGS	Shoreline survey (scheduled 2025), complete marine water quality sampling (~4 of 30 samples collected)	4 years	
Twin Spits	19600	Hood Canal	24.7	7			2019 NRC for PGS	Shoreline survey (scheduled 2025), complete marine water quality sampling (~4 of 30 samples collected)	4 years	
King Spit	21200	Hood Canal	31.5	7			2019 NRC for PGS, low density	Follow-up shoreline survey (majority of tract is Approved as part of the Hood Canal 2 Shellfish Growing Area)	2 years	Removed from management plan by comanager agreement
Snake Rock North	19000	Hood Canal	24.5	7			2019 NRC for PGS, low density	Shoreline survey, marine water sampling	5 years	Removed from management plan by comanager agreement
Colvos Rock East	19300	Hood Canal	128.1	7			Surveyed in 2019 by NRC for PGS tribe. Moderate density, in recovery.	Could be Conditionally Approved upon request. Sampling at historic marine water stations would be necessary	5 years	
Tala Point	19350	Hood Canal	84.4	7			Surveyed in 2019 by NRC for PGS tribe. Moderate density, in recovery.	Could be Conditionally Approved upon request. Sampling at historic marine water stations would be necessary	5 years	Last fished in July 1996
X-bed	150	Strait of Juan de Fuca	15	8		Overlap with DNR eelgrass and kelp restoration priorities		Shoreline survey, marine water sampling	5 years	
X-bed	200	Strait of Juan de Fuca	18	8		Overlap with DNR eelgrass and kelp restoration priorities		Shoreline survey, marine water sampling	5 years	
X-bed	250	Strait of Juan de Fuca	9	8		Overlap with DNR eelgrass and kelp restoration priorities		Shoreline survey, marine water sampling	5 years	
Travis Spit	900	Strait of Juan de Fuca	283	8			1971/76 DFW 20 transects, low density	Shoreline survey, marine water sampling	5 years	

RANKING METHOD MEMORANDUM

Prioritization of Wastewater Treatment Plant Outfalls Affecting Wild Stock Geoduck Harvest

Table of Contents

Tables

Appendices

Acronyms and Abbreviations

DNR	Washington Department of Natural Resources
DOH	Washington Department of Health
Ecology	Washington Department of Ecology
NSSP	National Shellfish Sanitation Program
RCW	Revised Code of Washington
Task Force	Geoduck Task Force
WWTP	Wastewater treatment plant

Summary

The Geoduck Task Force, led by the Washington Department of Natural Resources (DNR), was convened in January 2024 as required by the Washington State Legislature's enacted budget for fiscal years 23-25. The proviso language charged the Task Force with considering "opportunities to reduce negative impacts to tribal treaty and state geoduck harvest and promote long-term opportunities to expand or sustain geoduck harvest." In light of the effects of wastewater treatment plant (WWTP) outfalls and point sources of pollution on geoduck resources, the proviso specifically calls for an inventory of WWTPs affecting geoduck resources and a ranking of facilities for future correction. This memorandum describes and presents the method used for prioritizing the WWTPs considered, as well as the final ranked list of facilities.

Through coordination with Task Force and working group members, a list of 12 priority geoduck tracts affected by 8 WWTPs was consolidated. These tracts are in proximity to a WWTP outfall and are in locations that the Washington Department of Health (DOH) has classified as Prohibited. In Washington State, DOH evaluates and classifies shellfish growing areas as the designated authority responsible for implementing the U.S. Food and Drug Administration National Shellfish Sanitation Program, Guide for the Control of Molluscan Shellfish. This regulation requires identification of a Prohibited area around WWTP outfalls where shellfish harvesting is not allowed. Additional information on the regulatory authorities and authorization process for WWTPs is available in the technical memorandum developed for the Task Force (*citation to be added once finalized*). Based on the current extent of Prohibited areas in Puget Sound, this document considers possible options for reducing the size of Prohibited areas to expand opportunities for geoduck harvest and prioritizes specific WWTPs for future action.

In 2022, DOH published a Wastewater Treatment Plant Outfall Strategy report that outlines actions that could result in a classification upgrade based on plant or outfall improvement or a reduction in emergency closures. The suite of actions presented is a good starting place when considering options to reduce the effects of a WWTP outfall on geoduck harvest.

To prioritize geoduck tracts and WWTPs, a set of criteria were first established that sought to capture the potential value of the geoduck resource and the likelihood of actions resulting in a classification upgrade. The data for these criteria were obtained from publicly available sources or through coordination with Task Force and subgroup members and agencies, including DOH, the Washington Department of Ecology, the Washington Department of Fish and Wildlife, and DNR. The final set of criteria were:

- Acreage Potential,
- Necessary Remedies,
- Number of Co-Managers,
- Reasons for Closure,
- Ancillary Benefits,
- Tract Value, and
- Remedies to increase geoduck harvest currently planned.

For each geoduck tract and WWTP, these criteria were scored based on data available to create a final ranked list. The prioritization method ranked highly those locations where necessary remedies are currently planned or underway (i.e., Taylor Bay WWTP and Redondo WWTP) and those locations with outdated surveys considered to have high densities of geoduck (e.g., Steilacoom, Three Tree Point, and Dumas Bay geoduck tracts). Based on background information and context, specific recommendations are presented for the locations that ranked high on the list.

1.0 Introduction

This document has been developed as part of the Geoduck Task Force (Task Force) led by the Washington Department of Natural Resources (DNR), convened in January 2024, to fulfill the requirements of the language from the Washington State Legislature's enacted budget for fiscal years 23-25 (the proviso):

> "*The task force must investigate opportunities to reduce negative impacts to tribal treaty and state geoduck harvest and promote long-term opportunities to expand or sustain geoduck harvest. The task force must provide a report to the commissioner of public lands and the legislature, in compliance with RCW 43.01.036, by December 1, 2024, that includes analysis and recommendations related to the following elements:*
>
> *(i) The feasibility of intervention to enhance the wild stock of geoduck, including reseeding projects;*
>
> *(ii) Factors that are preventing areas from being classified for commercial harvest of wild stock geoduck or factors that are leading to existing wild stock geoduck commercial tract classification downgrade, and recommendations to sustainably and cost-effectively increase the number and area of harvestable tracts, including:*
>
> *(A) Consideration of opportunities and recommendations presented in previous studies and reports;*
>
> *(B) An inventory of wastewater treatment plant and surface water runoff point sources impacting state and tribal geoduck harvesting opportunities within the classified commercial shellfish growing areas in Puget Sound;*
>
> *(C) A ranking of outfalls and point sources identified in (b)(ii)(B) of this subsection prioritized for future correction to mitigate downgraded classification of areas with commercial geoduck harvest opportunity;*
>
> *(D) An inventory of wild stock geoduck tracts that are most impacted by poor water quality or other factors impacting classification;*
>
> *(E) Consideration of the role of sediment load and urban runoff, and pathways to mitigate these impacts; and*
>
> *(F) Recommendations for future actions to improve the harvest quantity of wild stock geoduck and to prioritize areas that can attain improved classification most readily, while considering the influence of outfalls ranked pursuant to (b)(ii)(C) of this subsection."*

The information in this document specifically addresses (b)(ii)(C) of the proviso language above. The scope of the locations considered through the prioritization framework described here was accordingly limited to areas affected by wastewater treatment plant (WWTP) outfalls and point sources. Consistent with (b)(ii)(F), this document also includes recommendations specific to locations affected by WWTP outfalls. A broader suite of recommendations is included in Section 5.0 of the technical memorandum (*citation to be added once finalized*) produced as part of the Task Force effort. The organization of this document is as follows:

- Section 2.0: Review of options and drivers for addressing the impacts of WWTP outfalls and other point sources of pollution on geoduck tracts,
- Section 3.0: A description of the prioritization method and framework,
- Section 4.0: Ranking and recommendations based on the application of the prioritization framework,

2.0 Review of Options and Drivers

The Washington Department of Health (DOH) is the designated authority responsible for implementing the U.S. Food and Drug Administration National Shellfish Sanitation Program (NSSP), Guide for the Control of Molluscan Shellfish (also referred to as the NSSP Model Ordinance) within Washington. The NSSP Model Ordinance requires identification of a Prohibited area around WWTP outfalls where shellfish harvesting is not allowed. In some locations, these Prohibited areas affect the availability of geoduck resources for harvest.

DOH developed the Wastewater Treatment Plant Outfall Strategy in 2022 to define a suite of actions and activities that, if implemented, could result in an upgrade to the classification of Prohibited shellfish growing areas around an outfall or reduction of emergency closures to increase opportunity to harvest shellfish. The document discusses strategies for improvement and identifies a set of actions for two possible paths: 1) classification upgrade based on plant or outfall improvement, and 2) emergency closure reduction. Actions described in the outfall strategy document are summarized below:

- Classification upgrade based on plant or outfall improvement
  - **Treatment improvement**: Reducing bacterial load of effluent stream after secondary treatment but before disinfection.
  - **Flow reduction**: Opportunities to reduce flow may lead to a reduced bacterial load, which could result in a smaller closure area or a classification change.
  - **Outfall extension/removal/dispersal**: Eliminating, extending, or changing effluent distribution by removal or extension of an outfall to decrease size of Prohibited area.
- Emergency closure reduction and opportunity to harvest
  - **Enhanced educational opportunities and retention for WWTP operators**: Understanding process of staffing and training of site staff to improve maintenance, management, and operation of the facility.
  - **Improved reliability of treatment and disinfection**: Reducing the need for emergency closures through redundant treatment and disinfection.
  - **Reduction of inflow and infiltration**: Reducing excess groundwater and surface water entering the system through leaks and cross connections to improve effectiveness of disinfection.
  - **Testing for viral indicators**: Utilizing male-specific coliphage testing to assess impact of sewage spill on shellfish species and reduce closure period.
  - **Conditionally Approved classification**: Improving effluent time of travel supported by adequate notification, dye/drogue studies, or modeling.

