November 2020
Whiteman Cove Project

Feasibility Report

Prepared for Washington State Department of Natural Resources

ANCHOR QEA
BLUE COAST ENGINEERING
kpff Consulting Engineers

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Prepared by
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ABBREVIATIONS

cy	cubic yard
DNR	Washington Department of Natural Resources
ESRP	Estuary and Salmon Restoration Program
FEMA	Federal Emergency Management Agency
fps	feet per second
FS	feasibility study
HPA	Hydraulic Project Approval
MLLW	mean lower low water
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
NRHP	National Register of Historic Places
Project	Whiteman Cove Project
RCW	Revised Code of Washington
SRT	self-regulating tides
USACE	United States Army Corps of Engineers
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WSDOT	Washington State Department of Transportation

1 Purpose

1.1 Project Overview

The Washington Department of Natural Resources (DNR) is currently evaluating four options for the Whiteman Cove Project (Project) to reestablish fish passage between Whiteman Cove and Case Inlet in Puget Sound. For the purpose of the Project, fish passage must meet the requirements of the 2013 federal court injunction for fish, which requires fish passage for "all species of salmon at all life stages at all flows where the fish would naturally seek passage" (*United States v. Washington*). It is also assumed that the Project must meet the standards of the Washington State Hydraulic Code.

The DNR Team, which includes Anchor QEA, LLC, Blue Coast Engineering, and KPFF Engineers, has collected and analyzed historical and newly collected data in and around the cove. In addition, the team has conducted outreach to stakeholders, including property owners of the cove and adjacent uplands, resource agency and permitting staff, and interested members of the public. In coordination with DNR, the team has identified the evaluation criteria and preliminary concepts that were used in this feasibility study (FS).

1.1.1 Fish Passage Requirements

This report relies on the language of the injunction and the Washington State Hydraulic Code (Revised Code of Washington [RCW] 77.55 and Washington Administrative Code [WAC] 220-660) in interpreting which alternatives meet the requirements of fish passage for this Project specifically. Fish passage in tidally inundated systems is not precisely defined in state or federal code. This is due, in large part, to the complexity of natural tidal channel systems. During a flood tide in a natural embayment similar to Whiteman Cove the embayment is typically perched above tidal waters at low tides and at some point during the flooding tide inundation would begin and continue until high tide. Water would then drain out of the embayment until a point when passage into the embayment was again no longer possible for fish. During this inundation and draining velocity and discharge varies and there are typically eddies and other areas of slower water even during peak flows where fish can pass. Given this complexity it is assumed that fish passage has been achieved if the historical conditions are mimicked or in a substitute condition that provides fish passage at tidal elevations at, or above the elevation of the embayment channel. The injunction states that this passage is best facilitated by a structure that simulates natural streamflow conditions. Of the four options being evaluated in Section 3.2, Options 3 and 4 best fit this criterion.

The Washington State Department of Fish and Wildlife does not currently provide specific criteria in tidally influenced systems to define fish passage due to reasons described above. Draft documentation for evaluating fish passage barriers in tidal systems would classify all non-self-regulating tides (SRT) as impassable (WDFW 2019). Weirs, as proposed in Option 2, are not specifically mentioned in this documentation. It should be noted that this methodology is currently in draft form and is also intended for evaluating existing structures, but this does indicate structures that artificially modulate the tide will be difficult to permit and may not meet the requirements of the injunction. The Washington Department of Fish and Wildlife (WDFW) does not generally permit new tide gate installations and tide gate removal is a preferred action for restoration (Barnard et al. 2013). In addition, research SRTs indicate that SRTs do not allow for suitable fish passage to meet injunction or state requirements (Greene et al. 2012).

Per state code, fish passage is assumed when there are no barriers due to behavioral impediments; excessive water slope, drops, or velocity; shallow flow; lack of surface flow; uncharacteristically coarse bed material; or other related conditions (WAC 220-660-190). In tidally inundated waters this only applies during times when there is a tidal connection. The Washington State Hydraulic Code also explicitly requires that any work that will use, divert, obstruct, or change the natural flow or bed of any of the salt or fresh waters of the state (RCW 77.55.011(11)) must demonstrate that it is protective of all fish species, including food fish, shellfish, game fish, unclassified fish and shellfish species, and all stages of development of those species (WAC 220-660-030(56)).

1.2 Report and Study Overview

This report summarizes evaluations completed to evaluate potential for establishing fish passage to Whiteman Cove. Section 2 provides background information, including site description and a summary of work conducted prior to this FS. Section 3 describes options and evaluation criteria developed as part of the FS work, and Section 4 summarizes discipline-specific studies, which are included in appendices, that evaluated proposed options. No preferred alternative has been selected as part of this phase of the Project.

2 Background

2.1 Site Description

Whiteman Cove is a historical barrier lagoon, separated from Case Inlet by a natural spit formed by net littoral drift to the north and feeder bluffs to the south (Figure 2-1). The historical opening to the cove, located at the northern end of the spit, was closed in the late 1950s to create a perched brackish water lagoon that was intended for the rearing of juvenile salmon. A road was constructed across the closure and along the historical tidal spit (Bay Road) that currently provides vehicular access to the YMCA Camp Colman located along the southern shoreline of the cove. Two control structures were put in place along the historical spit; the northern structure located on DNR property and the southern structure is located on YMCA property. Fish passage requirements for the Project focus on the presence and function of the DNR control structure. Property ownership within and adjacent to the cove includes DNR, the YMCA, and numerous private parcels (Figure 2-2).

The historical condition of Whiteman Cove is shown in Figure 2-3, which provides the 1876 topography survey (T-sheet) for the area. Figure 2-4 shows a photograph of the cove from 1951 prior to closure of the historical opening. Both the T-sheet and the 1951 photograph illustrate similar conditions at Whiteman Cove suggesting there was little change to the configuration or hydraulics of the cove within that time.

At present, water levels in the cove are currently regulated by two gated culverts that are not operating as originally designed but are currently meeting the design intent of maintaining current water surface elevation in the lagoon. Minimal exchange occurs between the perched lagoon and Case Inlet. Freshwater input to the cove comes primarily from a small intermittent stream (Whiteman Creek) at the eastern end of the cove that drains the approximately 1.7-square-mile upland watershed. Properties adjacent to the cove include Joemma Beach State Park to the northwest, private properties inland along the cove’s southern and northeastern shoreline, and private tidelands used for aquaculture in Case Inlet west of the historical tidal channel. Whiteman Cove itself includes DNR property along the northwest portion and YMCA Camp Colman south of the DNR parcel. The roadway berm, which separates Whiteman Cove from Case Inlet, is managed by DNR at the north segment of Bay Road KP South and by Camp Colman along the southern segment of the access road, which leads to Camp Colman.

Figure 2-1
Whiteman Cove Aerial Photograph (2019)

Figure 2-2
Property Ownership (Parcel Data) at Whiteman Cove

Figure 2-3
1876 Topography Survey (T-sheet)

Figure 2-4
1951 (U.S. Geological Survey) Aerial Photograph of Whiteman Cove

2.2 Fish Use of Whiteman Cove

There is currently very little potential for fish passage into Whiteman Cove from the streams feeding into the cove or from Puget Sound. Per a fish passage barrier survey conducted by WDFW in 2012 the northern structure is completely impassable. Based on a survey in 2000 by the Pierce Conservation District the southern structure is a barrier of unknown severity. During site visits stickleback have been observed in the cove, so there is some fish use of the cove.

Extensive work has been done by Eric Beamer (Beamer et al. 2009, 2012, 2016) in north Puget Sound with regards to understanding fish and salmonid use of small tidal embayments, also referred to as pocket estuaries. This research indicates that many fish, in particular endangered Chinook salmon, from the Skagit, Snohomish, and Stillaguamish rivers prefer to use non-natal embayments for rearing prior to out-migration. There is less research to indicate the importance of pocket estuaries to fish in south Puget Sound and there are currently no native stocks of Chinook salmon in south Puget Sound, although there is hatchery production, and genetic differences in stocks may lead to different preferences in rearing habitat.

Chum, steelhead, and coho salmon are documented in streams north of Whiteman Cove and if given access would likely use the cove periodically during out-migration from Case Inlet. Research completed by the Squaxin Tribe, similar to work done in north Puget Sound, did not indicate a preference for juvenile salmonids to use estuaries over nearshore habitat (Steltzner 2011). Although there was no statistically significant pattern between nearshore and estuary preference, juvenile salmonids were captured during the study in both environments. During this study at least 14 species were encountered between the nearshore and embayment sampling locations indicating the importance of these habitats to a variety of fish species.

2.3 Previous Studies

Anchor QEA conducted a preliminary FS to examine options to establish fish passage to Whiteman Cove in 2015 under contract with the South Puget Sound Salmon Enhancement Group (Anchor QEA 2015). This study included an evaluation of existing hydraulic processes at Whiteman Cove, a study of nearby reference sites, development of numerous options with potential to establish fish passage to Whiteman Cove, and a numerical modeling evaluation of the proposed options. The purpose of the modeling study was to evaluate potential for fish passage into the cove and changes to hydraulics (i.e., water levels, current velocities) in the cove due to proposed options. Options that were evaluated included control structures with culverts, control structures with weirs, and open channels created using box culverts or bridge structure to maintain the current vehicular access to YMCA Camp Colman along Bay Road.

The preliminary FS (Anchor QEA 2015) concluded that an opening smaller than 40 feet in width would attenuate the tide into or out of Whiteman Cove resulting in greater water velocity limitations to fish passage compared to historical conditions. The study of reference sites and historical photographs of the cove suggested that the elevation of the tidal channel into the cove was about 3 feet North American Vertical Datum of 1988 (NAVD88; 7 feet mean lower low water [MLLW]), which is about 1 foot lower than mean sea level[1] and would allow fish passable conditions to occur about two-thirds of the time[2] based on local tides. The preliminary modeling work showed that control structures that direct tidal flow through culverts or over weir structures would (1) attenuate the tide to a greater extent than open channel options, (2) produce significantly higher velocities over the tidal cycle than open channel options, and (3) provide less opportunity for fish passage than open channel options.

