Winter 2017

# Freestad Lake estuary restoration: environmental impact assessment

Alex Westcott
*Western Washington University*

Amanda Smith
*Western Washington University*

Angela Ralston
*Western Washington University*

Keelin Balzaretti
*Western Washington University*

Kimberly Kreis
*Western Washington University*

Environmental Impact Assessment

# Freestad Lake Estuary Restoration:

Winter 2017,
Western Washington University

Dear Concerned Citizen,

The following document is an Environmental Impact Assessment (EIA) intended to determine the ecological effects that occur from the restoration of the land north and west of Freestad Lake to an estuary. The project includes removing ineffective tide-gates, and building a new dike that will provide increased estuary and wetland habitat. Pocket estuary habitat was identified as having a disproportionately large benefit to species that utilize nearby habitat. Restoration is expected to yield benefits to fish species including Chinook salmon, which are on the endangered species list. Birds and shellfish will also benefit from the project’s completion.

This document is an Environmental Impact Assessment (EIA) that was conducted under the guidance of Dr. Leo Bodensteiner. The intent of the document is to follow the requirements of an Environmental Impact Statement (EIS) in an academic setting. The requirements for an EIS are described in the State Environmental Policy Act (SEPA) which is outlined in Washington Advisory Code (WAC) 197-11 and the Revised Code of Washington (RCW) 43.21c.b-b.

The EIA includes supporting information from other sites restored to estuary habitat, peer reviewed articles, and information provided from government documents to support our determination of site impacts. We hope you find the following information informative regarding estuary restoration at Freestad Lake.

Sincerely,

The Freestad Estuary Restoration Team

**Environmental Impact Assessment**
Huxley College of the Environment



Signature Alex Westcott

(Alex Westcott)

Signature

(Amanda Smith)

Signature

(Angela Ralston)

Signature Keelin Balzaretti

(Keelin Balzaretti)

Signature

(Kim Kreis)

HUXLEY
COLLEGE OF THE ENVIRONMENT

# Freestad Lake Estuary Restoration: Environmental Impact Assessment

Leo Bodensteiner, ESCI 493: Environmental Impact Assessment, Huxley College of the Environment


Alex Westcott
*Huxley College of the Environment*
*B.S. Environmental Science*

Amanda Smith
*Huxley College of the Environment*
*B.S. Environmental Science w/ Toxicology emphasis*

Angela Ralston
*Huxley College of the Environment*
*B.A. Economics & Environmental Studies*

Keelin Balzaretti
*Huxley College of the Environment*
*B.S. Environmental Science*

Kimberly Kreis
*Huxley College of the Environment*
*B.S. Environmental Science*


**Disclaimer:**

The Following Environmental Impact Assessment is intended for educational purposes only. The document is an exercise intended to teach the steps taken in developing an EIS, and is not intended to influence policy or inform steps potentially taken at the site of interest

# FACT SHEET

## Legal Site description:

Latitude and Longitude: 48.5692° N, 122.4947° W

## Proposer:

Huxley College of the Environment. Environmental Impact Assessment, Winter 2017. Freestad Estuary Restoration Team.

## Lead Agency:

Skagit County Public Works:
Natural Resources Division
1800 Continental Place
Mount Vernon, WA 98273

## Required Permits:

Aquatic Use and Authorization
Hydraulic Project Approval
Section 401 Water Quality Certification
Work in Navigable Waters
Discharge of Dredge or Fill Material
Shoreline Substantial Development permit
Special Use Permit or Exemption
Fill/Grade Permit
Flood Plain Development Permit
Structural permit

## Contributions By Author:

Alex Westcott
Project description, earth and transportation, historical/topographic images, Alternative Action

Amanda Smith
Dear Concerned Citizens Letter, Purpose and Objectives, Plants and Animals, Photos, Final Formatting

Angela Ralston
Air, Land and Shoreline Use, Formatting, Conclusion

Keelin Balzaretti
History, Water, Informational Interviews

Kimberly Kreis
Cover page, Design, Formatting, Citations, Editing, Research Assistance

## Distribution List of Digital Copies:

Dr. Leo Bodensteiner
Wilson Library digital collection for Huxley College
Alex Westcott
Amanda Smith
Angela Ralston
Keelin Balzaretti
Kimberly Kreis


## Acknowledgements:

We would like to thank Emily Derenne, Jeff McGowan, and Bob Warinner, from the Skagit County Public Works Department, for attending informational interviews and providing additional resources and information about the site.

We would like to thank Leo Bodensteiner for providing guidance, contact information, and resources throughout the project.


## Issue Date:

March 13th, 2017

## Public Hearing:

REI
400 36th St,
Bellingham WA, 98225

March 9th 5-6pm

# EXECUTIVE SUMMARY

The purpose of this environmental impact assessment is to assess and evaluate a restoration along the northeast side of Samish Island in Skagit Valley, WA. Freestad Lake, a human-made saltwater lagoon, is to be restored to a pocket estuary. Our environmental assessment team discusses the resulting effects on natural and built elements of the environment, with special focus on Earth, Water, and Plants & Animals. As it is in the interest of the land owner and all involved parties to reestablish pocket estuary functions, our team aimed to evaluate the effects of the proposed project on the environment and conclude with our recommendation.

Samish Island is located in the north half of the Puget Sound, approximately 25 miles south of Bellingham, near the Christ Community Church and its associated Campground on the northeast point of Samish Island (Figure 1). This is where Samish Bay forms an estuary and river delta. The goal of the project is to restore the project site to a type of habitat called a pocket estuary that hosts larger populations of fish species compared to other estuarine systems (Beamer et al., 2003). In doing so the church also wants to improve swimming conditions in the lake and provide children with the opportunity to learn about estuaries (Dahlstedt et al., 2015).


*Figure 1. An image from Google Earth showing the church, campground, and Freestad Lake.*

## DECISION MATRIX:

*Table 1. A decision matrix showing the elements that will benefit (+) be negatively impacted (-), or neither (0). The total number of + were added for each column and the - were subtracted to determine the total relative benefit of each plan.*

| Elements of the Environment | proposed project | Alternative | No Change |
|---|---|---|---|
| Natural Elements | | | |
| 1. Earth | | | |
| a. Geology | 0 | 0 | 0 |
| b. Soils | 0 | 0 | 0 |
| c. Topography | + | 0 | 0 |
| d. Unique physical features | + | + | 0 |
| e. Erosion and accretion | + | - | 0 |
| 2. Air | | | |
| a. Air quality | 0 | 0 | 0 |
| b. Odor | - | - | 0 |
| c. Climate | 0 | 0 | 0 |
| 3. Water | | | |
| a. Surface movement/quantity/quality | + | + | 0 |
| b. Runoff and Absorption | + | + | 0 |
| c. Floods | + | + | 0 |
| d. Groundwater | + | + | 0 |
| e. Public Water Supplies | + | + | |
| 4. Plants and Animals | | | |
| a. Habitat promoting species diversity | + | 0 | - |
| b. Unique Species | + | 0 | 0 |
| c. Fish and Wildlife Migration Routes | + | + | 0 |
| Built Environment | | | |
| 5. Land and Shoreline Use | | | |
| a. Relationship to existing plans and population | + | + | - |
| b. Housing | 0 | 0 | 0 |
| c. Light and Glare | 0 | 0 | 0 |
| d. Aesthetics | + | + | 0 |
| e. Recreation | + | + | - |
| f. Historic and Cultural Preservation | + | + | - |
| g. Agricultural Crops | - | - | 0 |
| 6. Transportation | | | |
| a Transportation Systems | - | - | 0 |
| b. Vehicular Traffic | - | - | 0 |
| c. Waterborne, rail, and air traffic | 0 | 0 | 0 |

| | | | |
|---|---|---|---|
| d. Parking | 0 | 0 | 0 |
| e. Movement and circulation of Goods and People | + | + | 0 |
| f. Traffic Hazards | 0 | 0 | 0 |
| Total Relative Benefits | 13 | 8 | -4 |

