EBEY ISLAND HABITAT RESTORATION FEASIBILITY STUDY

Final Report

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ABBREVIATIONS AND ACRONYMS

AMEC	AMEC Earth & Environmental, Inc.
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FEQ model	Full Equations Model
FRT	Forested riverine tidal
HEC-RAS	Hydraulic Engineering Centers River Analysis System
IVA	Indicator value assessment
LiDAR	Light Detection and Ranging
MHHW	Mean higher high water
MHW	Mean high water
MLW	Mean low water
MLHW	Mean lower high water
MLLW	Mean lower low water
MTL	Mean tide level
NAVD	North American Vertical Datum
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
NOAA	National Oceanic and Atmospheric Administration
SD	Standard deviation
SEWIP	Snohomish Estuary Wetland Integration Plan (City of Everett 1997)
SRSC	Skagit River System Cooperative
SRT	Self-regulating tide gate
US 2	United States Highway 2
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USDA	United States Department of Agriculture
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation
WY	Water year

EBEY ISLAND HABITAT RESTORATION FEASIBILITY STUDY

1.0 EXECUTIVE SUMMARY

The purpose of this study is to investigate the technical and social feasibility of restoring estuarine functions on 1,237 acres of Washington State Department of Fish and Wildlife (WDFW) land on the southern portion of Ebey Island, in support of Chinook salmon recovery in the Snohomish River estuary. A stakeholder advisory committee was convened and provided initial comments about the concerns, known constraints, and opportunities for beneficial project outcomes. AMEC Earth & Environmental (AMEC) developed a range of restoration alternatives, which were reviewed and critiqued by the advisory committee. WDFW selected two of the alternatives for more detailed investigation, after which AMEC explored the technical feasibility and the expected benefits of those alternatives to listed Chinook salmon. Other aspects of feasibility such as flood control issues, impacts to existing transportation and utility infrastructure, social acceptability, and rough costs were also evaluated. One alternative was called the Long Term Alternative because of the expected very long timeline that it would take to implement full restoration on all of WDFW property within the project area. The other alternative, called the Near Term Alternative, involved a combination of full tidal restoration, partial tidal restoration, and leaving land in its current condition to allow current land uses there to remain possible.

While restoration is technically feasible, the practical feasibility of restoring Chinook salmon habitat on WDFW holdings on Ebey Island is presently low. Reasons for the low practical feasibility are as follows:

- Limited support: Numerous land owners and interest groups expressed a strong preference for preserving existing conditions and the agricultural potential of WDFW land. Diking District #1, whose support would be essential because of the dike and drainage easements on the island, maintains that it would oppose dike configuration and hydraulic control structure changes that would be needed to fully or partially restore tides to WDFW holdings because of the possibility of increased flood damage and reduced drainage on the remainder of the island;
- High costs: Both alternatives that were explored are vastly more expensive than the magnitude of restoration funds that are likely to be available in the foreseeable future. Full restoration construction costs alone associated with the Long Term Alternative would be in the range of $33 to 44 million. The Short Term Alternative, which includes partial restoration measures to reduce risks to the surrounding properties, would have construction costs in the range of $16 to 25 million. In addition to construction costs, both alternatives would involve substantial costs to protect or replace existing infrastructure; and

- Partial tidal restoration was not found to be an attractive compromise. Partial restoration options did not drastically reduce stakeholders' concerns about preserving the potential for agricultural land uses or the viability of ongoing flood control and drainage functions. Also, partial tidal restoration was projected to be substantially less effective in improving Chinook salmon habitat conditions than full restoration and is unlikely to be approved by funding agencies due to uncertainties regarding its effectiveness.

Restoration WDFW holdings on Ebey Island are located in a key location in the watershed to improve conditions for Chinook salmon. Habitat improvements here could support large numbers of Chinook salmon smolts due to the large area of the holdings. The predicted habitat gains could be further increased if a relatively small amount of additional land was acquired to connect the separate areas of WDFW holdings. Conclusions about the technical feasibility for salmon habitat restoration on Ebey Island are as follows:

- Number of smolts that would benefit: The Long-Term Alternative could provide habitat for between 263,000 and 1.32 million Chinook salmon smolts per year. The Near Term Alternative could provide habitat for roughly 53,000 to 264,000 Chinook smolts per year;
- Dike Constructability: Construction of new interior dikes is feasible from an engineering perspective, but would require special design and construction considerations; and
- Flooding: Both alternatives could be built with measures to minimize the risk of increasing the height or duration of flooding within the island and surrounding areas.

Salmon habitat restoration on the north tip of Ebey Island seems to be more feasible socially and economically than the restoration alternatives proposed for WDFW holdings. The diking district is in favor of this option because of the anticipated reduction in dike operation and maintenance costs. If landowners in this area of the island were willing to sell, the restoration community would likely be able to procure funding to acquire the property and construct the required changes to the dike and drainage infrastructure to restore the land to full tidal conditions. This area lacks the transportation and utility infrastructure hurdles that are present in and adjacent to WDFW holdings.

While the present feasibility of meeting the long term goal of restoring fish habitat on Ebey Island is low, Ebey Island can contribute to the fulfillment of other aspects of WDFW's mission. The National Coastal Wetlands Conservation grant identified short term goals of enhancing and creating freshwater wetlands and implementing a moist soil management program (involving agriculture) that benefits waterfowl. Managing the site for those goals in the near term may be much more feasible technically, economically and socially.

If, over time, it is shown that salmon restoration goals can be achieved using other lands, the WDFW's long term goal of restoring their holdings on Ebey Island to tidal conditions may be reconsidered. However, in the event that future evaluations conclude that habitat improvements on Ebey Island are needed to meet salmon recovery goals, WDFW will pursue habitat improvements on this property. Should at some point a consortium develop to accomplish restoration on a substantial part of Ebey Island, then full tidal restoration of WDFW land in conjunction with that project would likely be pursued.

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2.0 INTRODUCTION

The WDFW mission is to *serve Washington's citizens by protecting, restoring, and enhancing fish and wildlife and their habitats, while providing sustainable fish and wildlife-related recreational and commercial opportunities*. WDFW strives to maximize the effectiveness of its properties in carrying out this mission by determining how different parcels can best help the agency meet different parts of its mission. One of the funding sources for acquiring the bulk of WDFW's holdings on Ebey Island was a National Coastal Wetlands Conservation grant. In the grant application, WDFW indicated that the long term goal on the site was the complete restoration of estuarine functions. Short term goals included enhancing and creating freshwater wetlands, restoring tidal action to sloughs, and implementing a moist soil management program (involving agriculture) that benefits waterfowl. The project is funded by the Recreation and Conservation Office's Salmon Recovery Funding Board, Natural Environmental Resource Damage Assessment funds, and by labor donations by numerous stakeholders.

The purpose of this study is to investigate the technical and social feasibility of restoring estuarine functions on 1,237 acres of land owned and managed by WDFW on Ebey Island. The primary purpose is to support salmon restoration while meeting other aspects of WDFW's mission. The 3,940-acre island is bounded by the mainstem Snohomish River on the west and by Ebey Slough on the east. The WDFW property is located just south of the US 2 trestle bridge that spans the Snohomish River floodplain between Everett and Snohomish, Washington (Figure 1).

Tidal marsh in the lower Snohomish River provides important rearing habitat for Chinook salmon and other species, although 85 percent of these historical habitats have been lost due to diking (Haas and Collins 2001). This loss of rearing habitat is considered one of the primary factors limiting recovery of Chinook salmon, which are listed as threatened under the Endangered Species Act (Snohomish Basin Salmon Recovery Forum, 2005). The Snohomish Basin Salmon Recovery Forum has identified the restoration of tidally influenced habitat in the Snohomish River estuary as a priority for Chinook salmon recovery in the basin. If properly implemented, habitat restoration is an effective tool for boosting the survival and productivity of depressed salmon populations (Haas and Collins 2001). However, habitat restoration is an expensive proposition, especially in urban and agricultural areas, and therefore requires careful planning and shepherding of resources. Many projects fail to reach their objectives due to technical infeasibility, cost, and lack of public support. For this reason, before significant monies are expended, it is prudent to carefully consider whether a restoration effort is likely to produce the desired outcome, and what steps can be taken to maximize the probability of success.

With the assistance and guidance of a stakeholder Advisory Committee (Table 1), the WDFW determined that the restoration of the Ebey Island site should commence with a feasibility study that explored a range of restoration alternatives, highlighted opportunities and constraints associated with each alternative, and addressed critical uncertainties and gaps in knowledge before committing

additional time and money to designing, permitting, and implementing a project. WDFW also recognized that the feasibility study would be most effective if it involved key stakeholders, local residents, and other individuals familiar with Ebey Island or whose interests would be directly affected by the agency's actions. The involvement of diverse interest groups and knowledgeable people at an early stage of the feasibility assessment was recommended as a way of tapping into local expertise, identifying potential pitfalls, reconciling differences of opinion, and shoring up support for one or more restoration options that might conceivably further the goals of the agency. Participation in the Advisory Committee does not imply endorsement of the feasibility study and its findings.

Table 1 Project team and Advisory Committee members.

Project Team			
WDFW		**Consulting Team**	
Name	**Role**	**Name**	**Role**
Richard Tveten	Project Director	Cleve Steward	Project Manager
Doug Hennick	Fish and Wildlife Biologist	Ryan Bartelheimer	Habitat Engineer
John Garrett	Wildlife Area Manager	Jim Dransfield	Geotechnical Engineer
Belinda Schuster	Asst. Wildlife Area Mgr	Dan Evans	Facilitator
Annette Hoffman	Fish Program Manager	Walker Stanovsky	Administrator
Kye Iris	Property Acquisitions	Tad Schwager	Fisheries Biologist
Russell Link	Program Manager	Cliff Strong	Planner
Ruth Milner	District wildlife biologist	Matt Brennan	ESA PWA, Hydrologist
Advisory Committee			
Name	**Organization**	**Name**	**Organization**
Everett Alexander	Diking District #1	Ryan Hembree	Snohomish County Agriculture Coordinator
Jason Anderson	Stilly-Snohomish Fisheries Task Force	Janne Kaje	King County Snoqualmie-Skykomish Watershed
Cory Armstrong-Hoss	YMCA of Snohomish County	Chuck Lobdell	Ducks Unlimited
Barney Bagwell	Diking District #1	Monte Marti	Snohomish Conservation District
Mike Blackbird	Pilchuck Audubon Society	Kurt Nelson	Tulalip Tribes
Brian Bookey	Snohomish County Ag. Advisory Board	Tom Nowak	Adjacent landowner
Maria Calvi	Tulalip Tribes	Graeme Peters	Ducks Unlimited
Andrew Corbin	WSU Snohomish County Extension	Casey Rice	NOAA Fisheries
Phil Cunningham	Diking District #1	Mark Sadler	City of Everett
John Engel	Snohomish County Public Works	Sharon Swan	Snohomish County Parks and Recreation
Kate Halstead	Snohomish Valley Tilth	Micah Wait	Wild Fish Conservancy
Nick Harper	Cascade Land Conservancy		

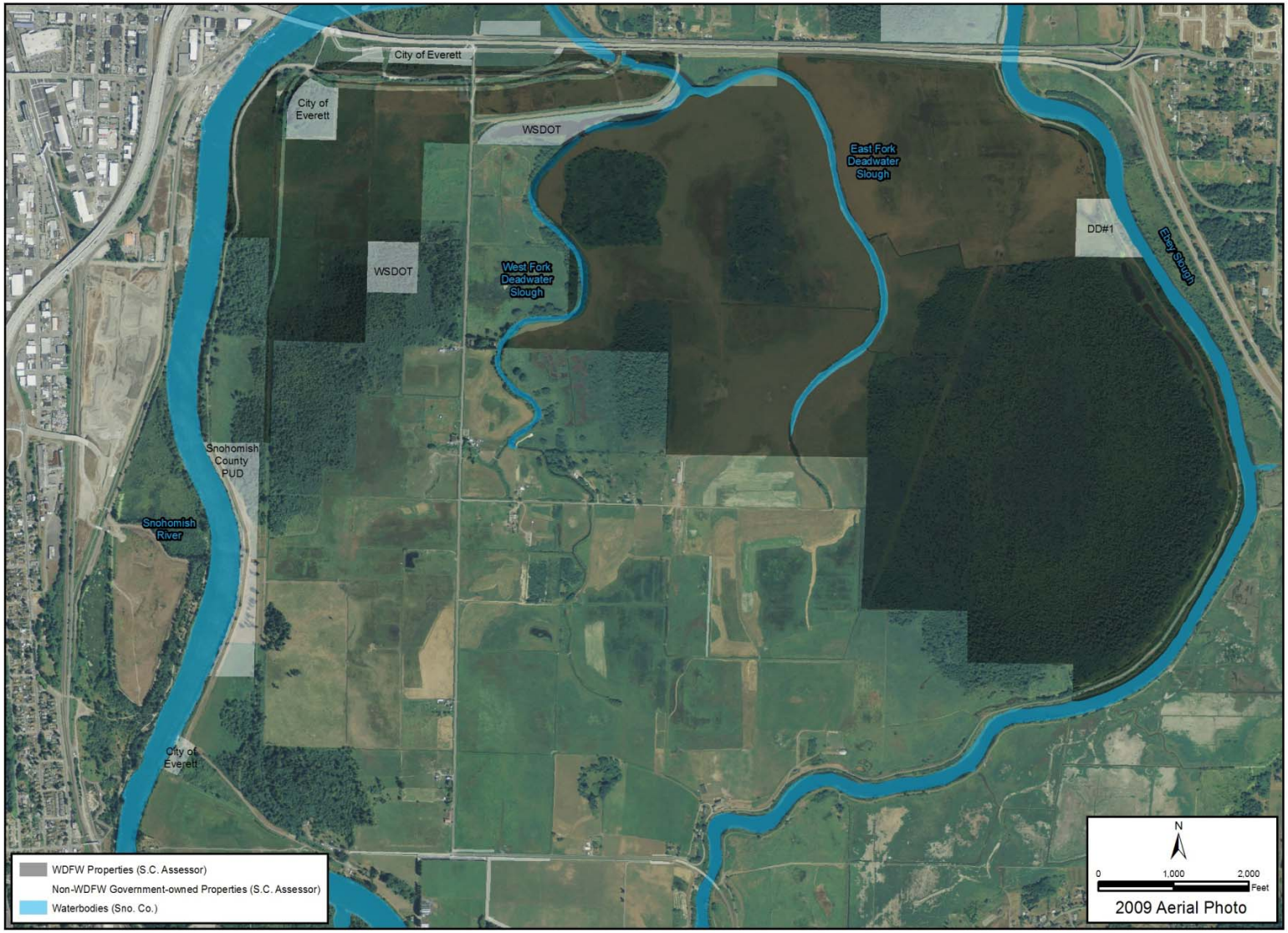

Figure 1 WDFW and other government-owned property, shown on a 2009 aerial photograph.

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The Ebey Island Habitat Restoration Feasibility Study commenced in February, 2010, with the solicitation of proposals and the hiring of a contractor, AMEC, joined by subcontractors ESA PWA (formerly Philip Williams and Associates) and Dan Evans Consulting. Working with the project Advisory Committee, the WDFW-AMEC team developed a process to formulate goals for the project, compile existing information, identify a suite of potential restoration alternatives, and evaluate and score the alternatives using a wide array of technical, ecological, and socioeconomic criteria. The highest ranking conceptual alternatives—those predicted to yield the greatest ecological and societal benefits—were selected for further in-depth hydrological modeling and geomorphological analysis. The modeling effort enabled project ecologists, engineers, and planners to evaluate the physical and ecological response of the system and to modify the preferred alternatives to achieve a broad range of benefits.

This report describes the evaluation process and the preliminary results and recommendations of the Ebey Island Habitat Restoration Feasibility Study. It is hoped that this effort will enable project proponents to secure addition funding and generate support among stakeholders to implement the recommended actions, should WDFW decide to pursue them.

3.0 DESIRED PROJECT OUTCOMES

The overarching goals of the Ebey Island habitat restoration project can be broadly divided into ecological and societal categories. The potential for the Ebey Island project to simultaneously maximize both ecological and societal goals is low. Successfully agreeing on a plan and moving forward with the design and implementation of a preferred habitat restoration alternative will require compromise.

3.1 ECOLOGICAL GOALS

3.1.1 Restore ecosystems

The primary ecological goal is to restore freshwater tidal marsh habitat and biological communities. These include a complex suite of aquatic and terrestrial plants, invertebrates, amphibians, birds, and fish. The complexity of their myriad interactions makes it difficult, if not impossible, to recreate an ecosystem by managing only a small subset of species. Therefore, ecosystem restoration efforts typically focus on reestablishing the physical processes that provide the template for an ecosystem. On Ebey Island, this means restoring the natural fluvial and tidal processes that would result in the type of habitat characteristic of nearby undisturbed areas.

3.1.2 Contribute to recovery of listed Chinook populations

Another major ecological goal of the Ebey Island Restoration Project is to provide habitat conditions that will contribute to the recovery of salmon populations listed under the ESA, particularly Puget

Sound Chinook salmon. A high proportion of juvenile Chinook salmon undergo a lengthy rearing stage in the Snohomish estuary, which makes them especially sensitive to the diking and other anthropogenic modifications to the Snohomish River delta over the last 150 years (Beamer and Larson 2004).

Focusing on one species seems contradictory to the goal of restoring whole ecosystems. However, Chinook are important not only because of their legal status, but also because as a keystone species, they are essential components of healthy Puget Sound river systems.

3.1.3 Benefit other salmonids

Several other species of salmon also use the lower Snohomish River to varying degrees. Coho salmon use the freshwater tidal, off-channel, and floodplain areas for rearing. Pink, chum, and sockeye salmon migrate through the estuary to spawn in reaches farther upstream, and consequently their juveniles migrate back through the estuary to marine waters. Bull trout, which are also listed under the ESA, exhibit several life history strategies. Bull trout with an anadromous life history use the lower Snohomish River for refuge and foraging. This project, if designed appropriately to improve the habitat components and processes that benefit Chinook salmon, will also benefit a wide range of other fish species.

3.1.4 Provide habitat for birds and other wildlife

Protecting and conserving other wildlife species, including non-commercial species, is an important goal of WDFW. Ebey Island has the potential to provide a large area of high quality habitat for migratory waterfowl, raptors, and resident bird species. Therefore, the restoration of habitat types other than fish habitat is also a project goal.

3.2 SOCIETAL GOALS

3.2.1 Address societal concerns

Ebey Island has supported farms and recreational uses since it was diked and drained in the first half of the 20th century. Local residents, especially those whose families have farmed on Ebey Island for many years, are understandably concerned that the restoration envisioned by WDFW would increase the risk of flooding and impair their ability to make a living as farmers. The general lack of information and opportunity for parties to dialogue in the past has heightened the ongoing need to address these issues in a collaborative setting.

Ebey Island is part of a larger, ongoing, vigorous debate between agricultural and environmental interests in Snohomish County. Even if it is technically feasible to restore tidal processes on a portion of the WDFW-owned land on Ebey Island, the project will move forward only if the proposed actions

are supported by a critical mass of stakeholders, including the agricultural community. The success of the Ebey Island Restoration Project hinges on the development of a carefully balanced design and implementation plan that accommodates a broad range of societal values.

Project implementation will also be constrained by potential direct and indirect effects on neighbors and surrounding land uses. As a neighbor and as a government agency, WDFW intends to be receptive to input from stakeholders to the extent practicable. WDFW also must comply with all diking district requirements pertaining to dike realignment or other modifications to the existing infrastructure. WDFW also considers it a prerequisite that any alternative be designed and implemented so as not to reduce the flood protection of the levee system, nor to place any additional financial burden on the district.

3.2.2 Benefits should outweigh costs

Construction and maintenance costs largely dictate the feasibility of any proposed project design. Costs for the construction components of the proposed alternatives are calculated elsewhere in this report. While the costs (and benefits) alone do not decide the feasibility, they form the basis for critical decision making.

4.0 STAKEHOLDER INVOLVEMENT

WDFW recognizes that the diverse community in and around Ebey Island comprises individuals and interest groups with diverse, and sometimes conflicting, views of habitat restoration. An important objective of the Ebey Island Habitat Restoration Feasibility Study was to convene an Advisory Committee representing these diverse interests to help define key issues, provide meaningful feedback on proposed alternatives, and deliberate in the selection of preferred habitat restoration alternatives. The goal was to facilitate dialogue and the exchange of information so that people's concerns and ideas would be heard, and ultimately, to generate support for the project. Hopefully, the result was a fair, well-informed process and a technical proposal that balances agricultural and restoration interests and provides a sound basis for future decisions and actions.

4.1 ENGAGEMENT STRATEGY

Ebey Island has been an important agricultural area in the past, and some areas are still farmed today. The island therefore represents a unique opportunity to implement a habitat restoration project sensitive to the needs of the agricultural community. The project team explored opportunities to benefit both salmon and farmers. While it may not be possible to fully adhere to the "no net loss of agricultural land" policy advocated by the Snohomish County Agricultural Advisory Board, the project can serve as an example of how to effectively involve and protect the interests of local farmers and open space advocates.

The following objectives guided the public outreach and stakeholder engagement efforts:

- Inform: Facilitate understanding of the feasibility study's intent, process (including opportunities for review and comment at each stage), alternatives, and recommendation of preferred alternatives.
- Support collaboration: Build rapport among participants and the project team, and develop a productive, collaborative dynamic.
- Engage: Invite the public, stakeholders, and directly affected individuals to review, evaluate, and comment on feasibility study information, initial findings, alternatives, and recommendations.
- Integrate: Monitor basin-wide efforts to address the tension between agricultural and restoration interests. Evaluate opportunities to learn and benefit from these efforts, avoid pitfalls, and use Ebey Island as a positive template or example.

Visual and descriptive materials presented to the Advisory Committee include:

1. Concise project description and list of project contacts
2. Detailed project description and overview, including maps, schedule, and Advisory Committee list
3. Handouts of ongoing project-related materials, including ecological indicators, evaluation criteria, and map-based overviews of alternatives at all stages
4. Detailed summary notes for Advisory Committee meetings
5. Summary of draft findings and conclusions
6. Draft and Final Feasibility Study Report

4.2 STAKEHOLDER ADVISORY COMMITTEE

Stakeholder engagement was conducted primarily through the Ebey Island Habitat Restoration Feasibility Study Advisory Committee, composed of over 20 individuals representing a broad and balanced set of interested parties, including farmers, fish and wildlife advocates, community leaders, recreational group representatives, diking and drainage groups, and others (Table 1). The Advisory Committee met five times over the course of the 12-month feasibility study.

Because of the Ebey Island Restoration Project's relationship to the broader agriculture-restoration conversation underway in the Snohomish basin, the Advisory Committee includes members of the County's Agricultural Advisory Board and contributors to the emerging Sustainable Lands Strategy.

Project team members also participated in these outside processes to ascertain issues, problems, and opportunities that are likely to arise, as well as to inform the broader discussion about any lessons learned or helpful strategies that may be gleaned from the Ebey Island Habitat Restoration Feasibility Study.

Advisory Committee meetings and members were especially helpful in gathering relevant information, understanding stakeholder sensitivities and perspectives, developing the optimal mix of project design elements, and serving as a sounding board for the project team in developing feasibility study recommendations.

The final Advisory Committee meeting, held on March 15, 2011, also served as a public meeting to present the draft conclusions of the feasibility study to the largest possible group of stakeholders. WDFW invited all interested parties to read the draft of this report, attend the meeting, and voice their questions and comments about the project. Input from that meeting, both from the Advisory Committee and from other attendees, has been useful in preparing the final report. In some instances, constructive comments are acknowledged in this report, even where responses could not be comprehensive.

4.3 PUBLIC COMMUNICATIONS

The WDFW has continuously updated a publicly accessible project website with Advisory Committee meeting notes, project documents, and updated process and schedule information (http://wdfw.wa.gov/lands/wildlife_areas/snoqualmie/restoration_study.php).

4.4 INDIVIDUAL COMMUNICATIONS

The project team directly contacted landowners—public and private—adjacent to the WDFW property to notify them of the study. In addition, letters were sent to all Ebey Island residents and landowners to describe the project, invite their participation in public or personal meetings, and comment on project findings, alternatives, and recommendations.

5.0 EXISTING CONDITIONS

5.1 SOCIAL CONDITIONS

5.1.1 WDFW mission

As a state agency, the WDFW is charged to protect, restore, and enhance fish and wildlife and their habitats and with providing the public with recreational and commercial opportunities to use the State's fish and wildlife resources on a sustained basis. The Ebey Island project is designed to balance these goals within a habitat restoration context. The various alternatives proposed for Ebey Island all aimed at restoring and enhancing fish and wildlife habitat, but at the same time, they also

promoted opportunities for recreational and/or commercial use. The WDFW is a public agency and therefore attempts to set and implement policy in a way that is sensitive to the needs and interests of different user groups. Depending on local circumstances, these considerations can serve as either an impetus or hindrance to implementing habitat restoration projects.

5.1.2 Diking District #1

Diking District #1 was formed to provide drainage and flood protection to the landowners within its boundary. The district infrastructure consists of about 13 miles of perimeter dikes and 42 miles of drainage ditches within the diked area (Figure 2). As usual for such a district, the diking district has obtained easements to guarantee access and the ability to operate and maintain its system of dikes and ditches. Any proposed actions to modify Diking District #1 ditches or dikes would require the district's approval. Diking District #1 commissioners have been engaged throughout the feasibility study process. When considering modifying the WDFW properties to improve habitat for salmon, the district has expressed these general concerns:

- The integrity of the dike system
- The function of the drainage system
- The time it takes the district to fill up in an overtopping flood
- The acres of real estate base for their assessment

5.1.3 Agriculture

Agriculture has a long history on Ebey Island. The 1938 aerial photos show that much of the island, including about two thirds of the present WDFW holdings, had already been cleared and put into agricultural production by that time. Today, land uses on Ebey Island include rural residential and agriculture. The current agricultural use on WDFW property is grazing. WDFW charges grazing lease fees for about 300 acres for seasonal grazing with a total annual lease value of about $23,000. That amount, plus whatever economic activities are spurred by the grazing, comprise the agricultural-related economic impacts of fully restoring WDFW-owned lands, presuming that WDFW avoids impacts on neighboring properties; the Near Term Alternative would affect less than half of the currently grazed land. WDFW recognizes that the land's potential agricultural and economic activity exceeds current use and could vary with market conditions.

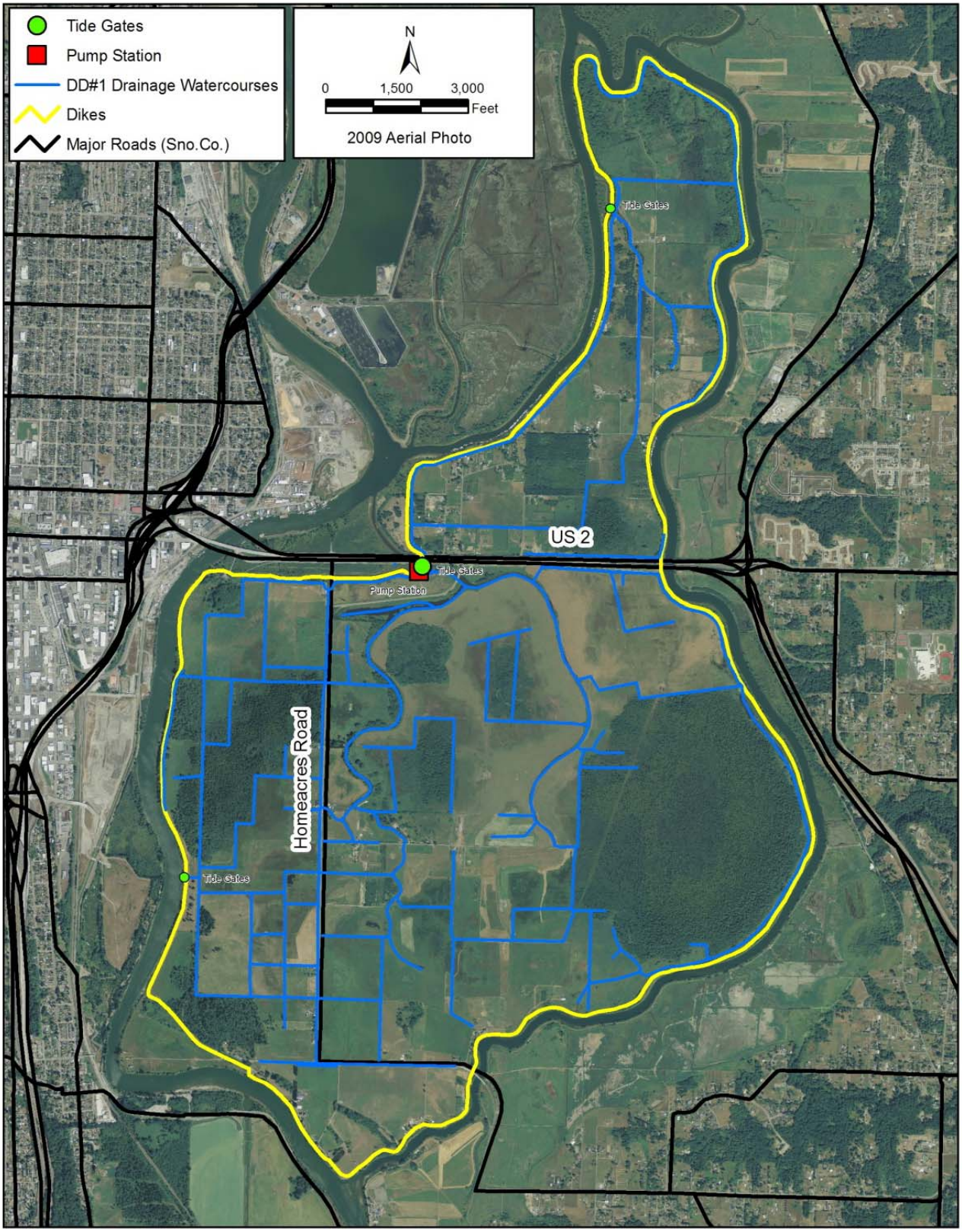

Figure 2 Diking District #1 map, showing perimeter dike, ditch system, tide gates, and pump station.

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5.1.4 Recreation

While there are no formal recreational facilities within the project boundaries, recreation does occur. Waterfowl hunting occurs on some of the pasture areas during the winter and in areas that are too wet to graze. Figure 3 shows a popular hunting area.. While WDFW does not own the dike, people who walk the dike look into the WDFW property as birdwatchers.

5.1.5 Ownership

WDFW owns about 1,237 acres on Ebey Island, south of US 2. Several other public entities own much smaller areas on the island. The remaining land is privately owned. The emphasis of this feasibility study is to explore options for fish habitat restoration on WDFW-owned land, and to consider what adjacent and/or nearby properties would be the most logical to consider purchasing to create a better project. A map of the government-owned properties is shown in Figure 1.

Figure 3 An area used by duck hunters.

5.1.6 Land outside of dikes

Getchell Ranch, a farm at the southwest corner of the island, lies mostly outside of the dike. Everett Alexander indicated that his grandparents, who owned the land, did not want their farm to be part of the diking district when it was formed. The only other location where there is a significant area of land outside of the dike is at the center of the island's west side, in the vicinity of US 2 and the mouth of Deadwater Slough. The elevations of the areas outside the dikes are much higher than the areas within the dikes (see Section 5.3.6 "Ground surface elevations (subsidence)").

5.1.7 Transportation and utilities

US 2 crosses through the middle of Ebey Island in the east-west direction. Homeacres Road provides access to the interior of the island and ingress and egress from the south. There are several roads within the island that provide local access, as well as onramps and off-ramps to US 2.

City of Everett water pipelines run east-west through Ebey Island parallel to and south of US 2, as shown in Figure 4. There are three water pipelines in the immediate vicinity or US 2, each 4 feet in diameter, above ground, and supported by pilings. The pipes are buried in a few places for road and major waterway crossings. Another City of Everett water pipeline runs east-west across Ebey Island about 2 miles south of the others. It is similar in size and configuration to the ones near US 2.

Olympic Pipe Line Company operates two high pressure petroleum pipelines, 16 and 20 inches in diameter, that run north-northeast to south-southwest through the eastern portion of Ebey Island, as shown in Figure 5. The pipeline system runs in a corridor from Ferndale, Washington, to Portland, Oregon, and ships 4.4 billion gallons of fuel a year, as of 2008, and is the sole supplier of jet fuel to Sea-Tac Airport. Company representatives indicated that accessing the pipeline corridor is challenging for them because of the soft soils and wet conditions.

Local power and water distribution corridors also exist on the island to serve the local residents and farms. Figure 4 shows US 2 and the City of Everett pipelines where they cross Deadwater Slough, in the vicinity of the Diking District #1 pump station.

5.2 ECOLOGICAL CONDITIONS

Ebey Island is located in the Forested Riverine Tidal (FRT) ecological zone of the Snohomish River Estuary (Figure 6). While water levels in the main channels fluctuate on a semi-diurnal basis due to tidal effects, salinity is rarely greater than 5 parts per thousand. The island has been extensively diked to allow agricultural development, eliminating the possibility of tidal flooding. The only examples of historic conditions nearby are Otter Island, which has never been diked, and the southern portion of Spencer Island where the dike was intentionally breached to restore tidal processes. Two blind slough

Figure 4 US 2 and the City of Everett water pipelines along the lower end of Deadwater Slough, within Diking District #1.

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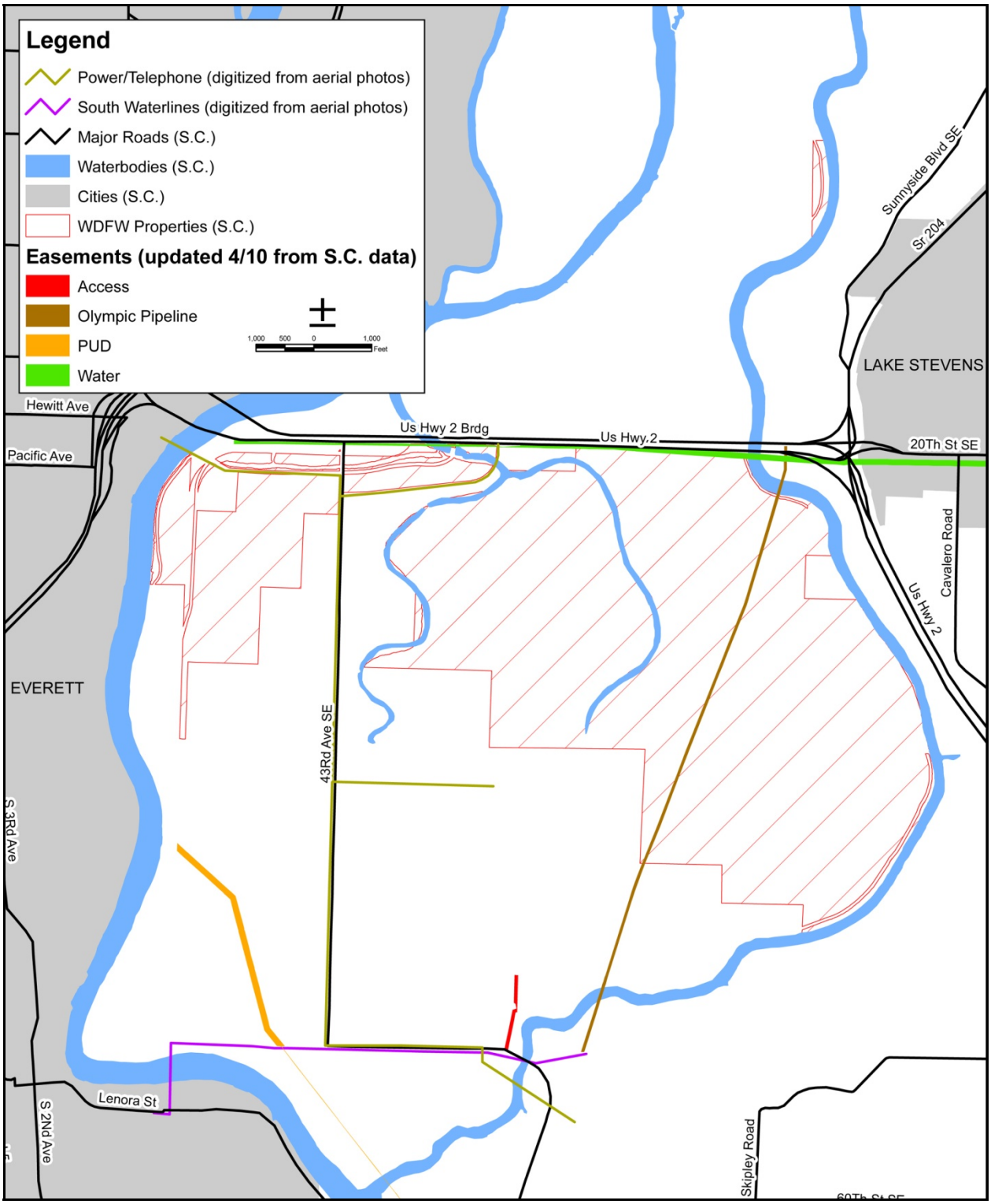

Figure 5 Utilities on Ebey Island

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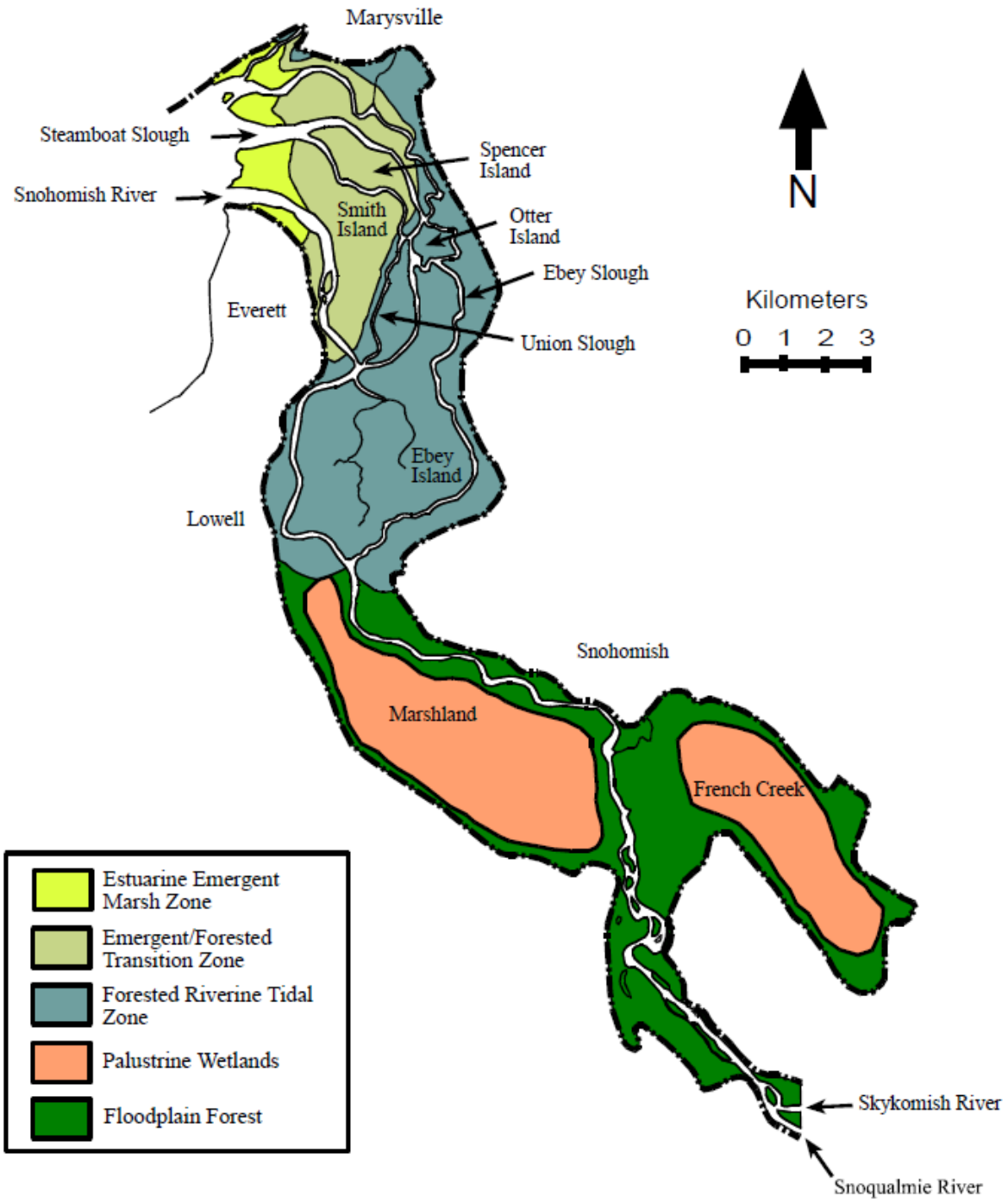

Based on interpretation of Government Land Office survey (Surveyor General, 1869-74)

Figure 6 Approximate location of wetlands within the 100-year floodplain of the Snohomish River in the mid-19th century (Haas and Collins 2001)

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networks, Deadman Slough north of US 2 and Deadwater Slough south of US 2, serve as the primary drainage networks for the island, and both have tide gates that prevent tidal inundation.

5.2.1 Wetlands

Significant portions of Ebey Island are currently covered by various types of wetlands. The largest forested wetland, 520 acres along Ebey Slough, has been owned by WDFW for many years and is densely forested with Sitka spruce, Western red cedar, shore pine, and red alder. Other patches of forested wetland are distributed elsewhere, primarily along the west side of the island along the mainstem of the Snohomish River and on the northern tip of the island. In addition, fallow agricultural fields, grazed wet meadows, tidal emergent, and scrub-shrub habitats all provide some value to wildlife (City of Everett 1997). Figure 7 shows the USFWS National Wetlands Inventory Map of Ebey Island.

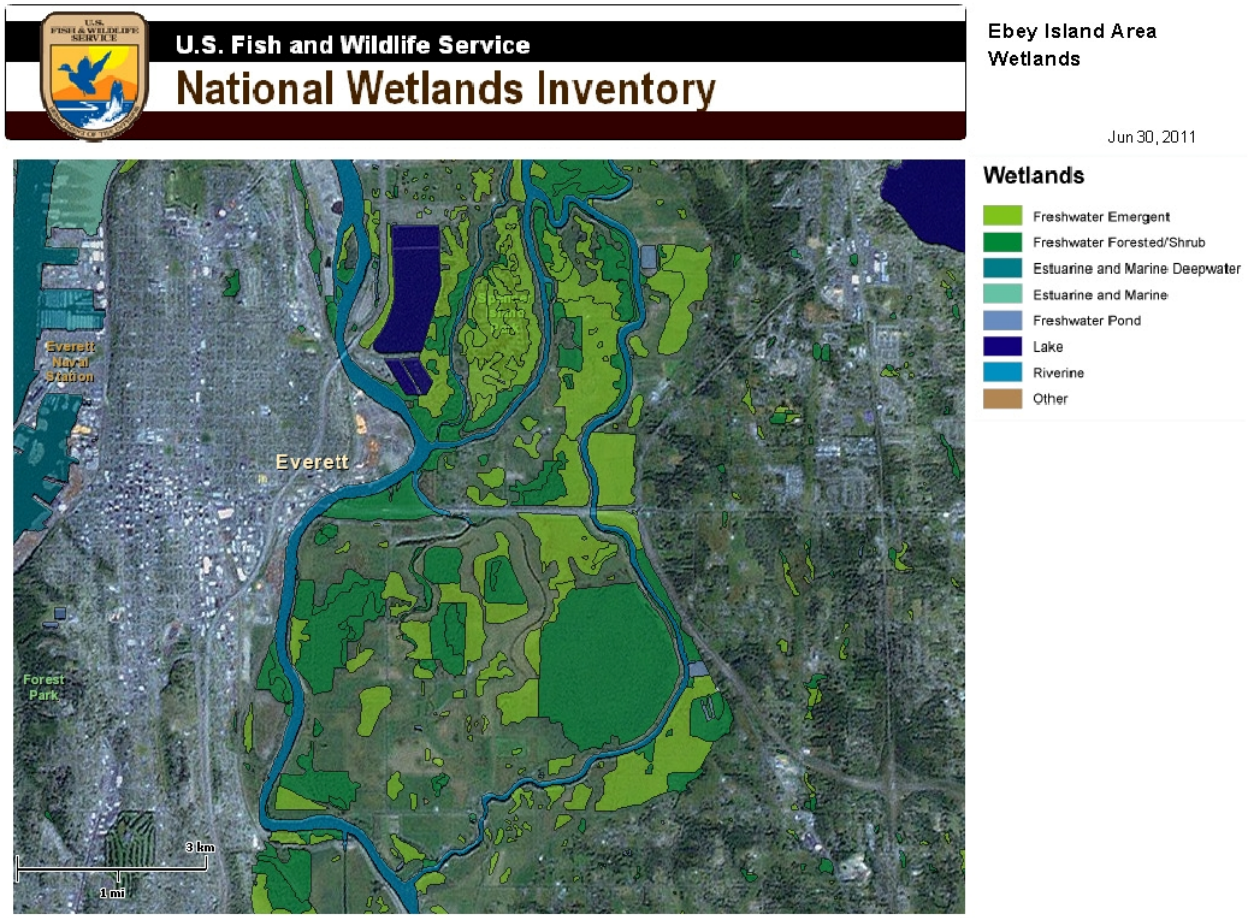

Figure 7 National Wetlands Inventory map of Ebey Island and vicinity.

5.2.2 Vegetation

A list of the dominant plant species found in the tidal and non-tidal freshwater zones of the estuary is reproduced here from SEWIP (City of Everett 1997):

- Aquatic bed emergent, tidal: *Callitriche heterophylla* (water chickweed), *Nuphar luteum* (yellow pond lily)
- Palustrine emergent, tidal: *Lysichiton americanum* (skunk cabbage), *Phalaris arundinacea* (reed canary grass), *Carex obnupta* (slough sedge), *Typha latifolia* (common cattail), *Caltha palustris* (yellow marsh-marigold), *Athyrium felix-femina* (lady fern), *Alisma plantago-aquatica* (broadleaf water plantain), *Sagittaria latifolia* (duck potato), *Oenanthe sarmentosa* (water parsley), *Veronica spp.* (speedwell), *Polystichum munitum* (sword fern)
- Palustrine scrub-shrub, tidal: *Cornus sericea* (red-osier dogwood), *Rosa nutkana* (Nootka rose), *Physocarpus capitatus* (Pacific ninebark), *Malus fusca* (crabapple), *Rubus spectabilis* (salmonberry), *Spiraea douglasii* (hardhack spirea)
- Palustrine forested, tidal: *Salix lasiandra* (Pacific willow), *Salix scouleriana* (Scouler's willow), *Picea sitchensis* (Sitka spruce), *Populus trichocarpa* (black cottonwood), *Thuja plicata* (western red cedar), *Alnus rubra* (red alder), *Rhamnus purshiana* (cascara)
- Palustrine aquatic bed, non tidal: *Potamogeton spp.* (pondweed), *Myriophyllum spicatum* (Eurasian water milfoil), *Lemna minor* (duckweed)
- Palustrine emergent, non-tidal: *Lysichiton americanum* (skunk cabbage), *Carex deweyana* (Dewey's sedge), *Carex obnupta* (slough sedge), *Typha latifolia* (common cattail), *Sparganium spp.* (burreed), *Athyrium felix-femina* (lady fern), *Alisma plantago-aquatica* (broadleaf water plantain), *Oenanthe sarmentosa* (water parsley), *Veronica spp.*(speedwell), *Iris pseudacorus* (yellow iris), *Tolmiea menziesii* (piggyback plant), *Juncus ensifolius* (dagger-leaf rush), *Impatiens noli-tangere* (yellow touch-me-not), *Eleocharis spp* (spikerush), *Glyceria spp.* (mannagrass), *Urtica dioica* (stinging nettle), *Solanum dulcamara* (bittersweet nightshade)
- Palustrine emergent non-tidal on agricultural lands: *Phalaris arundinacea* (reed canary grass), *Festuca spp*. (fescue), *Holcus lanatus* (common velvetgrass), *Agropyron spp.* (wheatgrass), *Alopecurus spp.* (foxtail), *Juncus effusus,* (soft rush), *Dactylis glomerata* (orchard grass), *Agrostis spp* (bentgrass), *Poa spp.* (bluegrass), Gly*Epilobium angustifolium* (fireweed), *Melilotis alba* (white sweet clover), *Ranunculus repens (*creeping buttercup*), Phleum pratense* (timothy), *Cirsium arvense* (Canadian thistle), *Cirsium vulgare* (bull thistle), *Polygonum sp.* (knotweed), *Chenopodium album* (lambs quarters)
- Palustrine scrub-shrub, non-tidal: *Cornus sericea* (red-osier dogwood), *Rosa nutkana* (Nootka rose), *Lonicera involucrata* (black twinberry), *Physocarpus capitatus* (Pacific ninebark),

Oemleria cerasiformis (Indian plum), *Spirea douglasii* (hardhack spirea), *Salix spp*. (willow), *Malus fusca* (crabapple), *Sambucus racemosa* (red elderberry), *Rubus procerus* (Himalayan blackberry)

- Palustrine forested, non-tidal: *Salix lasiandra* (Pacific willow), *Salix scouleriana* (Scouler's willow), *Picea sitchensis* (Sitka spruce), *Populus tricocarpa* (black cottonwood), *Thuja plicata* (western red cedar), *Alnus rubra* (red alder), *Pinus contorta* (lodgepole pine), *Acer macrophyllum* (big-leafed maple)

5.2.3 Fish

The project area does not currently contain tidal channels or areas of consistently ponded water that serve as fish habitat. Drainage ditches, canals, and a remnant reach of Deadwater Slough are the only areas that might contain enough water to support fish during certain times of the year, but fish access to these areas is prevented by a pump station and water quality is very poor (Haring 2002).

Deadman Slough, on the northern tip of Ebey Island, was found to contain some juvenile chum and Coho salmon, but abundance was 10 to 100 times less than in the same slough outside of the tide gate (Tonnes 2006). Other species that may use Ebey Island sloughs and ditches include threespine stickleback, starry flounder, and peamouth chub.

Numerous fish species reside in or migrate through the lower Snohomish River, including eight salmonid species (Chinook, coho, chum, pink, sockeye, cutthroat, steelhead, and bull trout) and estuarine species.

Fish sampling in conjunction with the nearby Spencer Island restoration/dike breach, in the same estuarine zone as Ebey Island, found catches predominately consisting of chum, Chinook, and coho salmon; threespine stickleback; and peamouth chub, and to a lesser degree, pink salmon, cutthroat and steelhead trout, bluegill, starry flounder, staghorn, and prickly sculpin (Tanner et al. 2002).

5.2.4 Birds

Existing conditions on Ebey Island provide a diverse assemblage of habitats for a wide array of birds, including migrating waterfowl, overwintering shore birds, raptors, and passerines. The following species have been observed using habitat on Ebey Island: wood duck, gadwall, yellowthroat, green-winged teal, canvasback, cedar waxwing, dunlin, Canada goose, brant, trumpeter swan, northern harrier, red-tailed hawk, bald eagle, roughlegged hawk, peregrine falcon, great blue heron, kingfisher, great horned owl, osprey, tree and barn swallows, song sparrows, downy woodpecker, pileated woodpecker, red-winged blackbird, killdeer, Swainson's thrush, and rufous-sided towhee (City

of Everett 1997). Western sandpipers are known to use the restored southern portion of Spencer Island nearby (City of Everett and Pentec Environmental 2001).

Agricultural fields and pastures provide overwintering habitat for dabbling ducks and trumpeter swans (City of Everett and Pentec Environmental 2001). A field in the center of Ebey Island is leased by a hunting club, and flooding at that site is managed by the farmer to provide optimal waterfowl habitat.

Several studies have been conducted regarding habitat preference by waterbirds in estuaries in the region. The results of these studies have often been controversial, and there is no agreement in the scientific community regarding how, when, and under what conditions waterfowl will use a particular area. Studies have generally found that the majority of shorebirds in our area will use agricultural fields near the bayfronts, but tend to prefer mudflats and low intertidal marsh. Dabbling ducks are known to use both emergent marsh and agricultural fields, but higher densities have been observed in emergent marsh (Slater 2004); patterns of habitat use by dabbling ducks have also been observed to be seasonal.

5.2.5 Amphibians and reptiles

Amphibians and reptiles are generally found in protected, non-tidal, freshwater aquatic habitats such as ponds, emergent wetlands, and ditches. Species common around the lower Snohomish River include Pacific tree frog, northern red-legged frog, bullfrog, and common garter snake (City of Everett 1997).

5.2.6 Mammals

Several species of mammal have been known to use Ebey Island, particularly the forested habitats. Deer, river otter, beaver, muskrat, mink, long-tailed weasel, porcupine, and raccoon are all commonly sighted (City of Everett 1997) across the island.

5.3 PHYSICAL CONDITIONS

5.3.1 Dikes and levees

The Diking District #1 commissioners believe that the existing perimeter location of the dikes is where the soils are most suitable to support a full-height flood dike. They think that the interior soils are too soft to support a full height set-back dike. AMEC's geotechnical engineers reviewed available sub-surface investigations and performed some additional subsurface sampling and analysis in the interior of the island. They concluded that construction of full height dikes is possible, but would require special design and construction methods to account for compressible soils and other conditions specific to the island interior. Figure 8 shows the dike along Ebey Slough near US 2. Appendix A, Preliminary Geotechnical Report, presents the findings of the analysis.

Figure 8 **Diking District #1 dike, with Ebey Slough on the left. The view is looking south toward at the eastern portion of the project area, with the heavily forested area visible in the background in the right half of the photo. The dike here is graveled to provide year-round access to the Olympic Pipe Line corridor.**

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About 20 years ago, Diking District #1 entered into an agreement with all the other diking, drainage, and flood control districts in the vicinity, as well as a number of agencies, to establish an approach for creating dike and levee profiles that would provide uniform flood protection for the districts. In the portion of the Snohomish River dominated by river flooding, the agreed-upon levee elevation is 1 foot above the 5-year flood level. The dikes on Ebey Island have been overtopped several times in the last few decades. Downstream, the dike elevations are set to minimize the chance of flooding from tides and storm surges. The southern half of the island is subject to river flooding, while the northern half is more susceptible to flooding from tides and storm surges. Diking District #1 is also in a unique situation, compared to most of the other districts, in that there are no adjacent upland areas: egress from the district is only by US 2 and Homeacres Road. The district commissioners have indicated that it is important not to reduce the amount of time available for residents to flee the island safely in the event of flooding.

The commissioners have also described efforts to repair dike breaches and erosion at the toe of the dikes in recent years. They have found it increasingly difficult to complete repairs affordably because of wetland regulations and limitations on placing rock riprap in favor of other materials, especially large woody debris, along with bio-engineering techniques. The commissioners have expressed interest in considering a project that would create a setback dike to calve off the northern part of the island for fish habitat. They anticipate that the reduction in dike length, and thus maintenance, in an area with poor access would more than offset the relatively minor loss of assessed land within the district. In response to this interest, and that of several other stakeholders, this study considered such a project in very general terms. However, the focus of this study is to look for opportunities for fish habitat improvement on WDFW-owned land, with consideration for what other areas, particularly adjacent land, would provide opportunities to greatly improve a potential project, either by increasing the potential habitat value or by reducing costs.

5.3.2 Interior watercourses

Aerial photos of Ebey Island dating as far back as 1938 reveal that the main river and slough channels have not migrated laterally. However, the older photos show evidence of historical sloughs and channels within the island that are not immediately evident in more recent photos. LiDAR elevation data collected by NOAA Fisheries in 2009 seems to show minor depressions corresponding with the historical channel centerlines and slightly elevated areas adjacent to the historical channels, where deposition naturally occurs. Longtime Ebey Island resident Everett Alexander recounts that before the dike system was completed, at high tide, it was possible to canoe from the southern end of the island through the interior all the way to the mouth of Deadwater Slough at the northwest perimeter of the island. Since then, the southern ends of many branches of Deadwater Slough have been regraded and the dike system has cut off the connection to tidal waters. It is also clear that by

1938, portions of the island had been cleared and put into agricultural production, while much of it had yet to be cleared.

5.3.3 Drainage

Because the ground surface of Ebey Island has subsided below usual water levels in the adjacent channels, the island is drained by a system of drainage channels that gather water from the island and convey it to one-way tide gates where it passes off the island. A pump station is co-located with the tide gates on Deadwater Slough to supplement the gravity drainage; this part of the system drains most of the island. When precipitation rates and water levels in the adjacent channels are low, enough water drains by gravity on each low tide to keep the island dry. However, when precipitation increases and water levels in the adjacent channel rise through a combination of tidal conditions and riverine discharge, water must be pumped out to prevent standing water within the diked area. Elements of the drainage system include (personal communication, Diking District #1 commissioners):

- A 4-foot-diameter culvert with a one-way tide gate on the west side of the district, about 7,000 feet south of US 2. Its bottom invert is exposed when water levels in the Snohomish River fall to approximately mean lower low water (MLLW, a “zero” tide).
- A 4-foot-diameter culvert and with a one-way tide gate on the west side of the district, about 7,000 feet north of US 2. Its bottom invert is exposed when water levels in the Snohomish River fall to approximately mean lower low water (MLLW, a “zero” tide).
- Four culverts, two approximately 5 feet in diameter and two approximately 7 feet in diameter, all with one-way tide gates, that convey flow off the island through the lower portion of Deadwater Slough. These culverts have inverts at approximately 2 feet below MLLW (Figure 9).
- A pump station with three pumps on Deadwater Slough. Figure 10 shows a photo of these pump outlets. The pumps are apparently mounted with inlets low enough that they could nearly pump Deadwater Slough dry. The pump specifications are:
  - 16-inch discharge, about 40-horsepower electric motor, axial flow pump
  - 20-inch discharge, about 60-horsepower motor, submersible pump
  - 20-inch discharge, about 100–horsepower motor, axial flow pump

Pumps are turned on when there is water over the low areas of Homeacres Road. Pumps are also typically used toward the end of February when low tide levels rise due to increased riverine discharge. One or more pumps are used as needed through the rest of winter and early spring,

Figure 9 **Diking District #1 tide gates discharging water into the tidally influenced portion of Deadwater Slough during a low tide. One of the outlet pipes from the pump station is visible at the lower left corner of the photo.**

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Figure 10 **Diking District #1 pump station, with outlets visible in the center of the photo, penetrating the dike. Deadwater Slough is tidally influenced in the foreground.**

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typically ending before June. Although the pumps have automatic controls, they are typically operated manually in response to observed changes in water levels.

5.3.4 Soils

The soils on the island are considered prime agricultural soils when drained and protected from flooding, as determined by the USDA Natural Resources Conservation Service (NRCS 2009). The practical limitations for agriculture on the island and within the project area are related to the depth of the water table from the soil surface. Not much high intensity agriculture is currently practiced on Ebey Island, so the diking district has chosen to limit the use of the pump system, though the commissioners report that in the past, landowners have grown crops, such as corn, that required a lower water table. The diking district used the pumps to drain the island sufficiently for that purpose, and asserts that their pump system is capable of providing the drainage needed to support such crops in the future.

AMEC evaluated available existing soil logs from nearby road and utility projects and performed additional subsurface explorations to evaluate the potential limitations to constructing new dikes on the island. See Appendix A for the preliminary geotechnical report.

5.3.5 Flooding

The entire project area and all of Ebey Island are within the FEMA mapped 100-year floodplain. As mentioned in Section 5.3.1 “Dikes and levees,” the Snohomish River and Ebey Slough can be expected to overtop the levees south of US 2 periodically during large floods. There are only two roads that provide egress from the island: US 2 and Homeacres Road. After the overtopping starts, residents have very limited time to leave the island before the water becomes too deep to drive. Most houses on the island have living areas elevated significantly above the ground elevation. However, the higher the water gets within the district, the greater the damage to structures and belongings. Proposed alternatives to create full or muted tidal conditions within the boundary of the district will cause flood waters to rise faster because of the reduction in flood storage capacity. This reduction in flood storage capacity can likely be mitigated wholly or in part by adding flood gates at the downstream end of the flood water receiving areas. Flood gates would work similarly to tide gates, allowing water to leave the district when the water level in the district is higher than the water level on the outboard side of the flood gate. Flood gates are typically installed above the existing ground surface and are designed to minimize the amount of water impounded in an area during a flood and to allow most of the flood water to rapidly leave the area as the outboard water levels subside.

The eastbound US 2 bridge over Ebey Slough is supported by multiple rows of pilings, which has created log jams in previous floods, as shown in Figure 11.

Applications to Snohomish County for flood hazard permits, which are needed when floodplain modifications are proposed, generally need to include a “zero rise” analysis, and it is prudent to forecast the expected change in the 100-year flood elevation that a project would cause, even if not required. It is not likely that Diking District #1 or other nearby districts would favor of any action that increased the expected water levels during a flood large enough to cause overtopping of their dikes and levees.

The basic premise is that proposed activities must result in “no rise” of the 100-year flood level, compared to existing conditions. To meet this requirement, and to get at the desire to improve the flood protection for the diking district, structures that release flood water after an overtopping event should be considered to provide an improved ability to drain water out of the district after a major flood event. An added benefit of this type of structure is that it greatly reduces the possibility of stranding fish within the dike system, which would be a concern primarily on the properties not within the project footprint. It would also greatly reduce the probability of a dike breach, which would have financial, social, economic, and environmental implications.

Full-height setback dikes allow more flow through the adjacent channel. However, when the dikes overtop, there is less flood water storage inside of the dike system, which results in the water level rising faster than it did previously. During a 100-year flood, the dikes would likely overtop long enough to completely fill the district, with the downstream dike on Ebey Island acting as a spillway to let floodwaters out. In the case of a full restoration of all the WDFW properties to full tidal influence, floodgates may need to be considered to allow flood water that overtops the dike system to flow out so that the level of inundation of the properties on the southern part of Ebey Island is minimized.

5.3.6 Ground surface elevations (subsidence)

The interior of Ebey Island is flat, although the land at the southern, upstream end of the island is higher than the northern end of the island. Ground surface elevations have subsided considerably behind dikes and levees on the Snohomish River due to soil compaction, organic matter decomposition, and reduced sediment deposition. Otter Island, which has never been diked and likely represents an approximate natural marsh elevation, is on average 13 feet MLLW (City of Everett 1997). Most of the land in the northwest corner of the project area is between 4 and 8 feet MLLW and in the northeast corner it is between 3 and 6 feet MLLW, indicating subsidence of perhaps 5 to 10 feet. In the SEWIP study (City of Everett 1997), an elevation of 7 feet MLLW (4.75 feet NAVD) was considered the lower limit for vegetated marsh to establish, and species diversity increased significantly above 12 feet MLLW. Restored areas below this elevation were expected to become intertidal mudflat at least until sediment accretion raised the marsh surface sufficiently.

Figure 11 Channel spanning log jam in Ebey Slough at the eastbound US 2 crossing. Some of the rows of pilings that support the highway are visible in the photo. These pilings caused the log jam to start. Circa 2003. Credit: A.G. Alexander.

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5.3.7 Water quality

The lower Snohomish River has a long history of poor water quality due to industrial effluent (Haring 2002) and continues to be plagued by high temperatures, turbidity, fecal coliform bacteria counts, and pollutant levels (organic and metal), and low dissolved oxygen concentrations and pH. In 1998, the river was included on the list of impaired water bodies in Washington State, also known as the 303(d) list.

Deadwater Slough is the large two-branched slough that serves as the trunk of the drainage system for the diking district. Blockage by the tide gates and dry conditions during summer have led to stagnant water conditions and poor water quality. High water temperatures and low dissolved oxygen have been cited in other documents as the leading water quality problems in this slough.

6.0 HABITAT RESTORATION ALTERNATIVES

A three-stage process was used to identify and screen a preliminary set of restoration alternatives, evaluate the feasibility of the most promising alternatives, and select, model, and conduct an in-depth assessment and public vetting of a single preferred alternative. The tiered approach represented a logical framework and process by which various candidate alternatives were screened and winnowed down by the AMEC team and the Advisory Committee to two preferred alternatives based on increasingly detailed design and technical and social performance criteria. The various data, analytical tools and methods developed to support the evaluation process are described below.

The first stage in the design, evaluation and selection process consisted of identifying 14 conceptual alternatives that warranted further consideration based on available information, including a preliminary site assessment and input received from landowners, stakeholders and experts. The ecological, social and economic feasibility of these alternatives was evaluated relative to an extensive set of technical and social feasibility criteria in the second stage of the process, and two leading alternatives were selected for further analysis. Section 6.2.2.5 describes how these alternatives were refined, hydrodynamically modeled, and subjected to further analysis in the third stage of the alternatives development process.

6.1 CONCEPTUAL ALTERNATIVES

6.1.1 Specification of conceptual alternatives

Conceptual alternatives were developed with the goal of providing significant fish habitat improvement, compared with existing conditions. The alternatives were placed primarily on the properties currently owned by WDFW and landowners known to be supportive of the concept of improving habitat for fish and wildlife. In one case, permission to include private property was denied by the landowner. The conceptual alternatives were developed to avoid this property as much as

possible. A few alternatives would require additional property acquisitions where the landowners were not contacted. The conceptual alternatives focused on possible land use configurations across the available property and the infrastructure that would be needed to support the changes in use. Infrastructure that needs to be added for a full tidal restoration is for the purpose of allowing other adjacent and nearby land uses to continue, whereas the infrastructure that needs to be added for a muted tidal restoration is generally needed to allow for the formation of the new habitat.

The conceptual alternatives, summarized in Table 2, were crafted based upon a careful study of the available information, including the various input offered by the stakeholders. All of the alternatives were crafted to provide an increase in the amount of fish habitat. Input from the fish biologists suggested that multiple connections between the river or slough and the restored area are better than a single connection, more juvenile salmonids outmigrate down the Snohomish River than Ebey Slough, full tidal restoration is better than muted tidal restoration, and the best new habitat is that which restores natural riverine and estuarine processes as much as possible.

Input was sought from the diking district to look for areas where deficiencies in their diking or drainage infrastructure could present an opportunity to improve habitat and improve the situation for the district. Most of the problem sections of dike are away from the project area. However, there remains ongoing concern about the section of dike just upstream of US 2 because of the history of logjams forming there. Additional input from the diking district included identifying areas within WDFW ownership that would least impact the ongoing farming operations. The diking district also suggested a project in the northern-most portion of the island that would create full tidal restoration and eliminate a problem area of dike for them. This alternative is discussed later in this report.

WDFW and stakeholders have expressed a desire to provide more opportunities to improve the recreational uses of the property, including boating, hunting, bird watching, and trail walking. All of these uses are secondary to the main categories of land use that include full tidal restoration, muted tidal restoration, and managed lands. Therefore, the conceptual alternatives do not explicitly propose recreational use areas or features because they can be overlain on a proposed project once it has been more fully formed and because at this stage, each alternative has an equivalent potential for recreational uses. Additionally, the managed lands category can include areas drained and used for agriculture, wetlands, and walking wetlands. Walking wetlands is a concept whereby an area is fully capable of supporting agriculture, but is managed in such a way as to alter the water table of sub-sections of the site to create wetland features that are moved to a different portion of the site each year, usually to promote use by waterfowl. These choices are all possibilities within the areas labeled in the alternatives as managed drained.