Section 4.1 of the technical memorandum developed by the Task Force describes the regulatory authorities and authorization process for WWTP outfalls (*citation to be added once finalized*). The Washington Department of Ecology (Ecology), DNR, and DOH all have roles in the process. It should be noted that the presence of a Prohibited area around an outfall is not an indication of insufficient treatment or monitoring at a WWTP. WWTPs that meet all permit conditions will still have a Prohibited shellfish growing area around the outfall. The suite of actions detailed above represent options and pathways to potentially upgrade or partially upgrade the shellfish growing classification surrounding an outfall.

3.0 Prioritization Method and Criteria

Available information from DOH, Ecology, DNR, and task force members was consolidated and reviewed to create a list of priority geoduck tracts affected by WWTP outfalls and point source pollution (Table 1). These tracts all have a portion of the total acreage closed for harvest due to a Prohibited area, as classified by DOH.

Table 1. Priority geoduck tracts within Prohibited areas affected by point source pollution

Geoduck Tract(s)	Facility	Outfall Location	DOH Growing Area	Reason for DOH Prohibited Area
South Central Sound Management Region				
Brownsville (07200), Battle Point North (07050), Keyport (06910)	Central Kitsap WWTP	47.6766° N, 122.6013° W	Port Orchard Passage	WWTP Outfall
Hood Canal Management Region				
Snake Rock (19100), Port Ludlow (19150), Colvos Rock (19200)	Port Ludlow WWTP	47.9361° N, 122.6756° W	Hood Canal #1	WWTP Outfall, Marina / Boating
South Puget Sound Management Region				
Three Tree Point (09800)	Miller Creek WWTP	47.4417° N, 122.3644° W	Three Tree Point	WWTP Outfall
Normandy Park (09850)	Des Moines Creek WWTP	47.4033° N, 122.3367° W	Poverty Bay	WWTP Outfall, Marina / Boating
Redondo (10380)	Redondo WWTP	47.34941° N, 122.3380° W	Poverty Bay	The classification change is based on the unpredictable impact from the Redondo WWTP.
Dumas Bay (10400)	Lakehaven Utility District	47.3358° N, 122.3817° W	Poverty Bay	WWTP Outfall
Steilacoom (10750)	Chambers Creek WWTP	47.1949° N, 122.5839° W	Ketron Island	WWTP Outfall
Taylor Bay (14300)	Taylor Bay WWTP	47.1823° N, 122.7795° W	West Key Peninsula	WWTP Outfall

The geoduck tracts were identified and discussed with Task Force subgroup members to confirm the potential for geoduck resources on the tract as well as interest in future access for harvest. The tracts were mapped in GIS and the area (acres) closed by harvest restrictions due to water quality (i.e., Prohibited area) was calculated.

In order to differentiate between and to prioritize identified tracts, a series of criteria were developed and evaluated. An initial list of criteria was reviewed, and applicable data were collected. These criteria and available information were presented to the subgroup for comment and refinement and a finalized list of criteria were chosen (Table 2).

Table 2. Prioritization criteria and scoring framework summary

Prioritization Criteria	Description	Data used	Scoring
Acreage potential	Tract acreage that may be opened through efforts to improve water quality. If an individual WWTP affects multiple tracts, tract areas are summed.	GIS overlay between DOH Prohibited areas and tract	3 points: acres > 70 2 points: acres between 40 and 70 1 point: acres < 40
Necessary remedies	Considers the technical feasibility and identification of remedies at the relevant WWTP	Tract and WWTP details from DOH and Ecology	2 points: remedy is known and feasibility either known or under investigation 1 point: technical feasibility of potential remedies is unknown and needs further investigation
Number of co-managers	Number of co-managers that would have access to the tract	Geoduck management plans	2 points: ≥3 co-managers 1 point: 2 co-managers
Reasons for closure	Considers whether the DOH Prohibited area is based on a WWTP outfall alone or not	DOH Shellfish Growing Area Classification layer	2 points: WWTP outfall only 1 point: WWTP outfall and other reason
Ancillary benefits	Other benefits associated with water quality improvements in the location	Information provided by agencies and co-managers	2 points: ancillary benefits identified 1 point: no ancillary benefits identified
Tract value	Considers the recent survey, likely density, and if the tract is in recovery	Information provided by Washington Department of Fish and Wildlife, DNR, and co-managers	3 points: high density and recent survey 2 points: high density based on outdated survey 1 point: recent exploratory or other information 0 points: known low density or no data
Remedies to increase geoduck harvest currently planned	Work underway at the treatment plant that may benefit geoduck harvest	Information provided by DOH and Ecology	2 points: work planned or underway 1 point: no work planned

For criteria with data available, the data were reviewed and scored relative to the dataset, with a higher score indicating higher potential for future correction to mitigate downgraded classification of areas with commercial geoduck harvest opportunity. In several cases, the available data for a given criterion were limited or incomplete. For example, the "necessary remedies and cost" (i.e., the likely actions required to correct the cause of the closure for a given outfall and associated dollar value) was not available for many locations. In order for a feasible solution and reasonably accurate cost estimate to be obtained, several steps would need to occur, including feasibility studies, to determine the range of possible solutions.

In instances where the data for a given criterion was not available or only partially available, the scoring criteria were adjusted to reflect the information that was available. In the previous example of "necessary remedies and cost", the highest score was given if the necessary remedy was known, and a lower score was given if the remedy and cost could only be estimated or needed further work (refer to Table 2).

The resulting criteria and ranking outcomes are being presented to the subgroup and task force for finalization and include the following:

- **Acreage Potential.** This criterion represents the amount of acreage within an existing geoduck tract that could potentially become available for commercial harvest if necessary remedies (e.g., relocation, extension, treatment modification, etc.) to the outfall were completed. This acreage was determined by using GIS layers and calculating the overlap between DOH shellfish harvest Prohibited areas and existing geoduck tracts affected by the closure. If an individual WWTP is affecting multiple geoduck tracts, the acreage across those tracts is considered in total for scoring. Note that some geoduck tracts may be truncated due to the presence of the DOH Prohibited area, potentially underestimating the effect of the closure area on geoduck resources.

- **Necessary Remedies.** This criterion identifies the improvements to the outfall or treatment system needed to allow the affected geoduck tracts to be approved for commercial harvest. This could include improvements such as outfall extensions to deeper water, outfall relocation, improvements to the treatment process, or other solutions addressing water quality related to shellfish harvest closure. Available information was obtained through discussions with DOH and Ecology about known issues and solutions for each identified outfall. Based on available information, WWTPs were scored according to the following categories: 1) remedy is known and likely to be completed in 5-10 years and 2) technical feasibility is unknown and needs further investigation.

- **Local Support**. This criterion identifies whether improvements or necessary remedies have local support. Interested parties could include local WWTP owners, local communities, local jurisdictions, state and federal agencies, and tribal entities. Support from these groups and organizations could indicate the likelihood of funding availability, increasing the probability of remedy completion. Meaningful data and information for this criterion was not available; the criterion is therefore not included as part of the prioritization framework.

- **Number of Co-Managers**. This criterion identifies the number of geoduck resource co-managers that would benefit from successful improvements to the identified outfall. Co-managers include the State of Washington and tribes.
- **Reasons for Closure**. This criterion identifies the reason(s) a given area is closed for commercial harvest of shellfish. In some cases, there are multiple issues beyond the identified WWTP outfall. These closure reasons may include other sources of potential contamination such as a marina or a combined sewer overflow.
- **Ancillary Benefits**. This criterion is intended to identify if improvements required for commercial shellfish harvesting would also result in benefits to other resources or entities. For example, water quality improvements near an outfall may also improve water quality near eelgrass or kelp recovery projects.
- **Tract Value**. This criterion identifies what is known about the geoduck resource within the area of potential improvement. This includes information about geoduck density, recency of survey information, and tract status related to previous harvest.
- **Remedies to increase geoduck harvest currently planned**. This criterion identifies if there are efforts underway seeking to address the commercial shellfish harvest closure.

4.0 Recommendations

Based on the information gathered and scoring outlined in Table 2, the 8 WWTP facilities under consideration (affecting 12 geoduck tracts) can be prioritized according to the list in Table 3. While the criteria presented above are specific to geoduck tracts, the prioritized list below is by WWTP facility, as actions at a WWTP facility would likely improve conditions for all nearby geoduck tracts. The data underlying the prioritization, and associated scores are available in Appendix A. The facilities highlighted in this list represent locations where WWTP outfalls affect high value geoduck resources, where potential remedies are known, and where the primary reason for the closure is the WWTP.

Table 3. Prioritized list of WWTP outfalls and affected geoduck tracts

Priority	Facility	Geoduck Tract(s)
1	Taylor Bay WWTP	Taylor Bay (14300)
	Redondo WWTP	Redondo (10380)
	Chambers Creek WWTP	Steilacoom (10750)
2	Lakota WWTP	Dumas Bay (10400)
3	Miller Creek WWTP	Three Tree Point (09800)
	Central Kitsap WWTP	Brownsville (07200), Battle Point North (07050), Keyport (06910)*
	Port Ludlow WWTP	Snake Rock (19100), Port Ludlow (19150), Colvos Rock (19200)**
4	Des Moines Creek WWTP	Normandy Park (09850)

* Recent surveys suggest that these tracts do not contain commercial densities of biomass.

