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Memorandum

November 25, 2020

To: David Palazzi, Washington State Department of Natural Resources

From: Merri Martz and Nikole Stout, Anchor QEA, LLC

Re: Whiteman Cove Project Fisheries and Habitat Assessment

Introduction

A team of consultants led by Anchor QEA has been retained by the Washington State Department of Natural Resources (DNR) to provide analysis, design, permitting, and outreach support for the Whiteman Cove Project (Project). The purpose of the Project is to re-establish anadromous fish passage between Whiteman Cove and Case Inlet in Puget Sound to 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*).

This memorandum compiles existing available data and reports on the biological communities and habitats within the study area and is supplemented with additional data and observations collected in May 2020 for this memorandum. In addition, this memorandum evaluates potential options for improving fish passage between Whiteman Cove and Case Inlet and how these options could affect habitat conditions in the study area.

As part of the analysis to assess the habitat characteristics in the study area, Anchor QEA biologists reviewed the following sources of information to support field observations:

- Pierce County Code
- Pierce County GIS Interactive Maps (Pierce County 2020)
- Natural Resources Conservation Service Web Soil Survey (USDA 2020)
- U.S. Fish and Wildlife Service Wetlands Mapper for National Wetlands Inventory (USFWS 2020; see Attachment 1)
- Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species maps and forage fish spawning maps (WDFW 2020a, 2020b)
- Aerial photographs, Google Earth, June 2020
- U.S. Coast and Geodetic Survey historical T-sheet (River History 2020)
- Historical aerial photograph (1951), prior to lagoon closure

Current Conditions in the Study Area

Whiteman Cove was historically a barrier lagoon located on the southwestern shoreline of the Key Peninsula in Pierce County, Washington. It is separated from Case Inlet by a natural spit formed by net littoral drift to the north and feeder bluffs to the south, which have been closed off by a sheetpile wall and fill. The historical opening to the cove, located at the northern end of the spit, was artificially closed by the Washington Department of Fisheries (now WDFW) in 1962 to create a perched brackish water lagoon that was intended for the rearing of juvenile salmon.

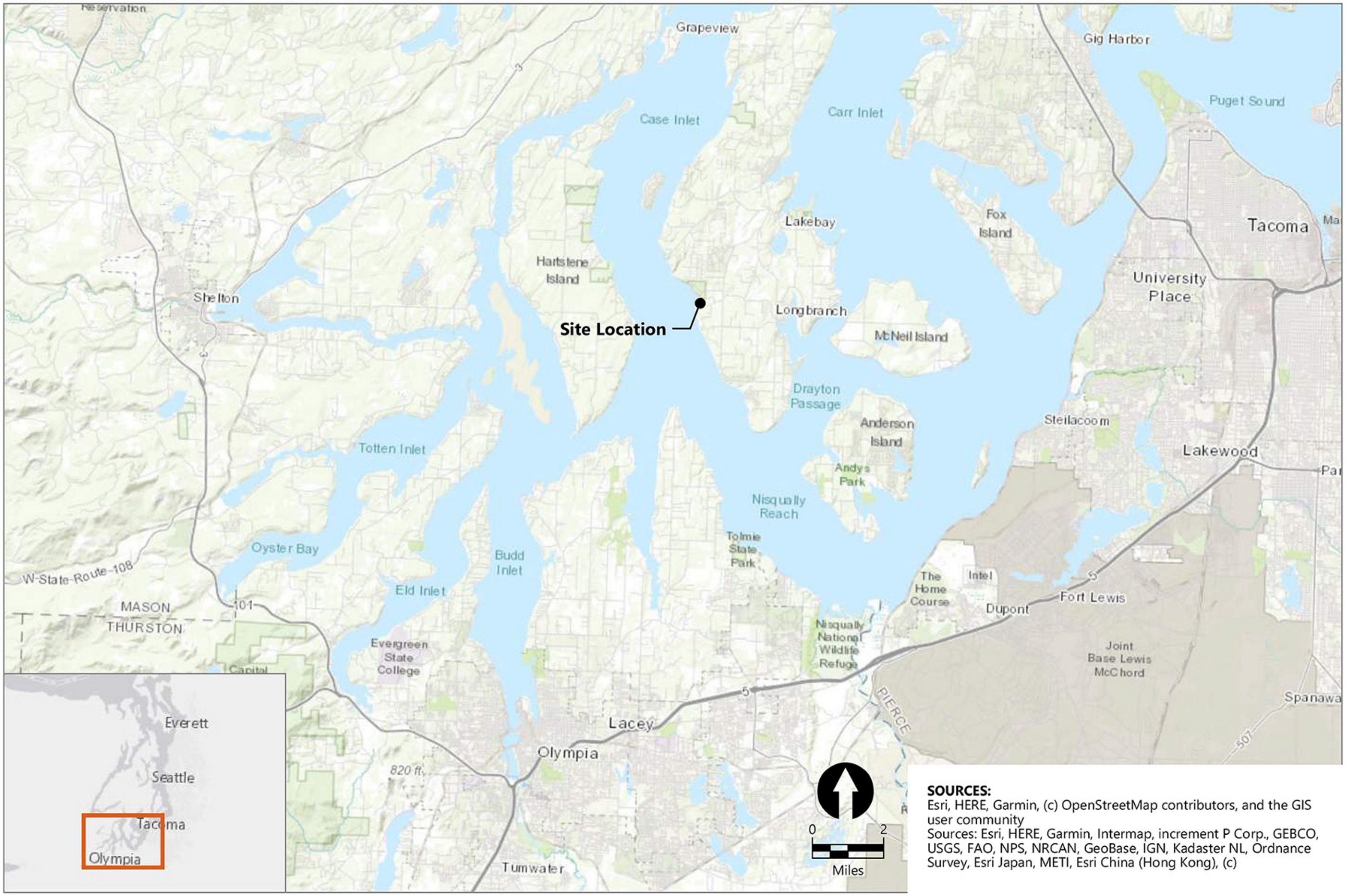
The impounded lagoon is approximately 25 acres in size. Two control structures maintain water surface elevations in the lagoon at an average of 13 feet mean lower low water (MLLW) or 8.9 feet North American Vertical Datum of 1988 (NAVD88). Minimal water exchange occurs through the control structures between the perched lagoon and Case Inlet resulting in a nearly static water surface elevation.

Fish passage is completely blocked by the control structures. The outlet of the north control structure is buried in beach sediment and is rated as a complete barrier (WDFW 2020c), and there is a large drop at the upstream end of the south control structure during all but the highest tides. 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. The WDFW Salmonscape mapping indicates that there are several fish passage barriers on this stream (WDFW 2020c).

The study area includes the YMCA Camp Colman located along the southwest shoreline, DNR property on the northwest shoreline, and private residential properties along the eastern shoreline of the cove. Public access to the site is via Bay Road Southwest, which crosses the former tidal channel via a filled causeway.

The study area includes Whiteman Cove, the barrier spit, the former tidal channel, the surrounding riparian zone, and the forested Pierce County road right-of-way south of the YMCA camp. Figures 1 through 3 show the Project vicinity, general study area, and the more specific marine study area.