Table 2 14 alternatives developed, along with a brief description of each. Figure 12 through Figure 25 depict these alternatives.

Alternative	Description
A	Full tidal restoration on WDFW-owned land with a minimum of additional acquisitions. Full tidal connections to Ebey Slough and connector to Snohomish River.
B	Muted tidal restoration on WDFW-owned land with a minimum of additional acquisitions. Tidal connections to Ebey Slough and connector to Snohomish River via regulated tide gate(s).
C	Full tidal restoration on WDFW-owned land with additional acquisitions. Full tidal connections to Ebey Slough and connector to Snohomish River. Requires elevating Homeacres Road and installing pump stations and flood gates to support ongoing uses outside project area. This alternative would require acquisition of about 150 more acres of land to fill in irregular edges of WDFW ownership and reduce dike lengths.
D	Full tidal restoration on extreme west and east portions of WDFW-owned land with a minimum of additional acquisitions. Full tidal connections to Ebey Slough and connector to Snohomish River. East-central portion of WDFW property proposed as muted tidal area to improve the flood water conveyance through the island during an overtopping event and to displace less flood water to reduce the rate of flood water rise compared to Alternative C.
E	Full tidal restoration on western portions of WDFW-owned land with additional acquisitions. Full tidal connections to connector to Snohomish River. Area east of the east branch of Deadwater Slough to be restored as a muted-tidal area. Central portion of the property unchanged to allow water conveyance through the island during an overtopping event.
F	Full tidal restoration on extreme west portion of WDFW-owned land with no additional acquisitions. Full tidal connection to connector to Snohomish River. East-central portion of WDFW property proposed as managed wet area with no tidal connection. Area between the branches of Deadwater Slough enhanced as a wetland.
G	Full tidal restoration on extreme northwest portion of WDFW-owned land with a minimum of additional acquisitions. Full tidal connections to Ebey Slough. East-central portion of WDFW property proposed as muted tidal area. Southeast and northwest portions of the property proposed for wetland enhancement.
H	Full tidal restoration on extreme west and east portions of WDFW-owned land with a minimum of additional acquisitions. Full tidal connections to Ebey Slough and connector to Snohomish River. Central portion of WDFW property proposed as muted tidal area. Area adjacent to east for of Deadwater Slough left open to allow flood water conveyance through the island during an overtopping event.
I	Full tidal restoration on extreme and east portion of WDFW-owned land with a minimum of additional acquisitions. Full tidal connection to Ebey Slough. East-central portion of WDFW property proposed as muted tidal area. Central portion of the project left alone to allow flood water conveyance through the island during an overtopping event.
J	Full tidal restoration on eastern half of WDFW-owned land with a minimum of additional acquisitions. Full tidal connection to Ebey Slough and to connector to Snohomish River. Western portion of WDFW property proposed as managed drained area, shown in a possible "walking wetland" configuration. Central portion of the project left alone to allow flood water conveyance through the island during an overtopping event.
K	Full tidal restoration on western portions of WDFW-owned land with additional acquisitions. Full tidal connections to connector to Snohomish River. Area east of the east branch of Deadwater Slough to be restored as a muted-tidal area, along with a portion of the eastern branch of Deadwater Slough. Central portion of the property unchanged.
L	Muted tidal restoration on western and northeastern portions of WDFW-owned land with no additional acquisitions. The muted tidal restoration areas shown were the areas where the diking district commissioners thought restoration would have the least impact to the adjacent and nearby landowners.
M	Full tidal restoration east of the petroleum pipelines. Muted tidal restoration on western and northeastern portions of WDFW-owned land with no additional acquisitions. The muted tidal restoration areas shown were the areas where the diking district commissioners thought restoration would have the least impact to the adjacent and nearby landowners. This option would require no additional property acquisitions.
N	Muted tidal restoration on western and northeastern portions of WDFW-owned land with no additional acquisitions. The muted tidal restoration areas shown were the areas where the diking district commissioners thought restoration would have the least impact to the adjacent and nearby landowners. This alternative shows the conceptual layout of chinampas-style elevated agricultural areas, surrounded by sloughs.

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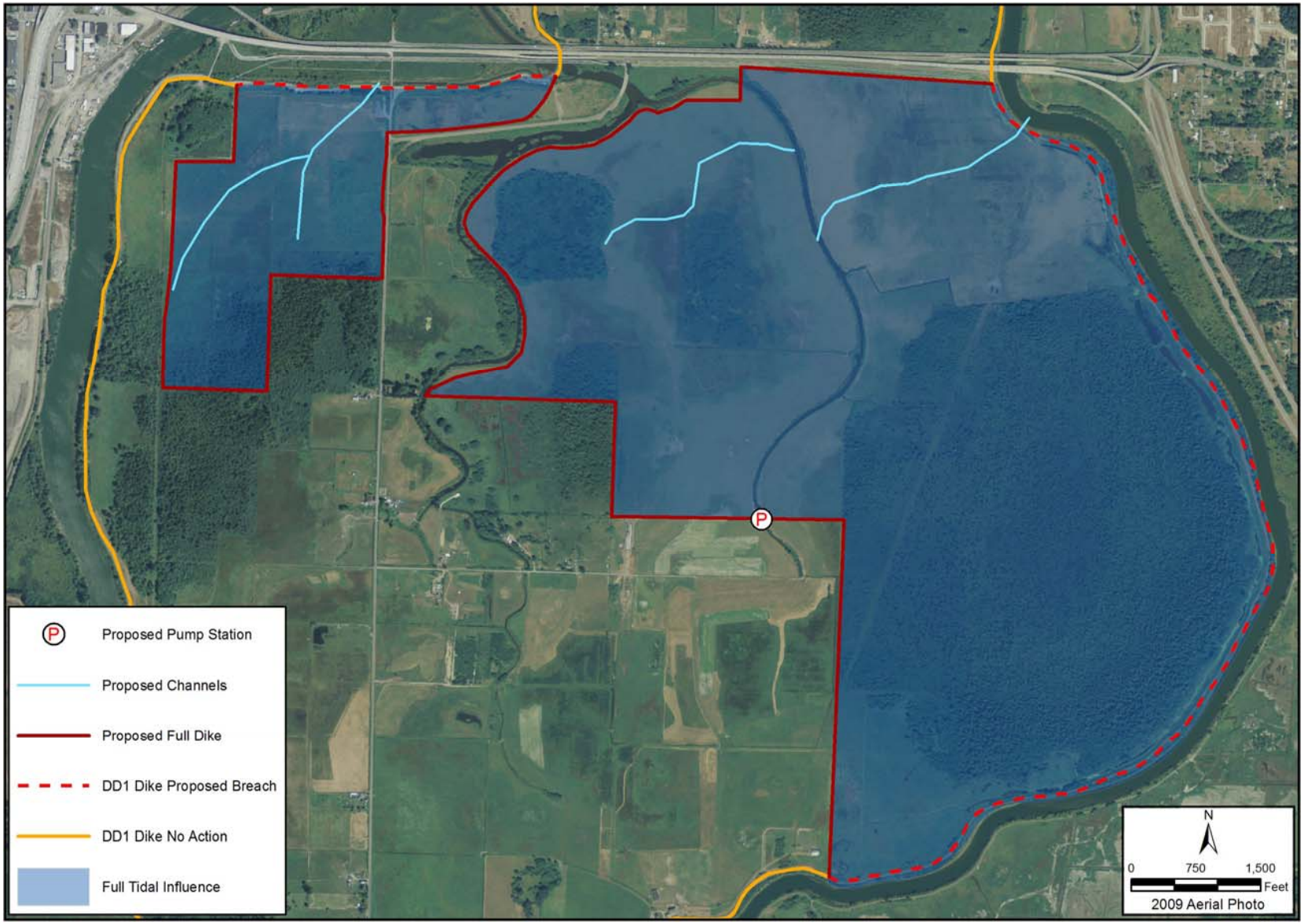

Figure 12 Alternative A

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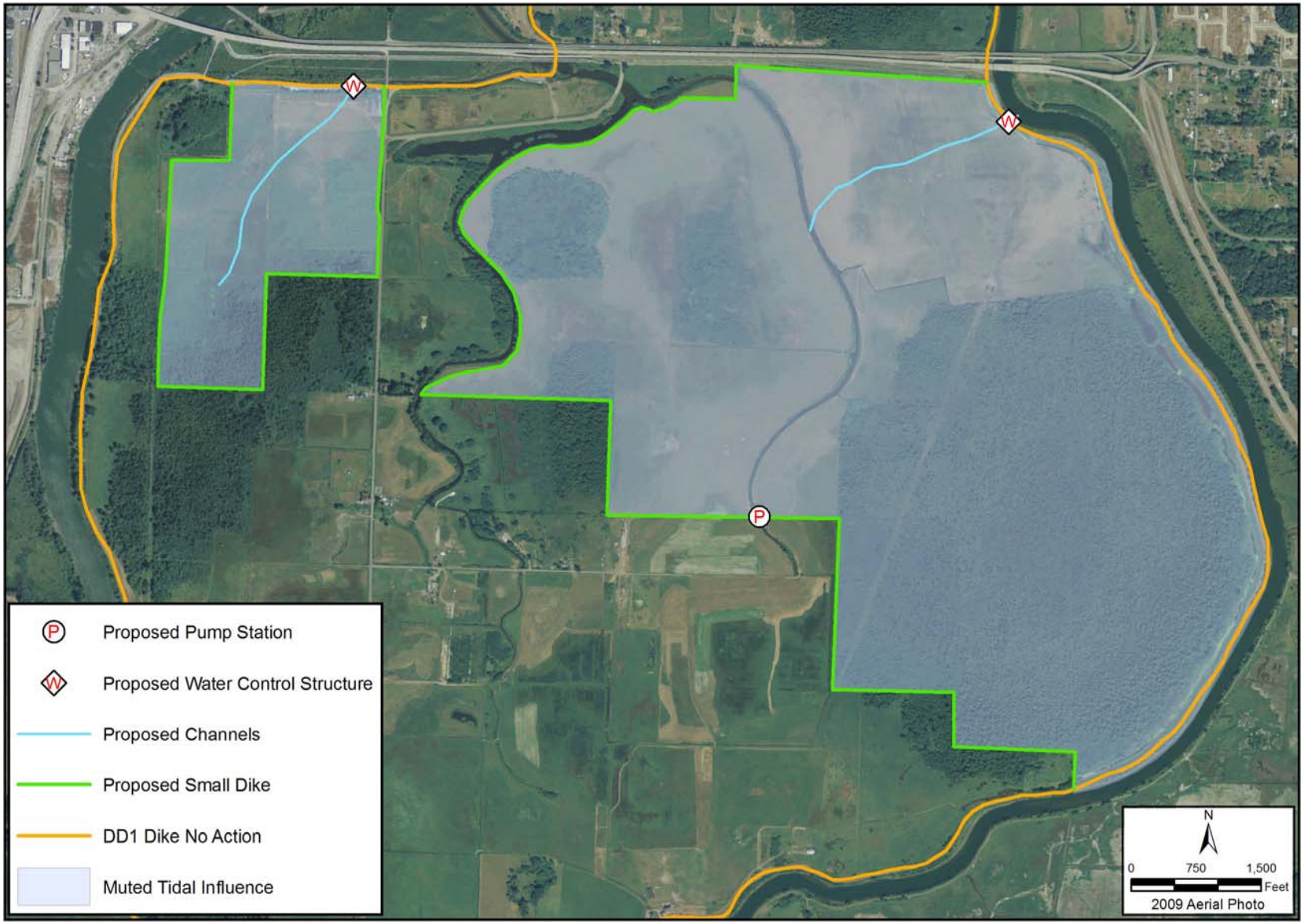

Figure 13 Alternative B

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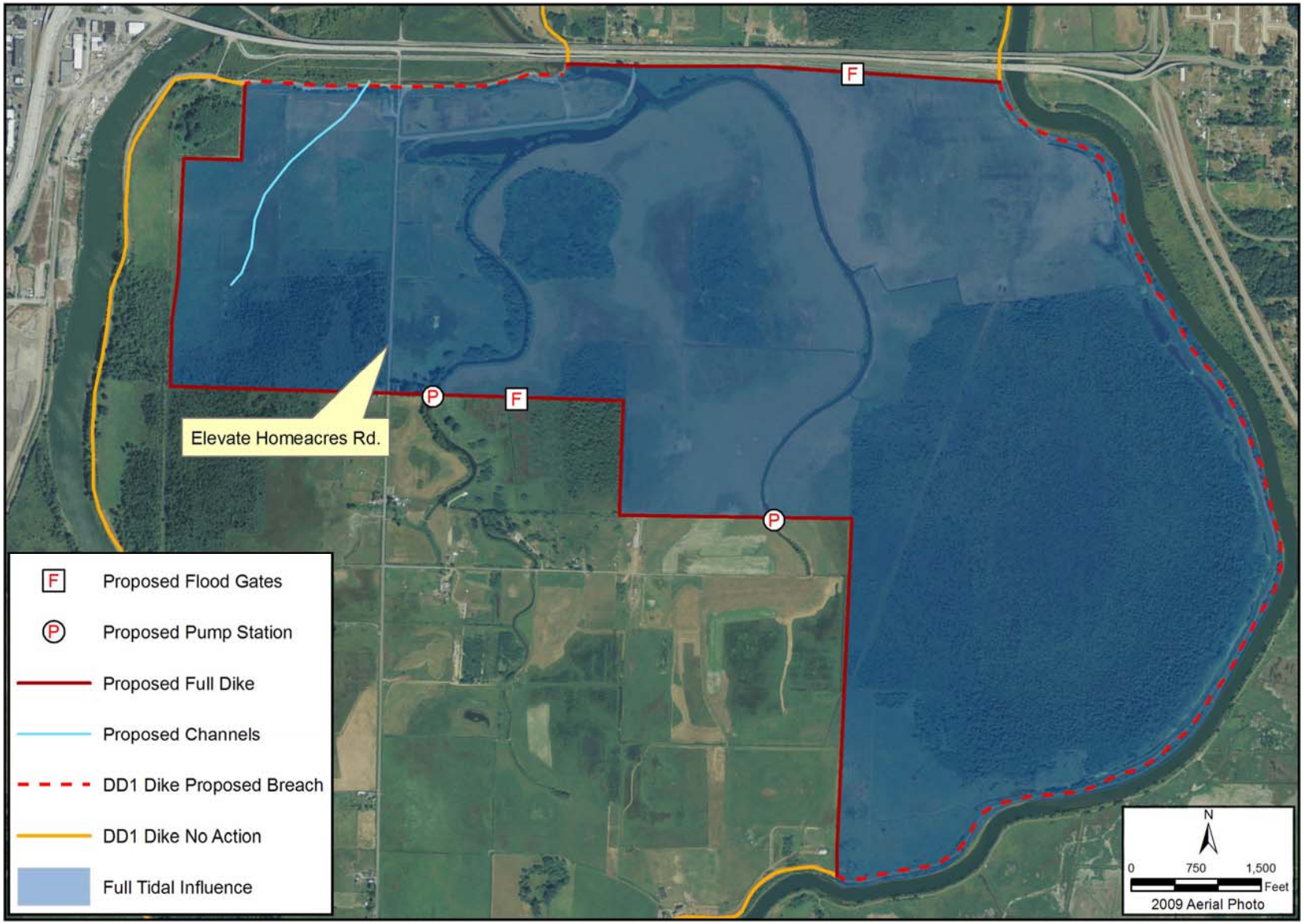

Figure 14 Alternative C

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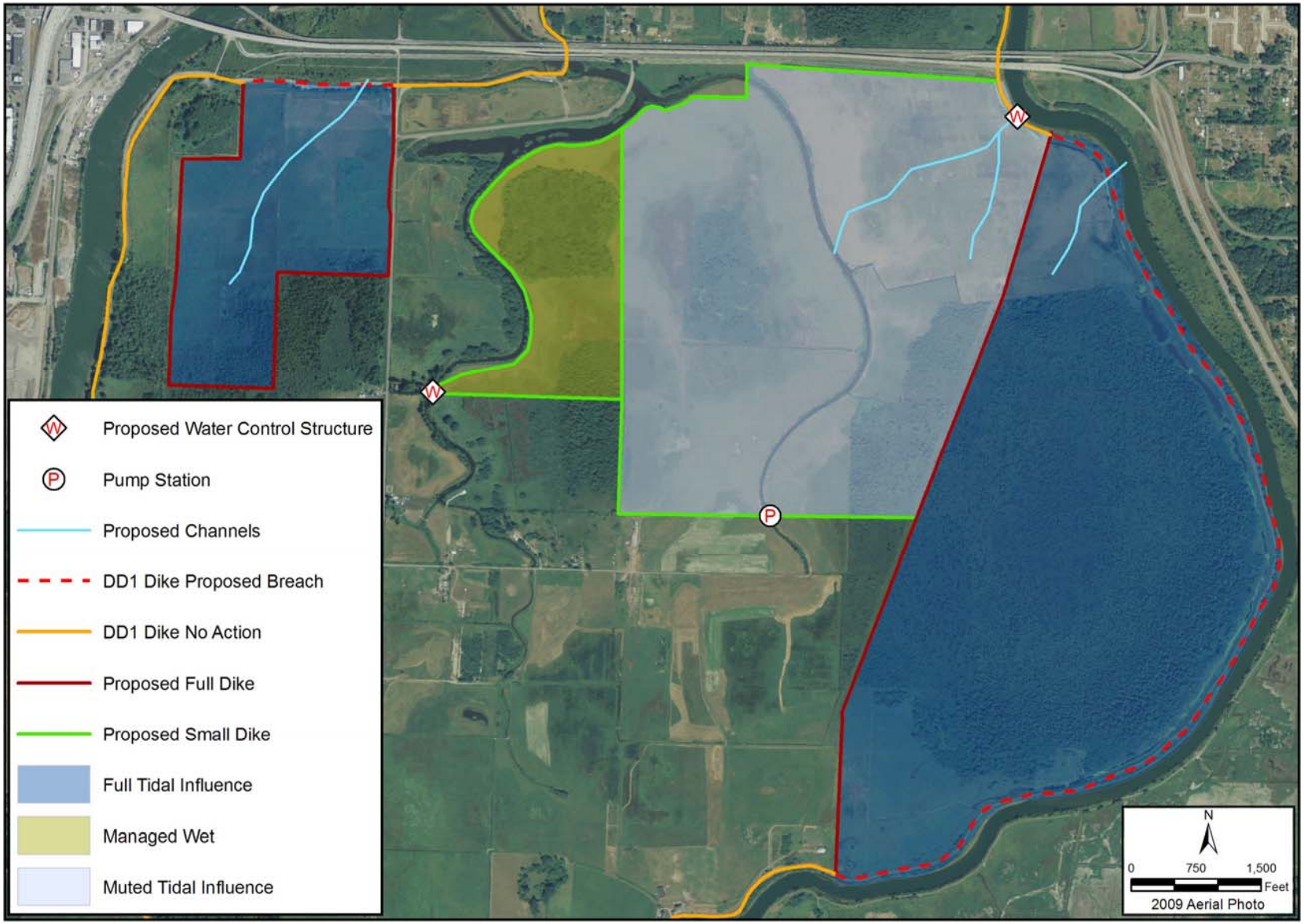

Figure 15 Alternative D

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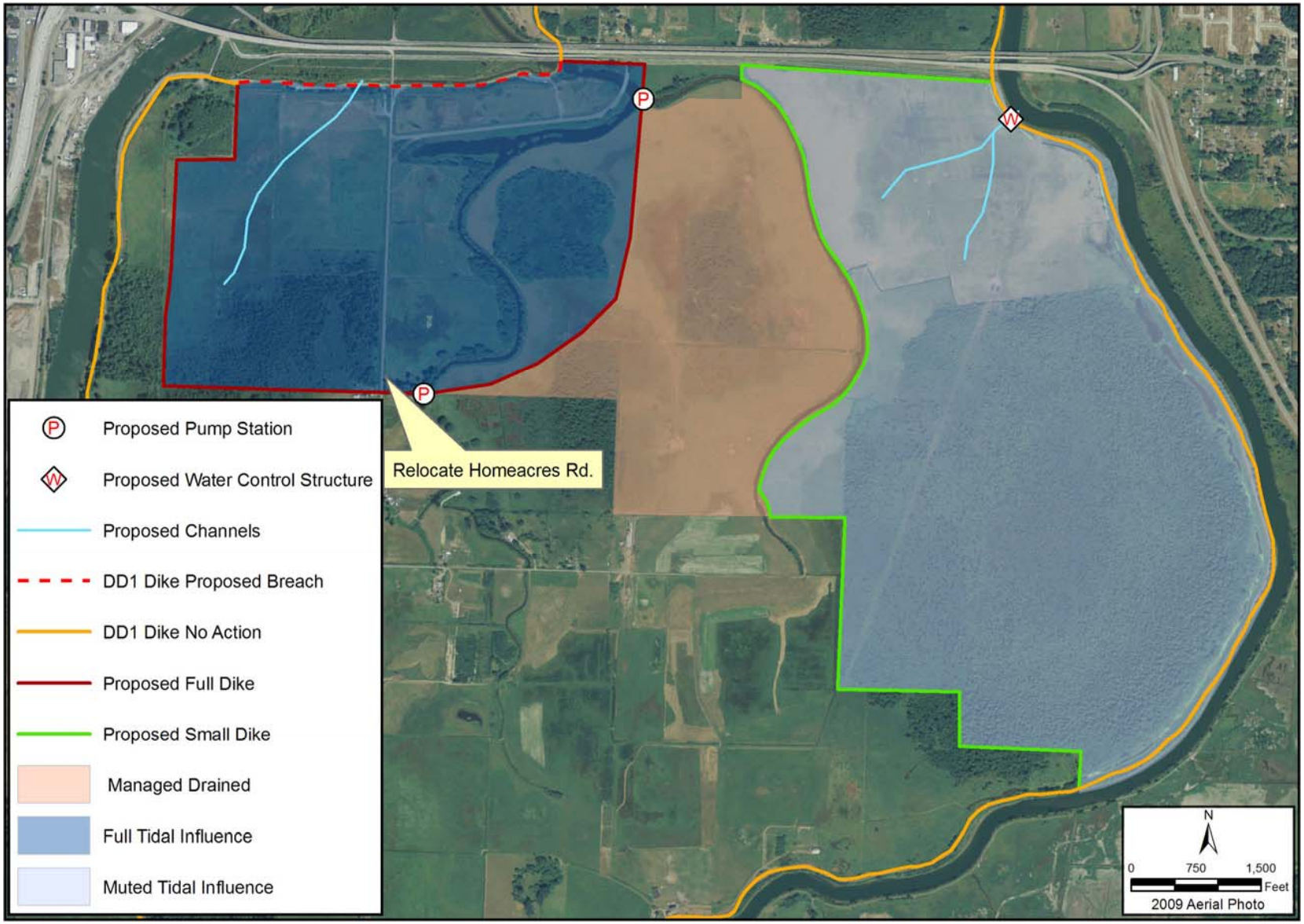

Figure 16 Alternative E

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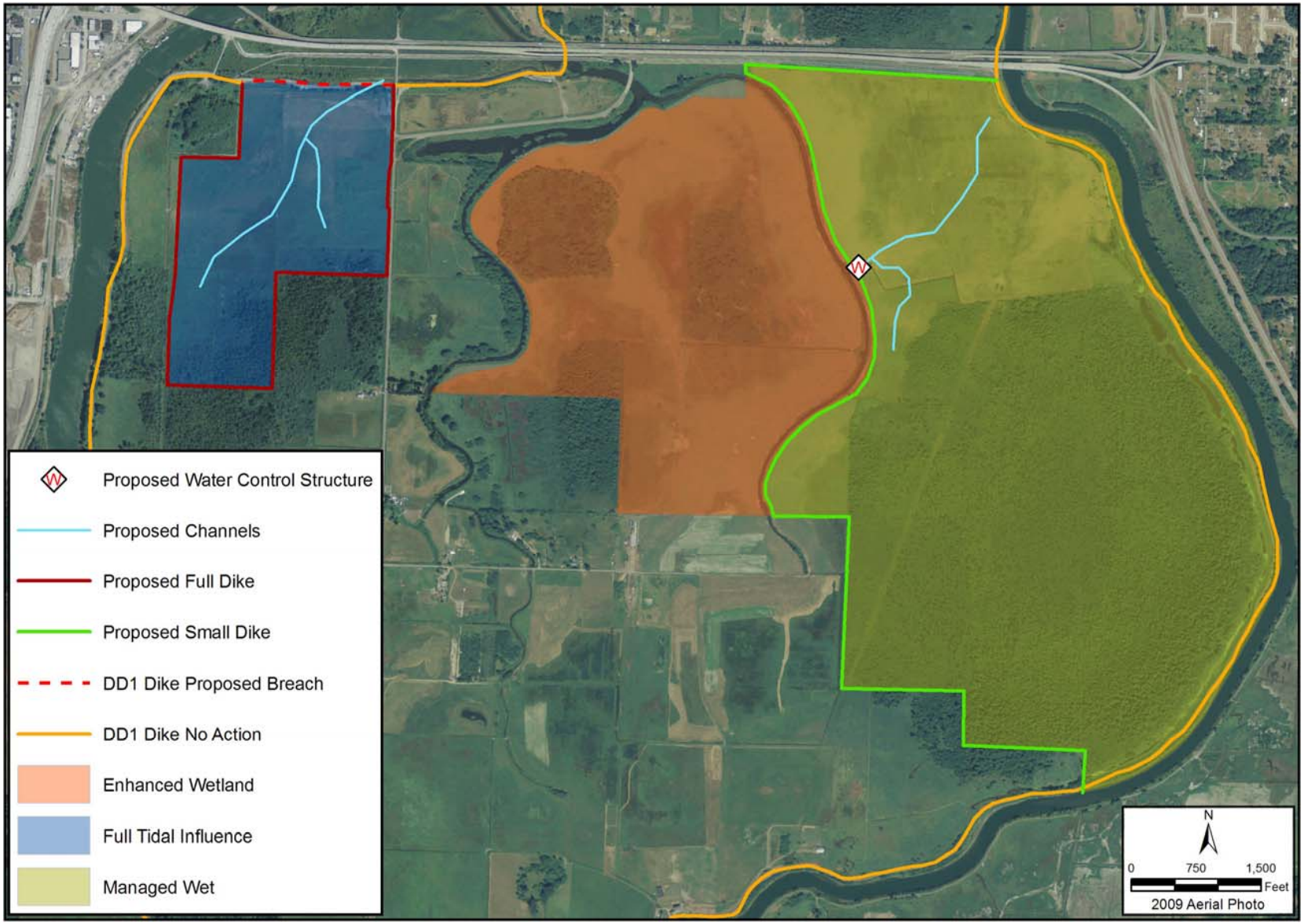

Figure 17 Alternative F

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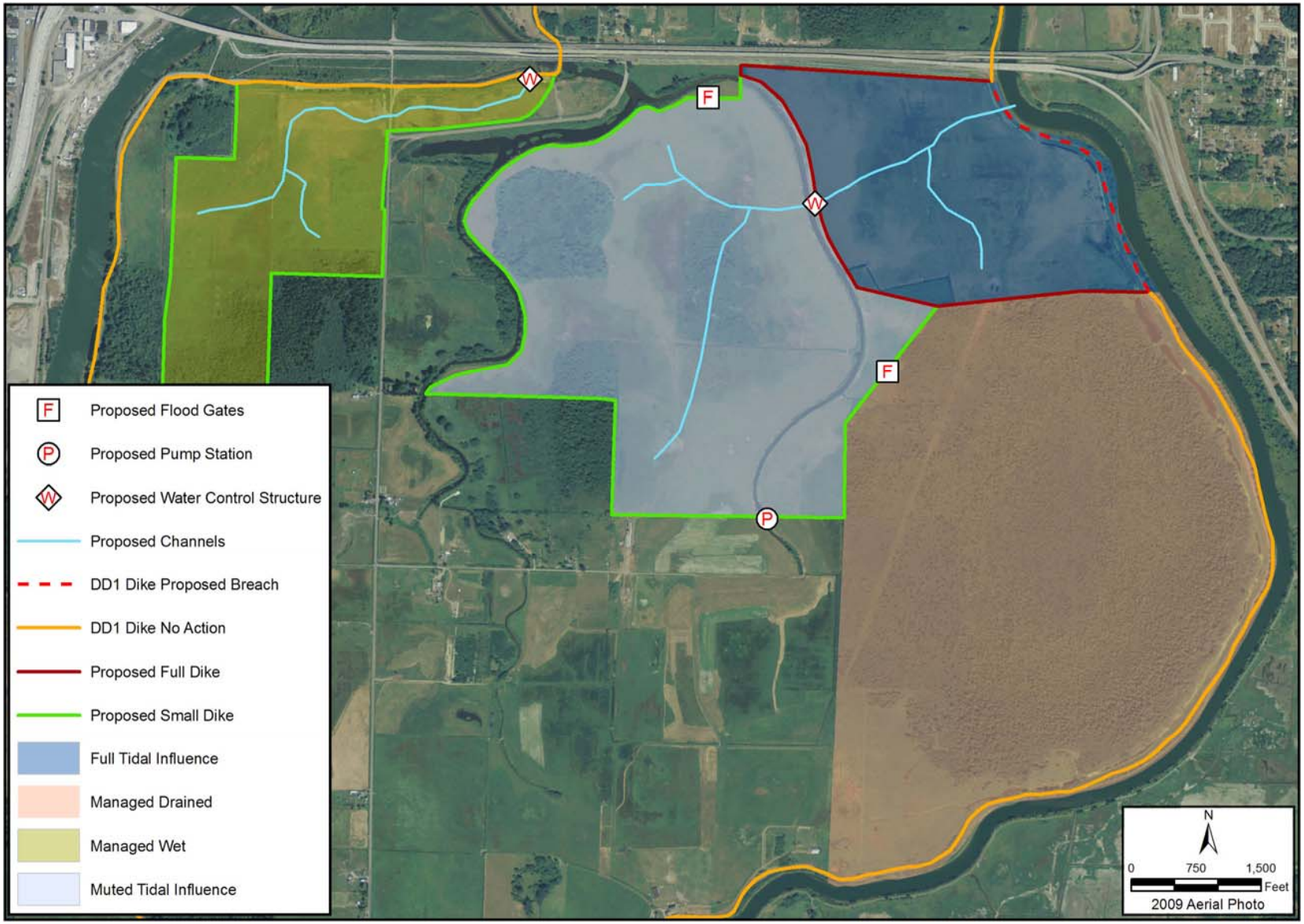

Figure 18 Alternative G

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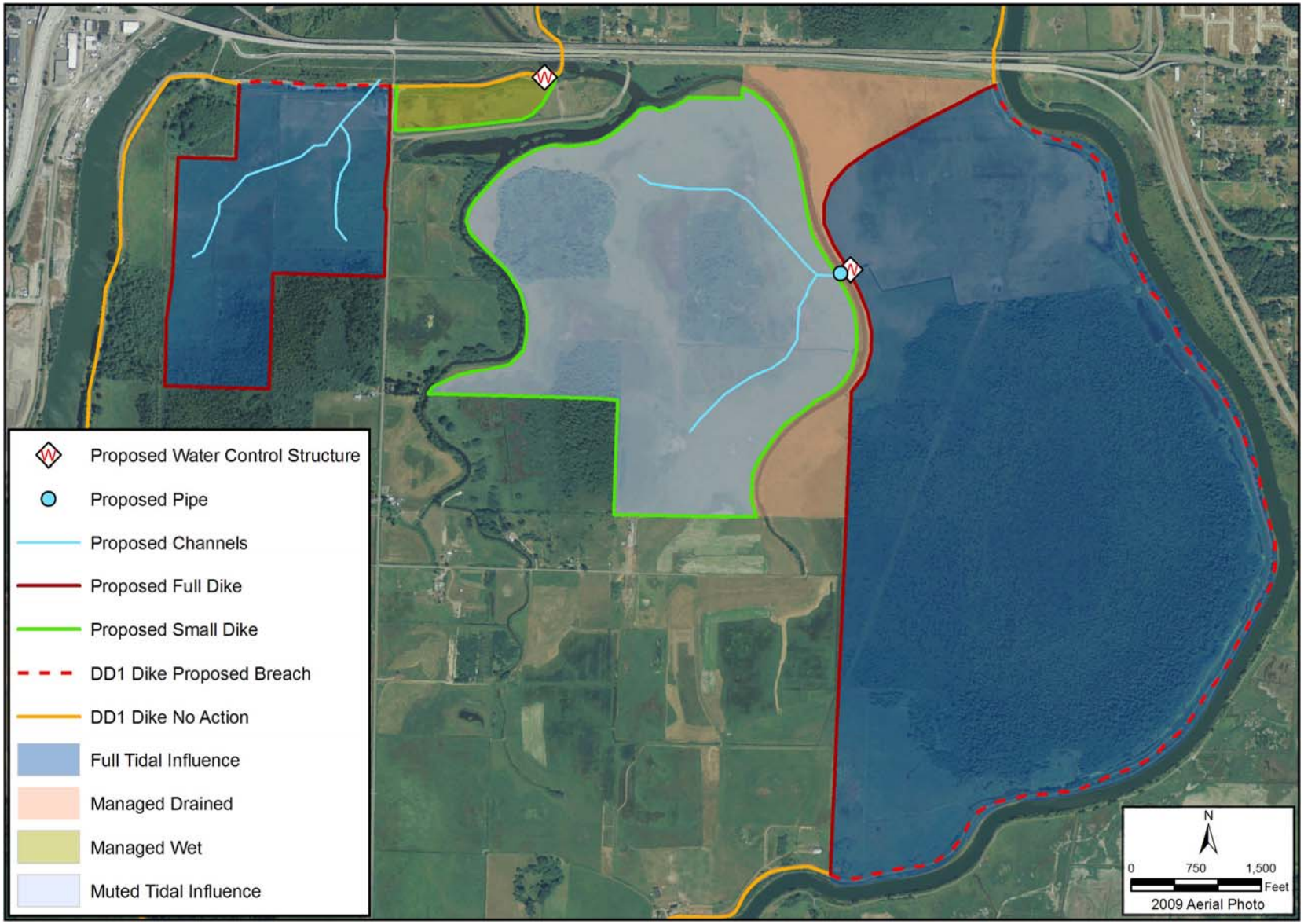

Figure 19 Alternative H

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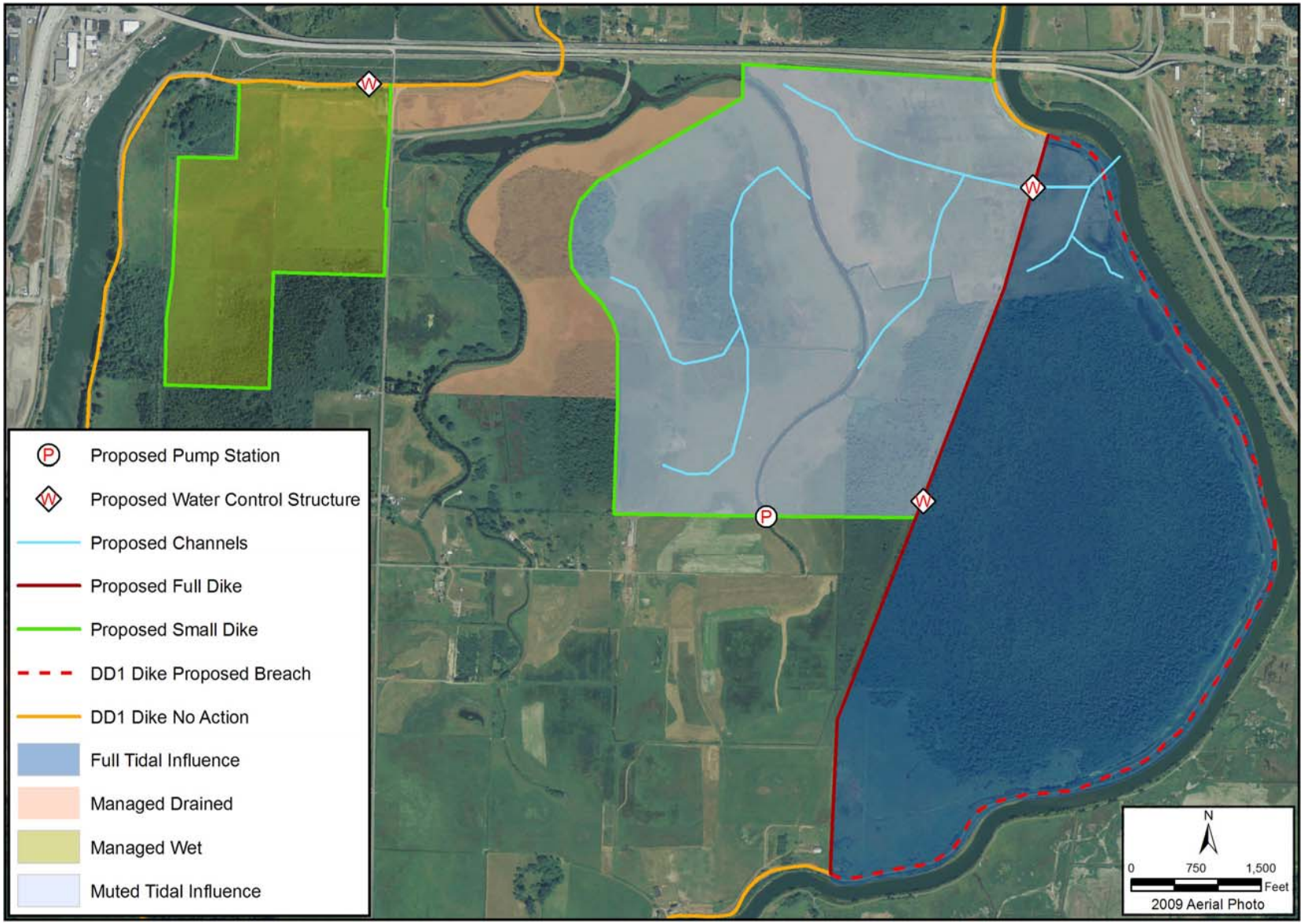

Figure 20 Alternative I

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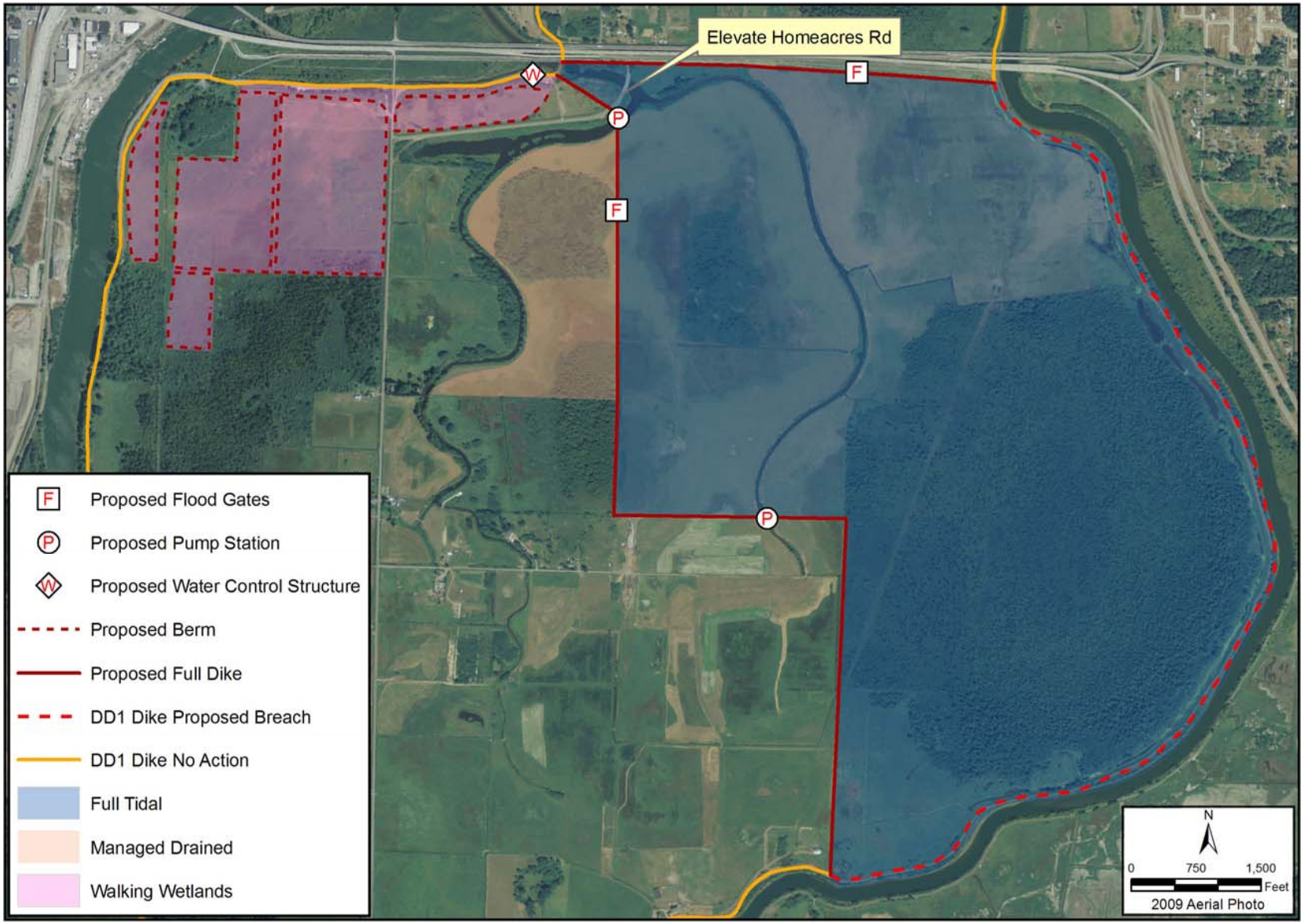

Figure 21 Alternative J

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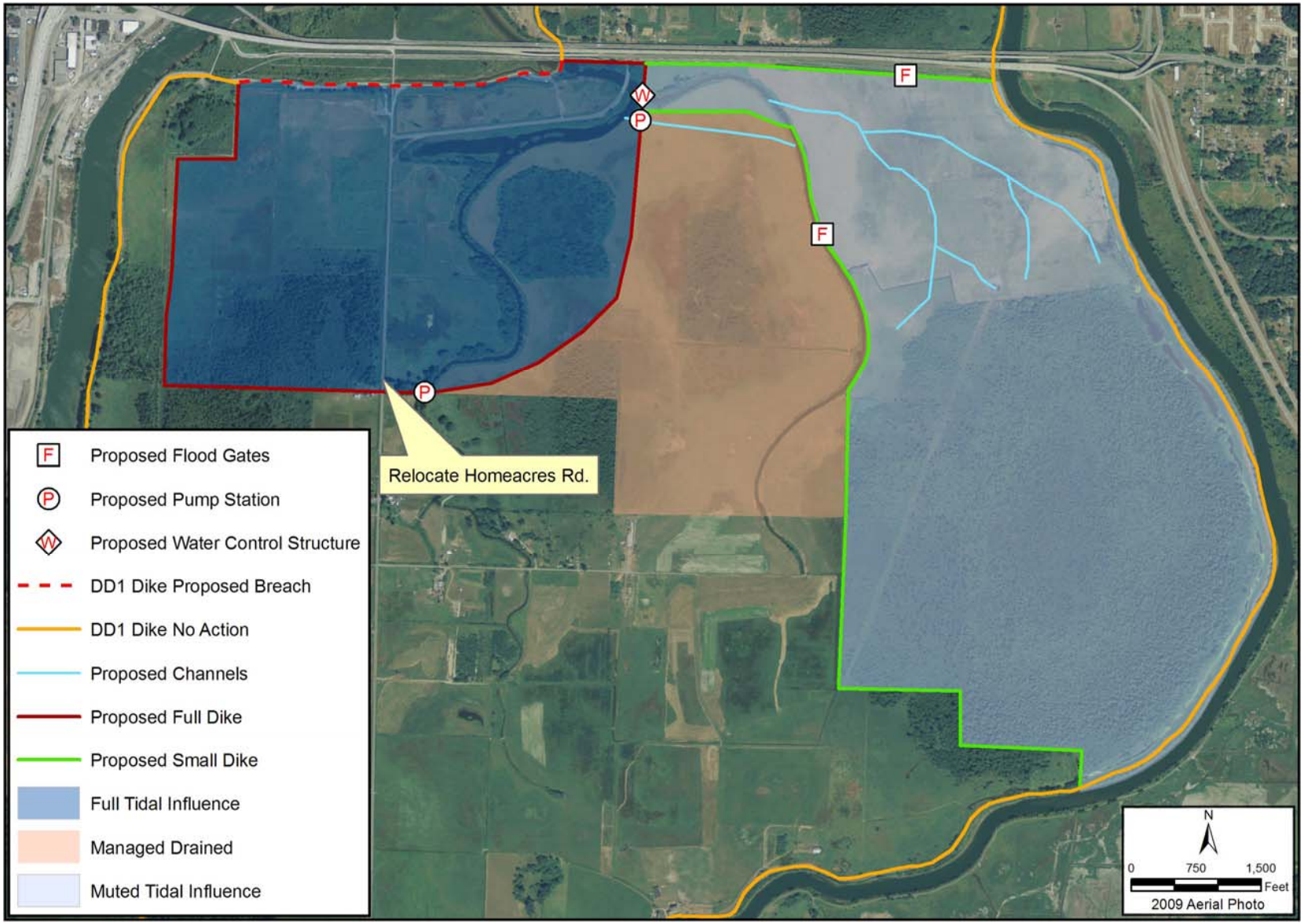

Figure 22 Alternative K

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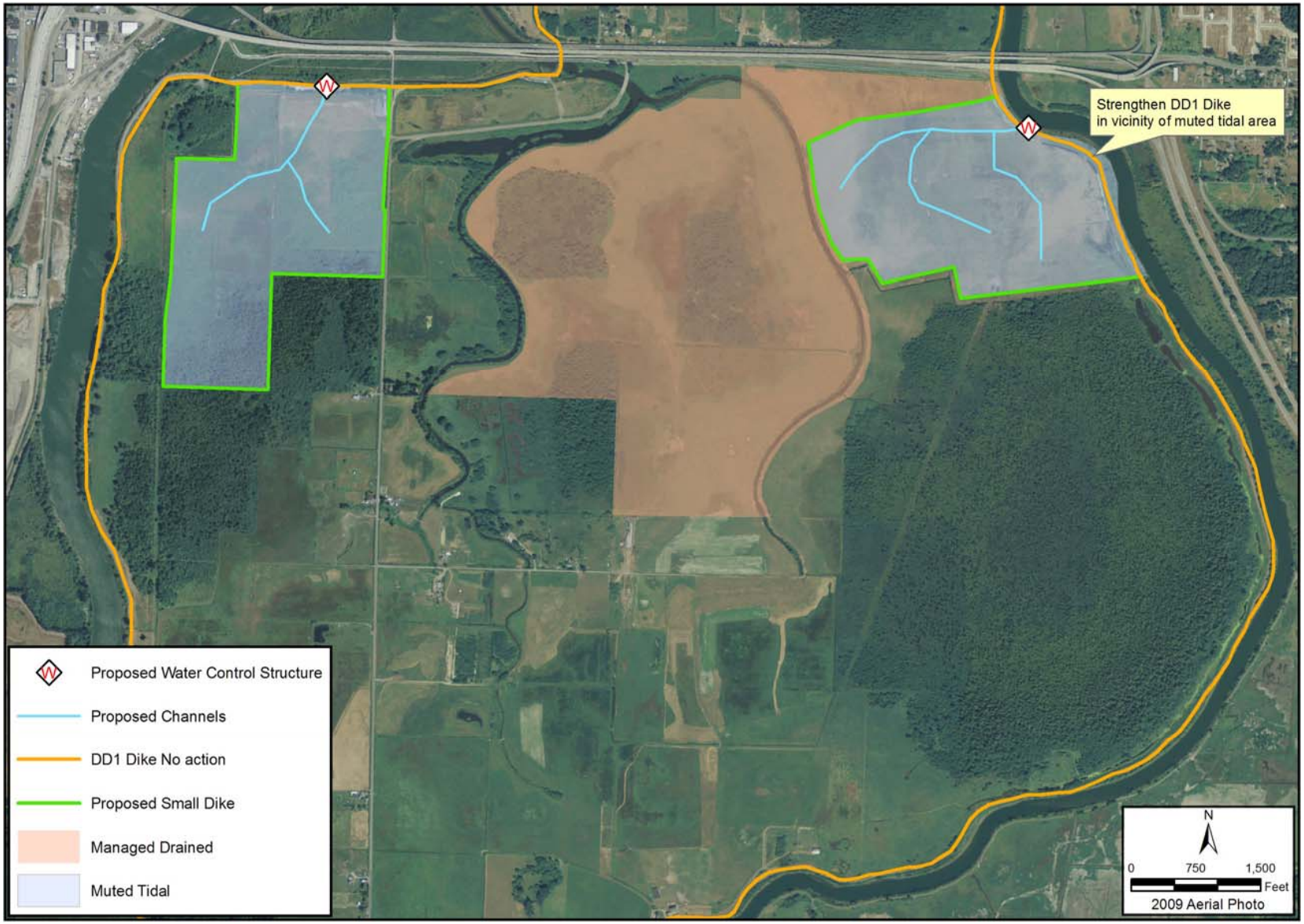

Figure 23 Alternative L

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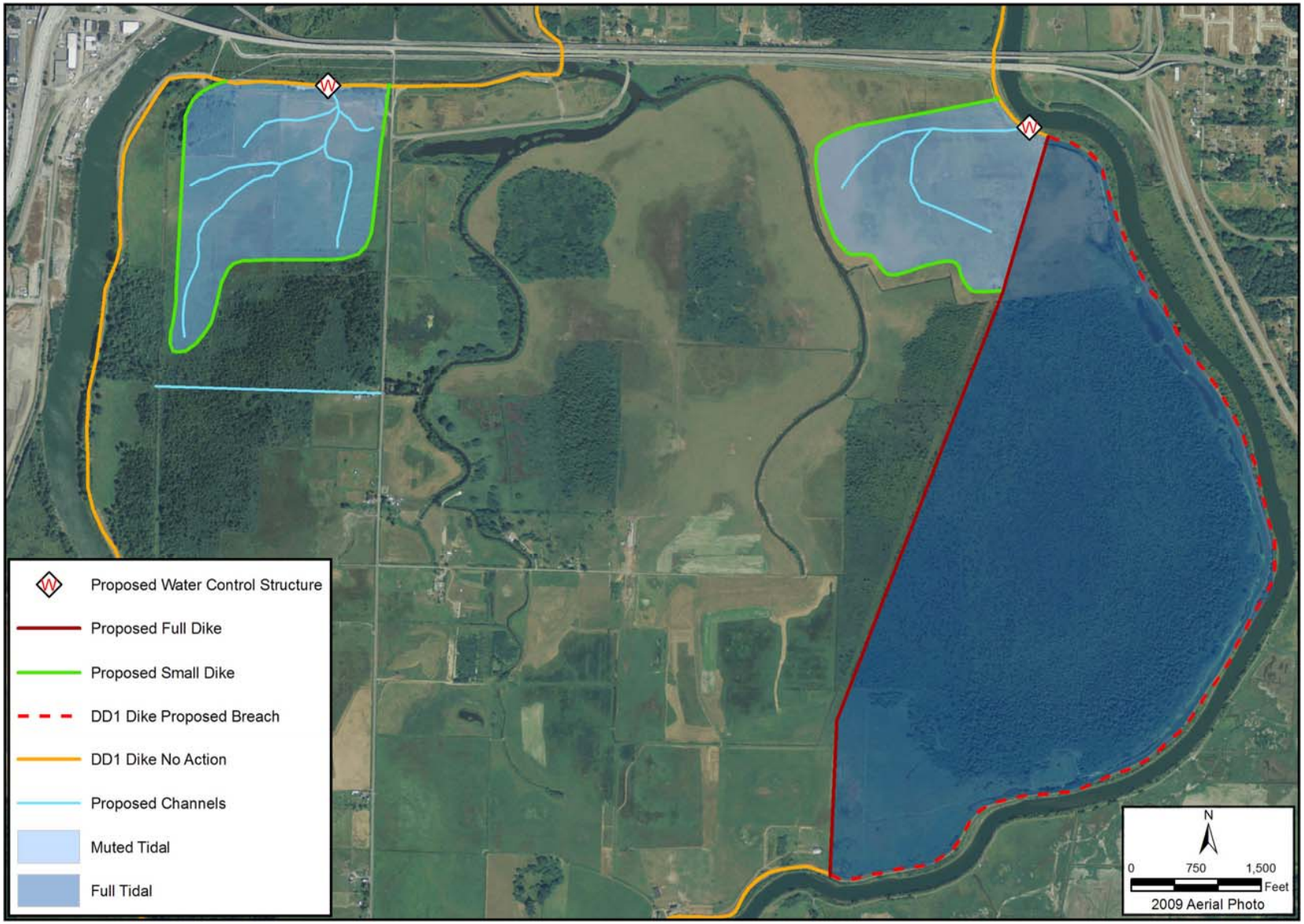

Figure 24 Alternative M

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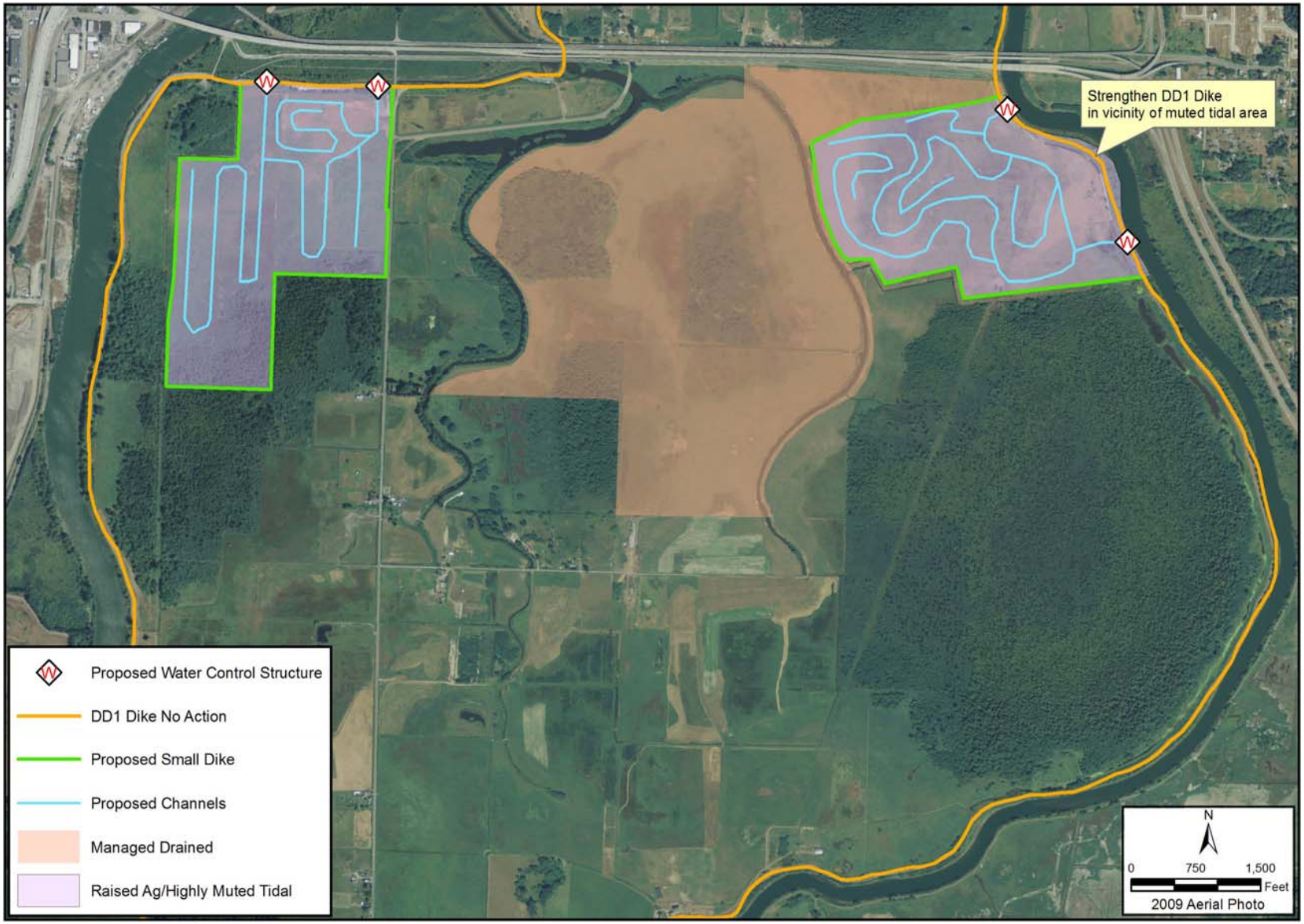

Figure 25 Alternative N

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6.1.2 Evaluation and ranking of conceptual alternatives

This section introduces the method and process used to evaluate the technical and social feasibility of the conceptual alternatives, and based on the results of this process, to identify a subset of alternatives for further analysis.

The method used to narrow and prioritize the range of alternatives was adapted from Felice and Franz (Felice & Franz, 1980). This method provides a straightforward procedure to efficiently score and rank the conceptual restoration alternatives, and meets this project's need for a relatively simple and systematic procedure to objectively rank-order potential restoration alternatives needed to improve salmon habitat while accommodating other social and recreational values.

The process followed in this study includes the following steps:

- Step One: Develop a draft list of potential evaluation criteria. Define scoring method. Review these with key stakeholders involved in fisheries, agriculture, and recreation in the project area. Amend the criteria and scoring method based on stakeholder feedback.
- Step Two: Collect, map, and compile pertinent data and metrics.
- Step Three: Score the various alternatives based on their metrics.
- Step Four: Normalize the scores to a 0 – 4-point basis.
- Step Five: Rank the identified criteria using a pairwise comparison procedure (Souder, 1975) as described in Section 6.1.3.2 of this report.
- Step Six: Calculate a weight for each decision factor based on the ranks determined in Step Three. Decision factor weights are calculated by the rank total being divided by the rank number (Baker & Moore, 1969).
- Step Seven: Calculate a final score for each alternative based on metrics and decision weighting factor.
- Step Eight: Evaluate the resulting score and identify the highest rated alternatives for further engineering analysis.

6.1.2.1 Application of criteria and scoring metrics

In trying to assess how best to evaluate the potential effects of different conceptual alternatives on fish, agricultural, social, and recreational resources, many criteria were originally considered. A draft list of 47 potential criteria was developed. Through evaluation and discussion with the Advisory Committee many were determined to not be useful, either due to lack of data, the lack of meaningful differentiating measurements, or because it was determined that the criterion shouldn't play a role in

deciding what is appropriate in rating an alternative (for example, cost). Some of these individual criteria were combined into one, single-subject criterion, as explained below. Additionally, while some of the criteria considered might be useful in prioritizing which properties to buy for future restoration within a watershed, they were found not to be determinative with such a small, homogenous area.

WDFW staff decided that cost should not play a role in determining the best alternative, because (1) They wanted to know what alternatives worked best for fish from a technical perspective (i.e., which ones provided the most and best habitat for salmon restoration) regardless of cost; and (2) Since this is a long-term plan (20-50+ years), no one knows what monies might be available in the future. This is not to say that costs will not ultimately play a role in determining what, if anything, is built; they just felt that cost should not figure in selecting the best alternative(s). Once this is determined from a purely technical standpoint, then costs can be introduced at the point of project selection, funding, and design. Undoubtedly, someone will ask which alternative gives “the biggest bang for our bucks.”

A list of criteria originally considered, but subsequently not used, is provided in Appendix B. Additionally, Appendix C contains a list of criteria that were found to be potentially useful for distinguishing between the final two alternatives (for which more intensive study was done), or at the very least, as something to consider (but not used as distinguishing criteria amongst all preliminary alternatives). The main reason was the cost of performing such analyses. Focusing such analyses on a smaller subset of alternatives saved limited resources.

6.1.2.2 Criteria used in narrowing the alternatives

The following are the final criteria used to choose amongst the 14 original alternative restoration scenarios to pare them down to the final two. In order to try to provide equity amongst the main competing issues many of the metrics of the original draft criteria were combined, and reduced to formulae for ease in creating replicable results.

As shown below, four of the final criteria were reduced to formulae, with quantifiable variables. These include Value to Fish, Agricultural Productivity, Economic Effects on the Diking District, and Impacts on Road System. For these, the metrics were developed from measurements derived from data that had been entered into a GIS program.

The criterion Impacts on Utilities was a little more subjective, relying on perceptions of scale of the utility facilities and difficulty/ease of relocating or flood proofing them.

For the criterion Effects on Recreational Opportunities it was determined that since there are no readily measurable formal facilities, we would simply rank the alternatives based on whether there

would be a positive, neutral, or negative effect on each of the activities using a -1, 0, or 1 score. These were then totaled for each of the alternatives.

Value to fish

Concept: A vast number of physical and biological factors determine whether a specific site will be valuable as fish habitat. These factors consist of habitat variables over a range of scales; from large scale site layout to small scale placement of LWD and contouring of channels. The level of detail in the 14 preliminary conceptual alternatives is insufficient to perform an in-depth assessment of this value. Instead, the fish habitat value of each alternative was scored based on simple parameters meant to capture the best available understanding of the way juvenile salmon use the lower Snohomish River and estuary. Parameters include: the number of acres within each parcel (alternatives may contain several parcels under different land use types); the degree to which tidal processes (semi-diurnal exchange) would be restored within the parcel; the degree to which fluvial processes (seasonal flooding and sediment deposition) would be restored within the parcel; and whether the site connects to Ebey Slough or the Snohomish River mainstem (where a restoration site may be more accessible to a higher proportion of juvenile fish and where few other tidal wetland rearing opportunities currently exist). The following formula was used to calculate fish value:

$$\sum A_i T_i R_i M_i$$

Where:

$i =$	Parcels	*the number of different parcels that comprise each scenario*
$A =$	Area	*the area (acres) within each proposed parcel*
$T =$	Tidal Processes	*the degree to which the full tidal amplitude is restored. Full = 1; Muted = 0.5*
$R =$	River Connectivity	*connectivity to natural riverine processes and the ease of access for fish (size and location of dike breach).*
$M =$	Mainstem	*access to the site from the mainstem or from Ebey Slough. Mainstem = 1; Ebey = 0.8*

Potential agricultural productivity

Concept: To account for potential agricultural acreage, function, contiguity, and infrastructure requirements a formula was created (Table 3).

Table 3 Agricultural productivity scoring method

	Description	Calculation
Step 1	Total agricultural acreage in alternative	Sum of forage and fallow acreage encompassed by each alternative, excluding managed drained
Step 2	Unaffected agricultural acreage (relative to 617 acres)	617 - Step 1
Step 3	Fraction of Enhanced Wet, Managed Wet, and Walking Wet acreage usable for agriculture annually	$\sum_i F_i Area_i$ $i =$ sector of enhanced wet, managed wet, or walking wet; values of F: 0.35=Enhanced Wet, 0.45=Managed Wet, 0.6=Walking Wet
Step 4	Total agricultural acreage available including usable Enhanced Wet and Walking Wet	Step 2 + Step 3
Step 5	Infrastructure requirements	D x Step 4; Values of D: 1=unaffected, 0.75=pump station relocated and draining to muted tidal, 0.5=pump station relocated and draining to full tidal
Step 6 (Final Score)	Contiguity of remaining agricultural parcels within WDFW property	C x Step 5; Values of C:1=unaffected, 1/(remaining agricultural sectors)=large portions, 0.25=isolated parcels

Economic effects on Diking District #1

Concept: Flood prevention infrastructure (dikes, etc.) are expensive to build and maintain. The smaller the system to the greatest amount of acres served, the more economical it is for the Diking District. Thus, a measurement of the ratio of dike length to acres of agriculture land protected (i.e., land left within the Diking District and/or assessed for their services) was used as an overall indicator of the Diking District's ability to continue providing this service.

Impacts on utilities

Concept: Are utilities and other infrastructure present? If so, can they be feasibly moved or flood proofed? Doing so could add substantial cost to the project. If not, this would narrow the alternatives. The major utility facilities include the Olympic Pipeline and the City of Everett's water transmission line; minor ones include electrical lines, communications lines, and stormwater systems. The alternatives were developed to avoid impacts to the greatest extent possible, though a few still had potential impacts. Scores were assigned based on relative difficulty of relocation and/or flood proofing.

Impacts on road system

Concept: After restoration, the road system will still need to work and not be flooded. There may be a need to replace roads, build bridges, etc., which would greatly increase the cost of the project. However, in some instances it may be cheaper to move a road than build a long dike to protect an existing road. Any project will also need to maintain access to private property, new and existing

dikes, flood control infrastructure, etc, but such mitigation can be designed into any of the final project alternatives.

As a simple measure of impacts, it was decided to use a measurement of the length of arterial or arterial collector roads and bike paths that would be affected by any of the alternatives.

Effects on recreational opportunities

Concept: Are any of the properties currently used for fishing, hunting, boating, hiking/walking, or bird watching? Would any existing recreational opportunities be lost due to project implementation? Are any added? Which properties have the most potential for recreational uses?

It turned out that there are no formal recreational facilities within the project boundaries, though recreation does occur (duck hunting, pheasant hunting, bird watching. etc.). Standard measurements of recreational Levels of Service are typically derived from measurements of formal facilities (number of play fields, acres of designated parkland, number of restrooms, number of parking stalls, etc.).

This criterion was initially used in scoring the various conceptual alternatives, but did not prove to be a meaningful differentiator. All of the considered could potentially support a wealth of recreational opportunities beyond the property's current (minimal) use. However, the recreational opportunities associated with any project will depend heavily on the specifics of the design, which is beyond the scope of the present study.

6.1.3 Scoring process

The preliminary alternatives were scored by the core project team based on the formulae described above, almost a purely mathematical exercise. These scores were then normalized (as described in Section 6.1.3.1), a pairwise comparison of the criteria performed to as to obtain weights for the criteria (Section 6.1.3.2), and then weights were applied to the scores (Section 6.1.3.3) to obtain final scores of the preliminary alternatives. These scores were then reviewed by the Advisory Committee (6.1.3.4)

It should be noted that different people might rank decision factors differently based upon individual goals and objectives. In this study nine members of the core project team, each with differing backgrounds, expertise and goals, participated in this exercise.

6.1.3.1 Normalizing the scores

Analysis and measurement of each of the above final criteria resulted in a score for that particular criterion. However, because of the differences in metrics, formula, and method of assessment, individual criterion scores had various ranges (for example, 4.6 to 1,213 for value to fish, 0 to 393 for

agricultural productivity). In order to compare apples to apples each score was normalized to a 1 to 4 point system based on their quartiles. Results are shown in Table 4.