The preliminary work also showed that the elevations of the bottom of the cove are relatively high compared to the tide; and opening up the cove to tidal inundation would result in most of the cove drying out at lower tides.[3] Finally, it was noted that changes to water levels in the cove due to increased tidal influence would have impacts to current uses of the cove by the YMCA Camp Colman and other property owners.

This earlier work was considered in developing the scope of this FS. However, the options, evaluation criteria, and summary of this study were developed solely for this study with specific input from DNR, the Project stakeholders including cove property owners, and regulatory agencies.

[1] Based on NOAA tidal benchmark provided in Table 4-2.
[2] See discussion in Section 4.2.1
[3] This is consistent with photographs of the cove at low tide prior to its closure in the late 1950s (see Figure 4-1).

3 Evaluation Criteria and Proposed Options

3.1 Evaluation Criteria

A set of evaluation criteria for use in developing and evaluating Project options was developed using input from DNR, interested members of the public, stakeholders (including cove property owners), and regulatory agency staff, and the consultant team. Each proposed option was evaluated against the evaluation criteria to determine which met the primary goal of the Project, which is to reestablish fish passage between Case Inlet and Whiteman Cove, and best met other Project objectives. The evaluation criteria include the following:

- Will the option meet the requirements of the 2013 federal court injunction for fish passage?
  - "In order to pass all species of salmon at all life stages at all flows where the fish would naturally seek passage" (*United States v. Washington*).
- What effect will the option have on lagoon water levels relative to existing conditions?
  - Will the changes affect recreational activities in the lagoon?
  - Will the changes alter the shoreline access or aesthetics for property owners on the lagoon?
- What effect will the option have on habitat in the lagoon relative to existing conditions?
  - Will the habitat change?
    - Habitats maintained/increased/decreased (lagoon, estuary, wetland)
  - Will the changes improve tidal flushing (improve water quality) in the lagoon?
- What other improvements are needed to provide unrestricted vehicular access to the YMCA camp?
- Can the option be feasibly permitted?
  - Will additional mitigation be required?
- What are the maintenance requirements to ensure design function in the long term (low, medium, high)?
- What is the relative level of cost to construct the alternative (low, medium, high)?
- What is the anticipated level of impact to adjacent shellfish beds?

3.2 Options

The following options were developed for this study. They represent a wide-range of fish passage opportunities and were developed based on specific input from stakeholders that options other than a full tidal reconnection be considered. Each of these options was evaluated using the evaluation criteria listed in Section 3.1, as described in Section 4. Options are described in detail below.

3.2.1 Option 1: New tide gate control structure at location of existing DNR control structure; limited improvements to existing roadway to Camp Colman (YMCA)

Construct a single or series of large culverts between Whiteman Cove and Case Inlet that are regulated by a hydraulic gate. The structure(s) would be built in the same location as the existing DNR control structure and would be similar to the existing structure in design. The gate would open to allow tidal exchange at higher tidal elevations, and close at lower tidal elevations to maintain a specific water surface elevation in the lagoon. This structure would also be able to close automatically or manually at extreme higher water levels to prevent flooding of infrastructure in the lagoon (if any is found to occur). No bridge structure is required for this option because the tide gate control structure can be designed to support vehicular access.

3.2.2 Option 2: New weir control structure at historical opening to the north; some improvements to existing roadway to Camp Colman (YMCA)

Construct a 40-foot opening in the berm with a non-erodible bottom (i.e., armor rock or concrete sill) at the approximate location of the historical opening to the north. The non-erodible bottom of the opening would act as a weir that would maintain the water level at a set elevation in the lagoon (9 feet NAVD88, 13 feet MLLW) and provide grade control for the outlet channel. The opening would allow some passage of sand and gravels through the opening depending on tidal elevations and flows and nearshore sediment supply. A single-span 40-foot bridge would be constructed over the opening to maintain vehicle access to Camp Colman along the exiting roadway.

3.2.3 Option 3: Open channel at historical opening to the north; construct a bridge over the new opening to maintain vehicle access to Camp Colman (YMCA)

Construct a broad, open channel connection between Whiteman Cove and Case Inlet with a natural (sand and gravel) bottom. The channel would be designed at the elevation of the historical channel, thought to be about 3 feet NAVD88 (7 feet MLLW). The elevation of the bottom of the channel would be allowed to fluctuate but is expected to remain stable within a range of a several feet over the long term. Water levels in the lagoon would be synchronized with Case Inlet, except when tides are below the elevation of the bottom of the channel. When tides are below the bottom elevation of the channel, most of the lagoon would be dry. This alternative would require construction of a single-span 100-foot bridge over the open channel to maintain vehicle access to Camp Colman along the existing roadway. The width of the channel would be limited by the bridge span, and is expected to be about 80 feet wide. This would be smaller than the width of the historical opening, which was between 100 and 120 feet wide.

3.2.4 Option 4: Open channel at historical opening to the north; construct a new road along existing, undeveloped county right-of-way from south into Camp Colman (YMCA)

Construct a broad, open channel connection between Whiteman Cove and Case Inlet with a natural (sand and gravel) bottom. The channel would be designed at the elevation and width of the historical channel, thought to be about 100 to 120 feet wide at 3 feet NAVD88 (7 feet MLLW). The elevation of the bottom of the channel would be allowed to fluctuate but is expected to remain stable within a range of a few feet over the long term. Water levels in the lagoon would be synchronized with Case Inlet, except when tides are below the elevation of the bottom of the channel. When tides are below the bottom elevation of the channel, most of the lagoon would be dry. The location and width of the channel would also be allowed to fluctuate over time but is not expected to migrate or expand significantly beyond its historical location. No bridge would be constructed over the opening and the access to YMCA Camp Colman from the north along the coastal spit would be removed.

This alternative would therefore require construction of a new roadway meeting Pierce County standards through an existing but undeveloped county right-of-way from the current west terminus of Rouse Road Southwest north to Camp Colman. Other access options may be evaluated if this option is selected.

4 Feasibility Study

Options described in Section 3.2 were evaluated in a series of discipline-specific technical studies selected to align with the evaluation criteria proposed in Section 3.1. The technical studies are provided as appendices to this report and are summarized in this section of the FS; technical studies include:

- Hydraulic Assessment (Section 4.2, Appendix A)
- Coastal Processes Assessment (Section 4.3, Appendix B)
- Fisheries and Habitat Assessment (Section 4.4, Appendix C)
- Transportation Study (Section 4.5, Appendix D)
- Cultural Resources Options Analysis (Section 4.6, Appendix E)
- Permitting Approach (Section 4.7, Appendix F)

Information from these technical studies was used to develop a high-level opinion of probable construction cost for each option (Section 4.8) and to develop a comparison of each option against the evaluation criteria outlined in Section 3.1 (Section 5).

4.1 Summary of Data Used in the Feasibility Study

Table 4-1 provides a list of the primary data used to inform each of the technical studies completed as part of this work.

Table 4-1
Data Used in Feasibility Study

Evaluation/Assessment	Data Source	Date
Hydraulic Assessment and Coastal Processes	Anchor QEA 1D Hydraulic Model (Anchor QEA 2015)	2014
	Anchor QEA bathymetric survey (Anchor QEA 2015)	2014
	Puget Sound Digital Elevation Model (DEM), Finlayson 2005	2005
	Pierce County Lidar Digital Terrain Model 2011	2011
	NOAA NOS water level station No. 9447130	2020
	U.S. Geological Survey (USGS) StreamStats hydrology	2016
	Federal Emergency Management Agency (FEMA) Flood Insurance Study and Flood Insurance Rate Map	2017
	NOAA Topographic T-sheet	1876
	USGS aerial photographs	1951, 1957, 1968, 1969
	Geologic Map of the Longbranch 7.5-minute Quadrangle, Thurston, Pierce, and Mason Counties	2003
	Puget Lowlands LiDAR topographic surface Finlayson 2005	2005
	Pierce County LiDAR Digital Terrain Model 2011	2011
	NOAA NOS water level station No. 9446807	2020
	Miller et al. sea level rise predictions	2018

Evaluation/Assessment	Data Source	Date
Habitat	Pierce County Code	May 2020
	Pierce County GIS Interactive Maps (Pierce County 2020)	May 2020
	Natural Resources Conservation Service Web Soil Survey (USDA 2020)	May 2020
	U.S. Fish and Wildlife Service Wetlands Mapper for National Wetlands Inventory (USFWS 2020; see Attachment 1)	May 2020
	Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species maps and forage fish spawning maps (WDFW 2020a, 2020b)	May 2020
	Aerial photographs, Google Earth, June 2020	May 2020
	U.S. Coast and Geodetic Survey historical T-sheet (River History 2020)	May 2020
Transportation	Washington State Department of Transportation (WSDOT) Design Manual	2019
	WSDOT Bridge Design Manual	2019
	AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads	2019
	AASHTO LRFD Bridge Design Specifications, 9th Edition	2020
	AASHTO Guide Specifications for LRFD Seismic Bridge Design, 2nd Edition	2017
	Manual on Design Guidelines and Specifications for Road and Bridge Construction in Pierce County	2011
	Pierce County Stormwater Management and Site Development Manual	2015
	Flood Insurance Study, FEMA	2017
	Water Crossing Design Guidelines, Washington State Department of Fish and Wildlife (WDFW)	2013
Cultural Resources	Washington Information System for Architectural and Archaeological Records Data, Department of Archaeology and Historic Preservation	
	Protection of Historic Properties, 36 Code of Federal Regulations Part 800	
Permitting	Whiteman Cove Project: Restoration Concepts Early Agency Consultation Meeting Notes	April 2, 2020
	Whiteman Cove Project: Agency Coordination Meeting Notes	September 25, 2020

4.2 Hydraulic Assessment

A hydraulic assessment was conducted to predict water levels and current velocities in the cove, the proposed opening or control structure, and the adjacent nearshore areas for each of the proposed options. Information gained from this hydraulic assessment was subsequently used to inform the coastal processes and habitat evaluations. A technical memorandum describing the details of the

Hydraulic Assessment is provided as Appendix A to this report. A summary of the study and its findings is provided in this subsection.