Figure 1
Project Vicinity Map



SOURCES:
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c)

Figure 2
Study Area

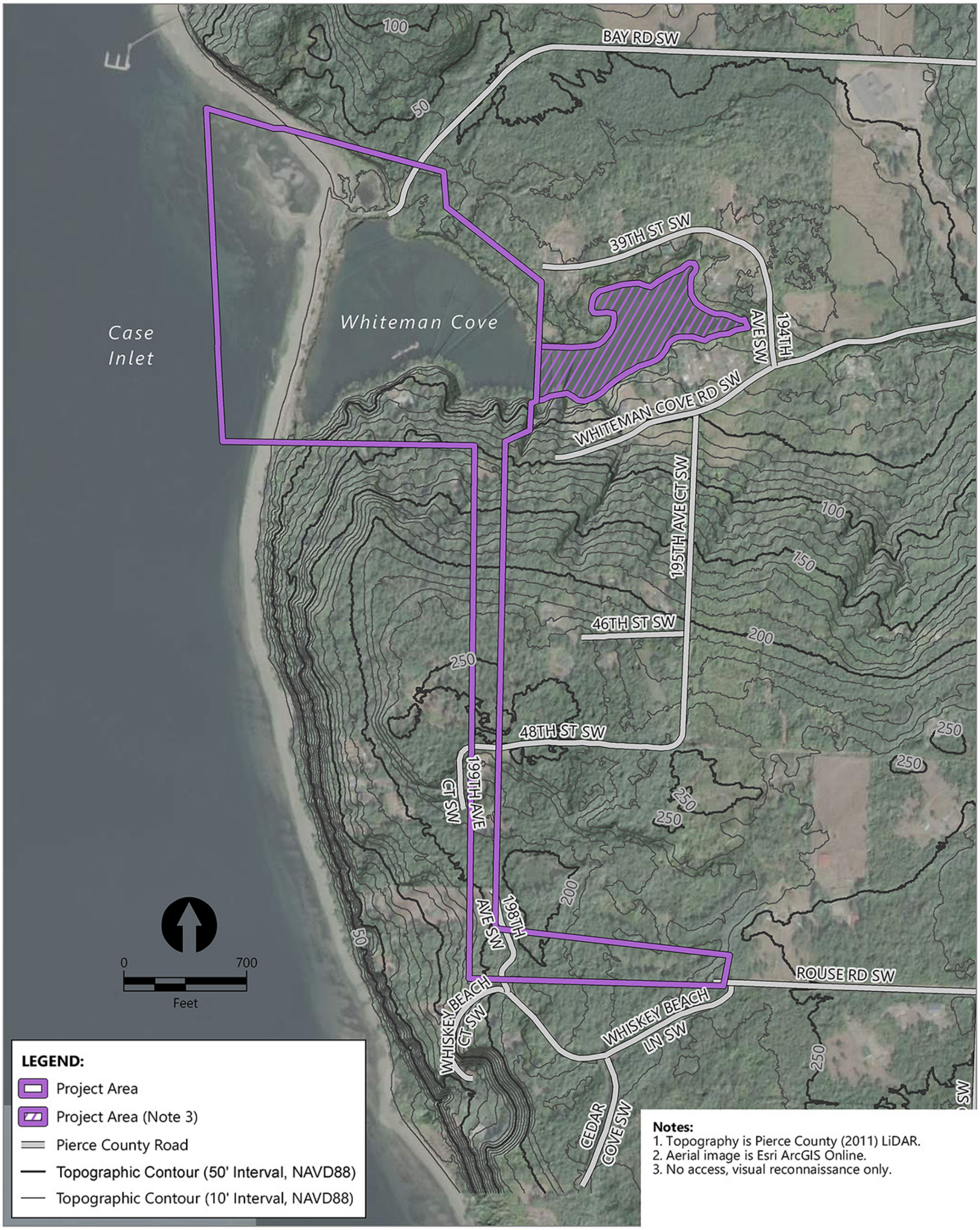
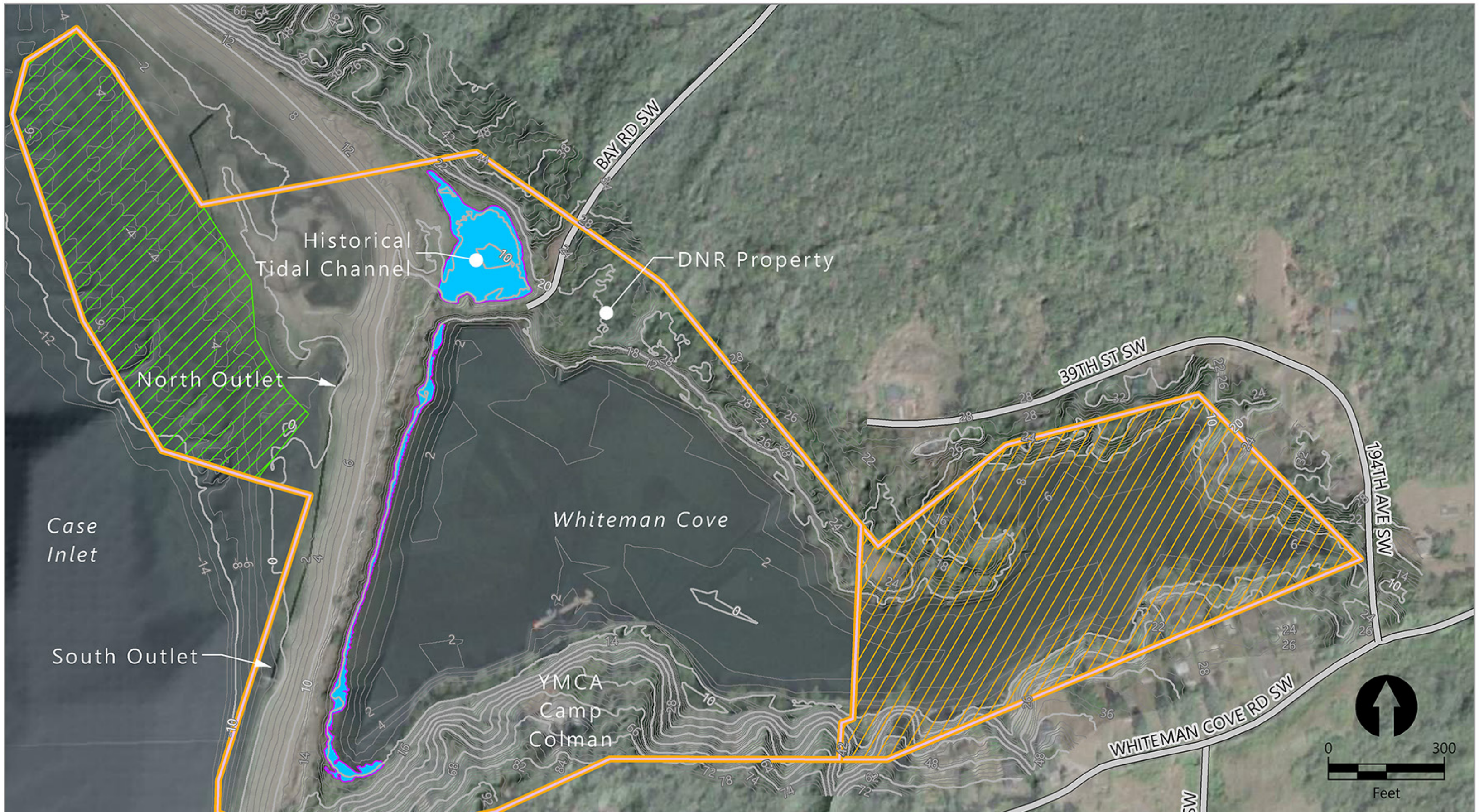


Figure 3
Marine Habitat Study Area



Notes:
1. Upland topography is Pierce County (2011) LiDAR.
2. Whiteman Cove bathymetry is Anchor QEA, LLC. (2014)
3. Aerial image is Esri ArcGIS Online.
4. Puget Sound bathymetry is Finlayson D.P. (2005) Combined bathymetry and topography of the Puget Lowland, Washington State.
5. Approximate shellfish area is provided by WA Department of Natural Resources.
6. Wetland estimated from May 2020 site visit. Other wetlands may be present in areas not accessed by Anchor QEA staff.
7. No access, visual reconnaissance only.