6.1.3.2 Pairwise comparison and ranking of decision factors

The six major decision factors identified and defined in Section 6.1.2.2 were ranked using the pairwise comparison chart developed by Souder (Souder, 1975). This process provides a ranking of the relative importance of each decision factor. The mechanics of the pairwise comparison require the construction of an n x n matrix, where n is the total number of decision factors. The decision factors are listed as column and row headings on the matrix as shown in Table 5. In a systematic order, all column headings are compared with each row heading so that all pairs of decision factors are individually compared. When a column heading is determined to be more important than a row heading, a “1” is placed in the square of the matrix where the row and column intersect. When a column heading is determined to be less important than a row heading, the cell is left blank. For example, if Value to Fish (column 1) is considered more important than, Agricultural Productivity (row B), a “1” would be entered where column 1 intersects row B; if Value to Fish is considered less important than Economic Effects on Diking District, then the cell at the intersection of column 1 and row 3 would be left blank.

After all the paired comparisons are completed, the rank for each decision factor is determined by summing the total number of “1’s” for each column. The decision factor with the highest number of “1s” is given a rank of “1,” the next highest is given a rank of “2,” etc., until all of the column decision factors have been ranked.

The pairwise comparison chart requires that the relative importance of each decision factor be consistently determined. Conflicts will reveal themselves at the end of the process as decision factors of equal rank, indicating that the relative importance of the decision factors has been evaluated inconsistently. This approach forces a reassessment of the decision factor(s) to verify that only one factor in each pair is considered of greater importance.

Table 5 shows the results of the pairwise comparison and decision factor ranks.

6.1.3.3 Decision factor weights

Once the decision factors were ranked using the pairwise comparison chart, a decision factor weight was calculated for each decision factor by dividing the rank total by the rank number. For example, in Table 4 decision factors are ranked 1 to 6. The rank total = 1 + 2 + 3 + 4 + 5 + 6 = 21. The decision factor weight for the highest ranked factor, which has a rank of 1, is 21/1 or 21. The weights for each decision factor in Table 5 are shown in the row at the bottom of the table. Decision factor weights used in the study range from 3.5 to 21.

Table 4 Criteria scoring scheme and raw normalized scores

Decision Factors	Measurement	Deal Breaker	Scoring Scheme: 1 (lowest)	2	3	4 (highest)	Alternatives' Raw Normalized Scores: A	B	C	D	E	F	G	H	I	J	K	L	M	N
Value to Fish	Based on formula accounting for area of restored areas, tidal processes, connectivity to the riverine processes, fish access, and connectivity to the mainstem.		Mathematical score normalized to a 4 point system	Mathematical score normalized to a 4 point system	Mathematical score normalized to a 4 point system	Mathematical score normalized to a 4 point system	3.2	1.2	4.0	2.1	1.4	1.1	1.3	2.4	2.0	2.9	1.4	1.1	2.0	1.0
Agricultural Productivity	Based on formula accounting for agricultural acreage, function, contiguity, and impacts to DD1		Mathematical score normalized to a 4 point system	Mathematical score normalized to a 4 point system	Mathematical score normalized to a 4 point system	Mathematical score normalized to a 4 point system	1	1	1	2	3	3	2	2	2	2	3	4	4	4
Economic Effects on Diking District	What effects will the project have on the Diking District's ability to maintain its flood protection infrastructure? Changes can be measured as a change in ratio of length of dikes to land protected from flooding.	Ratio such that the district is no longer economically viable	Mathematical score normalized to a 4 point system	Mathematical score normalized to a 4 point system	Mathematical score normalized to a 4 point system	Mathematical score normalized to a 4 point system	1	4	1	2	2	3	3	2	3	2	2	4	3	4
Impacts on Utilities	Will the project have significant impacts on existing utility infrastructure?	Major utilities are present that cannot be relocated, maintained, or flood-proofed	Major utilities are present that would be extremely difficult to relocate, maintain, or flood-proof	Major utilities are present that would be moderately difficult to relocate, maintain, or flood-proof	Minor utility infrastructure present, which can easily be relocated, maintained, and/or flood-proofed	No utility infrastructure present	1	2	1	2	2	2	1	1	2	1	2	2	2	2
Impacts on Road System	What effects will the project have on roads?	Project will cause a state highway to need to be relocated	Comparison of relative effects on roads and bike trails, based on length affected	Comparison of relative effects on roads and bike trails, based on length affected	Comparison of relative effects on roads and bike trails, based on length affected	Comparison of relative effects on roads and bike trails, based on length affected	3	4	1	4	1	4	3	4	4	2	1	4	4	4
Effects on Recreational Opportunities[1]	Overall, will the project have positive, negative, or neutral effects on fishing, hunting, boating, hiking/walking, or bird watching opportunities?		Score based on analysis of effects on each of the mentioned recreational activities	Score based on analysis of effects on each of the mentioned recreational activities	Score based on analysis of effects on each of the mentioned recreational activities	Score based on analysis of effects on each of the mentioned recreational activities	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Score							**13.2**	**16.2**	**12.0**	**16.1**	**13.4**	**17.1**	**14.3**	**15.4**	**17.0**	**13.9**	**13.4**	**19.1**	**19.0**	**19.0**

1 Since there are no formal, readily measurable recreational facilities, and any of the recreational activities/facilities could (and would) be built and formalized into any of the alternatives, all scores turned out equal.

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Table 5 Results of the pairwise comparison & resulting decision factor ranks

Decision Factors	Value to Fish	Agricultural Productivity	Economic Effects on Diking District	Impacts on Utilities	Impacts on Road System	Affects on Recreational Opportunities	Sum of Ranking
Value to Fish	0	1	2	2	1	1	
Agricultural Productivity	8	0	5	4	3	5	
Economic Effects on Diking District	6	3	0	4	1	3	
Impacts on Utilities	6	4	5	0	2	6	
Impacts on Road System	7	5	8	6	0	6	
Effects on Recreational Opportunities	7	3	6	3	4	0	
Total number of times factor checked	34	16	26	19	11	21	
Rank (highest number checked = #1 rank)	1	5	2	4	6	3	21
Weighted Decision Factor (sum of all ranks and divide by the rank of the specific decision factor)	**21.00**	**4.20**	**10.50**	**5.25**	**3.50**	**7.00**	

The procedure used to calculate the decision factor weights emphasizes the value of the highest ranked decision factor and reduces the range of values when the number of decision factor ranks is fewer. This procedure addresses the goal of using a method that focuses on determining the relative importance of the identified decision factors.

It is useful to examine the total points available in the final scoring in relationship to WDFW's agency mission and to the goals for the WDFW Ebey Island property.

Mission	**Relationship to criteria weighting**
The Washington Department of Fish and Wildlife (WDFW) serves Washington's citizens by protecting, restoring and enhancing fish and wildlife and their habitats…	Fish are rated very high (21 points possible) because the site historically provided habitat for what are now endangered fish that need to be protected and restored. Also, restoring or simulating natural processes, while not ideal for every species, should be best for more wildlife species in general than the existing, highly altered state.

…while providing sustainable fish- and wildlife-related recreational…	Recreation scores moderately (7 points possible), as it should not trump the primary part of WDFW's mission, and can be maximized under a variety of management scenarios.
…and commercial opportunities	Agriculture scores lower (4.2 points possible) because WDFW can be flexible as to where on our lands we meet this goal and how it best helps them meet the other objectives of their mission.

Furthermore, these three criteria that relate directly to WDFW's mission make up only 63 percent (32.2 points) of the total weighted points available. The other 37 percent (19.25 points), more than one-third of the total, fall into three categories that reflect WDFW's determination to be a good neighbor on Ebey Island: Economic Impacts to Diking District (10.5 points), Impacts to Utilities (5.25 points), and Impacts to Roads (3.5 points).

6.1.3.4 Stakeholder review of criteria

As previously explained, each of the steps above was presented to the Advisory Committee for review and discussion. This included a presentation of all the original draft evaluation criteria, the discussion of which helped pare down the list to the final ones. Concerns about them included "too many," "not measurable," and "too skewed toward one major issue over another."

The Committee also reviewed the results of the pairwise comparisons and resulting decision ranking scores. Concerns here mainly centered on taking umbrage with only the project team being involved in this step and not the full Committee (mainly concern that the results would be skewed to WDFW's objectives). This concern seemed to be alleviated once the results were shown, since the top scoring ones were the ones that several Committee members intuitively thought should come out on top.

6.2 PREFERRED ALTERNATIVES

6.2.1 Selection and refinement of preferred alternatives

After the top two alternatives were selected, they were refined by creating realistic dike alignments, habitat areas, basic channels needed for habitat or drainage, and infrastructure needed to support the alternative. This information was used to generate quantity estimates, cost estimates, habitat benefit estimates, and was used in the modeling process. Additionally, earlier input from the diking district created the addition of an option to restore the north tip of Ebey Island to full tidal conditions.

6.2.1.1 Key features and objectives

Alternative C, otherwise known as the Long Term Alternative, features full height setback dikes that bisect the island and the diking district to maximize the amount of area that would be restored to full tidal conditions. Full tidal conditions could be achieved by either complete removal of the perimeter dike, or by creating sufficiently large breaches. The primary goal of this alternative is to create an environment where the natural riverine and tidal processes would take over the restored area to create and maintain freshwater tidal marsh, which would provide high quality fish habitat. This alternative would allow for passive recreation in the form of wildlife viewing and walking along the setback dike, as well as more active recreation such as canoeing and kayaking in the restored tidal area. Connections are proposed both to the Snohomish River and Ebey Slough. Available research indicates that the highest fish usage in restoration sites generally occurs where there are multiple connections between the main water body and the restored habitat area. The water control structures and dikes that are proposed as part of this alternative are for the purpose of allowing existing uses in the rest of the diking district to continue. The infrastructure required would be substantial. Additionally, the current practice of leasing out part of the WDFW-owned property for agricultural uses would not be possible. Inclusion of this alternative for further study constitutes a “bookend” case, representing the most complete restoration conceivable using a core of WDFW’s current property with addition of some other nearby parcels, totaling an estimated 150 acres.

Alternative M, otherwise known as the Near Term Alternative, features short interior dikes in the northwest and northeast portions of the WDFW-owned land, to allow muted tidal exchange in these areas. Self-regulated tide gates and these dikes together would be required to allow for the creation of muted tidal areas within the island and the diking district. Muted tidal restoration areas are designed to provide some of the fish habitat benefits of full tidal restoration in areas where full tidal restoration is not feasible, practical, or desirable. The main limitation for fish habitat is the impeded ability of fish to volitionally pass from the main water body into the restored habitat area, and vice-versa. The lack of full tidal exchange would not allow the site to be subject to the full force of the natural processes. This alternative would not affect the adjacent and nearby properties and their owners as much as Alternative C, and would require no additional property acquisitions. The district and its infrastructure would remain intact, and agricultural and recreational uses on the WDFW-owned properties could continue.

The Near Term Alternative also includes a full tidal restoration area east of the Olympic Pipe Line corridor. To facilitate this, a full height setback dike would be created just east of the pipelines, and the existing dike east of this new dike would be breached in one or more locations and likely be lowered or removed near the breaches. Starter channels should be formed to encourage the evolution of this area to happen faster than if tidal action alone was used to form new channels.

6.2.1.2 Constraints and opportunities

A proposal to restore tidal inundation on the Olympic Pipe Line corridor would cause major problems with the operation and maintenance of the high pressure petroleum pipelines, according to Holly Williamson, who deals with right-of-way issues for Olympic Pipe Line Company. This is because both regular maintenance and emergency preparedness require access to the pipelines. The pipelines could potentially be relocated to a different alignment. This is not a desired course of action, according to Williamson, because of the time and expense that would be involved. Based on other recent projects, the construction budget for such relocation would be approximately $1 million per mile per pipeline, plus the cost of new easements through private and city/county properties. Acquiring easements, designing the relocation, and completing construction would take several years, and costs are likely to rise. When discussing if a muted tidal scenario would be compatible with pipeline operations, Holly said that in an emergency, the site would need to be drained within a few hours, the time required to mobilize a response after the first sign of trouble requiring immediate attention. A muted tidal system drained by tide gates would normally take a few days to drain fully. A large pump station would be required to assure that the area could be drained within a few hours in an emergency. Assuming that 400 acre-feet of water would need to be pumped out within 4 hours, the recommended budget to construct such a pump station would be in the range of $5 – 10 million.

The City of Everett has multiple 4-foot-diameter potable water pipelines that cross Ebey Island in the east-west direction. Three such pipelines are located parallel to and just south of US 2. A City of Everett representative indicated that their main concern is the ability to have unrestricted access at any point on their pipeline corridor for maintenance and operation. The pipelines would also need to be evaluated for their ability to withstand tidal inundation and exposure to greater and more frequent flooding. The two main restoration alternatives are both located south of these pipelines, and do not involve changing conditions within this pipeline corridor. The City of Everett has other water pipelines on Ebey Island. There is a major pipeline corridor that runs east-west toward the southern end of the island, outside of the area considered by this feasibility study. There is also a smaller pipeline corridor that parallels Homeacres Road, but is not currently being used. This pipeline corridor would be affected by the Long Term Alternative. A proposal to restore tidal inundation on Ebey Island would have to include protective dikes for the pipeline corridors or other compatible solutions to provide access and maintenance for the pipeline. Conceptually, the pipelines may be compatible with tidal inundation and flooding; however, the flooded condition was not considered in their design. The city reports a total of 40,000 linear feet of large-diameter pipe on the island. Recent pipeline seismic retrofits to some of this pipe cost over $3,000 per linear foot.

WSDOT owns a parcel of property adjacent to 51st Ave SE and Homeacres Road, as shown in Figure 1. According to Brian Bigler, WSDOT NW Region Biology Program Manager, this property is a wetland mitigation site constructed under a US Army Corps of Engineers (USACE) permit to fulfill the

mitigation needs of a former project that improved nearby portions of US 2. The site includes unique topography, hydrology, and vegetation that must be maintained in perpetuity or WSDOT will be out of compliance with the USACE permit. In the event that full or muted tidal conditions are proposed for the site as part of a larger restoration project, a study would need to be completed to predict how the site would respond. The study would result in determining whether the proposed changes would represent an overall improvement in wetland functions and values and therefore maintain compliance with the existing permits.

While none of the alternatives developed directly impact the US 2 trestle, some public comments have been received recommending that a larger project area be considered. According to Brian Bigler, the supports for US 2 would need to be evaluated to determine if the existing structures or their foundations would need to be modified or replaced to account for fluctuating water levels under a possible habitat restoration scenario.

Homeacres Road is considered important as a commuting route even if it would not be serving local residents, as in a buyout scenario. It is currently a substandard road. There would be an opportunity to elevate it and bring it up to current standards. It could be put on top of a setback levee, with a similar configuration to the Lowell-Snohomish River Road. Without a levee, it would likely be placed on a trestle, similar to US 2. Estimated costs are not readily available, but Snohomish County Public Works staff indicated that the costs to complete the Lowell-Snohomish River Road project would provide a reasonable cost estimate for budget purposes. A rough budget is likely on the order of about $2 million per mile to construct a road on top of a dike. The cost to construct the dike is not included in this estimate. A trestle is likely to cost in the multiple tens of millions of dollars per mile to construct.

AMEC completed a preliminary geotechnical report was completed for this project. Data from previous advance borings for transportation and utility projects was gathered. To supplement the available data, advance borings were done on WDFW property, away from areas where previous borings had been completed. The full report is included as Appendix A. The conclusion is that the construction of new interior dikes is feasible from an engineering perspective. However, the soils in the project area are soft enough to require special design and construction considerations. In order to properly design new dikes, it was recommended to advance borings along the centerline of a proposed dike alignment, collecting data in the field and soil samples for laboratory analysis. The results of the field data and laboratory analysis would allow slope stability, seepage, and settlement design elements to be addressed. The possible use of soil material that would be excavated for the creation of channels or other habitat features could also be evaluated to determine the feasibility of its re-use.

The long-term alternative is predicted to create much better fish habitat than the Near Term Alternative, and WDFW would have to provide more extensive mitigation to ensure the same or better

level of flood protection to the remnant areas of the diking district. This alternative would split the district into two parts, greatly reduce the amount of land within the district, and drastically change how quickly and completely flood waters would fill the upstream, southern part of the district. In order to keep the diking district viable, there would also have to be a financial commitment to make up for the financial impacts to the district. One part of the financial commitment would likely take the form of a negotiated up-front payment that would offset the short term impacts to the district or enable the district to complete changes in the diking or drainage system that would be needed to mitigate for project actions. The second part of the financial commitment would involve ongoing payments to allow the district to pay for operation and maintenance activities. This would be most easily accomplished by keeping the parcels within the diking district boundaries and on their assessment roll because a special agreement would not be required. Currently, the annual budget for the district is about $85,000 per year, or about $24 per acre, although the financial impact to the district could be disproportionate to the amount that would normally be assessed.

Home Acres Road, power lines, and other utilities would need to be flood proofed or re-routed. Full tidal restoration projects considered in this feasibility study each require at least one significant new setback dike to be constructed. The cost to install these dikes could be reduced or the habitat gains significantly improved by acquiring additional property. There are ongoing threats to the integrity of the exterior dikes. These threats occur in multiple spots around the perimeter dike. It is advisable to consider calving off a portion of the district for fish habitat and at the same time, getting rid of a problem section of dike, compared to continuing to battle the same problem dike into the future.

Public comments were received that suggested that it might be cheaper to open up the whole island to tidal exchange, compared to the cost of the proposed Long Term Alternative. Political and social issues aside, the transportation and utility corridors discussed above would be affected. Some of the facilities and/or access to them may be able to be flood proofed, while other facilities may need to be relocated into another alignment. There are many unknowns and it is unclear how the cost to mitigate for transportation and utility impacts and acquire the remaining property on the island would compare to the Long Term Alternative. Since WDFW holdings represent about one third of the island, the habitat gains would likely be substantially different on their holdings compared to the whole island.

6.2.1.3 North tip of Ebey Island

The North Tip Option would create full tidal conditions in the northern, downstream, tip of the island. A full setback dike would be created, a short section of new ditch would be needed, and a new tide gate would be created to allow the diking district to continue to provide flood protection and drainage within the district, as shown in Figure 26. Breaches would be created in the portion of the dike outside of the new setback dike and starter channels created to allow for the relatively rapid evolution of the site to conditions that would allow for natural processes to take over to improve habitat for fish. The diking

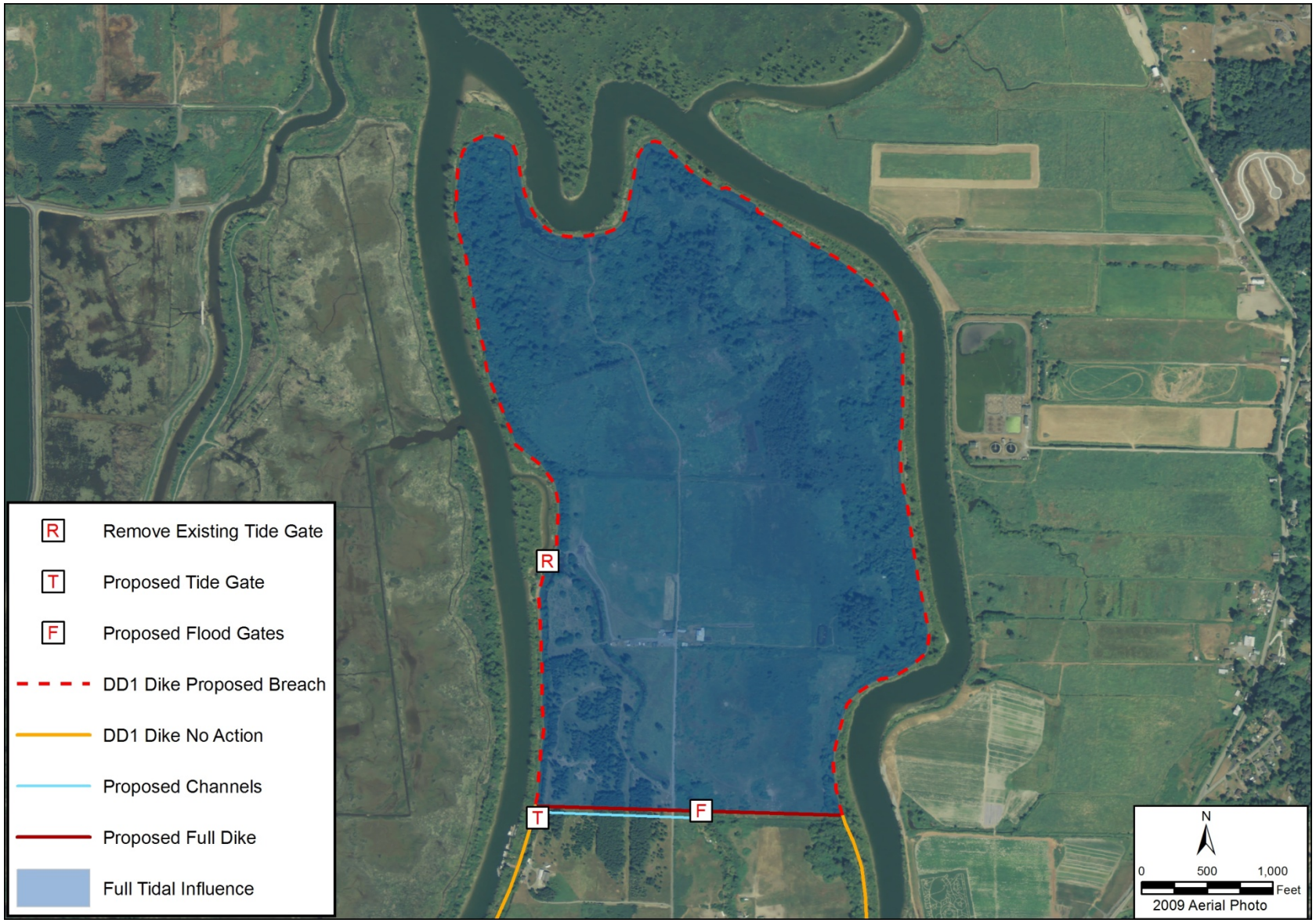

Figure 26 North tip Ebey Island

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district indicated that this option would remove a fairly minor amount of land from their district, but would relieve them from the responsibilities of maintaining about 14,000 feet of problematic dikes. This option was suggested by the district as a “win-win” situation for them and for the fish.

WDFW does not own property in this location, but this option was considered a valid extension of the feasibility study. Snohomish County owns the northern-most 191 acres of the island. Property from a few private landowners, totaling an estimated 160 acres, would need to be acquired to make this option happen.

6.2.2 Hydrodynamic modeling of preferred alternatives

Hydrodynamic models of existing conditions and the proposed alternatives were developed and applied to address the following questions:

- What are the likely hydrologic characteristics of habitat in the restored areas?
- What hydraulic structure is likely to meet both habitat and flood/drainage design criteria?
- How will alternatives affect water levels during overtopping flood events on developed areas of Ebey Island and adjacent land?
- How might the alternatives affect geomorphic conditions within the project site and in adjacent channels?

After briefly summarizing the relevant site hydrology and modeling approach, this section presents the results of this modeling and analysis and discusses the implications for the restoration alternatives.

6.2.2.1 Modeling approach

The primary tool used to evaluate the hydraulic response of the project site and adjacent channels to the restoration alternatives was the existing UNET model of the Snohomish Estuary. This model was developed by the USACE and applied to the Snohomish Estuary for FEMA flood insurance study (FEMA, 2001; FEMA, 2005). UNET is an unsteady, one-dimensional model that can represent a network of channels and storage areas. The Snohomish Estuary domain includes the river from just downstream of the City of Monroe to the mouth of its distributary channels where they enter Possession Sound. Significant areas of overbank storage were represented in the model as stage-storage nodes. Geometry in the existing UNET model was derived from a prior full equations model (FEQ model) of the Snohomish River and updated with additional data when available. More recent LiDAR data was used as a source for land surface elevations on Ebey Island (Puget Sound LiDAR Consortium, 2010). The model’s key boundary conditions are specified time series of river discharge at the upstream end and tidally varying water levels at the downstream end. Figure 27 shows the topography of the south portion of the island, compared to the tidal datums.

Water level management in the muted tidal areas will require hydraulic structures that can be configured with gates that open and close as a function of water level. Since the UNET model does not have the capability to represent hydraulic structures with operating rules, an additional HEC-RAS model was developed to assess conditions within the muted tidal areas. HEC-RAS, whose unsteady computation engine is actually based on UNET, provides all the features of UNET and the capability to model hydraulic structure operations. The HEC-RAS model is nested within the full UNET as the domain for each muted tidal area only includes the muted tidal area itself, a short stretch of outboard channel and the hydraulic structure linking these two. UNET predictions of water levels in the outboard channels immediately outside the muted tidal areas were used to force the HEC-RAS model.

Additional details about both the UNET and the HEC-RAS models can be found in Appendix D.

6.2.2.2 Restored tidal habitat hydrology

Under existing conditions, none of the project site is inundated with tidal exchange because of the dikes and hydraulic control structures which are maintained by the diking district. The restoration alternatives would re-connect portions or all of the project area to the outboard channels, causing water levels to fluctuate with the tides. This re-connection supports the project habitat objectives both by creating tidal habitat and by providing access for organisms, particularly salmonids, to access this habitat. This section interprets the model results to characterize the full tidal and muted tidal habitat in the proposed restoration alternatives.

Water levels – full tidal restoration

Water levels in the fully tidal regions of the Near Term Alternative and the Long Term Alternative are predicted to nearly match the tide range under existing conditions. Figure 28 shows water levels from all three conditions during three days of August from the WY2002 model scenario. This time period demonstrates water level response when riverine discharge is low and, consequently, the largest tidal range. Predicted water levels are nearly identical for the two restoration alternatives. At high tides, restoration water levels are up to 0.5 foot lower than existing conditions; at low tides, restoration water levels are up to 1 foot higher than existing conditions. This predicted reduction in tide range, or tidal damping, occurs because the restoration increases the volume of water exchanged on each tide via channels that have established equilibrium dimensions for conveying lower flow. Because the model geometry uses existing channel dimensions and Ebey Island bed elevations, these predictions probably represent an upper bound on the potential tidal damping. Geomorphic changes in response to restoration, in the form of channel scour and accretion on Ebey Island's intertidal areas, are likely to reverse tidal damping, as discussed in Section 6.2.2.5. Channel scour, which enlarges channel dimensions, would increase conveyance to the site while accretion would reduce the intertidal volume. Observations at implemented restoration projects confirm this trajectory of the largest tidal damping

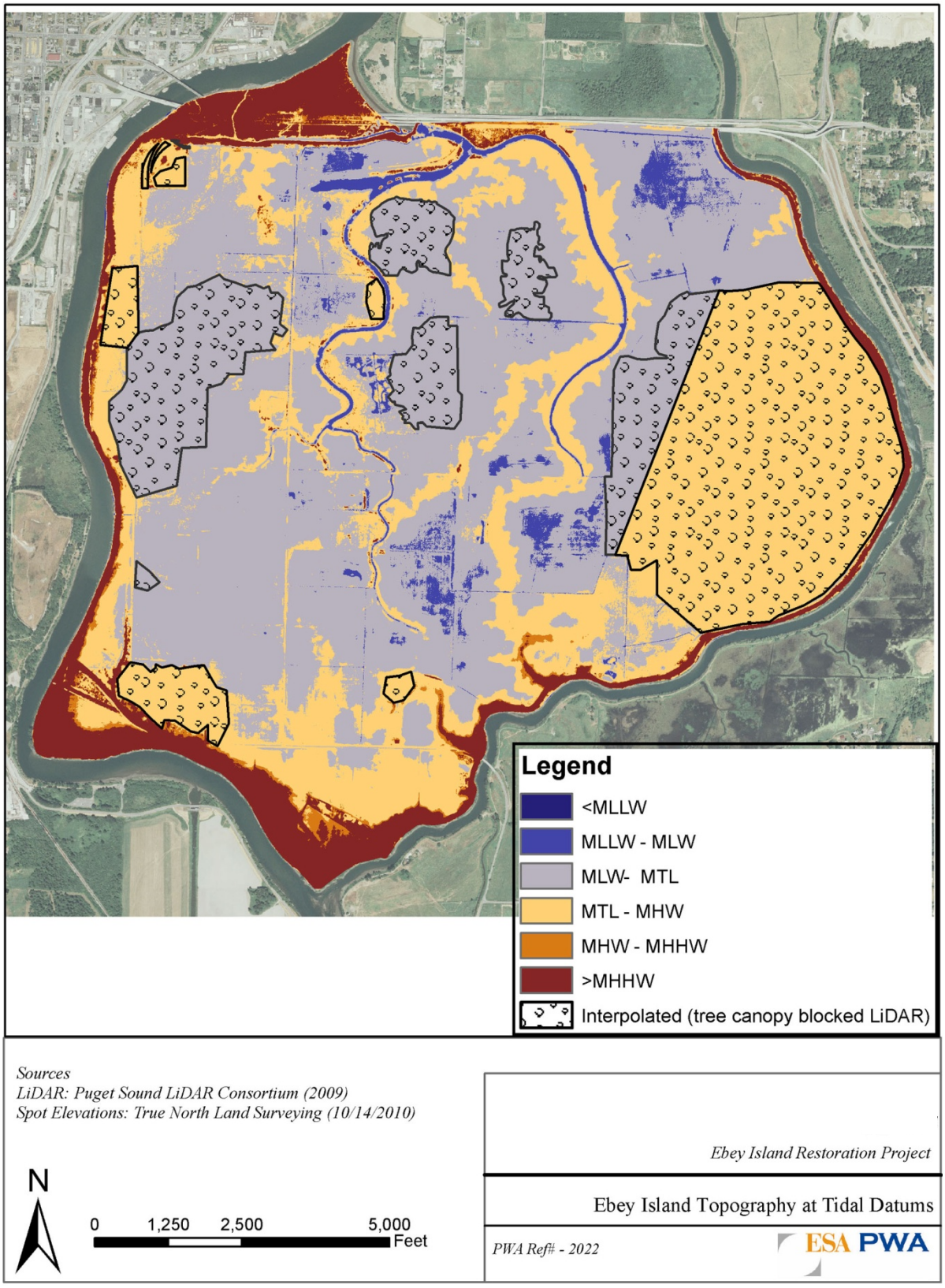

Figure 27 Map of fully tidal water levels, dry season, Ebey Slough

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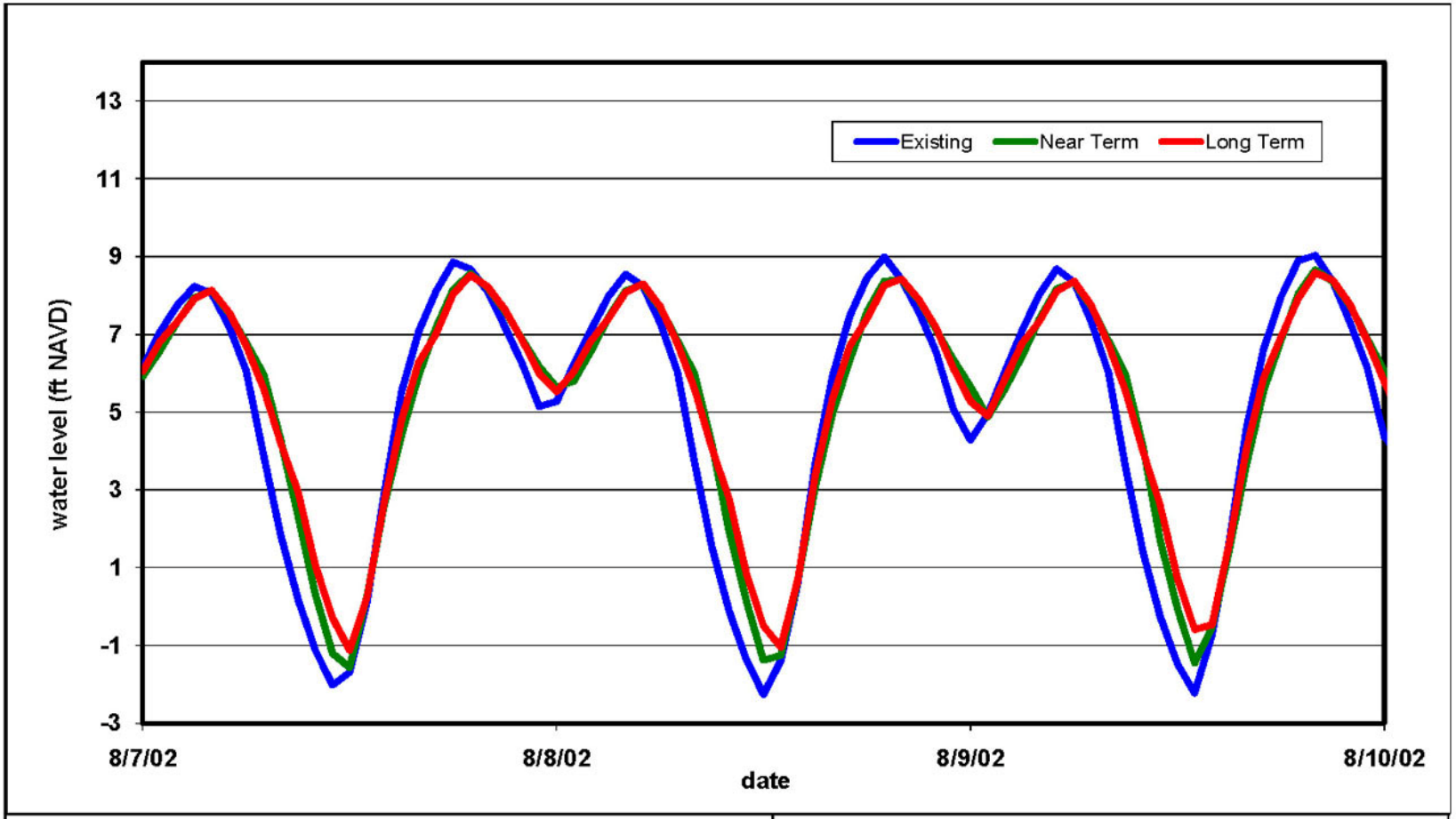

Sources: UNET model results

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Fully Tidal Water Levels, Dry Season, Ebey Slough

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Figure 28 Hydrograph of fully tidal water levels, dry season, Ebey Slough

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immediately after tidal re-connection, followed by increases in tide range as channels scour and accretion occurs in intertidal areas (Williams and Orr, 2002).

Because of the subsided ground surface of Ebey Island, portions of the project area exposed to full tidal exchange will be intertidal: inundated at high tide and drained at low tide. Most of the project area is below mean tide level and therefore will be covered with at least 4 feet of water more than half the time. The implications for habitat of these inundation characteristics are discussed in Section 6.2.4.

Water levels – muted tidal restoration

Target water levels

The Near Term Alternative proposes that portions of the project area be restored to muted tidal conditions by constructing a lower setback dike within the existing perimeter dikes and then connecting the areas to the outboard channels with hydraulic structures. The hydraulic structures would be configured to obtain target water levels within the restored areas. For this feasibility study, the target water levels were selected to sustain vegetated intertidal habitat and to promote Map of fHydrograph of fbedaccretion while also limiting water levels that pose a flood risk to adjacent Ebey Island properties. For the east muted area, a target high water level of 2.5 feet NAVD was selected and for the west muted area, which has higher bed elevations, a target high water level of 4 feet NAVD was selected.

Mature vegetated tidal marshplain typically occurs in the Snohomish estuary at elevations at or just above MHHW. Examples of this are the portions of Ebey Island outside the perimeter dikes (the southwest corner and the western portion of the island adjacent to US 2) and nearby, undiked Otter Island. However, at this point in the tide range, the inundation period is limited, which decreases the capacity of tidal flow to convey and deposit sediment, as well as carve tidal channels (Williams and Orr, 2002). Therefore, the target high water level was selected for each muted restoration area such that the areas' typical bed elevations would be inundated by one half to one foot of water. This will extend the inundation period, increasing the delivery of sediment to the marsh plain (Williams et al., 2002) and promote the formation of tidal channels. Even though this tidal regime will inundate the bed for longer periods than mature marshplain, vegetation should still be able to colonize the site, further promoting sediment to settle out from the tides and also adding organic material to augment total bed accretion. In subsequent phases of restoration design, water levels in the muted tidal areas can be further tuned to encourage colonization for target vegetation species based on ongoing monitoring of nearby restoration sites which are also subsided relative to the tides, for example, Spencer Island.

The muted tidal areas will require setback dikes to prevent flooding of adjacent Ebey Island properties. Because the target high water levels are four feet or less than average outboard water

levels and the hydraulic structures can be configured to block extreme water levels, the setback dikes can be significantly lower than the existing perimeter dikes.

Modeling assessment

To assess the temporal variation in water levels in response to outboard water levels, a HEC-RAS model was developed for each muted tidal area. Each model included a reach of the outboard channel linked to the muted area by a hydraulic structure with a gate that opens and closes as a function of outboard water level. The gate was set to close when the water level in the outboard channel exceeded the target high water level for the muted tidal area and re-open when water levels dropped below this elevation. Outboard water levels from WY2002 were predicted by the UNET model and used as boundary conditions for the muted tidal area models. Additional details about these models can be found in Appendix D.

Modeled time series of dry season water levels within the muted tidal restoration areas are shown in Figure 29. During this period, when riverine discharge is less than 5,000 cubic feet per second, the outboard tides have their greatest range because low tides are not significantly elevated by riverine discharge. Since the tide range within the muted tidal areas is constrained on the upper end by the target high water level, this period is when the muted tidal areas experience the largest tide range. For the eastern muted area, which has lower bed elevations and hence a lower target water level, the tide range during this period is approximately two feet during neap tides and up to 4.5 feet during spring tides (Figure 29a). Because the higher low tide in each day is typically above the target high water level, the water levels within the muted tidal area only have one high tide and one low tide per day for much of the spring-neap cycle instead of the twice-a-day tides in the outboard channel. Inside the muted areas, water levels persist near the high water target for approximately 18 hours of each day; the decline to low tide and subsequent recovery occupy the other 6 hours of the day. During several days of neap tides when both outboard low tides drop below the target high water level, water levels fluctuate twice per day in the muted areas, but maintain constant water levels near the target high water level for nearly three quarters of each day. Bed elevations in the western muted area are approximately 1.5 feet higher, so the target high water level and tide range are larger by a similar amount (Figure 29b). The timing of inundation (diurnal on most days, semidiurnal for several neap tides) is also similar in the west muted tidal area to the east area.

During the wet season (November through July), riverine discharge increases as a result of rainfall and/or snowmelt. This flow through the estuary elevates water levels, particularly low tides. When flow exceeds approximately 20,000 cubic feet per second, the minimum outboard water level does not drop below the target high water level for the east muted area, so the hydraulic structure does not open. An example of this response during a high flow event in January, 2002, is shown in Figure 30. The peak flow during this event is 56,000 cubic feet per second, slightly less than the 2-year event.

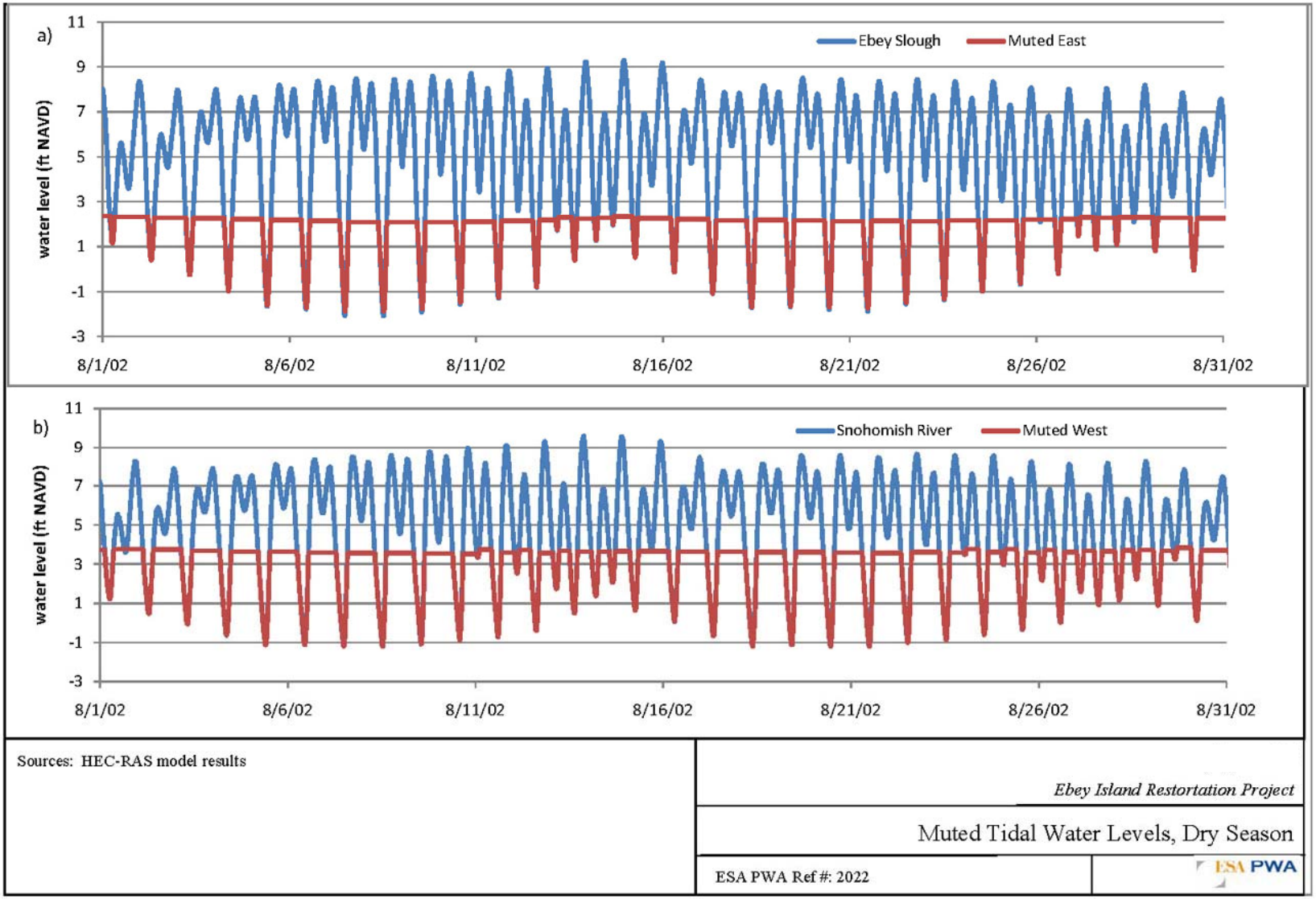

Figure 29 Muted tidal water levels, dry season

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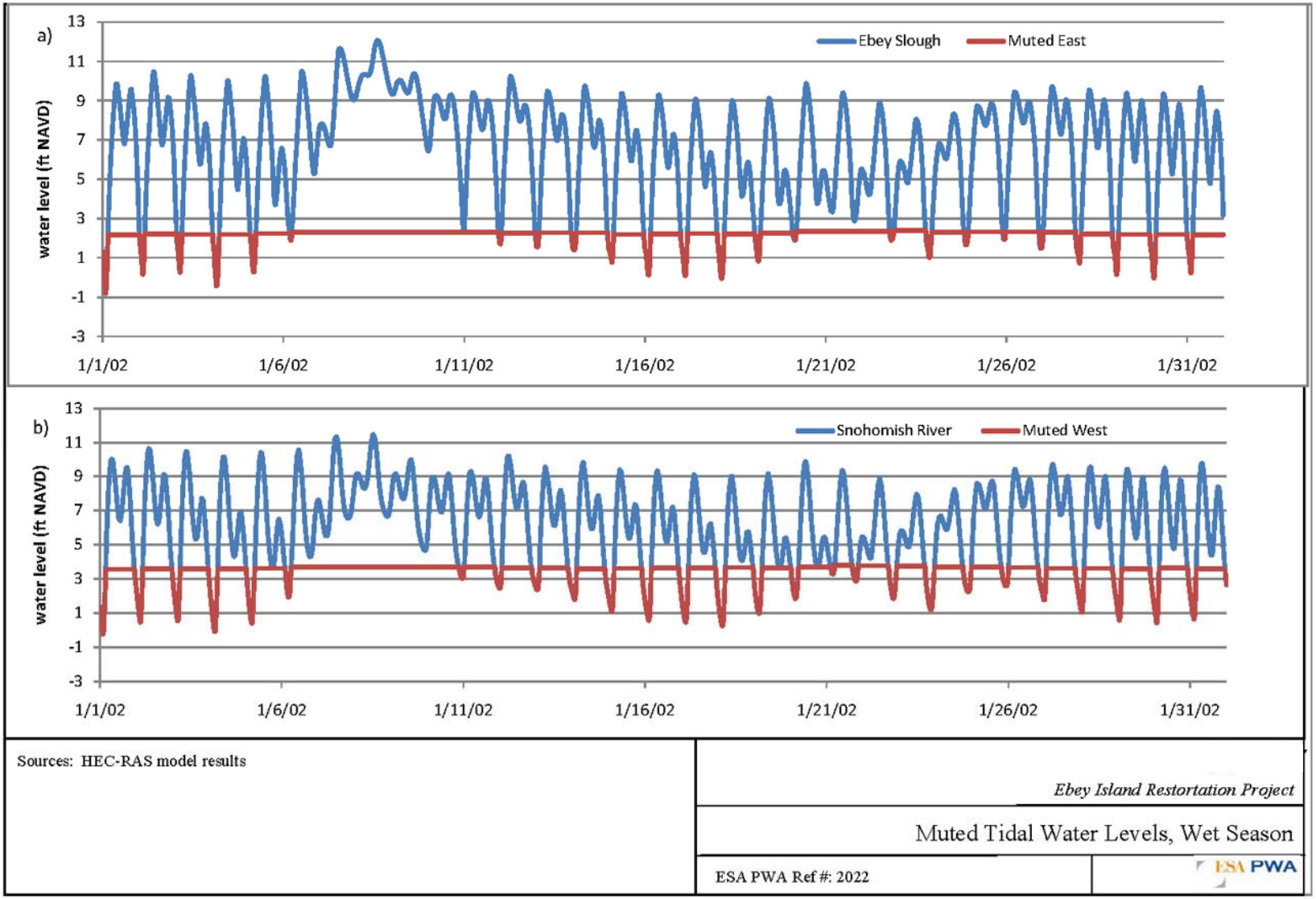

Figure 30 Muted tidal water levels, wet season

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Because of the elevated outboard water levels, the structure stays closed and water levels within the muted area stay constant for approximately 6 days. For the WY2002 scenario, the east muted area's hydraulic structure remained closed for more than a day on 13 occasions. The longest closure lasted twelve days and occurred in late May and early June during the peak discharge associated with snowmelt. Because of its higher bed elevation and higher target water level, the west muted area's hydraulic structure stays closed only when discharge exceeds approximately 30,000 cubic feet per second. Therefore, for the WY2002 hindcast, the west muted tidal area would be subject to only six multi-day closures. The longest closure is predicted to have lasted for 6 days.

Hydraulic structure operations attempt to balance among several constraints. For purposes of this feasibility study, only WY2002, which had flows close to mean values, was tested. Future analysis should consider a broader range of hydrologic conditions such as drought years and wet years. Based on a wider range of hydrologic conditions, the operation procedures for the hydraulic structure can be optimized to better balance between the criteria for habitat, water quality, and flood risk. Note that the modeling did not include direct precipitation onto the muted tidal areas.

Sizing of hydraulic structures

In addition to predicting the potential habitat conditions, the modeling was used to assess the size and vertical placement of the hydraulic structure required to adequately connect each muted tidal area to its outboard channel. For this initial assessment, the performance criteria for the structures was providing sufficient conveyance capacity to obtain nearly the full tidal range between the outboard channel low water levels and the target high water level. Based on several model iterations and sensitivity analysis, the culvert dimensions found to just meet this criteria was a box culvert six feet high by twelve feet wide with its bottom or invert elevation at -3.5 feet NAVD. To account for the development of a tidal channel network within the muted tidal areas, this sizing was done with additional storage volume added to the existing geometry of the muted tidal areas. The structures' invert elevation was set approximately 2 feet below the lowest water levels in the adjacent channels to ensure adequate flow depths and drainage capacity even at the lowest tides. An assessment of the ecologic implications of this structure can be found in 6.2.4. Subsequent planning stages will need to refine the design of the hydraulic structures to optimize the design for fish access, flood hazard management, and cost.

6.2.2.3 Flooding assessment

The proposed restoration alternatives include changes to the existing perimeter dike which will impact the water levels during flood events both on and adjacent to the project site. The UNET model of the Snohomish, which is the model used in FEMA's flood study of the Snohomish estuary, was applied to estimate potential changes to peak water levels resulting from restoration. Three flood scenarios were executed: a hindcast of the annual maximum flood event from January 2002 (representative of a

typical year), and two extreme riverine discharge events derived from statistical analysis of basin hydrology: the 5-year riverine flood and the 100-year flood.

January 2002 annual peak discharge

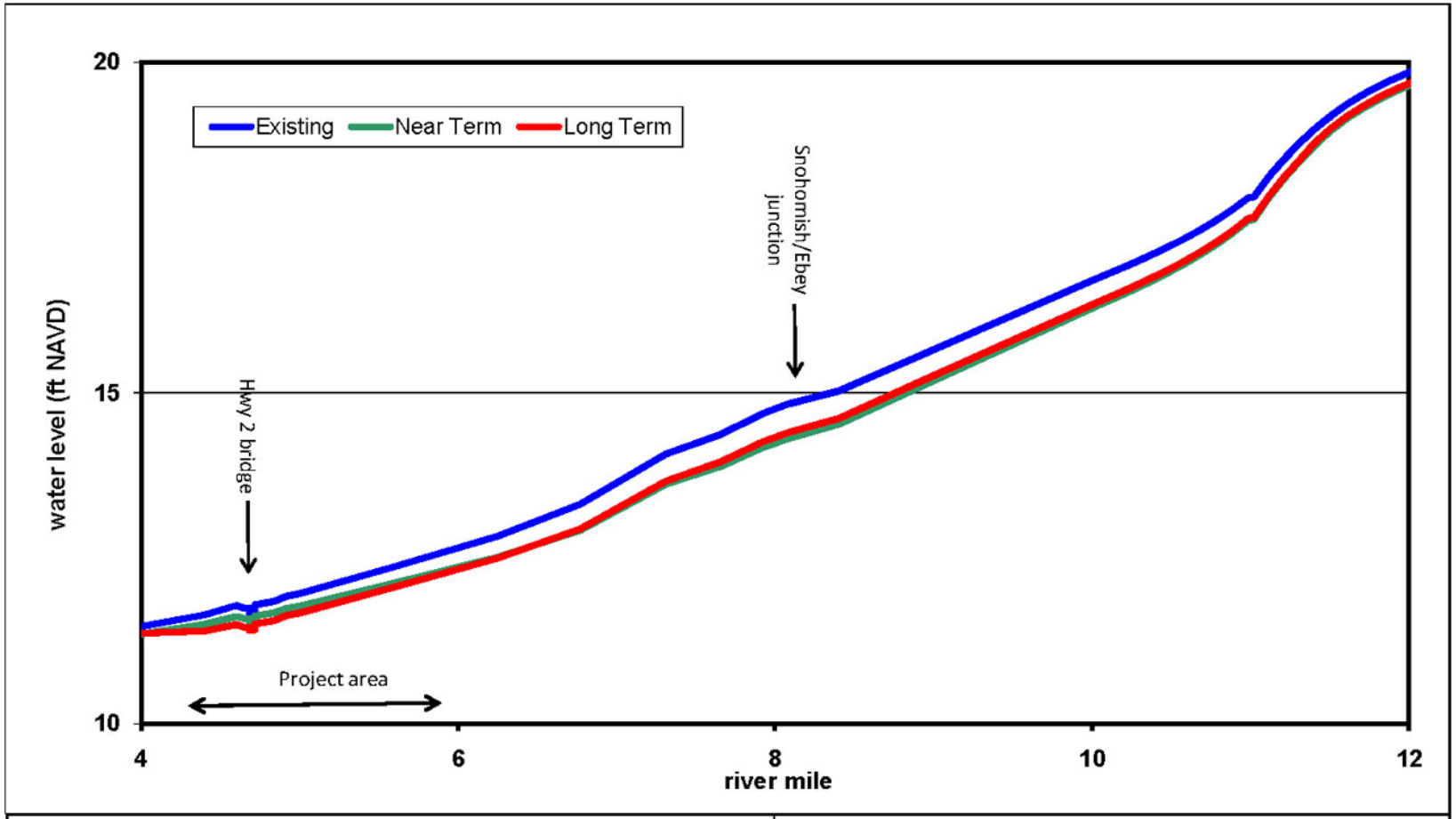
The riverine discharge event which occurred during January 6-10, 2002, is representative of the mean annual peak discharge. Peak discharge during this event was 56,000 cubic feet per second, which is just below the estimated 2-year discharge of 64,000 cubic feet per second (FEMA, 2001). This discharge was coincident with an observed 10.7-foot-NAVD high tide at the mouth of the estuary. This water level is approximately 2 feet greater than MHHW and 0.7 foot less than the 2-year tidal water level.

The peak January 2002 water levels predicted for existing conditions and the two restoration alternatives are shown for the Snohomish River main stem (Figure 31) and Ebey Slough (Figure 32). No levee overtopping was observed during January 2002 or was predicted by the model of existing conditions. Since the alternatives reduced peak water levels along both channels, no overtopping is predicted for the alternatives. The largest decrease in peak water levels of about one foot occurs in Ebey Slough under the Near Term Alternative. This decrease occurs in the stretch of the slough bordering the full restored region where the restored area provides both additional flood conveyance and storage. Near Term peak water levels are reduced on the main stem even though there are no significant changes to this reach's geometry because the additional conveyance capacity of Ebey Slough reduces flood discharge in the main stem. Changes to peak water levels under the Long Term Alternative are also lower than existing conditions and typically within 0.1 foot of the Near Term Alternative peak water levels. For a portion of Ebey Slough, the predicted Long Term peak water level is about 0.5 foot higher than the Near Term. Part of this difference may be attributed to different formulations of the full tidal area for the two alternatives.

Limited overtopping

To assess impacts of flood events which cause limited dike overtopping, existing conditions and the alternatives were modeled with discharge event peaking at 92,000 cubic feet per second and coinciding with high tides of 10.7 feet NAVD. Based on frequency analysis, this river discharge is approximately the 5-year event (FEMA 2001) and the high tide is approximately the 2-year return period (USACE 2002).

Nominally, the 5-year event is not supposed to overtop the Ebey Island dikes in accordance with completion of the Snohomish River Comprehensive Flood Control Management Plan for Diking District 1 (Snohomish County, 1991; and Snohomish County, 2011). However, when these discharge and tidal conditions were applied to existing conditions, the UNET model predicts overtopping into



Sources: UNET model predictions

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Peak Water Levels, January 2002, Snohomish River

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Figure 31 Peak water levels, January 2002, Snohomish River

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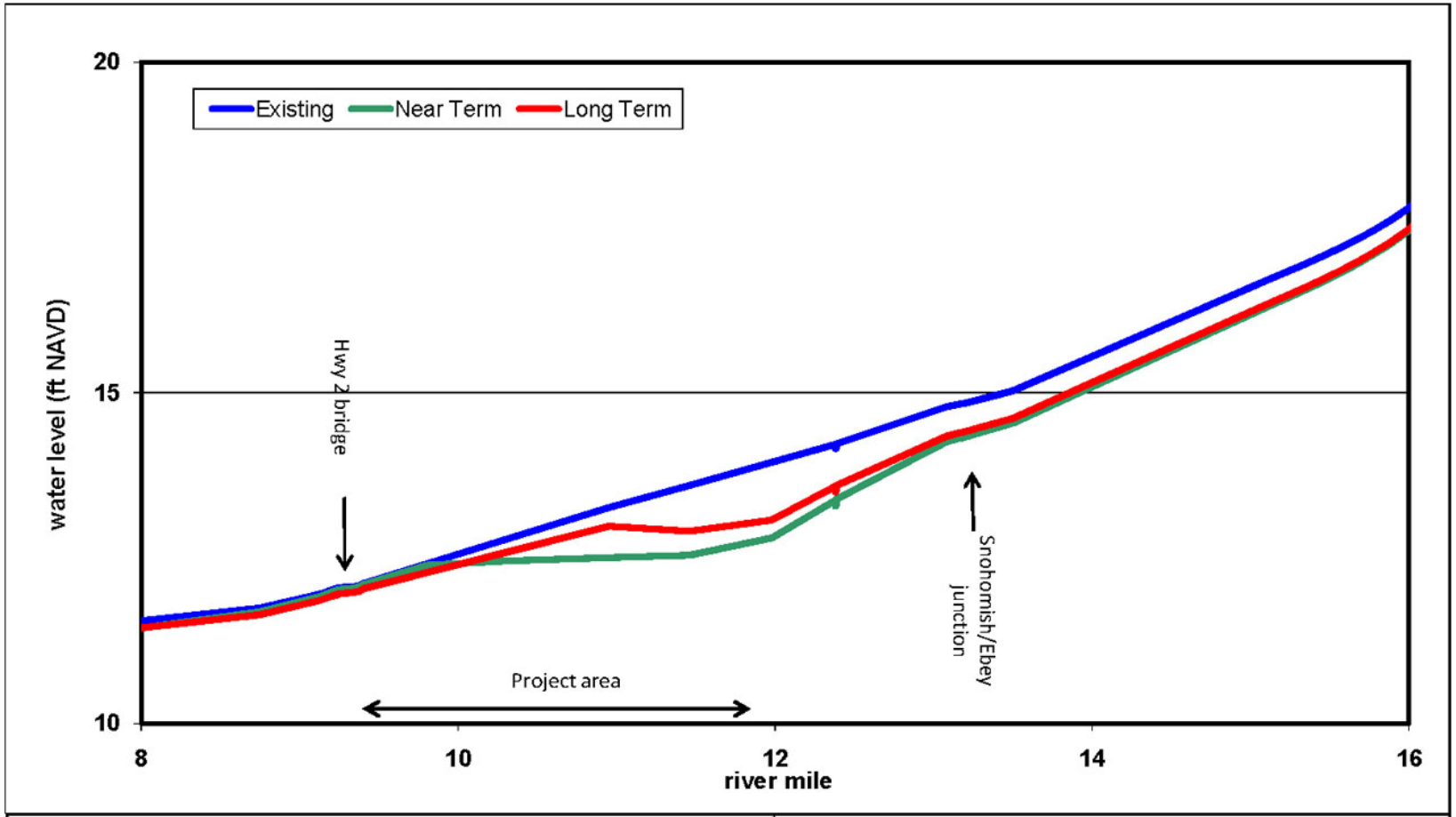

Sources: UNET model predictions

Ebey Island Restortation Project

Peak Water Levels, January 2002, Ebey Slough

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Figure 32 Peak water levels, January 2002, Ebey Slough

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Ebey Island. This discrepancy between the management plan and the current study's modeling results may be attributed to differences between hydraulic models (the 1991 management plan's use of the FEQ model versus the current study's use of FEMA's UNET model) and/or the implemented dike crest profile, which, by design, has a low point on Ebey Slough that is lower than the management plan's target crest elevation.

The peak 5-year discharge water levels predicted for existing conditions and the two restoration alternatives are shown for the Snohomish River main stem (Figure 33) and Ebey Slough (Figure 34). The largest decrease in peak water levels of a little more than 1 foot occurs in Ebey Slough under the Near Term Alternative. This decrease occurs in the stretch of the slough bordering the full restored region where the restored area provides both additional flood conveyance and storage. In addition, water from this reach overtops onto Ebey Island. Just upstream of the US 2 bridge, peak Near Term water levels exceed existing conditions by about four tenths of a foot and continue to be about two tenths of a foot higher downstream of US 2. Changes to Ebey Slough peak water levels under the Long Term Alternative follow a similar pattern of being lower than existing conditions along much of south Ebey Island, but then increasing slightly above existing conditions starting from just upstream of the US 2 bridge. For the portion of Ebey Slough between river mile 10 and river mile 12, the predicted Long Term peak water level is about 0.5 higher than the Near Term. Part of this difference may be attributed to different formulations of the full tidal area for the two alternatives.

Near Term peak water levels are reduced on the main stem (Figure 33) even though there are no significant changes to this reach's geometry because the additional conveyance capacity of Ebey Slough reduces flood discharge in the main stem.

Most of the overtopping onto Ebey Island that occurs under these discharge conditions is limited to the low point on the Ebey Slough dikes. Since the Near Term Alternative translates the existing crest elevation onto the new dike and outboard water levels are similar, the overtopping rate into Ebey Island would be similar between existing conditions and the Near Term Alternative. For the Long Term Alternative, which splits the island into two perimeter dikes, no overtopping is predicted for the southern perimeter dike. Overtopping is predicted for the northern perimeter dike. The total volume of this overtopping is less than the total volume predicted to overtop under existing conditions, but since the storage volume of the north perimeter dike is less than the storage volume of the entire island, increased water depths are predicted inside the Long Term Alternative's north perimeter dike as compared to existing conditions. Most of the flow into the north perimeter dike occurs from the full tidal area over the new cross dike. This new dike could be designed with a higher crest elevation, but doing so would increase predicted 100-year water levels, as discussed below.

Extensive overtopping (100-year discharge)

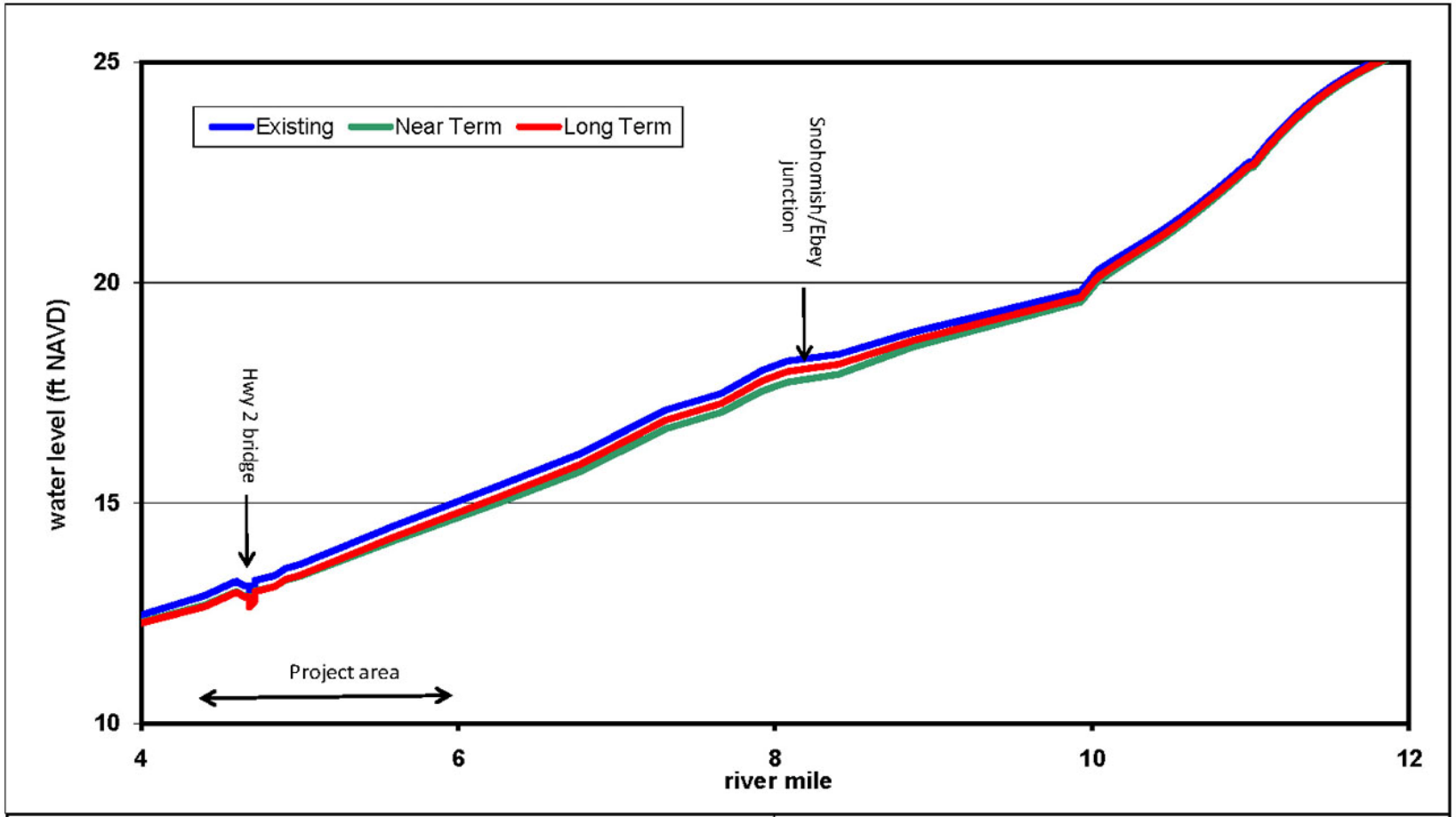
Hydrologic analysis as part of the FEMA study estimated the 100-year riverine discharge to be 204,000 cubic feet per second at Monroe (FEMA, 2005). This discharge was evaluated with a constant water level at the mouth of the estuary of 1 foot above MHHW or 9.9 feet NAVD. Under these conditions, the entire river valley is predicted to be inundated, such that most of the levees are overtopped. The November 1990 flood event, which inundated Ebey Island under more than 10 feet of water (Snohomish County, 1991), was approximately the 30-year event (FEMA, 2001).

Estimates of peak water levels for existing conditions and the two restoration alternatives are shown for the Snohomish main stem (Figure 35) and Ebey Slough (Figure 36).

For the Near Term Alternative, the model predicts a reduction in peak water levels all along main stem, with largest decrease of nearly one foot at the junction with Ebey Slough (Figure 36). The reduction in main stem water levels occurs because the model predicts that more water is diverted into Ebey Slough than under existing conditions. The additional water flows into Ebey Slough because adding the full tidal area as floodplain improves the Slough's conveyance capacity. Even with the additional water flowing into Ebey Slough, Near Term peak water levels are predicted to be nearly 2 feet lower in the upstream two miles of Ebey Slough (Figure 36). Just before the US 2 bridge, the distance between the levees narrows to its existing width; this narrowing, combined with the flow constriction at the bridge itself, cause water to back up and exceed existing conditions water levels by approximately 0.4 foot.

In the upstream portion of Ebey Slough, the Long Term Alternative decreases peak water levels by nearly a half foot (Figure 36). Further downstream, the water levels are predicted to increase by up to three quarters of a foot, then decline back below existing conditions downstream of the US 2 bridge. The Snohomish main stem also experiences a decrease of several tenths of a foot along the south end of Ebey Island. Peak water levels then increase to a maximum of one foot higher than peak water levels predicted for existing conditions.