4.2.1 Existing Hydraulic Conditions

Whiteman Cove is currently separated from Case Inlet by the historical spit and roadway prism. The tidal range in Case Inlet around 16 feet; tidal elevations near Whiteman Cove are provided in Table 4-2. Whiteman Creek, a perennial stream, flows in the far eastern end of the creek and there are other intermittent freshwater discharges into the cove due to runoff from adjacent slopes. However, freshwater flows into the creek are not significant and salinities in the cove range between 15 parts per thousand and 30 parts per thousand based on water quality sampling (Anchor QEA and Blue Coast Engineering 2019, 2020).

Table 4-2
Tidal Elevations (NOAA Station No. 9446807, Budd Inlet, South of Gull Harbor)

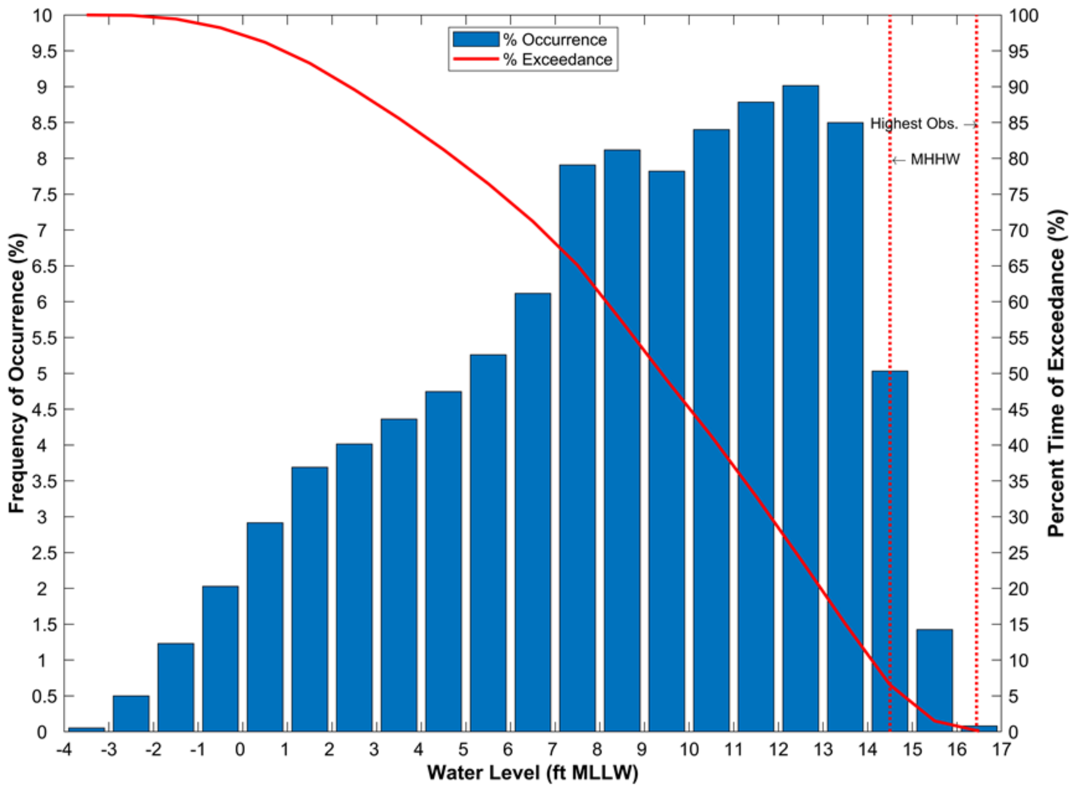
Tidal Datum	Elevation Relative to MLLW (feet)	Elevation NAVD88 (feet)[1]
Highest Astronomical Tide (HAT)	16.5	12.4
Mean higher high water (MHHW)	14.5	10.4
Mean high water (MHW)	13.5	9.4
Mean tide level (MTL)	8.3	4.2
Mean seal level (MSL)	8.3	4.2
Mean low water (MLW)	3.0	-1.0
Mean lower low water (MLLW)	0	-4.1

Note:
1. Conversion from MLLW to NAVD88 is -4.1 feet.

The water surface elevation in Whiteman Cove is currently controlled by the constructed sheetpile wall and roadway across the historical opening and the north and south control structures, which maintain a relatively constant value between 9 feet NAVD88 (13 feet MLLW) to 10.5 feet NAVD88 (14.5 feet MLLW). Based on tidal datums in Case Inlet, the water surface elevation in the cove ranges from mean high water to mean higher high water. Based on analysis of tide data at Olympia, Washington[4] (Figure 4-1), water levels in Case Inlet are expected to be higher than the current water level in the lagoon between 5% and 20% of the time over the course of a year.

[4] Long-term water level data were not available at the Budd Inlet Tide gage, which was used for tidal datums for the Project. The Budd Inlet gage is closer to the Project site.

Figure 4-1
Frequency of Occurrence and Percent Exceedance of Tidal Heights at Olympia, Washington



Note: for water levels in feet NAVD88, add 4 feet to water levels provided in feet MLLW

The elevations of the bottom of Whiteman Cove range from 0 feet NAVD88 (4 feet MLLW) in the middle of the cove to about 11 feet NAVD88 (15 feet MLLW) along the shoreline. The average elevation of the bed within the cove is about 3 feet NAVD88 (7 feet MLLW). The bed elevation of the cove is higher at the eastern end than the western end, which is adjacent to Case Inlet. The approximate average bed elevation of the cove is approximately 1 foot lower than mean sea level and is exceeded about two-thirds of the time over a typical year.

4.2.2 Effects of Options on Hydrodynamics

The United States Army Corps of Engineers (USACE) HEC-RAS modeling package (version 5.0.7) was used to develop a 2D hydrodynamic model of Whiteman Cove including the existing cove perched lagoon, barrier access road, the adjacent beach and tideflat, and Case Inlet. This model was used to evaluate Options 2, 3, and 4. A similar control structure to Option 1 was modeled as part of the preliminary FS completed in 2015 (Anchor QEA 2015); and results from that modeling effort were used to evaluate the performance of Option 1 in this study. A total of five hydrodynamic simulations were conducted to determine the effectiveness and feasibility of each option. The first simulation was of existing conditions, to evaluate how existing tidal currents in the nearshore compare to predicted velocities with an open inlet channel. A month-long simulation of tidal conditions including spring tide was performed for Options 2, 3, and 4. A 200-year freshwater flood event was simulated including the Option 3 inlet channel to evaluate flood risk associated with extreme freshwater flow conditions into the cove. These are generally consistent with the assumptions and methods used for simulations to evaluate Option 1 during the preliminary FS (Anchor QEA 2015).

The results of the 2D model simulations show that tidal exchange will be similar to historical conditions in the cove for both Options 3 and 4. During low tides in Case Inlet, the water level in the cove would drop approximately 6 feet below the current water level. This would result in most of the cove going dry at tides lower than 3 feet NAVD88 (7 feet MLLW). The tide is expected to be lower than this value about 30% of the time over the year.

The mean depth-averaged flow velocity in the inlet channel for both options was predicted to be low (below 2 feet per second [fps]). The most significant difference between both proposed options is the velocity through the channel inlet being slightly higher for the narrower channel with bridge abutments (Option 3) compared to the wider channel without the bridge (Option 4).

The 2D model predictions for Option 2 show that natural tidal exchange in the cove would not be achieved. For Option 2, when tides drop below the weir elevation (9 feet NAVD88, 13 feet MLLW), flow into and out of the cove is cut off and the water level in the cove remains static at the weir elevation. The minimum water depths in the cove would remain near the current levels. The tidal prism and the peak flow rates through the inlet were reduced by approximately 50% for Option 2 compared to Options 3 and 4. Predicted depth-average velocities in the inlet channel for Option 2 had similar peak velocities to Options 3 and 4. However, because the opening for Option 2 is significantly narrower than Options 3 and 4, higher velocities spanned the entire opening and lower velocities along the edge of the channel visible in Options 3 and 4 were not found in Option 2. In addition, the natural open channel in Options 3 and 4 is expected to form smaller low flow channels over time (see Section 4.3) increasing variation in velocity over the channel width. This will not occur with Option 2 because the opening to the lagoon will be an armored weir that will not erode or change over time.

The 1D model predictions for Option 1 show that tidal exchange will be limited through the control structure and current velocities would higher than what is considered acceptable for fish passage a majority of the time (see Section 4.4).

4.2.3 Effects of Options on Flooding

The effective 100-year Federal Emergency Management Agency (FEMA) flood elevation in Whiteman Cove is currently 13 feet NAVD88 (17 feet MLLW) (FEMA Map No. 53053C0250E, 3/7/2017). The 100-year FEMA flood elevation in Case Inlet adjacent to the cove is 16 feet NAVD88 (20 feet MLLW). The flood elevation in Case Inlet includes the influence of wave and wave runup, which would not impact flooding in the cove itself if it were connected to Case Inlet through an open channel (i.e., Options 3 and 4). The 100-year FEMA flood elevation in Case Inlet without including impacts of wave and wave runup is 13.2 feet NAVD88 (17.2 feet MLLW) (FEMA 2017). Based on this information, the FEMA 100-year flood elevation in the cove is not expected to change significantly due to implementation of any of the proposed Options.