# Section 1.

## 1.1 GLOSSARY OF TECHNICAL TERMS, AND ACRONYMS

| Term | Definition |
|---|---|
| **ALEA:** | Aquatic Lands Enhancement Account |
| **Anadromous:** | Species that spend early life stages in fresh water, and mature in marine waters |
| **Aquatic:** | Species that live in the water |
| **Benthic:** | Referring to species that live on or under the sediment in a body of water |
| **Berm:** | A sandy mound built up over time by sediment deposits or constructed of earth materials |
| **Bivalves:** | Species such as clams that have a soft body between two hinged shells |
| **ESRP:** | Endangered Species Recovery Program |
| **Fragmented:** | Referring to similar habitats that are broken up into smaller pieces. |
| **GMA:** | Growth Management Act |
| **Invertebrates:** | Any animal that has no spine; this includes species such as crabs and oysters |
| **Large Woody Debris:** | Large pieces of wood such as trees or root wads present in a body of water |
| **Life History:** | Stages of an organism's life and how long it spends in each life stage. |
| **LWD:** | Large Woody Debris |
| **Macroalgae:** | Large algae such as kelp or red algae that may have a root-like structure |
| **NAAQS:** | National and State Ambient Air Quality Standards |
| **Nursery Habitat:** | Habitat that species utilize as they grow into adulthood |
| **Pocket Estuary:** | A portion of estuary with less saline waters and additional sheltering compared to the larger surrounding estuary. They have large ecological importance for their size. |
| **PPMV:** | Parts per million by volume. At standard temperature and pressure, the mole ratio of a specific gas is the same as its volume ration. |
| **PSAA:** | Puget Sound Action Agenda |
| **SCHIP:** | Skagit County Habitat Improvement Plan |
| **Spit:** | An area of deposition that stretches from land out to sea |
| **Terrestrial:** | Species that live on land |
| **Turbidity:** | Sediment suspended in the water |
| **Zooplankton:** | Small marine creatures that include larval stages of marine animals, eggs, and other creatures on a similar size scale. |
| | |

## 1.2 LIST OF FIGURES:



## 1.3 LIST OF TABLES

# SECTION 2: INTRODUCTION

### Title: *Freestad Lake Estuary Restoration: Environmental Impact Assessment*

## 2.1 History

Sir Freestad and his wife, Tora Freestad, donated 82 acres of land to the Community of Christ church in order to build an area where people can come and experience peace and spiritual restoration. The historic site, donated in 1959, was a muddy estuary (Figure 2.). After a few years it became clear that they were in need of a place to swim. After noon, camp-goers would need to walk almost a mile out from the high water line to find an area deep enough to swim in. The campground decided to build their own swimming area in the 1970's. Sir Freestad excavated a small area and installed reverse tide gates that would allow water to flow in during high tide but would be captured during low tide, creating an artificial lagoon (Figure 3). This lake was named after the Freestad's, who donated the land.

Collection of Aerial Photographs
Center for Pacific Northwest Studies
Western Libraries Heritage Resources
Western Washington University

*Figure 2: 1954 aerial image of Freestad Lake restoration site, prior to salt pond excavation in the 1970s.*

***CWD: Skagit County, Washington***

***Agricultural Stabilization and Conservation Service. (Creating Agency)***

***Pacific Aerial Surveys. (Photography Service)***

***Scale: 1:20,000; Set of 6 sheets. CWD-4R***

*Figure 2. A photo of the dike that was constructed to create Freestad Lake. The existing estuary is on the left, and the lake is on the right, photo by Amanda Smith.*

In the early 2000's the church was approached by various salmon restoration groups asking them if they would be willing to participate in restoring the land's use as a pocket estuary. The church believed that this was a good idea seeing as they would not be using that part of the land, and it would give them an opportunity to be good stewards to the Earth. They were also having issues with the lagoon that they had created. The flood-gates were not filtering the water properly during high tide, and water was setting in the lagoon for long enough to warm up. The increase in temperature allowed nonnative jellyfish to inhabit the lake. Camp-goers were being stung by them, and there needed to be a solution to this problem. The church bought nets similar to the ones used in Australia to net out an area safe to swim in, but even this was not completely effective. Along with the jellyfish problem, the lake was filling with silt, and they were losing the depth needed to keep the lagoon cool, causing it to warm even more. An easy solution would have been to replace the tide-gates and dredge the lake, but both of these actions are very costly. The camp agreed to help in restoration, losing northern half of the lake for swimming, if they would get new tide gates to help reduce the jellyfish population.

The plan for the project is almost to completion, and the biggest blockade is the need for funding. Studies on the water table, tide tracking, freshwater inputs and other design plan necessities have been drafted.

## 2.2 Objectives and Purpose

Freestad Lake is part of the Skagit County Habitat Improvement Plan (SCHIP). The SCHIP includes multiple sites that have been identified as requiring restoration to benefit local species such as salmon and shellfish (County, 2012). The SCHIP allocates funding for identified sites and is part of Skagit Counties compliance with the Growth Management Act (GMA; County, 2012). The GMA requires local and state governments to take measures that protect and promote critical areas (Legislature, n.d.). Critical areas include fish and wildlife conservation areas, and wetlands that will be promoted by restoring Freestad Lake (legislature, n.d.). The site was selected as part of the SCHIP by the Puget Sound Action Agenda (PSAA). The PSAA is a collaborative plan involving multiple groups including state, federal, and local government, tribes, and local businesses (Partnership, 2012). The aim of the PSAA is to prevent pollution, recover shellfish beds, and restore salmon habitat (Partnership, 2012).

Freestad Lake is part of Skagit County's overall goal of preservation and restoration of critical areas (County, 2012). After restoration, Freestad Lake will be returned to its original status as a pocket estuary (Beamer et al., 2004/2005). Pocket estuaries are areas of more dilute salt-water within the greater area of an estuary and are understood to have high ecological importance relative to their size (Beamer et al., 2004/2005). They are also more protected from wave action relative to the surrounding area. Similar to larger estuaries, pocket estuaries have high nutrient availability in comparison to other marine systems and are able to support a wide variety of organisms. Because of this, pocket estuaries are often used as nursery habitat by aquatic animals and are also often used by adults of many species. (Beck 2001).

## 2.3 Project Description

The aim of this project is to restore the land north and west of Freestad Lake from converted upland back to its historical state of pocket estuary habitat (prior to anthropogenic modification). This includes conversion of 5.8 acres of lake (Freestad Lake itself) and approximately 35 acres of converted upland/freshwater emergent wetland mix into roughly 3 acres of lake, 25 acres of tidal wetland, and 11 acres of mudflat/open water (Figure 3) . Newly constructed dikes are expected to slightly reduce the size of the 5.8 acre lake, maintaining the southern portion for recreational use by property owners (figure 10). The remaining portion of the lake will be excavated (a yet-to-be-determined amount) to increase depth, as it has grown shallow due to sediment input.

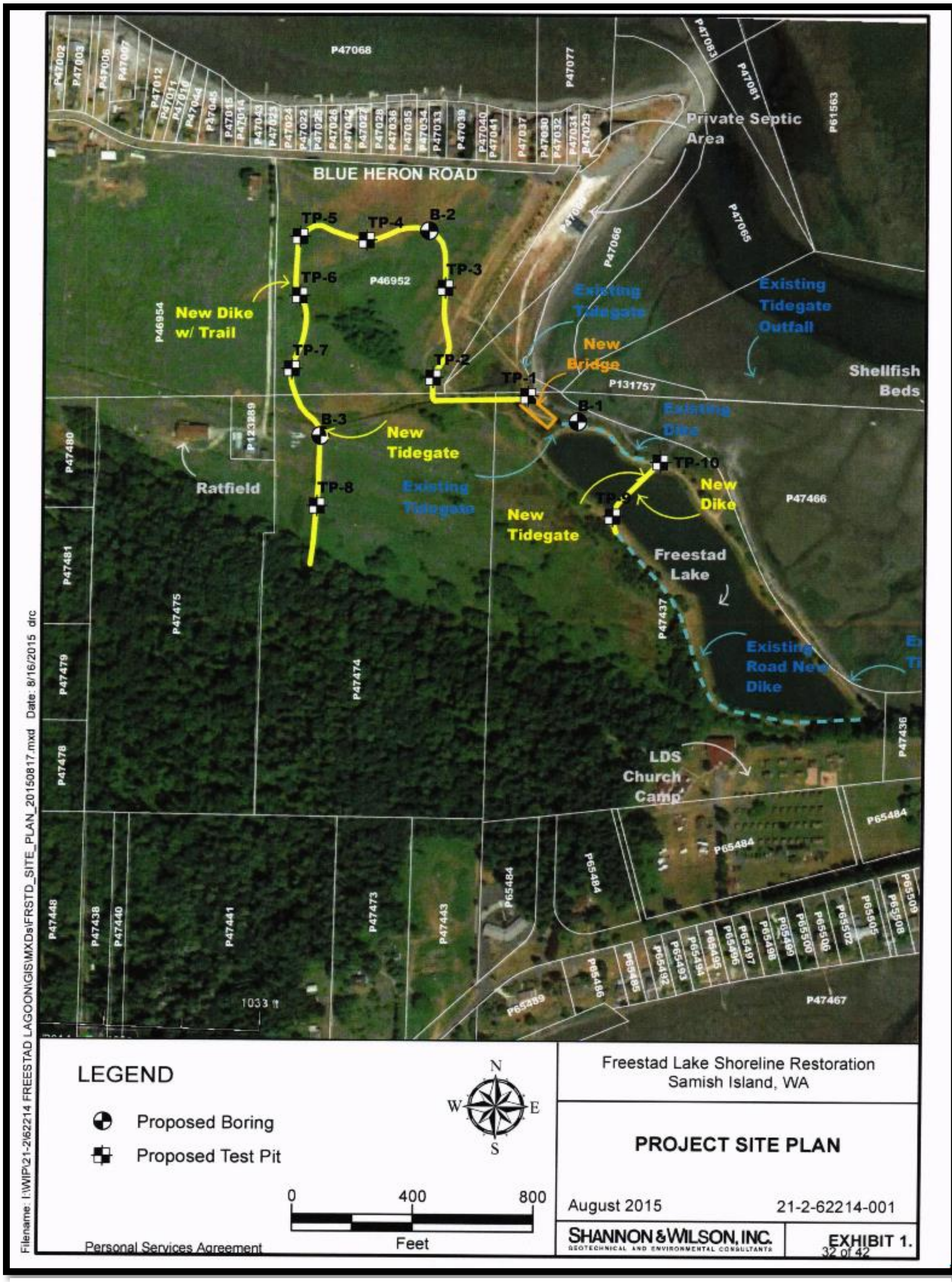


*Figure 3. Final Design Site Map. Credit: Final Design Contract – Shannon & Wilson (via PRISM project snapshot)*