In general, the new cross dikes proposed as part of the Long Term Alternative increase flow resistance during very large flood events with extensive overtopping, thereby raising predicted peak water levels. The decrease in both channels just downstream of the channel junction, followed by an increase downstream suggests that the proposed cross dike to the north of the restoration area plays a more significant role in peak water levels than the south cross dike. The north cross dike affects the flowpath of floodwaters that pass through the northern part of Ebey Island. Its crest elevation was set to 14.7 feet NAVD, which is similar to elevations where it joins the existing dikes. In contrast, a large fraction of the flood flow bypasses the proposed south cross dike, flowing through the main stem and



Sources: UNET model predictions

Ebey Island Restortation Project

Peak Water Levels, 5-Year Discharge, Snohomish River

ESA PWA Ref #: 2022

ESA PWA

Figure 33 Peak water levels, 5-year discharge, Snohomish River

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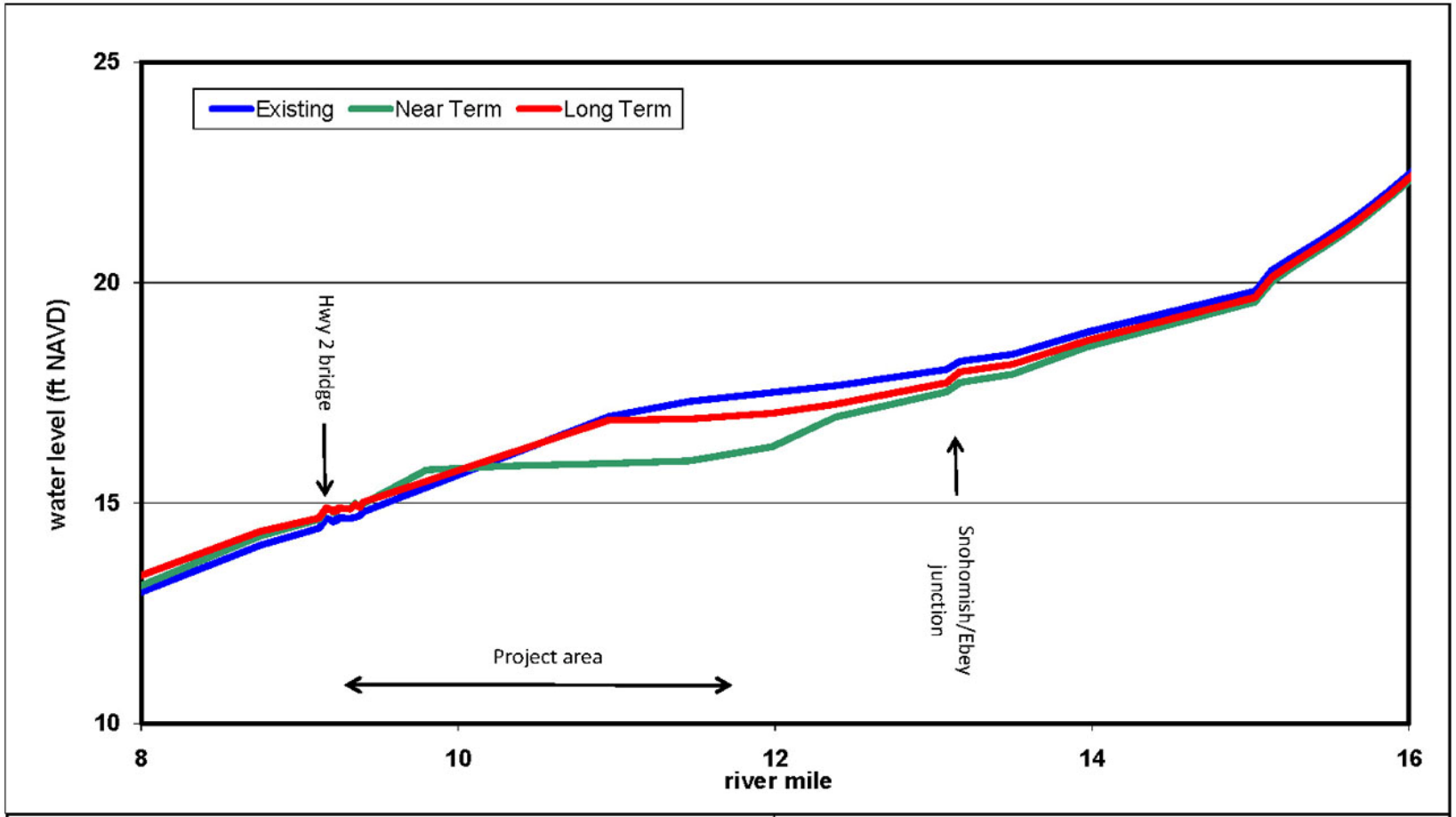

Sources: UNET model predictions

Ebey Island Restortation Project

Peak Water Levels, 5-Year Discharge, Ebey Slough

ESA PWA Ref #: 2022

ESA PWA

Figure 34 Peak water levels, 5-year discharge, Ebey Slough

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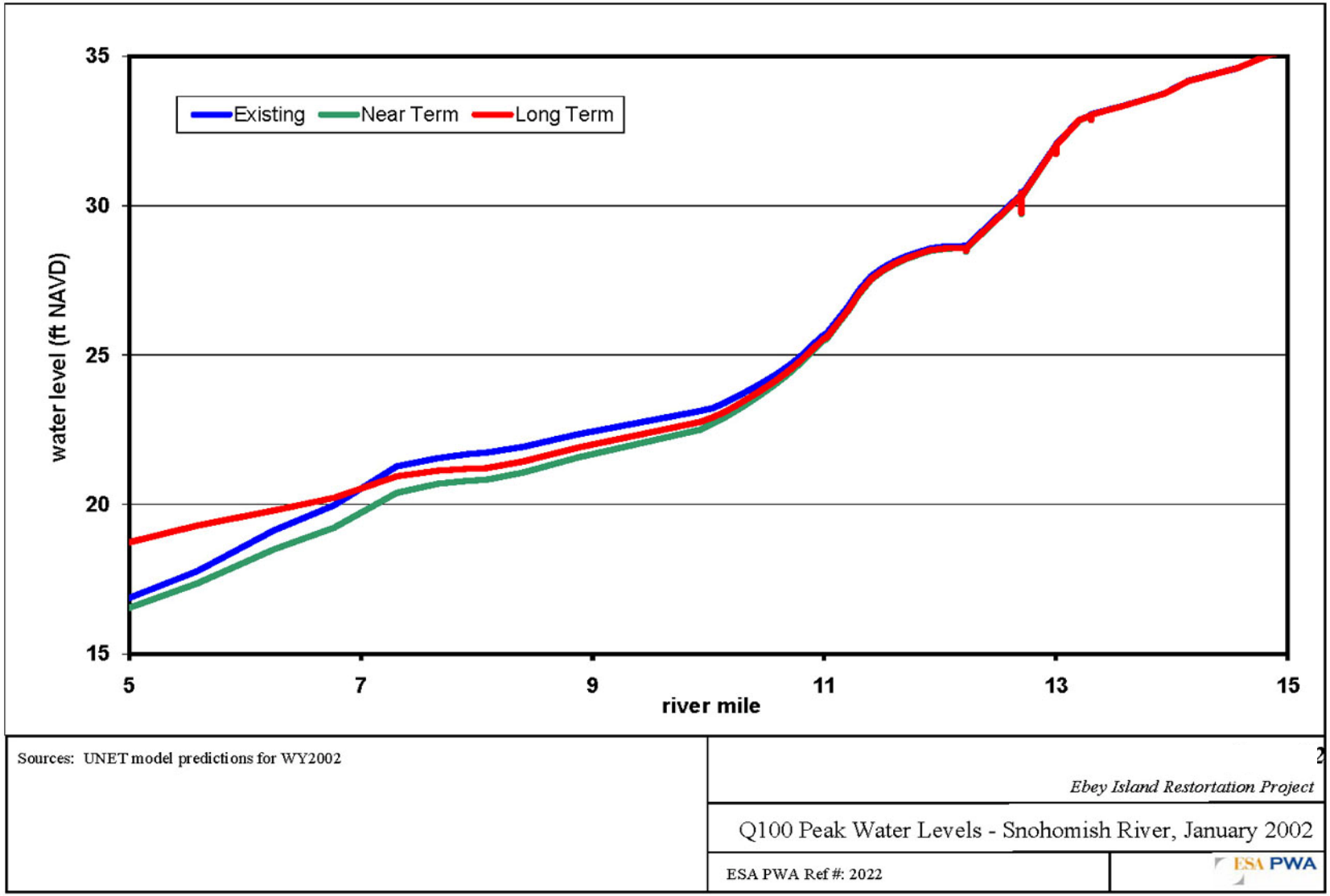

Figure 35 Q100 peak water levels - Snohomish River, January 2002

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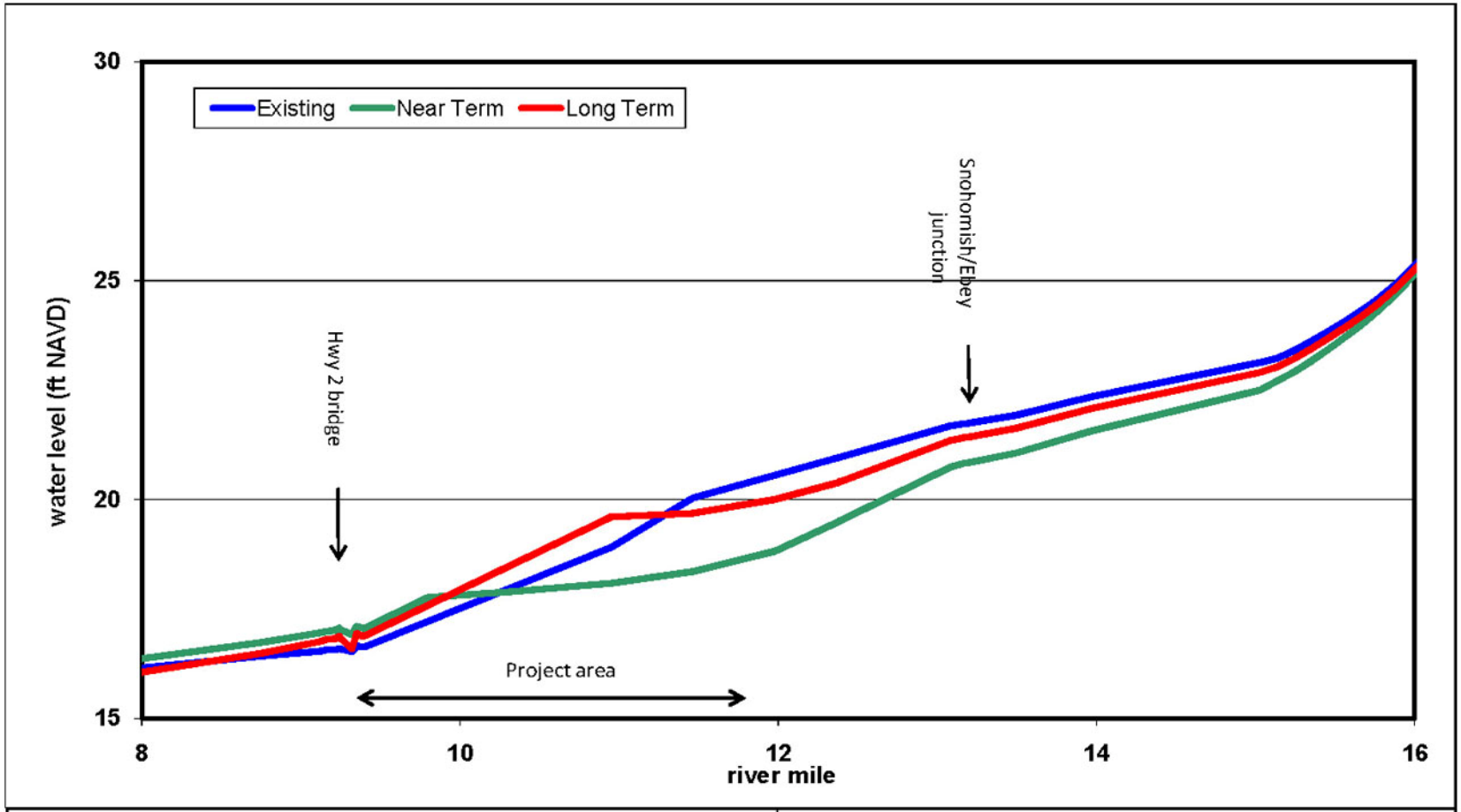

Sources: UNET model predictions

Ebey Island Restortation Project

Peak Water Levels, 100-Year Discharge, Ebey Slough

ESA PWA Ref #: 2022

ESA PWA

Figure 36 Peak water levels, 100-year discharge, Ebey Slough

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Ebey Slough. Hence, overall conveyance capacity is not as strongly influenced by the south cross dike.

For the Long Term Alternative, note that water is predicted to begin overtopping onto the developed portion of south Ebey Island later than existing conditions. The low point in the current perimeter dike, which provides the initial flood pathway for existing conditions, is not part of the Long Term Alternative's dike that surrounds the developed portion of south Ebey Island. As a result, water levels need to rise higher before overtopping, providing a delay in flooding during which evacuation could occur from the south island. The northern diked portion of the Long Term Alternative is overtopped in a similar timeframe as existing conditions.

6.2.2.4 North Tip Option

The option of including full tidal restoration on the northern tip of Ebey Island was assessed with the UNET model for its potential impact on peak water levels during the 100-year riverine discharge event. Predicted peak water levels with the north tip were nearly identical to the peak water levels predict for Long Term conditions (Figure 35 and Figure 36). The largest differences, which were less than 0.1 foot, occurred in Steamboat Slough to the west of northern Ebey Island and in the connecting channel between Steamboat Slough and Ebey Slough to the north of Ebey Island. The new cross dike required to separate the north tip restoration from the rest of Ebey Island appears to have little impact on the flow when its crest elevation is 13.7 feet NAVD. This crest elevation is similar to the crest elevation of the junction between the new cross dike and the existing dike and also one foot below the elevation of the proposed cross dike adjacent to US 2.

6.2.2.5 Geomorphic assessment of preferred alternatives

The restoration design includes several elements whose design will influence the site's geomorphic evolution after restoration is implemented, including breaching, dike lowering, and tidal channels. Below are guidelines to inform the design of these elements to facilitate site evolution towards mature vegetated habitat. Also discussed below is the potential for the restoration to cause off-site scour.

Breach sizing and dike lowering

The full tidal areas will be re-connected with the outboard channels by breaching and lowering the perimeter dikes. Breaches refer to incisions through the dike which are deep enough to convey water at all phases of the tide, providing a pathway for channels to penetrate into the site. Lowering refers to reducing the elevation of the dike crest such that flow can exchange with the site during a portion of the tide range. In general, the restored area will evolve more quickly towards mature habitat in equilibrium with physical processes if breaching and lowering is sufficient to reconnect the site to full tidal and riverine influence. Better hydraulic connectivity facilitates tidal channel development, bed accretion, fish access, food chain exchange, and recruitment of large woody debris.

An estimate of the desired breach size for the full tidal restoration areas can be calculated from the top width of Deadwater Slough and hydraulic geometry scaling factors. Hydraulic geometry refers to the observation that the dimensions of tidal channels are often found to develop an equilibrium condition that is a function of tidal hydraulics, specifically the diurnal tidal prism[1] (Williams et al. 2002). Quantifying the relationship between tidal prism and channel dimensions requires field observations. Such observations are lacking for Puget Sound, so the more extensive data set from San Francisco Bay (Williams et al. 2002) was used. This data set was adjusted to account for the larger tide ranges found in Puget Sound (ESA PWA, 2010).

The top width of the mouth Deadwater Slough has been relatively stable since it was first quantified on the historic map of 1869. Hence, its 170-f00t top width serves as the best reference for breach sizing for full tidal connectivity from the west side of the island to the Snohomish main stem. Since no depth data is available for Deadwater Slough prior to diking, the hydraulic geometry relationships can be use to infer a corresponding depth of -6 feet NAVD. We initially recommend a breach of this size, trapezoidal in cross section with side slopes of 3H:1V. Because of subsidence on the site, the initial tidal prism will be larger than for a mature marsh of the same area, which is the condition upon which the hydraulic geometry analysis is based. Therefore, a breach this size is likely to scour at the outset, creating a more natural shape. It will then trend back toward the original dimensions as the interior bed elevation evolves.

Since no historic channels information is available for the full tidal portion of the Near Term Alternative, the Deadwater Slough information can be scaled down according to the acreage of the Near Term fully tidal area, the acreage of the Deadwater Slough drainage area, and a hydraulic geometry factor. This yields an estimated top width of 120 feet at MHHW. The corresponding depth is -4 feet NAVD. These dimensions form the basis for designing a similar trapezoidal breach that would follow a similar evolution as for the Deadwater Slough and the Long Term Alternative discussed above.

Dike lowering provides better hydraulic connectivity between the restoration site and the outboard channels. On either side of the main breaches, for a distance of one to two breach widths, we recommend lowering the dike to the existing grade of the island's interior. This ensures full connectivity at the breaches and provides some latitude for natural lateral migration of the breach. Because of the infrastructure close to the location where Deadwater Slough intersects the levee, a design which only employs levee lowering to the west and protects infrastructure to the east may be required. Farther away from the breaches, we recommend lowering the dike to MHHW. This lowered dike will allow higher waters to exchange as sheet flow between the site and the outboard channels. A lowered elevation at MHHW balances between levee removal and construction practicality. This

[1] Average volume of water that flow through a channel cross section on the largest tide of each day.

elevation is consistent with the expected long term elevation, as indicated by marshplain elevations at reference sites. The total length of the dike to be lowered needs to be weighed against costs (for example, the need to balance cut and fill onsite) and benefits (degree of hydraulic connectivity) in future design stages. Minor breaks in the dike down to the island's existing grade and coinciding with historic drainage channels (when these can be identified), would provide additional lower-tide drainage across the dike and help create a range of channel sizes in the restored site. These minor breaks are expected to scour to some degree, but not to become major breaches.

Tidal channels in restored areas

The restoration design should facilitate the development of dendritic networks of tidal channels within the restored areas. These networks convey tides and suspended sediment into the interior of the sites, convey nutrients and primary production off the site, and provide habitat diversity. For the muted tidal areas and full tidal area of the Near Term Alternative, this network can be encouraged by excavating starter channels. Starter channels extend the main channel that enters the restoration site through a breach or structure and includes the addition of one to three smaller starter channels that branch from the main channel. For the additional full tidal area proposed for the western portion of the island under the Long Term Alternative, the existing network provided by Deadwater Slough should be sufficient. Because of the relatively large tidal exchange initially entering the site, this network will erode and expand to create a more extensive network of marsh channels. The linear drainage channels which currently exist on the site should be filled both to reduce fish stranding in unconnected reaches and to prevent the drainage ditches from capturing flow from the dendritic network.

Bed elevation evolution

Perimeter dikes built around Ebey Island have resulted in subsidence of the site, with the ground surface elevations now well below typical marshplain elevation (Figure 27). Currently, the ground surface elevation over much of the project area is between 2 and 6 feet NAVD, as compared to typical marshplain elevations, which at least MHHW or approximately 9 feet NAVD. Re-connecting the restored areas to the adjacent channels is expected to result in accretion of the existing ground surface as suspended sediment is transported onto the site and deposits. This sediment will be carried onto the site with flood tides and at higher concentrations during riverine flood events. When wetlands vegetation colonizes the site, it will provide an additional source of organic material to supplement the mineral sediment accretion rate.

Limited observations from other locations in the Snohomish Estuary provide an indication of potential accretion rates at the Ebey Island restoration site. Observations from cores collected in a marsh at the downstream end of Ebey Slough indicate long term accretion rates of approximately 0.4 inches per year (USACE 2002). Monitoring 5 years after breaching of a small restoration site also located on the downstream end Ebey Slough indicated that the site had accreted a rate of about 1.2 inches per year

in its first 5 years (Jones & Stokes 1999). Several other restoration sites in the lower Snohomish Estuary have been breached since 2000 and may provide additional insight into site evolution, but sources of observed accretion rates from these sites are not known at this time.

The accretion rates from these other locations in the Snohomish Estuary suggest that the highest ground on Ebey Island, which is approximately 3 feet below MHHW, would take at least take three decades to reach MHHW. Lower regions of the island, which are 6 feet or more below MHHW, would take a century or more to reach MHHW. These estimate are based on accretion rates when mean sea level was rising at a relatively modest 1 millimeter per year. With the expected acceleration of sea level rise, MHHW would be shifting upward as much as ten times faster (Mote et al. 2008), which would extend the time for the bed to reach MHHW.

USACE maintains a settling basin on the Snohomish main stem just downstream of the project site to trap silt before it deposits in the Port of Everett. This site experiences several feet of deposition per year, and is dredged every few years in installments of several hundred thousand cubic yards (USACE 2004). These accretion rates are not directly applicable to predicting accretion within the restored area because a substantial portion of the deposition in the settling basin may be bed load, which is not readily transported into off-channel locations, except perhaps during riverine flood events. Even if sediment from this settling basin is not transported to the restoration site by natural processes, it may be a viable source for dredged sediment that is mechanically transported to the restoration site and place there to augment the existing bed elevation. Previous testing of the settling basin has qualified its sediment for beneficial use (USACE 2004). Further study of the viability of dredge material reuse on Ebey Island is recommended; issues to be addressed would include available volumes, suitability as a substrate for wetlands vegetation (grain size, contamination), engineering feasibility, and costs.

Off-site scour

The proposed restoration will increase the tidal flow in the outboard channels as these channels will convey the additional water that exchanges with the restored areas on each tide. This increase in tidal flow may cause scour and enlarge the outboard channels since tidal channels are often found to develop an equilibrium dimension that is a function of the diurnal tidal prism, as described above in Section 6.2.2.2[2] (Williams et al. 2002). Observations from San Francisco Bay (Williams et al. 2002), which are then adjusted to account for the larger tide ranges found in Puget Sound (ESA PWA 2010), can be used to evaluate the potential for scour resulting from the increased tidal prism associated with restoration.

[2] Average volume of water that flow through a channel cross section on the largest tide of each day.

Estimates of potential changes to tidal prism (from the UNET model) and channel width and depth (from the hydraulic geometry relationships) are shown in Table 6. The tidal prism estimates are extracted from the model just downstream of the restoration areas to capture the region likely to have the largest impact. Only relative changes in channel dimension are show to emphasize that this is an estimate of the likely upper bound of channel scour, not a prediction for a particular location. Note that the channel dimensions do not scale linearly with the tidal prism because the assumed hydraulic geometry relationship is nonlinear[3]. Larger changes are predicted for Ebey Slough since the relative change in tidal prism is larger in the slough as compared to the main stem. The potential changes in channel width are shown, but would be constrained by the dikes. To balance this restriction on widening, deeper scour in the channels may occur. Since the predicted tidal prisms are for the existing bed elevations, the estimate corresponds to the period right after restoration. If accretion increases the bed elevations in the restored areas, the tidal prism will decrease and, correspondingly, the pressure for the outboard channels to enlarge to the extent shown below.

To develop a better understanding of the potential for restoration to scour the outboard channels, we suggest an estuary-wide review of evolution of channel dimensions over time. Several sources of bathymetric data were integrated into the model used for the Flood Insurance Study (FEMA, 2001). This data could be compared with side scan bathymetry data collected in 2006 (Yang and Khangaokar, 2007). Of particular interest is the channel response in the vicinity of Snohomish Estuary restoration sites breached in the last decade.

Table 6 Predicted tidal prism changes and potential channel dimension changes in response to restoration alternatives.

	Existing	Near Term	Long Term
Snohomish River			
Tidal prism (ac-ft)	5,702	5,886	8,094
Tidal prism (% change)	—	3%	30%
Potential % increase, channel depth	—	3%	6%
Potential % increase, channel width	—	2%	15%
Ebey Slough			
Tidal prism (ac-ft)	2,115	3,274	3,348
Tidal prism (% change)	—	55%	58%
Potential % increase, channel depth	—	11%	12%
Potential % increase, channel width	—	27%	28%

[3] Of the form $y = ax^b$ (as opposed to the linear form $y = ax + b$)

6.2.3 Design considerations

6.2.3.1 Estimated quantities and costs

Planning level budgets for the two chosen alternatives and the North Tip Option were created. The construction costs were estimated using available data and experience with similar projects. Three different options are shown for each, based on the range of dike removal scenarios. There are a number of uncertainties with the quantities of materials that would be needed for these projects. Quantity estimates were created for the construction of dikes, breaching of dikes, various levels of dike removal, construction of starter channels, creation of ditches, addition of tide gates, addition of self-regulated tide gates, and addition of flood gates. Estimated unit costs were used to come up with a planning level construction budget. The costs to offset impacts to the diking district and to transportation and utility purveyors were included using the best information available. The costs of design and permits were estimated as a fraction of the project budget. Land acquisition costs were also estimated, based roughly on the assessed value, with a multiplier added to account for some of the expenses, other than purchase price, that would be relevant.

Table 7 summarizes the quantities of various features for the two preferred alternatives and the North Tip Option, along with planning level construction budgets for each. Significant unknown costs to floodproof utilities or roads and mitigate for any environmental impacts have not been estimated.

Table 7 Summary of quantities and suggested construction budget for preferred alternatives.

							Suggested Construction Budget		
	New Habitat - Muted Tidal (ac)	New Habitat - Full Tidal (ac)	New Dike Needed - Short (ft)	New Dike Needed - Full Height (ft)	Number of Water Control Structures Needed	Dike Eligible for Breaching or Lowering (ft)	*Breach 10% of Dike	**Breach 10% Plus Lower Remaining To MHHW	***Breach 10% of Dike and Remove Remaining Dike Material
Near-Term Alternative	**210**	**574**	**13,780**		**2**	**12,640**	**$16,670,000**	**$18,700,000**	**$27,660,000**
West Muted Tidal Area	114		8,150		1	0	$1,490,000	$1,490,000	$1,490,000
East Muted Tidal Area	96		5,630		1	0	$1,170,000	$1,170,000	$1,170,000
East Full Tidal Area		574		8,930	0	12,640	$14,010,000	$16,040,000	$25,000,000
Long-term Alternative		**1,500**		**22,000**	**4**	**17,300**	**$33,840,000**	**$35,870,000**	**$44,840,000**
North Tip Option		**300**		**2,400**	**2**	**14,300**	**$3,990,000**	**$5,680,000**	**$17,050,000**

* Excavated materials assumed to be placed elsewhere within the project area
** Material removed from dike assumed to be placed on adjacent inboard dike slope
*** Excavated materials assumed to be removed from the project area, no disposal fee included

Table 8 summarizes the planning level construction budget, project budget, and the impacts expected to the utility and transportation purveyors. The project budget includes design, permits, construction oversight, and property acquisition.

Table 8 Summary of suggested construction budget, project budget, and utility and transportation impacts.

	Suggested Construction Budget			*Suggested Project Budget			Utility/Transportation Impacts			
	Breach 10% of Dike	Breach 10% Plus Lower Remaining To MHHW	Breach 10% of Dike and Remove Remaining Dike Material	Breach 10% of Dike	Breach 10% Plus Lower Remaining To MHHW	Breach 10% of Dike and Remove Remaining Dike Material	WSDOT	Snohomish County Roads	Olympic Pipeline	City of Everett Water Pipelines
Near-Term Alternative	**$16,670,000**	**$18,700,000**	**$27,660,000**	**$21,671,000**	**$24,310,000**	**$35,958,000**	-	-	-	-
West Muted Tidal Area	$1,490,000	$1,490,000	$1,490,000	$1,937,000	$1,937,000	$1,937,000	-	-	-	-
East Muted Tidal Area	$1,170,000	$1,170,000	$1,170,000	$1,521,000	$1,521,000	$1,521,000	-	-	Minor Impact	-
East Full Tidal Area	$14,010,000	$16,040,000	$25,000,000	$18,213,000	$20,852,000	$32,500,000	-	-	-	-
Long-term Alternative	**$33,840,000**	**$35,870,000**	**$44,840,000**	**$47,742,000**	**$50,381,000**	**$62,042,000**	Wetland Parcel	Homeacres Road	Major Impact	Impact to Abandoned Line
North Tip Option	**$3,990,000**	**$5,680,000**	**$17,050,000**	**$8,187,000**	**$10,384,000**	**$25,165,000**	-	-	-	-

* Suggested Project Budget includes consideration for design, permits, construction oversight, and property acquisition, when relevant.

6.2.4 Ecological effects of preferred alternatives

The Snohomish estuary is traversed by juvenile and adult salmonids representing seven different species, including ESA-listed Chinook salmon *(Oncorhynchus tshawytscha),* steelhead (*O. mykiss),* and bull trout *(Salvelinus confluentus).* All of these species are important from ecological, cultural and economic standpoints. The restored Ebey Island site is expected to provide high quality, accessible habitat that would be used extensively by juvenile (subyearling and yearling) Chinook salmon during their protracted downstream migrations each spring and early summer and, to a lesser extent, by upstream-bound adults in the late summer and fall. Estuarine sloughs and tidal marshes are highly productive areas that provide important acclimation, feeding, and refuge functions for salmonids, as well as non-salmonid species such as peamouth chub *(Mylocheifus caurinus),* which are common throughout the Snohomish estuary. Growth and survival rates are generally high for all fish species in estuaries.

Figure 37 presents the general effects of dike removal or modification on estuarine components and processes, and their combined effect on juvenile salmon movements (access), growth and survival (predator avoidance) in newly accessible restored habitats. The arrows indicate the pathways through which responses are expected to occur (the darker the line, the stronger the relationship).

The estuarine processes that would be restored by these alternatives include tidal hydrology, delivery and routing of sediment and LWD, nutrient cycling, and establishment and maintenance of a complex network of drainage channels. Some of the more important structural changes expected are sediment accretion, salt marsh vegetation recolonization, tidal channel network expansion, increased production of benthic and salt marsh invertebrates.

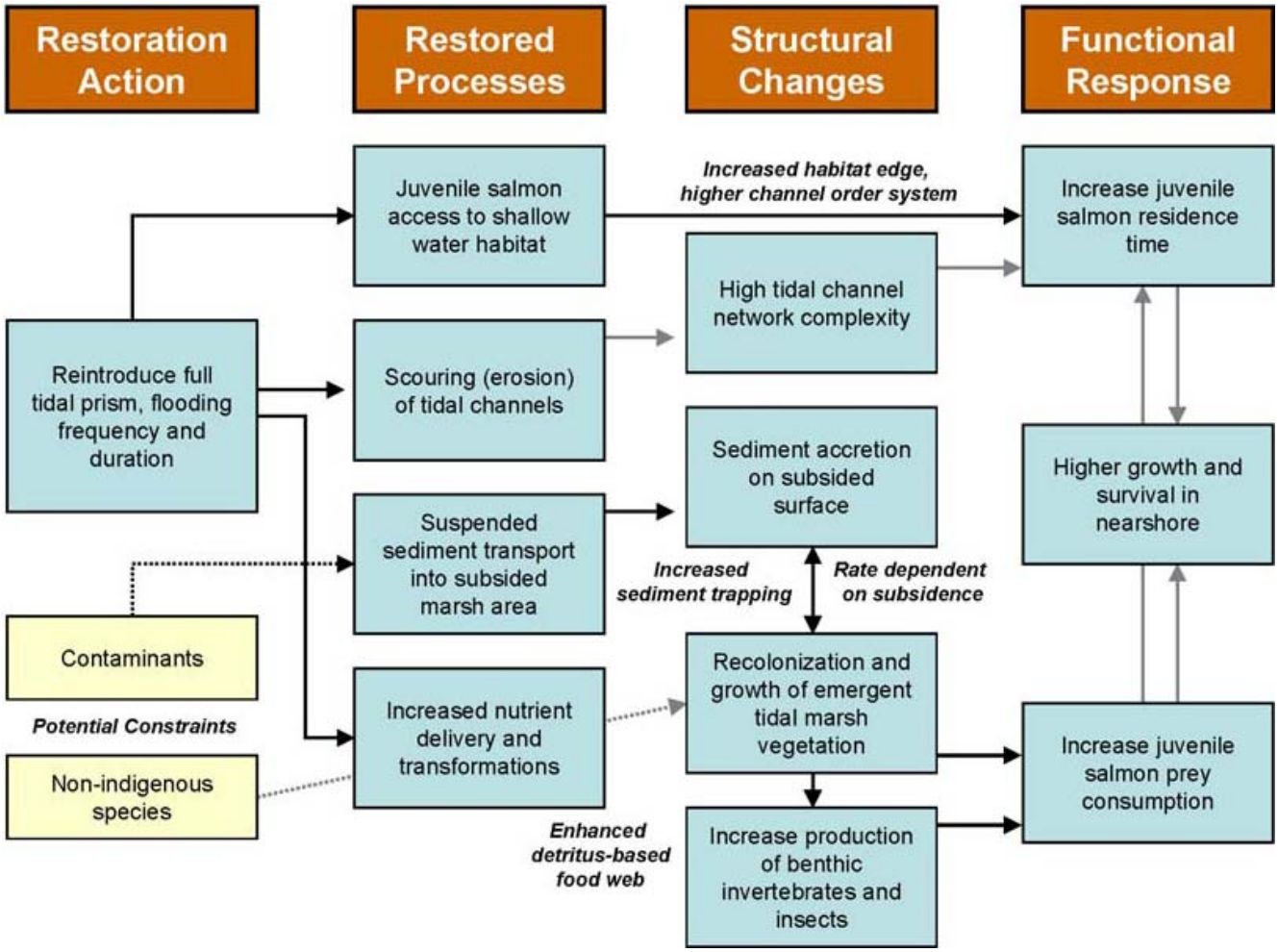

Figure 37 Conceptual example of the effects of dike removal, setback or modification on juvenile salmonids and associated habitat (adapted from Clancy et al. 2009).

The Near Term and Long Term Alternatives would restore, in varying degrees, the natural estuarine processes and components that are typical of healthy ecosystems. Restoration of muted tidal and full tidal conditions in areas behind the existing dikes, and provision for passage into these areas via tide gates, would ensure that they are accessible to downstream migrating fish.

We developed a conceptual model similar to the one described above to evaluate the potential ecological benefits of restoring the Ebey Island site under the two preferred alternatives. Anticipated benefits to fish resources were derived from model-predicted estimates of wetted surface area, combined with indices of hydraulic connectivity (i.e., accessibility) and habitat quality based on modeled hydraulic characteristics within the restored area. While juvenile salmonid densities are known to vary according to habitat type, as defined by water depth and velocity, temperature, salinity, dissolved oxygen, substrate, cover, and other parameters that affect habitat quality. Spatially explicit

predictions of these parameters were not part of our model. Instead, we evaluated the suitability of habitat expected to result from implementation of Near and Long Term Alternatives based on the assumption that restored habitat, over time, would develop physical characteristics similar to natural tidal marsh habitats elsewhere in the Snohomish River. Thus the total restored areas, weighted by the proportion of usable fish habitat and estimates of juvenile density obtained in similar habitats in the lower Snohomish River estuary, formed the basis of our analysis. This information was then incorporated into the alternatives effects analysis and the evaluation and design process.

6.2.4.1 Restoration of the Snohomish Estuary

Prior to anthropogenic modifications, Haas and Collins (2001) estimate the Snohomish River Delta contained approximately 3,950 hectares (9,760 acres) of tidal marsh habitat (not including lower intertidal/subtidal mudflat. Sixty-six percent (2,607 hectares [6,442 acres]) of this tidal marsh habitat was located around Ebey Island within the freshwater portion of the estuary, also referred to as the Forested Riverine Tidal (FRT) zone. Today, only 600 hectares (1,480 acres) of total marsh remain, and the FRT zone has lost 95 percent (only 130 hectares [320 acres] remain) of its historic area, primarily due to diking and conversion to agricultural uses. Only 25 percent of the blind tidal sloughs remain intact throughout the Snohomish River Delta and channel margins along the distributary sloughs and main channels have been significantly modified by extensive diking. Based on the amount of rearing habitat available for juvenile Chinook and coho salmon, the authors estimated historic capacity at approximately 2.6 million Chinook smolts, whereas current conditions accommodate only 1.0 to 1.6 million Chinook smolts.

In more recent years, and particularly with the listing of Chinook salmon as threatened under the Endangered Species Act (NMFS 1999; Good et al. 2005), estuarine tidal marshes have become the focus for habitat restoration. The following projects are a few examples of tidal marsh restoration in the Pacific Northwest.

In the Snohomish River Delta dikes have been breached intentionally and unintentionally. The Snohomish River Basin Salmon Conservation Plan (2005) lists a dozen projects that have been implemented or are in the planning phase.

One of these projects is the Qwuloolt site, about 162150 hectares (400370 acres) in the emergent/forest transition zone near Marysville, Washington, that was purchased by the Tulalip Tribes. In partnership with NOAA Fisheries, the Tribes have been developing a restoration design to breach the existing dikes and restore full tidal conditions across the marsh (Minick 2004).

In the oligohaline portion of the estuary near Ebey Island, tidal restoration occurred at the south end of Spencer Island in 1994. Dikes were breached in two places to reconnect tidal and fluvial processes to

23.7 hectares (58.6 acres; Cordell et al. 2001; Tanner et al. 2002). Spencer Island is located directly across Steamboat Slough from the northern end of Ebey Island and offers an example of what full tidal restoration might look like on Ebey Island. Many of the other restoration projects, such as those on Smith Island along Union Slough, are located lower in the estuary where salinities are higher.

In November, 1994, a dike dating from the early 1900s and enclosing the perimeter of the island was breached in three places near the south end, allowing inundation of approximately 23.7 hectares (58.6 acres)of the south part of the interior by tidal water from the estuary. In 2006, breaches were constructed in the rest of the dike of South Spencer Island, allowing tidal functions to an additional 140 hectares (346 acres), thus completing restoration of tidal functions to the entire site of South Spencer Island, about 164 hectares in all (404 acres).

A great deal of restoration work and biological recovery monitoring has occurred in the Skagit River delta where many of the same conflicts between land uses arise (Beamer et al. 2005). Wiley Slough (Hinton et al. 2005), Fisher Slough (Beamer et al. 2010), and Deepwater Slough (Beamer et al. 2006) are all useful examples of restoration design processes, implementation, and biological monitoring programs. Research conducted at these sites contributes to our understanding of fish use of restored sites and the effectiveness of removing and modifying tide gates.

The restoration of freshwater tidal marsh habitat and fish passage at tide gates are common concerns around the Puget Sound, in the Lower Columbia River Estuary, and in Oregon (Simenstad and Thom 1996, Charland 1998, Giannico and Souder 2004, Hering et al. 2006, Poirier et al. 2009).

6.2.4.2 Critical uncertainties

Restoration design details

Predicting the ecological benefits that will accrue as a result of a restoration project is difficult because the processes and successional nature of site evolution are inherently uncertain. The Ebey Island restoration project is still in the feasibility stage and therefore many of the design details have not yet been determined. These details, especially pertaining to the type of water control structures, the controlled height of water in muted tide areas, and the amount of grading and excavating that will be used to create starter channels, all play an important role in achieving ecological benefits. The quantification of ecological benefits presented in this report are uncertain and only predict future site conditions to extent possible given the feasibility level of design detail.

Tide gates

Tide gate designs have been creatively modified in recent years to improve water quality and fish passage in estuarine settings (Giannico and Souder 2005). Studies of juvenile fish distribution in the vicinity of traditional and modified tide gates show clear benefits to using either side-hinged or self-

regulating tide gates. Unfortunately, it is rare that tide gates function identically across a range of sites and thus it is difficult to quantify the improved level of access. These design specifics will greatly impact the ability of fish to access a muted tide area, and it will be important to define these specifics clearly before further refining this ecological effects analysis.

Water temperatures

Any type of tide gate, by definition, will impound water for some amount of time. If water is trapped in a shallow pool behind the dike for too long, air temperature and solar radiation will raise the water temperature. In the Near Term Alternative presented in this report, the muted tide areas flush at least once per day over most of the year. We assume this frequency of exchange is sufficient to keep the temperature of the water within the muted tide site equal to the water temperature in the mainstem/slough. However, a formal analysis has not been conducted and the lower Snohomish has been identified as having high water temperatures in the later summer low flow period. The spring outmigration period has generally cooler air temperatures, but higher river stages result in the gate being closed for longer periods of time.

Rates of sediment accretion and community succession

As noted above, subsidence has occurred across Ebey Island and will be an important factor in determining the affect of restored tidal processes on biological communities. This is not a unique problem; many other tidal marsh restoration projects have addressed this issue by assuming that restored fluvial and tidal processes will provide sediment inputs that, over time, will build up the marsh surface elevation and allow vascular plants to colonize. Wetland researchers have found that most intertidal vascular emergent species occur primarily between MLHW 9.39 feet and MHHW 11.11 feet in the Snohomish Estuary (Lewis 1982; Table 9).

The rate of accretion is primarily determined by the sediment budget for the river, and secondarily by the velocity and volume of flows across the restored site. In the Pacific Northwest, these rates are widely variable in different systems: 0.36 centimeters per year in Salmon Creek Estuary (Frenkel and Morlan 1990) and 4.80 centimeters per year in Puyallup River Estuary (Simenstad 1996).

There are fewer examples with which to predict sediment accretion rates in a muted tide system, but they will likely be much slower than in an area of full tidal influence because perimeter of the marsh has no connection to the sediment sources transported by the river (except through the culvert), and the tidal prism is greatly reduced. (Frenkel and Morlan 1990). Perimeter dikes will also prevent natural recruitment of large wood pieces that act as nurse logs and help expedite the establishment of emergent marsh vegetation (Hood 2007).

Table 9 Selected species and observed elevations in estuary.

Elevation Above MLLW in Feet	Dominant Plant Species	Habitat Type	Wetland Complex Number
+ 5.9 MLLW	Marine Algae, Diatoms (Mudflat)	Intertidal Mudflat	19, 171 Entrance Mudflats
+ 6.9 MLLW	*Carex lyngbyei*	Emergent Intertidal Salt Marsh	133, 134, 135, 18 Quilceda, N. Ebey, W. Smith
+ 9.9 MLLW	*Carex lyngbyei*	Emergent Brackish Intertidal Marsh	144, 138 Mid Ebey and Spencer
+ 8.8 MLLW	*Scirpus acutus*	Emergent Intertidal Salt Marsh	132 Quilceda
+ 7.9 MLLW	*Scirpus acutus*	Emergent Intertidal Brackish Marsh	148 Mid Ebey
+ 8.9 MLLW	*Typha latifolia*	Emergent Intertidal Brackish Marsh	144 Mid Ebey
+ 11.9 MLLW	*Typha latifolia*	Emerg/SS/Forest Intertidal Brackish & Freshwater Marsh	105 Otter Island
+ 11.9 MLLW	*Lonicera involucrata*	Scrub-shrub Inter-tidal Brackish Marsh	141 Mid Ebey
+ 12.9	*Lonicera involucrata*	Scrub-shrub Inter-tidal Brackish Marsh	137 South Spencer

Source: SEWIP Wetland Complex Inventories and COE 1973 Flooding Map for Snohomish Estuary

One of the uncertainties of particular concern is the fate of the forested wetland on the east side of Ebey Island. Elevation of the ground surface in this densely wooded, inaccessible area is unknown, and therefore, the response of the plant community to full tidal restoration is difficult to predict. Sitka spruce and many of the other species in this community can tolerate some level of inundation. If ground elevations are high enough, the forest may not be significantly affected by removing or breaching the dike. However, if the ground has subsided below its historical elevation, it is possible that many, if not all, of the trees would die. In that case, breaching the dike would “restore” fish habitat at the expense of forested wetland habitat, which is considered high value for many other species. Over the long term, dead trees could provide important small scale habitat features that contribute to the reestablishment of vegetation on nurse logs, and as hard elements that promote the scouring of tidal channels. Over the longer term a new vegetation community would likely grow on this Forested Riverine Tidal Zone site, adapted to the new hydrologic conditions.

6.2.5 Fish habitat value in muted tidal systems

All of the issues and unknowns described above lead to difficulty in predicting whether it is possible to mimic optimal fish habitat within the muted tidal systems proposed at Ebey Island. While many of the habitat conditions that are known to be of value to juvenile salmon and other native species can be

incorporated as design criteria, compromises are inevitably made to accommodate other types of criteria and key attributes or ecological interactions cease to function. Despite all that is known about fish use of estuarine tidal marsh habitat, it is still a daunting challenge to engineer optimal habitat in a system that does not allow natural processes to run their course, and to predict the use and value of this habitat for any given species.

6.2.5.1 Methods to quantify ecological benefits

The basic method for predicting fish use of a restored area involves simply multiplying the expected usable habitat area by an average density of fish. To increase the level of certainty, fish density and habitat type data should be compiled from field studies that are as comparable as possible.

Habitat area can be defined in many different ways: marsh area, channel surface area, channel volume, linear feet of channel, etc. Whichever unit of measure is chosen will need to correlate with the units of fish density values. In this report, we define usable habitat area as the length of the anticipated dendritic tidal channels, multiplied by an average distance from the bank that represents the edge habitat typically used by juvenile Chinook salmon. The expected length of dendritic channels is estimated using several different geomorphic principles and observed allometric relationships.

Fish density values are derived by multiplying the daily average density of juveniles over the course of the outmigration period by the average residence time in the marsh. Therefore, fish density represents the number of fish that would pass through a given acre of usable habitat in a given year.

This method is used most appropriately for areas where full tidal restoration is proposed. For areas where muted tidal ranges are proposed, this method is combined with further analyses that describe anticipated habitat conditions and fish access potential in these areas.

Usable habitat area

The amount of habitat that would be made accessible to fish under different alternatives is difficult to predict with certainty, but can be estimated using a few basic approaches. One is by using established allometric relationships that correlate the size of a marsh system to the number and order of its drainage channel network. The tidal prism of a marsh system, which represents the volume of water exchanged across the site over a standard tidal exchange, can be used to predict the morphology of these channels.

These relationships have been quantified based on observations of tidal marsh systems in the San Francisco Bay, California (PWA 1995) and the Skagit River Delta, Washington (Hood 2007b), and can be used to reasonably represent processes in the Snohomish River Estuary (M. Brennan, personal communication). Ideally, this analysis would be based on formulas developed specifically for the

Snohomish River, which would allow for local calibration; however, because these formulas have not been developed, we rely on the geomorphic relationships developed in the systems mentioned above. The biggest source of uncertainty in applying these models to the Ebey Island restoration alternatives stems from not knowing whether these relationships hold true in muted tidal areas. In these areas, the tidal prism is substantially reduced and tidal flushing occurs less frequently (diurnal instead of semi-diurnal).

The Skagit River System Cooperative (SRSC) compiled a database of geomorphic attributes that has been used to understand the relationship between the total acreage of a tidal marsh, either natural or restored, and the proportion of area that is covered by tidal channels (Beamer et al. 2005). Adapting these formulae to the restored acreages proposed on Ebey Island provides one method for estimating the channel area that would be available to rearing fish. The North Fork Skagit River Delta regression equation is:

$$y = 0.0018x^{1.80}$$

and the South Fork equation is:

$$y = 0.006x^{1.48}$$

where y is the total channel area (hectares), and x is the marsh island area (hectares). It is important to note that the largest areas of marsh that were included in this analysis were on the order of 70 hectares (170 acres). No marshes of a size comparable to the Ebey Island Long Term Alternative (greater than 490 hectares [1,200 acres]) were available for sampling. Nevertheless, we predicted the area of tidal channel in each of the Ebey Island restoration alternatives by applying both of the Skagit equations and averaging the results. In the Near Term Alternative, we predict a total of 29.0 hectares (71.7 acres) of channel to be either created or formed naturally across the restored full tidal and muted tidal areas. In the Long Term Alternative, we predict 131.5 hectares (324.9 acres) of channel to develop over time (Table 11).

Coats et al. (1995) compiled similar geomorphic data from tidal marshes in San Francisco Bay that can also be applied to the Snohomish River Delta to develop an alternative estimate of the drainage order and usable habitat for a given size marsh. Coats et al. (1995) report a simpler rule for predicting the drainage density, or the length of total channel per marsh surface area. On average 0.01 to 0.02 feet of channel is found for every square foot of marsh area. This is equivalent to 328 to 656 linear meters of channel per hectare. For this analysis, we assume an intermediary value of 0.015 linear feet per square foot, or 492 meters per hectare. This value is used to represent both the

equilibrium morphology of a marsh restored entirely by natural processes, and the design criteria for marshes systems that are “jump-started” by construction/excavation.

Using this relationship, the Ebey Island restoration Near Term Alternative would result in 155,964 meters (511,692 feet) of channel (114,144 meters [374,488 feet] in the full tidal area and 41,820 meters [137,200 feet] in the muted areas), and the Long Term Alternative would result in 298,644 meters (979,803 feet) of channel.

These channel networks are made up of a range of channel orders, especially in the large marsh sites. On the small end of the range, first order channels may be no wider than a ditch, whereas the large fourth and fifth order channels may be tens of meters across. Assuming an average channel width of 5 meters (16 feet), this would result in 78.0 hectares (192.7 acres) and 149.3 hectares (368.9 acres) of channel habitat in the Near and Long Term Alternatives, respectively.

An even simpler approach to predicting channel area in tidal marsh habitat used by Bartz et al. (2006) and based on prior analysis of the Snohomish River Estuary (Haas and Collins 2001), was to multiply the land area within a given habitat zone by a certain percentage. In blind tidal channel areas within the FRT, usable habitat area was calculated simply as 3.0 percent of the total area. Using this approach, and assuming the Ebey Island restoration alternatives create only blind tidal channel networks, the near term scenario would create 9.5 hectares (23.5 acres) and the long term scenario would create 18.2 hectares (45.0 acres).

Due to the great disparity in the results from these alternative methods, we chose to use the intermediary values from the Beamer et al. (2005) model. These equations were developed specifically to assist in calculating fish benefits. In addition, these equations capture the fundamental idea that larger sites produce a greater benefit per hectare than smaller sites.

Distinction between full tidal marsh and muted tidal areas

Estimates of usable habitat area that have been developed above focus exclusively on the habitat quantity that might be made available under different restoration alternatives. Unfortunately, the ability to predict the quality and the accessibility of this habitat is limited, especially in the areas where muted tides are proposed. Specific details regarding what these areas will look like, what hydrology and habitat features will be present, and what types of communities will reestablish, all contribute to the quality of habitat and the ability of these restored areas to benefit juvenile salmonids that rear in the estuary.

Fish densities

We compiled a variety of reported juvenile Chinook salmon density values from the literature, which when multiplied by the predicted channel areas in each area would allow a rough estimation of the number of smolts that would benefit from restoration. In general, there is very limited data available on typical juvenile Chinook salmon densities in Snohomish River tidal marshes, especially in the freshwater portion of the estuary. Sampling is problematic: very few sites still exist because of extensive diking, funding is limited, and the population dynamics (especially life history, behavior and carrying capacity) are not well understood, which make interpreting results difficult.

We found that many of the past efforts to quantify the effects of habitat alteration on Chinook populations relied on fish density numbers from tidal marshes in other systems. Bartz et al. (2006) provided a list of habitat-specific fish density values that they used to populate their model. Based on an average from several sources in the Fraser and Skagit Rivers, they estimated that FRT habitats could support 1,400 (SD=1,510) Chinook smolts per hectare (570 per acre).

Haas and Collins (2001) applied an average production capacity of 2,857 Chinook smolts per usable hectare (1,156 per acre) of blind tidal channel. This value was also derived from field work in the Skagit River (Hayman et al. 1996).

Both Bartz et al. (2006) and Haas and Collins (2001) applied higher juvenile Chinook densities to habitats zones lower in the estuary: 1,410 and 4,200 per hectare (571 and 1,700 per acre) in estuarine emergent marsh and estuarine scrub-shrub, respectively (Bartz et al. 2006); and 21,916 per hectare (8,869 per acre) in both estuarine emergent marsh and emergent/forested transition zones, respectively (Beamer et al. 1999 as cited in Haas and Collins 2001).

More recent work in the Skagit River has established a method for predicting the carrying capacity/density of a given site based on its location within the tidal marsh system, also known as the “landscape connectivity” (Beamer et al. 2005). A numerical score for landscape connectivity is derived as a function of the distance and the number of bifurcations from the mainstem. Then this score is used as a surrogate for habitat value and accessibility. In the Skagit River delta, sites with high landscape connectivity average 11,200 juvenile Chinook per hectare (4,530 per acre) of blind tidal channel over the outmigration season. While freshwater sites higher in the delta system naturally have higher connectivity because of fewer bifurcations, this value may be skewed by exceptionally high number of Chinook found in the brackish sites.

Two other key insights from the Skagit system are useful to consider when predicting the benefits of habitat restoration in the Snohomish River. First, the density of juvenile Chinook salmon observed in blind tidal channels was density dependent: data was collected over multiple years when the total

number of smolts ranged from 800,000 to 7.1 million; during this time the average number of fish per hectare ranged from under 2,000 to over 14,000 (under 800 to over 5,600 per acre). Second, as the total number of smolts increased, residence time in the delta habitat decreased. We assume these characteristics are also true of Snohomish River stocks (with total smolt production estimated at 1.0 to 1.6 million (Haas and Collins 2001), but the similarity of these dynamics between regions, and the plasticity of life-history strategies within populations over time is not well understood. Until a more thorough understanding of the Snohomish River Chinook population dynamics and juvenile behavior is attained and local values are made available, then it will be impossible to refine estimates of expected restoration benefits.

Some of the discrepancy between these carrying capacity estimates may reflect the fact that it is not simply measured in the field, but rather calculated from field data based on several assumptions. Sampling the number of smolts in blind tidal marsh habitat first requires a correction for capture efficiency (Hayman et al. 1996); then the average number of smolts captured on a given day is multiplied by the length of the outmigration season, approximately 150 days (Beamer and Greene 2005); and divided by an average residence time of 25 to 35 days (Healy 1980 and Beamer et al. 2000, respectively). These extra steps introduce a high degree of uncertainty to each capacity estimate and variability between studies.

Given the wide range of reported values for the smolt production potential of freshwater blind tidal channel habitat, we applied both a high (10,000 smolts per hectare [4,000 per acre]) and a low (2,000 smolts per hectare [800 per acre]) value to the anticipated amount of usable habitat area created under each alternative. This approach resulted in high and low estimates of smolt production for both the Near Term and Long Term alternative. If our other assumptions are valid, we can be reasonably confident that the future smolt production will fall somewhere within these ranges..

Other metrics

SEWIP salmon overlay

A planning process to identify and rank potential mitigation and/or restoration sites in the greater Snohomish River Estuary was undertaken a decade ago (City of Everett 1997 and Pentec Environmental 2001). First, the ecological functions of wetland and tidal areas across the estuary were evaluated using an “indicator value assessment” model (IVA). This IVA score is used to represent the relative current or future ecological value of each acre of land within a given area. This score is then multiplied by the acreage of a given site to determine the relative value of a specific project. The scoring process was initially completed for wetland function (1997), and subsequently modified to be used for predicting fish habitat function (2001; Table 10).

Table 10 Summary of indicator value assessment scores for preferred alternatives

Site	Min IVA Score	Max IVA Score	Acres	Relative Value
NW Corner - Muted Tidal	27.3	40.3	121	3,303.3
NE Corner - Muted Tidal	25.6	70.4	124	3,174.4
E Side - Full Tidal	62.1	62.1	552	34,279.2
Central - Managed Drained	29.8	58.0	400	0.0
Near Term Subtotal				**40,756.9**
Long Term - Full Tidal		59.4	1213	72,052.2
Long Term Subtotal				**72,052.2**
N Tip	66.2	103.7	303	31,421.1
Option Subtotal				**31,421.1**

Five of the top 25 potential sites that were evaluated in the SEWIP report overlap with the current project area being considered by WDFW: the central area around Deadwater Slough; the northwest corner along the mainstem; the northeast corner along Ebey Slough; the eastern forested portion along Ebey Slough; and the northern tip of Ebey Island. The boundaries of these areas do not match with those proposed in the currently proposed alternatives, and therefore the acreage calculations are not comparable, but the maximum IVA scores indicate the relative restoration value of these locations.

Based on their analysis, the northern tip of Ebey Island had the highest maximum IVA score (103.7), followed by the northeast corner (70.4), the eastern side (62.1), Deadwater Slough (58.0), and the northwest corner (40.3). The minimum IVA scores, which were calculated assuming only the dike was breached and no other habitat enhancement work was performed, for the northeast and northwest corners were 25.6 and 27.3, respectively.

If we apply the maximum IVA scores to the acres proposed for full tidal restoration under the current alternatives, and use the minimum IVA scores to the acres proposed for muted tides (not the way it was intended to be used), we can generate a relative score with which to evaluate the fish habitat restoration potential of each location.

The top 25 sites promoted in the SEWIP model summed to a maximum IVA restoration potential of 413,608 IVA-acres (City of Everett and Pentec Environmental 2001). Using this modified approach to the IVA model, the Near Term Alternative with the addition of the North Tip Option would yield benefits equivalent to the Long Term Alternative. Implementation of either would realize over

17 percent of the total IVA-acre potential. The Long Term Alternative plus the North Tip Option would meet 25 percent of the total potential.

Inundation frequency

Water surface elevation data (at 10 minute intervals) from the Snohomish River during WY2002 were used as an example of the anticipated fluctuations of river stage over the course of a normal year. We used these data to model inundation frequency across the sites proposed for full tidal restoration. For the muted tidal areas, we used water level elevation model output provided by ESA PWA based on the same WY2002 data. The time series of water levels were summarized in a frequency distribution and compared to the current site elevations to predict the extent of land that would be flooded for a given percentage of time. This analysis was based on current site elevations and did not account for any habitat design features involving earthwork (channel excavation or marsh island creation) or the long term changes that will likely occur at the site (sediment accretion and scouring).

We found that in both the muted tide scenarios and the full tidal scenarios approximately 80 percent of the land area would be flooded 80 to 90 percent of the time (Appendix D). The main difference is the depth to which these sites flood. In the full tidal areas of both the Near and Long Term Alternatives, the depth of the water across the site will vary continually, but 85 percent of the area will be inundated at a depth of at least 3 feet 40 to 45 percent of the time. In the muted tidal areas, only 1 to 2 percent of the land area will ever be flooded to a depth of 3 feet. Over time the ground surface elevation of the full tidal areas is expected to build up due to sediment accretion.

Vegetation elevation distribution

Emergent marsh begins to establish at approximately 7 feet MLLW (City of Everett 1997), below which mudflat habitat is predicted. This elevation corresponds to approximately 4.7 feet NAVD on Ebey Island. According to our analysis of the water level data on the mainstem, this elevation would be inundated approximately 75 percent of the time. In the near term muted tidal areas, none of the land is inundated 75 percent of the time; 78 percent and 85 percent of the area in the northwest and northeast areas, respectively are flooded over 80 percent of the time, and the rest is not flooded at all. Roughly 85 percent of the land in the Long Term Alternative is lower than this inundation threshold.

Bird habitat / general guild preferences and amount of acres of each

Bird habitat on Ebey Island would change as a result of the proposed Near or Long Term restoration alternatives. In the Near Term Alternative, the managed drained portion in the center of the island would retain its current habitat value and would be expected to be used by geese and swans, passerine species, and raptors. The northeast and northwest muted tidal areas, which would be inundated at a shallow depth for a significant portion of time, would reallocate this wetland habitat from scrub-shrub wetland to mudflat bordered by emergent marsh. The increased frequency of

flooding and low vegetation would greatly increase the use by waterfowl and shorebirds. Depending on the proportion of time the area is inundated, these areas may look similar to lentic habitats, which would attract a different composition of species.

The areas in which full tidal inundation is restored in the near term and Long Term Alternative would, especially in the first several years, revert to mudflat habitat. While some shorebirds may use these new areas, they are generally found in higher densities in brackish mudflat areas due to the distribution of preferred prey.

The effect of tidal inundation on the spruce forest on the east side of the island is not well understood. Ground surface elevation data from this area is lacking, and our ability to predict whether these trees would survive or not is limited. Undoubtedly, this area currently represents unique habitat – it is the largest remaining stand of Sitka spruce in the Snohomish estuary and is utilized by a wide variety of bird and mammal species. If the perimeter dike is removed and the area becomes exposed to the fluvial and tidal processes it is likely that this habitat will change significantly and may cease to function in an optimal way for the more terrestrial species.

Fish access to site

To this point, our analysis has ignored the question of whether fish will be able to access the restored site. This is an important issue, particularly in the proposed muted tide systems that will rely on water control structures to modulate water level elevation behind the dikes. The response of outmigrating juvenile salmon to tide gates is still relatively unknown (Giannico and Souder, 2005). Recent studies of passage success, and fine scale distribution of fish above and below tide gates indicate that some improvements in fish passage can be achieved by using modified tide gates instead of traditional top-hinged gates (Bass 2010, Beamer and LaRock 1998, Beamer et al. 2010). However, modified tide gates are unlikely to provide access equivalent to a natural tidal channel where the dike is fully removed. It is also important to note that these studies observed specific tide gate configurations at specific sites; therefore, the results are not broadly applicable nor useful for predictive purposes. At this time, there is little conclusive evidence regarding the degree to which fish are deterred from migrating into and out of tidal marsh habitat by tide gates and what the implications of deterrence or delay might be in terms of fitness and survival. Fish passage requirements developed by regulatory agencies for culverts at stream crossings focus primarily on upstream adult passage and do not apply to juveniles (NMFS 2008, WDFW 2008).

Full tidal restoration

For the areas of full tidal restoration that are proposed in the Near Term and Long Term Alternatives for Ebey Island, we assume that access to the site will be equivalent to a natural system. The full habitat opportunity resulting from restoration would be realized.

Self-regulating tide gage and other tide gate alternatives

In the muted tidal areas, fish will not have unimpeded access to the site. Even if high quality habitat conditions were to be created in the muted areas, the habitat may not be fully utilized because of impeded access. The existing perimeter dike would remain in place, which means fish would only be able to gain access to the site through the culvert and tide gate structure. At low tide, the ability to access the restore marsh area and blind tidal channel network may not be much different than in a natural system, since the fish would only be able to enter through the wetted channel anyway. However, at high tide, where fish would normally be able to enter the inundated marsh across an extensive perimeter, the water control structures in the muted system will limit access to the habitat.

Research at the Elkhorn Slough National Estuarine Research Preserve in California has documented the plant and animal presence within areas of minimal, muted, and full tidal influence (Ritter 2006). Full tidal exchange sites generally support the greatest number of species, but the sites with muted or minimal tidal exchange harbor unique species and some threatened species. Overall, the mosaic of different habitats, ranging from minimal to muted to full tidal exchange, increased the overall biodiversity in the slough. Restoration projects in the Snohomish River estuary should therefore be viewed with the potential to benefit a variety of plants, fish, and other wildlife.

According to Bass (2010), the effect of tide gates on chemical and physical processes has been studied by several groups, but the effects of these changes on fish movement and behavior have not been published in peer-reviewed journals to date. His research found differences in frequency of Coho movement upstream and downstream through a top-hinged, side-hinged, and non-gated channel. While his studies did not include SRTs, his research included one or more leaky gates that may function comparably. Bass recommended that his work be considered a case study and the findings should not be assumed to be transferrable due to the great diversity of tide gate installations in use.

While it is clear that fish access into and out of muted tidal systems will be limited compared to full tidal systems, this effect was not quantified because of the lack of relevant studies.

Percent time open/closed

Output from the hydrologic modeling work - primarily a time series of water velocities through the tide gate for WY2002 was used to calculate the percent of time that the tide gate would be open and thus passable by fish in a given year.

The specific design criteria of the self-regulating tide gate unit have not been fully identified. In the meantime, we used basic criteria to illustrate the effect that a generic SRT tide gate would have on

fish access. In reality, there are several design techniques that could potentially be employed to improve fish access. These are discussed elsewhere in the report.

To perform this calculation, we assumed that whenever the water level on the outside of the gate (either in the mainstem Snohomish River or Ebey Slough for the West and East muted tidal areas, respectively) is lower than or equal to the water level inside the gate, then the gate would be open and water would flow out of the site. When the water level outside the gate is higher than the water level inside the gate, the gate will remain open and water will flow back in until a certain water level is reached inside the gate. At this point, the gate will close and prevent fish from entering or exiting the site.

If the muted tidal system on the East side of Ebey Island closes when water level elevation reaches 2.5 feet (NAVD), then the gate is open only 12.0 percent of the year. On the west side of Ebey Island, if the gate closes when outside water level reaches 4.0 feet (NAVD), then the gate is open 23.7 percent of the year.

If only the outmigration period (March 1 through June 15) is used for the calculation, the East gate would be open for 11.0 percent of the time, and the West gate would be open for 23.0 percent of the time.

Modeled velocities through gate

Simply because the gate is open does not necessarily mean that fish will be able to volitional pass through the culvert into or out of the marsh. Juvenile salmon are generally weak swimmers due to their small size. The head pressure differential and the size of the culvert opening both affect the velocity of the water passing through the culvert. In Oregon, state guidelines for volitional passage through culverts by juvenile salmonids recommend that flows be limited to no greater than 2 feet per second (Stahl 2006). NMFS has not developed guidelines specifically for tide gates but recommends average velocities of less than 1 foot per second for juvenile passage through culverts (NMFS 2008).

The amount of time that both the tide gate was open and velocities through the culvert were below 2 feet per second was only 4.6 percent of the year (6.2 percent during outmigration) for the east tide gate and 13.8 percent of the year (16.0 percent during outmigration) for the west tide gate.

Of course it is possible that juvenile salmonids and other fish could pass through the gate, in one direction or another, if they allow themselves to be sucked through in the direction of the high velocity flow. In this case, we calculate the percentage of time a fish could enter the muted tidal marsh separately from when it could exit the tidal marsh. At the East tide gate, fish could swim or be swept IN to the area 5.4 percent of the year, and OUT of the area 6.3 percent of the year. During the

outmigration time period this would be 4.8 percent in and 5.8 percent out. At the west tide gate, fish could swim or be swept in to the area 9.5 percent and out of the area 13.6percent of the time. During outmigration, this would be 9.2 percent in and 12.9 percent out.

Design modifications to the tide gates and dikes, such as small orifices and “pet-doors,” could greatly increase the potential for fish access. These features allow a small volume of water to continually enter the site at a rate low enough to avoid substantial changes to the water level elevation across the site (Giannico and Souder 2005).

Thresholds for access?

Clearly access to a tidal marsh is limited by the presence of tide gates. But when using this information to quantify this effect, the question becomes: how much time does a fish require to get through? If juvenile Chinook salmon migrate downstream and seek tidal marsh habitat, how long will they wait at the mouth of a channel to gain access before moving on? A better understanding of outmigrant behavioral patterns is needed to appropriately quantify the impact of temporary blockages to juvenile fish passage.

One way to calculate the reduced habitat capacity of a muted tidal marsh is to discount the number of fish that would be expected to use the same area under fully restored conditions by the percentage of time access is available. This is a rather simplistic approach that does not consider any time thresholds for passage nor does it consider modified ecological setting behind the perimeter dikes.

6.2.5.2 Results of ecological effects analysis

Area × density × access calculations

To summarize the potential benefits to Chinook salmon of restoration on Ebey Island, we combined the values for usable habitat area, smolt capacity, and site accessibility that were discussed above and calculated the annual number of smolts that would be produced by the Near and Long Term Alternatives, and the North Tip Option (Table 11). Under the Near Term Alternative, we predict that the proposed land use changes would provide rearing habitat for approximately an additional 53,000 to 264,000 juvenile Chinook per year. Full implementation of the Long Term Alternative could provide habitat for roughly 263,000 to 1.32 million juvenile Chinook salmon. The option to restore the north tip of Ebey Island could provide habitat for 17,000 to 87,000 smolts.

Other Species

Of all the salmon species, coho salmon will benefit the most from muted tidal areas. Low velocity, off-channel areas such as oxbows and beaver ponds provide optimal habitat for rearing coho, as long

Table 11 Habitat and fish production estimates for preferred alternatives.