While the options will result in increased water levels in the cove at higher tides, based on current FEMA information and available LiDAR, flooding of homes will not occur. There will be some flooding along the shorelines of properties, especially in the eastern end of the cove, and private docks structures will likely need to be modified to function over the range of water levels that would be present in the cove due to the proposed options. Option 1 (control structure), on the other hand, could be designed to close at higher tides limiting the potential for flooding of shorelines along adjacent properties. However, water levels would still be increased compared to existing conditions for Option 1 (in order to facilitate fish passage), and dock structures would likely need to be modified to implement Option 1, as well.

4.3 Coastal Processes Assessment

An evaluation was completed of the coastal sediment dynamics at Whiteman Cove and its adjacent nearshore due to proposed options. The scope of the evaluation included a combined analysis of geology and hydraulics to determine the existing geomorphology and sediment dynamics and to evaluate the potential impacts of Options 1 through and 4 on these processes. The evaluation addresses the geomorphologic impacts, including the ability for a proposed tidal channel to remain open and be self-sustaining under coastal processes at the site as well as the potential impacts to nearshore habitats updrift from the Project site. A technical memorandum describing the details of the coastal processes study is provided as Appendix B to this report. A summary of the study and its findings is provided in this subsection.

4.3.1 Existing and Historical Coastal Processes

Whiteman Cove was historically a tidal barrier embayment, a lagoon or estuary that forms where the shoreline abruptly changes direction, protecting the embayment from wave action, and the depths are sufficiently shallow for sand bars to rapidly form into a barrier sand spit. These systems are protected from wave action inside the embayment by the sheltered configuration and the protective barrier spit. Inside the lagoon there is a tidal delta, which was formed by the asymmetry of tidal flows (stronger flood tide velocities) that transport and deposit sediment inside the lagoon near the opening as the currents decrease in magnitude. A small intermittent (perennial) stream enters Whiteman Cove but it is not significant enough of a water source to create estuarine conditions at this location.

A Coastal Geodetic Survey (T-sheet) from 1876 (see Figure 2-2) shows the barrier spit fronting the lagoon extending to the north with the inlet opening to the north. A similar configuration is also visible in a 1951 aerial photograph taken prior to the roadway construction (see Figure 2-3). The photograph shows an approximate 250-foot-wide opening (measured from inside of the barrier spit to the shoreline at the location of the current roadway) with two low flow channels less than 50 feet wide within the opening. Following closure of the inlet, the barrier spit grew to the north fronting the historical tidal channel entrance forming a small lagoon landward of the barrier spit.

A conceptual model of sediment transport was developed for Whiteman Cove to understand the potential sediment transport patterns and pathways and to predict a stable channel opening width and depth. Wave-dominated embayments can be divided into three sections (outer, middle, and inner) representing three distinct zones of energy distribution and morphology. The outer portion of the embayment is dominated by high wave energy with some tidal influence. Sediment transport on the barrier spit (the outer portion) is primarily a result of wind-wave energy and is fed by bluffs to the south that are part of a 2.5-mile-long littoral cell. The predominant wind direction over Case Inlet is from the south to southwest, which has the potential to generate an estimated 100-year return period wave with a significant wave height of 3.7 feet and a peak period of 3.6 seconds.

The middle portion of the embayment encompasses the lagoon between the flood tidal delta and creek delta and is the lowest energy regime in the system. The low energy regime results in an increased potential for sediment deposition, particularly of finer grained suspended sediment from the creek and marine environment. The inner portion of the embayment includes the creek delta at the head of Whiteman Cove and can be fluvial dominated. The fluvial energy and sediment input in this region vary seasonally with precipitation and discharge. Rain events increase the stream discharge, which can result in suspended sediment load entering the embayment. At Whiteman Cove the creek is perennial but with significant flows only in the winter months during intervals of higher rainfall.

4.3.2 Effects of Options on Wind-Wave Climate

Options 1 and 2 will not change the magnitude of wind-waves inside or outside of Whiteman Cove. Because no significant changes to the barrier spit are expected to be associated with either option, wave runup on the beach will also remain unchanged.

Options 3 and 4 will not change the magnitude of wind-waves inside or outside of Whiteman Cove. However, wave runup (the landward excursion of water caused by wind-waves) will change if the slope of the beach or barrier spit is changed as a result of Options 3 and 4. In addition, wind-waves generate alongshore sediment transport that can result in infilling of the tidal channel in Option 3 or 4. However, the channel will equilibrate to a stable morphology through a balance between sediment transport under wind-waves and tidal currents, and dependent on physical characteristics such as channel slope, thalweg elevation, and shoreline orientation as compared to wave direction.

4.3.3 Effects of Options on Coastal Geomorphology

Options 1 and 2 will allow tidal flushing of water at higher tidal elevations and some sediment exchange (Option 2) but neither option will fully reestablish the tidal channel or the dormant components of the barrier embayment. Option 1 will have minimal effect on coastal dynamics. Option 2 is expected to result in changes to the small lagoon formed behind the extension of the spit and across the intertidal zone. Hydraulic modeling suggests the velocity regime in the tidal channel associated with Option 2 will be ebb tide dominated (not flood tide dominated as typical for barrier embayments). The predicted velocities are strong enough to erode fine to medium-sized gravel (pebble), suggesting gravel armoring (up to 0.5-inch diameter) would occur along portions of the channel bed within the inlet.

Options 3 and 4 will allow tidal flushing of water and sediment exchange to occur through the inlet between Whiteman Cove to Case Inlet. The most significant changes to the lagoon due to the options will occur in the higher energy outer region along the barrier spit and outer ebb tidal delta as well as the interior flood tidal delta. Options 3 and 4 will increase near-bed velocities and shear stress across localized portions of the flood tidal delta (interior delta), outer tidal delta, and nearshore shellfish beds. Estimates of velocity and shear stress at the channel inlet from the 2D model developed by Anchor QEA and Blue Coast Engineering (Appendix A) were used to estimate the potential for sediment mobilization and scour in the channel. The predicted flood velocities are strong enough to erode fine to medium-sized gravel (pebble), suggesting gravel armoring (up to 0.5-inch diameter) would occur along portions of the channel bed within the inlet. Somewhat larger sediment can be transported by the velocities generated under Option 3 as compared to Option 4, but this is a localized increase in velocity under the bridge. The open tidal channel in both Options 3 and 4 will result in increased flow between the lagoon and Case Inlet as compared to existing conditions.

4.3.4 Sustainability of Proposed Tidal Channels

Options 2, 3, and 4 include an open tidal channel as part of the design. An evaluation was conducted to evaluate the sustainability of the proposed tidal channels for those Options. Option 1 does not include construction or development of a tidal channel and is not discussed in this section.

Option 2 will increase flow from Whiteman Cove into the small lagoon and subsequently into Case Inlet. The small lagoon outside of the weir may increase in size and become more dynamic and will provide refuge to fish in the smaller pools. The outer tidal delta and nearshore shellfish beds will be altered by this asymmetry in flow and potentially lead to increased deposition of sediment across the nearshore shellfish beds.

An evaluation for the Estuary and Salmon Restoration Program (ESRP) of tidal estuaries and barrier embayments has shown that the tidal channel hydraulic geometry (cross-sectional area, width, and depth) are correlated with the embayment marsh area and tidal prism (Côté et al. 2018). Observations and regression models from the ESRP study are used to predict changes to the Whiteman Cove tidal channel with respect to migration and if it will remain open or close-off in the future.

The predicted channel width for Whiteman Cove is 120 to 160 feet through the inlet that crosses the terminal end of the barrier spit (the location of hydraulic control). The channel width of 85 feet for Option 3 and 120 feet for Option 4 are measured across the proposed bridge span and are farther inside of the lagoon than the primary tidal channel. In general, the primary tidal channel of a barrier embayment is narrower than the opening just inside. Based on the ESRP regression models, embayment reference sites, and geomorphic understanding of barrier lagoons, the dimensions of the channel across the proposed bridge span at Whiteman Cove should be larger than 160 feet for the system to function naturally. The narrower-than-natural channel under the bridge will likely result in reduced morphologic complexity than would naturally occur under the bridge, as well as reduced complexity for several of the morphologic elements of the embayment forming farther inside the entrance.

Because of the location of the bridge, it is important that the area of the small lagoon outside of the bridge be maintained at the current size (not filled). It may increase in size in response to the dynamic conditions. This small lagoon will provide refuge to fish in the smaller pools, thus providing habitat complexity in the inlet of the barrier lagoon.

4.4 Fisheries and Habitat Assessment

An evaluation of current habitat conditions at Whiteman Cove, as well as potential changes to these habitats based on proposed options, was conducted as part of this FS. A technical memorandum describing the details of the habitat assessment is provided as Appendix C to this report. A summary of the study and its findings is provided in this subsection.

4.4.1 Existing Habitat Conditions

Existing shoreline and riparian habitats around Whiteman Cove and Case Inlet include the marine beach shoreline that has a sandy upper shoreline and gravel intertidal zone with cobbles present in some areas. Oysters and mussels are attached to the larger materials in deeper areas, such as the remnant tidal channel from Whiteman Cove. The supratidal zone along the barrier spit has a native dune grass vegetation community. The remnant of the old tidal channel and small lagoon outside the roadway prism to the north of the cove (see Figure 2-1) still receives tidal inundation at the highest tides. There are areas of standing water with fringing marsh, interspersed with driftwood and debris wracked up in this area.