** These tracts are in proximity to a marina and actions at the WWTP intended to expand harvest opportunities may not result in an upgrade of classification.

Limitations in the available data suggest that further work is needed to identify viable remedies for outfalls and tracts considered in this preliminary assessment. Recommendations for further work include:

- Work with stakeholders to continue to address the treatment reliability and hydraulic overloading issues at the Redondo Beach WWTP. DOH has funded an alternatives analysis for shellfish-related improvements, and Ecology has issued an administrative order and timeline for corrective action relating to hydraulic capacity.

- Provide funding and support for surveys at the Steilacoom, Three Tree Point, and Dumas Bay tracts to better understand the current geoduck density. Surveys conducted in the 1970s suggest there is a high density of geoducks in these locations.

- Fund voluntary feasibility studies at the Chambers Creek, Lakota, and Miller Creek WWTPs to identify possible options to reduce the size of the Prohibited areas around their outfalls.

- Engage with Tribes, state and federal agencies, and stakeholders to understand the level of support for actions at individual WWTPs to consider local support in the context of feasibility.

Appendix A
Prioritization Data and Scores

Geoduck Tract Name	Geoduck Tract Number	WWTP Facility	Outfall Latitude	Outfall Longitude	DOH Growing Area	Reason for DOH Prohibited Area	Geoduck Management Region	Size of WWTP (approved Max Monthly Average Design Flow (MGD))	Tract Acreage	Acreage of affected area	Percentage affected	Number of co-managers	Reasons for closure	Ancillary benefits	Last Survey Year	In recovery?	Survey Notes	Necessary improvements to reduce closure area	Other water quality issues limited opening	Work underway or planned at WWTP
Normandy Park	9850	Des Moines Creek WWTP	47.4033	-122.3367	Poverty Bay	WWTP Outfall, Marina/boating	South Puget Sound	9	76.6	6.6	9%	2	WWTP Outfall and marina/boating	N/A	2016	No	Currently scheduled for harvest	Implementation of activities defined in the WDOH Outfall Strategy may reduce the Prohibited area. Hydrographic studies or current analysis aimed at defining “time of travel” could result in a portion of the area classified as Conditionally Approved.	Marina/boating – A marina is in the Prohibited area boundaries. The marina and WWTP closure zones almost completely overlap. It is unlikely that much acreage could be upgraded.	Midway is currently reconstructing two primary clarifiers. New UV disinfection system installation will occur early 2025.
Snake Rock	19100	Port Ludlow WWTP	47.9361	-122.6756	Hood Canal #1	WWTP Outfall, Marina/boating	Hood Canal	0.64	23.3	23.3	100%	7	WWTP Outfall and marina/boating	N/A	2017			Implementation of activities defined in the WDOH Outfall Strategy may reduce the Prohibited area. Hydrographic studies or current analysis aimed at defining “time of travel” could result in additional portions of this area classified as Conditionally Approved. Classification changes would require new marine water stations and a shoreline survey.	Marina/boating – A marina is in the southern end of Port Ludlow. The overall impact from this marina would need to be defined; however, the associated Prohibited area would probably not impact Geoduck Tract 19500.	No active planning or construction at this time.
Port Ludlow	19150	Port Ludlow WWTP	47.9361	-122.6756	Hood Canal #1	WWTP Outfall, Marina/boating	Hood Canal	0.64	49.9	49.9	100%	7	WWTP Outfall and marina/boating	N/A	2017			Implementation of activities defined in the WDOH Outfall Strategy may reduce the Prohibited area. Hydrographic studies or current analysis aimed at defining “time of travel” could result in additional portions of this area classified as Conditionally Approved. Classification changes would require new marine water stations and a shoreline survey.	Marina/boating – A marina is in the southern end of Port Ludlow. The overall impact from this marina would need to be defined; however, the associated Prohibited area would probably not impact Geoduck Tract 19500.	No active planning or construction at this time.
Colvos Rocks	19200	Port Ludlow WWTP	47.9361	-122.6756	Hood Canal #1	WWTP Outfall, Marina/boating	Hood Canal	0.64	37.5	37.5	100%	7	WWTP Outfall and marina/boating	N/A	1986		Removed; DOH prohibited	Implementation of activities defined in the WDOH Outfall Strategy may reduce the Prohibited area. Hydrographic studies or current analysis aimed at defining “time of travel” could result in additional portions of this area classified as Conditionally Approved. Classification changes would require new marine water stations and a shoreline survey.	Marina/boating – A marina is in the southern end of Port Ludlow. The overall impact from this marina would need to be defined; however, the associated Prohibited area would probably not impact Geoduck Tract 19500.	No active planning or construction at this time.
Brownsville	7200	Central Kitsap WWTP	47.6766	-122.6013	Port Orchard Passage	WWTP Outfall	South Central Sound	6	201.1	34	17%	5	WWTP Outfall	N/A	1980		Low density; 2014 exploratory dive suggests no geoduck	Implementation of activities defined in the WDOH Outfall Strategy may reduce the Prohibited area. Hydrographic studies or current analysis aimed at defining “time of travel” could result in a portion of the area classified as Conditionally Approved.		Central Kitsap is planning for a digester project. Construction to begin 2025.
Battle Point North	7050	Central Kitsap WWTP	47.6766	-122.6013	Port Orchard Passage	WWTP Outfall	South Central Sound	6	414.6	30.4	7%	5	WWTP Outfall	N/A	2021		Low density; removed by comanager agreement	Implementation of activities defined in the WDOH Outfall Strategy may reduce the Prohibited area. Hydrographic studies or current analysis aimed at defining “time of travel” could result in a portion of the area classified as Conditionally Approved.		Central Kitsap is planning for a digester project. Construction to begin 2025.
Keyport	6910	Central Kitsap WWTP	47.6766	-122.6013	Port Orchard Passage	WWTP Outfall	South Central Sound	6	209	7.4	4%	5	WWTP Outfall	N/A	1994		Likely low density	Implementation of activities defined in the WDOH Outfall Strategy may reduce the Prohibited area. Hydrographic studies or current analysis aimed at defining “time of travel” could result in a portion of the area classified as Conditionally Approved.		Central Kitsap is planning for a digester project. Construction to begin 2025.

Geoduck Tract Name	Geoduck Tract Number	WWTP Facility	Outfall Latitude	Outfall Longitude	DOH Growing Area	Reason for DOH Prohibited Area	Geoduck Management Region	Size of WWTP (approved Max Monthly Average Design Flow (MGD))	Tract Acreage	Acreage of affected area	Percentage affected	Number of co-managers	Reasons for closure	Ancillary benefits	Last Survey Year	In recovery?	Survey Notes	Necessary improvements to reduce closure area	Other water quality issues limited opening	Work underway or planned at WWTP
Redondo	10380	Redondo WWTP	47.3494	-122.338	Poverty Bay	The classification change is based on the unpredictable impact from the Redondo Wastewater Treatment Plant	South Puget Sound	5.6	131.5	45.9	35%	2	WWTP Outfall	Upgrades would support permit and administrative order compliance	2016	Yes		Reduce hydraulic overloading that results in WWTP overflows	Successful efforts to correct issues at the WWTP would result in the elimination of the Prohibited classification. The area would remain Conditionally Approved based on nonpoint pollution impacts during portions of the year.	WDOH has funded an alternatives analysis that may result in a capital project to reduce the hydraulic overload. WDOE has issued an administrative order and timelines for correction. Actively working on I/I reduction in the collection system to address hydraulic issues in the plant. Also currently replacing biotower media and siding (active construction this and next year). Primary clarifier rehab is underway to improve access and function. In planning stages for a variety of other rehabilitation projects at the facility.
Three Tree Point	9800	Miller Creek WWTP	47.4417	-122.3644	Three Tree Point	WWTP Outfall	South Puget Sound	7.1	70.3	64.7	92%	2	WWTP Outfall	N/A	1970s		Surveys suggest high density	Implementation of activities defined in the WDOH Outfall Strategy may reduce the Prohibited area. Hydrographic studies or current analysis aimed at defining "time of travel" could result in a portion of the area classified as Conditionally Approved.		There is active construction happening on lift station LS-11 to increase capacity. LS-4 capacity work is planned for 2025. Currently in construction on electrical upgrades at the WWTP. I/I reduction activities are ongoing. Planned upgrades to digester in 2026. Laboratory improvements planned for 2028. (Per the 2023 GSP, this near-term work is estimated to cost $31M.) Early estimates for upgrading the Miller Creek RBC plant to an Integrated Fixed Film Activated Sludge process in support of nutrient removal has been estimated at $66M.
Dumas Bay	10400	Lakota WWTP	47.3358	-122.3817	Poverty Bay	WWTP Outfall	South Puget Sound	10	128.9	118.4	92%	2	WWTP Outfall	N/A	1970s		Surveys suggest high density	Implementation of activities defined in the WDOH Outfall Strategy may reduce the Prohibited area. Hydrographic studies or current analysis aimed at defining "time of travel" could result in a portion of the area classified as Conditionally Approved.		WDOH has funded an alternatives analysis primarily at the Redondo WWTP. One alternative is to transfer some flow from Redondo to Lakota, increasing the effluent stream at the Lakota facility. In design phase for solids project. Rehabilition of flow controls is underway throughout the plant.
Steilacoom	10750	Chambers Creek WWTP	47.1949	-122.5839	Ketron Island	WWTP Outfall	South Puget Sound	45.3	121.6	63.9	53%	3	WWTP Outfall	Overlap with DNR priority geographies for Watershed Resilience Program, State Kelp and Eelgrass Plan. Potential to bring additional resources and attention to mitigative impacts of WWTP.	1971		May be high density; Tract partially within 200 yards of shoreline	Implementation of activities defined in the WDOH Outfall Strategy may reduce the Prohibited area. Hydrographic studies or current analysis aimed at defining "time of travel" could result in a portion of the area classified as Conditionally Approved. Dye study to identify closure performed in 2012		No active planning or construction at this time. However there is an informal nutrient removal pilot study underway (not construction, multiyear study).
Taylor Bay	14300	Taylor Bay WWTP	47.1823	-122.7795	West Key Peninsula	WWTP Outfall	South Puget Sound	0.029	35.7	19	53%	2	WWTP Outfall	Overlap with DNR Priority geography for State Kelp and Eelgrass Program, possibility to get additional resources.			High density; location of a long-standing index station/show plot	Outfall extension and WWTP upgrades		WDOH has funded feasibility and permitting activities aimed at extending the outfall and upgrading the WWTP. Capital improvement and ongoing modeling is necessary to remove all or a portion of the Prohibited area. Currently planning for upgrade to MBR process. I/I reduction projects are currently underway.