Alternative	Sub-Area	Total Area		Channel Habitat	Access	Juvenile Chinook Capacity	
		(acres)	(hectares)	(hectares)		High	Low
Near Term	NW Muted	114	46	1.76	23%	4,050	810
	NE Muted	96	39	1.33	11%	1,461	292
	E Full	574	232	25.86	100%	258,596	51,719
	Center Drained	400	162	0.00	0%	0	0
Total		1184	479	28.95		**264,108**	**52,822**
Long Term	Full Tidal	1500	607	131.52	100%	**1,315,241**	**263,048**
Option	North tip	300	121	8.73	100%	**87,262**	**17,452**

as water quality (temperature, dissolved oxygen, etc.) and food supply remain adequate. Coho, like Chinook salmon, will also benefit from the restoration of full tidal freshwater areas.

The proposed restoration alternatives will likely lead to a shift in the bird species assemblages that use the area because the habitat and food types will change. Full tidal areas that create intertidal mudflat may lead to an increased proportion of shorebirds. Muted tidal areas that are frequently flooded to shallow depths will provide an extensive amount habitat for waterfowl. Similarly, the managed drained area will continue to provide benefits for waterfowl and geese. Raptors and cavity dwelling birds may lose habitat and the small mammals, reptiles and amphibians that serve as their food base if the existing forest is lost due to tidal inundation; however, some snags near the marsh will provide valuable perches for bald eagles, osprey and hawks.

Inundation and depth frequency

In this early, feasibility stage of design, the hydraulic dynamics across the marsh plane have not been modeled in great detail. Therefore, predicting the ecological response of these sites is difficult. Furthermore, the current modeling effort is based on the existing hypsometry of these sites, but most parties agree that earthwork will be an integral part of any restoration process, either excavating “starter” channels and/or piling up material to encourage emergent vegetation and expand edge habitat. Subsequent levels of design detail will undoubtedly rely on an iterative process between the engineers, hydrodynamic modelers, and biologists to optimize ecological benefits of the site.

Site evolution

The two natural processes that will be expected to drive site evolution toward equilibrium conditions are tidal (daily) and fluvial (annually and episodically). The tidal prism, or the volume of water that

flushes the site during a given tide cycle, is significantly reduced in the proposed muted areas, which means that rates of sediment deposition on the marsh plane, scouring in the channels and the supply of nutrients to the estuarine food web will also be reduced. The connectivity to fluvial processes, represented as the proportion of river edge to marsh area, is also significantly reduced in the muted tidal areas. The perimeter dikes that are left in place will prevent large wood and flood-borne sediments from accumulating across the muted marshes. Because of the limited connection of the muted tidal sites to these two essential processes, the expectations for site evolution should be significantly revised from those developed for the other, fully restored areas.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 PUBLIC MEETING

The first phase of the Ebey Island Habitat Restoration Feasibility Study concluded with 2.5-hour-long meeting of the Advisory Committee on March 15, 2011, at the Mill Creek, Washington, office of the Washington Department of Fish and Wildlife. This was the last of five meetings convened with the Advisory Committee. Prior to the meeting, letters were sent to all Ebey Island residents and property owners inviting them to attend the meeting. The meeting was also publicized through notices published on the project website[4] and local newspaper (*Everett Herald*). Ten members of the Advisory Committee and 26 members of the general public attended the meeting, in addition to 12 members of the project team.

The purpose of the final Advisory Committee meeting was to communicate the preliminary findings and recommendations of the project team, consistent with the information presented in the draft of this report, and to identify the best path forward. To elicit further feedback from the Advisory Committee, a questionnaire (Appendix E) was distributed prior to the meeting. The first set of questions focused on the technical feasibility of the short- and long-term restoration alternatives. The second set of questions asked the Advisory Committee to help us identify a path forward: what are the recommended next steps if the goal is to implement one of the alternatives? Based on feedback received from the committee and members of the public, additional analysis was conducted and incorporated into this final report. We also summarize the more salient comments received from the Advisory Committee and meeting attendees.

The Advisory Committee comprises individuals from diverse backgrounds who share an interest and have been willing to devote significant time to exploring restoration alternatives for the 1,237 acres of Ebey Island land owned by the WDFW. The agency has endeavored to engage stakeholders in the process and, to the extent practicable, address their concerns in the development of a habitat restoration strategy for the Ebey Island property. Members of the Advisory Committee have

[4] http://wdfw.wa.gov/lands/wildlife_areas/snoqualmie/restoration_study.php

responded positively by participating in meetings and fieldtrips to the project site, keeping themselves and others informed on project matters, engaging in debate with their fellow Advisory Committee members, and providing meaningful feedback to the project team.

WDFW Regional Director Bob Everitt kicked off the March 15, 2011, Advisory Committee meeting by summarizing the history and role his agency has played in managing the property on Ebey Island. He noted that a condition of the state funding used to acquire a portion of the Ebey Island property from the YMCA was that the full range of management options be evaluated. The result was this restoration feasibility study. Everitt stated that his agency was aware that a proposal to restore natural processes and conditions on Ebey Island would be controversial. Therefore, he instructed his charges to ensure that affected stakeholders would have the opportunity to participate fully in the evaluation process, and that any restoration alternative would not jeopardize human health and safety and would be compatible with remaining land uses on Ebey Island.

7.2 RESTORATION FEASIBILITY

The facts and analysis presented in this report lead to the following several conclusions: The feasibility of restoring WDFW holdings to Chinook salmon habitat is presently low. The diking district maintains that it would oppose dike configuration changes needed to fully or partially restore tides to WDFW holdings. Social feasibility is low as numerous land owners and interest groups expressed a strong preference for preserving existing conditions and agricultural potential of WDFW land.

Several issues must be addressed with stakeholders before any restoration project on the property is likely to be socially feasible: the feeling by many that agriculture is a better use of the island than fish habitat, the belief that salmon restoration projects are ineffective, concern that the government will ram a project through over the objections of residents and stakeholders, and lingering concerns, both general and specific, about the technical feasibility of constructing a restoration in such a way that it will maintain or improve the current level of flood protection.

From a technical standpoint, it is feasible to restore high quality estuarine habitat on the WDFW-owned land on Ebey Island. Restoration of tidally influenced components and processes on the property (or portions of it) can be either partial or complete. Partial restoration refers to restoration that is limited in time or space, resulting in improved, but not ideal, ecological conditions.

Of the 14 conceptual alternatives developed in this study, two were identified as being more desirable than the others and were subjected to further analysis. These two “preferred” restoration alternatives would enable water to flow in and out of land located on the inboard side of the dike, resulting in tidally influenced habitat access to salmonids. The Long Term Alternative would result in full habitat

restoration; the Near Term Alternative would result in partial habitat restoration. Nevertheless, both alternatives would yield tangible ecological benefits.

The Long Term Alternative would entail setting back or breaching existing dikes so that the entire WDFW site would be under water for at least a portion of each day, the depth of water depending on prevailing river flows and tidal action. This alternative will have direct and adverse impacts on existing agricultural values, and therefore socially infeasible at present. However, implementation of this restoration alternative in the future would be expected to yield significant benefits. Those benefits would be directly proportional to the ecological health of the surrounding estuary: the more degraded the estuary, the greater the relative benefit of restoring Ebey Island. Because existing conditions within the estuary are suboptimal, and because the abundance of species such as Chinook salmon that depend on estuarine habitat is depressed, the net benefit of implementing the long-term restoration alternative in the not-too-distant future is considerable.

Regardless of the timing of its implementation, the Long Term Alternative would yield even greater benefits for salmon and the other species that benefit from a restoration of natural processes in the estuary if it were implemented in conjunction with other large-scale restoration actions in the Snohomish estuary. Acquiring and restoring nearby properties would amplify the ecological benefits and achieve greater cost efficiencies. One such project—the acquisition and restoration of the north tip of Ebey Island—was examined in this study. We concluded that removing approximately 14,000 linear feet of existing dike and building a shorter length of new dike across the north tip of Ebey Island would be cost-effective, would cause minimal impact to existing agricultural and recreational values, and would result in over 300 acres of new, high quality estuarine habitat in a key juvenile salmon rearing zone of the Snohomish estuary. This option could be pursued either independently or in tandem with the restoration of the WDFW-owned property on Ebey Island.

The near-term habitat restoration alternative represents an attempt to blend the ideal with the practical. In this scenario, most of the existing agricultural land and infrastructure is protected, while the relatively unused section of land east of the Olympic pipeline, totaling over 400 acres, would be fully restored by constructing a new dike adjacent and parallel to the pipeline on the outboard side. New water control structures and small interior “balloon dikes” (surrounding approximately 200 additional acres) would be constructed to facilitate muted tidal exchange under the near-term restoration alternative.

Based on the amount of new habitat that would be created, our first order estimate of the number of juvenile Chinook salmon that would be able to use this habitat annually is roughly 53,000 to 264,000 smolts per year in the near-term restoration alternative. For the long-term restoration alternative, we estimate that between 263,000 and 1.32 million Chinook salmon smolts would be able to use this

habitat annually. The option to restore the north tip of Ebey Island would provide habitat for 17,000 to 87,000 smolts.

Comments received from members of the Advisory Committee with respect to the preferred alternatives were generally negative and strongly worded. Most individuals were not persuaded to alter their original positions. For example, certain advocates for fish recovery claimed that only alternatives that the diking district would consider were seriously considered in the evaluation. The diking district commissioners, on the other hand, stated their opposition to any proposal which would move the location of dikes or create increased risk of flooding and drainage problems.

Several constructive comments were received and acted upon.

7.3 SUGGESTED NEXT STEPS

While the present feasibility of meeting the long term goal of restoring Ebey Island is low, Ebey Island can contribute to the fulfillment other aspects of WDFW's mission. The National Coastal Wetlands Conservation grant that helped fund acquisition of the property identified short term goals of enhancing and creating freshwater wetlands and implementing a moist soil management program (involving agriculture) that benefits waterfowl. Managing the site for those goals in the near term may be much more feasible technically, economically and socially.

As the WDFW-owned portions of Ebey Island are not likely to be used for salmon restoration in the foreseeable future, the organizations responsible for Chinook recovery should determine whether or not the region can meet its obligations under the Endangered Species Act and Tribal Treaties without restoration of WDFW holdings on Ebey Island. If over time it is shown that salmon restoration goals can be achieved using other lands, the long term goal of restoring WDFW Ebey Island holdings to tidal habitat may be reconsidered. However, in the event that future evaluations conclude that rearing habitat on Ebey Island is needed, the goal will be retained. Should at some point a consortium of agencies, NGOs, and willing landowners develops to accomplish restoration on a substantial part of Ebey Island, then full tidal restoration of WDFW land in conjunction with that project would be allowed in accordance with the commitments made when acquiring the property.

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APPENDIX A:
PRELIMINARY GEOTECHNICAL REPORT

Ebey Island Habitat Restoration Feasibility Study

Snohomish County, Washington

Prepared for:

Washington Department of Fish and Wildlife
600 Capitol Way N.
Olympia, WA 98501-1091

Prepared by:

AMEC Earth & Environmental, Inc.
11810 North Creek Parkway North
Bothell, Washington 98011

February 14, 2011

Project No. 0-915-16971-0

February 14, 2011
0-915-16971-0

Washington Department of Fish and Wildlife
600 Capitol Way N.
Olympia, WA 98501-1091

Attention: Mr. Richard Tveten

Subject: Preliminary Geotechnical Report
Ebey Island Habitat Restoration Feasibility Study
Snohomish County, Washington

Dear Mr. Tveten:

AMEC Earth & Environmental, Inc. (AMEC), is pleased to submit this report describing our geotechnical engineering evaluation for the above-referenced project. The purpose of our geotechnical evaluation was to derive preliminary design conclusions and recommendations concerning the feasibility of dike geometry and construction.

As outlined in our proposal dated January 18, 2001, our scope of work comprised geotechnical research, supplemental field exploration, geotechnical analyses, and report preparation.

SITE AND PROJECT DESCRIPTION

The project site is located on Ebey Island, approximately 1 mile east of Everett, Washington. Washington Department of Fish and Wildlife properties are irregularly shaped parcels concentrated in the northern half of Ebey Island and are generally bounded by SR 2 on the north, Ebey Slough on the east, private properties on the south and west, and by City of Everett and WSDOT properties in the northwest. Ground surface elevations are near or at sea level. Levees border Ebey Slough in the site vicinity and rise approximately 12 feet above existing ground surface.

Most of Ebey Island is used for agricultural purposes with isolated residences and barns scattered across the island. An above-grade water pipeline is located to both the north and south of the subject properties traversing east-west, and a below-grade petroleum pipeline crosses the east side of the subject properties traversing northeast-southwest.

Vegetation across the sites consists of tall grasses with isolated trees throughout the grass-covered areas. A relatively large forested area is located on the east side of the subject properties with vegetation consisting of trees, vines, and brush at elevations above the high-tide elevations. Nearby fields are utilized as crop lands.

Ebey Slough is the largest water feature in the vicinity and runs north south across the eastern edge of the subject properties. Smaller sloughs, such as Deadman Slough, are located across the site. These sloughs are influenced by tidal fluctuations and are generally low-gradient waterways and are prone to periodic flooding activity.

The enclosed *Site & Exploration Plan* (Figure 2) illustrates these site boundaries and adjacent existing features. Preliminary plans include construction of partial or full height protection dikes across the mid sections of Ebey Island, where no significant filling has occurred in the past, and very soft and deep peat soils have been reported. During the first stage of the project, several diking alternatives are being evaluated.

EXPLORATORY METHODS

We explored surface and subsurface conditions at the project site during June, 2010. Our exploration and testing program comprised the following elements:

- A visual surface reconnaissance of the site;
- Five Cone Penetration Test (CPT) soundings (designated CPT-1 through CPT-5) advanced at strategic locations across the site;
- A review of the logs and CPT soundings advanced along the SR 2 trestle for the City of Everett Public Works Departments “Everett Waterline Replacement Project-Phase 6” project by ZZA dated October 11, 2004;
- A review of four geotechnical reports from Olympic Pipe Line Company for the petroleum pipe line that crosses the east side of Ebey Island traversing northeast-southwest, by GeoEngineers, dated October 15, 1996, January 22, 2002, and March 10 and November 19, 2004 August, 1991; and
- A review of published geologic maps.

Table 1 summarizes the approximate functional locations, and termination depths of our CPT soundings, and Figure 2 depicts their approximate relative locations. The following text sections describe our procedures used for soil borings and observation well installations.

Table 1 Approximate Locations, and Depths of CPT Soundings

Exploration	Functional Location	Termination Depth (feet)
CPT-1	NW corner of Ebey Island	50.2
CPT-2	NW corner of Ebey Island, approx. 950 ft west of Homeacres Road	50.2
CPT-3	Central portion of Ebey Island, approx. 2,700 ft north of Alexander Property (Barn)	50.2
CPT-4	Central portion of Ebey Island, approx. 1,200 ft north of Alexander Property (Barn)	50.2
CPT-5	East side of Ebey Island, approx. 2,100 ft east of Alexander Property (Barn)	49.9

The specific number, locations, and depths of our explorations were selected in relation to the existing and proposed site features, under the constraints of surface access, underground utility conflicts, and budget considerations. We estimated the relative location of each exploration by measuring from existing features and scaling these measurements onto a layout plan supplied to us by Washington Department of Fish and Wildlife. Consequently, the data listed in Table 1 and the locations depicted on Figure 2 should be considered accurate only to the degree permitted by our data sources and implied by our measuring methods.

It should be realized that the explorations performed for this evaluation reveal subsurface conditions only at discrete locations across the project site and that actual conditions in other areas could vary. Furthermore, the nature and extent of any such variations would not become evident until additional explorations are performed or until construction activities have begun. If significant variations are observed at that time, we may need to modify our conclusions and recommendations contained in this report to reflect the actual site conditions.

CPT PROBING PROCEDURES

Our exploratory CPT probings consisted of advancing an electric cone penetrometer piezocone, using a track-mounted probe rig operated by an independent firm working under subcontract to AMEC. CPT probes were advanced while electronic monitoring equipment in the probe rig automatically logged the subsurface conditions. After each probing was completed, the probehole was backfilled with a mixture of sand and bentonite chips.

Throughout the probing operation, soil and groundwater properties were measured by means of the CPT per ASTM:D-3441. This testing procedure involves pushing an electric piezocone mounted on 1.5-inch diameter cylindrical steel rod into the soil with hydraulic rams. The cone consists of a standard design having a 60-degree tip apex, a 10-cm^2 projected area at the tip, a 150-cm^2 sleeve, and a porous element at the tip. The cone was advanced at a rate of approximately 2 cm per second, and the cone tip resistance (q_T), sleeve friction (f_s), and penetration porewater pressure (u_2) were

recorded continuously during the tests. As the penetrometer is pushed downward, the tip resistance, sleeve friction, and porewater pressure are measured electronically and plotted as a function of depth. Through interpretation, the resulting graphs can reveal soil types and groundwater levels, as well as the relative density of granular soils and the relative consistency of cohesive soils.

The enclosed CPT graphs present the vertical plots of several soil properties and groundwater pressures measured by the cone penetrometer in each probing. These graphs also depict the Standard Penetration Resistance (N_{60}) corresponding to each test interval, based on published conversion charts. The enclosed *Probing Logs* describe the vertical sequence of soils encountered in each probing, based primarily on interpretation of the CPT graphs and supported by correlation with our logs of nearby borings.

SITE CONDITIONS

The following sections of text present our observations, measurements, findings, and interpretations regarding development, utility, surface, soil, groundwater and seismic conditions at the project site.

DEVELOPMENT CONDITIONS

Most of Ebey Island is used for agricultural purposes with isolated residences and barns scattered across the island. An above grade water pipeline is located to both the north and south of the subject properties traversing east-west, and a below grade petroleum pipeline crosses the east side of the subject properties traversing northeast-southwest. Although not observed, the presence of utilities corridors along the existing roadway alignments should be assumed.

SURFACE CONDITIONS

The Washington Department of Fish and Wildlife properties are irregularly shaped parcels concentrated in the northern half of Ebey Island and are generally bounded by SR 2 on the north, Ebey Slough on the east, private properties along the Snohomish River on the south and west, and by City of Everett and WSDOT properties in the northwest. Ground surface elevations are near or at sea level. Levees border Ebey Slough and the Snohomish River in the site vicinity and rise approximately 12 feet above existing ground surface.

SOIL CONDITIONS

According to the published geologic map of the Ebey Island area, *Geologic Map of the Everett 7.5 minute Quadrangle, Snohomish County, Washington* (Minard, 1985), soil conditions in the site vicinity are characterized by Peat deposits (Qp) and Alluvium (Qal). The Peat deposits are composed predominantly of organic matter consisting of plant material and woody debris and occasionally contain small amounts of sand, silt, clay, and volcanic ash deposited in swamps and bogs. The

Alluvium deposits are composed of clay, silt, very fine to fine sand, and abundant organic material deposited by streams and running water. Glacial soils including till, recessional outwash, and advance outwash are mapped within upland areas to the south, east, and west. No glacial units are mapped within the subject property.

Our on-site explorations revealed similar near-surface soil conditions as the mapped stratigraphy. In general, the results of our CPT soundings showed that compressible soils consisting of peat and silty clay underlie the site(s). The silty clay was predominantly very soft to soft with occasional zones that would be described as medium stiff. These compressible soils were encountered to a depth of about 17.5 feet below existing grade in the NW corner of the Ebey Island (CPT-1) and were underlain by predominantly medium dense to dense sand and silty sand with occasional interbedded layers of medium stiff to stiff clays and silts. The compressible peat and clay was encountered in the other four CPT soundings to the full depth explored (50 feet below existing grade) with the peat generally encountered within the upper 15 feet.

AMEC obtained the subsurface information in the form of borings logs and a cross section for the City of Everett Public Works Departments “Everett Waterline Replacement Project—Phase 6” project. These explorations traverse E-W along the north side of Ebey Island parallel to the HWY 2 trestle. The soils underlying the waterline alignment west of Homeacres Road generally consist of about 20 to 25 feet of compressible soils consisting of peat and very soft to soft clayey silt, sandy silt, organic silt, and silty clay. East of Homeacres Road, these same compressible soils were generally encountered up to 80 to 120 feet below existing grade. Along the entire alignment, the peat was generally encountered within the upper 20 to 30 feet. The compressible soils were underlain by medium dense to dense sand, gravelly sand, and sandy gravel. A cross-section illustrating these subsurface conditions is presented in Figures 3A through 3C.

AMEC obtained four geotechnical reports from Olympic Pipe Line Company for the petroleum pipe line that crosses the east side of Ebey Island traversing northeast-southwest. Compressible soils consisting of very soft to soft peat, silt and organic silt were encountered to depths of about 50 to 90 feet below existing grade. The compressible soils were underlain by medium dense sand and silty sand and medium stiff to stiff silt.

We interpret these soils to be above their optimum moisture contents, and to be highly sensitive to moisture content variations. These soils are moisture sensitive and would be impossible to use as structural fill due to the presence of abundant organic material

GROUNDWATER CONDITIONS

Groundwater measurements were not taken during our CPT soundings. However, based on the geotechnical information provided in the City of Everett Public Works Departments "Everett Waterline Replacement Project—Phase 6" project and the four geotechnical reports from Olympic Pipe Line Company for the petroleum pipeline that crosses the east side of Ebey Island traversing southwest and northeast, groundwater was encountered at various depths ranging from within 1 to 2 feet of the ground surface to as deep as 88 feet below ground surface. Shallow groundwater depths were observed in the north end of Ebey Island, whereas groundwater was generally encountered much deeper toward the south.

SEISMIC CONDITIONS

The soils beneath the site consist of peat deposits and alluvium overlying mostly medium dense to dense and silty sand (older alluvium). In accordance with 2006 *International Building* Code Table 1613.5.2, we recommend using Site Class D, due to the relatively soft condition of the upper 100 feet of soil (based on geologic maps and our explorations).

The following maximum considered spectral accelerations should be used to determine the design response spectrum, per Figure 1613:

Spectral Acceleration for short periods (Ss):	114 percent of gravity (1.143g)
Spectral Acceleration for a 1-second period (S1):	40 percent of gravity (0.397g)

A value of 0.90 should be used for site coefficient Fa and 2.412 for site coefficient Fv.

The peak ground acceleration for the site was determined using the U.S. Geological Survey Website (http://earthquake.usgs.gov/research/hazmaps/design/) and the project area latitude and longitude. According to current USGS mapping, the peak ground acceleration for a 10 percent probability of exceedance in 50 years (475 year return period) is 0.28g.

LIQUEFACTION ANALYSIS

Liquefaction is a sudden increase in porewater pressure and a sudden loss of soil shear strength caused by shear strains, as could result from an earthquake. Research has shown that saturated, loose sands with a fines (silt and clay) content less than about 25 percent are most susceptible to liquefaction. The soils are not likely to liquefy during an earthquake due to the relatively high silt and clay content of the upper alluvial soils and the density of the deeper, older alluvial soils.

CONCLUSIONS AND RECOMMENDATIONS

Preliminary plans include construction of partial or full height protection dikes across the mid sections of Ebey Island, where no significant filling has occurred in the past, and very soft and deep peat soils have been reported. During the first stage of the project, several diking alternatives are being evaluated. We offer the following preliminary geotechnical conclusions and recommendations concerning this improvement project.

We understand that a full height cross dike will be about 13 to 15 feet high and smaller muted tidal exchange dikes will be about 6 to 8 feet high. The crown for both dikes will be a minimum of 10 feet wide for access and have side slopes of 2H:1V. Based on our review, the construction of new dikes is feasible, with the following considerations:

SITE PREPARATION AND GRADING

Preparation of the project site should involve temporary drainage, clearing, subgrade compaction, and construction of access roads. The paragraphs below discuss our preliminary geotechnical comments and recommendations concerning site preparation.

Prior to site development, the contractor should install a temporary erosion control system to divert runoff away from the areas to be exposed during grading, and to prevent sediments from being transported off the site. Also, the contractor should make provisions for the interception and diversion of any groundwater seepage entering the work areas. After surface and near-surface water sources have been controlled, the construction areas should be cleared of all trees and bushes and, where possible, the grass mat should be closely mowed. Grubbing should be performed to remove any localized larger stumps or root wads. We do not recommend stripping the grass sod or topsoils since the underlying disturbed, soft organic silts will be difficult for heavy equipment to operate upon.

Due to the soft nature of near surface soils across the site, it may be necessary to use special, low-impact, track-mounted vehicles to perform most of the earthwork. Additionally, it will likely be necessary to temporary construction roads using reinforcement geogrid, or lightweight fills, such as hog-fuel, shells, or lightweight rock (pumice or scoria). Typical construction traffic across the existing ground would likely destroy the surface, resulting in severe rutting or even the possible loss of equipment.

DIKE CONSTRUCTION

Following clearing and grubbing, we recommend that a layer of soil stabilization geotextile per WSDOT 9-33.2, Table 3, Soil Stabilization, Non Woven be installed on the native ground prior to the placement of new fill. Fill placed atop the separation fabric should be constructed by advancing a

single initial soil lift with a dozer. In no case should dump trucks or other heavy equipment operate directly upon the native subgrade or separation fabric. We would recommend an initial, loose lift thickness of 2 feet be placed by this method. Subsequent filling should be accomplished by spreading level lifts not exceeding 1 foot in loose thickness, with each lift compacted to at least 90 percent density, using ASTM:D1557 as the standard.

Since the foundation soils are very soft and nearly saturated, rapid fill placement during levee construction would likely cause bearing capacity failures of foundation soils. Therefore, we recommend that both the new and expanded levees be constructed in two or three stages to avoid potential bearing capacity failure of foundation soils. We estimate that 6 to 7 feet of fill can be constructed and left in place following the site preparation. The first stage fill should remain in place for approximately 1 year prior to the placement of the remaining fill. During the 1-year period, the foundation soil will consolidate and regain most of its drained strength. Settlement plates should be installed along the levees to monitor the progress of consolidation of the foundation soils.

We anticipate that approximately 2.5 to 5 feet of overfill would need to be added during initial construction to account for the primary consolidation of the foundation soils within the first 2 years. The estimate for future settlement, i.e. the actual amount of overfill, can be more accurately refined following the settlement observation of the first stage levee construction.

STRUCTURAL FILL

On-Site Soil Considerations: The on-site soils that would be excavated from the channels have elevated moisture contents, are high in organic matter, and would require significant drying in order to re-use as structural fill. While these soils would not be suitable for use as structural fill within the new levees, they could be used in the berms that would be constructed within the habitat area, or as organic topsoil material on the side slopes of the levees.

Borrow Sources: According to the US Army Corps of Engineers Engineering and Design Manual for the Design and Construction of Levees (EM-1110-2-1913), there is no specific requirement for levee borrow material. Section 4-2a of the manual states that “almost any soil is suitable for constructing levees, except very wet, fine-grained soils or highly organic soils.” Most of the near-surface on-site soils meet the description of very wet, fine-grained, or highly organic soils and would therefore not be a suitable borrow source. At this time, we are not aware that a possible borrow source of “low-permeability” soils has yet been identified.

As the sources of imported material are identified, we recommend conducting at least two grain size distribution tests and two Proctor compaction tests for soils obtained from each borrow source. In addition, we recommend conducting a direct shear test on soil samples prepared by using standard

Proctor compaction (ASTM D-698) for each borrow source to verify the design shear strength of the levee soils. If desired, the hydraulic conductivity of the compacted soils can be determined by a series of laboratory permeability tests for seepage analysis purposes.

EROSION CONTROL

We anticipate that 2H:1V slopes would be feasible on embankments not exposed to water, assuming the embankment is fully compacted and is protected from erosion with continuous grass vegetation cover. On the other hand, embankment slopes that are inundated by water could experience surficial erosion or sloughing under sudden drawdown conditions. For several of the alternatives considered on this project, both sides of the embankment would be inundated by water with fluctuating water surfaces. We anticipate that these water-side embankments will need to be on the order of 2.5H:1V or flatter. We would recommend that slopes exposed to water be blanketed with a 1-foot layer of quarry spalls per WSDOT 9-13.6, or shoulder ballast, per WSDOT 9-03.9(2). A geotextile fabric (per WSDOT 9-33.2, Table 1, Moderate Survivability, Non Woven and Table 2, Class A) should be placed beneath the crushed rock armoring, to provide separation and to limit fines migration out of the embankment. It may be feasible to protect the slopes with permanent erosion control fabric and a thick grass vegetative cover. However, in our experience, there may be a need for periodic maintenance using additional planting, or by placing shoulder ballast or quarry spalls in failed areas. If quarry spall facing is not permitted, vegetated slopes of 3H:1V or flatter would be required.

If portions of the dike are also to be protected from periodic overtopping, more extensive armoring and flatter slope inclinations may need to be considered. NCRS has recommended slopes as flat as 5H:1V with thick grass vegetation to protect against uniform overtopping of a dike. If concentrated flow is directed to a portion of the dike as an emergency spillway, heavy rock armoring or concrete facing would need to be considered.

FUTURE MAINTENANCE

Due to the anticipated long-term settlement, additional fill may be required to maintain the design heights of the dikes. Surficial erosion and sloughing may occur on the slope, especially following a rapid drawdown event. As a result, periodic repair of the slope and restoration of vegetation may be necessary. We would recommend the slope conditions be examined after each major rainstorm (or at least monthly) for the first year after construction. Less frequent visits (semi-annual or quarterly) would be anticipated in the future.

RECOMMENDATIONS FOR GEOTECHNICAL DESIGN PHASE

After the preferred alternatives have been established, we should be retained to perform a design-phase geotechnical evaluation. Such an evaluation should include advancing additional borings along

the new dike alignments, conducting laboratory tests, performing geotechnical engineering analyses including slope stability, seepage, and settlement analyses of the dikes, and preparing a *Geotechnical Engineering Report*.

CLOSURE

The preliminary conclusions and recommendations presented in this report are based, in part, on the explorations that we performed for this study. If our design-phase geotechnical explorations reveal significant variations in subgrade conditions, we may need to revise these conclusions and recommendations. AMEC would be pleased to submit a proposal for a design-phase evaluation after building locations and details have been established.

We appreciate the opportunity to be of service on this project. If you have any questions regarding this report or any aspects of the project, please feel free to contact our office.

Sincerely,
AMEC Earth & Environmental, Inc.

CARLO EVANGELISTI
STATE OF WASHINGTON
43063
REGISTERED
PROFESSIONAL ENGINEER

14 Feb 11

Carlo Evangelisti, P.E.
Senior Engineer

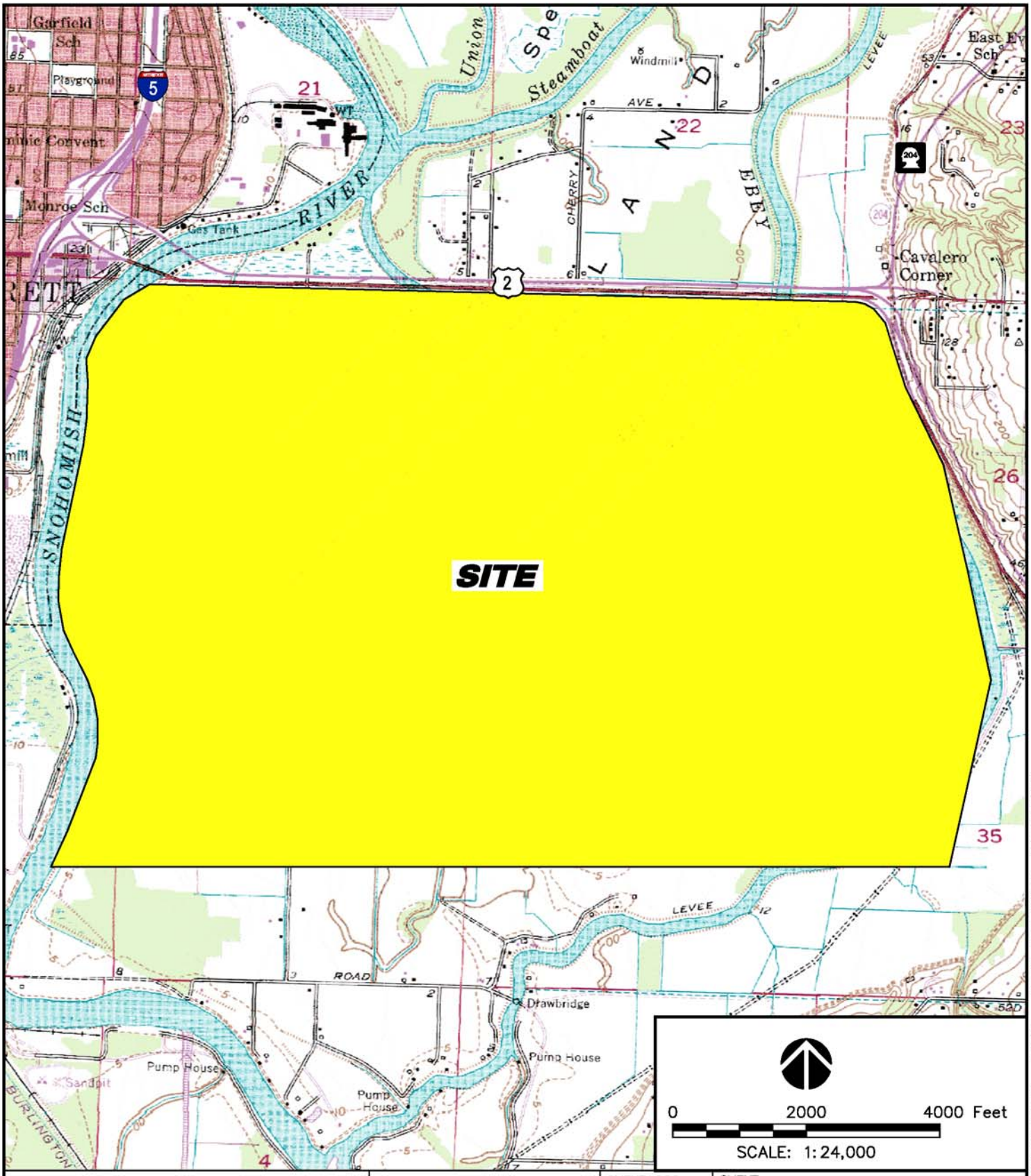
Reviewed by: James S. Dransfield, P.E., Principal

CE/JSD/VM/LS

Enclosures:

Figure 1	Location Map
Figure 2	Site & Exploration Plan
Figure 3A – 3D	Plan and Generalized Subsurface Profile—WSDOT Eastbound SR-2 LE Centerline (From Everett Waterline Replacement Project—Phase 6)

CPT Logs CPT-1 Through CPT-5



AMEC Earth & Environmental 11810 North Creek Parkway North Bothell, WA, U.S.A. 98011-8201	amec	CLIENT LOGO	CLIENT WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

PROJECT EBEY ISLAND HABITAT RESTORATION FEASIBILTY STUDY	DWN BY: JRS	DATUM: NAD83	DATE: JULY 2010
TITLE SITE LOCATION MAP	CHK'D BY: CE	REV. NO.:	PROJECT NO: 0-915-16971-0
	PROJECTION: WA STATE PLANE	SCALE: AS SHOWN	FIGURE No. 1

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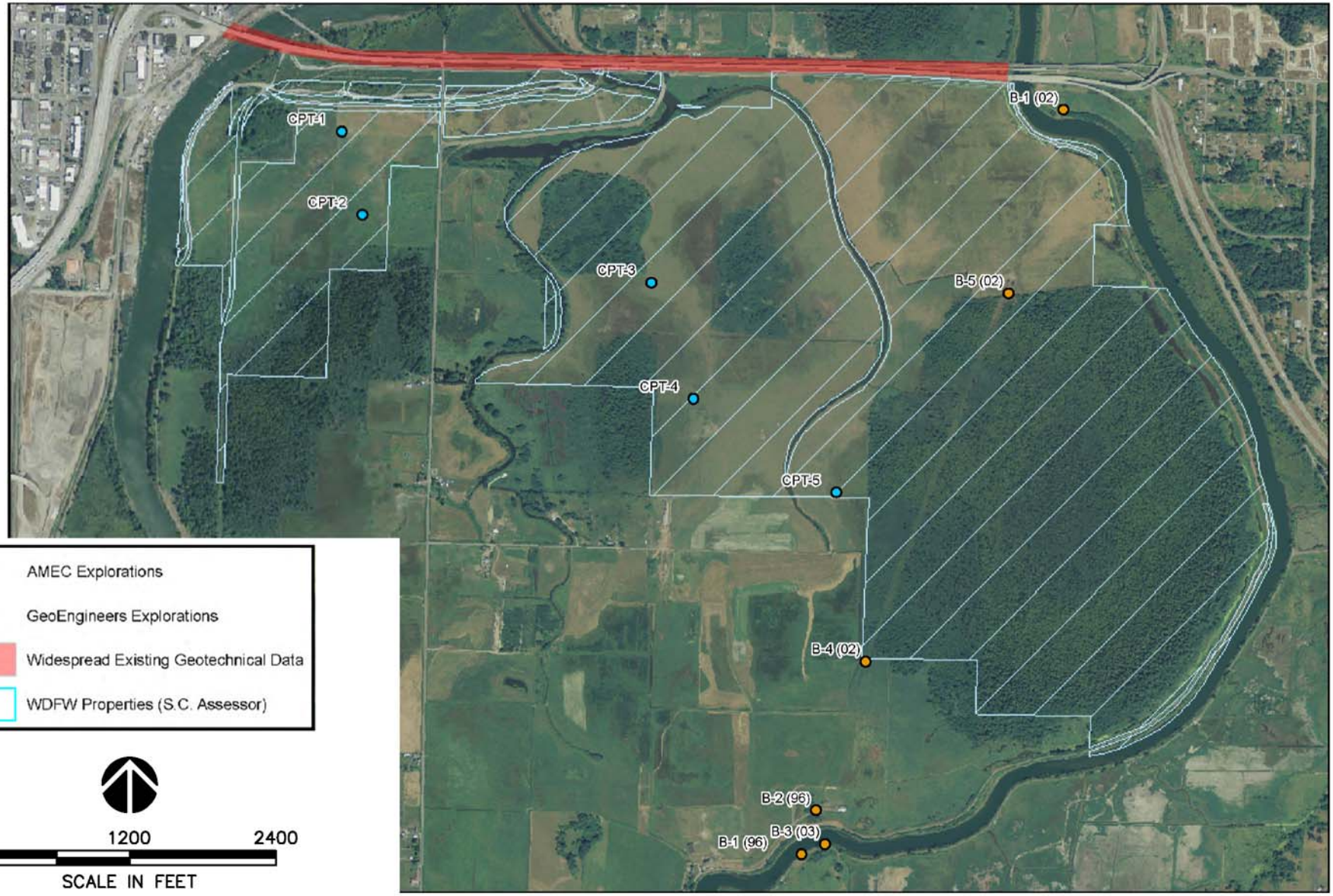

AMEC Explorations

GeoEngineers Explorations

Widespread Existing Geotechnical Data

WDFW Properties (S.C. Assessor)

0 1200 2400

SCALE IN FEET

CLIENT LOGO	CLIENT WASHINGTON DEPARTMENT OF FISH AND WILDLIFE	DWN BY: JRS CHK'D BY: CE	PROJECT EBEY ISLAND HABITAT RESTORATION FEASIBILITY STUDY	REV. NO.: DATE: JULY 2010
AMEC Earth & Environmental 11810 North Creek Parkway North Bothell, WA, U.S.A. 98011-8201	amec	DATUM: NONE PROJECTION: NONE SCALE: AS SHOWN	TITLE SITE AND EXPLORATION PLAN	PROJECT NO: 0-915-16971-0 FIGURE No. 2

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SOIL UNIT DESCRIPTION

UNIT 1	FILL - GRAVELLY SAND, SILTY SAND AND SAND
UNIT 2	VERY SOFT TO SOFT CLAYEY SILT, SANDY SILT, ORGANIC SILT AND SILTY CLAY WITH THIN TO THICK LAYERS OF PEAT. FIBROUS ORGANIC MATERIAL IS PRESENT THROUGHOUT THE DEPOSIT. INCREASING TO MEDIUM STIFF TO STIFF WITH DEPTH AND WHERE UNIT 2 UNDERLIES UNTI 4.
UNIT 3	VERY LOOSE TO MEDIUM DENSE SAND AND SILTY SAND
UNIT 4	MEDIUM DENSE TO VERY DENSE SAND, GRAVELY SAND, AND SANDY GRAVEL WITH VARIABLE AMOUNTS OF SILT AND INTERBEDS OF SANDY SILT. COBBLES WERE ENCOUNTERED IN THIS UNIT IN SOME AREAS.
UNIT 4B	SAME AS UNIT 4 BUT LOOSE TO DENSE.
UNIT 5	INITERBEDDED MEDIUM STIFF TO STIFF CLAYEY SILT AND SANDY SILT, AND MEDIUM DENSE TO VERY DENSE SILTY SAND.
UNIT 6	THIS SOIL UNIT, WHICH IS DESCRIBED IN THE GEOTECHNICAL REPORT FOR STAGE 1 OF THE WSDOT EASTBOUND SR-2 PROJECT, WAS NOT ENCOUNTERED IN THE EXPLORATIONS WITHIN PHASES 6 AND 7 OF THE CITY OF EVERETT WATERLINE REPLACEMENT PROJECT.
UNIT 7	VERY DENSE SILTY SAND, SAND, GRAVELLY SAND AND SANDY GRAVEL.
UNIT 8	THIS SOIL UNIT, WHICH IS DESCRIBED IN THE GEOTECHNICAL REPORT FOR STAGE 1 OF THE WSDOT EASTBOUND SR-2 PROJECT, WAS NOT ENCOUNTERED IN THE EXPLORATIONS WITHIN PHASES 6 AND 7 OF THE CITY OF EVERETT WATERLINE REPLACEMENT PROJECT.
UNIT 9	MEDIUM STIFF TO STIFF, MASSIVE, NON-PLASTIC SILT AND LOW PLASTICITY CLAY.
UNIT 10	VERY SOFT TO SOFT, GRAY TO VERY DARK BROWN, SATURATED, FINE SANDY, SILTY PEAT AND PEAT WITH OCCASIONAL GRAVEL CLASTS AND INTERBEDS OF UNIT 2 SOILS.

SOURCE: PLAN & PROFILE LEGEND, FROM EVERETT WATERLINE REPLACEMENT PROJECT - PHASE 6 PROJECT BY ZIPPER ZEMAN ASSOCIATES, INC., DATED FEBRUARY 20, 2004.

AMEC Earth & Environmental
11810 North Creek Parkway North
Bothell, WA, U.S.A. 98011-8201

CLIENT LOGO

CLIENT: WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

PROJECT: EBEY ISLAND HABITAT RESTORATION FEASIBILITY STUDY	DWN BY: JRS	DATUM: NONE	DATE: JULY 2010
TITLE: SOIL UNIT DESCRIPTION FOR PROFILES	CHK'D BY: CE	REV. NO.:	PROJECT NO: 0-915-16971-0
	PROJECTION: NONE	SCALE: NONE	FIGURE No. 3A

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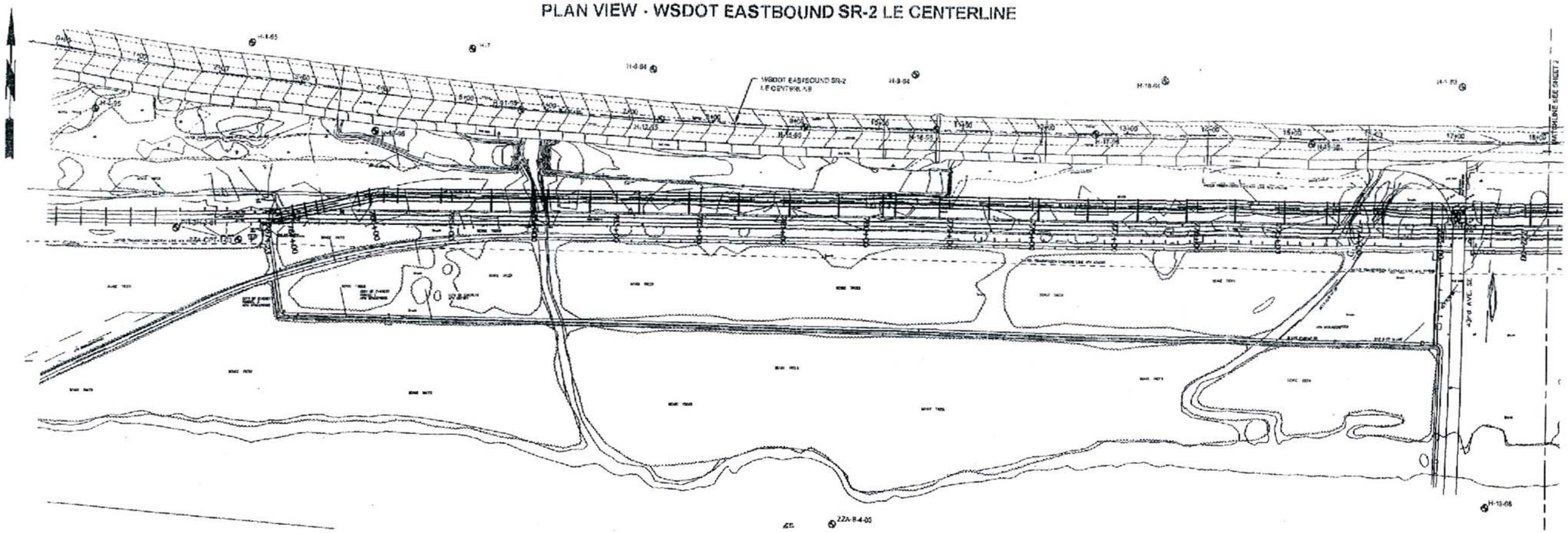
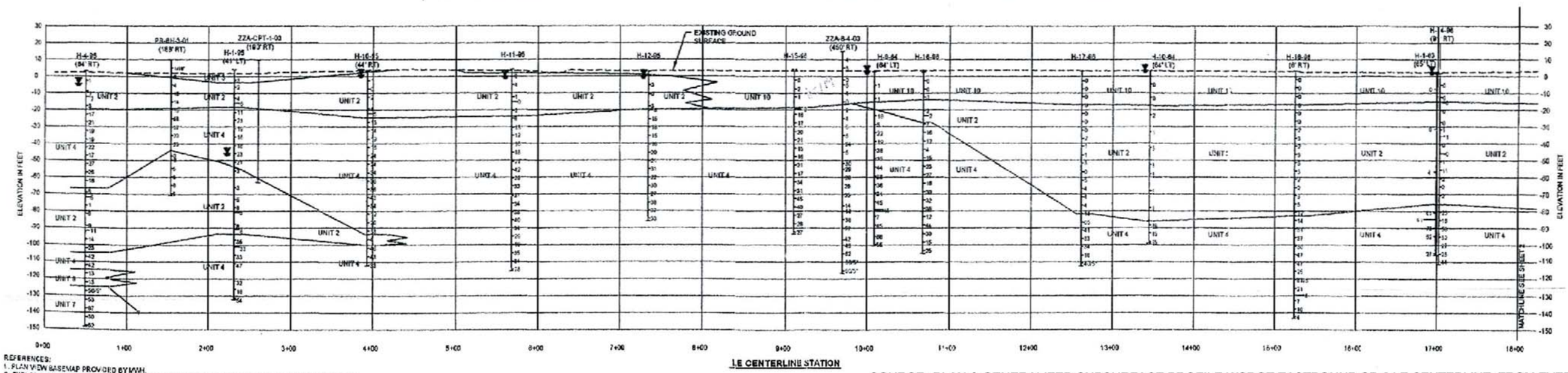
PLAN VIEW - WSDOT EASTBOUND SR-2 LE CENTERLINE



GENERALIZED SUBSURFACE PROFILE - WSDOT EASTBOUND SR-2 LE CENTERLINE



REFERENCES:
1. PLAN VIEW BASEMAP PROVIDED BY MWH.
2. EXPLORATION LOCATIONS AND LOGS PROVIDED BY WSDOT, CONVERSE CONSULTANTS N.W. AND PACRIM.

SOURCE: PLAN & GENERALIZED SUBSURFACE PROFILE WSDOT EASTBOUND SR-2 LE CENTERLINE, FROM EVERETT WATERLINE REPLACEMENT PROJECT - PHASE 6 PROJECT BY ZIPPER ZEMAN ASSOCIATES, INC., DATED FEBRUARY 20, 2004.

0 70 140 280
SCALE IN FEET

CLIENT LOGO

CLIENT:
WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

AMEC Earth & Environmental
11810 North Creek Parkway North
Bothell, WA, U.S.A. 98011-8201

DWN BY:	JRS
CHK'D BY:	CE
DATUM:	NONE
PROJECTION:	NONE
SCALE:	AS SHOWN

PROJECT
EBEY ISLAND HABITAT RESTORATION FEASIBILITY STUDY

TITLE
PLAN AND GENERALIZED SUBSURFACE PROFILE WSDOT EASTBOUND SR-2 LE CENTERLINE

DATE: JULY 2010
PROJECT NO: 0-915-16971-0
REV. NO.:
FIGURE No. 3B

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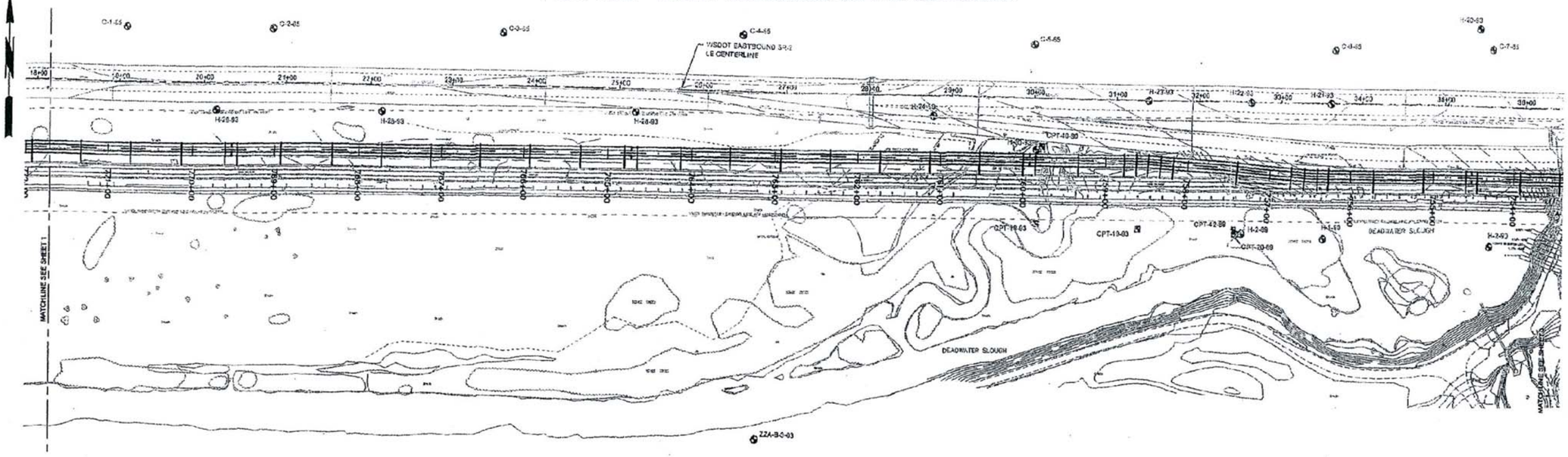
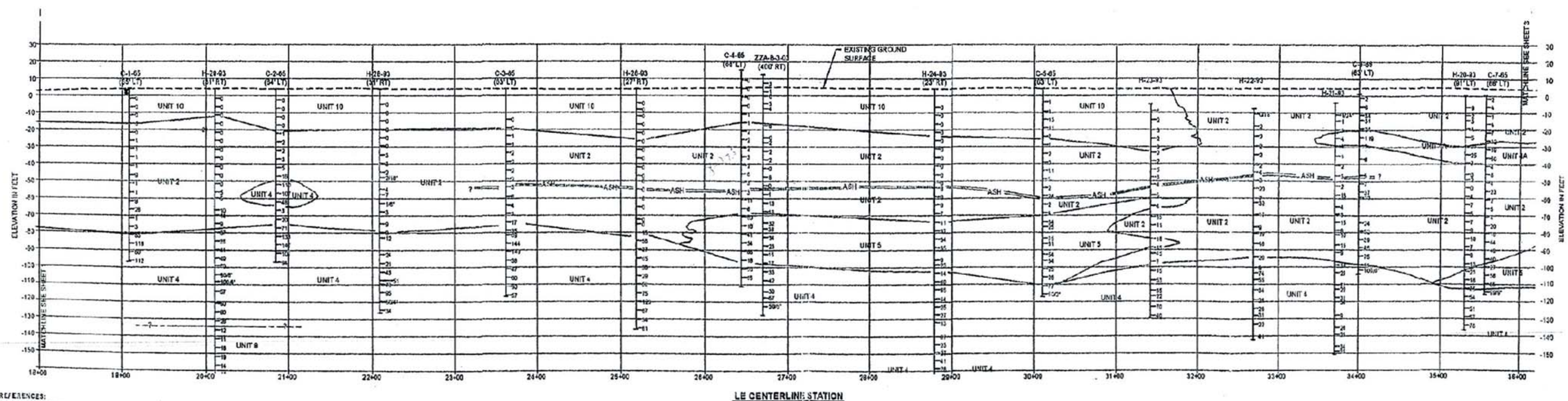
PLAN VIEW - WSDOT EASTBOUND SR-2 LE CENTERLINE



GENERALIZED SUBSURFACE PROFILE - WSDOT EASTBOUND SR-2 LE CENTERLINE



REFERENCES:
1. PLAN VIEW BASEMAP PROVIDED BY NWH.
2. EXPLORATION LOCATIONS AND LOGS PROVIDED BY WSDOT, CONVERSE CONSULTANTS N.W. AND PACRIM.

SOURCE: PLAN & GENERALIZED SUBSURFACE PROFILE WSDOT EASTBOUND SR-2 LE CENTERLINE, FROM EVERETT WATERLINE REPLACEMENT PROJECT - PHASE 6 PROJECT BY ZIPPER ZEMAN ASSOCIATES, INC., DATED FEBRUARY 20, 2004.

0 70 140 280
SCALE IN FEET

CLIENT LOGO

CLIENT:
WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

AMEC Earth & Environmental
11810 North Creek Parkway North
Bothell, WA, U.S.A. 98011-8201

DWN BY:	JRS
CHK'D BY:	CE
DATUM:	NONE
PROJECTION:	NONE
SCALE:	AS SHOWN

PROJECT
EBEY ISLAND HABITAT RESTORATION FEASIBILITY STUDY

TITLE
PLAN AND GENERALIZED SUBSURFACE PROFILE WSDOT EASTBOUND SR-2 LE CENTERLINE

DATE: JULY 2010
PROJECT NO: 0-915-16971-0
REV. NO.:
FIGURE No. 3C

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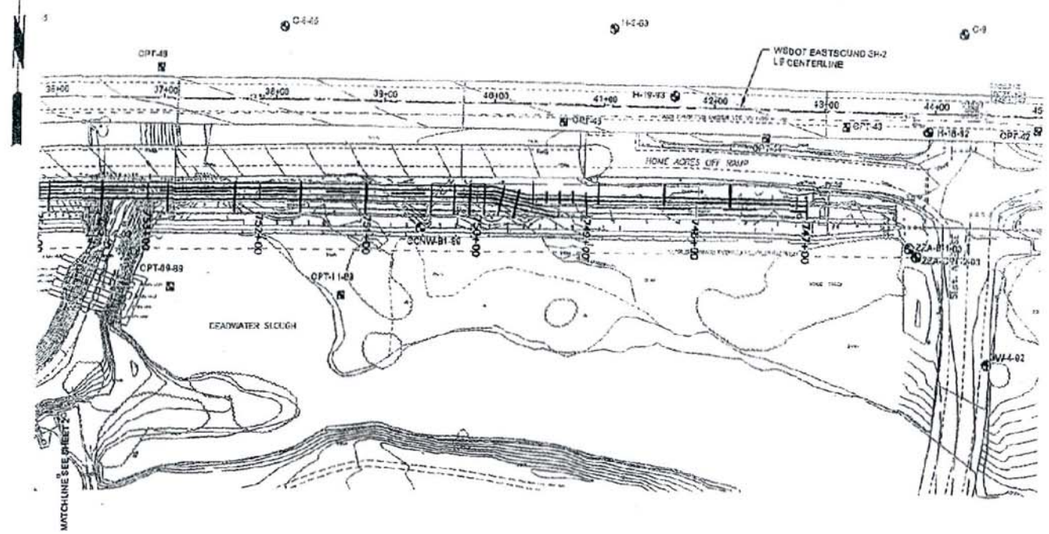
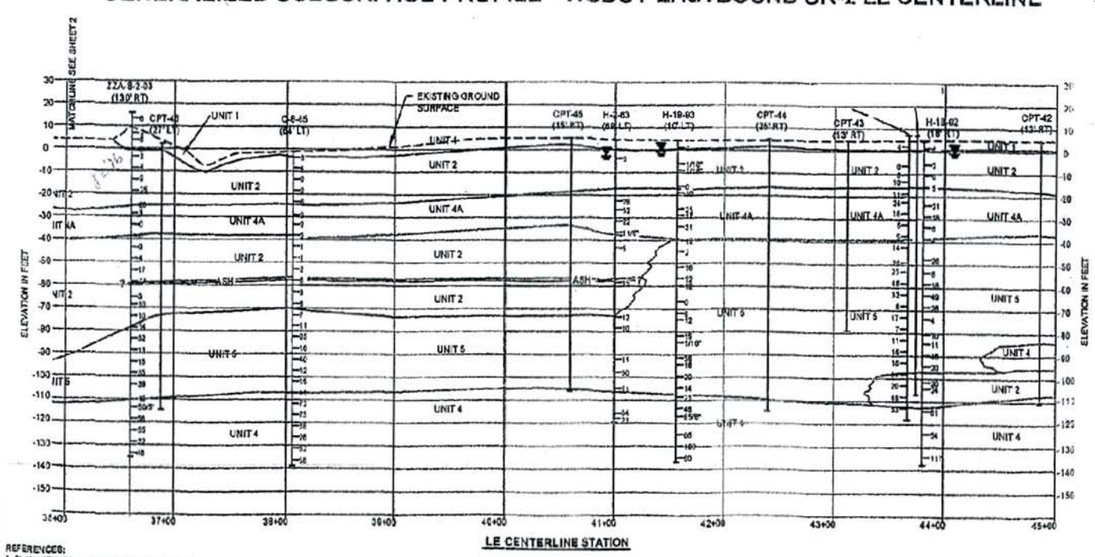
PLAN VIEW - WSDOT EASTBOUND SR-2 LE CENTERLINE



GENERALIZED SUBSURFACE PROFILE - WSDOT EASTBOUND SR-2 LE CENTERLINE



REFERENCES:
1. PLAN VIEW BASEMAP PROVIDED BY MWH.
2. EXPLORATION LOCATIONS AND LOGS PROVIDED BY WSDOT, CONVERSE CONSULTANTS N.W. AND PACRIM.

SOURCE: PLAN & GENERALIZED SUBSURFACE PROFILE WSDOT EASTBOUND SR-2 LE CENTERLINE, FROM EVERETT WATERLINE REPLACEMENT PROJECT - PHASE 6 PROJECT BY ZIPPER ZEMAN ASSOCIATES, INC., DATED FEBRUARY 20, 2004.