Along the interior shoreline of the barrier spit, a salt marsh is growing between elevation 9 and 11 feet NAVD88 (13.0 and 15.0 feet MLLW). This marsh is quite diverse. Along the southwest corner of the lagoon at the base of the barrier spit is a narrow fringing wetland with herbaceous understory and overhanging trees. There is a significant presence of non-native species (ivy and blackberry) in the forested areas adjacent to this wetland area. The remainder of the lagoon shoreline has steep banks with mixed coniferous and deciduous forest cover on the YMCA camp and DNR parcels, and open lawns and ornamental vegetation in the residential properties.

In the marine nearshore of Case Inlet, there are numerous anadromous and marine fish including Chinook, coho, chum, and pink salmon; cutthroat trout; bull trout; Pacific lamprey; Pacific sand lance; Pacific herring; surf smelt; longfin smelt; lingcod; shiner and pile perch; and a variety of rockfish, sculpins, sanddabs, sole, and flounder (Pletsch and Orr 2015). Due to the filling of the old tidal channel into Whiteman Cove and the existing water control structures within the barrier spit, there is little to no fish access possible into the cove.

Water quality sampling for temperature, dissolved oxygen, salinity, and pH within representative areas of Whiteman Cove and at one nearby location in Case Inlet (at Joemma State Park pier) was conducted in April 2015 (Anchor QEA 2015) and in June, September, and December 2019 (Anchor QEA and Blue Coast Engineering 2019, 2020; Blue Coast Engineering 2020). Water temperatures are seasonally high within the lagoon (summer, early fall) and dissolved oxygen levels are reduced seasonally. Salinities in Whiteman Cove are slightly lower (less saline) than those in Case Inlet and vary seasonally similar to Case Inlet. Fecal coliform have been sampled within Whiteman Cove that do not meet state water quality standards. Water quality in Case Inlet is typically excellent and a commercial shellfish bed is located offshore of the barrier spit.

4.4.2 Effects of Options on Water Quality

For all options, increased flushing and tidal exchange following the opening of a connection between the cove and Case Inlet would result in the water quality conditions of the lagoon becoming more similar to that of Case Inlet. For Options 1 and 2, because there would still be water held in the cove and limited exchange, water quality would likely remain similar to existing conditions. For Options 3 and 4, the fluctuation in water levels and frequent tidal change would result in the water temperatures generally remaining lower in the lagoon through the summer, resulting in higher levels of dissolved oxygen benefitting salmonids and other marine life. Similarly, for Options 3 and 4, the higher fecal coliform levels that currently occur in the lagoon would likely be reduced due to dilution and flushing. However, the tide could also convey periodic higher fecal coliform levels into Case Inlet, although similarly, due to dilution with the much larger waterbody, levels measured at the barrier spit are not anticipated to show measurable increases.

4.4.3 Effects of Options on Shoreline and Riparian Conditions

With Options 1 or 2, the shoreline and riparian conditions within Whiteman Cove would change slightly as water levels would be allowed to fluctuate between 9 and 10.4 feet NAVD88 creating a slightly larger fringing marsh of an estimated 4 acres around the perimeter of the cove, which is an increase of about 1 acre. With Option 1 or 2, extreme high tides could flow into the lagoon and could cause some mortality of existing trees along the fringe and this narrow band could transform from forested to a fringe marsh.

With Options 3 or 4, Whiteman Cove would convert to a mudflat-dominated pocket estuary, likely with a larger fringing marsh (estimated to be about 5 acres) around the perimeter of the cove (Appendix C, Figure 6) and extending along the inlet tidal channel due to additional draining below 9 feet NAVD88 (estimated area using bathymetry of the cove). This would be an approximately 2-acre increase over existing fringe marsh area. As with Options 1 and 2 extreme high tides could flow into the lagoon and could cause some mortality of existing trees along the fringe and this narrow band could transform from forested to a fringe marsh in Options 3 and 4.

Option 4 would require creating an alternate access road along an existing Pierce County right-of-way from the south that would cross through undeveloped forested areas and other habitats. This area has not been directly observed, but Pierce County mapping (Pierce County 2020) indicates wetlands habitats may also be present in this right-of-way (see Appendix C, Attachment 1).

4.4.4 Effects of Options on Fish and Wildlife Species

The primary purpose of the Project is to provide fish passage into and out of the lagoon. Option 1 would not meet the requirements of the 2013 injunction as tidal connectivity would only occur for about 20% of the time over the year and the velocities would be greater than 2 fps for most of that short time. In addition, the presence of a tide gate may further restrict fish passage, and juvenile salmonids may also not be able to find the culvert entrance during higher tides when the culverts are submerged. Fish passage would not be substantially improved from existing conditions.

Option 2 would provide improved fish passage, but because the weir would disconnect the lagoon from Case Inlet approximately 80% of the time over the year, fish passage would only be viable approximately 20% of the time, substantially less than all flows where the fish would naturally seek passage and which would not meet the requirements of the 2013 injunction.

Options 3 and 4 would provide fish passage during tidal stages when passage would have historically occurred. Predicted velocities would typically be at or below 2 fps during most of the tidal cycles and tidal exchange and connectivity would occur for the full natural duration. Channel geomorphology would also be more natural and complex, providing holding areas and back eddies for passing fish. Either of Options 3 and 4 would vastly improve fish access and allow all life stages of salmonids to enter the pocket estuary, and both would meet the requirements of the injunction.

Marine fish could also use the lagoon for rearing and spawning, including sculpin species such as Pacific staghorn sculpin (*Leptocottus armatus*) and shiner perch; these species were found in high abundance in the Nisqually Delta restored tidal channels (David et al. 2014). Mudflats and salt marshes are highly productive areas and the export of nutrients, detritus, and insects from the lagoon would also likely enhance the food web of Case Inlet.

4.4.5 Effects of Options on Shellfish

Option 1 would continue to have flow towards the west through the shellfish bed similar to existing conditions. Options 2, 3, or 4 would result in short-term pulses of turbidity from erosion of new tidal channels within Whiteman Cove once tidal fluctuation is established. Only limited information is available on turbidity impacts on geoduck life cycles. Suspended sediment (turbidity) has the potential to adversely affect geoduck eggs, larvae, and adults, with eggs being the stage most sensitive to turbidity (DNR 2001). Generally, studies of turbidity effects on other bivalves have concluded that short durations of elevated turbidity are unlikely to have significant impacts on geoduck survival. Frequent flushing of the cove is anticipated to keep water quality in the cove very similar to that of Case Inlet. Under Options 1 or 2 flushing would be less than in Options 3 and 4 potentially leading to some water quality degradation from elevated temperature and fecal coliform and a reduction in dissolved oxygen.

Options 2, 3, and 4 would have changed flow patterns and increased water velocities through existing remnant channels near the geoduck planting area that could have short-term, localized effects to recently planted geoducks. The channel geomorphology in the area after the channel opening is likely to continue to change due to the mobilizing sand and gravel and it is likely that the channel would become a braided network with lower flows and velocities in any individual channel. Overall, this would occur in a relatively small area of the existing shellfish beds. The commercial harvest area is unlikely to experience significant adverse effects from any of the options because initial turbidity from channel adjustments is likely to be temporary, and because potential channel formation is likely to be localized and not cause disturbance over the larger bed. Careful coordination of the timing of the proposed Project with the schedule for planting geoducks could ensure that effects on recently planted juveniles are minimized or avoided altogether. It is recommended that any planting of geoducks occur at least 1 year before Project construction begins or at least 1 year after Project construction is completed to mitigate impacts.

4.5 Transportation Study

An evaluation of the current access to YMCA Camp Colman at Whiteman Cove, as well as potential changes to this access required to implement proposed options, was conducted as part of this FS. A technical memorandum describing the details of the Transportation Study is provided as Appendix D to this report. A summary of the study and its findings is provided in this subsection.

The barrier spit and causeway that was installed at the north end of the spit in the 1950s serves as the primary access for Camp Colman via Bay Road South. Proposed options to establish fish passage for Whiteman Cove require that vehicle access to Camp Colman be retained. Alternatives for maintaining or providing vehicular access to the camp associated with each of the proposed Options considered in this FS (see Section 3.2) are described below:

- Option 1: Roadway improvements at the proposed gated control structure at the current location of the DNR control structure
- Option 2: Bridge and roadway improvements over the proposed weir control structure at the historical opening to the north
- Option 3A: Bridge over the proposed open channel (minimum channel width)
- Option 3B: Bridge over the proposed open channel (wider channel width)
- Option 4: New County Road – Rouse Road Extension. Current access along Bay South Road would be abandoned

In addition, Whiteman Cove Road South was investigated to gain an understanding of the issues associated with its use as an access route. Whiteman Cove Road South is partially owned and maintained by Pierce County and partially privately owned. A formal evaluation was not performed. Figure 1-1 in Appendix D shows access alternatives for the Project.

4.5.1 Roadway Classifications

Bay Road South is a Pierce County roadway that is classified as a Local Road. The roadway section would be 36 feet in width (12-foot lanes with 6-foot shoulders) with asphalt pavement per Pierce County Standard Drawing PC.A4.2. Typically, where work is performed within county right-of-way, improvements would be constructed to the current Pierce County standard. For the purpose of this study, however, a very limited portion of the roadway would fall within County right-of-way for any of the alternatives. The bulk of the work would be within DNR-owned property or private property and a variance to the standard would be justifiable. The minimum width would be based on providing emergency access. The minimum width for a private road would be 24 feet, and minimum bridge width would be 28 feet (measured from face of barrier to face barrier). A variance would be required at the time of permitting through Pierce County Planning and Land Services.