LEGEND:
- Potential Marine Habitat Impact Area
- Potential Marine Habitat Impact Area (Note 7)
- Existing Wetland (Note 6)
- Commercial Shellfish Beds (Approx.)
- Major Contour (10' Interval, NAVD88)
- Minor Contour (2' Interval, NAVD88)
- Pierce County Road

Tidal Exchange and Bathymetry

Historically, Whiteman Cove was a barrier lagoon that was connected, filled, flushed, and disconnected over most common tidal cycles via tidal channels on the north side of the barrier spit. Figure 4 shows this configuration of the lagoon as it looked in 1951. The thalweg elevation of the historical tidal channel was most likely around 7 feet MLLW (3 feet NAVD88) (see Blue Coast Engineering 2020).

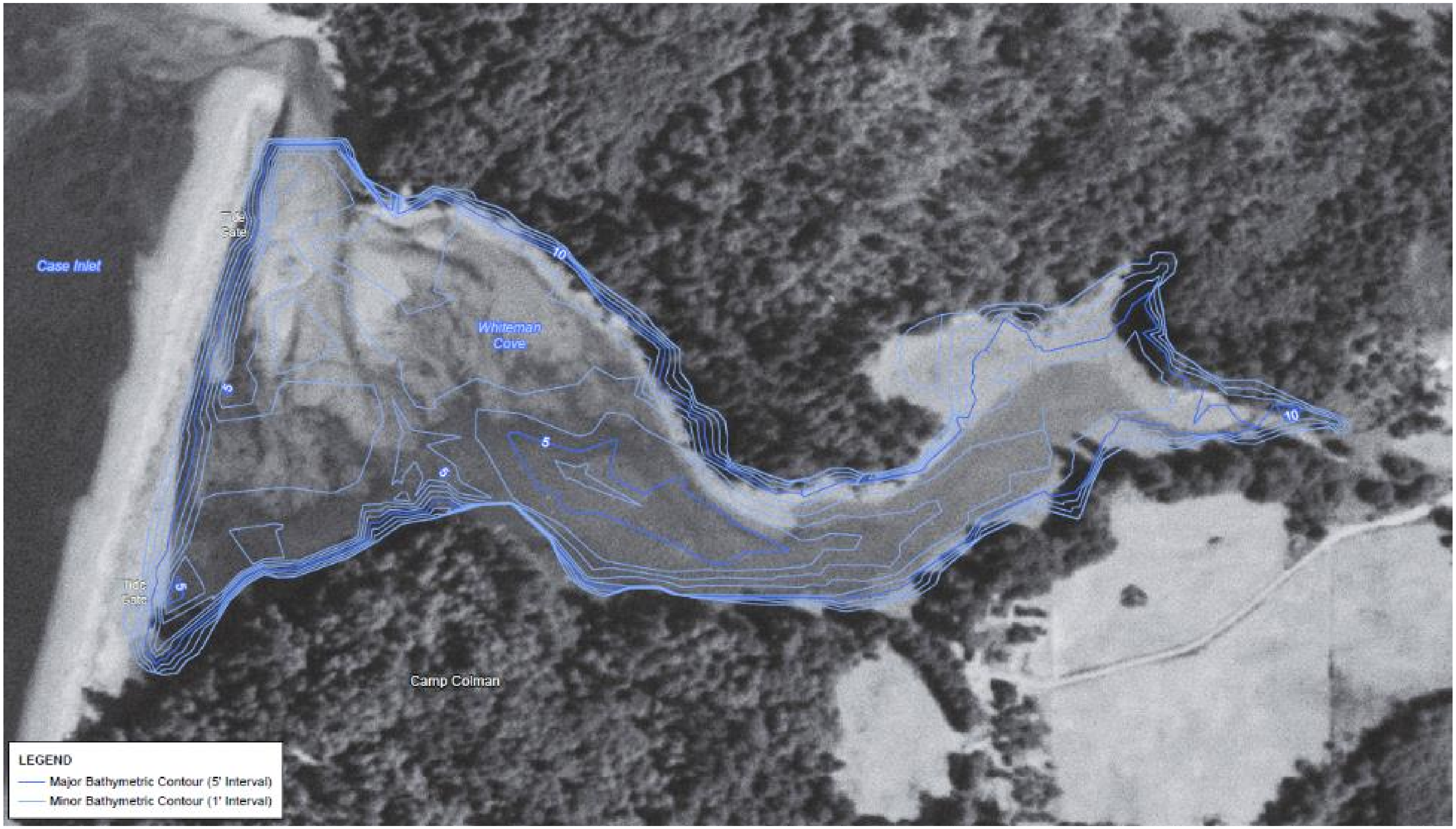
The nearest National Oceanic and Atmospheric Administration (NOAA) tide station with a long-term record is located at Budd Inlet, south of Gull Harbor (NOAA Station No. 9446807). Tidal elevations are shown in Table 1.

Table 1
Tidal Datums (NOAA Station No. 9446807, Budd Inlet, South of Gull Harbor, Washington)

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)	13.6	9.5
Mean tide level (MTL)	8.3	4.2
Mean sea level (MSL)	8.3	4.2
Mean low water (MLW)	3.1	-1.0
Mean lower low water (MLLW)	0	-4.1

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

Figure 4
1951 Historical Aerial Photograph of Whiteman Cove



Note: Whiteman Cove bathymetry is from Anchor QEA, LLC (2014).

To guide the identification of habitats within the study area, typical tidal habitat zones delineated based on elevations are shown in Table 2. These zones can also guide predictions for what types of habitats could form if a full tidal connection is established between Case Inlet and Whiteman Cove.

Bathymetry in Whiteman Cove ranges from approximately 0 feet NAVD88 (+4.1 feet MLLW) to 12 feet NAVD88 (16.1 feet MLLW) around the shoreline perimeter. The lagoon is typically maintained around 8.9 feet NAVD88 (13 feet MLLW), which is slightly below mean high water. The elevation where the historical tidal channel was located is currently at or below 10 feet NAVD88 (14.1 feet MLLW), or just below mean higher high water (MHHW).