This will be accomplished by setting back existing dikes and tide gates to re-establish the daily inundation patterns typical of estuarine habitats. The new dike will be constructed further inland from existing dikes, encompassing the land slated for restoration to pocket estuary habitat. Approximately 3600 feet of new diking is planned, along the path indicated in Figure 10. While no final plans have been agreed upon, design is likely to be similar to that used in the nearby Fir Island restoration site, in which the following guidelines were observed (Dahlstedt et al., 2015; Derenne, 2016).

As in the Fir Island spur-dike design, finished elevation of newly constructed dikes is to be roughly 15 feet, with a slope ratio of 2.5:1 (horizontal:vertical). Height is set to be 1' higher than estimates for extreme tide-wind-wave events, as indicated in the NRCS 2002 Conservation Practice Standard. The dike's lifespan is estimated to be 50 years, and predicted sea level rise of 0.93 ft during that period will be taken into account during design. Construction will require soil and gravel importation, though some earth materials will be sourced from excavations associated with other aspects of the project. Design of new dikes will be based upon those recently installed at the Fir Island Restoration site. Test pits and borings will be installed approximately every 200' to aid in groundwater monitoring (Dahlstedt, Janicki and Wesen 2015).

A trail will be built upon the crest of the finished dikes, forming a path around the project site (Johannessen and Waggoner 2011). It will be a gravel-road design with pedestrian traffic in mind but will be large enough to accommodate a very limited amount of vehicle traffic for access to nearby oyster beds (Dahlstedt, Janicki and Wesen 2015), (Warinner n.d.).

The current exterior tide gate (exit point for local drainage) will be replaced with an open bridge for foot and vehicle traffic. The bridge will be pre-manufactured, but its substructure will be custom-designed by the contractor tasked with bridge installation. Overall design will be based upon Skagit County's Hansen Creek bridge, a painted steel structure capable of small vehicle traffic (Skagit County, 2014). Informational kiosks will be placed along the path to accomplish the public education aspect of the project. (Derenne, ESRP Application Narrative: Freestad Lake Barrier Lagoon Restoration 2016)

Two new tide gates are to be installed. One will be in the western dike near the Ratfield property to provide freshwater drainage in case of flood conditions. The other will be in the dike forming the new northern border of Freestad Lake, to control water movement through the lake and improve drainage. These can be seen in Figure 10.

A limited amount of pilot channel excavation will be done to the central portion of the restoration site to encourage daily inundation and related nearshore processes. The intention of pilot channels is to provide an initial path for marine waters to enter the system, encouraging natural processes to shape the rest of the restoration site. Some large woody debris (LWD) may be anchored in these open areas to further encourage habitat development.

Ultimately, the project design aims to minimize the need for maintenance costs and to promote habitat formation via natural processes rather than by human action wherever possible. Land that is intended to become tidal wetland habitat will be contoured using a 'naturalistic design.' Efforts will be made to do minimal excavation while assisting in the restoration of nearshore processes. No manual revegetation is planned, as no local invasive plants are expected to survive in the completed restoration site.

While plans are not finalized, this project is expected to take approximately 2 years of work before completion. Year one will likely involve construction of setback dikes and on-site restoration. Year two will see outer dike removal, shoreline grading, and replacement of the outer tide gate with a bridge. This work is likely to be done during early winter in order to avoid disturbance to out-migrating salmonids from the Samish River (Breamer 2004/2005).

## 2.4 Alternative Action

All previously described measures will be taken, except pilot channels will not be excavated in the tidal wetland to promote habitat formation. Natural processes, reestablished by dike setback and tide gate replacement, will be allowed to fully shape the landscape in the absence of human assistance. This reduces the amount of human activity required within the pocket estuary restoration site itself, possibly at the expense of increased time required for development of wildlife habitat.

## 2.5 Impact Summary

Impacts are expected to occur to the following areas.

### Water:

No change to public water sources or flood conditions are expected to occur from Freestad lake's restoration. As the area becomes subject to additional action from the Samish River and tides, there are expected to be changes to surface water, groundwater, and runoff.

### Earth:

Conversion to an estuary is expected to alter all the aspects of earth, though some may not be significant in terms of environmental impact. Conversion of the field north and west of Freestad Lake to an estuary makes it subject to river system dynamics, as it had been prior to diking in the 18$^{th}$ century. Significant changes are expected to local sediment exchange patterns and local topography. The proposed changes are predicted to be beneficial to the local ecosystem, as well as to improve the quality of Freestad Lake for recreational swimming.

### Air:

There is expected to be a change in odor because of the additional mud flats that will form as a result of the estuary restoration. As a result of increased tidal flats, we expect an increase in the density of decomposing seagrasses that will result in more hydrogen sulfide to be produced over the larger area. The additional hydrogen sulfide is not expected to impact air quality. No other impacts to air are predicted as a result of project completion.

### Vegetation:

As a result of project completion current native terrestrial species in the area will not be able to survive. Available ranges will be increased for aquatic plant species. Species will be allowed to self-propagate, and invasive species are not expected to present an issue at the site because there are no known aquatic invasive species near the site.

### Animals:

Marine species that make use of estuary habitat will be positively affected. Additional habitat will be available for multiple fish species and invertebrates. Birds species will also benefit from additional foraging opportunities after Freestad lake is restored to an estuary. The current invasive jelly fish that are periodically found in Freestad lake are expected to be eliminated or less frequently observed after the project is completed.

### Land and Shoreline Use:

Historic use of the site as a campground and swimming area will be maintained with the proposed plan. Swimming conditions are expected to improve because the presence of invasive jellyfish will be reduced. The current trails will be maintained, with minor adaptations to accommodate the new dike. In addition, there are plans to add educational signposts along the trail.

### Aesthetics:

Because of the restoration project there will be additional shoreline in the area considered to have aesthetic appeal. As well, the improved quality of Freestad Lake will improve aesthetics of the Lake itself for summer campers and church attendees.

# Section 3: Elements of the Environment

## Section 3.1: Natural Environment

### 3.1.1 Earth

#### Existing Conditions:

The project site encompasses approximately 35 acres of converted upland, from what was once a pocket estuary composed of saltmarsh (Johannessen and Waggoner 2011). (Chapman 2017) (Chapman 2017). Much of this converted upland appears to be in the process of conversion to patchy freshwater wetlands.

In the mid-1970s, a 5.8-acre salt pond [Freestad Lake] was excavated in the southeastern portion of the Freestad property and removed earth was used to construct the lake's western dike (Chapman 2017). This pond is maintained by the existing dike network, which has proven very resistant to erosion (Johannessen and Waggoner 2011).

Due to inadequate flushing, the lake has experienced an accumulation of sediment and has grown shallower than desired by property owners. This sediment appears to have come from both local terrestrial erosion and transportation from marine water, as there is an open inlet pipe located in the southeastern portion of the lake that extends to the nearby beach.

*Geology:*

This landscape has been heavily influenced by glacial advance/retreat cycles over the course of the last million years, and to a lesser extent by periodic ash deposition from volcanic eruptions in the Cascade Mountains (Wilson and Shannon 2014). Since the most recent glacial retreat, soil profiles indicate that the property in question has been primarily shaped by delta-forming alluvial deposition from the nearby Samish River (USDA 2016). The Samish River's influence on the site proposed for restoration has been effectively severed due to the presence of dikes.

### *Soils:*

Soils within the area of proposed action, as seen in Figure 4, are classified as Tacoma Silt Loam (USDA 2016). They are poorly drained and classified as hydric soils. They have a low to moderate salt content as a result of historical interaction with marine waters, despite their relatively recent agricultural use. Drainage is slightly better on the southern portion of the property, where a silty clay loam layer underlies the upper 30 inches of silt loam. In the northern portion of the Freestad property, the clay-free silt loam layer extends to at least 60 inches in depth. Beneath these layers is a mixture of coarse sandy material that contains a small amount of pebbles.