0 70 140 280
SCALE IN FEET

CLIENT LOGO

CLIENT:
WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

AMEC Earth & Environmental
11810 North Creek Parkway North
Bothell, WA, U.S.A. 98011-8201

DWN BY:	JRS
CHK'D BY:	CE
DATUM:	NONE
PROJECTION:	NONE
SCALE:	AS SHOWN

PROJECT
EBEY ISLAND HABITAT RESTORATION FEASIBILITY STUDY

TITLE
PLAN AND GENERALIZED SUBSURFACE PROFILE WSDOT EASTBOUND SR-2 LE CENTERLINE

DATE:	JULY 2010
PROJECT NO:	0-915-16971-0
REV. NO.:	
FIGURE No.	3D

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AMEC

Operator: Witthus
Sounding: CPT-1
Cone Used: DSG1079

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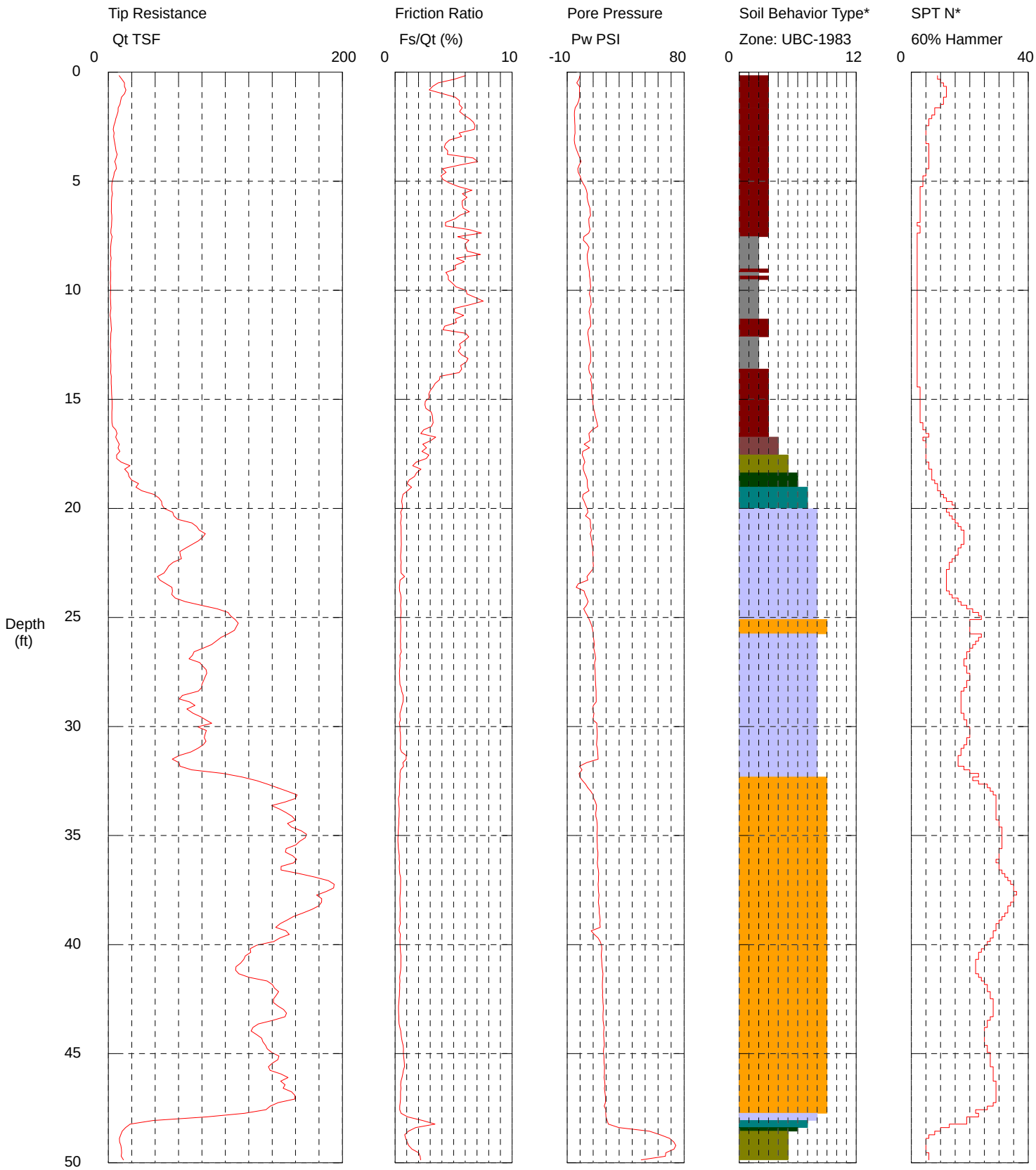
Location: Ebey Island Restoration Feasibility Study
Job Number: 0-917-16971-0



Maximum Depth = 50.20 feet

Depth Increment = 0.164 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

In Situ Engineering

*Soil behavior type and SPT based on data from UBC-1983

AMEC

Operator: Witthus
Sounding: CPT-2
Cone Used: DSG1079

CPT Date/Time: 6/15/2010 10:14:49 AM
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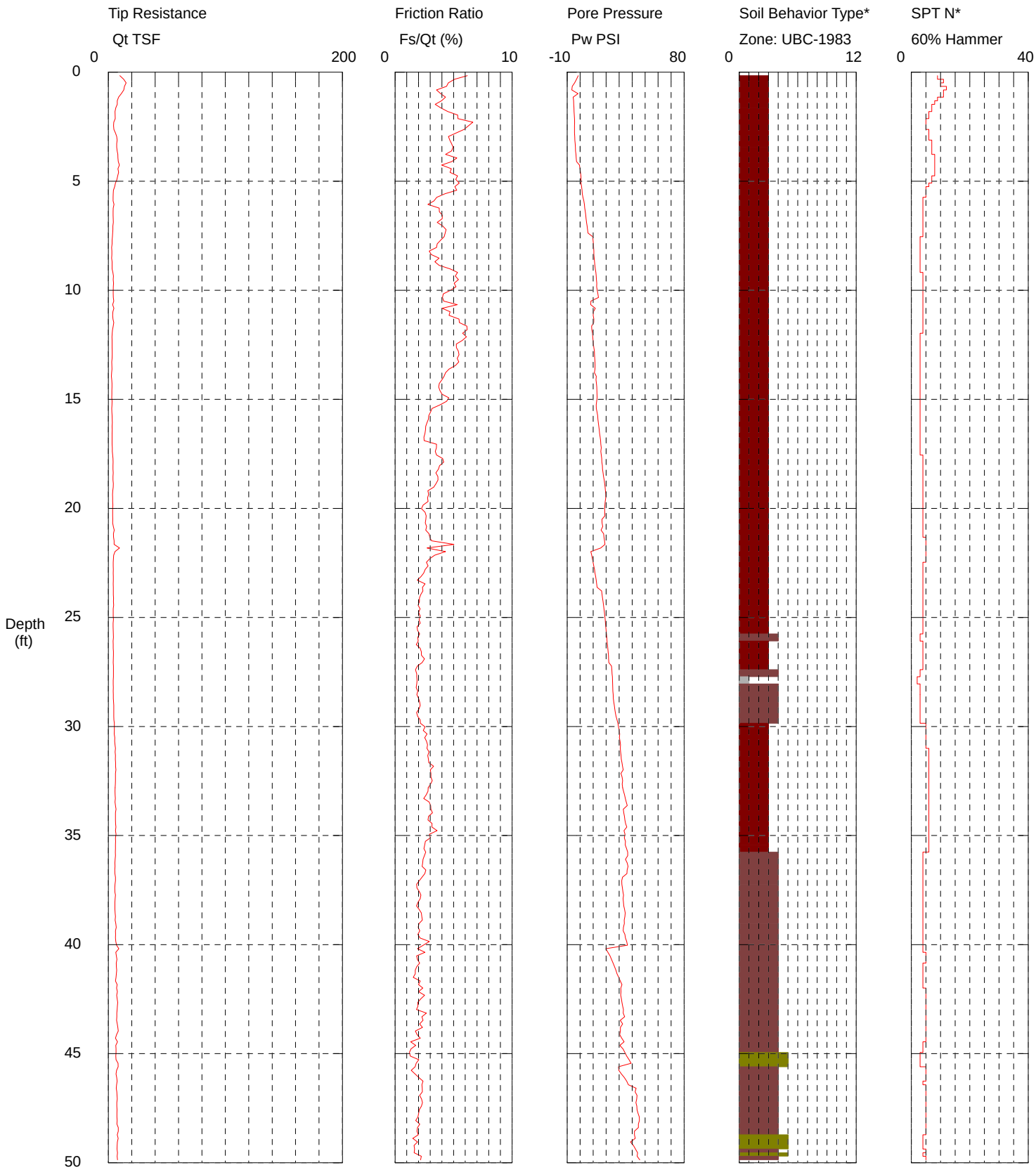
Job Number: 0-917-16971-0



Maximum Depth = 50.20 feet

Depth Increment = 0.164 feet

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2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

In Situ Engineering

*Soil behavior type and SPT based on data from UBC-1983

AMEC

Operator: Witthus
Sounding: CPT-3
Cone Used: DSG1079

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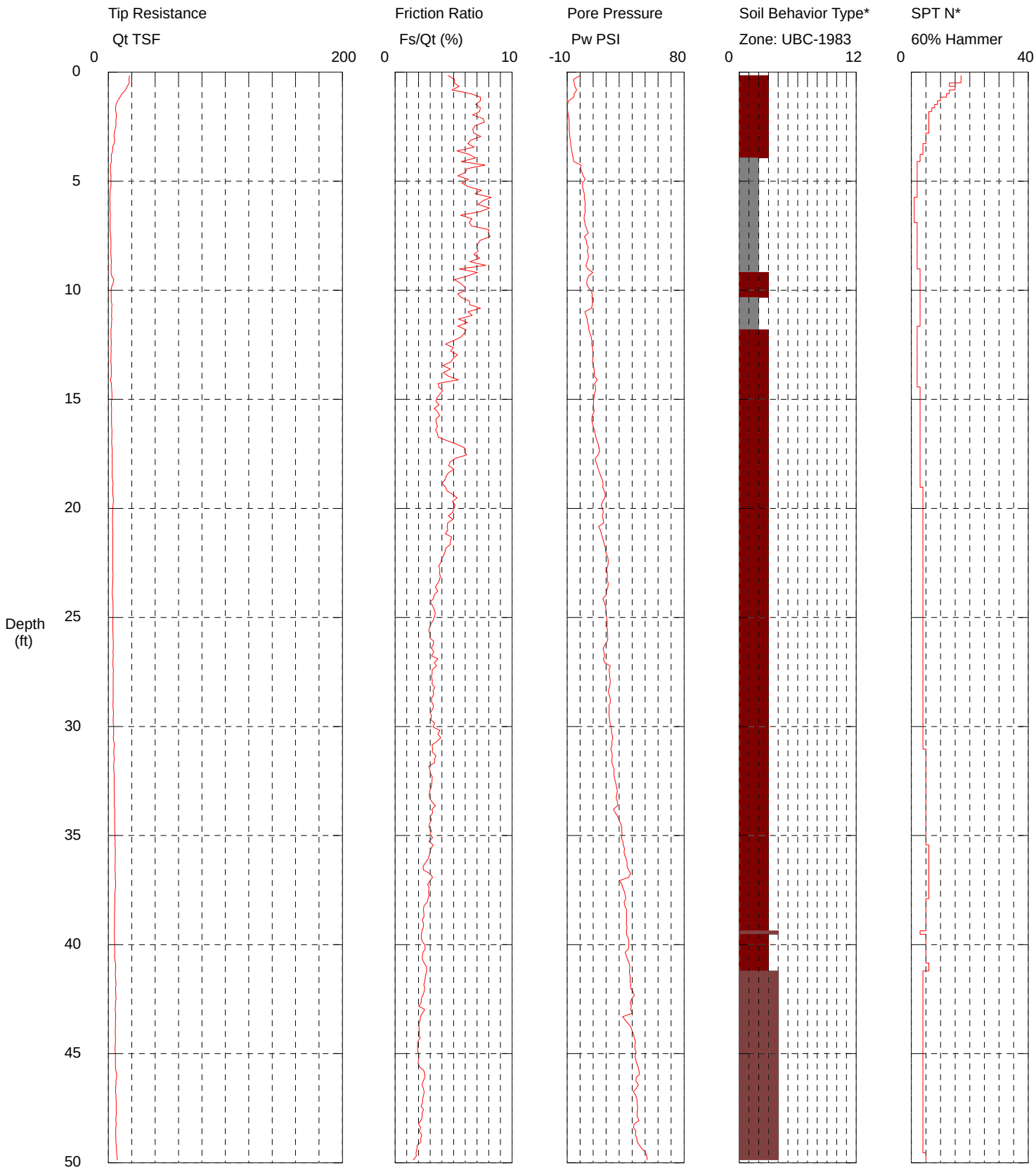

Maximum Depth = 50.20 feet

Depth Increment = 0.164 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

In Situ Engineering

*Soil behavior type and SPT based on data from UBC-1983

AMEC

Operator: Witthus
Sounding: CPT-4
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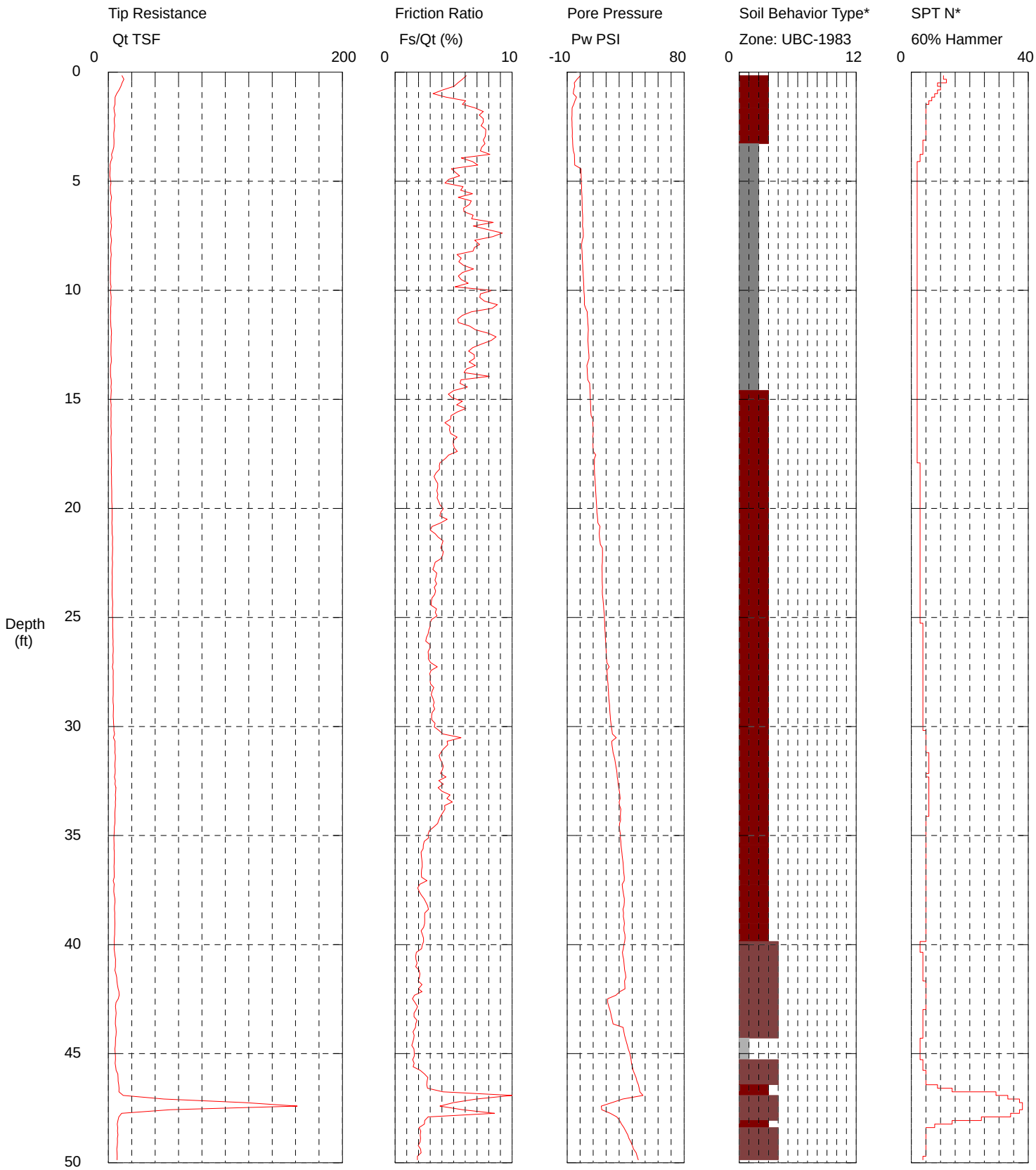

Maximum Depth = 50.20 feet

Depth Increment = 0.164 feet

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3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

In Situ Engineering

*Soil behavior type and SPT based on data from UBC-1983

AMEC

Operator: Witthus
Sounding: CPT-5
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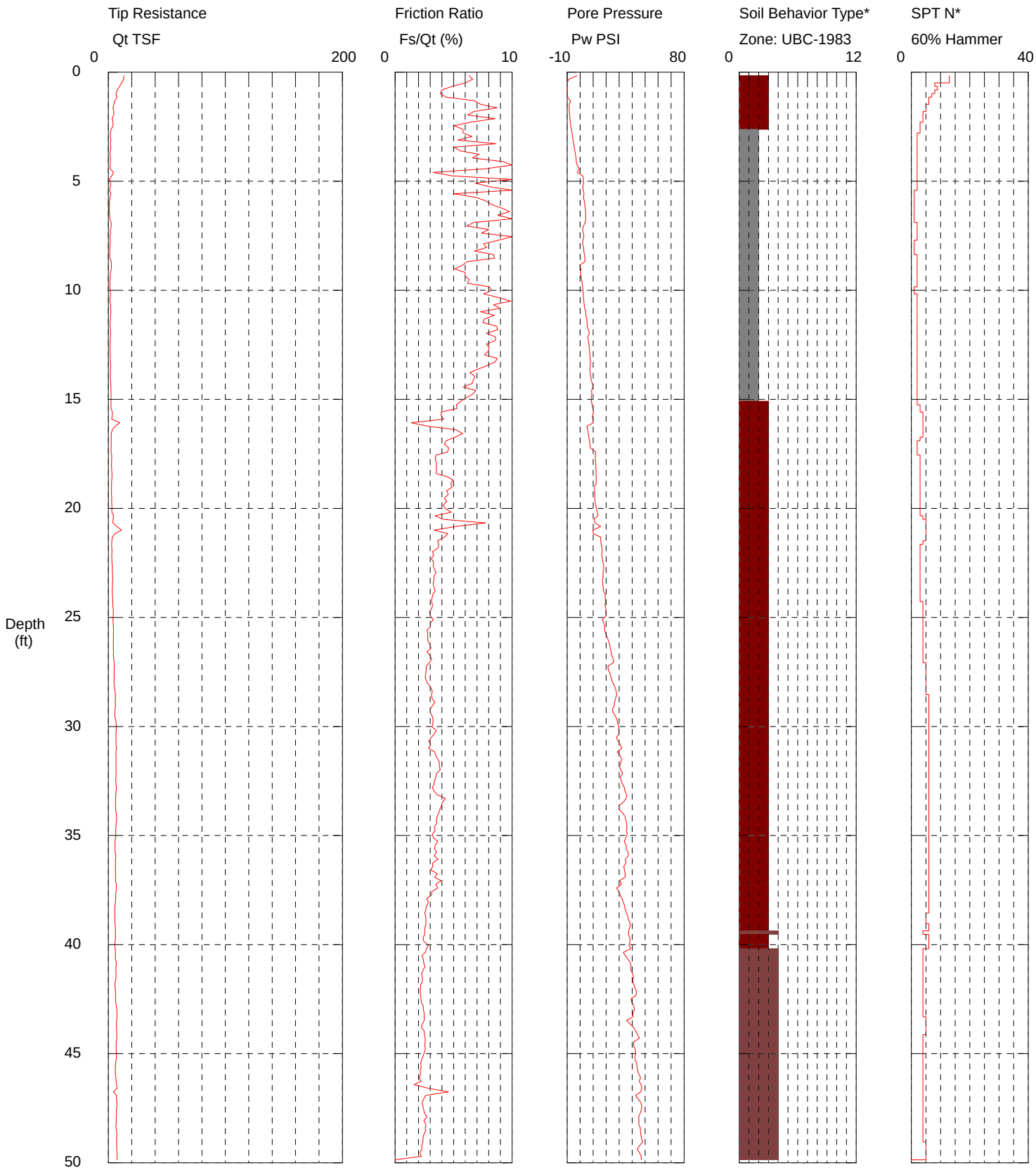

Maximum Depth = 49.87 feet

Depth Increment = 0.164 feet

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8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

In Situ Engineering

*Soil behavior type and SPT based on data from UBC-1983

APPENDIX B: CRITERIA CONSIDERED BUT NOT USED IN THE EVALUATION

Criterion	Concept	Potential Metrics	Reason Not Used
Ability to improve soil fertility	If prime agricultural conditions do not exist for a particular parcel, can they be made available or the land improved, and what is the estimate cost of improving soil conditions?		This criterion was dropped since most of the soils in the area are essentially the same (prime agricultural), thus there was no real differentiating factor.
Impacts on local community	Might there be a nearby community (e.g., town or neighborhood) that would be affected by the restoration of the property? If so, how? Would it cause physical, social, or economic impacts?		There are no larger communities that would be substantially affected by the Ebey Island project. While there is a small community of individual property owners (farmers), most of their concerns had more to do with continued agriculture, which is already accounted for in the final criteria.
Compatibility with Adjacent Uses	Would the restoration of parcels affect adjacent uses (either negatively or positively)? For instance, would restored land preclude or make farming more difficult on an adjacent property? Would it make it easier?		It was determined that this would not be determinatively measurable on such a small, homogenous subset of properties. It would be more of a judgment as to whether the restored property "works well" with adjacent lands in terms of access, effects, lack of impacts on farming, etc., and that most of these issues could be avoided or minimized through proper design. Restoration in and of itself would not preclude farming on adjacent properties.
Permitability	A restoration project would require federal, state, and/or local permitting. Does it meet current regulations? Furthermore, a project may support one agency's goals, but contravening another's (e.g., restoration supports salmon recovery, but removing or breaching dikes runs contrary to the Diking	• Obtain opinions from various permitting agencies as to their level of support for said project • Obtain estimates of timeframes for obtaining permits	It was determined that going into such detail at this stage (feasibility) was not within the scope or budget of this project. Once final alternatives are chosen, this step would need to be done as part of the due diligence process.

Criterion	Concept	Potential Metrics	Reason Not Used
	District's mission). It could be helpful to determine if a particular project is acceptable to all agencies that have a regulatory role in its permitting, and if not, explore what could be done to make the project acceptable.		
Assessed Value	Would the value, and thus cost, of particular parcels have any bearing on which alternative(s) to choose?	• Assessed Value • Assessed Value per acre	It was determined that since the project was focusing primarily on restoring parcels already owned by WDFW, property value would not have any bearing on choosing between alternatives. Additionally, an analysis was run and most properties had relatively the same value per acre (differences being in whether there were any buildings on the parcel, but even this was not a huge difference).
Comprehensive Plan Land Use Designation & Zoning	Is restoration (or some of the ancillary uses such as recreation) even allowed under the local jurisdictions Comprehensive Plan and zoning code? If not, would WDFW need to work with that jurisdiction to try to amend the codes, and how long would that take?	• Determine the zoning of the property, and whether habitat restoration and recreation are permissible uses in the property's zone.	In Snohomish County (agency with jurisdiction), habitat restoration is not specifically listed as an allowed use, but neither is it a non-permissible use. Other such projects have been allowed, including some done by Snohomish County. Recreational uses are allowed under the current zoning. Thus, this was found to be non-determinative.
Project Costs	Each project alternative will have an estimated cost of designing, constructing, maintaining, and policing it. In determining the best alternatives, a cost-benefit analysis could be performed.	• Estimated costs of designing, building, and maintaining/policing the habitat restoration projects	WDFW decided that cost should not play a role in determining what the best alternative should be (explained more fully in Section 5.1.2.1.
Visibility from Public Spaces & Rights-of-Way	Would the completed projects be more or less aesthetically pleasing to the public than what is there now? Which properties can best be seen from public	• Conduct a viewshed analysis, analyzing changes in the public's view of restored properties.	It was determined that this would not be very useful on this project given that all potentially restored properties are equally visible to the public, and that the public

Criterion	Concept	Potential Metrics	Reason Not Used
	vantage points?		probably wouldn't readily distinguish (or have a strong opinion about) the difference between restored habitat or agricultural uses (both being rural in nature).
Agricultural Impacts on Surrounding Properties	Dust, odors, farm equipment on public roads, etc., often bring complaints from adjacent non-agricultural (residential) neighbors, which cause political pressures against agriculture. Conceivably, some properties would be more or less prone to causing impacts to neighbors if used for agriculture. Those properties that would likely cause more such impacts might better be used for restoration. In Snohomish County, this may not be as big of a political problem since the County has a Right-to-Farm ordinance.	• Proximity to residential neighborhoods • Number of such complaints received by local Code Enforcement Division	There are not many residential uses in close proximity (other than the farmers on the island. The County had no reportable complaints from this area.
Recent/Previous Land Uses	What were the past uses were on the properties? Was there ever anything that might have caused hazardous conditions (e.g., contaminated soil)? Remediation of contaminated site might be prohibitively costly.	• Review historical records (County records, aerial photographs) to determine whether there were any uses that might have contaminated the soil. • Check the Department of Ecology Brownfield database.	No such sites were found on the WDFW properties.
Opportunities to Restore Agricultural Land Values	Could restoration of some properties provide an opportunity to improving farming on adjacent properties through acquisition and improvements in infrastructure or exchanging low quality agricultural land for habitat?	• Estimate cost of providing agricultural infrastructure to properties that do not have it now.	Not a measurable criteria, but through the other criteria one can judge whether it would be possible to trade lands better suited to agricultural for those better suited for habitat restoration. Furthermore, WDFW intends to "cause no harm" to adjacent agricultural properties, and will build into any restoration project components to improve their continued use.

Criterion	Concept	Potential Metrics	Reason Not Used
Value That Land Has for Other Purposes	What is the opportunity cost of using land for salmon recovery rather than for industrial, commercial, or residential uses?	• Appraised $/ac value based on highest and best alternative uses. • See if there are any recent appraisals done for any of the major utility or roadwork done on the island. •	It is highly unlikely that Snohomish County would rezone any of these properties to something other than agriculture. Additionally, there is no budget to have appraisals done for all these properties, let alone one that looks at all the alternative restoration scenarios.
Size of Restored Area	How much surface area will be opened to tidal processes?	• Wetted Area at Mean High High Water	This metric was incorporated into the formula used in determining *Value to Fish*
Amount of Fish Habitat	How much channel area or ponded water will remain available to fish at low tide?	• Wetted Area at Mean Low Low Water	This metric was incorporated into the formula used in determining *Value to Fish*
Energetics/Exchange	How much water will flush the site during a tide cycle? How much exchange of sediment, nutrients, and productivity will occur between the site and existing river network? This is a number that can be calculated, but is only relevant comparatively between scenarios.	• Tidal Prism (Volume)	This metric was incorporated into the formula used in determining *Value to Fish*
Connectivity to Total Fish Population	What is the percent of the total fish population that can access the restored habitat? How readily can fish get to the restored areas, especially if a muted design? Do any fish passage barriers prevent access? How easily will fish find the habitat? What proportion of the fish will take advantage of it? Is it connected to a main channel, or a side channel? Each channel has differing % of total fish population	• If known, use percent of total fish population each channel has; otherwise, use: • Channel order • List of barriers	This metric was incorporated into the formula used in determining *Value to Fish*

Criterion	Concept	Potential Metrics	Reason Not Used
	(main stem of river is presumed to have the most).		
Influence by Adjacent Land Uses	What are the surrounding land uses, and how might those uses affect the restoration site? Adjacent land uses could affect success of salmon recovery by introducing pollutants, noise, etc. For example, channels that extend beyond the WDFW properties (e.g., Deadwater Slough) could transmit agricultural contaminants (e.g., fertilizer, pesticides). Noise from heavy machinery could affect wildlife.	• Relative scoring system for adjacent land use types (e.g., spruce forest = 5, scrub/shrub = 4, mowed wetland = 3, grazing = 2, crops = 1)	Was determined that this criterion, though potentially useful in a higher density land use setting, it is not very differentiating in this rather homogeneous, low-intensity agricultural/residential area.
Completeness of Restored Tidal Action	Will the full tidal signal be restored, or will it only be a muted signal (e.g. through tide gate)?	• Percent of full tidal signal at relevant location	This metric was incorporated into the formula used in determining *Value to Fish*
Impacts of Restoration Project on Agricultural Uses	Does the restoration project have negative, or positive, impacts on agriculture? Does it preclude certain uses? Or, does it help create new agricultural opportunities?	•	This metric was incorporated into the formula used in determining *Agricultural Productivity*.
Soil Suitability for Agriculture	Different lands have different types of soil, some being more valuable to different types of agriculture (e.g., crops, animal husbandry), and some being more suitable for the restoration projects. From agricultural point of view, it is better to maintain prime agricultural land in agricultural production and use those that are not quite as good for restoration.	• Soil Conservation District's soil rating • Value as agricultural land, where 0 = no value, 1 = low value, 2 = medium value, 3 = high value	All lands within the study area are homogenous and similarly categorized; all are considered prime agricultural soils, with minor differences in how well it is drained, which can be remedied through infrastructure and management.
Acres of WDFW Land Removed from Agricultural Production	How much of WDFW's land currently leased for agricultural uses will be removed from production?	• Number of WDFW acres leased to farmers	Agricultural leasing decisions are based on a variety of fish and wildlife management and recreation objectives. It would be inappropriate to consider leases would continue

Criterion	Concept	Potential Metrics	Reason Not Used
			even if salmon restoration projects were not to occur.
Contiguity of Agricultural Land	As with other types of uses, agricultural activities are more efficient when clustered. Often the closer agricultural parcels are to one another makes them more valuable; isolated farms are more expensive to operate. This is true whether they are large or small farms.	• Percentage of an agricultural parcel's (or group of parcels') boundary the restoration project shares	This metric was incorporated into the formula used in determining *Agricultural Productivity*.
Effects on Recreational Uses - Hunting/Shooting	Are any of the properties currently used for hunting or shooting? Would any existing hunting/shooting opportunities be lost due to project implementation? Are any added? Which properties have the most potential for hunting/shooting uses?	• 1 – 5 rating of recreational potential; or 1 point for each activity that could be done? • -1 – -5 rating of recreational potential; or, -1 point for each activity that could be lost?	It was decided to combine all potential recreational impacts (positive or negative) into one criterion, *Effects on Recreational Opportunities*.
Effects on Recreational Uses - Boating	Are any of the properties currently used for boating? Would any existing boating opportunities be lost due to project implementation? Are any added? Which properties have the most potential for boating uses?	• 1 – 5 rating of recreational potential; or 1 point for each activity that could be done? • -1 – -5 rating of recreational potential; or, -1 point for each activity that could be lost?	It was decided to combine all potential recreational impacts (positive or negative) into one criterion, *Effects on Recreational Opportunities*.
Effects on Recreational Uses - Hiking/Walking	Are any of the properties currently used for hiking or walking? Would any existing hiking/walking opportunities be lost due to project implementation? Are any added? Which properties have the most potential for hiking/walking uses?	• 1 – 5 rating of recreational potential; or 1 point for each activity that could be done? • -1 – -5 rating of recreational potential; or, -1 point for each activity that could be lost?	It was decided to combine all potential recreational impacts (positive or negative) into one criterion, *Effects on Recreational Opportunities*.
Effects on Recreational Uses - Bird Watching	Are any of the properties currently used for bird watching? Would any existing bird watching opportunities be lost due to project implementation? Are any added? Which properties have the most	• 1 – 5 rating of recreational potential; or 1 point for each activity that could be done? • -1 – -5 rating of recreational potential; or, -1 point for	It was decided to combine all potential recreational impacts (positive or negative) into one criterion, *Effects on Recreational Opportunities*.

Criterion	Concept	Potential Metrics	Reason Not Used
	potential for bird watching uses?	each activity that could be lost?	

APPENDIX C: POTENTIALLY USEFUL CRITERIA

Criterion	Concept	Potential Metrics
Topography	Knowing the existing topography will help determine the ability of a property to be tidally influenced. Lands below Ordinary High Water Mark (OHWM) will be best for habitat restoration projects. Could help determine how much a property will need to be altered (i.e., soil removal or augmentation) and thus potentially a large part of the cost of the project. Elevation can also help determine what type of habitat it provides (ponds, tidally influenced mudflats, or other); whether there would be variable topography in the finished project helping to create more areas of land/water interface, and thus shorelines where protective cover can grow, and the overall predicted hydraulics of the island and river. Would also need to know elevations of ditches to assist with hydrological modeling.	• Existing elevation throughout the WDFW properties
Predicted long-term elevation distribution	What is the expected breakdown of land area within different elevation ranges? Does this distribution reflect natural conditions observed in reference sites? What are the general habitat types expected based on these elevations?	• Histogram of area per elevation, compared with associations between communities' elevation ranges
Complexity and Diversity of Habitats	Will the restoration design lead to the formation of dendritic channels, different habitat types, natural vegetation communities, natural bank structure Large Woody Debris (LWD), riparian shade/cover?	• Histogram of area per elevation; compared with associations between communities elevation ranges • Planting plans • Channel creation plans • Hydrodynamic model results
Other Species: Birds	How will the predicted changes in habitat types affect use of the site by different waterfowl guilds (e.g. dabblers, divers, waders, geese, etc.)?	• General change in predicted species composition based on bird guild associations with habitat types and predicted habitat types based on elevation
Effects On or Due To Other Restoration Projects and Salmon Recovery Actions	One restoration project may affect another (or others) hydrologically. If vast areas of Ebey Island are flooded, will it affect others' (e.g., DD6's) projects by lowering the overall water level?	• Determine through modeling how proposed project will affect OHWM • Determine via other projects' design specifications whether there would be an affect

Criterion	Concept	Potential Metrics
Water quality	Clarity, oxygen content, & temperature. How long will water sit without being exchanged for fresh?	• Residence time
Current Land Use	In considering whether to restore a parcel, look at whether the property is currently or recently used for agriculture. If not, it might not be as important in terms of removing it from the agricultural inventory. If it is, there may be more opposition to removing it from the inventory.	• Score based on whether agricultural or not, and • Whether high production or not
Drainage System Required for Continued Agricultural Use	The height of the water table, especially during the growing season, can play an important role in determining the usability and thus value of land for agriculture. Land that is too wet is not as valuable as well drained soil. Ditches and other methods of managing the land can modify the height of water table. Maintenance of those facilities plays a huge role. If ditches are maintained improperly, the water table can rise; proper maintenance can lower the water table. Different properties under same circumstances, or even the same property, might have different water tables based on how well the drainage system is maintained. In terms of choosing between project alternatives, it is less costly if the land remaining in agriculture can be drained by gravity rather than equipment. Height of water table will also have an impact on the ability and cost of moving/replacing infrastructure.	• Water table elevation
Effects on Archaeological, Historical, and Cultural Resources	Are there any protected archaeological, historic, or cultural resources on the property? Would the project destroy, protect, or have no effect on them? Would they be better protected if the property were restored, or remain in agricultural use? What would the mitigation measures be?	• Presence of important archaeological, historic, or cultural resources. 0 = none; 1 = minor resources that can be impacted w/o mitigation; 2 = resources that can be impacted but mitigation required; 3 = important resources that cannot be impacted
Effects on Existing Flood Protection Infrastructure	Will the project(s) cause erosion, sedimentation or slope stability issues for the existing dikes (i.e., will breaching one area cause stability issues for dikes in other areas?)	• Soil erodability and slope stability based on geotech analysis/opinion, where 0 = no issues; 1 = project will cause minor issues that can be easily mitigated; 2 = project will cause medium issues that can be mitigated, but it is relatively expensive to do so; 3 = project will cause major issues that cannot be mitigated.

Criterion	Concept	Potential Metrics
Feasibility of New Flood Protection Infrastructure	If dikes are breached to allow tidal influence, can new dikes/ditches be feasibly built to protect remaining farmland? Will the soils support them? Can we minimize diking while maximizing area to be flooded because of geography?	• Ratio of area (ac) to be flooded to length (mi) of dike • Will the soils support them?
Other Stakeholder Concerns	This was originally a placeholder for any issues raised by the Advisory Committee or other stakeholders that were not in the preliminary list develop by the project team. However, though these groups had great interest and influence on refining and narrowing the final criteria, no new concerns were raised.	

APPENDIX D: Hydrodynamic Modeling and Geomorphic Analysis

A.1. UNET MODEL

The Ebey Island restoration feasibility study adapted the UNET model used to conduct FEMA flood insurance studies on the lower Snohomish River. The model was used to assess potential changes to hydraulic conditions as a result of the proposed restoration alternatives. UNET, developed by the U.S. Army Corps of Engineers (USACE, 2001), is an unsteady, one-dimensional model that can represent a network of channels and storage areas. The application of the UNET model to the lower Snohomish River is documented in FEMA (2001).

A.1.1. Geometry

Snohomish River, its distributary channels, and adjacent flood plains were schematized as a networks of channels as shown in Figure 1a. In addition to these channels, significant areas of overbank storage were represented in the model as stage-storage nodes (Figure 1b). Geometry in the existing UNET model was derived from a prior FEQ model of the Snohomish River. Bathymetric data from the older FEQ model was supplemented and updated with survey data from the US Army Corps, WSDOT bridge plans, and other assorted surveys. Within the model, all data was reference to the 1929 NGVD vertical datum. Conversion between the model datum and the NAVD vertical datum were accomplished by adding 3.68 ft, as provisional tidal datums developed by the Corps for Everett.

A.1.1.1. Existing conditions

The FEMA version of the UNET model became unstable when modeling tidally-dominated flow conditions such as the low discharge conditions in late summer, 2002. The unstable conditions were traced to the geometry of the SR-529 Bridge where it crosses the downstream end of Union Slough. Therefore, these bridge cross sections were removed from the model. A sensitivity analysis indicated that the changes to water level and velocity as a result of this modification were local and did not affect the project site, which is more than four river miles the removed cross sections.

A.1.1.2. Near Term

The existing conditions geometry described above was modified to represent the full tidal area and the muted tidal areas of the Near Term Alternative. Details of the modification which restored tidal exchange to portions of Ebey Island are described below. In addition to adding these tidally connected areas, the stage-storage node for the portion of the Island which would remain inside the perimeter dike was altered to reflect its decreased extent.

A.1.1.2.1. Full tidal area

The Near Term Alternative proposes that the tree-covered eastern portion of the project site be converted to fully tidal by building a setback dike which mostly follows the existing pipeline right-of-way, and then removing the existing dike along Ebey Slough. This restoration area was incorporated into the model by adding cross sections along the Ebey Slough reach and also extending the western side of the new and existing cross sections to describe the full tidal area. The additional cross sections were added at the upstream end, downstream end, and width transitions of the restored area to capture its planform dimensions. Bed elevations in the restored area were estimated from limited ground survey data collected primarily along the pipeline right-of-way in October 2010. The restored area was assigned a Mannings n value

equal to 0.15. This value was selected based on Acrement and Schneider (1989) to capture the roughness associated with the trees that are expected to cover a substantial portion of the restored area.

A.1.1.2.2. Muted tidal areas

Each of the muted tidal areas was represented in the Near Term Alternative as a state-storage node connected by a hydraulic structure to the adjacent outboard channel. UNET does not have the capability to specify gate operations that prevent flow through the structure as a function of water level. Therefore, UNET predictions of water levels for the muted tidal areas are considerably higher than target water levels for creating intertidal habitat and reducing flood hazard. To provide a better understanding of habitat conditions and hydraulic structure design specifications, separate models of the muted tidal areas were developed using HEC-RAS, a model which can specify water-level-controlled gate operations. These models are described in more detail in Section X below. After the hydraulic structure configuration in HEC-RAS was completed to achieve target water levels in the muted tidal areas, the hydraulic structures' flow rates predicted by the HEC-RAS model were compared to the flow rates predicted by the UNET model. The peak flow rates were of similar magnitudes (100-200 ft3/s), as expected since the structures' cross-sectional area, which was identical between the models, is the limiting factor. Since the peak flow rate predicted by the UNET model is similar to the more refined HEC-RAS model and also considerably less than the flow rates in the outboard channel (approximately 9,000 ft3/s in Ebey Slough and 16,000 ft3/s in the Snohomish main stem), the flow rate predictions from the UNET model can be used to assess restoration impacts on off-site scour.

A.1.1.3. Long Term

To represent the Long Term Alternative, Ebey Island was divided into a series of linked stage-storage areas: one for the southern diked area, one for the northern diked area, and a pair of stage-storage areas for the full tidal area. This treatment of the Long Term conditions follows the level of detail used in the FEMA flood study. The full tidal area was split into two stage-storage areas to associate the western two thirds to the Snohomish main stem via Deadwater Slough and the eastern third draining to Ebey Slough. Besides echoing natural watersheds, this configuration establishes flood pathways that are consistent with existing conditions. Specifically, the partitioning of flow between Ebey Slough and the Snohomish main stem is roughly preserved during the 100-year discharge event. The crest elevation of the new cross dikes which separate the restored tidal area from the developed areas were set to constant values similar to the crest elevation of the adjacent existing levee. For the south cross dike, the crest elevation is 17.7 ft NAVD; for the north cross dike, the crest elevation is 14.7 ft NAVD.

A.1.1.3.1. North Tip Option

The option of restoring the north tip of Ebey Island to full tidal conditions was modeled by dividing the stage-storage node representing Ebey Island north of Highway 2. The first node, adjacent to Highway 2, maintains its existing dike configuration to protect developed areas. The second node, at the northern tip, is connected to full tidal exchange by lowering the dike elevation to existing bed grade and adding a breach at the location of the historic channel entering Ebey Island from Steamboat Slough. The crest elevation of the new cross dike between these two regions is 13.7 ft NAVD, an elevation consistent with the existing dikes to which it connects.

A.1.2. Boundary conditions

Three sets of boundary conditions were used to assess the potential hydraulic response to the restoration alternatives. To evaluate typical conditions, water year (WY) 2002 was simulated, spanning the period from October 1, 2001, to September 30, 2002. To evaluate both mild and extreme dike overtopping during flood conditions, both the 5-year and the 100-year riverine flood were simulated. Each of these scenarios requires two boundary conditions:

- discharge specified at the upstream end of the model domain
- water levels specified at the downstream end of the model domain

The details of the boundary conditions representing these two scenarios are provided below.

A.1.2.1. WY2002

Verified discharge observations from the USGS gage on the Snohomish River near Monroe (Station ID 12150800) were downloaded from the USGS website (http://waterdata.usgs.gov) for the period from October 1, 2001 to September 30, 2002. This discharge time series is plotted in Figure 2. This data was applied to Snohomish River at the upstream end of the model domain, near the city of Monroe. The peak flow rate during this year was 56,000 ft3/s. This flow rate is slightly less than the estimated 2-year flow of 64,000 ft3/s (FEMA, 2001).

Verified water level observations from the NOAA gage on Puget Sound near Seattle (Station ID 9447130) were downloaded from the NOAA website (http://tidesandcurrents.noaa.gov) for the period from October 1, 2001 to September 30, 2002. This water level time series is plotted in Figure 3. This data was applied to the three downstream ends of the model domain, where the Snohomish River, Union Slough and Ebey Slough connect with Puget Sound.

A.1.2.2. 5-year flood

The 5-year peak river discharge, estimated in the hydrology section of the FEMA FIS for the Snohomish River (FEMA, 2001), was used to the upstream end of the model domain. The hydrograph describing the rate of rise and fall to and from this peak was derived from a modeling study of the DD6 restoration project (Snohomish County, 2001) and is shown in Figure 4.

Following Snohomish County (2001), the water level at the downstream end of the model domain was a synthetic tide with three successive higher high waters of 10.7 ft NAVD (Figure 5). This water level falls between the average annual high water level and the 2-year return interval for Puget Sound (USACE, 2002).

A.1.2.3. 100-year flood

The 100-year river discharge hydrograph, estimated in the hydrology section of the FEMA FIS for the Snohomish River (FEMA, 2001), was applied to the upstream end of the model domain. This synthetic flood event occurs over a period of seven days and has a peak flow of 204, 000 ft3/s. This discharge time series is plotted in Figure 6. In addition, the estimated 100-year discharge from the Pilchuck River into the Snohomish was also applied to the model. Peak flow in the Pilchuck River is only 5% of the peak discharge in the main stem.

The water level at the downstream end of the model domain was held fixed at 6.2 NGVD, which is one foot above MHHW for Puget Sound. This downstream water level, which follows FEMA

guidance, was carried over from the FEMA flood study so that results from the proposed restoration alternatives would be comparable to the flood study.

A.2. HEC-RAS MODEL

Balancing water levels within the muted tidal areas for habitat and flood mitigation calls for connecting these areas to the adjacent outboard channels with hydraulic control structures that can be operated to open and close at specific water levels. The UNET model that has been developed for flood mapping in the lower Snohomish does not have the capability to specific operating rules for hydraulic structures. Therefore, HEC-RAS, a U.S. Army Corps of Engineers model which can apply operating rules for hydraulic structures (USACE, 2010), was used to model the muted tidal areas. Besides this difference in operating rules, the two models are similar since the unsteady solver in HEC-RAS is based on UNET. HEC-RAS is a publicly available model widely used for hydraulic analysis. It represents open channel flows as one-dimensional networks of channel reaches and stage-storage area nodes.

A.2.1. Geometry

Two HEC-RAS models, one for each of the muted tidal areas, were created to assess the Near Term restoration alternative for Ebey Island. Each model consisted of a short reach of the adjacent outboard channel and the muted tidal area, as depicted in Figure 7 for the eastern muted tidal area. The dimensions of the outboard channel were derived from the existing UNET model of the entire estuary. The muted tidal area was represented as a stage-storage node. The Puget Sound LiDAR Consortium data collected in 2009 provided the basis for estimating the stage-storage relationships. Because the muted tidal areas are anticipated to include tidal channels that do not exist in the current topography, the stage-storage relationships were modified to add additional volume below the exiting bed to account for these channels. The volume and depth of the tidal channels that may form were predicted from hydraulic geometry relationships between marsh area, tidal prism, and channel depth (Williams et al, 2002).

A.2.2. Hydraulic Structures

The outboard channel and stage-storage node representing the muted tidal area were connected with a gated spillway with closed top, which only permits flow when water levels in the outboard met specific elevation criteria. The model representation is similar to the performance characteristics of a culvert with a self-regulating tide gate (SRT) on its outboard end. A SRT includes a mechanism whereby the gate is closed, blocking flow through the culvert, when the water level exceeds a specified value. For the proposed muted tidal areas, the hydraulic structures' dimensions were set as follows:

Width: 12 ft

Height: 6 ft

Sluice discharge coefficient: 0.5

Orifice coefficient: 0.8

Broad-crested weir coefficient: 3

Invert: -3.5 ft NAVD

Outboard water level closure criteria: 2.5 ft NAVD (east), 4.0 ft NAVD (west)

The outboard water level closure criteria were set to obtain target water levels within the restored muted tidal areas. The target water levels were selected to sustain vegetated intertidal habitat and to promote bed accretion while also limiting water levels that pose a flood risk to adjacent Ebey Island properties. The invert is approximately 2 feet below the lowest water levels in the outboard channel to ensure adequate flow depths and drainage capacity even at the lowest tides.

A.2.3. Boundary conditions

Water levels in the outboard channels from WY2002 were predicted by the UNET model and used as boundary conditions for the muted tidal area models. This time period represents conditions in the estuary during a typical year.

A.3. REFERENCES

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FEMA. 2001. Technical Support Data Notebook for Snohomish County, WA, City of Everett, City of Marysville, City of Snohomish, and Unincorporated Areas Restudy Flood Insurance Study.

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Williams, P, M. Orr, and N. Garrity. 2002. Hydraulic Geometry: A Geomorphic Design Tool for Tidal Marsh Channel Evolution in Wetland Restoration Projects. Restoration Ecology 10(3), 577-590.

USACE. 2001. UNET: One-Dimensional Unsteady Flow Through a Full Network of Open Channels, User's Manual. US Army Corps of Engineers, Institute for Water Resources, Hydrologic Engineering Center.

USACE. 2002. Qwuloolt/Poortinga Technical Report, Prepared for the Tulalip Tribes of Washington by the USACE Seattle District, January 17, 2002.

USACE. 2010. HEC-RAS River Analysis System User's Manual. Institute for Water Resources, Hydrologic Engineering Center.

A.4. FIGURES

Figure 1. Snohomish River UNET Model

Figure 2. Snohomish River Discharge at Monroe, WY2002

Figure 3. Water level at Seattle, WY2002

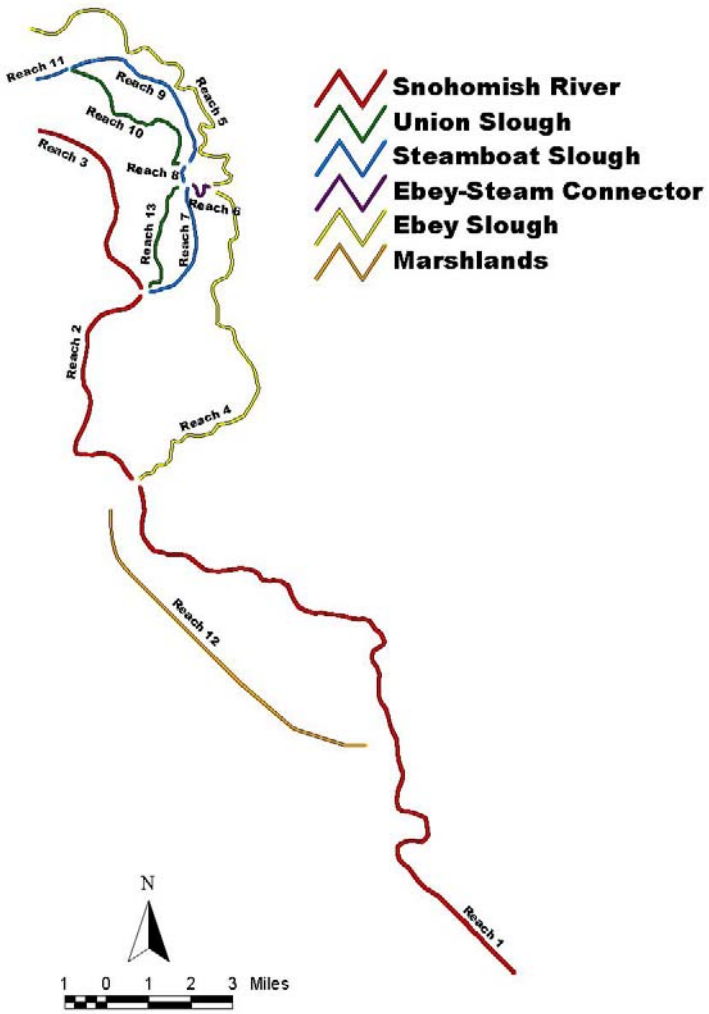
Figure 4. Snohomish River Discharge at Monroe, 5-Year Event

Figure 5. Water Level at Mouth of Snohomish Estuary, 5-Year Event

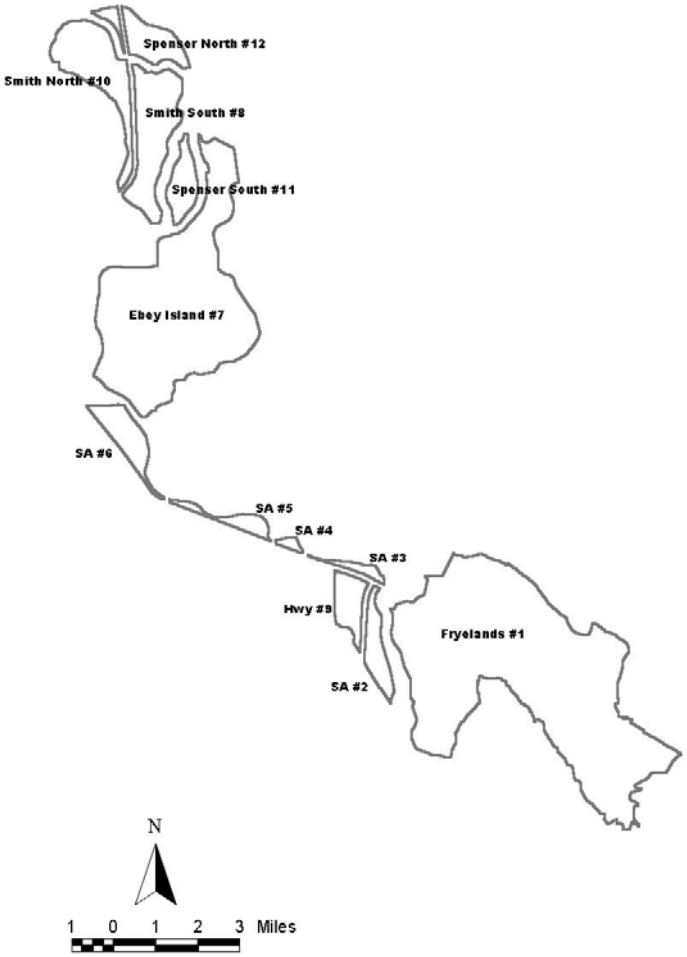
Figure 6. Snohomish River Discharge at Monroe, 100-Year Event

Figure 7. HEC-RAS Model Extent, East Muted Tidal Area

a)



b)



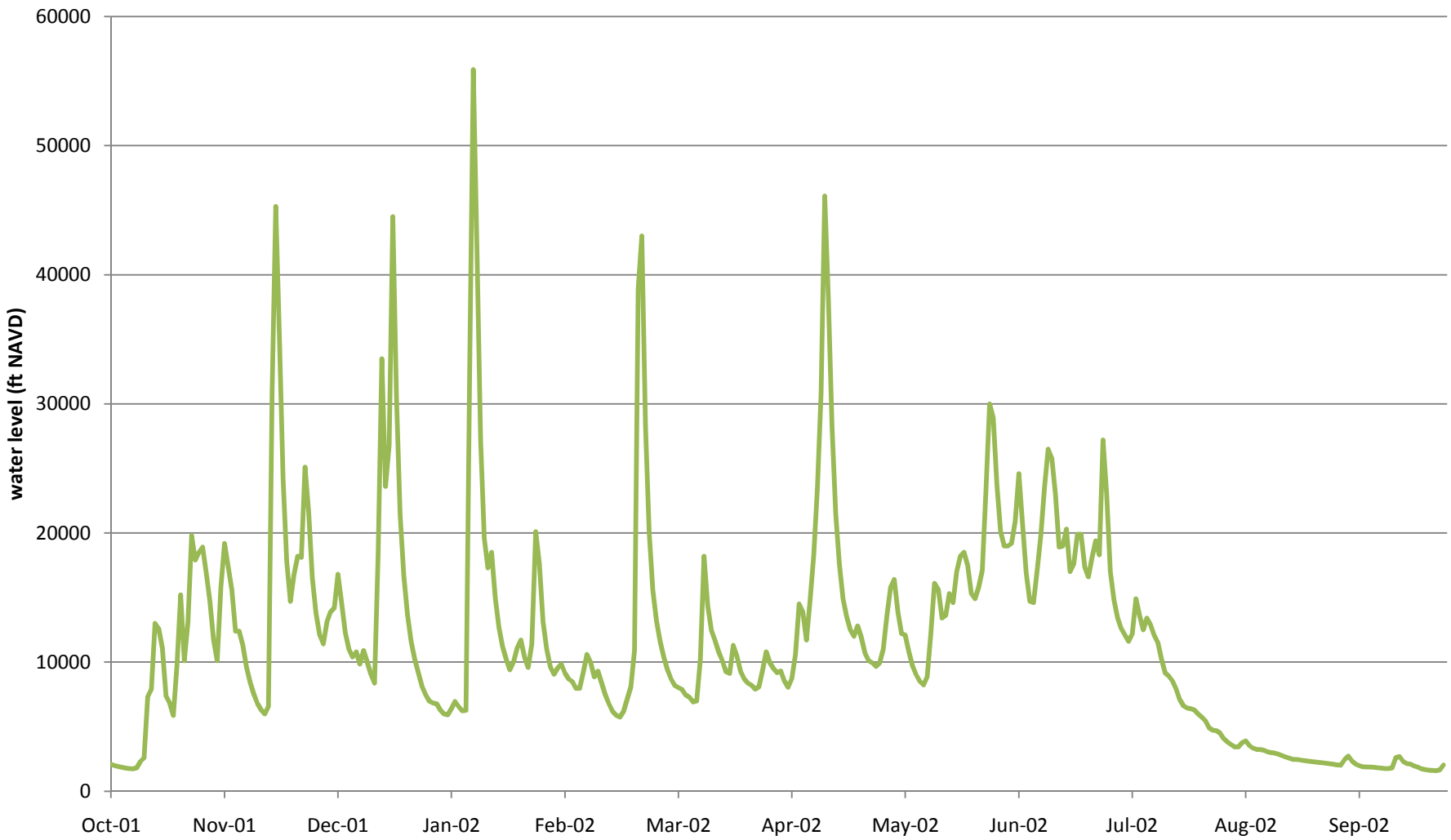
Source: FEMA (2001)

figure 1
Ebey Island Restoration Project

Snohomish River UNET Model

PWA Ref# 2022

ESA PWA



Sources: USGS, Snohomish River near Monroe (Station ID 12150800)

figure **2**

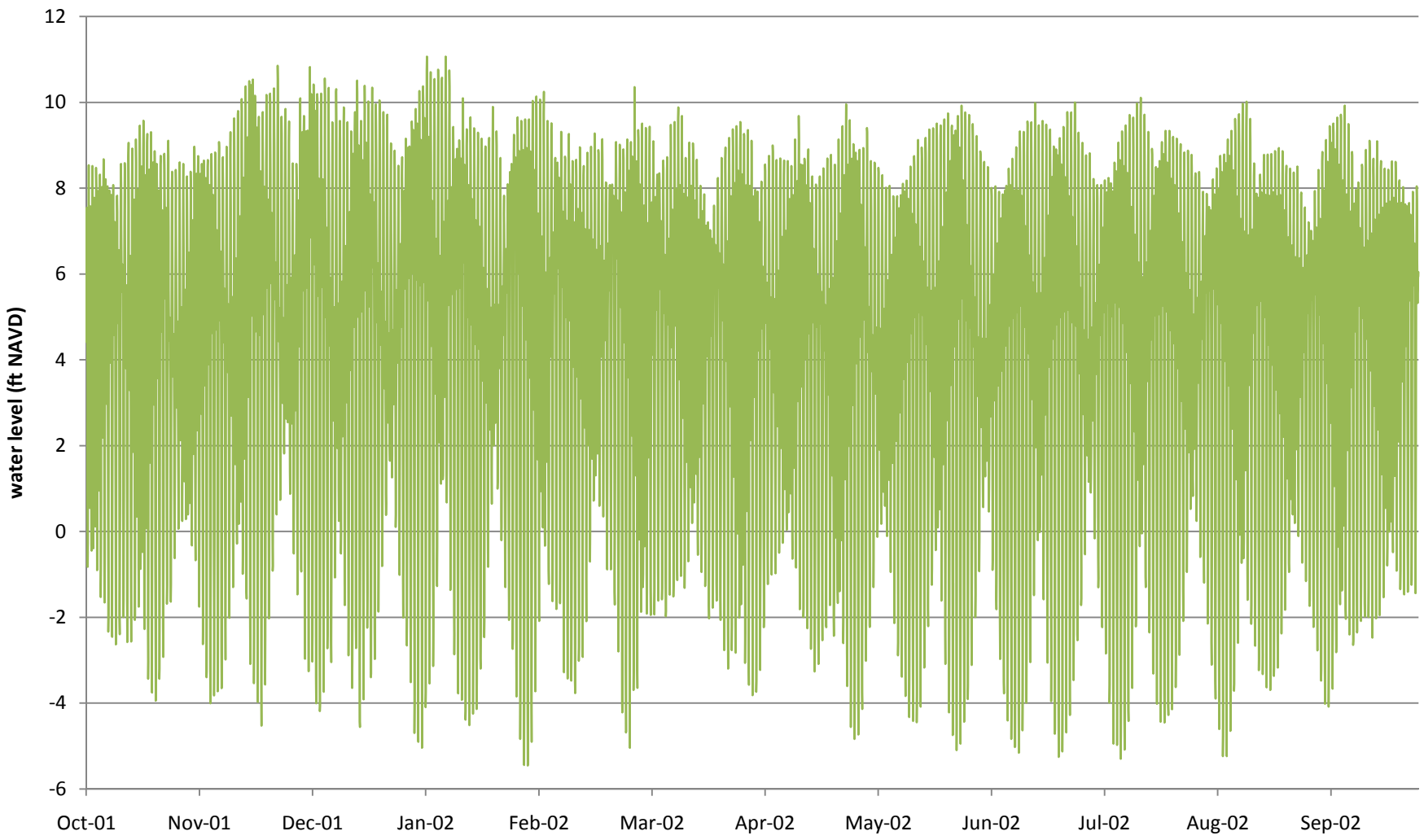
Ebey Island Restortation Project

Snohomish River Discharge at Monroe, WY2002

ESA PWA Ref #: 2022

ESA PWA

A02 WY2002 q BC.xls / PlotWLaug2002



Sources: NOAA , Seattle (Station ID 9447130)

figure ***3***

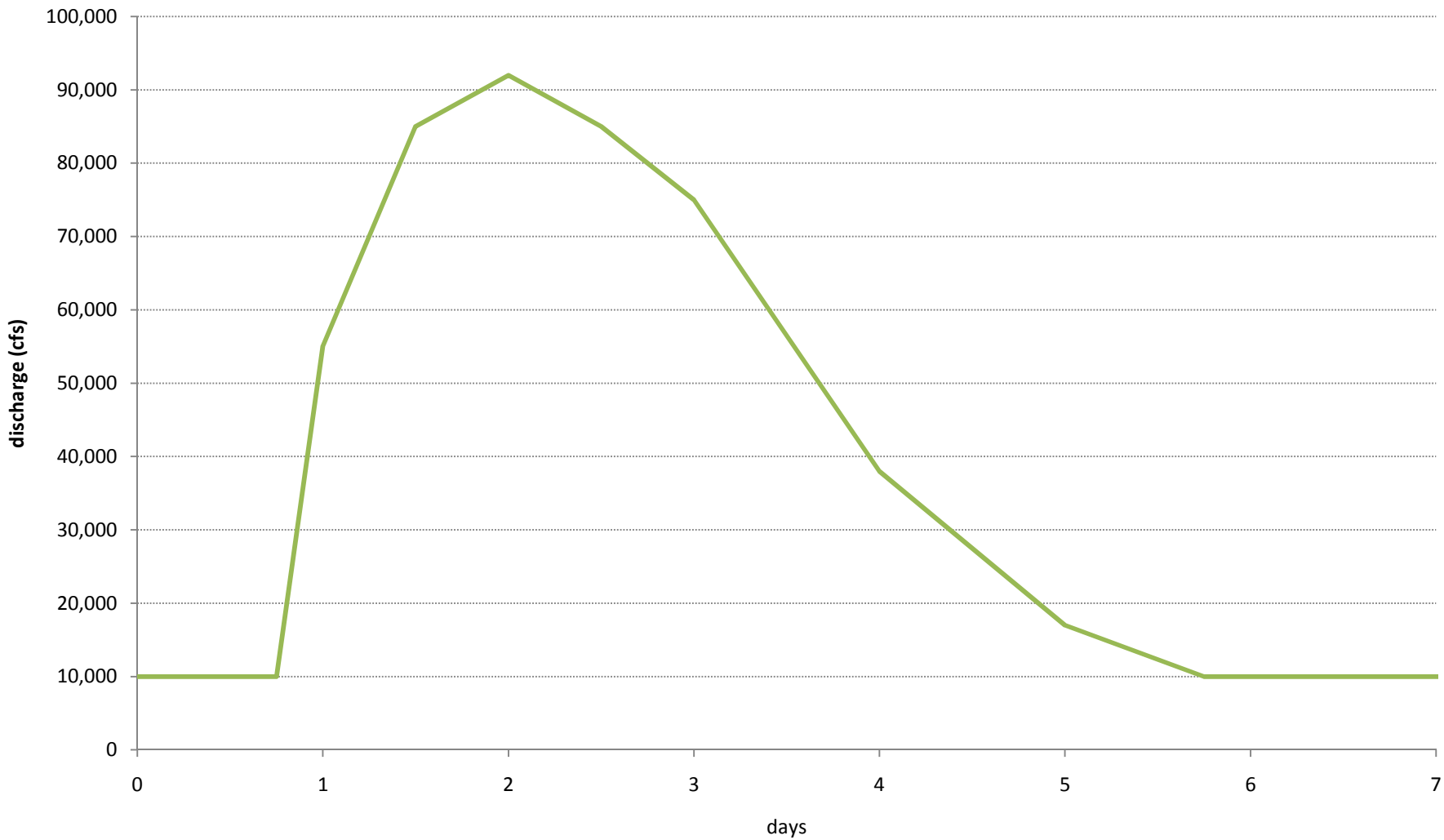
Ebey Island Restortation Project

Water level at Seattle, WY2002

ESA PWA Ref #: 2022

ESA PWA

A03 WY2002 wse BC.xls / PlotWLaug2002



Sources: FEMA (2001), Sonohomish County (2001)

figure ***4***

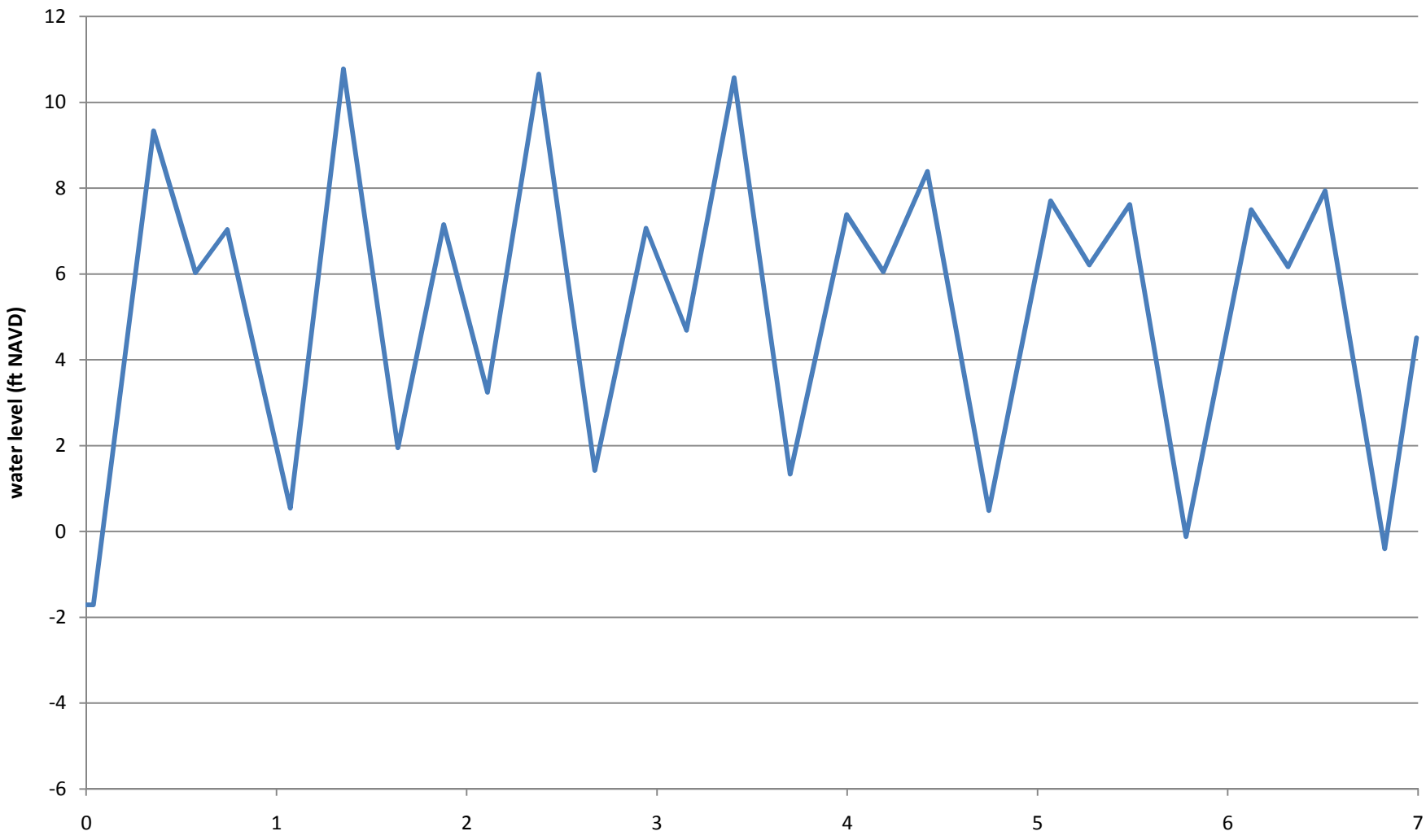
Ebey Island Restortation Project

Snohomish River Discharge at Monroe, 5-Year Event

ESA PWA Ref #: 2022

ESA PWA

A04 Q5 q BC.xls / Plot



Sources: Snohomish County (2001)

figure **5**

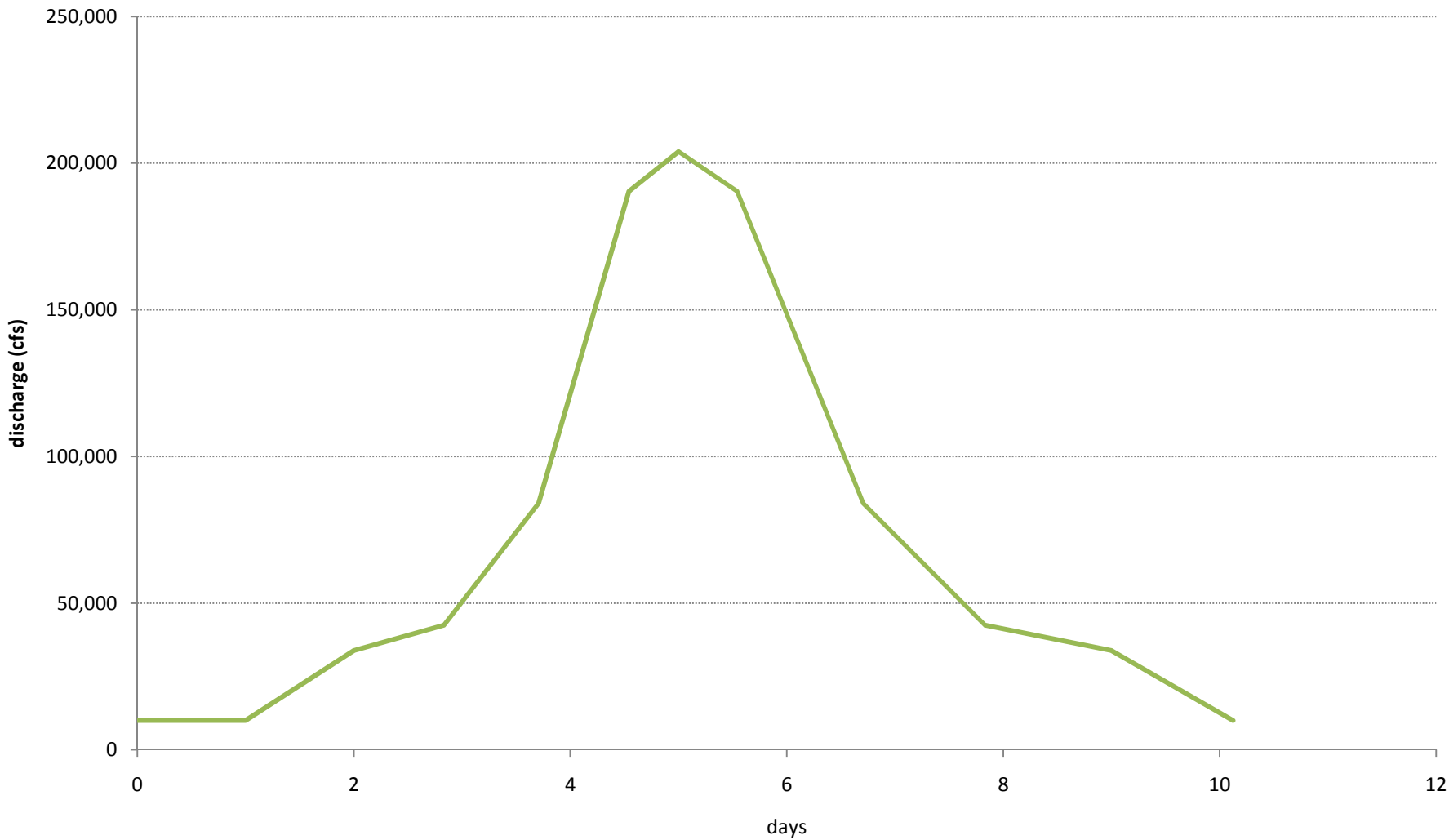
Ebey Island Restortation Project

Water Level at Mouth of Snohomish Estuary, 5-Year Event

ESA PWA Ref #: 2022

ESA PWA

A05 Q5 wse BC.xls / Plot



Sources: FEMA (2001)

figure **6**

Ebey Island Restortation Project

Snohomish River Discharge at Monroe, 100-Year Event

ESA PWA Ref #: 2022

ESA PWA

A06 Q100 q BC.xls / Plot

figure 7
Ebey Island Restoration Project

HEC-RAS Model Extent, East Muted Tidal Area

PWA Ref# 2022

ESA PWA

Appendix E. March 15, 2011, Public Meeting Handout and Questionnaire

Ebey Island Habitat Restoration Feasibility Study

March 15, 2011, 6:00 – 8:30 PM

Meeting Agenda

Time	Topic
6:00 PM	**Open House**
6:30 PM	**Introduction & Opening Remarks** • Richard Tveten & Bob Everitt, WDFW
6:40 PM	**Feasibility Study Process** • Cleve Steward, AMEC
6:50 PM	**Review of Preferred Restoration Alternatives** • Ryan Bartelheimer, AMEC
7:00 PM	**Results of Physical Modeling Study** • Matt Brennan, ESA PWA
7:10 PM	**Predicted Biological Effects of Preferred Alternatives** • Tad Schwager, AMEC
7:20 PM	**Feasibility Summary and Questions & Answers** • Cleve Steward, AMEC
7:30 PM	**Public Discussion** • Cleve Steward and WDFW staff
8:25 PM	**Wrap-up** • Richard Tveten & Bob Everitt, WDFW
8:30 PM	**Adjourn** • Richard Tveten & Bob Everitt, WDFW

Ebey Island Habitat Restoration Feasibility Study

WDFW

Name	Role
Richard Tveten	Project Director
Doug Hennick	Fish and Wildlife Biologist
John Garrett	Wildlife Area Manager
Belinda Schuster	Asst. Wildlife Area Mgr
Annette Hoffman	R4 Fish Program Manager
Kye Iris	Property Acquisitions
Russell Link	Program Manager
Ruth Millner	District Wildlife Biologist

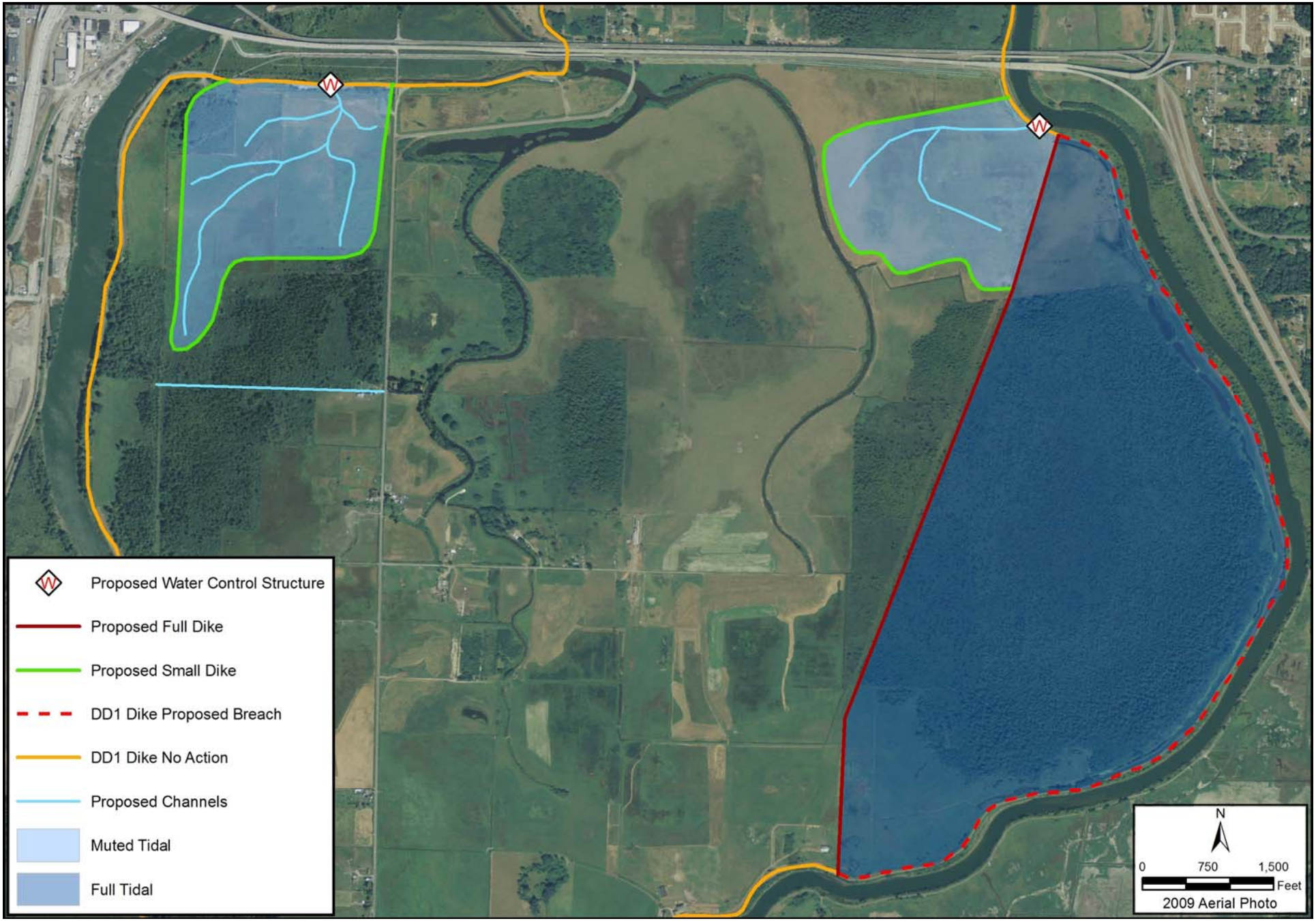
Consultant Team

Name	Organization
Ryan Bartelheimer	AMEC
Jim Dransfield	AMEC
Carlo Evangelisti	AMEC
Jennifer Leach	AMEC
Tad Schwager	AMEC
Paul Smidansky	AMEC
Walker Stanovsky	AMEC
Cleve Steward	AMEC
Cliff Strong	AMEC
Matt Brennan	ESA PWA
Bob Battalio	ESA PWA
Dan Evans	Dan Evans Consulting

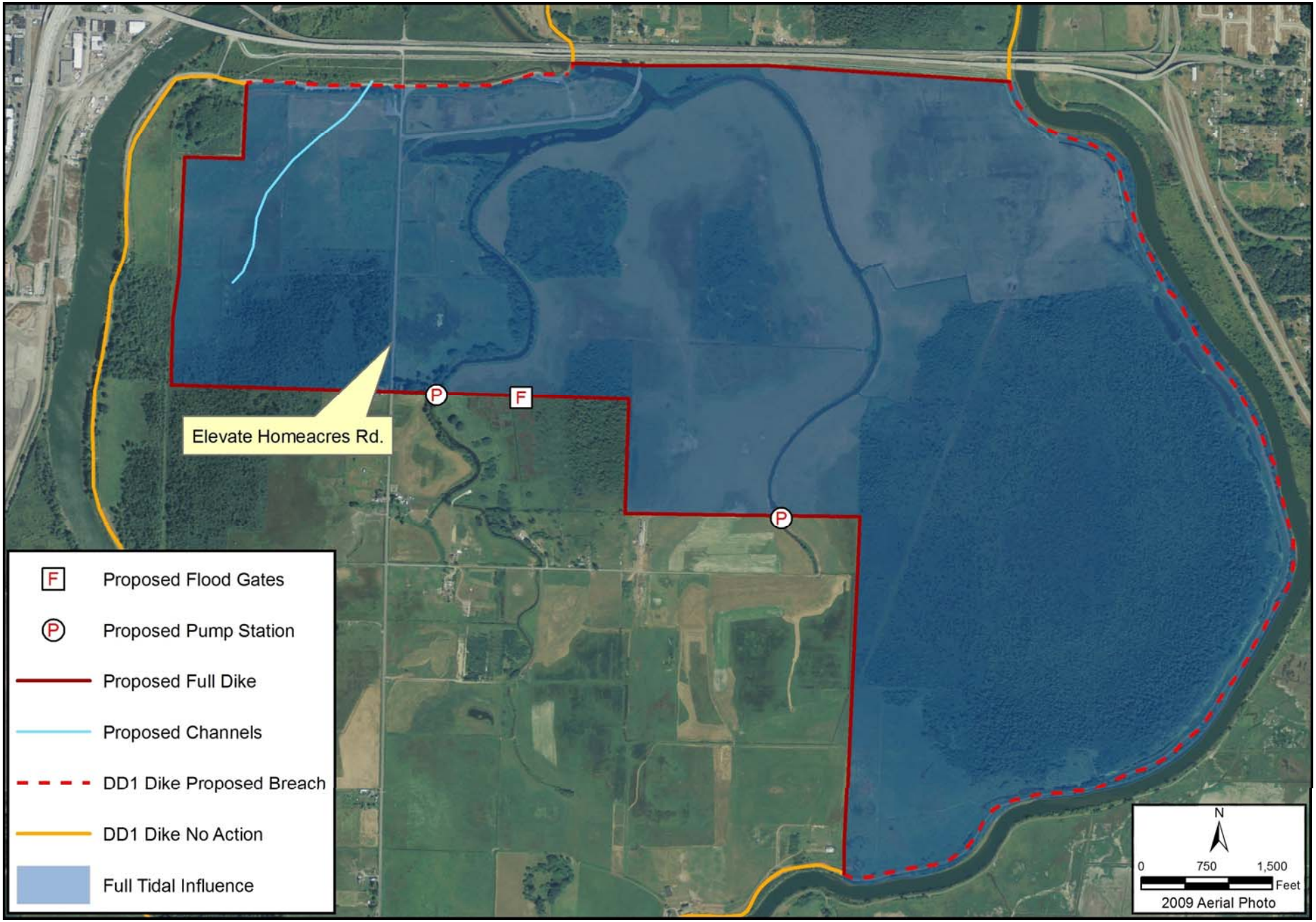
Advisory Committee

Name	Organization
Everett Alexander	Diking District #1
Phil Cunningham	Diking District #1
Barney Bagwell	Diking District #1
Jason Anderson	Stilly-Sno Fish Task Force
Mike Blackbird	Pilchuck Audubon Society
Brian Bookey	Sno Co Ag. Advisory Board
Andrew Corbin	WSU Sno Co Extension
John Engel	Sno Co Public Works
Kate Halstead	Snohomish Valley Tilth
Nick Harper	Cascade Land Cons.
Ryan Hembree	Sno Co Ag Coordinator
Janne Kaje	KC Sno-Sky Watershed
Chuck Lobdell	Ducks Unlimited
Graeme Peters	Ducks Unlimited
Kurt Nelson	Tulalip Tribes
Maria Calvi	Tulalip Tribes
Casey Rice	NOAA Fisheries
Mark Sadler	City of Everett
Sharon Swan	Sno Co Parks and Rec
Micah Wait	Wild Fish Conservancy
Cory Armstrong-Hoss	YMCA of Sno Co
Dr. Tom Nowak	Adjacent landowner
Monte Marti	Sno Conservation District

Near Term Alternative



Long Term Alternative



Ebey Island Project Questionnaire

We would like to hear your ideas about how the Ebey Island project can move forward. To aid us in our planning, we have compiled a list of questions to solicit input from the Advisory Committee and other concerned citizens. You can download these questions from the project website (http://wdfw.wa.gov/lands/wildlife_areas/snoqualmie/restoration_study.php) and email your answers to Richard Tveten, Project Director, at Richard.Tveten@dfw.wa.gov. Alternatively, simply write in your answers below and mail them to the address on back. We will consider all comments received by March 31, 2011.