Table 2
Elevations and Features of Typical Shoreline and Intertidal Habitat Zones in Puget Sound[1]

Habitat Zone	Elevation (relative to MLLW)	NAVD88 Elevation	Description
Upland (above MHHW)			
Upland/Riparian	+16.5 feet and above	+12.4 feet and above	Shrub and forested community adapted to salt spray (e.g., Sitka spruce [*Picea sitchensis*], red alder [*Alnus rubra*], willows [*Sitka* sp.], snowberry [*Symphoricarpos albus*], and Nootka rose [*Rosa nutkana*]). The lower end of this zone is the limit for woody vegetation and approximates the HAT level.
Supratidal	+14.5 to +16.5 feet	+10.4 to +12.4 feet	Sandy, gravelly backshore with driftwood where space allows. This zone approximates the elevation band between MHHW and HAT levels. Vegetation includes dune grass (*Elymus mollis*) and Puget Sound gumweed (*Grindelia integrifolia*) that tolerate periodic inundation in saline water and deposition of sediment and wood.
Intertidal			
Upper Intertidal	+11 to +14.5 feet	+6.9 to +10.4 feet	Inundated at high tides. Sand or gravel substrates. Barnacles, green and red algae present if coarser materials are available for attachment. Upper elevation range for spawning of forage fish species such as surf smelt (*Hypomesus pretiosus*) and Pacific sand lance (*Ammodytes hexapterus*).
Mid Intertidal	+6 to +11 feet	+1.9 to +6.9 feet	Inundated at mid and high tides. Gravel, sand, or mud substrates; red and green algae present if suitable substrate available for attachment. Lower elevation for spawning of forage fish species.
Low Intertidal	0 to +6 feet	-4.1 to +1.9 feet	Exposed during lower tides. Upper limit of eelgrass (*Zostera marina*) within this zone. Red, brown, and green macroalgae, crabs, clams, sea stars, etc. Key elevation for juvenile salmonid use.

Habitat Zone	Elevation (relative to MLLW)	NAVD88 Elevation	Description
Subtidal			
Shallow Subtidal	-10 to 0 feet	-14.1 to -4.1 feet	Exposed at the lowest tides or continuously inundated. Kelp, red, brown, and green macroalgae present if suitable attachment surfaces are available. Eelgrass, rockfish, flatfish, clams, crabs, etc. Important habitat for larger juvenile salmonid use.

Note:

1. Zone descriptions from multiple sources and personal observations (Downing 1983; Dethier 1990; Kruckeberg 1991).

Water Quality

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 September and December 2019 (Anchor QEA and Blue Coast Engineering 2019). At the time of sampling (spring, fall, and winter), water temperatures in the cove were suitable for all life stages of salmonids (Washington Administrative Code [WAC] 173-201A-200). Dissolved oxygen and pH readings were at least fair quality, meaning greater than 4 milligrams per liter (mg/L) for dissolved oxygen, and pH between 6.5 and 9. For marine water, good quality has dissolved oxygen above 5 mg/L, excellent quality above 6 mg/L and extraordinary above 7 mg/L. For pH levels, good, excellent, and extraordinary quality are between 7.0 and 8.5. Salinity levels were an average of 26.4 parts per thousand (ppt) in December 2019 and 29.5 ppt in September 2019. Salinities measured in Case Inlet were 27 ppt in December 2019 and 34 ppt in September 2019. From this information, salinities in Whiteman Cove are lower (less saline) than those in Case Inlet.

The average temperature at a mid-water depth in Whiteman Cove was 9.9°C during December 2019 sampling and 17.9°C during September 2019 sampling. For marine water, good quality includes water below 19°C for the 1-day maximum, excellent quality below 16°C, and extraordinary quality below 13°C (WAC 173-201A-210). Fecal coliform levels in September 2019 ranged from 10 to 420 colonies per 100 milliliters and total coliform levels ranged from 10 to 1,200 colonies per 100 milliliters (compared to April 2015 sampling that showed a fecal coliform range from 5 to 120 colonies per 100 milliliters and total coliform range from 10 to 720 colonies per milliliter; Anchor QEA 2015). These levels exceed shellfish harvest and contact recreational criteria. Additional information about water quality in the cove is provided in Anchor QEA and Blue Coast Engineering (2019).

Water quality in Case Inlet is typically excellent, with dissolved oxygen ranging from nearly 6 to over 10 mg/L (lowest levels observed in November 2018). Case Inlet monitoring data from 1999 showed dissolved oxygen at 8 mg/L, temperature at 14°C, and salinity at 29 ppt (Ecology 2020). Fecal coliform levels are monitored by the Washington Department of Health at the barrier spit and levels have ranged from 1.8 to 79 Most Probable Number (MPN) per 100 milliliters (Ecology 2020). Lower levels are most common. Higher numbers may be associated with heavy rainfall events and input from septic tanks or runoff from domestic and wild animal wastes. Shellfish harvesting criteria requires a geometric mean of less than 14 colonies per 100 milliliters with less than 10% of samples exceeding 43 colonies per 100 milliliters (WAC 173-201A-210). Primary contact recreation criteria are the same as for shellfish harvest.

Shoreline and Riparian Conditions

Shoreline and riparian habitat conditions around Whiteman Cove include the beach along the outside part of the barrier spit, the former lagoon entrance channel that has converted primarily to marsh habitat, and the riparian shoreline of the interior of Whiteman Cove. Anchor QEA staff accessed the DNR and YMCA properties and made the following observations on May 22, 2020.

Marine Shoreline Habitat

The beach shoreline along the barrier spit includes a sandy upper shoreline and gravel intertidal zone with cobbles present in some areas (Photograph 1). Oysters and mussels are attached to the larger materials in the approximate alignment of the outer portion of the old tidal channel (Photograph 2).

Photograph 1
Intertidal Gravel Along Barrier Spit

Photograph 2
Oysters and Mussels in Old Tidal Channel Area

The supratidal zone along the barrier spit has a vegetation community dominated by dune grass *(Elymus mollis*), beach pea (*Lathyrus japonicus*), European sea rocket (*Cakile maritima*), and silver bursage (*Ambrosia chamissonis*).

The old tidal channel at the north and east sides of the spit still receives tidal inundation at the highest tides and at high tides during storms (due to wave runup during high wave events). There are areas of standing water with fringing marsh, interspersed with driftwood and debris wracked up in this area (Photograph 3). The lower marsh is dominated by pickleweed (*Salicornia depressa*), saltgrass (*Distichlis spicata*), fat hen (*Atriplex patula*), Lyngby's sedge (*Carex lyngbyei*), and jaumea (*Jaumea carnosa*). The high marsh and fringing supratidal areas are dominated by Gerard's bulrush (*Juncus gerardii*), dune grass, beach pea, and American vetch (*Vicia americana*).

Photograph 3
Open Water and Marsh in Old Tidal Channel Area

Wetland Habitat

Along the interior shoreline of the barrier spit, a salt marsh is growing between elevation 9 and 11 feet NAVD88 (13.0 and 16.0 feet MLLW). This marsh is quite diverse, including pickleweed, fat hen, seaside arrowgrass (*Triglochin maritimum*), seaside plantain (*Plantago maritimum*), Puget Sound gumweed, jaumea, and Gerard's bulrush (Photograph 4). Along the southwest corner of the lagoon at the base of the barrier spit is a narrow wetland with Lyngby's sedge, angelica (*Angelica genuflexa*), and impatiens (*Impatiens noli-tangere*) in the understory, with big leaf maple (*Acer macrophyllum*) and western red cedar (*Thuja plicata*) rooted on the banks and overhanging the shoreline. There is a significant presence of the non-native species ivy (*Hedera helix*) and Armenian blackberry (*Rubus armeniacus*) in the forested areas adjacent to this wetland area.