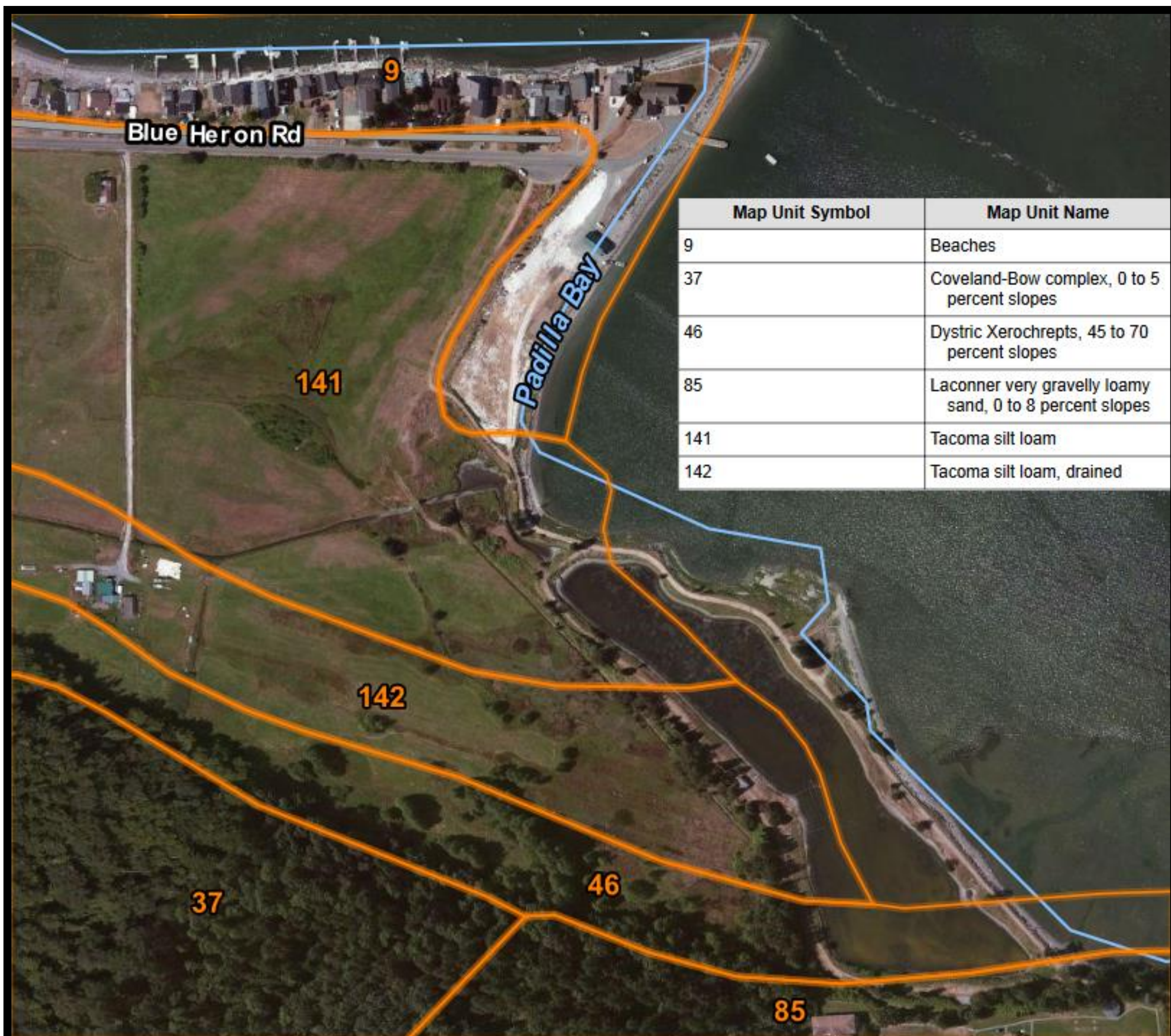


*Figure 4. Soil types at Freestad Lake*

Along the site’s southern border is an escarpment landform with a 45-70% slope, containing well-draining soils of glacial origin (USDA 2016). It consists of mixed gravelly bedrock underlain with a gravel/sandy loam mix, with gravel and sand proportions increasing with depth. This soil is characterized as Dystric Xerochrepts.

### *Topography:*

Consistent with landforms of deltaic deposition, the portion of the Freestad property of interest is flat. The exception to this is the hill along the southern edge of the property, and local manmade features such as dikes and ditches. The area’s natural topographic features can be seen in Figure 5. (USGS Store 2012).

*Figure 5. Topographic map of Freestad Lake restoration site. Contour lines in 20' increments. Credit: U.S. Geological Survey, Department of the Interior/USGS.*

Dikes on the property are built 6-12 feet tall, having a ten-foot-wide top and an estimated 45-foot toe width. They currently extend approximately 5,100 feet in length. Roughly 3,370 feet of diches are located on the property, and they range from 3-6 feet deep and 3-8 feet wide (Johannessen and Waggoner 2011).

### *Erosion/enlargement of land:*

Freestad Lake itself has accumulated sediments and grown shallow as described by the landowner. The majority of sediment input is likely from Samish Bay, having been transported by seawater into the inlet pipe in the southeast corner of the lake. Additional sediment input is likely due to erosion of nearby slopes and trails.

The rest of the property has effectively been severed from natural erosion and deposition processes by 18th century dike construction. Sediments carried by ditches from the interior of the island appear to effectively flush via the outer tide gate.

## Proposed Action:

### *Geology:*

At the site of bridge installation and the proposed estuary inlet, removal of the exterior tide gate and an estimated 80-120 feet of the surrounding dike will reestablish interaction of the restored site with deltaic deposition processes. The period of time this area was cut off from these processes is, in geologic terms, relatively short. No large-scale changes are expected, aside from resumption of the briefly-interrupted natural land-forming processes. (Dahlstedt, Janicki and Wesen 2015).

### *Soils:*

Soils within the project site, being of alluvial origin, will either return to their natural state of interaction with coastal processes or will be far enough inland to undergo no significant change. Coarser subsoils may be exposed in inundated areas via erosion of the silt-loam surface soils, and this is likely to benefit aquatic wildlife associated with pocket estuary habitats.

Materials excavated from Freestad Lake are likely to be repurposed for dike construction, as was done during previous dike construction events, but this limited supply will need to be supplemented with imported fill. An indeterminate amount of landfill will require importation for dike construction, as no plans exist detailing their design. Since the same contractor is involved in planning as was hired for the nearby Fir Island restoration, similar dike designs may be implemented. This would imply a dike structure 15 ft. tall, 15 ft. wide at top, and 37.5 ft. toe width at the base, satisfying the 2.5:1 horizontal to vertical design ratio (Wilson and Shannon 2014). Considering the estimated 3,600 ft of new dike construction, this would indicate a need for approximately 52,000 yd3 of fill (Dahlstedt, Janicki and Wesen 2015).

### *Topography:*

Approximately 3,600 feet of new dike is proposed to be constructed along the northern and western portions of the Freestad property (Dahlstedt, Janicki and Wesen 2015). The lake itself is to be excavated an indeterminate amount to allow recreational swimming, but no finalized plans exist that define the desired depth. The water body will remain isolated by currently existing dikes during construction, so sediments are likely to be locally retained. A dike is to be constructed across the northern portion of Freestad Lake, reducing total area of the lake and allowing the newly separated portion to join the rest of the restoration site. This new portion is predicted to be excavated to form a deep-water pool relative to the rest of the restoration site (Johannessen and Waggoner 2011).

Pilot channel excavation will be conducted to guide tidal water into and around the core of the restoration site. No final designs exist, but a small network of channels roughly estimated to be 5-25 feet wide and 3-10 feet deep seems reasonable.

Grading will be done along the inlet channel and along the shorelines near the proposed bridge installation where current dikes are to be removed (Dahlstedt, Janicki and Wesen 2015). This reduction in local topography is intended to reduce erosion risk to soils underlying the bridge's substructure and to provide a more natural landform for the inlet of the restored pocket estuary. This open inlet will allow for much better movement by fishes and other wildlife than the previous tide gate or a culvert might (Figure 14).

In terms of small scale topographic features, LWD installation and anchoring were referenced in Final Design Contract but no specific plans were presented. There is abundant woody debris available along the existing beach, so relatively little importation may be needed. A relatively small amount of excavation will be required to partially bury LWD in and around pilot channels.

*Erosion/enlargement of land:*

The water body will remain isolated by currently existing dikes during construction, and sediment is thus likely to be retained until removal of exterior dikes. The restoration site will undergo a considerable amount of erosion upon removal of the exterior tide gate and immediately surrounding dike. A pulse of sediment export is likely as a result of dike construction and pilot channel excavation within the enclosed work site prior to exterior dike removal. Proximity of this site to the Samish River's channel in Samish Bay is likely to assist in sediment export, particularly during the initial pulse (Chapman 2017). Estimates are that 11 acres of mudflat are to be created as a result of restoration, and sediment export from the restoration site is likely to play at least a minor part in this (Dahlstedt, Janicki and Wesen 2015).