WWTP Facility	Outfall Latitude	Outfall Longitude	Geoduck Tract Name	Geoduck Tract Number	DOH Growing Area	Reason for DOH Prohibited Area	Geoduck Management Region	Tract Acreage	Acreage affected by WWTP	Tract Acreage Score	Necessary remedies and cost	Necessary remedies and cost score	Number of co-managers	Number of co-managers score	Reasons for closure	Reasons for closure score	Ancillary benefits	Ancillary benefits score	Tract value	Tract value score	Remedies currently underway	Remedies currently underway score	TOTAL
Taylor Bay WWTP	47.1823	-122.7795	Taylor Bay	14300	West Key Peninsula	WWTP Outfall	South Puget Sound	35.7	19	1	known	2	2	1	WWTP Outfall	2	Overlap with DNR Priority geography for State Kelp and Eelgrass Program, possibility to get additional resources.	2	High density	2	Feasibility and permitting funded	2	12
Chambers Creek WWTP	47.1949	-122.5839	Steilacoom	10750	Ketron Island	WWTP Outfall	South Puget Sound	121.6	63.9	2	need further investigation	1	3	2	WWTP Outfall	2	Overlap with DNR priority geographies for Watershed Resilience Program, State Kelp and Eelgrass Plan.	2	No recent survey, high density	2	N/A	1	12
Redondo WWTP	47.3494	-122.338	Redondo	10380	Poverty Bay	The classification change is based on the unpredictable impact from the Redondo WWTP.	South Puget Sound	131.5	45.9	2	known	2	2	1	WWTP Outfall	2	Permit and administrative order compliance	2	Recent survey, in recovery	1	alternatives analysis funded; remedy expected	2	12
Lakota WWTP	47.3358	-122.3817	Dumas Bay	10400	Poverty Bay	WWTP Outfall	South Puget Sound	128.9	118.4	3	need further investigation	1	2	1	WWTP Outfall	2	N/A	1	No recent survey, high density	2	N/A	1	11
Miller Creek WWTP	47.4417	-122.3644	Three Tree Point	9800	Three Tree Point	WWTP Outfall	South Puget Sound	70.3	64.7	2	need further investigation	1	2	1	WWTP Outfall	2	N/A	1	No recent survey, high density	2	N/A	1	10
Central Kitsap WWTP	47.6766	-122.6013	Brownsville	7200	Port Orchard Passage	WWTP Outfall	South Central Sound	201.1	71.8	3	need further investigation	1	5	2	WWTP Outfall	2	N/A	1	No recent survey, likely low density	0	N/A	1	10
Central Kitsap WWTP	47.6766	-122.6013	Battle Point North	7050	Port Orchard Passage	WWTP Outfall	South Central Sound	414.6	71.8	3	need further investigation	1	5	2	WWTP Outfall	2	N/A	1	Recent survey, low density	0	N/A	1	10
Central Kitsap WWTP	47.6766	-122.6013	Keyport	6910	Port Orchard Passage	WWTP Outfall	South Central Sound	209	71.8	3	need further investigation	1	5	2	WWTP Outfall	2	N/A	1	Likely low density	0	N/A	1	10
Port Ludlow WWTP	47.9361	-122.6756	Snake Rock	19100	Hood Canal #1	WWTP Outfall, Marina/boating	Hood Canal	23.3	110.7	3	need further investigation	1	7	2	WWTP Outfall and marina/boating	1	N/A	1	Recent survey	1	N/A	1	10
Port Ludlow WWTP	47.9361	-122.6756	Port Ludlow	19150	Hood Canal #1	WWTP Outfall, Marina/boating	Hood Canal	49.9	110.7	3	need further investigation	1	7	2	WWTP Outfall and marina/boating	1	N/A	1	Recent survey	1	N/A	1	10
Port Ludlow WWTP	47.9361	-122.6756	Colvos Rocks	19200	Hood Canal #1	WWTP Outfall, Marina/boating	Hood Canal	37.5	110.7	3	need further investigation	1	7	2	WWTP Outfall and marina/boating	1	N/A	1	Recent survey	1	N/A	1	10
Des Moines Creek WWTP	47.4033	-122.3367	Normandy Park	9850	Poverty Bay	WWTP Outfall, Marina/boating	South Puget Sound	76.6	6.6	1	need further investigation	1	2	1	WWTP Outfall and marina/boating	1	N/A	1	Recent survey, planned harvest	1	N/A	1	7

ENHANCEMENT FACTSHEET

Wild Stock Geoduck Population Enhancement
Review and Priorities

Table of Contents

Terms and Definitions

Broodstock reserve: a group of sexually mature geoduck maintained for breeding purposes to enhance larval production and availability in the wild stock population.

Enhancement: an approach or set of approaches for increasing or sustaining the number of geoduck available for harvest in the wild stock fishery.

Recruitment: the process of geoduck larvae or juveniles joining the harvestable wild stock geoduck population.

Seed: larval or juvenile shellfish sold by hatcheries. Where applicable, this document specifies whether 'seed' is referring to larval or juvenile-stage geoduck.

Settlement: the process of post-larval geoduck burrowing or digging into the substrate and developing into juveniles.

Survival: the continued existence of geoduck to a harvestable size. Also defined as recruitment into the wild stock fishery.

Summary

The Geoduck Task Force, led by the Washington Department of Natural Resources, was convened in January 2024 as required by the Washington State Legislature's enacted budget for fiscal years 23-25. The proviso language charged the Task Force with considering, among other topics, "The feasibility of intervention to enhance the wild stock of geoduck". This topic was assigned to the Geoduck Population Enhancement subgroup, which identified potential enhancement strategies and opportunities as well as risks that need to be considered when planning enhancement efforts.

Geoduck population enhancement has the broad goal of augmenting the wild stock geoduck population in Puget Sound in support of continued and sustainable harvest. Two separate approaches to achieve this goal were identified:

- Planting of juvenile geoduck or distribution of geoduck larvae and enhancement of survival for the purpose of direct harvest.
- Planting of geoduck seed, protection of adults, and/or transplantation of adults for the purpose of enhancing broodstock (creating a "broodstock reserve").

These approaches support the fishery in different ways and could be applied in tandem, depending on location, co-manager interest, and other management considerations. Enhancement trials to date have focused on the first approach and highlighted the need for predator protection to ensure survival of the planted seed. Enhancement in support of the wild stock fishery would involve introduction of hatchery-raised individuals to the wild population. While standard hatchery practices for raising geoduck have been established in support of the geoduck aquaculture industry, larval production, development, dispersal, recruitment, settlement, and survival of geoduck in the wild remain poorly understood. Addressing research questions related to factors driving geoduck reproduction and distribution could help to inform successful enhancement efforts.

Opportunities and risks that should be considered when planning geoduck population enhancement or further research are summarized below. These opportunities and risks were identified by Task Force and Geoduck Population Enhancement subgroup members or are based on a review of best available science.

Opportunities	Risks
• Geoduck are a long-lived species, and successful enhancement actions could support the population for decades. • Geoduck enhancement could support harvest in the near term through efforts that allow for harvest of planted individuals. • Hatchery seed is available, and common hatchery practices have been established. • Enhancement efforts could target specific locations known to have slow recovery. • Geoduck are broadcast spawners, so enhancement could support overall larval availability beyond enhanced locations. • Geoduck aquaculture provides a strong foundation of knowledge and experience. • The population genetic structure of geoduck has been studied, though with some limitations.	• Sampling limitations and geoduck growth rate could make it challenging to assess the success of an enhancement project. • Hatchery-raised geoduck could interact with the wild population, potentially affecting genetic diversity. • There is the potential for disease introduction. • Juvenile geoduck are susceptible to predation at high rates. • Environmental drivers of geoduck settlement and larval survival are poorly understood, potentially limiting the effectiveness of enhancement projects. • The costs of enhancement (including seed, gear, and labor) are likely to be significant. • Availability of seed can vary significantly depending on broodstock quality. • Geoduck population enhancement activities have the potential to be subject to a complex regulatory framework. • Stakeholders may object to enhancement activities occurring in the subtidal environment, especially given potential resource conflicts.