Other wetland habitats may be present in the study area but were not accessed during the May 2020 site visit. A map showing National Wetland Inventory potential wetlands is included as Attachment 1.

Photograph 4
Fringing Marsh Along the Interior of the Barrier Spit

Riparian and Upland Habitats

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. Forested areas are dominated by big leaf maple, red alder (*Alnus rubra*), western red cedar, and Douglas fir (*Pseudotsuga menziesii*) in the canopy layer and sword fern (*Polystichum munitum*), trailing blackberry (*Rubus ursinus*), thimbleberry (*Rubus parviflorus*), and ivy in the understory. Ivy is climbing many of the trees and will likely kill them if not controlled. Armenian blackberry is dominant in all disturbed areas.

Photograph 5
Riparian Along North Shoreline of Lagoon

Fish and Wildlife Species

Currently, three-spine stickleback (*Gasterosteus aculeatus*) and perch (likely shiner perch [*Cymatogaster aggregata*]) are present in the lagoon, as reported by YMCA staff (and stickleback were observed in May 2020). Both of these species are common in Puget Sound bays and lagoons. Cutthroat trout (*Oncorhynchus clarkii*) and various sculpin species were not observed but may also be present in the small stream and lagoon. WDFW identifies several fish passage barriers in the stream that limit fish access (WDFW 2020c). The forested uplands likely support black-tailed deer (*Odocoileus hemionus*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), Eastern gray squirrel (*Sciurus carolinensis*), Douglas squirrel (*Tamiasciurus douglasii*), and forest nesting birds. Bald eagles (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), great blue heron (*Ardea herodias*), and a variety of waterfowl are likely to be present.

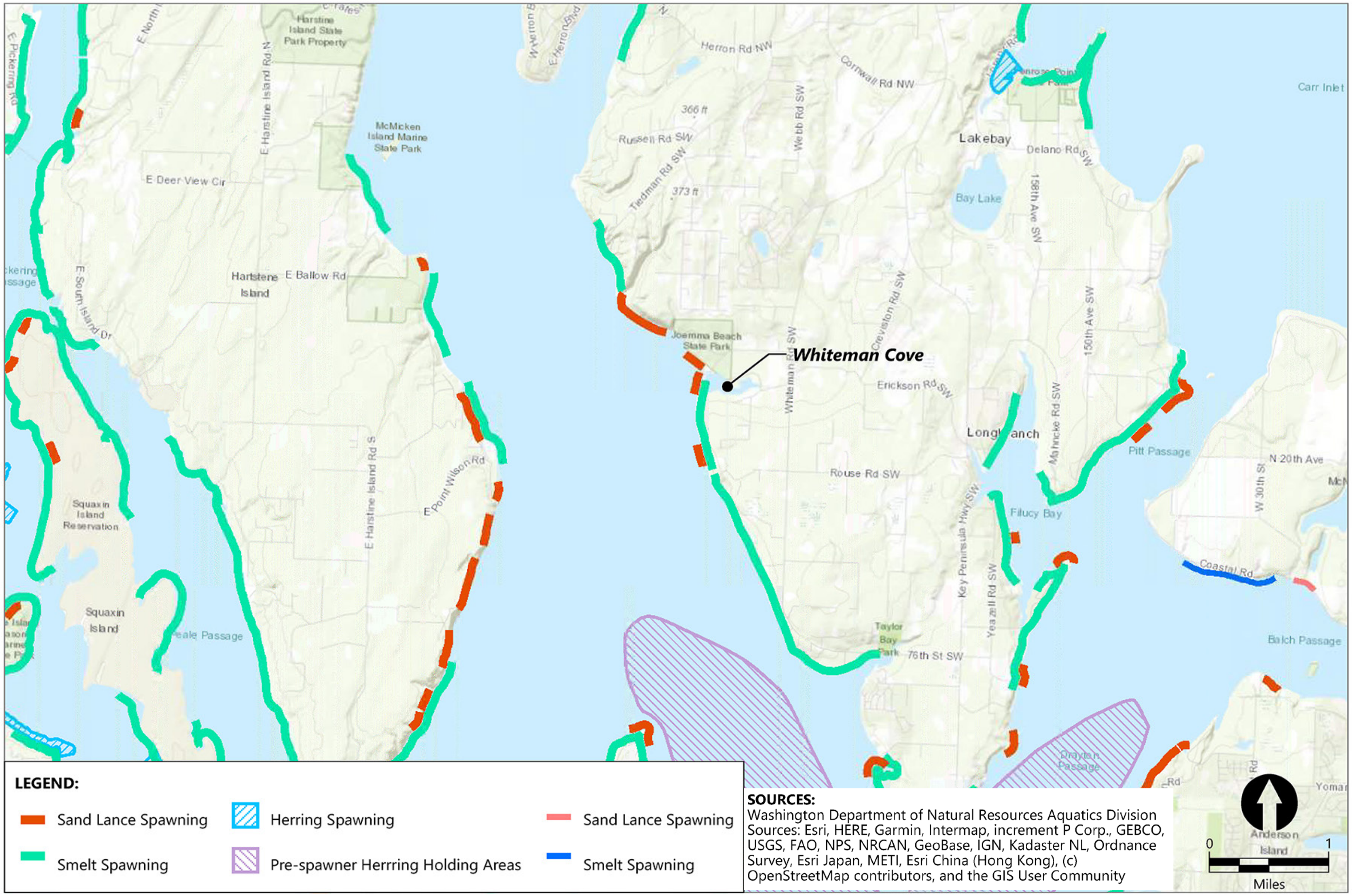
In the marine nearshore of Case Inlet, there are numerous anadromous and marine fish including Chinook, coho, chum, and pink salmon (*Oncorhynchus tshawytscha, O. kisutch, O. keta, and O. gorbuscha*); steelhead (*O. mykiss*); cutthroat trout; bull trout (*Salvelinus confluentus*); Pacific lamprey (*Entosphenus tridentatus*); Pacific sand lance (*Ammodytes hexapterus*); Pacific herring (*Clupea pallasii*); surf smelt (*Hypomesus pretiosus*); longfin smelt (*Spirinchus thaleichthys*); tubesnout

(*Aulorhynchus flavidus*); three-spine stickleback; bay pipefish (*Syngnathus leptorhynchus*); lingcod (*Ophiodon elongatus*); shiner and pile perch (*Rhacochilus vacca*); and a variety of rockfish (*Sebastes* sp.), sculpins, sanddabs (*Citharichthys* spp.), sole, and flounder (Pletsch and Orr 2015).

Anadromous salmon species are present in multiple small streams and the Nisqually and Deschutes rivers that flow into Case, Henderson, Budd, Eld, Totten, and Hammersley inlets in proximity to Whiteman Cove (WDFW 2020c). Specifically, fall Chinook salmon have been documented to be present or spawn in Woodland Creek (Henderson Inlet), Deschutes River and Percival Creek (Budd Inlet), McLane Creek (Eld Inlet), Kennedy Creek (Totten Inlet), Goldsborough and Mill creeks (Hammersley Inlet), Rocky and Coulter creeks (Case Inlet), and the Nisqually River. Coho and chum salmon and winter steelhead are present in all of those same streams and rivers, plus additional smaller creeks.