Restoration will restore the natural sediment exchange dynamics that were in place prior to 18th century dike construction, as tidal wetlands undergo regular erosion and deposition events with tidal activity. It is likely that sediment accumulation will take place in areas experiencing low wave energy, and erosion will take place in areas of higher wave energy. Pocket estuaries are dynamic environments, and these erosion and deposition processes will promote wildlife habitat formation in the long term (Derenne and Ramsey, Washington State Recreation and Conservation Office 2016).

Freestad Lake's drainage should be improved by installation of the new tide gate along its new northern dike, as the existing one was described as moving a 'quite low' amount of water (Johannessen and Waggoner 2011). The lake will presumably be swimmable for another ~50 years, assuming the new tide gate provides any improvement to the lake's flushing capacity.

Alternative Action:

*Geology:*

No ecologically significant difference would be expected by not excavating pilot channels, as both measures will reestablish historic patterns of interaction between the restoration site and both riverine/estuarine influences.

*Soils:*

Slower rates of erosion will be expected to result from the alternative plan, as a result of decreased disturbance in the restoration site. This may lead to an increased proportion of silt-loam substrate in the restoration site during habitat development, although these poorly drained soils will likely still be lost to erosion processes. Less sand and pebble substrate will be available for habitat as a result, at least for a period of time until

*Topography:*

No excavation of pilot-channels will produce less topographic complexity in the short term following completion of the project. These channels will develop over time as a result of erosion by tidal activity, but would take longer.

*Erosions/enlargement of land:*

An increased window of time during which a comparatively small amount of sediment is exported will result from the alternative action. In the long term, no significant change in sediment export will be expected. One consideration to take into account may be the preferred timing of sediment export to the Samish Bay estuary upon removal of the exterior tide gates and dikes. For this reason, the proposed action may better enable human management of the timing of sediment export events. (Figure 6)


*Figure 6. Credit: Image taken from PRISM, 'aerial photo of tide gate on the Northern end of Freestad Lake.*

That said, allowing natural processes to shape the landscape from a figurative blank slate could conceivably improve final habitat quality. Human-directed habitat formation may be based upon faulty assumptions or might interrupt natural habitat formation processes that would proceed regardless of human intervention.

### 3.1.2 Air

### Existing Conditions:

*Air Quality:*

Dangerous levels of hydrogen sulfide, which produces the rotten egg smell associated with decaying sea grasses, is harmful to humans at levels of 100 ppm or more (Occupational Safety and Health Administration 2005). National and State Ambient Air Quality Standards (NAAQS) set $SO_2$ annual average concentration standards to not exceed 0.02 parts per million by volume (ppmv) in a calendar year as set in Chapter 173-476 of the W.A.C. Neither the Dept. of Ecology nor Dept. of Health has noted levels exceeding standards in the current estuarine tidal flats surrounding Samish Island.

*Odor:*

The odors emitting from the tidal flats are naturally occurring, and no noxious or unnatural odors are present.

### Proposed Action:

*Air Quality:*

The excess in tidal flats will create an increase in the release of Sulfur Dioxide ($SO_2$). This increase will be minimal due to the relatively small amount of land that will be added to the large estuarine mud flats already compromising the area.

*Odor:*

The proposed action will combine 35 acres of converted upland/freshwater emergent wetland, 25 acres of tidal wetland, and 11 acres of mudflat/open water to create a pocket estuary. This new pocket estuary will increase the density of aquatic macrophytes (plants and attached algae) such as seagrass. As well, the increase in mud flats will produce an increase in hypoxic (low oxygen) environments.

One group of bacteria that will thrive in the hypoxic organic muds that accumulate as the estuary develops is sulfate-reducing bacteria. Instead of using oxygen for respiration, like aerobic bacteria, they use sulfate ($SO_4$), which has a molecular bond between sulfur and oxygen. These bacteria are able to live in low oxygen environments, such as the new pocket estuary, and break down organic material present. These bacteria create a waste product as they respire called hydrogen sulfide ($H_2S$). $H_2S$ smells like rotten eggs (Marine Science Institue Blog 2012). Some common names for the gas include sewer gas, stink damp, swamp gas, and manure gas.

Since $H_2S$ is heavier than air, it stays low to ground and can travel at ground level, making the odor noticeable from both the adjacent diked walkway and "lake." Both of these locations are within hundreds of feet of the new pocket estuary. However, while some may find the smell noxious, it is a natural occurrence in estuaries. There are a few elements of this pocket estuary on Samish Island that may increase the presence of the smell to habitants of the island. Because of the variance in high and low tides, paired with the being in a 100 year flood plain, large areas are expected to be populated by sea grass that will accumulate along the shores of the pocket estuary. $H_2S$ fluctuates with tidal cycles, with maximum emission rates at night and at low tide (Bo Barker Jorgenson 1967). Other areas, such as Western Port beaches in Australia have closed estuaries due to the rotten-egg-like smell as a result of accumulated decomposing seagrass (Taylor 2015). Some people can smell these gases at concentrations as low as 0.6 parts per billion (ppb). However, severely dangerous levels of $H_2S$ do not occur until levels of 100 parts per million (ppm). Lower concentrations can irritate the throat, eyes, nose, and respiratory systems (e.g. burning/tearing of eyes, cough, shortness of breath; Table 2; (Occupational Safety and Health Administration 2005).

*Table 2: Health Effects of hydrogen sulfide*

| Concentration (ppm) | Symptoms/Effects |
|---|---|
| 0.00011-0.00033 | Typical background concentrations |
| 0.01-1.5 | Odor threshold (when rotten egg smell is first noticeable to some). Odor becomes more offensive at 3-5 ppm. Above 30 ppm, odor described as sweet or sickeningly sweet. |
| 2.0 - 5.0 | Prolonged exposure may cause nausea, tearing of the eyes, headaches or loss of sleep. Airway problems (bronchial constriction) in some asthma patients. |
| 20 | Possible fatigue, loss of appetite, headache, irritability, poor memory, dizziness. |
| 50-100 | Slight conjunctivitis ("gas eye") and respiratory tract irritation after 1 hour. May cause digestive upset and loss of appetite. |
| 100 | Coughing, eye irritation, loss of smell after 2-15 minutes (olfactory fatigue). Altered breathing, drowsiness after 15-30 minutes. Throat irritation after 1 hour. Gradual increase in severity of symptoms over several hours. Death may occur after 48 hours. |
| 100-150 | Loss of smell (olfactory fatigue or paralysis). |
| 200-300 | Marked conjunctivitis and respiratory tract irritation after 1 hour. Pulmonary edema may occur from prolonged exposure. |
| 500-700 | Staggering, collapse in 5 minutes. Serious damage to the eyes in 30 minutes. Death after 30-60 minutes. |
| 700-1000 | Rapid unconsciousness, "knockdown" or immediate collapse within 1 to 2 breaths, breathing stops, death within minutes. |
| 1000-2000 | Nearly instant death |

With the new pocket estuary, levels of hydrogen sulfide likely will remain under the limits set by WDOE because of the relatively small amount of increased tidal flats and the typically windy marine waters of the Puget Sound that act to disperse smells such as those produced by $H_2S$. And while the increase in $H_2S$ may evident to nearby homeowners, it will not affect the health of any of those around the area. Monitoring of levels of $H_2S$ could be conducted by WDOE in order to ensure complete aeration of the area is occurring and levels of $H_2S$ are not building up.

## Alternative Action:

With the alternative action, the difference between pilot channel excavation and natural erosion processes will not affect the size and shape of the estuary. The size is the main determinate of hydrogen sulfide density, which is the concern for both air quality and odor. Because size will not be affected, the alternative will likely cause no change to air quality or odor compared to the proposed action.

## No Action:

### *Air Quality*:

If no change were to occur to the current land, then air quality will remain the same. The natural windy atmosphere of the coastal PNW aids in flushing air throughout the northeast corner of the island. Air quality conditions will remain within the standards set by the WDOE.

### *Odor:*

As Samish Island is a coastal environment surrounded by mud flats, there is already a presence of hydrogen sulfide concentrations at low tide. If no action is taken this will not increase or decrease the presence of the smell emitted by hydrogen sulfide.

## 3.1.3 Water

### Existing Conditions:

*Overview of Current Water quality, quantity, and movement:*

The temperature of the marine water in Freestad Lake is warmer than the open waters of Puget Sound. This warmer environment can provide a thermal refuge for cold-intolerant nonnative organisms.

The site has ditches for drainage from abandoned agricultural fields.

The watershed does not encompass a lot of land and is isolated from population centers and thus is not subject to point sources of pollution to its waters.

*Surface Water:*

Lake Freestad is a constructed marine lagoon that has a tide gate on the southern end of the lake. The tide gate is too small to have efficient exchange with the water of the incoming tides; this causes the lake to be warmer than the adjacent marine waters. The ditches at the site from when they were for agriculture drain the fields; however, these ditches do not drain into the lake, as there are no freshwater inputs. There are no active agricultural uses of the property, and therefore there is no large nutrient input to the bay. The ditches also do not run near roads or other impervious surfaces, and therefore the water quality is quite good. The only water quality problem may be due to dog walkers that do not pick up their dog's feces causing bacterial pollutio, but the area is not heavily trafficked.  The area itself does not pull water from a large area and does not have many opportunities to acquire pollution.