In order to address some of the uncertainties and unknowns regarding methods for geoduck population enhancement, example pilot-scale projects are proposed, based on co-manager interest, including trials at the Warrenville and Dash Point tracts. The Task Force and Geoduck Population Enhancement subgroup recommend support of these and similar projects to further the collective knowledge about effective methods to sustain wild stock geoduck harvest. Additionally, the following recommendations are made:

- Convene a genetics working group to evaluate available information on the genetics and population structure of geoduck in Puget Sound, update information using modern techniques, as needed, and establish best practices for 'restoration grade' hatchery production that minimize the potential effects of introducing hatchery-raised individuals into the wild stock population.
- Conduct research in support of establishing broodstock reserves (i.e., locations with adult geoduck intended to support larval availability), including consideration of siting, larval movement, geoduck settlement, and survival information. High-resolution water circulation modeling could inform appropriate siting.
- For relevant enhancement activities, including planting larvae or juvenile geoduck for direct harvest and establishment of broodstock reserves, conduct a cost-benefit analysis within the existing framework of the wild co-managed fishery to determine upfront capital investments,

scale dependence, and potential value gained (e.g., revenue, population benefit) on a project basis.

Geoduck population enhancement has the potential to support the wild stock fishery and sustain continued harvest. Careful consideration of certain factors, especially genetic, ecological, and social dimensions of introducing hatchery-raised individuals to a wild stock population, will be necessary to inform a robust and successful enhancement program.

1.0 Introduction

This document has been developed as part of the Geoduck Task Force (Task Force) led by the Washington Department of Natural Resources (DNR), convened in January 2024, to fulfill the requirements of the language from the Washington State Legislature's enacted budget for fiscal years 23-25 (the proviso):

"The task force must investigate opportunities to reduce negative impacts to tribal treaty and state geoduck harvest and promote long-term opportunities to expand or sustain geoduck harvest. The task force must provide a report to the commissioner of public lands and the legislature, in compliance with RCW 43.01.036, by December 1, 2024, that includes analysis and recommendations related to the following elements:

> *(i) The feasibility of intervention to enhance the wild stock of geoduck, including reseeding projects;*
>
> *(ii) Factors that are preventing areas from being classified for commercial harvest of wild stock geoduck or factors that are leading to existing wild stock geoduck commercial tract classification downgrade, and recommendations to sustainably and cost-effectively increase the number and area of harvestable tracts, including:*
>
> > *(A) Consideration of opportunities and recommendations presented in previous studies and reports;*
> >
> > *(B) An inventory of wastewater treatment plant and surface water runoff point sources impacting state and tribal geoduck harvesting opportunities within the classified commercial shellfish growing areas in Puget Sound;*
> >
> > *(C) A ranking of outfalls and point sources identified in (b)(ii)(B) of this subsection prioritized for future correction to mitigate downgraded classification of areas with commercial geoduck harvest opportunity;*
> >
> > *(D) An inventory of wild stock geoduck tracts that are most impacted by poor water quality or other factors impacting classification;*
> >
> > *(E) Consideration of the role of sediment load and urban runoff, and pathways to mitigate these impacts; and*
> >
> > *(F) Recommendations for future actions to improve the harvest quantity of wild stock geoduck and to prioritize areas that can attain improved classification most readily, while considering the influence of outfalls ranked pursuant to (b)(ii)(C) of this subsection."*

Prior to the first Task Force meeting, the facilitation team conducted one-on-one interviews with Task Force members to understand the goals and interests of fishery co-managers, state agencies, and other

Task Force representatives for the Task Force effort. The language of the proviso and the results from the interviews formed the basis for the three Task Force subgroups:

- Water Quality
- Harvest Restrictions
- Geoduck Population Enhancement

The work of the Task Force and the Geoduck Population Enhancement subgroup related to wild stock geoduck enhancement has been incorporated into this document, the Wild Stock Geoduck Population Enhancement Review and Priorities ("Enhancement Factsheet"). The Enhancement Factsheet documents enhancement efforts that have already been conducted; summarizes the existing literature and knowledge around geoduck population structure and reproduction; identifies research questions; and outlines pilot projects to guide future wild stock geoduck population enhancement efforts. The organization of this document is as follows:

- Section 1.0: Review of enhancement goals, known enhancement efforts to date, factors that affect geoduck population size and structure, and opportunities and risks associated with enhancement.
- Section 2.0: List of research questions regarding unknowns and uncertainties associated with enhancement.
- Section 3.0: Conceptual descriptions of pilot-scale enhancement projects.
- Section 4.0: Recommendations.

1.1 Goals and Strategies for Enhancement

Geoduck population enhancement activities have the broad goal of augmenting the wild stock geoduck population in Puget Sound in support of continued and sustainable harvest. Through conversations of the Geoduck Population Enhancement subgroup, two separate approaches or strategies to address this goal were identified: (1) planting of juvenile geoduck or distribution of geoduck larvae and enhancement of survival for the purpose of direct harvest, and (2) planting of geoduck seed, protection of adults, and/or transplantation of adults for the purpose of enhancing broodstock.

These two approaches support the fishery in different ways, and their application may be location dependent. Planting geoduck seed with the intention of direct harvest could augment the stock of harvestable geoduck in specific locations. Enhancing broodstock would serve to support the overall population through spawning and larval production and would be especially relevant in regions or areas that are known to be recruitment or spawning limited. This type of enhancement would prohibit harvest in the enhanced location, thereby protecting individuals in a "broodstock reserve."

The application of these two different approaches to enhancement would depend on co-manager interest, tract dynamics, and location limitations, among other factors considered below. It is important to note that the commercial wild stock geoduck fishery is jointly managed by DNR, the Washington Department of

Fish and Wildlife (DFW), and the Puget Sound treaty tribes and the process for managing and harvesting geoduck planted through enhancement efforts has not yet been determined. Cost would also be a key component when considering any geoduck population enhancement activities. Geoduck seed is costly, and certain enhancement methods would be equipment and labor intensive. These and other important decision-making factors are considered further in Section 1.4.

1.2 Enhancement Efforts to Date

Initial geoduck population enhancement trials were conducted by the Washington Department of Fish and Wildlife (DFW) in the mid-1970s and 1980s using hatchery seed (Beattie 1992). Survival of seed during these trials was extremely low (0-3%), suggesting overall low survival of out-planted hatchery seed, significant impacts of predation, or a combination. The efficacy of predator exclusion was confirmed during subsequent trials in 1991 and 1992, when 2,520 juvenile geoduck were planted at 4 subtidal sites in Puget Sound (Sizemore et al. n.d.). Survival of geoduck with predator exclusion devices was higher across all substrate types but especially in sandier substrates. These enhancement trials, highlighting the necessity for predator exclusion, led to the development of standard geoduck aquaculture practices widely in use today. Both intertidal and subtidal geoduck aquaculture rely on predator exclusion devices for at least a portion of the life of the geoduck. The juvenile life stage is known to be the most susceptible to predation; cultured geoduck are typically protected from predators for the first 1-2 years of cultivation.

Most geoduck aquaculture occurs in the intertidal zone, allowing for easier access for maintenance and harvest. Subtidal geoduck aquaculture occurs in a limited capacity in Washington state and more extensively in British Columbia. Maintenance and harvest must be conducted by divers and subtidal aquaculture typically still employs predator exclusion methods to help ensure survival. Example predator exclusion devices include polyvinyl chloride (PVC) tubes, mesh plastic tubes, or mesh nets secured to the substrate. The latter method is used extensively by the Underwater Harvesters Association in British Columbia for subtidal geoduck aquaculture, although reported survival can still be low, depending on the site (Suhrbier et al. 2014). PVC or mesh tubes are installed around the geoduck seed and may be secured or covered so that predators are not able to access geoduck from the top. The use of PVC or mesh tubes is standard practice for intertidal geoduck aquaculture in Washington State.

It should be noted that enhancement trials to date, and the subsequent development of geoduck aquaculture methods, assumed direct harvest of the planted individuals. These efforts therefore focused on planting costly juvenile geoduck, necessitating attention to predator protection to ensure survival and return on investment. The management framework of the wild stock fishery may allow for use of larval geoduck to enhance the population, depending on funding, integration with fishery management, and natural larval supply. Additionally, as described above in Section 1.1, potential geoduck enhancement in support of the wild stock fishery could also look to create broodstock reserves to support larval availability, recruitment, and recovery on existing geoduck tracts. Siting of such broodstock reserves would be important to ensure that spawning of planted individuals would meet the intended purpose of increasing larval availability. Restoration efforts for species such as Pinto abalone (*Haliotis kamtschatkana*) and Olympia oysters (*Ostrea lurida*) could help to inform the process of establishing broodstock reserves for geoduck.

1.3 Factors Driving Population Size and Structure

The population size and structure of wild stock geoduck in the Salish Sea are shaped by four primary factors: (1) genetics, (2) larval availability, (3) settlement, and (4) predation and survival. These factors are themselves also affected by a variety of environmental variables creating the distribution and abundance of geoduck. Existing literature related to the four primary factors is reviewed and summarized below. Where necessary, unknowns associated with these factors are included as research questions in Section 2.