Option 4 would extend Rouse Road South and connect to the camp via a new county road. Rouse Road South is located 3,200 feet to the south of Whiteman Cove and Camp Colman. The county-owned right-of-way exists along the entire route from Whiteman Road South to Camp Colman via Rouse Road and turns north via what would be 202nd Avenue South. Rouse Road South is classified as a Local Road Feeder and would have the same roadway section described above for Bay Road South with 12-foot lanes and 6-foot shoulders per county standards. The existing road is improved to 1,400 feet west of Whiteman Road South; beyond that it is wooded and undeveloped and would require clearing, earthwork, and stormwater improvements among other work.

Whiteman Cove Road South is the most direct route to Camp Colman and is a county-owned and maintained roadway from Whiteman Road South to a point 1,300 feet to the west where it intersects with 194th Avenue South. West of this point ownership is more complicated. It is private right-of-way, but it has been maintained by Pierce County for an extended period of time. RCW 36.75.070 states that roadways that have been maintained at public expense for a period of 7 years or more are considered Pierce County roads. While Pierce County could claim prescriptive rights, use of this roadway could present legal challenges. Access for a temporary duration during construction could be negotiated with the property owners as part of an alternative to eliminate the need to provide a temporary access to the north during construction.

4.5.2 Option 1: Roadway Improvements at the Proposed Gated Control Structure

Option 1 would replace the existing water level control structure located in the embankment with a new functional structure. There are two approaches to the construction of this alternative:

- Full closure of the access road. Access to Camp Colman would be provided via Whiteman Cove Road South.
- Construct a temporary embankment within the lagoon that would provide access for traffic as well as act as a coffer dam to provide a work zone for installation of the tide gate.

Whiteman Cove Road South extends west from Whiteman Road South and follows the south side of the cove. As described above, it is a Pierce County-owned and maintained roadway for some distance to the west, but becomes a private tract and access for the residential community on the south shore of the cove. It is currently used for emergency access to Camp Colman, but it is not the regular access. Use of the road for temporary access during construction would be predicated on approval of the property owners. It is assumed that no improvements would be needed to the existing access as it currently is used for emergency access.

4.5.3 Option 2: Bridge and roadway improvements over the proposed weir control structure

Option 2 would install a weir control structure at the historical opening location. A short bridge above the weir control structure would be needed to carry traffic to and from Camp Colman via the existing northern access road. Construction could be approached in a similar fashion to Option 1 described above with a full closure or with a temporary shoofly; however, a third approach could also be considered, which is to build the weir waterward (toward the Sound) of the existing access road and realign the road to this location. The existing embankment would be removed after completion of the new roadway and weir.

The bridge spanning the weir would use precast, prestressed concrete deck bulb tee girders (W35DG) with an asphalt overlay to accommodate the 40-foot clear span. This solution provides a single-span girder and bridge deck combined in a single element with both construction and cost advantages over other options considered. Based on similar project experience, the foundation is anticipated to consist of concrete abutments supported by steel piles. Subsequent geotechnical investigations will be required to determine the final foundation system.

4.5.4 Option 3: Bridge over the proposed open channels

Options 3A and 3B evaluated bridge structures to provide access to Camp Colman from the north over the proposed open channel. Option 3A provided a crossing for what is considered the minimum width of channel needed to allow an attenuated tidal inundation of the cove and 3B provided a wider channel that would allow unattenuated tidal inundation of the cove to occur.

The shorter span of Option 3A proposes the use of precast, prestressed concrete deck bulb tee girders (W35DG) with an HMA overlay to accommodate the 40-foot clear span for the narrower channel. This solution provides a single-span girder and bridge deck combined in a single element with both construction and cost advantages over other options considered. Based on similar project experience, the foundation is anticipated to consist of concrete abutments supported by steel piles. Subsequent geotechnical investigations will be required to determine the final foundation system. The roadway and bridge alignment under this scenario would follow the existing berm alignment. The new construction would be a private road 24 feet in width with 3:1 side slopes.

Option 3B proposes a wider channel that more closely matches the historical channel. This alternative would also employ precast, prestressed concrete deck bulb tee girders (W35DG) with concrete abutment walls and driven steel piles. This utilizes the longest single-span concrete girders that are accessible via a transporter truck resulting in a 100-foot clear span between the abutments. As with Option 3A, the number, size, and location of piles is based on previous project experience. Subsequent geotechnical investigations will be required to determine the final foundation system. The roadway alignment for this option would be built to the north of the existing access, which would allow vehicular access to the camp during construction. This alternative would require more roadway within the county right-of-way than Option 3A; however, a narrower roadway section than the standard 36 feet is justifiable. Further coordination with Pierce County is required to obtain a variance.

4.5.5 Option 4: New County Road – Rouse Road Extension

Option 4 would eliminate the existing primary access to Camp Colman, which currently uses the natural spit as its access. There is a second access along Whiteman Cove Road South located to the east of the property, but as described above, a portion of that road is privately owned. Currently, it is only used for emergency access. In order to maintain access to Camp Colman, an option was evaluated that uses existing county right-of-way. Rouse Road Southwest currently terminates to the west of Whiteman Road Southwest which is over 3,000 feet south and east of Camp Colman.

The existing Rouse Road Southwest right-of-way extends 2,650 feet to the west of Whiteman Road South, where undeveloped county right-of-way continues north another 3,270 feet to Whiteman Cove, bordering the east property line of Camp Colman.

The roadway classification of Rouse Road Southwest is a Local Road Access or Feeder. Roadway surfacing is HMA pavement and drainage is accommodated with roadside ditches. Significant earthwork would be required to implement this alternative. The preliminary estimates that have been prepared are based on daylighting these cut and fill sections without the use of walls; however, property and easement acquisition would be necessary. Subsequent work will need to evaluate the benefits and costs associated with this assumption. Additionally, the impacts to wetlands and buffers has not been assessed at this time. Impacts to upland and wetland habitats would need to be weighed against the benefit to the aquatic and nearshore habitats.

A significant cost component for construction of a new roadway will be stormwater mitigation, which will be required for the conversion of forested and other landcover areas to pavement. At this study level, we have attempted to account for these costs by quantifying the clearing and new pavement associated with the roadway extension and approximating a volume of stormwater detention that would typically be associated with that for this region. Subsequent design will need to perform additional analyses to determine the most appropriate form or forms of mitigation. Potential options include infiltration or dispersion through natural areas. While these options could potentially reduce the volume of detention, the reduction of costs would not be directly proportional as these methods would have their own unique costs to implement such as property acquisition.

4.6 Cultural Resources Options Analysis

An evaluation of cultural resources at Whiteman Cove and potential environmental reviews and impacts for cultural resources associated with proposed options was conducted as part of this FS. A technical memorandum describing the details of the Cultural Resources Options Analysis is provided as Appendix E to this report. A summary of the study and its findings is provided in this subsection.

Depending on its specific elements, the selected option could require environmental reviews under the State Environmental Policy Act, the National Environmental Policy Act, and Section 106 of the National Historic Preservation Act. Section 106, which would apply if the Project receives federal funding or approval, requires federal agencies to consider the effects of their undertakings on historic properties. Historic properties are defined in 36 Code of Federal Regulations 800 as prehistoric or historic sites, structures, districts or objects that are eligible for listing in the National Register of Historic Places (NRHP). Some historic properties may also be Traditional Cultural Properties or Cultural Landscapes if they meet the applicable guidelines. To be NRHP-eligible, a historic property must be older than 50 years, have historic significance, and have sufficient integrity to convey that significance. State Environmental Policy Act and National Environmental Policy Act require consideration of cultural resources, which is generally understood to mean NRHP-eligible historic properties.

The potential for each option to adversely affect NRHP-eligible historic properties depends on whether ground disturbance could encounter archaeological materials, and whether historic structures would be modified or demolished.

Options 2, 3, and 4 include ground disturbance in the area of the historical channel that formed the entrance to Whiteman Cove. The area would have been in-water in the late Holocene to historic period, and it is possible that evidence of resource gathering (such as fish weirs or traps) remains. It is also possible that submerged shorelines from the late Pleistocene through mid-Holocene are present. It is less likely that excavation for the channel would encounter these because it would return the channel to near its previous depth. To the extent that there may be archaeological resources in the channel area, Option 4 is more likely to encounter them because it includes a wider channel and therefore more ground disturbance.

All three options have the potential to encounter archaeological materials in upland areas during ground disturbance for construction access and staging.

Options 2, 3, and 4 also include decommissioning of one existing DNR control structure, which is older than 50 years. Option 1 includes removal of that structure. It has not been evaluated for NRHP-eligibility. The structures are not currently functioning or being maintained, so there would be no change to existing conditions under Options 2, 3, and 4.

Option 3 includes construction of a bridge. The bridge foundations would require deep ground disturbance, which could impact buried paleoshorelines. The horizontal extent of ground disturbance would presumably be limited to the width of pilings. Depending on how pilings are installed, it may not be possible to test the area beforehand or observe any sediments during construction.

Option 4 includes construction of a new road. Precontact archaeological materials are known to be present in upland areas around the lagoon, so road construction could encounter previously unrecorded sites.

The primary differences between the four options are as follows:

- Option 1 includes removal of the existing DNR control structure, which could be NRHP-eligible.
- Option 3 has more potential to encounter upland resources during road construction.
- Option 4 has more potential to encounter buried paleoshorelines or late Holocene resource gathering features during channel creation and bridge construction.

The options have equal potential to affect any archaeological resources present in access and staging areas.

4.7 Permitting Approach

A permitting approach providing an overview of the local, state, and federal permits that may apply and regulatory considerations for each of the proposed options was completed as part of this FS; and is provided as Appendix G to this report. A summary is provided in this subsection.

The anticipated permitting approach for the Project is to identify and apply for programmatic permits and exemptions to streamline the permit review process. Two multi-agency coordination meetings were held to discuss the options during and after their development (Attachments 1 and 2, Appendix F). At the meetings, agency representatives identified several permits and approvals that could be selected to streamline the permit review process. For the option carried forward for permitting, the permitting approach will need to be updated based on design refinements and the design consistency with the applicable permit criteria.