*Runoff:*

The reed canary grass that populates most of the property, along with a few deciduous trees and even fewer coniferous trees, do not provide much retention for runoff. The longer ditch runs west to east and a shorter ditch runs south to north. These ditches provide excellent drainage for the area and move water efficiently. There is a paved residential street running along the northern end of the site but there is approximately 750 feet between the road and the nearest ditch creating a buffer to let toxicants settle and infiltrate into the ground.

*Flooding:*

Flooding is a concern for the area, and historically residents had to time their commutes with the tides. Flooding occurs on the residential side and can flood over the road. This happens during large storm events corresponding to high tides.

*Groundwater:*

The area contains freshwater wetlands and was once a pocket estuary. This means that the ground water is very close to the surface at only 4 to 6 feet deep.

*Public Water Supplies:*

Residents are on city water but have septic fields.

## Proposed Action:

*Surface Water:*

The proposed action would drain the northern half the lake and open up the land surrounding it to the bay. This would inundate the land and form an estuary. The effect of this plan on the lake itself would convert land to be used a habitat for forage fish. The plan will channel some areas of the land to be flooded in order to aid the water flow across the land. The construction of this adds some suspended solids to the water column but this decreases over time as the water settles. This also increases the overall movement of surface water throughout the property, and the increase in the salinity of surface water would kill much of the current vegetation. This would leave the area less vegetated and may decrease the absorption capacity for water of the property. This also would be mitigated once marine vegetation repopulates the area. The proposed project, along with the alternative, must account for the loss of the drainage area. Placing the berm will account for this loss, whether it includes the north-south ditch or not. If it does not include the north-south ditch, then there will need to be proper drainage available in case of flooding.

*Runoff:*

Runoff would not be affected by this proposed action because it will not increase impervious surfaces to the already minimal impervious surfaces on the property.

*Flooding:*

The proposed action will not mitigate flooding through the residential areas because it does not address the residential area but rather the open fields south of the houses. When storms that flood those homes occur, they come from the north rather than the east where the dike has prevented flooding and erosion. If a storm came from the east and the river was flooded, then the area will allow some mitigation. However, the likelihood of that occurring is very minimal. If project does not account for drainage for the ditch, then a resident's home could flood. This would happen via the ditch intersection where it meets the berm. The proposed project will either include the south-north ditch within the berm or provide adequate drainage in the event of a flood.

*Groundwater:*

Though the area will be inundated, the groundwater table will not be affected. This is because the increase in surface water will not feed into underground aqueducts. The surface water will increase and meet the groundwater, but the actual water table will not increase where there is no existing surface water.

*Public Water Supplies:*

Due to the fact that residents are not on well water, there is no concern that their drinking water may be contaminated by inundation of the property. The residents are concerned that their septic systems may be affected since some residents are on older systems.

### Alternative Action:

The alternative action will allow the tides to naturally channel the estuary without mechanical aid from people. Therefore, the amount of water, the quality, and the movement surface and groundwater will have the same outcome as the proposed action.

## 3.1.4 Vegetation and Animals

### Existing Conditions:

*Overview of current habitat:*

The terrestrial habitat is a patchwork of fresh water wetlands (Figure 7). Species composition in the lake is affected by interactions with the marine environment through the tide gates.


*Figure 7: Wetlands at or near the project site. The image was taken from the United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (2017) and modified to include the approximate outline of the project site in red.*

### *Vegetation:*

The majority of the site is currently dominated by grasses. The native species nootka rose (*Rosa nootkana)*, red alder (*Alnus rubra)*, shore pine (*Pinus contorta)*, and vine maple (*Acer Circinatum)* are sparsely located on the site. The noxious weeds himalayan blackberry (*Rubus armeniacus)* and english ivy (*Hedera helix)* are also present throughout the site.

### *Fish:*

Small fish could enter the lake through the culvert at the southeast edge of the lake shown in Figure 8. the three-spine stickleback (*Gastrosteus aculeatus)*, a common estuarine species, is expected to inhabit Freestad Lake (Lefébure et al., 2011). Three-spine sticklebacks are able to tolerate wide temperature and salinity ranges (Lefébure et al., 2011) ; However, no fish species have been reported in the lake.

*Figure 8: Image of existing culvert, on the southeastern corner of Freestad Lake.*

### *Invertebrates:*

Freestad Lake periodically contains non-native jellyfish. Experts have not been able to positively identify the species beyond determining that the species is not native to the Puget Sound (Dahlstedt et al., 2015). The jellyfish are small when they enter the lake and then become trapped because there is little tidal action. It is suspected that the warmer water in the lake promotes their growth, and they become larger in the lake than in the rest of the Puget

Sound. The jellyfish are not expected to represent a source population to the rest of the Puget Sound because their numbers fluctuate greatly within the lake itself, and no jellyfish have been seen in the lake the last two years.

### *Birds:*

Migratory birds are found seasonally at Freestad Lake because of its location on the Pacific Flyway. The Pacific Flyway is a migratory flight path that is used by over 350 bird species (Council n.d.). killdeer (*Charadrius vociferous)*, buffleheads (*Bucephala albeola)* , and bald eagles (*Haliseetus leuceocephalus*) are migratory birds that were observed at the site in March.

## Proposed Action:

### *Overall Habitat Changes*

After restoration, the habitat will be converted to a pocket estuary. This is expected to increase the diversity and number of plants and animals in the area.

### *Vegetation:*

Current terrestrial plants will not survive salt water inundation. Marine and nearshore species will replace them. Aquatic plant species were identified that are indicative of nearshore habitat in the Skagit County Intertidal Habitat Inventory (Ritter, et al. 1996). These include eelgrass (*Zostera marina)*, kelp (*Laminariales*), red algae (*Rhodophyta*), and green algae (*Chlorophyta)* (Ritter, et al. 1996). Gumweed (*Grindelia)* and saltweed (*Atriplex)* are plants that populate areas of deposition with occasional flooding that were identified by the Skagit County Intertidal Habitat Inventory (Ritter, et al. 1996)

Eelgrass is the primary plant species of interest because it fulfills multiple ecological functions within the estuarine system.  When eelgrass is present, the available nutrients in nearshore systems are increased (Dept. of Ecology 1998). Bacteria flourish in the stable soil surrounding the root system, and small organisms consume decaying plant matter that collects on the leaves (Dept. of Ecology 1998). In the fall and winter eelgrass decays, and the nutrients are released into the marine system. Eelgrass increases the amount of nutrients available at the bottom of the nearshore food web.

When the tides are low the eelgrass beds retain moisture. This prevents any organisms hiding in the eelgrass and their eggs from becoming desiccated. Because of this eelgrass provides refuge from larger predators and is the preferred spawning habitat for small fish. Because of the services eelgrass provides, it has been identified as critical habitat by Washington Department of Ecology Shoreline Management Act (Encyclopedia of Puget Sound, 2017)

Eelgrass is expected to begin providing ecosystem services shortly after the project is completed. In the fall and winter when there is less light available, the visible eelgrass shoots die back (Encyclopedia of Puget Sound, 2017). During the spring and summer eelgrass rapidly grows to heights of 3 feet from existing root systems and propagates via seed dispersal (Encyclopedia of Puget Sound, 2017). Because of this eelgrass can begin to populate an area after a single growing season.

### Fish:

### Forage fish:

Nearshore habitats are used by forage feeders as spawning habitat and as nursery habitat for juveniles (Penttila, 2007; Essington et al., 2011). The Freestad Lake project is predicted to benefit forage feeders because it increases the habitat they have available for spawning and juvenile growth. Sand lance (*Ammodytes*), surf smelt (*Hypomesus pretiosus)*, and Pacific herring (*Clupea Pallasii)* are all known to be responsive to changes in estuarine habitat (Penttila, 2007; Essington et al., 2011). Improving habitat that promotes spawning is considered an effective way to manage forage fish populations (Penttila, 2007). Because of this forage fish are expected to benefit greatly from the changes that take place after restoration is complete.

Forage fish are considered ecologically important because they provide a food source for larger predators such as salmon, birds, and marine mammals. They consume the zooplankton that is found on eelgrass or floating in the water. Forage feeders form a link in the food web from zooplankton to larger predators. Pacific herring are considered a keystone species in the Puget Sound marine ecosystem because of their role in the food web. (Penttila, 2007)

Pacific herring spawn from January to April (Essington et al., 2011). They prefer to spawn in eelgrass beds growing in sheltered bays (Essington et al., 2011). They have core areas that they visit annually in addition to spill over areas (Penttila, 2007; Essington et al., 2011; Sandell, 2017). The Freestad Lake project is located near documented spawning ground for Pacific herring (figure 9.). Herring populations are expected to benefit because of the ideal spawning conditions that will be created at the site and the proximity to existing spawning habitat.