1.3.1 Genetics of Geoduck Populations

Work conducted in the early 2000s on the population structure of geoduck in Washington State suggests that there is little differentiation among individuals across spatially distinct sites with the exception of one site on the Strait of Juan de Fuca (Vadopalas et al. 2004). These conclusions were made based on samples collected at 16 sites in Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca. Subsequent work found similar genetic homogeneity at the scale of Puget Sound, although genetic variation at small scales suggests some spatial differences in settlement (Vadopalas et al. 2012). Based on this information, the wild stock geoduck population is assumed to be largely homogeneous within the inland waters of Washington State, especially in the context of the regional fishery management framework. However, it is worth noting that these studies used older molecular methods that may not have captured genetic structure that could be seen by using newer technologies (e.g., single nucleotide polymorphisms). Evaluating the geoduck population using modern genetic methods would help to inform the genetic risk associated with potential enhancement projects, especially if there is evidence of local genetic structure.

Even if the geoduck population is genetically homogeneous, introduction of hatchery-raised or cultured individuals in proximity to wild populations raises concerns about outbreeding depression. Vadopalas et al. (2015) investigated the potential for interactions between cultured geoduck and the wild stock population. Sampling of farmed and wild individuals to assess reproductive development suggested that interaction could occur through synchronized spawning (allowing for cross breeding between cultured and wild populations) and larval movement and settlement (creating the potential for larvae from cultured individuals to settle and propagate with wild populations). Geoduck are considered to be sexually mature by age 3, suggesting that there are likely multiple seasons of reproductive maturity in which planted geoduck could interact with wild populations (Vadopalas et al. 2015). Interactions between wild stock and hatchery-raised individuals would need to be considered when planning enhancement activities, especially given the long-term interaction associated with certain types of enhancement (e.g., broodstock reserves).

For conservation purposes, there is often the need to demonstrate that natural reproduction and recruitment is not occurring at a high enough rate to support the population. If natural reproduction and recruitment are insufficient to meet management objectives, the benefits of artificial supplementation may outweigh the risks; without the hatchery, the population might not persist. For geoduck, enhancement is envisioned to support the wild stock fishery and therefore has dual goals of bolstering harvestable individuals while also supporting natural reproduction and recruitment. Rather than needing to demonstrate failure of natural reproduction and recruitment, the focus for geoduck would be on ensuring limited genetic impact of the introduced individuals. In a report prepared for the Port Gamble S'Klallam Tribe titled "Approaches to optimize the production of genetically diverse geoduck seed," Vadopalas described steps to meet two objectives of conservation breeding: (1) retain genetic diversity of the wild population and (2) reduce unintentional, inadvertent hatchery selection (Suhrbier et al. 2014, Appendix B). Broadly, the steps and recommendations to meet these objectives consider use of wild broodstock, number of broodstock, broodstock husbandry and rotation, and mating design. The lifespan of geoduck elevates the risk of introducing hatchery-raised individuals, increasing the need to consider conservation breeding hatchery practices that maximize genetic diversity and protect effective breeding size.

Geoduck hatcheries are already in operation to support the geoduck aquaculture industry. The work conducted in these hatcheries provides important foundational knowledge: it is possible to successfully spawn geoduck and raise seed in hatchery and nursery settings. Commercial hatcheries in support of the aquaculture (or other) industry are typically distinct from a conservation hatchery as the focus is maximizing seed production rather than genetic diversity. For example, in support of pinto abalone restoration, the Puget Sound Restoration Fund uses a factorial mating design with as many broodstock as possible and raises each family separately, and DFW outplants families in equal proportions and seeds sites over multiple years to ensure high genetic diversity. These conservation hatchery practices can be an order of magnitude higher in cost compared to practices used to maximize seed production. Such cost considerations could limit capacity for geoduck seed production in support of enhancement efforts. However, given the limited population structure of geoduck within Puget Sound, it may be possible to adopt an approach that minimizes potential genetic impacts while also ensuring sufficient capacity and availability of seed. Recommendations based on Vadopalas et al. (2015) and Appendix B of Suhrbier et al. (2014) provide a good starting point for hatchery practices in support of wild stock geoduck enhancement. Additional work on the population structure of geoduck using newer analysis techniques (ongoing work by DFW and DNR) and interactions between cultured and wild stock populations may provide further clarity on appropriate hatchery practices for enhancement.

1.3.2 Larval Availability and Production

Geoduck are broadcast spawners, and larvae are widely distributed by currents and predominant water circulation patterns. Larval production in any given year, including total number and condition of larvae released by adults and survival of the larvae through metamorphosis to juvenile stage, is poorly understood in the natural environment of Puget Sound. It is generally assumed that larval dispersal mirrors modeled water transport, but studies have found different patterns of connectivity (e.g., Parker et al. 2003; Becker et al. 2007), suggesting that the dispersal is more complex and larvae are not simply moving as particles at a fixed depth. Understanding an individual species' larval dispersal is additionally complicated due to challenges in differentiating shellfish species at the larval stage and patchiness of larvae (in both time and space). Using a novel sampling approach, Becker et al. (2012) sought to understand the dispersal of geoduck larvae in Quartermaster Harbor, a small embayment in south Puget Sound. Sample collection using time-integrating larval tube traps over the course of 4 months at three locations captured two distinct pulses of larvae (one in March and one in late May/early June). These larvae were consistently found at the surface, and their abundance was weakly correlated with the degree of stratification of the water column (Becker et al. 2012). Larval size throughout Quartermaster Harbor suggested that there was some larval retention and that there may have been import of larvae from a different location later in the season. This work highlights the complexity of geoduck larval dispersal. However, additional application of the methods used could provide a better understanding of how geoduck larvae are moving at larger spatial scales (i.e., within and between regions of Puget Sound) and whether there are patterns of connectivity distinct from the predominant water circulation.

Given the challenges in understanding larval survival, dispersal, and connectivity, it is not possible to estimate larval availability in a meaningful way. Geoduck are considered to be prolific spawners, typically spawning multiple times a year with 1-2 million eggs per spawning event, as observed in a hatchery setting (Goodwin and Pease 1989). Therefore, it is logical to presume that the population is not larvae limited; however, *in situ* larval development and spatial variation in spawning could limit larval availability in certain locations. Variability in environmental conditions can also affect spawning of geoduck, suggesting that there may be significant temporal variation in larval availability.

In addition to the availability of larvae from spawning of wild stock geoduck, the availability of larvae from hatcheries is also an important consideration in the context of a potential enhancement program. There are currently six shellfish hatcheries producing geoduck seed operating in Washington State and an additional two in British Columbia that are approved for import of geoduck seed into the state. Two of the six hatcheries in the state are operated by tribal co-managers of the geoduck fishery (Lummi Tribe and Jamestown S'Klallam Tribe), and two other co-managers have plans to open shellfish hatcheries in the near future (Tulalip Tribe and Suquamish Tribe). These existing hatcheries produce high quality geoduck seed, typically sold at around 4-7mm in shell length. Hatcheries need new broodstock each year (spawning effectiveness declines significantly with time in the hatchery), relying on locally harvested adults from the wild stock population. Quality of broodstock is considered to drive overall supply of geoduck seed across the industry, although specific drivers of broodstock quality are poorly understood. Supply of seed can therefore vary significantly year to year. Hatchery production of geoduck seed in support of an enhancement program may be further limited by standard practices to protect genetic diversity and effective breeding size (refer to Section 1.3.1).

1.3.3 Geoduck Settlement

After dispersal as planktonic larvae, geoduck larvae settle out and dig into the substrate to continue their growth. Although geoduck can be induced to settle in a hatchery setting, the environmental factors driving settlement *in situ* are poorly understood. Geoduck are known to occur more commonly in loose, unconsolidated, sand substrate (Goodwin and Pease 1989; McDonald et al. 2015), and observations suggest a strong association between geoduck density and other invertebrates, including chaetopterid polychaetes (*Spiochaetopterus costarum* and *Phyllochaetopterus prolifica*), the sea pen (*Ptilosarcus gurneyi*), and horse clams (*Tresus* spp.) (Goodwin and Pease 1991). The specific chemical or physical signal that induces settlement in these habitats is unknown. Additional research and information to better understand the environmental factors driving *in situ* geoduck settlement would help to support siting of successful enhancement projects.

1.3.4 Predation Pressure and Survival

Prior enhancement trials and standard practices of geoduck aquaculture highlight the significant effects of predation on geoduck, especially at the juvenile stage. As described in Section 1.2, predator protection dramatically increases survival. Anecdotal information suggests that the need for predator protection is highly site-specific and dependent on the density of predators. Common predators of geoduck include California sea lions (*Zalophus californianus*), Dungeness crab (*Cancer magister*), red rock crab (*Cancer productus*), and other crab species. Additionally, sea stars and flat fishes may prey upon juvenile geoduck. Understanding the range of predator densities that affect overall survival of geoduck at the tract-scale or scale of an enhancement project would inform methodology and support appropriate siting.

1.4 Enhancement Opportunities and Risks

Geoduck population enhancement in the context of the wild stock fishery could support recovery, helping to ensure sustainable harvest, but also comes with certain limitations and considerations. Section 1.3 describes the factors that are controlling and shaping the size and distribution of the wild stock geoduck population in Puget Sound. In light of these factors and the discussions of the Geoduck Population Enhancement Subgroup and Task Force, the following bullets consolidate opportunities and risks associated with geoduck population enhancement in support of the wild stock fishery.

1.4.1 Opportunities

- Geoduck are a long-lived species, and successful enhancement actions, especially establishment of broodstock reserves, could support the population for decades.
- Conducting geoduck population enhancement could support harvest in the near term through efforts that allow for harvest of planted individuals.
- Hatchery seed is available, and common hatchery practices have already been established in support of the geoduck aquaculture industry.
- Enhancement efforts could target specific locations known to have slow recovery, bolstering natural spawning and recruitment.
- Geoduck are broadcast spawners with larval dispersal, and enhancement efforts could increase overall larval availability in Puget Sound, thereby supporting the geoduck population at a spatial scale beyond the direct enhancement location. This would be beneficial only if wild populations are limited by the availability of larvae (see Section 1.3.2). It is more likely that wild populations are limited by juvenile survival.
- Culture of geoduck in both subtidal and intertidal locations has provided a strong foundation of knowledge and experience to inform geoduck population enhancement efforts.