Permitting time frames generally correspond with project complexity, which can be affected by agency or tribal negotiation or increased public scrutiny. The total time frame for obtaining permits and approvals for any of the options being considered for the Project will be approximately 9 to 12 months. These time frames are subject to change and could be impacted by post-submittal design updates or agency coordination. Recent consultations for a USACE Nationwide Permit on other projects in Puget Sound have been extending past the more conservative 12-month time frame; therefore, we recommend that DNR anticipate at least a 12-month duration for planning purposes. In-water construction is generally subject to agency-approved in-water work windows established for specific project areas. If work is proposed to occur outside of the allowable in-water work window, this will need to be requested in the permit application materials.

Note that Options 1 and 2 may not be viable as they do not meet the Washington Hydraulic Code fish passage criteria per WAC 220-660-190.2.a. Therefore, a Hydraulic Project Approval (HPA) may not be issued for Options 1 or 2, if selected (see Attachments 1 and 2, Appendix F).

4.8 Opinion of Construction Cost for Options

A concept-level opinion of construction cost was developed for each of the options for relative comparison of construction cost between them (Table 4-3). Costs do not include sales tax, engineering design, permitting or construction oversight.

Table 4-3
Conceptual Opinion of Construction Cost, Options 1 through 4 (in 2020 dollars)

Item	Option 1	Option 2	Option 3		Option 4
			Bridge Option 3A	**Bridge Option 3B**	
Construct Control Structure[1] (Option 1 only)	$1,500,000	n/a	n/a	n/a	n/a
Excavate Channel and Place Material On Site[2]	n/a	$180,000	$360,000	$360,000	$510,000
Roadway Improvements[3]	$550,000	$189.00	$138,000	$140,000	$3,700,000
Bridge Superstructure and Foundations[3]	n/a	$840,000	$840,000	$1,240,000	n/a
Rock Sill under Bridge[5] (Option 2 only)	n/a	$340,000	n/a	n/a	n/a
Utility Relocation[6]	n/a	$50,000	$50,000	$100,000	$200,000
Planting	$10,000	$20,000	$20,000	$20,000	$40,000
Subtotal	$2,060,000	$1,430,189	$1,408,000	$1,860,000	$4,450,000
Mobilization (10%)	$206,000	$143,019	$140,800	$186,000	$445,000
Subtotal + Mobilization	$2,266,000	$1,573,208	$1,548,800	$2,046,000	$4,895,000
Contingency (30%)	$679,800	$471,962	$464,640	$613,800	$1,468,500
Total	$2,945,800	$2,045,170	$2,013,440	$2,659,800	$6,363,500

Notes:

1. Construct new tide gate control structure and culvert(s) in location of existing DNR control structure for Option 1. Cost for these types of structures can vary greatly depending on final design and operational criteria for the control structure. Tide gate structure for this location may require innovative design to manage expected fouling by sediment and large wood and/or require significant maintenance to remain functional.
2. Channel excavation volume was estimated to be approximately 6,000 cubic yards (cy) for Options 2 and 3A, 12,000 cy for Option 3B, and 17,000 cy for Option 7. Unit cost was assumed to be $30 per cy to excavate and place on site.
3. Costs taken from Table 8-1 in Appendix D (Transportation Study). Costs for foundations based on previous projects; no geotechnical data are available for this site.
4. Construct rock armor sill under bridge at set elevation of 9 feet NAVD88 (13 feet MLLW).
5. Rock sill (weir) under bridge assumed to cover an area of 40 feet by 20 feet with an armor rock depth of 6 feet. Unit cost assumed to be $70 per cy to procure and place.

6. Utility poles for overhead lines will need to be relocated to accommodate the bridges proposed for Options 2, 3A, and 3B. Utility poles will need to be relocated and improved to span the opening in Option 4 with no bridge. Costs for utility relocation and improvements are highly variable. These costs could be significantly lower (if utility lines running to the spit are no longer needed post-Project) or significantly more expensive.

The Transportation Study also included an additional evaluation of a possible shorter roadway extension for Option 4 that developed an access road to Camp Colman through YMCA-owned property along the eastern end of Camp Colman (see Appendix D). This road alignment would lower the roadway improvement construction cost for Option 4 to $600,000 (see Table 8-1 in Appendix D) and the overall opinion of construction cost of Option 4 approximately $2,710,000. This option would need to be vetted with the YMCA and adjacent property owners because the roadway alignment is located on private property and not within an existing county easement (as is the Rouse Road extension currently proposed for Option 4).

5 Summary and Conclusions

5.1 Summary of Options Based on Evaluation Criteria

The Project team evaluated the four Project options presented in Section 3.2 based on the evaluation criteria in Section 3.1 and results of the technical studies summarized in Section 4. Given the complexity of the Project and variety of Options being considered a matrix was developed that provides a summary of the feasibility evaluation for each evaluation criteria question and design Option. This matrix is presented in Table 5-1.

5.2 Conclusions

This FS report documents studies conducted to determine the potential of the proposed options to reestablish fish passage between Whiteman Cove and Case Inlet in Puget Sound based on requirements outlined in the 2013 federal court injunction for fish (*United States v. Washington*) and the Washington State Hydraulic Code. Evaluations were also conducted to evaluate impacts of proposed options on hydrodynamics, coastal processes, habitat, vehicular access to Camp Colman, and cultural resources at Whiteman Cove. Permitting strategy and regulatory limitations for each option were also developed. A brief summary of how each option is expected to meet fish passage goals for the Project and significant impacts, if any, associated with each option is provided below.

Option 1 proposes to replace the existing DNR control structure with a similar new control structure that will allow tidal exchange with Whiteman Cove at tidal elevations above 9 feet NAVD88 (13 feet MLLW), which is the current water level in the lagoon. Tides are higher than this elevation about 20% of the time over a typical year. Tidal exchange would occur within one or two culverts similar to the existing structure. Current velocities in the culvert(s) are expected to be higher than 2 fps about 80% of the time. Water levels in the cove would not fall below existing water levels but would be higher than existing levels during high tides. No significant changes in hydrodynamics in the cove or coastal processes along the adjacent shoreline of Case Inlet are expected with this option. Water quality may improve due to increase tidal flushing; average temperatures are expected to decrease, and salinities increase post-Project. Habitat changes in the cove will be limited to changes to riparian vegetation along the shoreline due where the tide will increase water levels 2 to 3 feet above the current water level throughout the year due to high tides. No impacts to existing shellfish beds are expected. Access to Camp Colman would continue to be provided along the spit. However, based on discussions with regulatory agencies (see Appendix F), this option would not meet Washington State Hydraulic Code for fish passage and would not be eligible for an HPA permit. Subsequently, this option would most likely not meet the requirements of the 2013 federal court induction (*United States v. Washington*). This is one of the more expensive options to construct and most difficult to maintain due to expected fouling of the intake pipes and/or gates from coastal sediment movement and large wood.

Option 2 includes construction of a 40-foot bridge at the historical opening of the cove with a rock weir underneath set to an elevation of 9 feet NAVD88 (13 feet MLLW), which is the current water level in the lagoon. A channel will be excavated out onto the beach to facilitate fish passage and tidal inundation above the elevation of the weir, which will occur about 20% of the time. At tide elevations below the weir elevation the channel will be disconnected from the lagoon. Current velocities in the channel, when the tide is above the weir elevation, are predicted to be lower than 2 fps at discrete locations across the channel width. The channel will induce current velocities into and out of the cove near the channel opening which do not presently exist in the cove. A tidal channel will form on the beach to the north of the cove and additional tidal exchange will also occur between Case Inlet and the small lagoon (see Figure 2-1), which may increase in size post-Project. Impacts to water quality and habitat are expected to be similar to Option 1. Impacts to shellfish beds may occur due to formation of a tidal channel over the beds, but impacts are expected to be localized and short term. Access to Camp Colman would continue to be provided along the spit over the newly constructed bridge. However, as with Option 1, based on discussions with regulatory agencies (see Appendix F), this option would not meet Washington State Hydraulic Code for fish passage and would not be eligible for an HPA permit. Subsequently, this option would most likely not meet the requirements of the 2013 federal court induction (*United States v. Washington*). This is one of the least expensive options to construct.

Options 3A and 3B include construction of a 40-foot or 100-foot bridge, respectively, at the historical opening of the cove, spanning a natural open channel with a bed elevation of 3 feet NAVD88 (7 feet MLLW), which is the estimated historical elevation of the channel into the cove. This will provide tidal exchange with the cove about 70% of the time over a typical year. Current velocities in the channel, when the tide is above the weir elevation, are predicted to be lower than 2 fps at discrete locations across the channel width. While the 40-foot channel will provide full tidal inundation into the cove, the 100-foot channel will provide additional velocity variation across the channel width and will more readily allow formation of tidal channel networks within the 100-foot width. At tides below 3 feet NAVD88 (7 feet MLLW), the lagoon will go dry in most places with some standing water in the western end up to about 2 feet deep; this will occur about 30% of the time over a typical year. Tidal current velocities will extend throughout the cove with higher velocities near the opening. Water quality in the cove is expected to be the same as Case Inlet due to the almost full exchange of water that will occur each day, and an in-tide flat and salt marsh habitat is expected in the cove. Impacts to shellfish beds will be similar to Option 2 with some higher risk of channel movement. Access to Camp Colman would continue to be provided along the spit over the newly constructed bridge. Based on discussions with regulatory agencies (see Appendix F), Option 3B would meet Washington State Hydraulic Code for fish passage and be eligible for an HPA permit. Subsequently, this option would most likely meet the requirements of the 2013 federal court induction (*United States v. Washington*). Option 3A would most likely not meet Washington State Hydraulic Code or requirements of the 2013 injunction for fish passage due to the smaller size of the channel opening. Option 3A is the least expensive option to construct while Option 4B is one of the more expensive options to construct.