Near Freestad Lake surf smelt typically spawn from May to October, though smelt have been documented to spawn year-round near Whidbey Island and the San Juan Islands (Essington et al., 2011). They are known to spawn on both sheltered and open beaches in the upper intertidal zone (Penttila, 2007). Like Pacific herring they prefer eelgrass for spawning habitat. Completing the Freestad Lake project will increase spawning grounds for smelt.

Sand lance spawn in the upper intertidal zones from November to February. They prefer to spawn in eelgrass and areas where sand and gravel are deposited. Of the three forage fish they tend to spawn the closest to shore. After restoration, deposition that is expected to occur at the site will create favorable spawning conditions for sand lance (Essington et al., 2011).

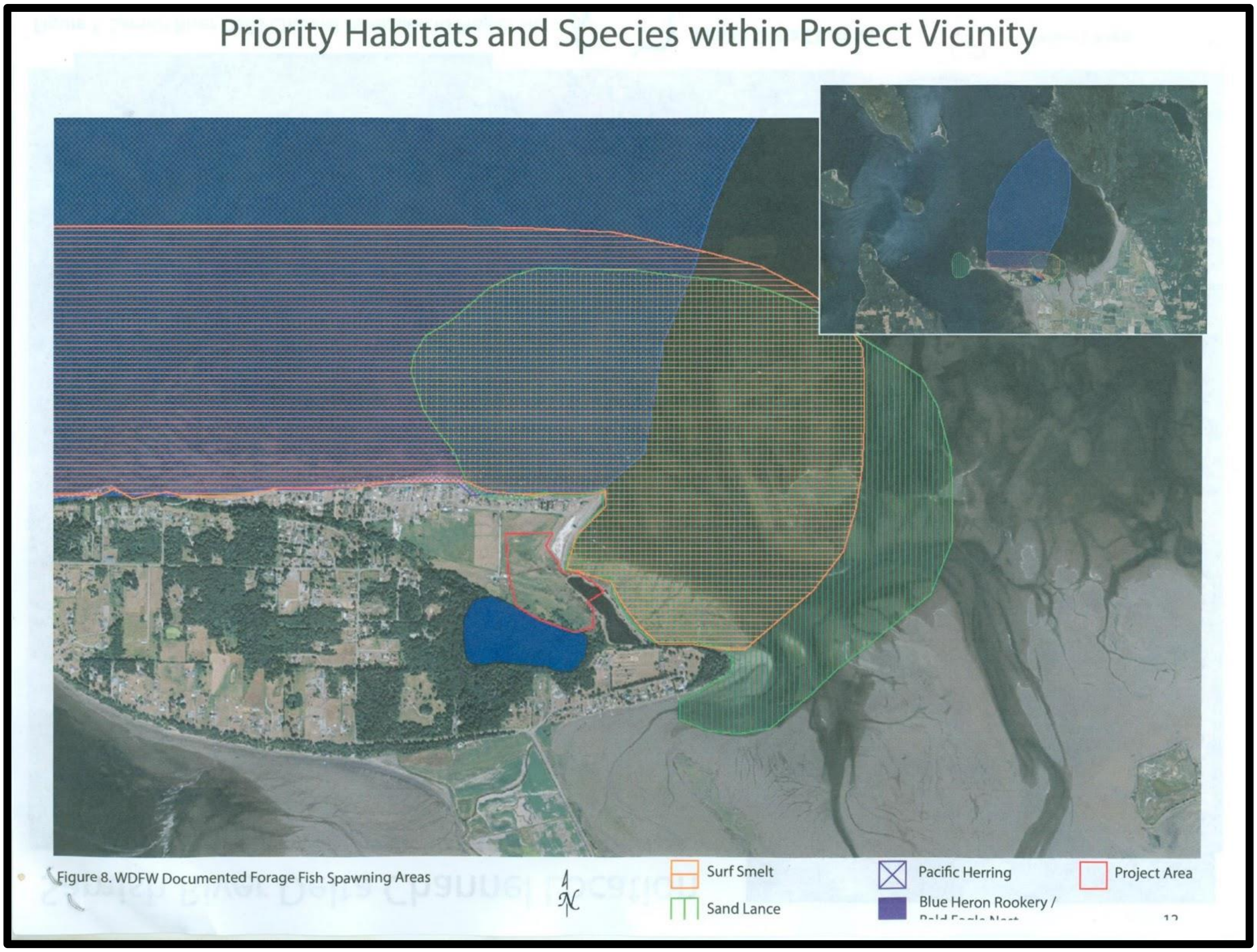


*Figure 9. Existing spawning habitat of Pacific herring, surf smelt and sand lance (Derenne and Ramsey, Washington State Recreation and Conservation Office 2016).*

### Salmon:

Salmon species will benefit from the Freestad Lake restoration project because they prey on forage fish and take refuge in eelgrass as juveniles (Dept. of Ecology 2016). Coho (*Oncorhynchus kisutch)*, pink (*Oncorhynchus gorbushca)*, chum (*Oncorhynchus keta)*, and chinook (*Oncorhynchus tshawytscha*) all utilize the Samish River and rely on estuaries for part of their life cycle (Dept. of Ecology 2016).

Chinook salmon were identified in the Skagit County Habitat Improvement Plan (2012) and the Puget Sound Action Agenda (2012) as the primary species of interest. Chinook salmon in pocket estuaries exceed numbers found in surrounding areas (Beamer et al., 2003). There were between 10 and 100 times more Chinook salmon found in pocket estuaries within the Puget Sound (Breamer et al., 2003)

### *Invertebrates:*

Jellyfish are expected to be eliminated after the site has been restored. After completion the water will be colder and subject to greater influence from tidal changes. The conditions that have supported the jellyfish populations will no longer exist.

Oysters and clams will benefit from the site. Pacific oysters (*Crassostrea gigas)* are currently harvested near the site and are a species of interest. They are a non-native species farmed by Taylor Shellfish and the Blue Oyster Company in Samish Bay (Dethier, 2006). They occupy a different niche than native oysters because they have different salinity and temperature tolerances (Dethier, 2006) They do not reproduce well on their own and have not been documented to cause ecological harm (Dethier, 2006).

Crab species are commonly found in the eelgrass beds and intertidal zones that will be created after the site is completed (Encyclopedia of Puget Sound, 2017). Crab shells were found on the beaches near the project site, and crabs are predicted to begin using the restored area once eelgrass has established (Figure 10). Dungeness crab (*Metacarcinus magister)* is a species of interest because these crabs have recreational value within Samish Bay (Dethier, 2006).

Dungeness crab also occupy multiple ecological niches within their lifetime depending on their developmental stage (Encyclopedia of Puget Sound, 2017). During their earliest stages of development Dungeness crab is one of the many species that make up zooplankton and are consumed by forage fish (Encyclopedia of Puget Sound, 2017). As they grow larger they are consumed by birds and marine mammals.

*Figure 10: Dungeness crab shell found on the beach near Freestad Lake, photo taken by Amanda Smith*

*Birds:*

All birds that rely on the Pacific Flyway and use nearshore habitats will benefit from the project's completion. Birds that use the Pacific Flyway will stop briefly as they migrate, or take up seasonal residence in estuaries (Council, n.d.). Species of interest include the marbled murrelet (*Brachyramphus marmoratus)*, bald eagle, and great blue heron (*Ardea herodias)*.

The great blue heron  nesting sites bordering Freestad Lake are shown in Figure 9 in blue, and these birds can be found on Washington’s coasts year round (Skagit Land Trust n.d.). A great blue heron was observed in the existing estuary surrounding Freestad Lake (Figure 11.). They protect themselves from predators by nesting in large groups called a rookery (Audubon society n.d.). Their preferred diet is forage fish, but they also eat invertebrates and smaller birds (Audubon Society n.d.). They will benefit from the increased number of forage fish that will populate the restored area.

Bald eagles inhabit coastal habitat in the Puget Sound year round. They prefer to eat fish, including forage fish and salmon that will populate the site. They will also prey on birds and mammals that inhabit the area (Audubon Society n.d.).

The marbled murrelet is a threatened bird species that spend their breeding season on Washington's coast (Audubon Society n.d.). They forage in shallow waters near the shore for sand lance, herring, and small invertebrates. Their preferred diet are the forage fish that will populate the restored site.

*Figure 11: A Great Blue Heron fForaging in the surrounding estuarine wetlands photo taken by Amanda Smith, 2017.*

## Alternative Action:

### *Differences from proposed action:*

The same habitat changes that take place in the proposed action are expected to take place over a longer time frame in the alternative action. The wave action is low so terrestrial areas are expected to persist for a longer period of time. When erosion does begin to occur the landscape is likely to be dominated by saline emergent wetland first. Saline emergent wetland is occasionally flooded and is dominated by salt tolerant species such as saltweed and gumweed (Dept. of Ecology 1998). Over time the pocket estuary would develop but the benefits to fish, invertebrates, and birds would be delayed.