Juvenile salmonids from the numerous above streams and rivers could potentially use pocket estuaries and marine shorelines for foraging. Studies in the Skagit River Delta and Whidbey Basin indicate that Chinook, chum, pink, and coho salmon all use pocket estuaries as early subyearling migrants or as later subyearling or yearling migrants after leaving their natal streams (Beamer et al. 2009, 2012, 2016). Due to the high productivity of estuary habitats, juvenile salmonids can grow substantially, increasing their long-term survival. Marine fish can likewise use lagoons as nursery habitat or seasonal refuge.

Figure 5
Forage Fish Spawning Map (from WDFW 2020b)



Impaired Natural Processes

The fill across the natural inlet to the lagoon restricts tidal fluctuations into the lagoon. The control structures significantly restrict tidal fluctuation into the lagoon and preclude most fish passage. The three-spine stickleback and shiner perch likely enter the lagoon through the southern control structure at higher tides, but juvenile salmonids are typically surface oriented and avoid descending down to enter submerged culverts (potentially due to pressure changes; Bell 1991) and are unlikely to be present except as resident fish in the small stream (e.g., cutthroat trout).

Potential Habitat Conditions with Proposed Options

Four options to provide fish passage to the cove were considered and evaluated as part of a screening-level feasibility study conducted by the Anchor QEA team as part of this Project. The results of that analysis are documented in the Feasibility Report for the Project (Anchor QEA et al. 2020). The screening analysis provided information regarding fish passage, permitting, and site use challenges and opportunities for each of the proposed options. Following the screening analysis, all four options were moved forward into the feasibility study. This memorandum summarizes the results of the hydraulic analysis conducted for each proposed option described briefly below:

- Option 1: A new gated control structure at the current location of the DNR control structure
- Option 2: A new weir control structure at the historical opening to the north
- Option 3: An open channel at the historical opening of the cove with a bridge crossing
- Option 4: An open channel at the historical opening of the cove with road removal and rerouted access from the south

Tidal Exchange and Bathymetry

With either Option 1 or Option 2, there would be tidal connectivity between Whiteman Cove and Case Inlet only about 20% of the tidal cycle. Both options would be designed to impound water in the cove and maintain a minimum elevation of approximately +9 feet (NAVD88). With Options 3 or 4, the thalweg of the channel would be set to +3 feet NAVD88, which would provide tidal connectivity and exchange between Whiteman Cove and Case Inlet about 70% of the time. This is similar to historical conditions. The tide in Case Inlet is semi-diurnal (two high tides per day) and the average daily tide range is 14.5 feet, ranging from 10.4 feet NAVD88 at MHHW to -4.1 feet NAVD88 at MLLW. In Options 1 and 2, the average daily tidal range would be about 1.4 feet within Whiteman Cove (ranging between +9 and +10.4 feet NAVD88). However, more extreme high tides would be able to flow into Whiteman Cove with Options 1 and 2, although Option 1 may be not fill as quickly during flood tide as Option 2. In Option 1, the tidal exchange would lag behind Case Inlet due to the water passing in and out of relatively small culverts. In addition, the closure of the tide gate would halt exchange through the culverts when the elevation reached 10.4 feet NAVD88.

Options 3 and 4 would have a large exchange of water (called the tidal prism) between high tide and the thalweg of the tidal channel that would tend to form braided and deeper tidal channels similar to those that still appear as deeper areas on the bathymetric map (Figure 6). In Option 2, the tidal prism and velocities would be lower and may not cause as much channel formation.

Velocities through a new culvert and gate system or the proposed tidal channel were estimated through hydrodynamic modeling conducted as part of the Project (Anchor QEA and Blue Coast Engineering 2020). For Option 1, velocities are predicted to exceed 2 feet per second (fps) more than 80% of the time when tidal exchange is occurring. While juvenile salmonids would typically enter tidal channels as the tide is flooding into the channel, fish may avoid areas of higher velocity (Bell 1991; Barnard et al. 2013 indicates typical swimming speeds of juvenile salmonids are from 0.5 to 2 fps). This would be difficult for juvenile salmonids to pass upstream when flows are ebbing from the cove, and if the culvert(s) are submerged when the tide is rising then juveniles may not be attracted to enter the culverts because they are typically present in the top few feet of water (Barnard et al. 2013).

For Options 2, 3, and 4, predicted velocities would vary substantially over the tidal cycle, from 0 fps up to a maximum of 9.2 fps for Option 2, up to 6.7 fps for Option 3, and a maximum of 5.5 fps for Option 4. The mean and median velocities are less than 2 fps for Options 2, 3, and 4. Option 2 would not provide as much connectivity to Case Inlet as Options 3 or 4 (approximately 20% of the time, as opposed to approximately 70% of the time with Options 3 or 4).

Option 2 would have a rock weir or hardened channel bottom to maintain elevations above +9 feet NAVD88. This would likely be covered by sand and wood over time. Options 3 or 4 would simulate natural tidal channel conditions with natural substrate and occasional wood present and would have varying depths and velocities across the channel, allowing fish passage at tides when tidal exchange was occurring.

Water Quality

For all options, increased flushing and tidal exchange would likely result in the water quality conditions of the lagoon becoming more similar to that of Case Inlet. Salinity would likely remain similar to existing conditions, although potentially lower during the rainy season when more freshwater enters Case Inlet (29 ppt or less). For Options 1 and 2, since there would still be a pool held at 9 feet NAVD88, water temperatures, dissolved oxygen, nutrients, and bacteria would likely remain similar to existing conditions during the summer and early fall months. For Options 3 and 4, the fluctuation in water levels and frequent tidal change would likely result in the water temperatures generally remaining lower in the lagoon through the summer and higher dissolved oxygen levels, which would be beneficial for both salmonids and marine fishes. 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.

Shoreline and Riparian Conditions

With Options 1 or 2, the shoreline and riparian conditions within Whiteman Cove would slightly change 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 from elevation 9 to 10.4 feet NAVD88, which is an increase of about 1 acre. With Option 2, extreme high tides could flow into the lagoon that could cause some mortality of existing trees along the fringe and this narrow band could convert to shrubs such as willows or marsh.

With Options 3 or 4, Whiteman Cove would generally convert to a mudflat-dominated pocket estuary, likely with a larger fringing marsh of an estimated 5 acres around the perimeter from elevation 9 to 11 feet NAVD88 (Figure 6) and extending along the inlet tidal channel (estimated area using bathymetry of the cove). This would be an approximately 2-acre increase over existing wetland area. The highest tide elevations would exceed 12 feet NAVD88, thus potentially changing some areas of forested riparian vegetation to supratidal vegetation such as dune grass, Puget Sound grindelia, and Douglas aster (*Aster douglasii*). Sitka spruce (*Picea sitchensis*) or willows could grow well fringing the marsh, and western red cedar may also remain as it is more tolerant of wet conditions. Understory species would be less salt tolerant.

Option 4 would require creating an alternate access along an existing County right-of-way from the south that likely crosses some existing wetland areas. This area has not been directly observed, but potential wetlands are shown in Attachment 1. If wetlands are present, then mitigation for wetland impacts would be required, which could increase the cost of this alternative.