Option 4 includes construction of a natural channel opening into the cove and extension of Rouse Road along existing Pierce County right-of-way to provide vehicle access to Camp Colman from the south. Access across the spit would no longer occur. The channel opening would be the same as the historical opening to the cove, with a width of wide 120 feet and a bed elevation of 3 feet NAVD88 (7 feet MLLW). Similar to Options 3A and 3B, this will provide tidal exchange with the cove about 70% of the time over a typical year. Current velocities, tidal exchange, and impacts to water quality, habitat, and shellfish are all expected to be similar to Options 3A and 3B. Access to Camp Colman would continue to be provided along the spit over the newly constructed bridge. Based on discussions with regulatory agencies (see Appendix F), this option would meet Washington State Hydraulic Code for fish passage and be eligible for an HPA permit. Subsequently, this option would most likely meet the requirements of the 2013 federal court induction (*United States v. Washington*). Option 4 was preferred by some regulatory agencies because the opening more closely resembles the historical opening and is not confined by a bridge. This is also the most expensive option to construct.

Flooding risk is the same for all options. While all options will result in increased water levels in the cove at higher tides, based on FEMA information and available LiDAR, flooding of homes will not occur. There will be some flooding along the shorelines of properties and private docks structures will likely need to be modified to function over the range of expected water levels. Option 1 (control structure) could be designed to close at higher tides limiting the potential for flooding of shorelines along adjacent properties.

Table 5-1
Options Evaluation Summary Matrix

Evaluation Criteria	Option 1 New Tide Gate Control Structure	Option 2 New Weir Control Structure	Option 3 Open Channel with Bridge	Option 4 Open Channel with New Access Road	Notes
Will the option meet the requirements of the 2013 federal court injunction for fish passage?	No	No	Yes	Yes	The injunction states "In order to pass all species of salmon at all life stages at all flows where the fish would naturally seek passage" (*United States v. Washington*).
What effect will the option have on lagoon water levels relative to existing conditions?	Water levels would drop no lower than 9 feet NAVD88 (13 feet MLLW) during any tidal cycle (current water level in lagoon). Water levels are higher than 9 feet NAVD88 (13 feet MLLW) between 20% to 25% of the year. Water levels would not typically exceed 16 feet MLLW. Control structure could reduce inundation at high water levels if desired.	Water levels would drop no lower than 9 feet NAVD88 (13 feet MLLW), similar to Option 1. No control for upper limit of water levels expected.	Water levels would drop to approximately the elevation of the bottom of the open channel; assumed to be around 3 feet NAVD88 (7 feet MLLW). At tides equal to or less than this elevation, there would be 2 feet maximum depth in the lagoon in remaining ponded areas and the majority of the lagoon would go dry. Water levels are higher than 3 feet NAVD88 (7 feet MLLW) between 65% and 70% of the year. No control for upper limit of water levels expected.	Same as Option 3	The elevation of the historical tidal channel into the cove was approximately 3 feet NAVD88 (7 feet MLLW). Mean higher high water is 10.4 feet NAVD88 (14.5 feet MLLW) at the Project site. The water level in the cove does not currently fluctuate significantly over an average tide cycle.
Will the changes affect recreational opportunities in the lagoon?	Potential effects to current recreational opportunities are expected to be negligible for this option.	Same as Option 1	Current recreational opportunities will be changed by this option because water depths will fluctuate throughout the day due to tides. Water levels will remain at or higher than the current water level in the lagoon (around 9 feet NAVD88/13 feet MLLW) between 20% and 25% of the time over the year. The water level will reach current levels in the lagoon for some time almost every day of the year.	Same as Option 3	The water level in the lagoon currently remains relatively constant at 9 feet NAVD88 (13 feet MLLW). At this water level, the water depths in the lagoon range from 2 to 9 feet deep with deeper areas in the western end of the lagoon. Recreational activities in the lagoon include swimming and use of non-motorized small boats (i.e., canoes and rowboats).
Will the changes alter the shoreline access or aesthetics for property owners on the lagoon?	Changes to shoreline access and aesthetics in the lagoon due to this option should be minor. Minor tidal fluctuations in the water levels will create a zone of salt marsh and/or mudflat along the fringe of the lake. This fluctuation will complicate some access and may require adaptation of some facilities.	Same as Option 1	Shoreline access and aesthetics in the lagoon will be changed by this option because water levels will fluctuate through the day due to tides. Water levels will remain at or higher than the current water level in the lagoon (9 feet NAVD88/13 feet MLLW) between 20% and 25% of the time over the year. The water level will reach or exceed current levels in the lagoon for some time almost every day of the year.	Same as Option 3	The water level in the lagoon currently remains relatively constant at 9 feet NAVD88 (13 feet MLLW). This is defined as the shoreline for the purpose of evaluating changes to shoreline access and aesthetics due to proposed options.
Will existing habitats be maintained/ increased/decreased (saline lake, estuary, wetland)?	There will be a small increase in tide flats and salt marsh and small decrease in the saline lake inside the cove because water levels will fluctuate by about 2 feet during high tides. There will be a small increase in the tidal channel but no change to the tidal delta outside the cove.	Same as Option 1	There will be a large increase in tide flats and salt marsh and large decrease in the saline lake inside the cove because water levels will drop 6 feet lower than the current water level in the lagoon during low tides. There will be a large increase in the tidal channels inside and outside the cove near the opening and a medium increase in tidal flats outside the cove.	Same as Option 4	Small, medium, and large are relative indications intended only to provide comparison between alternatives. The water level in the lagoon currently remains relatively constant at 9 feet NAVD88 (13 feet MLLW).

Evaluation Criteria	Option 1 New Tide Gate Control Structure	Option 2 New Weir Control Structure	Option 3 Open Channel with Bridge	Option 4 Open Channel with New Access Road	Notes
Will the changes improve tidal flushing (improve water quality) in the lagoon?	This option will provide a minor increase in tidal flushing and water quality; approximately 70 acre-feet of water will exchange with Case Inlet on average each day.	Same as Option 1	This option will provide a significant increase in tidal flushing and water quality; approximately 200 acre-feet of water will exchange with Case Inlet on average each day.	Same as Option 3	At present, there is very low exchange between Case Inlet and the lagoon and the water level in the cove does not fluctuate over an average tide cycle.
Level of improvements needed to provide unrestricted vehicular access to the YMCA camp	Improvements to existing roadway at the new structure location following construction of the tide gate structure. Bridge not required.	Construct a 40-foot single-span bridge over the constructed weir to retain vehicle access to Camp Colman along the coastal spit roadway.	Construct a 40 or 100-foot single-span bridge over the constructed open channel to retain vehicle access to Camp Colman along the coastal spit roadway.	Construct a new road along a non-developed county right-of-way that would provide vehicle access to Camp Colman from the south. The coastal spit road would no longer connect to the uplands at the north end of the cove.	The existing access road that leads to the YMCA Camp Colman from the east is a private road and cannot be used for unrestricted access to Camp Colman.
Permitting feasibility of the option	Low; agencies have expressed preference toward options that meet the 2013 federal court injunction fish passage criteria. The Washington Department of Fish and Wildlife confirmed this option is not consistent with Washington State Hydraulic Code fish passage criteria and would not qualify for a Hydraulic Project Approval, which would be required to construct the Project. Otherwise, the permitting processes would be anticipated to take 12 to 18+ months after permit package submittal.	Same as Option 1	High; this option would meet the standards for habitat restoration and fish passage programmatic permits and approvals. This would streamline the agency review process anticipated to take 8 to 12+ months after permit package submittal.	High; this option would meet the standards for fish passage programmatic permits and approvals. Road construction may impact wetlands or wetland buffers requiring additional permits and approvals to construct. If wetland or wetland buffer impacts are minimal, programmatic permits may apply. Similar to Option 3, the agency review process is anticipated to take 8 to 12+ months after permit package submittal.	Streamlined and programmatic permits may include the U.S. Army Corps of Engineers Nationwide Permit and the Washington Department of Fish and Wildlife Hydraulic Project Approval for Fish Passage. Anticipated agency review timing may vary based on Project complexity and level of public interest. All four options are likely to require SEPA review and Shoreline Permits (substantial development or conditionals use) from Pierce County
Level of maintenance to maintain design function in the long term (low, medium, high)	High	Medium	Low	Low	Maintenance level is relative to other options proposed.
What is the relative level of cost to construct the alternative (low, medium, high)?	Medium	High	High	Very High	Cost for each option is relative to the other options proposed. Range of construction costs for all options is estimated to be between $1.4 million and $7 million.
Level of impact to adjacent shellfish beds	Low	Medium, may result in increased flow velocities and sedimentation in the shellfish bed area. No changes in salinity are anticipated because freshwater input to the cove is very small.	Same as Option 2	Medium-High. Same as Option 2 with some higher risk of channel movement that could increase velocities and sedimentation in the shellfish area compared to Options 1 and 2.	Impacts to shellfish beds considered are changes to average salinity over the tidal cycle, increase in flow velocities, or increase in sediment deposition within the shellfish bed areas.

Note:
Habitat types derived from geomorphic classification of barrier lagoon and closed lagoon components found in: Shipman, H., 2008. A Geomorphic Classification of Puget Sound Nearshore Landforms. Puget Sound Nearshore Partnership Report No. 2008-01. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

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Appendix A
Hydraulic Assessment

Appendix B
Coastal Processes Assessment

Appendix C

Fisheries and Habitat Assessment

Appendix D
Transportation Study

Appendix E
Cultural Resources Options Analysis

Appendix F
Permitting Approach