# SECTION 3.2 Built Environment

## 3.2.1 Land and Shoreline Use

### Existing Conditions:

The shore has a long history of anthropogenic alterations, some of which predate the earliest aerial mapping efforts. Records kept by local farmers surrounding dike work and agricultural efforts indicate that this was once a pocket estuary that was ditched and diked to create agricultural fields that are evident with the current formation of the land. Because of this, not much is known of the natural state of this part of Samish Island. Currently the configuration of the shore is an excavated salt pond (Freestad Lake) and drained agricultural fields surrounded by dikes with drainage ditches, fill areas, and tide gates.

As agricultural fields, the land is currently used for recreation by the adjacent church for summer camps. The saltwater lagoon is used for recreational swimming by the same church. The area is also within a 100-year flood plain, with the dikes in place to prevent flooding. This grey infrastructure, meaning built infrastructure versus green infrastructure which would be natural elements preventing flooding (tidal flats), works most of the time, but drain fields can become saturated at times.

### Proposed Conditions:

The proposed action of channel excavation that will convert 5.8 acres of lake and 35 acres of converted upland and freshwater emergent wetland (drained agricultural fields) mix into roughly 3 acres of lake, 25 acres of tidal wetland, and 11 acres of mudflat/open water (Figure 18). There will be approximately 2,500 linear feet of tide channel habitat. Pocket estuary functions will be re-established with dike removal, land contouring, and dike setbacks. All of this converted land will likely function as a pocket estuary. The remaining section of the lake will be improved in quality through a lower ground level, reducing lake temperatures and invasive species of jelly fish that currently sting those swimming in the lake.

The new dike will decrease current land use by about 35 acres, which will only affect the church (current property owners) and its activities. However, the increase in estuarine land and diked walkway for public access will likely supplement most of the activities that took place on the drained agricultural fields.

The National Oceanic and Atmospheric Administration (NOAA 2017) notes that "coastal wetlands – our natural defenses – help protect coastlines by acting as a permeable barrier that slows waves and surge through friction and reduces flooding" (NOAA 2017). While floods have historically been controlled through diking and ditching (gray infrastructure), flooding will likely be more controlled by green infrastructure in the estuary (John Talberth 2012). NOAA cites many cases where coastal wetlands have decreased property damage that would have otherwise occurred without wetlands in place. Along with flood mitigation, the new pocket estuary will likely serve as a haven for an array of flora and fauna as denoted in Section 3.1.4: Plants and Animals. With the introduction of the pocket estuary, and the visible natural conversion process to a usable ecosystem, the new dike surrounding the estuary will be used as a natural interpretive walk where church summer camps and public will be able to enjoy the natural environment while being informed by interpretive signs. As well, the church plans to provide nature classes that will be integrated into the summer camp as an additional educational opportunity for summer camp attendees.

### Alternative Action:

The alternative action of allowing natural  action will likely cause the shoreline to go through natural erosion processes that were not historically documented because they predate aerial mapping efforts. The same amount of land area will be used for the new habitat, and no change in composition of land use would occur. The change in erosion processes would create a slower

rate of erosion for the tidal flats. However, the observation of natural erosion processes could have educational benefits. These benefits could be enjoyed by summer camp attendees who are attending nature classes and community members enjoying the dike walk with nature signs, and for scientific observation. NOAA states that over 50% of tidal estuaries have been lost in the past century, and so to observe natural processes of estuarine takeover of agricultural lands could be very valuable as a model for future restorations (NOAA 2017).

Recreational uses of the remaining portion of Freestad Lake will remain the same for summer camp attendees that can continue to enjoy boating and swimming. The aesthetics of the alternative will offer the same views of the estuarine revival process, but at a slower rate. The relationship of the existing land to the proposed project area will remain unchanged, as well (Figure 12).

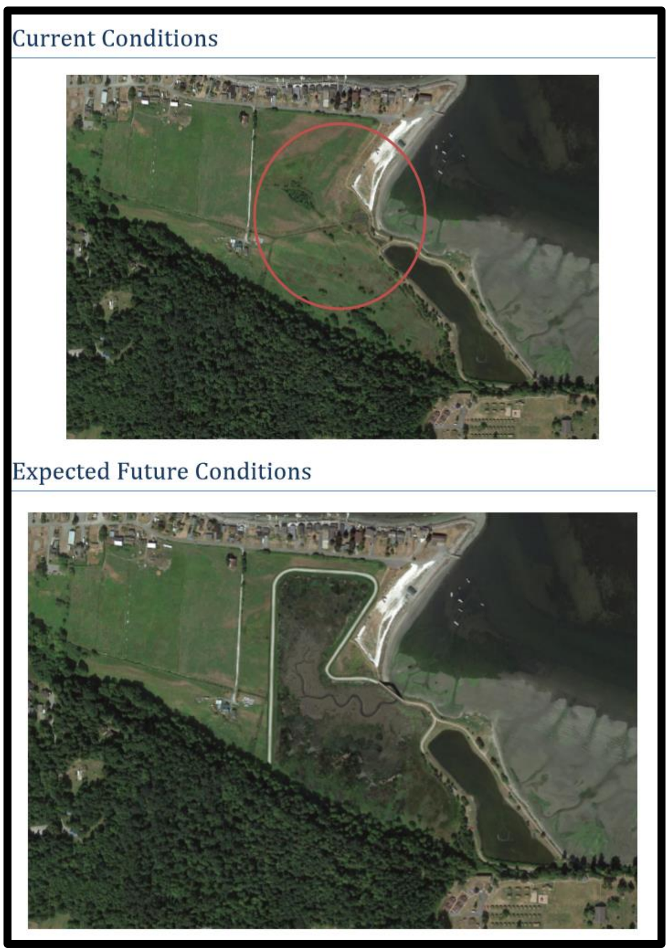


*Figure 12. Proposed estuarine changes*

## 3.2.2 Transportation

### Existing Conditions:

Very little transportation infrastructure currently exists on the site. A 10-foot wide gravel trail circles Freestad Lake, running along the top of the surrounding dike. Members of the church use the church parking lot and proceed from there on foot. Other visitors use the parking lot near the community garden along Blue Heron Road to the north. Vehicle access to the lake is allowed for members of the church and for established oyster harvest activity.

### Proposed Condition:

Given the estimated need for approximately 52,000 $yd^3$ worth of fill and an average dump truck capacity of 12 $yd^3$ (How much dirt can a dump trunk carry? 2015) over 4000 average-sized dump truck loads are be required for new dike construction. This should be considerably reduced by the inclusion of excavated fill from other areas of the project, however. The gravel road on top of newly constructed dike is to serve as a recreational public trail, though continuation of limited vehicle access may be expected by property owners and local oyster growers.

Access to the site for construction will be from Blue Heron Road to the north and from the private driveway for the Ratfield's property, west of the restoration site. While compaction would be an expected result of vehicular traffic, the dike will be designed with settling/compaction in mind and will be intended to restrict water flow, so should be unlikely to suffer functional degradation.

Upon completion of the project, the vast majority of use for this road is likely to remain foot traffic, with the exception of previously described limited vehicular traffic. Most visitors will continue to use either the church's parking lot or the public lot north of the site and will generally set off on foot to walk the trail, stopping to observe wildlife to read posted educational materials.

### Alternative:

While the need for excavation-related traffic will decrease as a result of the alternative plan, this would be offset by increased need to import fill for dike construction.  As a result, the proposed action is predicted to cause the least amount of environmental impacts associated with construction-related vehicle traffic.

### 3.2.3 Public Services and utilities

#### Existing Conditions:

The land is used for summer camp activities, and the lake is used recreationally for swimming by the summer camp.

#### Proposed Action:

The smaller lake will still be used for recreational swimming. The new dike will have a walkway surrounding the pocket estuary that will act as an interpretive trail for nature classes held by the church and the public. The historical restoration of the estuary will be informative for those who see it,  promoting understanding about pocket estuaries and their benefit to Chinook salmon. Juvenile chinook prefer pocket estuaries, and the reintroduction of such habitat will provide and ecological and an educational benefit for those who come to see it (Breamer, 2003)

#### Alternative Action:

No significant differences are expected from the alternative action in comparison to proposed action.

# 4. Conclusion

The purpose of this environmental impact assessment was to assess and evaluate the restoration of a pocket estuary along the northeast side of Samish Island. It is the interest of the land owner and all involved parties to reestablish pocket estuary functions, with the intention of recovering habitat for local fish, birds, and invertebrates, with a special focus on increasing salmon and trout populations in Skagit Bay.

After evaluation of the preceding environmental impacts on the environment, it is the recommendation of this environmental assessment team that the proposed action be implemented. The proposed action has the greatest chance of achieving the proponent's goals while minimizing environmental damage. The alternative action would delay reestablishment of pocket estuary functions due to an extended period of sediment export from the restoration site. The no action alternative would block any reestablishment of the pocket estuary so none of the ecosystem services will be provided.

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