1. Please provide your name and contact information

2. What is your opinion of the near- and long-term habitat restoration alternatives?

   a. Does the near-term alternative provide a viable outline for a restoration project in the next ten years?

   b. Does the long-term alternative provide a viable outline for a future restoration project?

   c. Do you have specific recommendations that would improve the near- or long-term alternatives for Ebey Island?

   d. Is the North Tip Ebey Island option worth pursuing?

3. What should be the next steps?

   a. Does the Feasibility Study provide a clear path to a restoration project that balances competing values?

   b. If not, what additional information, processes, or steps would be helpful in developing such a path forward?

Thank you for your feedback.

Ebey Island Habitat Restoration Feasibility Study
c/o AMEC Earth & Environmental
11810 North Creek Parkway N
Bothell, WA 98011

Appendix F. Summary of Public and Stakeholder Input and Response to Input

Include key stakeholders and provide opportunities for them to express their interests and concerns?

Janne Kaje: In general, all key stakeholders were involved and able to express opinions.

Kate Halstead: Input was invited and given, apparently taking those inputs seriously was not part of the deal.

Incorporate Advisory Committee input into the development and evaluation of the alternatives?

Janne Kaje: Yes, input was incorporated. As noted above, the issue of cost was not handled evenhandedly in the criteria. Also, the normalization and ranking process, conducted primarily by the consultant team, was insufficiently transparent.

Kate Halstead: A bit of lip service here and there, but that's about it. The final alternatives selected made zero sense based on the feedback given.

Rone Brewer: Provided detailed concerns about the ranking process.

Response: Additional cost estimation was done and included in the report. Description of ranking process updated in the report.

Provide information that could be used to evaluate the different habitat restoration alternatives, including their effects on ecological and societal values (e.g., fisheries, agriculture, recreation, and wildlife)?

Janne Kaje: The team did a good job (given the resources at hand) to attempt to quantify ecological benefits for fish of project alternatives after being pressed by some parties to do so. It is a difficult, data:poor step that requires substantial simplifications of reality. It would be useful (especially for the public) to know how much non:WDFW acreage (or # parcels) would be affected by each alternative, if any. Separately, the amount of affected WDFW-owned acreage that has a continuous history of being leased to farmers and other groups.

Response: Added to the report.

Janne Kaje: At the end of the committee process, it seemed that the language used to describe full tidal options shifted more to the concept of 'several breaches' rather than 'full dike removal.' This is a concern, as remnant, large blocks of dikes may impede the pace of natural recovery. It is of course conceivable that some segments may be too difficult to remove entirely, but the goal should be full removal, adjusted downward only by documented necessity.

Response: Costs for a wider range of dike removal options were developed and reported.

Kate Halstead: No, very sadly and glaringly absent. Most common comment seemed to be, "No, we didn't look at that."

Viability

North tip

Janne Kaje: Yes, but only as a full tidal.
Kate Halstead: Yes, but only if the landowners are agreeable.
Kenneth Erickson: If you have to flood any part of the island the north tip is OK.
Everett Alexander: DD would support this option, but people who live there would have to OK, as well.
Warren Bakken: Owns 40 acre farm on north tip - not in favor of it.
From Waterfowl Association's view, NTA has some benefit, but still issues.

Short term

Janne Kaje: The full-tidal eastern portion is worth pursuing.
Kate Halstead: Why bother?
Kenneth Erickson: Ebey Island is the best farm land in the state.

Long term

Janne Kaje: Yes, but the failure to incorporate the western-most parcel of WDFW land (along the mainstem river) reduces the value of the alternative.
Kate Halstead: Pure and utter idiocy. It will never be allowed to happen.

Do you have specific recommendations that would improve the near: or long:term alternatives for Ebey Island.

Janne Kaje: Include the westernmost WDFW parcel along the mainstem Snohomish.
Kate Halstead: Yes. Scrap them both and start over.
Kenneth Erickson: Do not flood the island.
Steve Arbaugh: Take your money and go away.

Does the Feasibility Study provide a clear path to a restoration project that balances competing values?

Janne Kaje: I believe WDFW can use the study to frame certain alternative actions that could conceivably be implemented.
Kate Halstead: Not even close. It helps make the divide between fish and farms even deeper.
Kenneth Erickson: No.

If not, what additional information, processes, or steps would be helpful in developing such a path forward?

Janne Kaje: Clearly articulate the impacts of alternatives to public vs private land. Divulge cost implications for diking district so that they can be regarded as costs rather than as 'deal breakers.'

Response: Scope of work expanded to include this.

Kate Halstead: WDFW must be tasked with developing innovative solutions to ensure that prime agricultural lands over which they have control are not taken out of production but enhanced and augmented so that organic, sustainable food production can take place side by side with salmon habitat enhancement.

Fate of forest and existing habitats on island

Casey Rice: Uncertainty (trees live or die) should be resolved.
Monty Holmes: Will kill trees.
Rone Brewer: Will kill trees and harm wildlife.
Martha Jordan: Should study.
Mike Blackbird: Suspects that forest will survive.
Rod Hanna: What will do to animals?

Government not smart about how use money and how much will it cost.

Man not named: Government does not weigh options well - Cheaper to flood entire island.
Woman not named: How much will this cost?

Response: Additional relevant information gathered and included in report.

Need to evaluate socio-economic impacts.

Clayton Smith
Steve Arbaugh
Janne Kaje: Quantify and include short term ag impacts.

Response: Additional relevant information added to report.

Blame other things

Monty: Sea lions, Orcas.
Bob Heirman: Spiny ray fish and other fish incompatible with salmon if water is too warm.
Man in back: Logging in headwaters.
Ronald Brown: Landfill, bad water quality, spawning areas.
Kate Halstead: Sprawl.
Ronald Brown Steve Arbaugh: Tulalip dump and WQ.

Juvenile estuary habitat a limiting factor 90% gone critical to recovery

Janne Kaje
Casey Rice

Response: Statement with citation added to report.

Agriculture is considered by many to be a better use of the island than fish habitat

Steve Arbaugh
Monty Holmes
Phil Cunningham
Everett Alexander
Kate Halstead
Ed Moats
Ronald Brown
Kenneth Erickson

Many have strong opinions that salmon restoration projects are ineffective

Phil Cunningham
Unnamed attendee
Monty Holmes
Second attendee on Left: Doesn't like what sees at Nisqually.
Bob Heirman: Creating shallow water conditions can lead to warm water and spiny ray fish taking over.

Concern of government ramming things through

Steve Arbaugh
Man and woman
Ed Moats

Flooding concerns

Rod Hanna
Bob Everett

Response: Additional clarification added to report, clarifying WDFW's intent to not make flooding or drainage worse and to do what it takes to keep the diking district viable.

Potential trespassing public on dike

Rod Hanna

Summary of additional cost evaluation

- Cost estimates should be for full project, not just dike modifications
- Dike removal costs should include full versus breaching costs for each alternative
- Costs to keep dike district whole over time (both alternatives) to offset project impacts
- Costs to society to keep dike is place if the government grants routinely used to maintain status quo
- Road trestle construction associated with long term alternative (Homeacres Road)
- Boring the Olympic Pipe Line deep under entire site (initial costs and long term operational impacts)
- Impacts of short and long term alternative to WSDOT

- Putting wire utilities up on concrete poles with bases on fill
- Putting local waterlines deep enough to withstand tidal inundation
- Purchasing required land acquisitions (For long term alternative)
- Entire island comparison
    - Entire island acquisition costs
    - Infrastructure impacts (alterations plus long term operating cost impacts)
        - WSDOT (i.e., perhaps new trestle, can't maintain from below)
        - Water pipeline (City of Everett)
        - Gas line (Olympic Pipe Line Company)
        - Other utilities

Response: Scope of work expanded to address most of these items and include in report.

April 15, 2011

Casey Rice comments on Ebey Island Habitat Restoration Feasibility Study draft report dated March 4, 2011. Prepared for WDFW by AMEC. Project No. 0-915-16971-0

Overall:

While I recognize the information, time, and funding constraints faced by the contractor the study is seriously flawed in terms of process and product. General problem areas are:

1) Unbalanced treatment of various interests. In the meetings and in the document excessive deference is given to agriculture interests, especially the diking district. By the contractor's own admission in at least two meetings, the only seriously considered alternative was the single one the diking district would consider, regardless of any non-agricultural values. This decision appears to have been made before the largely qualitative and superficial alternative review that selected the two alternatives for further analysis. No analysis was done of the economic status and viability of the area for agriculture, nor of the long-term maintenance issues associated with farming activities versus ecological restoration. While the land was often described as "prime" farmland in the meetings, there was no exploration of the validity of that claim. Several large, formerly farmed areas (e.g., Mid-Spencer and Ebey Island across from the Qwuloolt site) of the Snohomish estuary exist where dikes failed decades ago and the land was so marginal agriculture never returned. The most common activity in the project area today is grazing. These factors alone strongly suggest something other than a "prime" agricultural designation.

Comment: No promise of an economic analysis was made, nor was it in the scope of work. WDFW explicitly wanted to stay away from having costs and economic factors influence the outcome.

Comment: Yes, there was. We reviewed the NRCS soil maps and the soils are classified as "prime."

Conversely, arguments of restoration advocates were given much less weight. Hydrologic controls and dike breach versus removal, for example, were repeatedly and strongly discouraged by consulting natural resource professionals yet are common design features across alternatives.

Comment: A fuller range of dike removal cost were calculated and added to the report.

2) Incomplete range of alternatives. How the various alternatives were formulated isn't well explained. Most important in my view is the omission of one obvious alternative—additional property acquisition to restore the entire Island south of Highway 2. There isn't even simple accounting to explore that scenario.

Comment: This was not one of bookends of possible alternatives. This was beyond the scope of what WDFW would entertain.

3) Incomplete technical review of restoration alternatives. Initial review was unbalanced and superficial. Only applying further analysis to the two alternatives seems very odd. The alternatives weren't evaluated thoroughly.

Comment: Was done this way due to budget.

4) ***Uneven research and poor referencing throughout.***

Comment: References were subsequently reviewed, added and updated.

1.0 Introduction:

Please make it clear that the presence of the names of the Advisory Committee in the document does not imply any endorsement of the document. Further, it would be honest to note that some (probably most) members have a negative view of it.

Comment: This was added to the report.

Comment: Added to report.

2.0 Desired Project Outcomes:

"… will require compromise." Of course it will. But what it looked like to me was capitulation from the outset.

Comment: And the ag folks are saying the same thing, but from the other side of the argument.

2.1 Ecological Goals

It should be explicitly stated that the target condition for any restoration is historical condition within modern constraints.

More should be said about the case for estuarine restoration in Chinook salmon recovery. We have relatively high certainty that estuarine wetlands are limiting at the juvenile stage, and we are quite sure that the status of Puget Sound Chinook is a modern problem directly related to modern human activity.

Comment: Added to report with citation.

2.2 Societal Goals

Nowhere in the document, nor in any of the meetings, did the contractor raise the point that making a major improvement to the ecological integrity of the Snohomish River estuary through Ebey Island restoration represents a potentially major gain in nature capital for society. Significant cultural, economic, recreational, and other benefits are all likely, and presumably warrant inclusion in societal goals statements. Yet the overwhelming emphasis was on protecting two interests: public utility and transportation infrastructure, and local agricultural interests.

Comment: He's right, we did not mention this, because it wasn't in our scope of work to address "nature capital."

"Benefits should outweigh costs." Appropriate cost-benefit analysis was seriously lacking in this exercise.

Comment: True, but we knew this. We talked about it, but WDFW wanted to stay away from costs.

3.0 Stakeholder Involvement

As already noted, I do not think this process and document achieved reasonable balance. It simply reflected the imbalance that created the problems that created the need for restoration.

Comment: Again, everyone from all sides believes this.

4.0 Existing Conditions

Where is the review of economic state of agriculture on the site, and the condition and maintenance requirements of the dikes?

Comment: Beyond scope.

On the ownership topic, it would be good to note what ownership requires of WDFW with respect to contributing to the diking district and their lack of control as a public entity.

Comment: Comments added to report.

A map of the Collins reconstruction of historical conditions would be a very good addition.

Very uneven detail across the different major taxa, including scientific names.

5.0 Habitat Restoration Alternatives

This needs much more explanation of how the different alternatives were developed. And one obvious conceptual alternative—property acquisition and restoration of the whole area—isn't included.

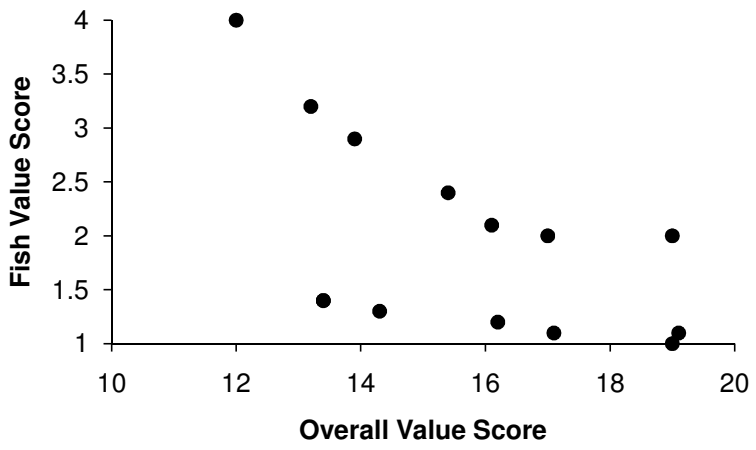
Comment: See above. Brief discussion of this added to report.

5.1.2 Evaluation and Ranking of Conceptual Alternatives

Since recreation is strangely neutral in this evaluation, having value to fish as the only ecological criterion is not reasonable. And it's not clear in the document how the outcome of Table 5 influenced the results of Table 4, but Table 4 would have to change an awful lot to make it anywhere approaching "balance." A plot of the scores from the first and last rows in Table 4 shows a very clear inverse relationship between what's good for fish and what's good for "everything." We don't need this analysis to tell us that. It's been the case for over a century. With this sort of treatment, why bother even raising the prospect of restoration at all?

Comment: Clarification added to the report.

Comment: This table only shows that if fish wins, other things (e.g., ag) loses. We know that, as they are competing interests.



5.2.2 Hydrodynamic Modeling of "Preferred" Alternatives

Water levels seem to be the only variable worked with here to any extent, even though others (e.g., temperature and velocity) will influence fish significantly.

5.2.4.1 Restoration of the Snohomish Estuary

"Research at these sites contributes to our understanding of fish use of restored sites…" Why is so little of this understanding discussed and applied in this document?

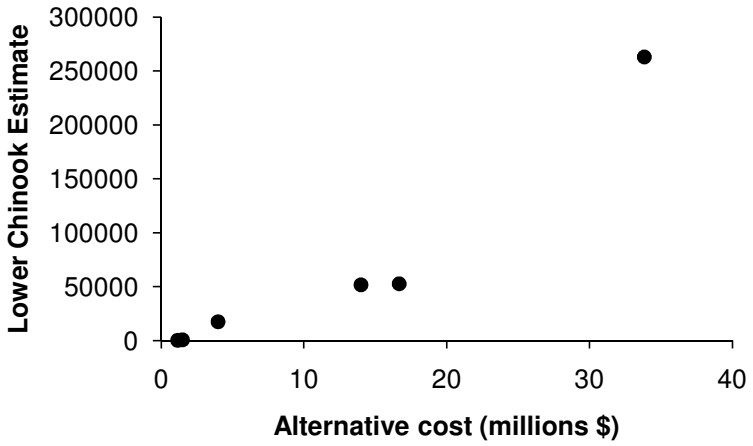
The "spring outmigration period" of March 1 to June 15 is referred to several times and is too narrow. What's the basis of this?

Glad the attempt was finally made very late in the process to apply the fish/habitat estimates from the Skagit. This should have happened much sooner, and the results submitted to rigorous review by the authors of that analysis. I don't see anything wildly

wrong with this as a first cut, though. There is a ton of uncertainty around this and the authors convey that fairly well.

Discussion of the spruce forested area (page 126) is superficial and probably incorrect. As far as I can tell, nobody on the project team did any background research to document the age of the forest on that site and simply took the word of the locals about whether it would die back with inundation. Most of the Snohomish estuary was forested wetland, including that area, so why should we expect that it would dieback?

Why not combine the (very uncertain) estimates of fish production with the (very limited) cost estimates. This picture sure does argue for fuller restoration, especially since the tide-gated scenarios surely overestimate relative capacity.



Answers to questionnaire:

1. Did the project team provide sufficient information and opportunities for the Advisory Committee to thoughtfully evaluate and discuss alternatives and a path forward? Specifically, did the Feasibility Study process:

    a. Develop and make available information necessary to evaluate habitat restoration alternatives and other values, including agricultural productivity, recreation, and wildlife?

    Response: Some but not enough.

    b. Include key interests and provide fair opportunities for stakeholders to express their interests and concerns?

    Response: No

    c. Incorporate Advisory Committee input into the alternatives and respect participants' investment of time and effort?

    Response: No

2. Generally, what is your view of the near- and long-term alternatives?

   a. Does the near-term alternative provide a viable outline for a restoration project in the next ten years (with or without the north tip of Ebey Island)?

      Response: No. Especially in the muted areas, it's likely to be an expensive reflecting pond project with a tidegate study that will duplicate negative results of other studies.

   b. Does the long-term alternative provide a viable outline for a future restoration project?

      Response: It's probably the best of the bunch but why not go farther if you're going at all.

      Comment: Additional information was gathered and reported.

   c. Do you have specific recommendations that would improve the near- or long-term alternatives for Ebey Island?

      Response: No tide gates, remove rather than breach dikes, and put money into property acquisition rather than dike building and road raising.

   d. (No question 2.d)

      Response: Of course.

3. What should be the next steps?

   a. Does the Feasibility Study provide a clear path to a restoration project that balances competing values? If not, what additional information, processes, or steps would be helpful in developing such a path?

      Response: No, it's very unbalanced in favor of the relatively narrow interests that helped create fish and wildlife problems in the first place.

   b. Can the Feasibility Study provide valuable information for broader planning efforts, such as the emerging Snohomish Sustainable Lands Strategy, which seeks to harmonize farm and fish/wildlife needs in the County?

      Response: Serious socioeconomic analysis that includes credible cost estimates of all alternatives, including full restoration of the area south of Highway 2 with dike removal.

      Comment: Additional analysis was completed and included in the report.

Ebey Island Restoration Feasibility Study

Advisory Committee Meeting #1 and Site Tour

April 27, 2010

Submitted to:

Washington Department of Fish and Wildlife
16018 Mill Creek Boulevard
Mill Creek, WA 98012-1541

Submitted by:

AMEC Earth & Environmental, Inc.
11810 North Creek Parkway North
Bothell, Washington 98011

April 30, 2010

AMEC Project No. 0-915-16971-0

The following notes were recorded at the April 27, 2010 meeting of the Stakeholder Advisory Committee for the Ebey Island Restoration Feasibility Study. A list of meeting attendees and their affiliations is included. The committee met from 3-6 PM, beginning with a 1.5-hour long meeting at the Snohomish County Administration West Building in Everett, and concluding with a 1.5 hour tour of the project area. Questions regarding these notes should be directed to Cleve Steward, Consultant Project Manager, Tel. 206-719-1260; cleve.steward@amec.com.

Meeting Notes:

I. Introductions by WDFW Project Manager Richard Tveten
   A. Introduced self briefly
   B. Introduction of Doug Hennick
      1. Watershed Steward
      2. Fish biologist
      3. Working in Snohomish watershed 12 years
      4. Key to acquisition of Ebey Island property for restoration
   C. Introduction of John Garrett
      1. Wildlife Area Manager
      2. Work goes beyond fish: includes recreation, waterfowl
   D. DFW mission
      1. Protect, enhance, and restore fish, wildlife, and their habitat
      2. Provide sustainable, fish- and wildlife-related recreational and commercial opportunities.
   E. Ebey Island
      1. A key "choke point" for salmon in Snohomish watershed
      2. Overview of selection process by which AMEC was chosen
II. Self-introductions of meeting attendees
   A. Dan Evans, Dan Evans Consulting, public outreach lead on AMEC team
   B. John Engel, Snohomish County Public Works, Surface Water Management
   C. Janne Kaje, King County
      1. Co-Chair of Salmon Technical Committee for Snoqualmie-Skykomish Watershed
      2. Representing King County's interest in the basin
   D. Jason Anderson, Stilly-Snohomish Fisheries Task Force
   E. Kye Iris, WDFW, property acquisitions and grant proposals for acquisitions
   F. Sharon Swan, Snohomish County Parks and Recreation
   G. John Garrett, WDFW, Wildlife Area Manager
   H. Russell Link, WDFW, Program Manager
   I. Doug Hennick, WDFW, Fish and Wildlife Biologist
   J. Mike Blackbird, Pilchuck Audubon
   K. Nick Harper, Cascade Land Conservancy, runs Snohomish County office
   L. Kate Halstead, Sno-Valley Tilth
   M. Walker Stanovsky, AMEC
   N. Ruth Millner, WDFW, district wildlife biologist
   O. Cliff Strong, AMEC, project administrator / land use planner
   P. Cory Armstrong, YMCA of Snohomish County
   Q. Cleve Steward, AMEC, project manager, fisheries biologist
   R. Micah Wait, Wild Fish Conservancy
   S. Dr. Tom Nowak, owns parcels adjacent to SE corner & center of WDFW land
   T. Brian Bookey, Snohomish County Ag Advisory Board
      1. Dan E notes Ryan Hembree would have attended as well, if he could.
   U. Matt Brennan, PWA, hydraulic engineer on AMEC team

V. Bob Battalio, principal at PWA, civil engineer on AMEC team
W. Ryan Bartelheimer, AMEC, engineer
    1. Formerly employed by Snohomish County Conservation District
    2. Former Flood Control District Commissioner
X. Phil Cunningham, Ebey Island landowner, DD 1 Commissioner
Y. Everett Alexander, adjacent landowner, (past DD 1 Commissioner?)
Z. Casey Rice, NOAA fisheries in Mukilteo, monitors restoration in Snohomish basin
AA. Monty Marty (sp?), Snohomish Conservation District
BB. Andrew Corbina, WSU faculty
    1. Works w/ Snohomish County agriculture
    2. Also works w/ surface water management on Smith Island
CC. Richard Tveten, (previously introduced)
DD. One latecomer, a man who sat near the door and whose name we didn't catch

III. Dan Evans: Purpose of the Advisory Committee
A. Identify key information and values for the process
B. Aside: Addressing tension between agriculture and restoration communities
    1. The "elephant in the room"
    2. Several people in the room are working for common ground on countywide level
C. The current project
    1. Feasibility study—not decisional
    2. Goal is to narrow to a preferred alternative with broad support
    3. This is a "rowboat" in the larger tide of the ag/restoration conflict
    4. We will try to design a project that is capable of moving forward
D. Advisory Committee
    1. A place to test ideas
    2. Not a decision-making body
E. We're looking for a way forward with broad support
F. This may not mean strict consensus

IV. Cleve: Feasibility Study Process
A. Working w/ finite time (12-13 months) and money
B. The goal: Arrive at a preferred alternative
    1. Enough to describe to funding sources and constituents
    2. A vision we can all support
C. To achieve commonality of vision,
    1. Project team will be interactive with Advisory Committee
    2. We've set up milestones w/ checkpoints along the way.
D. The process:
    1. 6 technical phases (ran through as described on handout, p.1)
    2. If an attendee is not on Advisory Committee, but would like to receive project information sent to the Committee, provide your contact info and we will add you to the distribution list
E. Project schedule and milestones
    1. Described as on p. 2 of meeting handout
    2. Goal is preferred alternative
    3. Secondary goal relates to evaluation of 3 selected alternatives
        a. All 3 should be detailed enough for further grant funding in case we need further information or we have not reached agreement
    4. Want product in time to turn around for 2011 grants
    5. "You're all experts in your own way, and we want to take advantage of that"

6. Door prize: 1 dozen fresh eggs from Cleve's chickens

F. Advisory Committee meeting dates, as listed on handout p. 2
G. Deliverables, as on handout p. 3. "Grand Finale" is Feasibility Report
H. Group contact information, as on handout pp. 4-5

V. Project Concepts
A. Dan: At this stage, we want to compile not judge
B. Ryan: Introduction of maps
1. Small map handout
a. Whole island
b. White: County map shows public rights-of-way
2. Big wall map
a. Corresponds to red rectangle on handout map
b. Is area of primary focus on this project
c. Includes Snohomish County dike data
d. But amended with input from recent Diking District meeting
C. Ryan: drawings of breaching alternatives
1. Existing conditions
a. Dike, tide gates, pump station
b. Interior of island compared to range of tidal influence outside
2. Concept #1
a. Full setback dike
b. May not be feasible because of soft soils in island interior
c. Would restore full tidal influence to restored land
d. Could essentially cut island into two separate diked areas
3. Feasibility study as a concept
a. Should try to find "bookends" of what is possible
b. Ensures that later evaluation includes diverse alternatives
4. Concept #2
a. Leave outboard dikes as they are
b. Leave overall drainage of diking district intact
c. Construct new partial-height setback dike
d. Restore muted tidal influence between setback dike and existing dike
e. Use self-regulating tide gate
D. Dan: Asks Ryan to characterize present usage of land on the island
1. Ryan: Ag is predominantly grazing
a. Mainly beef, some others
b. Not a lot of crops
2. Everett Alexander:
a. Lots of haying, too
b. Anything needed can be done
c. Right now, cows are most viable
3. Ryan: In the past, various crops and corn have been grown
a. The difference is how much the pumps are run
b. Island could be kept dryer for higher-value crops
E. Richard: What about the forest in the SE of the WDFW property?
1. Ryan: It's basically intact spruce forest
a. Pretty wet
b. Probably pretty intensive use by wildlife
c. Not been cleared in recent past, partly because of soft organic soils

        d. Buried gas line
    F. John Engel: Could DD commissioners describe infrastructure in specific?
        1. Would be helpful
        2. Maybe not at this meeting
    G. Dan: That's a good segue to Q&A / group discussion
VI. Conversation / Q&A segment (started 3:58)
    A. Dan: Let's hear from the "fish folks"
        1. Janne Kaje:
            a. Different watersheds have different constraints on salmon life history
            b. In this watershed, juvenile habitat is missing
            c. Three key types of juvenile habitat
                i. Estuary habitat (includes Ebey Island)
                ii. Main-stem river habitat
                iii. Marine nearshore
            d. In the Puget Sound, few intact estuaries remain
            e. He knows Ebey Island some, but not intimately
            f. Anxious to learn more from residents
            g. In Snohomish basin, estuary habitat is very limiting on salmon
            h. All anadromous fish move through estuaries twice in their life-cycles
        2. Casey Rice:
            a. There's quantitative evidence of estuary's importance in Skagit basin
            b. Snohomish data is developing, but not there yet
            c. Fish use of habitat is a function of its "plumbing"
                i. Distance and number of bifurcations are limiting
                ii. Need to design with this in mind
                iii. Then document whether the restored habitat is actually working
            d. They're now doing fish counts in the vicinity of Ebey Island
            e. Dan: How good is this habitat?
                i. Casey: Intuitively it's good
                ii. We don't have the data to back that up yet
            f. Sharon Swan: How important is salinity?
                i. Casey: Not so important
                ii. But tidal range is very important
        3. Doug Hennick:
            a. Length of channel formation is exponential with restoration size
            b. Therefore one big restoration is better than several small ones
            c. Deadwater Slough is just off the mainstem, therefore easier for fish to find than are other distributary channels
            d. Chinook seem perhaps to prefer least salty parts of estuary
            e. Ebey fits that bill
        4. Everett Alexander:
            a. Recently the river has been alive with 4" fish jumping. Why?
                i. Cleve: They all come down in a slug when released from the hatchery; the hatchery release record should tip us off. Mass release gives fish a chance to overrcome mergansers and other predators by sheer numbers; food may become limiting though.
            b. Why not just shoot the mergansers?
            c. Why instead ask all these sacrifices from agriculture?
    B. Dan: Let's hear from some of the other agriculture people

1. Brian Bookey:
   a. He's a neophyte on habitat restoration
   b. Thought he heard opposite about juvenile chinook salinity preference at Blue Heron Slough recently
   c. Troubled by lack of integration of/overall strategy for restoration projects
      i. DFW, Port of Everett, City of Everett all have their own
      ii. They're not coordinated
   d. Is this project appealing just because WDFW already owns the land?
   e. His understanding of regional responsibility
      i. Snohomish County is responsible for basin-wide salmon recovery
      ii. Why isn't there more coordination?
   f. Need to look at current AND future land use
   g. Sustainability
      i. Once habitat is underwater, it's gone
      ii. Chance to farm it with future techniques is lost forever
   h. Land use policy
      i. Believes land use designation is Ag 10
      ii. Says we are talking about converting that
      iii. Where does this fit into County land use plan?
      iv. He's told habitat is not a "use," it just "happens"
      v. So there's no larger process / structure to restorations
   i. Leque Island
      i. Growth Management Act (GMA) makes considerations for ag
      ii. Felt WDFW didn't account for these on that project
      iii. All emphasis was on Endangered Species Act
   j. Happy to participate in this group, but concerned about:
      i. Isolation from other restoration projects
      ii. And from any larger strategy
2. Kate Halstead
   a. Floating gardens of ancient Mexico City
      i. Used dredge & pile to turn wetlands to farm
      ii. Intensive ag supported large, dense population
   b. "I'm convinced that we could create and develop a template version" on Ebey
      i. Create 5- to 15-acre islands
      ii. Farm intensively and organically
      iii. High visibility on US-2
      iv. Weekend barges could bring tourist visits
3. Andrew Corbina
   a. Demand for local, organic food is too large to meet
   b. Good opportunity to teach best management practices for ag
   c. Teach the many people from cities who want to become farmers
   d. His value for this project would be to save the *best* land for farming
4. John Garrett
   a. A major component of wildlife strategy is ag for wildlife benefits
   b. Another is trying for moist-soil management
      i. Water-management cell
      ii. We can manipulate water levels within each cell
      iii. Facilitates desirable invertebrate populations
   c. Recent study by Mark Petrie (needs to be verified)

        i. Working in Skagit w/ Ducks Unlimited
        ii. Goal: Identify ideal balance of ag/moist soil/estuary
        iii. Bottom line result: We still need a high level of ag
        iv. Supports over-wintering birds, etc.
    5. Phil Cunningham
        a. Went to meeting (site visit?) about Smith Island restoration
        b. Asked "What do you think the success rate will be?"
        c. He was answered, "We don't know."
        d. That's a tough way to do business.
C. Mike Blackbird: Bird perspective
    1. Need to consider populations of birds before & after restoratioWhen evaluating alternatives
D. Sharon Swan: Recreation values
    1. Opportunities for urban populations
        a. Population in county is booming
        b. This estuary is located right between Everett and Marysville
        c. For this site, recreation is complementary to both ag and restoration
        d. Getting people out *to* places builds love for them
    2. As Brian said, we need to look at the whole estuary
    3. Hunting needs to be considered; she's surprised there's no representative at meeting RT.
    4. Regarding public property north of US-2 on the map
        a. She doesn't know what the plans are (county owned?)
        b. But will look into it.

VII. Cliff: Logistics about site visit

We have not reproduced the flip chart notes or the large drawings that were used to describe existing water control structures and illustrate general restoration concepts.

Notes from the tour of the project area (3 stops)

I. Stop 1 – Hunting Club (end of 38th St. SE near Everett Alexander's barn)
    A. Arrive 5:03 PM
    B. Discussion topics:
        1. Looking east, northeast - generally wet pastureland w forested area off to the east; leased for cattle grazing
        2. Past uses
            a. John Garrett: High ground, incl. Everett's barn, formerly an airstrip
        3. State of spruce forest at SE corner
        4. Ducks Unlimited
            a. Past & future work – some lack of clarity of what already done, what planned
            b. Related to the shallow ponds just there.
II. Stop 2 – WDFW Property (where Homeacres Road turns south, at NW corner of site)
    A. Arrive 5:15 PM
    B. Cleve explains why we're standing there
    C. Does WDFW have a vision for this corner of the land?
        1. John Garret: Not really; acquisition is too new
        2. But they did think of setting aside for watchful wildlife (not hunting)
    D. Cleve: Question about state of the dike

1. John Engel: Near-breach in January this year
2. John Garrett: Diking district mentioned that it could use repair
    a. At south end of WDFW SE property
    b. Ryan: Also at very S tip of island

E. John Garrett & Cliff point out location of pump station
1. Elsewhere, mainly scrub wetlands
2. Plus WSDOT mitigation site to SE

F. Problem with dike along WDFW boundary (re. restoration)
1. Private parcel in middle
2. Homeacres Road / 43rd street also runs through middle
3. Ryan: Raising road is possible, but expensive
    a. There's not really an inexpensive alternative
4. John Garrett: Would probably just do a setback dike along road
    a. On WDFW property
    b. And just not mess with the road issue

G. Cliff: Logistics: No time for both stops 3 + 4
1. Which to keep?
2. Cleve: Stick w/ WDFW property and go to stop 3

III. Stop 3 – Dike Walk

A. Arrive 5:30 PM

B. Ryan: Description of how the dike system works
1. Now is high tide
2. Can get higher in a flood
3. Gas pipeline
    a. Can see where it crosses dike to SE
    b. Comes onto island from Ebey Slough
4. Get a sense for how high water would be in island if tidal
5. Conditions on interior of island
    a. Away from flowing water, softer, organic soils occur
    b. For example, road beds on island settle unevenly
    c. Geotech report from pipeline installation
        For each 1 foot of fill addedThey observed 6 to 9 inches of subsidence

C. Question: How much have soils subsided?
1. Ryan: Don't really know.
    a. The very south tip of island has never been diked
    b. It is about 2 feet higher
2. John Engel: Anecdotally, has heard 5 feet of subsidence

D. Ryan: Fill material for dikes themselves
1. Borrow ditches are visible inside dike, left from construction
2. It would be hard to remove all the dike material
3. A lot was brought in (not all from borrow ditches)

E. John Engel: Question for fish guys about connectivity
1. What are benefits of one main point of connectivity
2. Vs. many little breaches along the dike?
3. Casey:
    a. Not known; no one has ever tried the latter
    b. They may try it at Spencer Island, near the breach at the N end

F. Ryan: Full tidal vs. muted tidal influence

1. Big problem with muted tidal influence: how much time water is flowing
2. Full tidal is ideal
    a. Different ecosystems at different levels
    b. Provide different habitat
    c. Diverse fish habitat through different flow levels and seasons
3. Casey:
    a. But we do know a lot about salinity, flow, etc.
    b. As they relate to plants
    c. As well as some limits on fish usability

G. Ryan: Recommend edge habitat? Strategies, etc.?
1. Janne:
    a. Subsidence since diking can be problematic
    b. When flooded, water can be too deep
    c. You'll just get mud flat
    d. Some evidence: ~100 years before siltation yields emergent marsh

H. John Engel: Important to think about infrastructure within the diking district
1. 10-11 miles of dikes, pump station, etc.
2. We need to think about how that dike system affects regional infrastructure
    a. US-2
    b. City of Everett water supply lines
    c. Gas pipeline
3. Dikes are maintained by farmers on the island
4. Keep this in mind through the process

IV. Stop 4 – Diking District 6 restoration project – Not visited due to time constraints.

Ebey Island Restoration Feasibility Study

Advisory Committee Meeting #2

June 22, 2010

Submitted to:

Washington Department of Fish and Wildlife
16018 Mill Creek Boulevard
Mill Creek, WA 98012-1541

Submitted by:

AMEC Earth & Environmental, Inc.
11810 North Creek Parkway North
Bothell, Washington 98011

June 29, 2010

AMEC Project No. 0-915-16971-0

The following notes were recorded at the June 22, 2010, meeting of the Stakeholder Advisory Committee (AdCom) for the Ebey Island Restoration Feasibility Study. A list of meeting attendees and their affiliations is included. The committee met from 3 to 5:30 PM in the conference room at the Washington Department of Fish and Wildlife's (WDFW) offices in Mill Creek, WA. Questions regarding these notes should be directed to Cleve Steward, Consultant Project Manager, Tel. 206.719.1260; cleve.steward@amec.com.

Project Goal

The goal of this project is to evaluate the technical and social feasibility of restoring high quality, tidally-influenced aquatic habitat on 1,237 acres of WDFW-owned land on Ebey Island, and, in consultation with the project Advisory Committee, to select a preferred alternative that would generate the greatest biological and social benefits.

Attendees

AMEC Consultant Team:
Cleve Steward
Ryan Bartelheimer
Dan Evans (Dan Evans Consulting)
Walker Stanovsky
Cliff Strong
Matt Brennan (Philip Williams Associates, on the phone)

WDFW:
Richard Tveten, Project Director
Doug Hennick, Fish and Wildlife Biologist
Belinda Schuster, Assistant Wildlife Area Manager
Russell Link, Program Manager
Ruth Millner, District Wildlife Biologist
Kye Iris, Property Acquisitions
Annette Hoffman, Region 4 Fish Program Manager

Advisory Committee:
Everett Alexander, Diking District 1 Commissioner
Barney Bagwell, Diking District 1 Commissioner
Phil Cunningham, Diking District 1 Commissioner
Kate Halstead, Sno-Valley Tilth
Maria Calvi, Tulalip Tribes
Janne Kaje, King County Snoqualmie-Skykomish Watershed
Micah Wait, Wild Fish Conservancy
Ryan Hembree, Snohomish County Agriculture Coordinator
Mike Blackbird, Pilchuck Audubon
Bobbi Lindemulder, standing in for Monte Marty, Snohomish Conservation District

Sharon Swan, Snohomish County Parks and Recreation
Jason Alexander, Stilly-Snohomish Fisheries Task Force
John Engel, Snohomish County Public Works, Surface Water Management
Andrew Corbina, WSU Snohomish County Extension

Meeting Notes:

I. Richard: Brief welcome
II. Agenda and recap
    A. Dan's intro
        1. Agenda
            a. Brief recap
            b. Project overview and update: what we're about, progress to date
            c. Preliminary Conceptual Alternatives (PCAs): Tech background, range of options, how generated
            d. Criteria used to evaluate PCAs and select preferred alternative
            e. Discussion, expected outputs, next steps
        2. Recap of AdCom #1
            a. Richard introduced the feasibility study project and team
            b. We noted the ag/restoration issue underway in Sno. County and elsewhere
            c. Purpose:
                i. Gather info
                ii. Evaluate technical and social feasibility and alternatives
                iii. With AdCom input, recommend a preferred alternative
            d. Ryan presented technical aspects of the project
                i. Restoration strategies
                ii. Full tidal, muted tidal, managed areas
            e. Group discussion highlighting four values:
                i. Fish restoration: (Janne, Casey, Doug)
                (a) Intuitively, good fish restoration site
                (1) Need to evaluate and verify
                (2) Estuary habitat is a limiting factor, especially for Chinook
                (3) Deadwater Slough is on mainstem Snohomish River – the main migratory route for juvenile salmon
                (4) Large area – potential for land-water interface
                (5) Sweet (fresh) water, not too brackish, preferred by Chinook
                (b) Many tech challenges and uncertainties we need to address
                ii. Ag land – Site is designated Ag10
                (a) Grazing, hay
                (b) Some row crops
                (c) Drier land could increase value (with greater pumping and controls)
                (d) Future? Floating gardens (Kate)
                iii. Wildlife and birds
                (a) Overwintering waterfowl
                (b) Migratory birds
                (c) Resident birds and wildlife
                iv. Recreation
                (a) Bike / hike
                (b) Birders

(c) Hunting
(d) Kayaking
f. Site visit

B. Richard: Goals and objectives of the project
1. Restate WDFW mission: dual mandate
a. Protect fish and wildlife habitat
b. Provide sustainable fish and wildlife related recreation
2. Expectations for the WDFW land on Ebey Island
a. Details of request for funding
i. Goal is healthy, diverse, sustainable fish and wildlife populations and habitat
ii. Long term: Restore estuarine functions
iii. Short term: Enhance wetland, moist soil management
b. Feasibility study grant from Salmon Recover Funding Board (SRFB)
i. Examine possibilities for fish habitat restoration
ii. We must consider "not just an empty island" but everything that's there
3. Expectations of the Advisory Committee (AdCom)
a. Project goal restated, as above
b. AdCom is expected to ensure that the study considers a full range of options

C. Cleve:
1. Acknowledges Dan's efforts in outreach
2. Goal is to incorporate AdCom's views
3. Today's meeting is meant to show them that process
4. Slide 2: Project schedule recap
a. Feedback opportunities not limited to meetings
b. Dan or others will act as points of contact
c. The schedule is used to "set a course" for the project
d. AdCom meeting #3 could be pushed back if more time is needed
i. We now realize how much "homework" we have to prepare for that meeting
ii. However, schedule has to be driven by next round of SRFB funding

D. Ryan B: Recap of this meeting's agenda

III. Ryan B: Existing information in and around project area
A. Slide 5: Existing waterways and flow directions
B. Slide 6: General direction of flows during floods is north
C. Slide 7: Ebey Slough gage data
1. Gravity flow drainage is possible ~2-5% of the time
2. When tide is low
D. Slide 8: Historic aerial photo, noting 3 historic slough channels
E. Slide 9: LiDAR data, processed by PWA
1. Vegetated areas show artificially high (as in forested SE corner of island)
2. Color-coding shows elevations relative to tide stages
3. Notes historic channels from previous slide as remnant low areas
F. Slide 10: Sample muted tidal heights
1. There's potential to fine-tune this curve
2. Different combinations of water-control structures can provide desired flexibility
G. Slide 11: Area of WDFW land inundated as a function of water elevation
1. Inflection point gives possible target muted tidal height ~6 ft NAVD
2. Recap of difference between full and muted tidal inundation
H. Slide 12: Full vs. muted tidal restoration

1. Three- to five-fold difference in fill volume required
2. Micah: Which alternatives does this apply to?
   a. Ryan B: Actual volumes vary by alternative
   b. Cleve: These fill volumes are per 1,000 linear feet of dike
3. Kate: Why the difference in dike height for full vs. muted tidal?
   a. Ryan B: Recap using schematic drawings from AdCom #1
   b. Difference in width of footprint and geometry and height of dikes
4. Russell: Are there examples of muted tidal systems in the Snohomish estuary?
   a. Ryan B: Not to his knowledge, but they definitely exist elsewhere
5. Maria: Is there a difference in maintenance requirements / sustainability?
   a. Ryan B: Assurances are much more difficult w/ full-height dike
      i. With muted, can retain and modify water control structure in original dike
      ii. Also lower "cost of entry" with muted
      iii. Muted system is more flexible by using "nimble" water control structures
   b. Maria: Maintenance of these "nimble" structures vs. traditional ones?
      i. Ryan B: They're designed robustly
      ii. In some ways, easier to maintain than unregulated tide gates
      iii. Can be opened between tides to remove debris, unlike older designs
6. Cleve: Obvious differences make muted tidal look like a better option
   a. There are nuances we're not seeing at this level
   b. We're not endorsing one or the other at this stage
   c. Some alternatives use both
   d. This slide is just meant to highlight differences objectively
7. Everett: With muted, if tide gate fails, it will flood the island with no backup
   a. Ryan B: There are ways to build in backups
   b. For example, a shutoff valve on the inboard side of the culvert
8. Russell: How many tide gates per length of dike?
   a. Ryan B: Not many; maybe one to four at most on whole property
   b. It's premature to discuss now
   c. Specifics vary depending on the system's goals and other components

I. Slide 14: Conceptual dike cross-sections and recap of relationship to fill volume

J. Slide 15: Land use descriptions
   1. Note: Most alternatives don't incorporate land WDFW doesn't already own
   2. A few include minor acquisitions
   3. Conceptual alternatives intentionally cover a wide range of options, from do nothing to full inundation ("bookends")
   4. WDFW has already spoken w/ some owners and right-of-way holders conceptually
   5. No one will be blindsided by suggestions of possible acquisitions

IV. Ryan B: Presentation of conceptual alternatives

A. Slide 16: Draft alternative A
   1. Full tidal
   2. Note inclusion of several small parcels outside present WDFW land
   3. WDFW has talked to owners, including diking district at east edge
   4. Olympic Pipeline wouldn't have their needed maintenance window

B. Slide 17: Draft Alternative B
   1. Everett: How much is the difference in dike lengths in these alternatives?
      a. Ryan B: Hasn't been calculated yet for the draft alternatives
   2. Janne:
      a. Full tidal (as in alternative A) is described as an extreme option

   b. However, it requires less dike than others - some of the material removed from the existing dike can be reused
   c. Construction of muted tidal berms would require new material to be brought in
3. John: What about roads and infrastructure?
   a. Ryan B: Very preliminary; placeholders in plan say simply to raise them
4. Dan: What is usual use / disposal of material in these situations?
   a. Ryan B: Tidal range is high enough that you couldn't reuse much
   b. It would require wet work, which is much harder and more expensive
5. Dan: What percentage of dike is usually removed? What about at Nisqually?
   a. Ryan B: At Nisqually, it was all removed
   b. Depends on available money and on height of tidal range
6. Everett: What are the differences in area of the diking district?
   a. Funding is by area
   b. To cut their area in half and add dike is something significant
   c. Ryan B: Note that some alternatives could include land to the north too
      i. But this is outside the scope of the SRFB grant
      ii. Though the diking district has expressed willingness to consider
   d. Maria:
      i. Don't assume areas / lengths / volumes on this alternative
      ii. Also don't assume that diking district funding will be as it has been
      iii. Dike on WDFW land might include a State obligation to maintain it
      iv. Richard: Yes, but many of these options are very expensive
7. Ryan H: Why looking at some land swaps / acquisitions but not others?
   a. For example, land at north end of Ebey Island
   b. Richard: Distinction between contiguous properties and those elsewhere
      i. Conditions of SRFB grant were to look at feasibility for this property
      ii. Have to draw a line for how far afield to look
   c. Micah: Has worked w/ SRFB
      i. Thinks we could go back and modify grant conditions
      ii. Could allow consideration of more distant land swaps
   d. Ryan H: Feels there's inconsistency in what options are evaluated
   e. John: Concurs with Micah
      i. Thinks SRFB and the forum would be flexible in considering solutions
      ii. Encourages team not to be locked into considering only present parcels
8. Kate:
   a. What else does "bookends" mean?
   b. Why not consider alternatives that improve ag to the detriment of fish?
9. Cleve: AMEC's mandate to evaluate the feasibility of different restoration alternatives was in context of existing property boundaries
   a. Nevertheless, it may be possible to broaden scope to include restoration of north Ebey Island
   b. Good to talk about this at early stage of the process
   c. We'll have to look at the effect of including north Ebey Island on the budget and analytical approach we've proposed to evaluate alternatives
   d. We'll discuss it and get back to you
10. Maria: Need to consider total dike length vs. area diked, even off the island
11. Ryan B: Note that actual dike configurations wouldn't have the sharp angles depicted in the aerial photographs
   a. These are just a "first cut" to illustrate the basic restoration concepts

b. Actual dikes would be set back farther from property edges
12. Micah: Question about current conditions
a. How often are the dikes overtopped?
b. Everett: Last time was 1990

C. Slides 18-21: Quick presentation of Draft Alternatives C through F
D. Slide 22: Draft Alternative G
1. John: How would muted tidal in the middle drain connect to full tidal at NE?
2. Ryan B: Need to add water control structure (not presently shown)
3. Located at intersection of full height dike and watercourse
E. Slides 23-26: Quick presentation of Draft Alternatives H through K
F. Slide 27: Comparison of alternatives
1. Includes rough sketch of relative areas and lengths
2. Dan: No difference in this chart between full height and shorter dikes?
a. Ryan B: No.
b. Dan: Will we account for this, and % of dike removed vs. breaches, later?
i. Ryan B: Yes, these distinctions will be made in later analysis
ii. Also will develop more detail in water control structures
3. Dan: This will all be available electronically after the meeting
G. Cleve: Everyone will have 3 weeks (until July 13) to submit comments by email, phone, in person

V. Questions and answers / open discussion
A. Kate: A map with overlay of soil types would be helpful in evaluating alternatives
1. Ryan B: It exists, but we don't have it with us
2. Will put it on the project FTP site
B. John: Hard to see distinctions in the alternatives within the "working lands" category
1. Ryan:
C. Everett: We've heard nothing about destruction of prime ag land
1. Will there be any mitigation for that?
2. He understood that the county would try to maintain area of ag
3. Has this been given any consideration?
4. Ryan H: As far as mitigation, there's an effort to put it into county codes
a. Mitigation requirement is not very "iron-fisted" yet
b. Individual permit requirements can be and are put into place
c. County executive is trying to get a new policy enacted within 6 months
i. This study therefore won't account for it
ii. But hope to have it in place before this project would apply for permits
d. Agencies involved:
i. Farm Bureau
ii. Ag Advisory Board
iii. Tulalip and Stillaguamish Tribes
iv. WDFW – Bob [Edward]
D. Kate: National Marine Fisheries Service (NMFS) Biological Opinion of 2008 regarding FEMA's Regional Flood Insurance Program
1. Bars development of floodplain habitat – have the potential effects (e.g., "taking" of listed salmon) been considered
2. Will any of the presented options be dead on arrival?
3. Ryan B: That question involves meeting zero-rise flood requirements[1]

[1] A 'zero-rise' floodway is an area reserved to carry the discharge of a flood without raising the base flood elevation.

        a. Will need to work w/ the County
        b. Hasn't been evaluated yet
        c. Will require more detailed modeling by PWA later down the road
    E. Kate's understanding of ideal fish habitat
        1. Small side channels with water flowing in and out
        2. Overhanging vegetation
        3. Why no option representing interweaving of existing channels w/ ag between?
        4. Ryan B: Not precluded – there's room for fine-tuning and small-scale enhancements not represented here
    F. Phil Cunningham: Any idea at all what kind of salmon numbers we're talking about?
        1. Ryan B: Keep this question on the table as Cliff gets into evaluation criteria
    G. Maria:
        1. re. Kate's last comment: larger areas generally have more small channels
        2. re. Phil: Current hypothesis is that estuary is limiting factor in this basin
        3. Therefore this property is very high priority
    H. Phil: But why spend all this money without knowing how many fish are going to be produced?
        1. Doug: In Skagit, they're required to estimate numbers
            a. Would expect this project to do likewise
            b. 75% of smolts go down the Snohomish mainstem
            c. Therefore fish benefit is not based solely on area restored
            d. Location is also important
            e. Janne: As basin is restored over years, expect changes in migration
        2. Janne:. This basin has more science than any other in the state
            a. Different life cycle steps use different good-quality habitats
            b. The plan does have basin-wide number goals
            c. It's hard to break those up into individual projects
            d. Would like this process to include presentation about basin-specific science
                i. Would like project team to plan for this
                ii. Should help explain why numerical goals are hard to break down to project level
    I. Ryan H: Would hope to see balance between fish and ag in alternatives analysis
        1. To Cliff: would hope to see RCWs and County policies in criteria in advance
    J. Bobbi: Factors to consider
        1. How soon after restoration do we expect benefit?
        2. How deep is water?
        3. How warm does it get while inside restored area?
        4. Ryan B: This is all part of more detailed analysis in next phase.
VI. Cliff: Presentation of draft criteria, as sent to AdCom last week
    A. Slides 1-6 present the proposed criteria (PowerPoint file different from that used by Ryan B)
    B. Size of restored area at mean high water
    C. Area of habitat at mean low water
    D. Energetics exchange
        1. Janne: re. energetics and tidal prism criteria
            a. Scoring of this criterion is based on relative values; different from other criteria
            b. What if *none* of the alternatives is good enough?
    E. Predicted long-term elevation distribution
        1. Micah: Does elevation distribution take into account sedimentation trajectories?

2. Cleve: It should, and to the extent we can predict them, it will

F. Connectivity to total fish population
   1. Micah: For fish, depth of tidal opening is more important than width
      a. In contrast to restoration of processes
   2. Maria: Need to consider total fish resources (e.g., food), not just where they can swim
   3. Mike: Does anyone know of studies of the effects of salmon restoration on shorebirds?
      a. Janne: Don't know
      b. Micah: We're restoring whole ecosystems, not just fish habitat
         i. If we get back to conditions under which birds evolved, should be good
         ii. Ruth: True in theory, but may not play out exactly that way
            (a) We don't really know how animals have changed and adapted
            (b) They have responded to our changes in the landscape
      c. Maria: As in Criterion 9, birds need to be considered
         i. There are data for various birds and landscape types
   4. Kate: Emphasize that edge habitat along channels is important for fish and birds
      a. This should be taken into account in the evaluation criteria
      b. Ruth: Depends on species – edge habitat is detrimental to some
         i. For example, edge habitat benefits raptors
         ii. So it could reduce presence of shorebirds they prey on

G. Complexity and diversity of habitat

H. Influence by adjacent land uses
   1. Janne: This is a "blunt tool"
      a. Wouldn't want to penalize neighboring land use if done sustainably
      b. Not clear how to apply this criterion in a nuanced way
      c. What does "adjacent" mean?
      d. This criterion needs to be fleshed out more
   2. Ryan H: Intensive vs. organic agriculture
      a. Intensive gets a negative rating
      b. Some intensive farms are very sustainable
      c. Likewise, an organic farm can be horribly unsustainable
      d. Need to have some more education to tune this criterion
   3. Maria: Functional adjacencies exist with some developments or even industry

I. Completeness of restored tidal action

J. Other species: birds

K. Quick run through remaining criteria

L. Final criterion: placeholder for others the AdCom may suggest

M. Slide 7: Pairwise comparison for ranking and weighting importance of criteria

N. John: There needs to be more discussion of this whole process, including criteria
   1. Has used pairwise comparison and it's not a panacea
      a. Can produce results in a narrow range
      b. This makes it difficult to tease out what's important.
   2. Feels very complicated, need something "a little more concrete"
   3. Would project team be open to having groups develop their own alternatives?
   4. Russell: Or rank the various alternatives?
   5. Ryan H: Doesn't see that this process will maximize as many criteria as possible

O. Slides 8 and onward: Example application of criteria, using Alternative E
   1. Micah: Note that the end score in the example uses unweighted criteria

P. Doug: AdCom will have until July 9 to submit alternatives

Q. Cleve: The process doesn't end there
   1. Two main paths the project could follow:
      a. Set goals, say we're going to design to meet those goals
      b. Or, look at all options that could conceivably be implemented on the ground
         i. Even if some are dead on arrival or fall off the table very quickly
         ii. Pick top candidate(s) and refine
   2. With available time and money, how much influence does AdCom have?
      a. Need to balance hearing all voices and not getting bogged down in details
      b. Project team is open to feedback and "not absolutely committed to the proposed analytical process and framework"
R. Sharon: Any chance of expanding the scope to other properties?
   1. Richard: WDFW can be reasonable, but have to find a balance
      a. But we don't have the money to, say, model the whole watershed
      b. We need to see what we can do with this land or the land near it
      c. Need to avoid redoing the work of larger basin or county plans
   2. Russell: This work will be useful to others working on the same issues
S. Janne: Hoped the criteria would be grouped for evaluation
   1. Stakeholders who are experts would give input on those groups
   2. A weighting system could then weight the groups, not individual criteria
   3. Will want to see details about proposed approach
   4. Hopes that project team will be open to feedback
T. Kate: Economic value doesn't seem to be present
   1. For example, fish value vs. ag value vs. maintenance costs
   2. Would like to see dollar values; lots of these criteria are intangibles
   3. "We need to assign dollar values because we just won't survive without them"
U. John: Analysis should evaluate flood-storage benefit of setting back full-height dikes

VII. Closing discussion
A. Dan: Given time and money, would funders be amenable to modifying project scope?
   1. To Cleve and Richard: Is it feasible to adjust scope or ask SRFB for approval?
   2. Richard: Will clarify how much flexibility the team has under terms of the grant
      a. Great ideas may come up that aren't fundable by this project
      b. At least, should make a list of such ideas for use by others or in the future
   3. Dan: Timeframe to hear an answer to that question?
      a. Richard: Depends on ability to meet with their contracting officer this week
         i. If lucky, answer this week
         ii. But Richard is out of town next week, so really doesn't know for sure
B. Cleve: AdCom doesn't seem displeased with the recommended approach, although there is room for improvement
   1. We've heard several good ideas that we'll respond to
   2. July 27 seems too soon for next meeting – probably sometime in early to mid-August
   3. Goal of next meeting will be to present three detailed restoration alternatives for further evaluation
      a. One for fish, one for ag, one for recreation; or gradations thereof
      b. We can modify the process as we go
   4. There will be more interaction with AdCom before we finalize our recommendations
C. Russell: Would like to see how we end up weighting the criteria
   1. Cliff: Understood
D. Kate: Understands limits of AMEC's scope

1. Offered to meet / host / facilitate meetings among AdCom members
2. Goal would be to develop materials for AMEC to use
3. Cleve: We would welcome any such effort even if we may not be able to fully participate
   a. We will accept contributions
4. Kate: Happy to arrange places / times if that would be of value to people

E. Cleve: Tentatively, next meeting August 10, same place and time if possible
F. Maria: Not clear on next steps
G. Cleve: Want to conduct assessment and process feedback in time to recommend 3 alternatives for further evaluation at next meeting
   1. Project team will then "ask whether we got it right"
   2. AdCom will help vet the process for completing the next stage of the analysis, like today
   3. Will incorporate AdCom advice, though not hand them the reins
H. 3 weeks from meeting for feedback: firm date of July 13 for submission
I. Kye: Will AMEC be soliciting feedback outside the AdCom?
   1. Cleve: No, but others are welcome to do so.
J. John: Will next meeting give AdCom a chance to work with selected alternatives?
   1. Cleve: Yes, will follow more of a workshop format
   2. Will send out 3 alternatives, plus results of screening, in advance
K. John: Graphics showing all utilities would be really helpful
   1. Also, the 11 alternatives, which weren't in pre-meeting email
   2. Ryan: Will upload to FTP
      a. Also, files are small enough to email
      b. If that doesn't work, can send hard copy
      c. Will also re-send FTP link to AdCom, being sure to include Maria (joined late)

Technical Questions / Issues noted by Dan:

1. Can feasibility study scope be expanded to allow for consideration of land swap? (North Ebey Island)
2. Soil type overlay for preliminary conceptual alternatives (PCAs)?
3. Electronic version of summary PCAs page (volumetric bar graph and linear feet)
4. Ag land mitigation? County policy and regulations
5. FEMA Biological Opinion and Zero-Rise Flood Analysis constraints
6. Salmon benefits analysis for PCAs – the project is in a data rich area – a brief summary of the science behind salmon plan would be desirable
7. "Sweet spot" analysis (ag, economics, fish)

Criteria:

1. Assumptions tentative => latitude to revise adaptively (for example, juvenile chinook preference for mainstem river over Ebey Slough)
2. Fish benefits => Bird (shorebird) benefits? What types of habitat benefit both? Varies by species => differential analysis
3. Circulate criteria in spreadsheet file to allow for comments in text
4. Revised criteria / evaluation process: submit new alternatives? Groups to focus on outcomes? Transparency encouraged
5. Bundle criteria and weight by group objective: fish, ag, wildlife, recreation, flood control, hydrodynamic analysis
6. Economic value: costs/benefits

7. Possible to expand scope (i.e., land swap) and approach? => Richard discuss w/RCO; Cleve w/project team; and report back to AdCom

Alternatives:

1. 11-12 PCAs will be evaluated.
2. Seek AdCom input on dike configurations, etc. Comments are due by July 13
    a. Offer by Kate: Small group collaboration?
3. Three alternatives will be developed by the project team and presented at the next AdCom meeting (tentatively August 10)

Action Items:

- Re-send FTP site login information to AdCom
- Post map with overlay of soil types on FTP site
- Arrange for a presentation of the science behind the basin plan and why it's hard to break down benefits by individual projects
- Send spreadsheet version of evaluation criteria to AdCom
- Consider expanding analysis to include wider geographic scope
- Ask SRFB about modifying terms of grant
- Finalize schedule for AdCom meeting #3, tentatively August 10, same place and time
- Upload map showing all utilities in study area to FTP site
- Upload PCAs (Powerpoint presentation) to FTP site
- As feasible, email supplementary materials to AdCom

Ebey Island Restoration Feasibility Study

Advisory Committee Meeting #3

August 10, 2010

Submitted to:
Washington Department of Fish and Wildlife
16018 Mill Creek Boulevard
Mill Creek, WA 98012-1541

Submitted by:
AMEC Earth & Environmental, Inc.
11810 North Creek Parkway North
Bothell, Washington 98011

August 17, 2010

AMEC Project No. 0-915-16971-0

The following notes were recorded at the August 10, 2010, meeting of the Stakeholder Advisory Committee for the Ebey Island Restoration Feasibility Study. A list of meeting attendees and their affiliations is included. The committee met from 3 to 5:30 PM in the conference room at the Washington Department of Fish and Wildlife's (WDFW) offices in Mill Creek, Washington. Questions regarding these notes should be directed to Cleve Steward, Consultant Project Manager, tel. 206.719.1260, cleve.steward@amec.com.