Fish and Wildlife Species

The primary purpose of the Project is to provide fish passage into and out of the lagoon for all life stages of salmonids, meeting the requirements of the 2013 injunction. 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. Transitions between low velocity areas and high velocity areas can cause fish to avoid the area (Bell 1991). Fish passage would not be substantially improved from existing conditions.

Option 2 would provide improved fish passage but as the weir would disconnect the lagoon from Case Inlet approximately 80% of the time over the year, fish access would only be viable approximately 20% of the time over the year, thus also not meeting the requirements of the 2013 injunction.

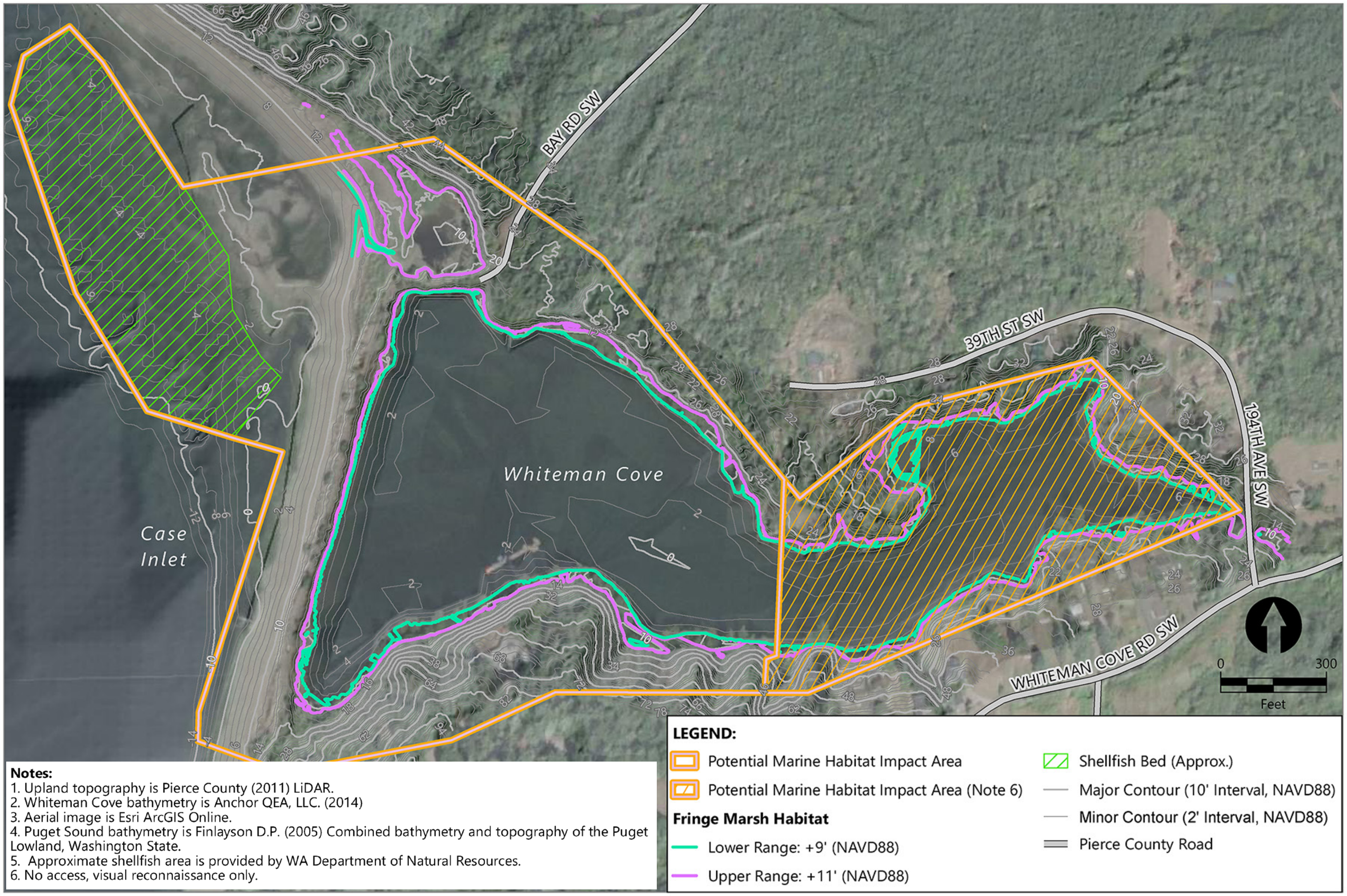
Options 3 and 4 would provide fish passage most of the time, because predicted velocities would typically be at or below 2 fps during most of the tidal cycles and tidal exchange and connectivity would occur for the full natural extent. Both Options 3 and 4 would vastly improve fish access and allow juvenile salmonids to enter and rear in the pocket estuary over the majority of the tidal cycle similar to natural conditions (above elevation +3 feet NAVD88), approximately 70% of the time over a year. Both Options 3 and 4 would likely meet the requirements of the injunction to allow fish passage during all times that they would naturally seek passage.

Juvenile salmonids can swim for sustained periods at speeds from 0.5 to 2 fps, depending upon size (Bell 1991). However, for Options 3 and 4, fish would tend to enter the lagoon on rising tides and exit on ebbing tides, thus avoiding the need to swim against the tidal flows and naturally seeking passage during appropriate times of the tidal cycle.

Studies from the Skagit River indicate that pocket estuaries can provide important rearing habitat for multiple salmonid species, but particularly Chinook salmon (Beamer et al. 2009, 2012, 2016) because they use estuarine habitats for longer periods of time than other salmonids. Studies at the Nisqually Delta have also shown that restoring tidal influence to formerly diked pasture land restored a mix of salt marsh and mudflat habitats that provided important prey resources for juvenile Chinook salmon including epibenthic crustaceans, dipteran flies, and terrestrial insects (David et al. 2014). Foraging performance and growth rates were very similar between the restored tidal channels and reference tidal channels (David et al. 2014).

Marine fish are also anticipated to use the lagoon for rearing and spawning, including sculpin species such as Pacific staghorn sculpin (*Leptocottus armatus*) and shiner perch that 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 most likely further enhance the food web of Case Inlet.

Figure 6
Potential Future Condition with Fringing Marsh (Options 3 and 4)



Notes:
1. Upland topography is Pierce County (2011) LiDAR.
2. Whiteman Cove bathymetry is Anchor QEA, LLC. (2014)
3. Aerial image is Esri ArcGIS Online.
4. Puget Sound bathymetry is Finlayson D.P. (2005) Combined bathymetry and topography of the Puget Lowland, Washington State.
5. Approximate shellfish area is provided by WA Department of Natural Resources.
6. No access, visual reconnaissance only.

Shellfish

Both natural and commercial beds of shellfish exist in Case Inlet. The beaches at Joemma Beach State Park and the study area are closed to sport shellfish harvest due to concerns about conservation or human health. Both oysters and mussels were observed on the barrier spit at low tide in May 2020.

Case Inlet includes approved geoduck (*Panopea generosa*) growing areas. Seattle Shellfish owns subtidal lands and commercially plants and harvests just north of Whiteman Cove (Figure 3). Another mapped 50.9-acre geoduck tract (14400) also occurs north of Whiteman Cove. A tract is defined as any subtidal area with well-defined boundaries that has been surveyed and found to contain geoducks of commercial quantity and quality, as identified by WDFW, DNR, or the Tribes.