- The population genetic structure of geoduck in Puget Sound has been studied, though with limitations due to older methodologies used, and provides a basis for management decisions.

1.4.2 Risks

- Due to sampling limitations and geoduck growth rate, it could be challenging to assess the success of an enhancement project. An effective method for sampling juvenile geoduck is currently unknown, and geoduck do not typically reach market size for at least 5 to 8 years.
- Pacific geoduck are native to Puget Sound. Introduction of hatchery-raised individuals with the potential to interact with the wild population (through breeding) could affect the genetic diversity and effective breeding size of the wild population. Studies conducted to date on genetic structure of geoduck in Puget Sound used older methods and left some research questions unanswered.
- There is potential for disease introduction through introduction of hatchery-raised individuals. At this time, there are no known diseases affecting geoduck in Puget Sound.
- Juvenile geoduck are susceptible to predation at high rates. Enhancement trials conducted to date and standard practice of geoduck aquaculture suggest that predator protection is necessary to ensure sufficient survival.
- The environmental drivers of geoduck settlement and larval survival are poorly understood. Without a better understanding of these factors, geoduck enhancement projects may not be sited in locations that would support larval availability and recovery of the population beyond the enhanced location.
- The costs of enhancement (including seed production/acquisition, permitting, gear, and labor for planting, maintenance, and harvest) are significant. Enhancement would likely need to be conducted at an appropriate scale or with necessary support to make it cost effective. It is currently unclear how funding would be developed or provided. Funding may also require special considerations, given the longer timescale likely necessary to see results.
- The availability of seed can vary significantly year to year based on the quality of broodstock and may be further limited by standard practices and requirements to protect genetic diversity and effective breeding size.
- Based on requirements for shellfish aquaculture (both subtidal and intertidal), geoduck population enhancement activities have the potential to be subject to a complex regulatory framework at the federal, state, and local levels. Specific permitting requirements for geoduck population enhancement activities have yet to be determined.
- Many stakeholders may object to enhancement activities occurring in the subtidal environment, especially given potential resource conflicts. Other commercial fisheries may occupy and harvest

resources within subtidal geoduck tracts and could be limited by potential population enhancement efforts.

2.0 Research Questions

Unknowns associated with geoduck population enhancement could be addressed through further research and experimentation. The following section describes questions related to geoduck enhancement raised by Task Force and subgroup members and identified through review of prior enhancement efforts and best available science. Where possible, existing work that has been conducted related to the question is referenced. The questions included here are considered to be fundamental but do not represent the full suite of potential uncertainties associated with geoduck population enhancement. Three broad topics have been identified and used to organize the questions, as outlined below.

2.1.1 Maximize Success and Effectiveness

These questions focus on elements of geoduck reproduction and survival that are necessary to ensure success and effectiveness of enhancement efforts.

- Are there chemical and/or physical controls of geoduck settlement?
    - Evidence from Mexico suggests that serotonin and epinephrine may induce settlement in the Pacific geoduck (Pérez-Bustamante and García-Esquivel 2017). Trials could be designed to use these methods to induce metamorphosis of late-stage larvae at depth to be spread on existing geoduck tracts by divers.
    - The presence of certain invertebrates (e.g., chaetopterid polychaetes [*Spiochaetopterus costarum* and *Phyllochaetopterus prolifica*], the sea pen [*Ptilosarcus gurneyi*], and horse clams [*Tresus* spp.]) may also support geoduck settlement (Goodwin and Pease 1991).
- Does current speed affect the likelihood or success of geoduck recruitment?
    - There is evidence for a weak positive correlation between current speed and tract recovery (Stevick et al. 2021).
- How does water circulation within and among Puget Sound basins support or hinder geoduck recruitment?
    - The Salish Sea Model could support evaluation of this question. Geoduck larval dispersal and movement in Puget Sound is poorly understood (as described in Becker et al. 2012). Water circulation modeling would need to be paired with additional information on geoduck larval behavior to consider the issue more fully.
- How do external environmental conditions affect natural reproduction and recruitment? This question is especially relevant in the context of climate change and shifting conditions (e.g., ocean acidification, warming waters).

  - Laboratory experiments could help answer questions about pH and temperature controls on geoduck reproduction and recruitment. *In situ* work on geoduck growth and survival suggests that geoduck may be resilient to low pH conditions; other abiotic factors (e.g., temperature, dissolved oxygen) may have a greater impact (Spencer et al. 2019).
  - Factors affecting recruitment and survival include oceanographic processes, larval selection of habitat, and post-settlement survival. In Hood Canal, researchers found that densities of geoduck declined with north-south patterns of deepwater dissolved oxygen and duration of seasonal hypoxia (McDonald et al. 2015).
- Do higher densities of adult geoduck in a location lead to higher recruitment?
  - Available evidence suggests no relationship between the density of adults and the rate at which density increases (recruitment + survival to countable size) at the scale of an entire tract (Stevick et al. 2021).
  - High densities of adult geoduck are likely to support fertilization success but may not lead to a real effect for recruitment or survival. Recruitment and survival are dependent on a much broader suite of effects (e.g., McDonald et al. 2015). This highlights the limited information available related to larval production and development of larvae to the juvenile life stage.
- Would seeding of shallower depths support recovery of wild stock geoduck within commercial tracts?
  - Vadopalos et al. (2015) found potential for interaction between cultured geoduck in the intertidal zone and wild stock geoduck. There is therefore basis to believe that seeding at shallower depths could support larval availability and recruitment within depths available for commercial harvest.
  - The goal of broodstock reserves would be to increase larval availability within Puget Sound. The concept of larval spillover has been considered in the context of conservation aquaculture for Olympia oysters, where aquaculture could support larval availability in locations that are recruitment limited (Ridlon et al. 2021). Assuming geoduck are recruitment limited in certain locations, appropriately sited broodstock reserves could increase densities of geoduck in proximity. A limitation of this approach is that it will be impossible to measure the contributions of these spawning aggregations to natural recruitment either locally or in general.

2.1.2 Methods and Evaluation

The research questions below center around specific methods and feasibility for enhancement. There is also uncertainty around the best way to determine success of enhancement efforts. Sampling of geoduck, especially at early life stages, is challenging and resource intensive. Determining success of enhancement will require clear goals and effective methods for assessing progress relative to those goals.

- Do seed life stage, size, and method of release drive differential success in survival?
    - Evidence from the geoduck aquaculture industry suggests that success and survival are highly dependent on seed size. Geoduck become less effective diggers as they grow; 4-7mm in shell length is considered to be an optimal size for planting. Beyond that, a hole typically needs to be started for the geoduck to become established. Seeding of larvae (prior to metamorphosis to the juvenile stage) is also a potential option that remains poorly understood.
    - Method of release, including sprinkling on an incoming tide, direct injection of seed, and planting at a larger size, is also likely to affect survival.
    - Experimentation and testing are necessary to understand appropriate methods and environmental factors that may affect success and survival.
- What are the key species driving geoduck predation pressure and what densities necessitate predator protection?
    - Dungeness crab (*Cancer magister*), red rock crab (*Cancer productus*), and other crab species are known predators of geoduck. Additionally, sea stars and flat fishes may prey upon juvenile geoduck. A better understanding of geoduck survival relative to predator densities could inform suitability criteria for siting enhancement projects.
- What is the best way to effectively sample juvenile geoduck?
    - Current methods for sampling geoduck are sufficient for capturing numbers of adults but do not effectively capture geoduck below a certain size. Without a method to count juvenile geoduck, survival of planted individuals would be difficult to measure for many years after seeding.
    - Measuring success of enhancement efforts is difficult without a way to see recruitment and aging of year classes.

2.1.3 Hatchery Practices and Other Considerations

As alluded to in Section 1.3.1, appropriate hatchery practices will be necessary to minimize effects on geoduck population structure. The underlying questions are captured here. Additional questions related to economic feasibility are also included.

- What hatchery practices are necessary to limit potential genetic effects while ensuring sufficient seed availability to support enhancement?

    - As discussed in Section 1.3.1, practices based in conservation breeding (including use of a large number of wild broodstock, appropriate broodstock husbandry, and mating design) could limit the potential for potential genetic effects of enhancement efforts.
    - Production capacity and larval availability would be limited by certain conservation breeding practices. Additional work and coordination would be necessary to determine practices protective of genetic diversity while ensuring sufficient hatchery production. It would be best practice to assemble a working group of genetic experts, hatchery operators, and fishery managers to evaluate the available scientific research, establish research needs, and develop hatchery protocols that balance conservation and production needs.
- How does cost vary with seed size? Based on differential survival, is there a point of diminishing returns for doing enhancement?
    - Cost substantially increases with seed size and life stage (i.e., larvae versus juvenile). Geoduck seed are typically sold at 4-7mm in shell length. Beyond this size and after settlement, geoduck must remain in a nursery setting, which requires additional space, algal production (for food), and labor.
    - A cost benefit analysis conducted by the Underwater Harvesters Association, an organization of subtidal geoduck growers in British Columbia, suggests that geoduck aquaculture in a subtidal setting can be cost effective, depending on the cost of seed, size of farm, and harvest yields (Ministry of Agriculture and Lands 2005).
- What is the social acceptance of wild stock geoduck population enhancement? How would the public view the potential for supplementing and enhancing a native, wild stock population?
    - For intertidal geoduck aquaculture, an assessment of stakeholder perspectives and policy issues revealed interests and concerns around aesthetic, recreational, ecological, and economic aspects of the activities, among others (Ryan et al. 2016). While proposed geoduck population enhancement is likely to occur in subtidal locations, necessitating a different suite of considerations, understanding the social dimensions of the practice will be necessary to ensure acceptance.