Commercial planting of juvenile geoducks includes placement of PVC tubes approximately 6 to 10 inches into a sandy substrate. Tubes are removed after 1 or 2 years once the geoducks have burrowed deep enough into the substrate to be protected. This stage is when the geoducks are most sensitive to disturbance. Adult geoducks are harvested after 5 to 7 years, once they are large enough to be marketable. Washington State is the largest producer of geoducks in the United States, both wild and cultured.

Significant studies have not been done to date on turbidity or water velocity impacts on geoduck life cycles. Many technical analyses on geoduck study the effects of harvest on the surrounding marine environment, not the effects of actions on geoducks themselves because they are not a protected species. However, in 2001 DNR evaluated environmental impacts surrounding a proposed geoduck fishery in Washington State in the *Final Supplement Environmental Impact Statement for the State of Washington Commercial Geoduck Fishery* (DNR 2001). Suspended sediment (turbidity) has the potential to adversely affect geoduck eggs, larvae, and adults, with eggs being the stage most sensitive to turbidity. 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.

Option 1 would continue to have flow towards the west through the shellfish bed similar to existing conditions. 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. This would occur in a relatively small area of the existing shellfish beds.

Overall, the commercial harvest area is unlikely to experience significant adverse effects because initial turbidity from channel adjustments is likely to be temporary, and because the channel formation and movement will 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 are minimized (e.g., time the planting of geoducks to occur 1 year before Project construction or after Project construction).

Conclusions

Options 3 and 4 would provide significantly improved fish access into and out of the lagoon that would both likely meet the requirements of the 2013 federal court injunction for fish passage for juvenile fall Chinook, coho, and chum salmon. Passage would occur during all but the lowest tides (when the lagoon would naturally disconnect) and velocities would typically be 2 to 3 fps, or less. The lagoon would likely become mudflat dominated with a fringing salt marsh. Both mudflats and salt marsh habitat are extremely productive rearing habitats for juvenile salmonids, particularly for Chinook salmon. Overall, Option 4 will establish fish passage at all tidal elevations that salmonids will seek access under natural conditions and at velocities similar to those found naturally. Option 3 would provide a similar passage opportunity but with slightly higher velocities, which could cause fish to temporarily avoid the transition between low and high velocities.

Option 1 would not improve fish passage to any substantial effect from existing conditions and would not meet the requirements of the 2013 injunction. Option 2 would improve fish passage, but not over the full tidal range and would also not likely meet the requirements of the 2013 injunction.

With Options 2, 3, and 4, other marine fish would also likely use the lagoon for rearing and spawning, including sculpins and shiner perch. The overall increase in connectivity, with over 25 acres of habitat that will export nutrients, detritus, and insects into Case Inlet, will most likely provide additional food web enhancement to the Case Inlet ecosystem.

Initial channel and sediment adjustments for Options 2, 3, and 4 could transiently flush out fine sediments and would likely create one or more channels outside of the lagoon that might cut through the current commercially owned shellfish (geoduck) bed. A potential channel could cause higher velocities in a small portion of shellfish bed. Careful coordination on the timing of Project completion with shellfish operations could minimize sediment or velocity impacts to shellfish.

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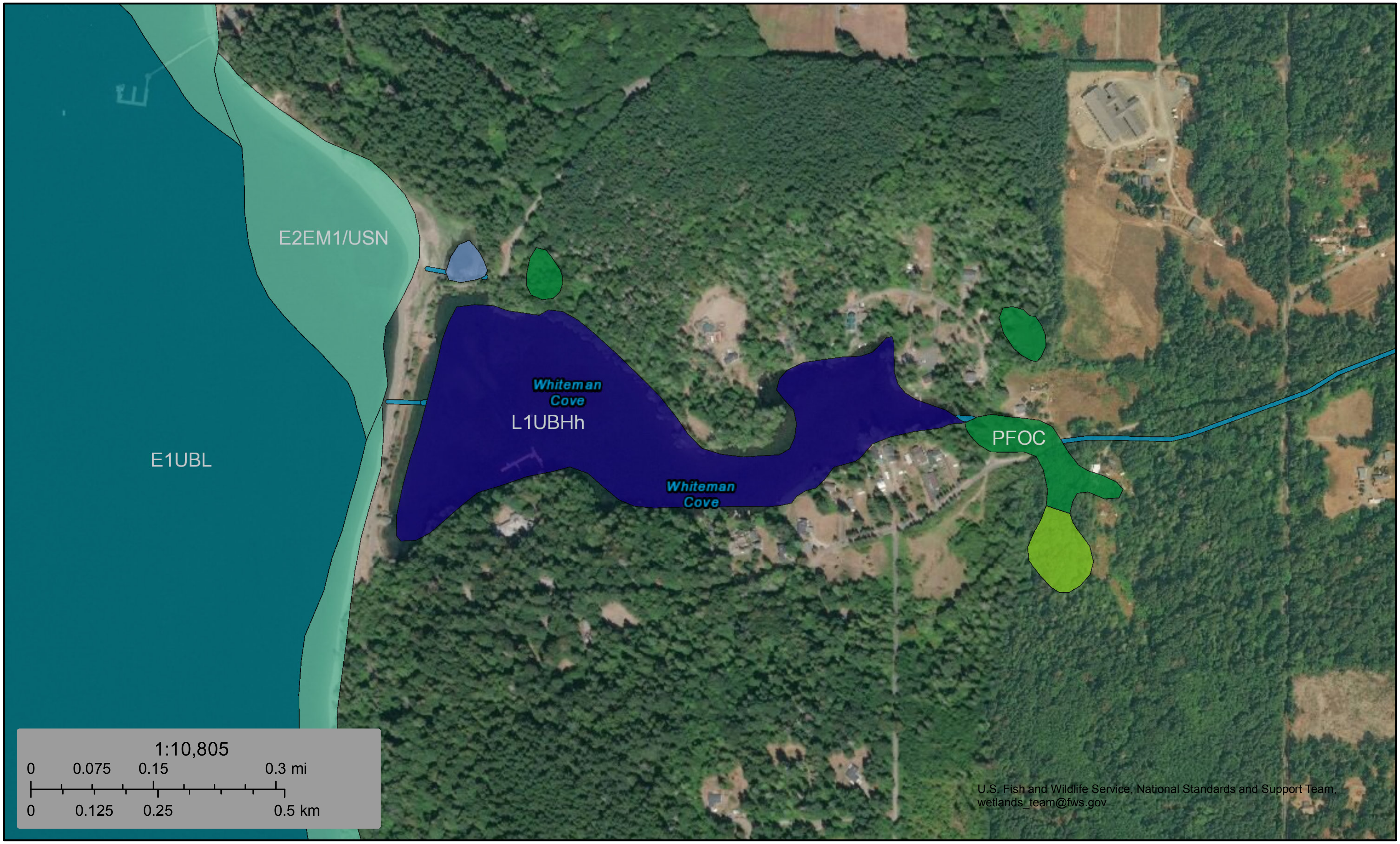
Attachment 1
National Wetlands Inventory Map

U.S. Fish and Wildlife Service

National Wetlands Inventory

WhitemanCove1



May 20, 2020

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

National Wetlands Inventory (NWI)
This page was produced by the NWI mapper