3.0 Proposed Pilot Projects

The following subsections describe potential pilot-scale projects for geoduck population enhancement. These project concepts are initial ideas introduced through the Task Force effort. The projects described in this section do not reflect a complete list of locations where geoduck population enhancement may potentially be conducted. Other sites in Puget Sound may be suitable for conducting a pilot-scale project based on considerations such as accessibility, environmental conditions, cost, and regional interest and priority. Exact locations and methods of the enhancement trials will need to be further developed and refined before considering the implementation of a pilot project. It is important to note that additional work is needed to investigate key elements of population enhancement projects, including cost-benefit analyses, permitting and regulatory processes, and role of aquaculture practices. Sections 1.0 and 2.0 describe other important factors to consider before administering a pilot project, such as genetic risk, larval availability, methods and evaluation, and survival of geoduck.

3.1 Enhancement Trials at Warrenville (21450)

The Warrenville tract is located along the western shoreline of central Kitsap Peninsula, near Big Beef Creek, in the Hood Canal geoduck management region and has been identified by the Skokomish Tribe as a potentially viable candidate for a geoduck enhancement pilot project. The tract is approximately 430 acres and is entirely within a Washington Department of Health (DOH) Approved shellfish growing area. This tract has historically supported large populations of wild stock geoduck but has been harvested down and is currently in recovery. Several characteristics of the Warrenville tract create an accessible and suitable site for conducting enhancement trials: the tract has a large, flat area with soft substrate and a good depth profile with a mild slope, and it has supported a historical population of quality geoduck. Use conflicts that may be considered at this location include commercial fishing of crab, though there is typically less catch within this area than in other crab fishing sites (as observed by the Skokomish Tribe).

There are several potential approaches for conducting a pilot project at this site. One approach consists of establishing a set of control and test plots that employ larval dispersal methods or direct injection of juvenile plantings. The large, flat area of the Warrenville tract could be suitable for providing consistent habitat conditions across the plots. Geoduck seed size and type may depend on availability from hatcheries and cost considerations. Methods and design would be finalized based on available resources, interest, and feasibility.

3.2 Enhancement Trials at Dash Point (10430)

The Dash Point tract is located along the shoreline of Dash Point State Park in the South Puget Sound geoduck management region, within Puyallup Tribe Usual and Accustomed harvest areas. The tract is approximately 60 acres, is within DOH Approved and Conditionally Approved shellfish growing areas and is currently active for harvest. This tract was identified by the Puyallup Tribe as a potential site to conduct geoduck enhancement trials due to accessibility and local interest.

The primary method proposed for geoduck enhancement at this site involves releasing near-settlement larvae with various types of predator protection, including off-bottom canopy netting, on-bottom canopy netting, and no netting at all. Investigation of site-specific predators may be beneficial for refining which predator protection materials will be suitable for enhancement trials on this tract. Assessing success for projects at this location may include pre-project density sampling to estimate geoduck populations and monitoring every 1-3 years until adult geoduck start to show (about 5-10 years).

3.3 Transplantation

The concept of transplantation, moving adult geoduck from one place to another, was introduced during discussion of potential pilot projects by the Geoduck Population Enhancement subgroup. The question of whether transplanting geoduck would provide spawning enhancement and encourage larval recruitment has not been thoroughly researched, and there is limited knowledge on methods for conducting transplantation or drivers of success. One example of a geoduck transplantation trial discussed by the Geoduck Population Enhancement Subgroup entailed an aquaculture company transplanting small juvenile geoducks (2-4 years) darker in color to understand their survival rate and document any change in their quality. A venturi and double venturi system was used to loosen substrate to plant the geoduck. The trial resulted in an approximate 80% survival rate of planted geoduck and no change in the quality of geoduck (Gibbons, J., Seattle Shellfish, pers. comm. 2024).

The Tulalip Tribe has identified the North Sound region as a suitable area for conducting a pilot-scale project to transplant geoduck for the purpose of spawning enhancement and establishment of a broodstock reserve. A pilot project in the North Sound area would also be beneficial for additional restoration efforts that could occur within the same or nearby areas that focus on kelp or other species of shellfish enhancement. Experiments and pilot-scale projects using geoduck transplantation will need additional work to refine methods and to address considerations such as DOH regulations for moving geoduck within varying shellfish growing area classifications and precautions against potential disease considerations.

4.0 Recommendations

This section includes general recommendations based on Task Force and Geoduck Population Enhancement subgroup discussions and considering the information presented in the preceding sections. These recommendations are not in a prioritized order, but there may be a logical sequence based on co-manager interest and funding availability. The Task Force recommends the following to increase harvest opportunities for wild stock geoduck through enhancement efforts:

- Convene a genetics working group to evaluate available information on the genetics and population structure of geoduck in Puget Sound, update information using modern techniques, as needed, and establish best practices for 'restoration grade' hatchery production that minimize the potential effects of introducing hatchery-raised individuals into the wild stock population.
- For relevant enhancement activities, including planting larvae or juvenile geoduck for direct harvest and establishment of broodstock reserves, conduct a cost-benefit analysis within the existing framework of the wild co-managed fishery to determine upfront capital investments, scale dependence, and potential value gained (e.g., revenue, population benefit) on a project basis.
- Conduct research in support of establishing broodstock reserves (i.e., locations with adult geoduck intended to support larval availability), including consideration of siting, larval movement, geoduck settlement, and survival. High-resolution water circulation modeling could inform appropriate siting.
- Provide funding, as appropriate, for pilot projects, like those described in Section 3.0, to test enhancement methodology, better understand survival and success of planted individuals, and evaluate the feasibility of transplanting adult geoduck in support of enhancement.

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Austin Paul	Point No Point Treaty Council	✓	✓	✓	
Courtney Hart	Port Gamble S'Klallam Tribe	✓			✓
Jason Haveman	Port Gamble S'Klallam Tribe	✓		✓	
Tyler Sullivan	Port Gamble S'Klallam Tribe	✓	✓	✓	
Chris Tom	Port Gamble S'Klallam Tribe	✓	✓	✓	
Todd Hass	Puget Sound Partnership	✓	✓		
Fred Dillon	Puyallup Tribe	✓			
Deanna Finley	Puyallup Tribe	✓			
George Stearns	Puyallup Tribe	✓		✓	
David Winfrey	Puyallup Tribe	✓	✓		✓
Jim Gibbons	Seattle Shellfish				✓

Name	Affiliation	Main Task Force Member	Subgroup Member		
			Water Quality	Harvest Restrictions	Geoduck Population Enhancement
Alex Gouley	Skokomish Indian Tribe	✓			
Blair Paul	Skokomish Indian Tribe	✓		✓	✓
Rana Brown	Squaxin Island Tribe	✓			
Eddie Kim	Squaxin Island Tribe	✓	✓		✓
Julie Owens*	Squaxin Island Tribe	✓		✓	
Eric Sparkman	Squaxin Island Tribe	✓		✓	
Franchesca Perez	Stillaguamish Tribe	✓	✓		✓
Josh Bagley	Suquamish Tribe	✓			
Viviane Barry	Suquamish Tribe	✓	✓	✓	✓
Tony Forsman	Suquamish Tribe	✓			
Aaron Purser	Suquamish Tribe	✓	✓		✓
Paul Williams	Suquamish Tribe	✓	✓		
Jeremy Wilbur	Swinomish Tribe	✓			
Bill Dewey	Taylor Shellfish Farms		✓		
Aaron Jones	Tulalip Tribe	✓			
Mike McHugh	Tulalip Tribe	✓	✓	✓	✓
Cathy Stanley	Tulalip Tribe	✓			
P. Sean McDonald	University of Washington	✓		✓	✓
Leslie Connelly	Washington Department of Ecology	✓			
Ron Cummings	Washington Department of Ecology		✓		
Tonya Lane	Washington Department of Ecology		✓		
Vince McGowan	Washington Department of Ecology	✓			
Henry Carson	Washington Department of Fish and Wildlife			✓	✓
Chris Eardley	Washington Department of Fish and Wildlife	✓	✓		✓
Scott Berbells	Washington Department of Health		✓	✓	

Name	Affiliation	Main Task Force Member	Subgroup Member		
			Water Quality	Harvest Restrictions	Geoduck Population Enhancement
Lauren Jenks	Washington Department of Health	✓			
Merita Trohimovich	Washington Department of Health		✓	✓	
Katie Allen	Washington Department of Natural Resources	✓			
Abby Barnes	Washington Department of Natural Resources	✓	✓		
Tom Gorman	Washington Department of Natural Resources	✓			
Hannah King*	Washington Department of Natural Resources		✓	✓	✓
Blain Reeves	Washington Department of Natural Resources	✓		✓	✓
Max Showalter	Washington Department of Natural Resources	✓	✓	✓	✓
Alex Smith*	Washington Department of Natural Resources	✓			

* Partially participated in Main Task Force and/or Subgroup(s) during the extent of the Geoduck Task Force.