Project Goal

The goal of this project is to evaluate the technical and social feasibility of restoring high quality, tidally-influenced aquatic habitat on 1,237 acres of WDFW-owned land on Ebey Island, and, in consultation with the project Advisory Committee, to select a preferred alternative that would generate the greatest biological and social benefits.

Attendees

AMEC Consultant Team:
Cleve Steward
Ryan Bartelheimer
Dan Evans (Dan Evans Consulting)
Walker Stanovsky
Cliff Strong
Matt Brennan (Philip Williams & Associates, on the phone)

WDFW:
Richard Tveten, Project Director
Doug Hennick, Fish and Wildlife Biologist
Russell Link, Program Manager
Ruth Millner, District Wildlife Biologist
Kye Iris, Property Acquisitions

Advisory Committee:
Everett Alexander, Diking District 1 Commissioner
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Kate Halstead, Sno-Valley Tilth
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Brian Bookey, Snohomish County Agriculture Advisory Board
Mike Blackbird, Pilchuck Audubon (left early)
Monte Marti, Snohomish Conservation District
Sharon Swan, Snohomish County Parks and Recreation
John Engel, Snohomish County Public Works, Surface Water Management
Andrew Corbina, WSU Snohomish County Extension
Cory Armstrong-Hoss, YMCA of Snohomish County
Mark Sadler, City of Everett
One other man who arrived late, sat in the back row, and left before we could get his name

Meeting Notes

I. Introduction: Dan
   A. Recap of Advisory Committee (AdCom) meeting 2
      1. Presented preliminary alternatives A through K
      2. Moved date of current meeting (AdCom 3) to allow more time for feedback
   B. Preview of alternatives selected for further analysis
      1. "Near-term," blended alternative
         a. Attempt to represent balance of various values
         b. Best effort given current scope, budget, and timing
      2. "Long-term" alternative
         a. Fish-oriented conceptual bookend to possibilities for the site
         b. Not detailed, but provides analytical basis for further evaluation
   C. Preview of today's agenda
   D. Roll call: Names and affiliations of attendees. See previous page.
II. Project overview and update
   A. Richard
      1. Depth & quality of feedback after AdCom 2 is "astounding"
      2. AMEC is going down pathways not even on the radar a month ago
   B. Cleve
      1. AMEC took comments to heart
         a. For example, John Engel suggested goal-oriented approach
         b. Today AMEC will rely on AdCom for analysis during the breakout session
      2. After AdCom 2, project team talked with grantor and then modelers (PWA)
         a. Acceptable under grant to consider options for north end of Ebey Island
         b. Selected alternatives reduced from intended 3 to present 2
         c. Time / budget freed up will be applied to north end modeling and analysis
      3. Ryan Hembree: Is grant from RCO available to look at?
         a. Richard: Yes, but he doesn't have it
            i. Have to do formal public records request from WDFW
            ii. Farm Bureau also requested it this morning
         b. Ryan H: Would like to see Ecology grant too
      4. Kate: Would like to see comments submitted after AdCom 2
III. Review of conceptual alternatives: Ryan Bartelheimer
   A. Recap of original alternatives A through K
   B. Brief introduction of new alternatives added after AdCom 2
      1. Alternative L
         a. After AdCom 2, Ryan B met with Diking District (DD)
         b. DD said none of alternatives A through K was acceptable
         c. This was Ryan's attempt to incorporate their comments into an alternative
      2. Alternative M
         a. This "balanced alternative" is Alternative L with additional restoration
         b. Includes setback dike to the east of the Olympic Pipeline
         c. Full tidal inundation of much of forested area at the southeast of the island
         d. DD has structural concerns about any dike in interior of island
         e. However, our geotechs say the hurdles aren't insurmountable
         f. Would take lots of engineering and money, but no fatal flaw technically
      3. Alternative N
         a. Kate suggested an option with dendritic channels between organic ag plots
         b. Ryan attempted to combine that with DD constraints from Alternative L

C. Recap of other comments from various AdCom members

IV. Evaluation of Conceptual Alternatives: Cliff

A. Summary of meetings and coordination within AMEC team

B. Actions in response to comments

1. Reduction of criteria to six
    a. Some were simply eliminated as unhelpful
    b. Most were collapsed into three main criteria
2. Creation of new alternatives L, M, and N
3. Reduced judgment calls in criteria, in favor of objective metrics

C. New criteria (see memo handed out during meeting)

1. Value to fish
2. Ag productivity
3. Economic effects on DD
4. Impacts to road system
5. Impacts on utilities, including a judgment call: major vs. minor utilities
6. Recreational opportunities
    a. Least useful, because no formal opportunities exist currently
    b. Will matter later, depending on what components we build in
    c. Then we will be able to make measurements
    d. Every alternative has significant opportunities

D. Pairwise comparison of criteria

1. Rating team each scored a copy of the criteria chart independently
2. Ryan H and Kate: Who was the group?
    a. Cliff: Cliff, Cleve, Richard, Doug, Paul, Ryan, Tad, and Dan
    b. Kate: Any 8 people would generate other ratings. It's all opinion-based.
    c. Cleve: Yes, but biases are inevitable. Is the AdCom balanced?
        i. Ultimately, the rating group is the selected consultant team and the client
        ii. AdCom should comment on results, because no process will be perfect
        iii. Also, AMEC has attempted to acknowledge the team's biases
    d. Ryan H: Ag came out weighted just ahead of roads
        i. But the whole point of the study is to have ag at the table
        ii. No one on rating team was a representative of ag interests
        iii. Has had conversations with the Forum about the project
        iv. The chair said the point of the grant was to have ag in the conversation
    e. Richard:
        i. Restatement of WDFW's dual mission
            (a) Protect fish and wildlife habitat
            (b) Provide sustainable recreational opportunities related to those
        ii. Terms of WDFW's purchase of the land
            (a) Long term, must be used for fish benefits
            (b) Short term, some usage for recreation and ag
            (c) Though these are not the fundamental goal
    f. Dan: Discussion of Alternative M in breakout will "truth test" the weightings
    g. Janne:
        i. Agrees with concerns about how AMEC arrived at weightings
        ii. Would rather know within each criterion how detailed factors compare
        iii. Notes that economic effects on DD has strong relationship to ag values
        iv. Though the two aren't exactly the same
    h. Brian: Please clarify meanings of numbers in pairwise comparison chart
        i. And is "ag productivity" limited to project area, or basin-wide?

ii. Cliff: Yes, just project area
iii. Cleve: Could have tried to look more broadly at benefits
    (a) But didn't, as we didn't with fish
    (b) Criteria and analysis become too fuzzy
iv. Brian: Ag advisory board wrote to WDFW asking to suspend this study
    (a) Pending results of Sustainable Lands Initiative
    (b) WDFW said no.
    (c) Brian wants to make sure AdCom is aware of that ongoing process
v. Cleve: AMEC was very aware
    (a) Hired Dan Evans because he's facilitating that process
    (b) But also have a timeline to follow on this project
    (c) See this as "case study" in how a single project relates to that process
vi. Dan: Opportunity here is technical feasibility analysis
    (a) Will lay analytical groundwork for future process
    (b) Any decision on this land will take years
    (c) Later on, Sustainable Lands Strategy (SLS) will be part of guidance
    (d) Any Ebey Island restoration will incorporate SLS in design
vii. Ryan H: When adopted, SLS will dictate both policy and code in County
viii. Cleve: Can make time for SLS presentation in later meeting, perhaps Oct.
ix. Brian: From beginning, this process failed to give ag due consideration
    (a) Due to considering only this one small piece of land
    (b) Not the broader context in the basin and county
x. Dan: Good discussion point later, but moving on now because of time

V. Description of Near- & Long-Term Alternatives: Ryan B
   A. Near-Term / Alternative M
      1. DD concerns related to US-2 crossing
         a. 36 (?) pilings in Ebey Slough, where WSDOT wanted none
         b. In floods, wood and debris tends to hang up on pilings
         c. Raises water level in slough
         d. Could lead to overtopping & catastrophic failure of levees
      2. In breakout, consider wood-loading effect of putting forest at SE into estuary
      3. What about possibility of land acquisitions or other tweaks?
         a. Vegetation types?
         b. Recreational features?
      4. Uncertainties related to the pipeline
         a. Alternative M assumes dike east of pipeline
         b. But maybe owners would rather have dike on top for maintenance access?
   B. Long-term: Full setback and tidal inundation across the island
   C. Consider other "add-ons," especially possible cross-dikes at north end of island
   D. Matt: Modeling considerations
      1. PWA will do hydraulic model and geomorphic assessment of alternatives
      2. Wooded area in SE
         a. Least amount of topographic data available
         b. LiDAR may not be very accurate because it could show treetop height
      3. Selected alternatives, as revised, will be put into hydraulic model
         a. Will model flow velocities, flood behavior, duration of wet / dry periods
         b. Considered in terms of effects on fish behavior
   E. Ryan B: Quick comment before breakout
      1. Previous project with Snohomish Conservation District used heavily muted tidal
      2. Even that appears to have huge benefit to water quality and fish usage

VI. Breakout Group Discussions: Dan (see breakout group notes below)
   A. AdCom's chance to say what they liked / didn't like from foregoing presentation
   B. As Ryan said, we need to think bigger
   C. Can't promise comments will be built into preferred alternative
   D. Groups are as designated on name tents
VII. Conclusions and Next Steps: Cleve
   A. Need to get modelers up and running
   B. Do AdCom members feel that we're heading in the right direction?
      1. Kate
         a. Breakout helped a great deal
         b. Understands that options in October may be very different from those today
         c. Feeling better about process than at beginning of day
      2. John E
         a. Breakout was good
         b. AMEC should "take thinking further" on ag elements
         c. How would we enhance ag on whatever land we don't restore?
      3. Phil
         a. As landowners, they are nervous
         b. They're down there working and don't want to see their values compromised
         c. Cleve: Is it useful to work one-on-one with AMEC / Ryan, as we have done?
         d. Phil: Meeting today was positive
      4. Ryan H
         a. As John E said, look for opportunities to add value to existing ag
         b. If muted tidal doesn't help fish much, may not be worth it
         c. AMEC should actively solicit input from rec interests not represented
         d. For example, Washington Waterfowl
         e. Ruth: Has contacts at Washington Waterfowl. Contact her for info.
      5. Brian
         a. Won't get solved today, but positive view to ag would give process credibility
         b. For example, look whether we could make the SE corner less wet
         c. We're in this together
         d. Also, wonders what we'd be doing in absence of existing WDFW ownerships
            i. What would be best use for fish on the whole island?
            ii. Might well not be the locations / ideas we're looking at
      6. Maria
         a. SLS could do concurrent analysis of other Ebey areas
         b. Our process could inform their work
         c. Could use this as a test case in larger valley wall-to-valley wall analysis
      7. Janne
         a. On both fish and ag sides, we should:
         b. Take all of this just as sketches
         c. Maximize productivity of selected use in each area
      8. John E
         a. Articulate very clearly what we hope to get out of the modeling
         b. Note that SnoCo has a gaging station over at DD 6 to use as a data point
      9. Andrew
         a. Doesn't understand laws and regulations governing DDs
         b. What are the implications when Everett says, "The dike won't be breached."
         c. Cleve: Would someone be willing to present at a future meeting:
            i. Ryan H: Not that knowledgeable about it

ii. Everett: Would think about presenting
    (a) DD has hired a lawyer for some advice
    (b) The laws are pretty strong

d. John E: State law is complex, but short answer: Everett holds all the cards
e. Kye: Both WDFW and DD have rights to eminent domain
    i. WDFW would never use theirs in a situation like this
    ii. Tries to avoid getting both sides armed up for court fights

Breakout Session Notes

Group #1

- Cleve Steward, facilitator
- Matt Brennan
- Ryan Hembree
- Doug Hennick
- Mark Sadler
- Maria Calvi
- Everett Alexander
- Ruth Milner
- Andrew Corbina
- Walker Stanovsky

Notes:

- Doug: Unlikely that any alternative will be funded in near future. Want to be sure that we produce data that will help address many more alternatives in future. 20 years from now, we may be looking at a very different social situation.
- Cleve: Does long-term alternative do that?
- Doug: I think it could, if it comes up with answers to feasibility of dike changes
- Want to generate data to be able to analyze future scenarios
    - Dike length, quantities, safety, cost
    - Fish use of various resulting habitat types and locations
- Maria: So Alt C, for example, could generate info useful to similar options, even if not identical?
- Ryan H: Would be interested to see best scientific guess about benefit, best bang for buck
- Andrew: For both sides, fish and ag
- Cleve: That's what's coming up in next step. Answers will be further developed, though not fully developed.
- Ryan H: Alt M, if fully restored tidal on E, would additional channelization help?
- Doug: He would also like to know the answer: Should we be carving channels or letting them develop naturally? Especially in muted tidal.
- Effects on fish of multiple access points?
- Duration of wet/dry periods?
- Relative benefits of muted vs. full tidal? (less than in weighting system)
- Refine understanding of correlations between habitat type and fish use
- Will full tidal on E portion really work well for fish?
    - In the wooded area, would fish even be able to use it?
    - How would infiltration channels form?
    - What happens to trees, including if they die?

- Matt: LiDAR shows highest point at berm on deadwater slough. Much of wooded area likely below mean water level. Likely not to have much vegetation if restored to full tidal. But using the LiDAR is tough: Trees and even long grass can make errors of several feet, which can be the difference between vegetated area and tidal mud flat.
- Why is area uncut?
    - Lower, and therefore soupy and unfarmed?
    - Public ownership since the 1930s, when it was foreclosed on?
    - Everett: Worked on an attempt to clear it in the 1950s, but no stream channels and was low and wet; couldn't clear cost effectively.
- Perimeter along slough is higher
    - DD spent 100 years to get that dike built
    - Still has to maintain it for elevation
- Does the project team have a careful understanding of DD laws?
- Relative values of slough connection to main channel?
    - Do/can juvenile fish get back upstream on flood flow?
    - Relative values of number / size of breaches vs. which channel
- Data about fish usage of main stem vs. Ebey Slough? Maria: Lots of data collected, but not analyzed yet.
- Army Corps: Feasibility study on DD6 restoration could be useful.
    - How do hydraulics on Ebey interact with possible DD 6 restoration?
    - Mark Sadler will check on DD 6 progress / schedule
- Ag effects / improvements in drained area?
    - DD can pump it down any time, but no one wants / needs to run pumps at max capacity right now
    - How <u>can</u> we enhance ag? (Everett: Leave it alone and let the farmers do what they want to do.)
    - Andrew: Management practices can improve ag productivity or crop value: Reduced pesticides & fertilizers, organic ag, improved riparian buffers
- Possibility of using setback dikes for vegetative cover, especially on outboard side?
- What about no tidal in NE in exchange for full tidal in NW?
- Evaluate Alt C primarily; with view to information gathering?
    - What about with/without elevated Homeacres Road?
    - Elevation using berm or trestle?
    - Implications for modeling?
- Computing costs can be legitimate element of analysis, even if the result is that an option is totally infeasible
- Ag use at north end of island?
    - Very little on Sno County land, increasing southward
- Recreational possibilities
    - Fishing, hunting, birding, boating. Access to fields / flooded areas? Blind locations? (WDFW doesn't maintain blinds, though the Feds do.) Fishing off dikes?
    - Need to actively solicit input from rec interests who haven't been participating, like Ducks Unlimited
- Length of cross-dikes and removed sections on north end?
- BIGGEST QUESTION: What is the real benefit of muted tidal? May be limited for fish, and you still lose it totally to ag.

Group #2

- Cliff Strong, facilitator
- Kate Halstead
- Janne Kaje
- Russell Link
- Sharon Swan
- Richard Tveten

Notes:

- SnoCo owns north end of island, as well as other properties (e.g., on west side, on river just south of NW WDFW property), bought with monies that require them to be used for habitat purposes. Restoration as we're talking about it meets the intent of the property's covenants, and the County would probably be amendable to allowing WDFW do full tidal restoration on them. (Sharon)
- Primary goal should be achieving natural processes as best as possible. There is better riverine process potential on east side. West side, without direct connection to the river, provides less opportunity, especially if muted tidal. Same with central portion (via Deadwater Slough), even though channels are a good thing. (Janne)
- DD6 restoration project across slough adds more contiguous area; doing full tidal on eastern side of island would contribute to a larger area for riverine processes.
- Dendritic channels would seemingly be of more benefit than tides twice a day. But these can be designed into any project.
- Forested area will provide LWD either on-site or downstream
- Flooding spruce forest may be problematic PR-wise (public may object). However, other such forests are dying off of their own accord, so this one might be at the end of its lifecycle already.
- Chiapas-style farming/habitat channels could work w/ new types of small-scale agriculture, but not so much w/ traditional agricultural practices on the island.
- Need to include formal recreation opportunities. Need to find best location of boat launch. Work with DD1 to allow formal trails atop dikes. Should probably provide hunting opportunities.
- Group then worked on drawing up an alternative that they could all agree on. This includes (see attached map):
    - full tidal restoration on
        - the SE parcel (spruce forest area, east of Olympic pipeline)
        - NW corner down and including to SnoCo shoreline property (would mean purchasing a few parcels and old rail right-of-way), and north end (SnoCo property)
    - Managed wet/agriculture/hunting (Chiampas-style) in central parcel along Deadwater Slough with lots of channels

Group #3

- Dan Evans, Facilitator
- Ryan Bartelheimer
- Brian Bookey
- Phil Cunningham
- John Engel
- Monte Marti
- Sharon Swan?

Discussion based on Alternative M:

SE Section (aka, eastern lobe):

- DD1 concerned about soft soils for setback dike, security; generally concerned about any removal of perimeter dike
- Impact on flood storage? Currently this low-lying area absorbs some water during overtopping event (floodwater storage on *inside* of dike = "safety valve" that would buy time during overtopping event)
- What would happen to the trees?
- Habitat impacts with possible loss of wetland spruce forest?
- Setback dike might compromise pipelines (1 shallow, 1 deep)
- Fish would gain, "rare" spruce forest habitat, large mammals, eagles/birds would lose
- Farmland on northern end of SE Section would be lost if part of project; with improved drainage (open ditch rather than tiles) and/or pumping this area could be very productive

NW Corner:

- If current landowner of in-holding were amenable, the project could connect to mainstem, creating highly-valued off channel habitat, improving water quality, and reintroducing habitat forming processes
- Property owner (Alexander) and ag community would need to be made whole (and perhaps then some – make an attractive offer…)
- Full tidal inundation is much better for fish than muted and can help dampen flood flows *outside* of the dikes
- But DD1 is currently opposed to any removal of perimeter dike; DD1 is one of the few districts operating in the black
- Trying to balance options within confines of Ebey Island (or, more narrowly, WDFW ownership on Ebey) may not make sense
- Could try to make these improvements (or some of them) within larger context ("swaps," mitigation that makes ag whole)

North Ebey:

- County owns the tip; low opportunity ag land down to middle, thus the plan would be to install cross dike and remove downstream perimeter dike (this would be supported by DD1)
- Makes sense: little loss to ag, significant benefit to fish, less perimeter dike to maintain (which DD1 appreciates)
- Report not available, but previous consultant decided north end of island was highest fish priority
- Question: what's the relative value to fish (i.e., Chinook salmon) of improved habitat on Steamboat/Ebey Sloughs vs. mainstem?
- Juvenile fish tend to follow the bank with the best habitat and not cross channel
- Off-site mitigation to make ag whole is an important principle, DD6 offer any mitigation opportunity?

Action Items:

- From pre-meeting: Look into Olympic Pipeline replacement schedule and design
- Make Ecology and RCO grants available to AdCom
- Post comments from after AdCom 2 on project website

- Post Cliff's memo about alternatives evaluation
- Incorporate presentation on Sustainable Lands Strategy into agenda for future AdCom meeting, possibly in October
- Try to find previous consultant report on desirability of restoration at N end of island
- Coordinate with Army Corps on DD6 restoration, and if possible get info from their feasibility study. Coordinate with Mark Sadler, City of Everett
- Actively solicit feedback from rec interests. Could include contacting Ruth Milner's contact(s) at Washington Waterfowl Association. (Walker sent email to Ruth to ask, 08/11/10)

Ebey Island Restoration Feasibility Study
Advisory Committee Meeting #4
November 16, 2010

Submitted to:
Washington Department of Fish and Wildlife
16018 Mill Creek Boulevard
Mill Creek, WA 98012-1541

Submitted by:
AMEC Earth & Environmental, Inc.
11810 North Creek Parkway North
Bothell, Washington 98011

December 10, 2010

AMEC Project No. 0-915-16971-0

The following notes were recorded at the November 16, 2010, meeting of the Stakeholder Advisory Committee (AdCom) for the Ebey Island Restoration Project (EIRP) Feasibility Study. A list of meeting attendees and their affiliations is included. The committee met from 3:00 to 5:30 PM in the conference room at the Washington Department of Fish and Wildlife's (WDFW) offices in Mill Creek, Washington. Questions regarding these notes should be directed to Cleve Steward, Consultant Project Manager, tel. 206.719.1260, cleve.steward@amec.com.

Project Goal

The goal of this project is to evaluate the technical and social feasibility of restoring high quality, tidally-influenced aquatic habitat on 1,237 acres of WDFW-owned land on Ebey Island, and, in consultation with the project Advisory Committee, to select a preferred alternative that would generate the greatest biological and social benefits.

Attendees

AMEC Consultant Team:
Cleve Steward
Ryan Bartelheimer
Dan Evans (Dan Evans Consulting)
Walker Stanovsky
Tad Schwager
Matt Brennan (ESA PWA, formerly Philip Williams & Associates)
Bob Battalio (ESA PWA, formerly Philip Williams & Associates)

WDFW:
Richard Tveten, Project Director
Doug Hennick, Fish and Wildlife Biologist
Russell Link, Program Manager
Ruth Millner, District Wildlife Biologist
Kye Iris, Property Acquisitions
John Garrett, Wildlife Area Manager
Belinda Schuster, Assistant Wildlife Area Manager

Advisory Committee:
Everett Alexander, Diking District (DD) 1 Commissioner
Phil Cunningham, Diking District 1 Commissioner
Kate Halstead, Sno-Valley Tilth
Kurt Nelson, Tulalip Tribes
Maria Calvi, Tulalip Tribes
Mike Blackbird, Pilchuck Audubon
Monte Marti, Snohomish Conservation District
Sharon Swan, Snohomish County Parks and Recreation
John Engel, Snohomish County Public Works, Surface Water Management
Chuck Lobdell, Ducks Unlimited
Graeme Peters, Ducks Unlimited
Micah Wait, Wild Fish Conservancy

Casey Rice, NOAA fisheries

Meeting Notes

I. Introduction
   A. Cleve: Welcome
   B. Roll call
   C. Richard: Restatement of WDFW mission / dual mandate
      1. Protect fish & wildlife habitat
      2. Provide sustainable fish & wildlife related recreation
   D. Cleve: State of the project
      1. About 75% complete
      2. Today's meeting presents modeling results
      3. Structure for this meeting
         a. Technical presentation of modeling
         b. Breakout discussion groups
      4. Future steps
         a. After AdCom meeting #4, incorporate feedback into draft report
         b. Send to AdCom members 1-2 weeks before last AdCom meeting
         c. Incorporate further comments into final report
         d. Discuss if/how this group will persist
         e. Open public meeting at end of project
      5. Request for advice or suggestions of other future directions
      6. May seek further funding
         a. Could seek to evaluate EIRP more broadly
         b. As model project within framework of larger land strategy
II. Ryan: Review of restoration alternatives
   A. Near-term alternative (originally Alternative M)
      1. Where does restoration make most sense with current ownerships?
      2. Difficulty of dikes in Ebey Island interior?
         a. DD #1 not comfortable with any full-height interior dikes
         b. Geotech analysis sees possibilities to design around the challenges
      3. Interior dike, full height at SE corner of island
         a. Located immediately east of the petroleum pipeline corridor
         b. Results separable from other components for modeling
         c. DD still not in favor
      4. Yellow area (on slide) – Partial-height dike with muted tidal exchange
         a. Self-regulating tide gate
         b. In some locations, theoretical dike height is barely higher than ground
      5. Length of accessibility to fish
         a. Can be improved to long periods
         b. Uses low flow-rate control structures for longer duration of access
   B. Long-term alternative (originally Alternative C)
      1. Full tidal restoration across entire island center, splitting the DD
      2. New water-control structures are required to maintain DD functions outside of the project area
      3. This is different than in near-term alternative in that the water control structures are to provide the muted tide conditions in the restoration area
   C. 1938 aerial photo shows historic channels
      1. Not exactly followed in proposed alternatives
      2. But were used to suggest effective areas

D. Conceptual cross-sections for full and muted dikes
    1. Gives sense of different volumes:
        a. Water in tidal areas
        b. Fill in dikes
E. Next steps
    1. Adjust modeling results
    2. Start thinking about engineering solutions
F. John Garrett: Estimated acreages?
    1. Ryan: Don't have it now, but was presented in earlier AdComs
    2. Matt: Ballpark numbers from memory:
        a. Near term alternative muted areas about 100 acres each
        b. Near term full tidal area about 500 acres
        c. Full restoration about 1200 to 1500 acres

III. Matt: Presentation of modeling results from ESA PWA
A. Slide 1 – Hydraulic Modeling Assessment
    1. Reintroduce himself in person, after participation by phone in AdComs 2 and 3
    2. Reintroduce Bob Battalio
B. Slide 2 – Hydraulic modeling objectives
    1. Focus has been on hydraulic modeling assessment
    2. How could restoration affect "plumbing" of the system?
        a. Habitat conditions – primary focus
            i. Hydraulic structure design
            ii. Interior dike design
        b. Potential impacts (to neighbors, etc.)
            i. Tidal water levels in island areas not regularly inundated now
            ii. Scour and geomorphic change as channels readjust
            iii. Flooding
C. Slide 3 – Modeling tools
    1. UNET, developed by FEMA in late 1990s to early 2000s
        a. Used for flood mapping
        b. Benchmark for comparison of restoration to existing
        c. Consists of 1-dimensional network of channels
        d. Also uses reservoir / storage areas
        e. Problem: Doesn't represent sophisticated structures, as in muted tidal
    2. HEC-RAS
        a. Developed by Army Corps of Engineers
        b. Incorporates UNET, which is now outdated
        c. Allows for more sophisticated structure operations
D. Slide 4 – Near Term Alternative
    1. No new flow pathways
    2. Appendages to sloughs in muted tidal
    3. Expanded floodplain of Ebey Slough
E. Slide 5 – Long Term Alternative: by contrast, creates new flow connectivity between Ebey Slough and Snohomish River
F. Slide 6 – Full tidal habitats, Ebey Slough water levels, August 2002
    1. What kind of tides in fully restored areas?
    2. Shows 3 scenarios in Ebey Slough
    3. Almost same as existing; slight decrease in range
    4. Chose 2002 as characteristic year
        a. Flood peak close to 2-year return event
        b. Dry season fell in typical time band

G. Slide 7 – Existing ground surface elevation
    1. Current bathymetry (LiDAR)
    2. Color-coded relative to tide elevations
    3. Micah: How accurate are data within forested area?
        a. Matt: Will get back to that.
        b. Additional day of foot-based survey
            i. Made a loop down pipeline
            ii. And a few transects across the forest
        c. Elevation under canopy is similar to surrounding clear area, above MTL
    4. Casey: Estimate of how far LiDAR is off?
        a. Data are recent, bare-earth model
        b. Matt: Maybe 10 to 20 feet off in high trees
            i. LiDAR shows highest elevation equal to levee crest
            ii. This is very unlikely to be accurate
        c. Casey: LiDAR people said it should be good
            i. Accuracy of these data is an important question
            ii. Survey downstream in forest seems to be much closer to correct
        d. Bob: Invested some budget in new field data, which support the concern
        e. Matt: Survey crew said interior is visually dense, with visibility of about 20 feet
    5. Full tidal restoration would inundate ground about 50% of the time
    6. Muted areas
        a. Would be inundated most of the time if subjected to full tide range
        b. According to biologists, this wouldn't be consistent with habitat objectives
H. Slide 8 – Near Term Alternative, Muted areas (HEC-RAS)
    1. Next slides focus on NE muted area
    2. Made iterations toward initial optimization of design elements
    3. Summary of initial culvert / tide gate specifications
I. Slide 9 – Muted tidal area habitat, WY 2002 water levels
    1. Full year of data
    2. Slough has about a 10- to 11-foot tide range
    3. Muted areas have a typical water depth of 6 inches
J. Slide 10 – Muted tidal area habitat, Water levels for 'typical' (~Q2) winter discharge
    1. Zooms in on January
    2. High flow of about 50% probability in any given year
    3. Slough flow is controlled by discharge, rather than tides as normally
    4. No drainage in muted area
    5. Flat water surface elevation throughout this period
    6. Stationary pond for about 6 days
    7. In wet season, corresponds to lowest tide range of the year
K. Slide 11 – Muted tidal area habitat, Dry season water levels
    1. Zooms in on August
    2. Inflow through culvert barely keeps up at lowest tides
    3. Gives a ballpark for culvert sizing
    4. Kurt: Tide gate appears to be open about 25% of the time?
        a. Matt: Yes, see next slide
    5. Russell: How are muted tidal areas designed?
        a. To fulfill some limiting factor on Chinook in the system?
        b. Matt: Designed to mimic intertidal habitat with subtidal channels
        c. Russell: Designed to mimic that?
        d. Matt: Today's presentation is initial estimat looking for input from biologists on how to optimize.

6. Chuck: 2 concerns
    a. Does muting compromise vegetation by allowing undesirable species?
    b. Where does 6-inch inundation as optimal come from?
    c. Matt: Tad and biologists will keep working on this
    d. Chuck: 6 to 8 hours of 6-inch water will allow canary grass, for example
    e. Tad: Matt modeled based on current land elevation
        i. Land has subsided
        ii. Modeled to allow full area to be covered and drained with each tide cycle
    f. Chuck: Just suggesting it as a consideration
    g. Cleve: We're trying to determine optimal parameters from the literature
    h. Any addition to our sources is helpful
7. John Engel: What is typical elevation in this area?
    a. Matt: About 2 feet NAVD in NE muted area, about 1.5 ft higher in NW muted area
    b. Low tide is deeper than this in channels within each area

L. Slide 12 – Muted tidal area habitat, Hydraulic structure flow conditions
1. Shows flow velocities
2. Width of bands indicates how often tide gate is open
3. Closed period occurs with water *in*, so it stands in the area
4. First indication of duration of fish access
    a. Alternative is several smaller structures
    b. They would allow fish access but no significant hydraulic flows

M. Slide 13 – Total discharge in Ebey Slough, Downstream of restoration
1. Kurt Nelson: This is with existing ground elevation.
    a. Does interior dike add additional tidal prism?
    b. Ryan: Fish are surface and edge oriented
        i. Small orifices at various elevations give fish best chance to find passages
        ii. As used, for example, at Cherry Creek
2. Cleve: Do we know anything about interior dike height yet?
    a. Ryan: Will come with upcoming engineering
        i. Currently thinking about 2 to 3 feet of freeboard
        ii. Depends on many engineering constraints
    b. Everett: DD will want internal dikes at full height
        i. Cleve: Why?
        ii. Everett: If anything goes wrong, it won't flood the island.
        iii. Ryan: There are other engineering solutions to mitigate those risks
            (a) Details may be outside scope of feasibility study
            (b) Need to provide assurances to DD
3. Russell: Draft report should include examples of existing structures
    a. Like those proposed for EIRP
    b. Pictures, descriptions, and locations for visiting and consideration
4. Matt: Back to the slide
    a. Shows August. Positive direction is outflow / ebb tide
    b. Both alternatives increase discharge by similar amounts

N. Slide 14 – Tidal discharge in Snohomish River, Downstream of restoration
1. Very small change between existing and near-term alternative
2. Long-term increases discharge by 2 to 2.5 times
3. Location is main stem along the N of Ebey Island, by outlet of Deadwater Slough
4. Maria: Did model include flow pathways?
    a. Matt: These are all from UNET model
5. John Engel: Where are velocities measured?

    a. Matt: Main stem, just N of US 2 bridge.
        i. River discharge is about 1,000 or 2,000 cfs
        ii. Discharge is therefore dominated by tidal flows
        iii. This is August, which has lowest flow level
        iv. Q2 event is about 62,000 cfs
        v. Q100 event is about 204,000 cfs

O. Slide 15 – Peak water levels – Ebey Slough, 'Typical' (~Q2) winter discharge
    1. Note: Slide displayed had project area added along x-axis; not present in printout
    2. Mileage is measured upstream from the mouth of Ebey Slough
    3. How do restoration scenarios change peak water levels?
    4. Significant drop along project area and upstream
    5. Larger drop with long-term than with near-term alternative
    6. Not totally confident that existing model represents actual conditions – lack of data, limitations of 1D model

P. Slide 16 – Peak water levels – Snohomish River, 'Typical' (~Q2) winter discharge
    1. Note: Slide displayed had project area added along x-axis; not present in printout
    2. Mileage is measured upstream from river mouth
    3. Kurt: At RM 11, upstream of project area, surface elevation drops by ½ foot
        a. Would this potentially relieve dike pressure there?
        b. Matt: Yes.
    4. John Engel: What point in the tide sequence does this occur?
        a. Matt: Looking back at previous slide
        b. May be a relatively high neap tide, but difficult to tell

Q. Slide 17 – Peak water levels – Ebey Slough, 100-year discharge
    1. Drop in water levels along most of project area in both scenarios
    2. Near-term alternative shows somewhat higher level just at the US 2 bridge

R. Slide 18 – Peak water levels – Snohomish River, 100-year discharge
    1. Near-term alternative drops water level along length
    2. Long-term alternative shows increase below US 2 and beyond
    3. These results for the 100-year event call the modeling into question
        a. For example, model predicts more flow down Ebey Slough than main stem
        b. Could be that levees are lower on that side
        c. So slough becomes preferential pathway through "storage" area
        d. This is an oversimplified representation of Ebey Island
    4. 2 questions that need to be answered
        a. Does the model accurately represent the flow split in the Q100 event?
            i. Possibly not due to 1-dimensional nature of model
        b. If a real concern, how can restoration design provide assurances?
            i. So that pathway doesn't unbalance flows
            ii. To keep peak flood elevations as they currently are

S. Slide 19 – Model's flood pathways – 100-year event
    1. Micah: Why use 1-D and not 2-D model?
        a. Matt: Given level of effort, 2-D would have taken a lot of calibration
        b. 1-D is sufficient to weed out "deal-killers"
        c. Bob: Institutionally, it's good to use same model as for FEMA flood maps
    2. Kurt: Could we support modeling results by talking with residents?
        a. To see if model accurately predicts what has actually happened
        b. Matt: Had that conversation with DD, but don't have real data for 1990 event
            i. In 10-year case, model overpredicts flooding within Ebey Island
            ii. Shows whole island filling up
            iii. According to Everett, the model wasn't accurate for small-scale event

        c. Everett: At big scale, the model doesn't mean anything
            i. At small scale, small elevation differences affect flow location & direction
        d. Matt: Model doesn't represent the island well
            i. It's represented as having a flat bottom
            ii. Unlike in real life, in which water overtops levee along Ebey Slough, then flows northward in drainage ditch to west of levee, then drains back to Ebey Slough just south of Hwy 2
    T. Slide 20 – Conclusions
        1. Casey: Have you modeled temperature effects?
            a. Matt: No, but HEC-RAS may be able to
            b. Cleve: Thinking about long periods disconnected from flows?
                i. They occur in high-flow periods in winter
                ii. Water is probably colder during those times
                iii. Don't have resources to analyze at this stage
        2. John Engel: Have asked similar questions for locations downstream
            a. About effects of discharge changes
            b. Need to consider that tides may not be the channel-forming regime
            c. Rather, high river discharges in winter may be

IV. Breakout sessions: Introduced by Dan Evans. See notes below.
V. Cleve: Conclusion:
    A. Project team will come up with a working draft for collaboration
    B. Considering the possibility of something like a Wiki
    C. After postponing last two meetings, not setting date yet for next meeting
    D. We'll schedule later, as we see how the work advances
VI. Report of breakout session facilitators to the full Advisory Committee
    A. Asked participants if facilitators "got it right"
    B. Further discussion
VII. Adjourned at 5:10 PM

<u>Breakout Session Notes</u>

Three interdisciplinary groups of 8-9 participants, each with a facilitator (Dan, Cleve, or Walker), engineer (Ryan, Bob, or Matt), fish biologist, wildlife expert, ag rep, agency staff, recreation rep, etc. Breakout questions included:

- What does the hydro modeling tell us about the feasibility of alternatives?
- How can we optimize fish and other values in this restoration project?
- What are the key questions and next steps in the process?

Group #1

- Dan Evans, facilitator
- Ryan Bartelheimer, engineer
- Kate Halstead
- Doug Hennick
- John Garrett
- Monte Marti
- Casey Rice

QUESTION 1: FEASIBILITY OF ALTERNATIVES

- Principal question is whether muted tidal restoration provides much value for fish – little evidence it does. Fish performance is the key, not “feel good” engineered solutions that may not result in improved performance.
- Water control structures are the central issue – will fish access the area? Will sedimentation or debris jam tidegates?
- Muted tidal restoration works for wildlife, such as migratory waterfowl, and provides management flexibility to meet seasonal and other needs.

QUESTION 2: OPTIMIZE FOR MULTIPLE VALUES

- Design and management of restored areas can potentially address multiple needs:
    - Chinook salmon most need off-channel habitat April-Aug;
    - Waterfowl: overwintering Sept-March; nesting April-Aug;
    - Ag productivity can be enhanced by selective muted tidal restoration (i.e., during dry periods for sub-irrigation) or creating dendritic channels for fish/wildlife within farming areas.
- Need to consider Ebey in larger context – basin- or county-wide – to determine its highest benefit. How does it compare with other restoration options? Where do we get the greatest bang for the buck (benefit/cost)?

QUESTION 3: CRITICAL ISSUES AND NEXT STEPS

- Determine whether muted tidal restoration works for fish?
- Balance resource management values on Ebey, and in broader context.
- Make fish & wildlife value case:
    - Literature review is a must
    - Be realistic about uncertainty (inevitable)
    - Restore natural processes
- Evaluate value of forested (spruce) wetland on East Ebey
- Factor in value of pedestrian wildlife recreational opportunities near urban Puget Sound population centers

Group #2

- Cleve Steward, facilitator
- Bob Battalio, engineer
- Ruth Millner
- Russell Link
- Micah Wait
- Everett Alexander
- Phil Cunningham
- John Engel

Notes:

- Relation (sequencing?) of near- and long-term options. How named?
- Downstream effects
    - Will increased discharge affect channel structure downstream?
    - Long-term channel adjustment
    - Potential for scour?

- Will muted system work?
    - Can we create desired conditions?
    - Will they be beneficial for fish?
        - Water depth
        - Temperature
        - Interior channels
- Diking District Commissioner concerns:
    - Don't endorse either option
    - Don't want to modify existing dikes
- Best (most acceptable) aspect of near-term alternative is full tidal restoration on east (forested) side of gas pipeline
- What to do with forest (trees) under both alternatives? Downstream effect on other restoration projects; risk to bridge
- Question about accuracy of elevations used in modeling analysis
- 30-40 acres existing at north end of WDFW property that isn't diked. Look at it – brush, not fish habitat
- Recreation
    - Opportunity for both upland bird (pheasant) and waterfowl hunting – possibility for multiple recreational activities
    - Where would kayakers put in?
        - Underneath bridge?
        - Don't prevent access
- Next steps, needed info
    - Range of conditions (e.g., depth) possible under muted tidal option
    - Evolution of site following implementation
    - More info on fish-friendly tide gates
    - Agricultural improvements, mitigation required
- More ag issues
    - Bad economy has increased demand for ag land located near population and water supply
    - Concern about saltwater intrusion; effect on water quality

Group #3

- Walker Stanovsky, facilitator
- Matt Brennan, engineer
- Sharon Swan
- Mike Blackbird
- Kye Iris
- Richard Tveten
- Phil Cunningham
- Maria Calvi
- Tad Schwager
- Belinda Schuster

QUESTIONS:

- How beneficial is muted tidal? Under what conditions?
- What effect do restoration scenarios have on flow conditions and water level behind dike?
- How can we design to minimize or mitigate seepage / drainage impacts to DD #1?

    - Belinda: We need to measure and define metric for existing conditions before construction to have a baseline for comparison.
    - Matt: We would also want to translate these into design criteria. Seepage will depend on head difference and soil conditions.

NEXT STEPS:

- Some concrete estimate of fish benefits
    - Need more examples of muted tidal systems for comparison
- How do we improve conditions for recreations and for other wildlife? And how do we build support for them?
- Structure and costs of future studies? And of actual implementation / construction?
    - This will inform cost / benefit analysis relative to other projects
- Determine habitat conditions for desired vegetation vs. invasive weeds, under both full tidal and muted conditions
- Examine long-term sedimentation effect of restoration

Ebey Island Restoration Feasibility Study

Advisory Committee Meeting #5

DRAFT MEETING NOTES

March 15, 2011

Submitted to:
Washington Department of Fish and Wildlife
16018 Mill Creek Boulevard
Mill Creek, WA 98012-1541

Submitted by:
AMEC Earth & Environmental, Inc.
11810 North Creek Parkway North
Bothell, Washington 98011

March 15, 2011

AMEC Project No. 0-915-16971-0

The following notes were recorded at the March 15, 2011, combined meeting of the Stakeholder Advisory Committee (AdCom) for the Ebey Island Restoration Project (EIRP) Feasibility Study and interested members of the public. A partial list of meeting attendees and their affiliations is included. The meeting occurred in the conference room at the Washington Department of Fish and Wildlife's (WDFW) offices in Mill Creek, Washington. The project team hosted an open-house from 6:00 to 6:30 pm, followed by a 1-hour presentation on the feasibility study and its results and a 1-hour public comment / question & answer session. Questions regarding these notes should be directed to Cleve Steward, Consultant Project Manager, tel. 206.719.1260, cleve.steward@amec.com.

Project Goal

The goal of this project is to evaluate the technical and social feasibility of restoring high quality, tidally-influenced aquatic habitat on 1,237 acres of WDFW-owned land on Ebey Island, and, in consultation with the project Advisory Committee, to select a preferred alternative that would generate the greatest biological and social benefits.

Attendees

AMEC Consultant Team:
Cleve Steward
Ryan Bartelheimer
Dan Evans (Dan Evans Consulting / Sustainable Lands Strategy)
Walker Stanovsky
Tad Schwager
Matt Brennan (ESA PWA, formerly Philip Williams & Associates; joined by telephone)

WDFW:
Richard Tveten, Project Director
Doug Hennick, Fish and Wildlife Biologist
Russell Link, Program Manager
Ruth Millner, District Wildlife Biologist
Kye Iris, Property Acquisitions
Bob Everitt, North Puget Sound Regional Director

Advisory Committee:
Everett Alexander, Diking District (DD) 1 Commissioner
Phil Cunningham, DD 1 Commissioner
Kate Halstead, Sno-Valley Tilth
Kurt Nelson, Tulalip Tribes
Mike Blackbird, Pilchuck Audubon
Chuck Lobdell, Ducks Unlimited
Graham Peters, Ducks Unlimited
Casey Rice, NOAA fisheries
Janne Kaje, King County Snoqualmie-Skykomish Watershed
Andrew Corbin, WSU Snohomish County Extension

Public (from sign-in sheets; anyone who didn't register their presence may not be included):
Don Scott
Rhonda Gailford
Gregg Olsen
Mike Adams
Mark Jobe
Martha Jordan
Rone Brewer, Washington Waterfowl Association
Tom Slomer, Washington Waterfowl Association
Steve Arbaugh
Brian Williams, WDFW
Shirlee Holmes, Ebey Island Tree Farm
Loren "Monty" Holmes, Ebey Island Tree Farm
Kenneth Erickson
Donna McGhie
Rod Hanna
Ed Moats, Snohomish County Farm Bureau
Erik Bakker
Ron Barber
Matthew Pinney
Ronald Brown
Lino Malgesini
Clayton C. Smith
Bob Heirman, Snohomish Sportsmen's Club
Ralph Dahlquist, Snohomish Sportsmen's Club
Jim Snodgrass
Craig Garric, Snohomish County

Meeting Notes

I. Introduction: Richard Tveten
   A. There are 2 groups here
      1. Stakeholder group that has worked together a year
      2. Public
   B. WDFW mission – dual mandate
      1. Protect fish & wildlife habitat
      2. Provide sustainable fish & wildlife related recreation
   C. Why the study?
      1. Condition of property purchase by WDFW
      2. Required to study feasibility of restoration to benefit endangered Chinook
   D. Brief introduction of Bob Everett
II. Opening remarks: Bob Everitt
   A. Greeting and thanks
      1. Especially to Stakeholder Advisory Committee
      2. Also to consultant team
   B. History of WDFW's Ebey Island land
      1. WDFW has owned wooded wetland at SE for a long time
         a. No one is sure why / how WDFW got it

        b. No access nor formal use
    2. More recently, WDFW became aware that adjacent land might be available
        a. YMCA selling it as part of capital campaign
        b. Funds for purchase were set aside by WA legislature
        c. Finalized with grant that had strings attached
        d. WDFW was required to examine management options beyond its current use
        e. The result was this study
C. WDFW has an interest in benefiting listed fish
    1. Throughout the Puget Sound region
    2. One of several restorations in the area
    3. Some are going well, others not
    4. They're complicated, hard projects
D. Most important factor from the agency's perspective
    1. Not to jeopardize human health and safety
    2. Not to jeopardize nearby landowners and residents
    3. There are many variables, including protection by dikes from tides and floods
    4. Anything WDFW does must be compatible with remaining land uses on Ebey
E. Timeline for the project
    1. "Out there"
    2. It would take a lot more time, money, and design work
    3. Nothing will be done any time soon
    4. The point of this study is to establish what is possible
F. Sustainable management
    1. It's always harder for WDFW to maintain its infrastructure
    2. Their funding keeps shrinking
    3. Snohomish County Sustainable Lands Strategy
        a. Collaboration between agricultural and restoration communities
        b. From WDFW perspective, ag use is much better than paved and developed
G. It's important to coordinate closely with Ebey residents, owners, and users
    1. This is an opportunity for that communication
    2. And for you [members of those groups] to comment
    3. WDFW will receive comments through the end of the month

III. Feasibility Study Process: Cleve Steward
A. Recap of Advisory Committee – this is the fifth meeting
B. Preview of question & answer session at the end
    1. Hoping for interaction among attendees
    2. Not just questions directed solely at the project team
C. Preferred alternatives
    1. "Near-term alternative (NTA)" (relatively named) – as much as 10 years out
    2. "Long-term alternative (LTA)" – much farther out
    3. Emphasis is not on a timeline
    4. Rather, on balancing uses and needs
D. Feasibility Study process (see Cleve's PowerPoint slide)
    1. Development of alternatives
    2. Evaluation against selected criteria
    3. Hydraulic and hydrologic modeling of top alternatives
    4. Estimate of benefits to fish
E. Evaluation criteria
    1. Value to fish – this criterion is what enabled the study
    2. Agriculture – Long history and tradition on Ebey

3. Diking District – Calls a lot of the shots
4. Impacts to existing infrastructure
5. AMEC's role
    a. Bring together expert opinion and incorporate it into the study
    b. Not exhaustive analysis of any factors
    c. Just a feasibility study – all factors deserve more study
    d. We strongly advocate that if the project proceeds, it do that further analysis

F. Alternatives analysis and results
1. LTA is greatest fish benefit and ranks second overall. Unabashedly "for fish"
2. NTA, or "balanced alternative," tries to balance various values
3. LTA is meant as a bookend case: What is the best we could possibly do for fish?

IV. Review of Preferred Restoration Alternatives: Ryan Bartelheimer (see PowerPoint)

A. NTA
1. Right / dark blue is full tidal restoration
2. Historic channel at E shoulder visible in historic aerial photo
3. Recent tidal hydrograph in Ebey Slough
4. Ditch at SW to drain SW area after reconfiguration
5. Muted tidal areas
    a. Water flows out when outside water level is lower
    b. Adjusted to allow some water back in
    c. Example of muted tidal hydrograph

B. LTA
1. New dikes across island
2. Dike removal along E and W sides of island
    a. Probably not total removal
    b. Rather, strategic breaches more likely
3. Use historic channels where possible
4. New pump station(s)
5. New flood gates to empty island quickly after overtopping

C. Everett Alexander
1. [Reads from draft FS report a section about need for DD to approve any plan)
2. Notes that this is a major change and there's no way the DD would allow it

D. Ryan – North Tip alternative
1. Suggested by the DD
2. Hard to access that area for repairs
3. Not much used for ag
4. Owned by Snohomish County
5. Restoration would shorten dike and shrink diked area
6. Everett: DD would support this option
    a. But people who live there would have to OK, as well
    b. DD can't just "chop them off"

E. Summary of the three alternatives re. non-fish criteria

F. Introduction of Matt Brennan on the phone

V. Results of Physical Modeling Study: Matt Brennan (see PowerPoint)

A. Hydraulic modeling objectives
1. Habitat conditions
    a. Water levels / inundation
    b.
    c.
2. Potential impacts

        a. Tidal water level
        b. Scour
        c. Flooding
B. Modeling tools
    1. UNET
        a. Developed by FEMA
        b. One-dimensional
    2. HEC-RAS
        a. Used to represent the muted tidal area
        b. Nested inside the UNET model
C. Restoration alternatives
    1. NTA
    2. LTA
D. Full tidal habitats
    1. Ebey Island water level, August, 2002
    2. Under various alternatives
    3. Slight muting in tidal heights
    4. Elevation key is at right
E. Ground elevation relative to tides
    1. Left – Elevation map
        a. Relative to tides
        b. Based on LiDAR
        c. Interpolated where there's dense vegetation
    2. Mini version of color scale at right
    3. Area within dike has subsided
    4. Only NW and SW corners of Ebey, outside dike, are above tidal range
F. Muted tidal area habitat
    1. Represents inset HEC-RAS model
    2. Models action of muted tide gate
    3. Outboard water level in blue
    4. Water level inside muted area in red
G. Anticipated tide range within muted tidal area
    1. W area is higher – overall range of 4 feet
    2. E area is more subsided – shallower inundation of about 2.5 feet
H. Rainfall event – about peak annual to 2-year flood
    1. Muted tidal area closed off for about 5 to 6 days
I. East tide gate flow velocities
    1. The only flows are around low tide
    2. Short periods of flow
J. J. Potential changes to tidal discharge and channel dimensions
    1. Evaluation using hydraulic geometry relationships
    2. Volume of water versus cross-section of river
    3. Estimated increase in outboard channel depth
K. Ebey Slough peak water levels
    1. Longitudinal profile of river
    2. Water level predicted to be lower along project site
L. Ebey Slough peak water levels – 100-year discharge
    1. Corresponds with event used for FEMA flood mapping
    2. Slight increase in water level at downstream ½ of project area under NTA
M. Snohomish River Q100 peak water level

1. LTA has significant increase due to new flood flow path across island
2. May not be well represented by UNET model

N. Conclusions
1. Muted tide characteristics – minimum flow area of about 70 square feet
2. Impacts
   a. Increased tidal discharge
   b. Improved conveyance of Q2 flood
   c. Variable impacts on Q100 – model uncertainty

VI. Predicted Biological Effects of Preferred Alternatives: Tad Schwager

A. NTA
1. Full tidal / fluvial restoration – about 500 acres
   a. Vegetation shifts with inundation of spruce forest
   b. Rapid accretion of marsh plain and channel scouring
   c. Trees probably die
   d. LiDAR uncertainty about actual ground elevation
   e. Habitat for range of species
      i. Channel
      ii. Scrub
      iii. Snags
   f. Large wood promotes reformation of marsh
2. Muted tidal areas
   a. Reduced tidal prism and sediment input
   b. Shallow, less than diurnal flushing
   c. Slower site evolution
   d. Limited fish access
      i. Not as much Chinook
      ii. More waterfowl, maybe Coho
   e. Experimental, requiring engineering controls and adaptive management

B. LTA
1. 1500 acres restored to full tidal
2. Connected to both Ebey Slough and the Snohomish River
3. Maximizes habitat area
4. New distributary channel could form between current river courses
5. This would yield a new migration pathway
6. Initially mud flat with gradual evolution to vegetated freshwater marsh
7. Would be largest estuary restoration in Puget Sound to date

C. Estimating fish use
1. Central to restoration conversations because prominent and visible
2. Used metrics based on literature
3. No modeling of habitat quality – assumed equivalent across options
4. Usable habitat area
   a. Used relationship developed for Skagit
   b. Regression relationship on log scale
   c. Greater percentage f channel area in larger marshes
5. Juvenile Chinook density
   a. 4 different values from literature
   b. Only 2 are from fieldwork; both of those are in the Skagit
   c. Others are modeling for the Snohomish
6. Accessibility of muted tidal areas to fish
   a. Percentage of time tide gates are open

        b. Relationship not well developed
    D. Summary – Table 10 in draft FS report
VII. Questions and answers
    A. Phil Cunningham: What will success rate be?
        1. Tad: With full restoration areas
            a. Higher rate of success
            b. Consistent with other examples in Snohomish and elsewhere
        2. Phil: That's the trouble with these studies. No one has an answer
        3. Cleve: True, but we have defined the problem much better than in the past
    B. Steve Arbaugh
        1. His family has land on Ebey and interests counter to restoration
        2. "They want us to take our money and go elsewhere"
        3. Tulalips filled thousands of acres in river mouth with Seattle garbage
            a. WDFW let it happen in the 1980s
            b. Now leaching into river and washing up and down with tides
            c. Fish are sitting in this dead zone of garbage
        4. The land's best use since turn of 1900s is ag
        5. WDFW wants to turn it back into a swamp and mosquito factory
        6. Cleve: Reminder to submit additional comments with questionnaire
        7. Steve: This is info WDFW should have given you at the start
    C. [Unknown attendee]: What is success rate at Union Slough restoration?
        1. Monty Holmes: It's DD6 that they've flooded
            a. Has a tree farm at N end of island
            b. Knows what will grow and die
            c. Trees will all die at SE when flooded
            d. Has a letter written to submit
            e. Restoration will destroy food basket close to town
            f. 2nd-richest soil in the state
            g. Should have studied other restorations
                i. DD6 300-500 acres
                ii. What have results been?
        2. [Attendee]: What are the fish population changes because of that?
        3. Cleve: Study underway, prelim results this time next year
            a. Ebey Island FS
                i. Makes assumptions, but are based on lit
                ii. Data from DD6 and others would give even better idea of site's response
                iii. We didn't gather new data for this study
            b. Not advocating one position or another
                i. Intent is to look at possibilities
                ii. Not all may agree this was best use of money
                iii. But there is interest, as well as laws, that drive the process
                iv. We're trying to answer questions as objectively as we can
                v. To generate useful info to make informed land decisions
    D. Kurt Nelson: Response to Steve Arbaugh
        1. Wrong to blame salmon problem in the river on the landfill
        2. Tulalip landfill is 300 acres, not 1,000
        3. Tribe has spent millions capping it and capturing leachate
        4. State Department of Ecology (Ecology) has done independent sampling
            a. Various locations in estuary and bay
            b. There are contamination problems

    c. Sources of pollutants in estuary are not their landfill

E. Kate Halstead
    1. Services estimates for juvenile Chinook presuppose that they exist
    2. Cleve: We know they don't
    3. Kate: Then why build something for them not to come to?

F. Janne Kaje
    1. He's from King County and Snohomish Basin Salmon Recovery Tech. Committee
    2. Here because 49% of basin is in King County
    3. Over 90% of this type of habitat is gone in Puget Sound
    4. Research shows juvenile habitat is one of the biggest things missing
        a. There are spawning gravels upstream
    5. There's work to do elsewhere
        a. Headwaters of Snoqualmie and Skykomish
        b. Even the ocean
    6. Still, research shows estuaries are biggest missing piece
        a. Juveniles like estuaries and river edges
    7. Adding up projects like Union Slough take a while to "get there"
        a. 300 acres is small – need much more, piece by piece, over time
        b. Won't notice any change in the short term

G. Kurt Nelson
    1. Tulalips have counts at stations in Snoqualmie and Skykomish
    2. Estimate 1.2 million fry come out of the system
    3. Even that is probably 10% of what it used to be – long way to recover still

H. [Ebey resident]: A statement and a questions
    1. Statement
        a. Everett spent $9 million on temporary bridge to protect wetlands
        b. These were originally bridged by water system across the island
        c. Would have gone a long way to buying people off the island
        d. Then could cut a hole in the dike and turn everything back to nature
        e. Doesn't see us weighing these options well
    2. Question: Why is fish number at N tip so low given acreage (compared to LTA)
        a. Tad: Relationship isn't linear with area
        b. Much more channel acreage on larger areas
        c. Cleve: Also doesn't factor in habitat quality
            i. Also didn't evaluate possibility of land swaps
            ii. This would be fair game for next phase

I. [Another questioner]: Where is boundary of N tip restoration?
    1. Relative to tree farm, etc.
    2. What becomes of people on the land?
    3. [Previous questioner]: Boundary is about the N side of Monty's land
    4. [Questioner]: That's Peterson Farm, which just sold for $500,000

J. Clayton Smith: When will sociological impact to people on the land be analyzed?
    1. Concerned because eminent domain will happen, and then you'll flood the land
    2. Ebey is one of few areas where people can work and produce
    3. We talk a lot about where the small farmer is going, but tend not to act on it
    4. "I'm a taxpayer. Maybe we can stop it by stopping some of our taxes."
    5. Worked on base closure study plan in Sacramento
        a. Had a huge impact – had to do it slowly
        b. Used 5-year phased closure to protect local economy

K. Cleve: County Sustainable Lands Strategy (SLS)

1. Goal is to elevate ag to planning level that fish recovery is at
2. And balance efforts with fish
3. Introduces Dan Evans

L. Dan Evans
1. Has been involved in SLS, started 9 months ago
2. Eight members of executive committee
    a. Four from ag
    b. Four from restoration, including Stillaguamish and Tulalip Tribes
3. Charged with developing consensus
4. Four major pieces
    a. Good information on both ag and restoration, and combine them
    b. Making connections between decision makers
        i. Hard-wire connections between Ag Advisory Board and watershed groups
        ii. Establish fish & wildlife / farm coordination group for landscape decisions
        iii. Estuaries account for 95% of conflicts between ag and restoration
        iv. Develop plans that integrate strategies for the two interests
    c. Identify net gain actions
        i. Some tilt toward one side or the other
        ii. Some projects even generate both communities
        iii. E.g., agricultural digesters and flood fencing
    d. Monitor, evaluate, and adaptively manage activities on 3-year cycle
5. SLS has just delivered Phase I report on SLS framework
    a. Needs additional refinement
    b. And implementation

M. Phil Cunningham: Real stakeholders are those who own the land. What about us?
1. As population grows, we're going to need that land down the line
2. It's the best ag land in the country
3. "To turn around and flood it is almost criminal"

N. Bob Herman
1. Has examined DD6 pretty thoroughly in last 2-3 years
    a. It's heavily populated with spiny ray fish like bass
        i. As shallow water warms, they multiply
        ii. These conditions are poor for salmonids
    b. Used to be forested
    c. Homeacres land was forested
    d. Great grandfather and grandfather had boathouse on Ebey Slough
        i. Saw it in 1938 aerial phot
        ii. Fished Chinook commercially there until 1939
2. Also examined Haskell Slough
    a. At dedication, there was a big school of bass
    b. As they were bragging about how great it was
3. Wildlife park
    a. Two lakes and two small ponds, often flooded
    b. Contain numerous bass, squawfish, all bad for salmonids
4. Has examined others, too, where we've wasted a lot of money
    a. People are constantly introducing undesirable fish species
    b. Lives on Blackman Lake, recently overrun by two carp species
5. Has been in fish recovery for over half a century
    a. Spiny rays and salmonids don't mix

O. [Man]: In Snohomish estuary, if juvenile Chinook don't occur, why grab more land?

1. Also, what's the cost of this project?
2. Casey Rice: Response
    a. Has done fishing throughout the whole estuary
    b. Juvenile Chinook occur pretty much everywhere from mainstem down to bay
    c. Densities vary, and we don't fully understand relationships
    d. They're found in both slough and wetlands
        i. Anywhere connected to saltwater
        ii. Both channels and sloughs
    e. [Question]: Did you catch any other fish? What?
        i. Casey
            (a) Lots of cutthroat trout
            (b) Coho salmon
            (c) Some "troubling invasives"
                (1) Yellow perch
                (2) Bass
                (3) Shad
            (d) Pink salmon
            (e) Chum salmon
            (f) [Questioner]: Carp? Give it time. They're coming.

P. Casey: Point about certainty and uncertainty
1. Certainties
    a. The problem of endangered Chinook is real and well-documented
    b. We know it's caused by humans
    c. Best available science about estuaries
        i. Shows they're critical to solving the problem
        ii. If society wants to solve it
2. Uncertainty
    a. We don't know w/ certainty how many fish a given area will produce
        i. We have to go with evidence and make inferences
        ii. Today's presentation is a first crack at that
        iii. Credible estimate with error bars
        iv. Acknowledging the uncertainty
        v. We're trying to—and should—and will do better with time
    b. If that's not certain enough, think about uncertainty elsewhere in your life
        i. What will the Dow do tomorrow?
        ii. What will your property value do in the next 2 years?
    c. We can only know things so well; have to be realistic about uncertainty
    d. Fish go from headwaters halfway around the world and back
    e. They're pressed at every point
    f. We understand the process pretty well, but there are a lot of variables
3. But we know salmon need these wetlands if we want to keep them

Q. [Woman]: What will the project cost?
1. Cleve: It's in the report
2. [Woman]: Is it funded?
3. Cleve: We haven't identified funding
4. [Man]: Just assume the taxpayers will pay for it

R. Ron Brewer, VP of WA Waterfowl Association
1. Will provide written comments, as well
2. Liked the 12 alternatives – looke like a lot of thought went in
3. Doesn't like that we chose two, nor the way we chose them

    a. Ranking, then applying weighting on top of ranking
    b. None of the criteria shows wildlife
    c. Recreational ranking is nullified by all being equal – should have left it out
    d. Weighting factors
        i. No description of the factors, nor how they were applied
        ii. Seems like one or two sections were skipped in the report
        iii. Need to explain the weighting in the report
4. From Waterfowl Associaton's view, NTA has some benefit, but still issues
5. Doesn't like "near-term" and "long-term" names
    a. Sounds like here's what we'll do now, and then later
    b. Why not just "C" and "M"
6. Cleve
    a. Good point about weighting – will make sure it's written up in report
    b. Selection is a subjective process
        i. Would come out different with different evaluators
        ii. Not perfect and won't make everyone happy
        iii. But we should be required to make the process transparent
        iv. Allows report users to make up their minds

S. Casey
1. Recalled uncertainty from AdCom #4 about fate of forest at SW
2. Doesn't think that's been sufficiently followed up
3. This would be an important answer
4. If it was historically forest, and still has several-hundred year old trees
    a. Not sure if it does or not
    b. But if it does, why would we assume they'll die if we flood them now?
5. Cleve: Site evolution Tad started to describe wasn't really part of our analysis

T. Monty Holmes
1. Sea lions are waiting out there to kill the salmon
    a. They take so many fish you can't believe it
    b. Efforts at Ballard Locks have been ineffective in controlling them
2. This study should be looking at what happens to them
3. Cleve: It's a good point; there are connections to be evaluated
    a. That is one example
    b. Another is effect on orcas
    c. These questions are real and are being investigated
    d. But is beyond scope of this study

U. Martha Jordan: Worked on Elwha River restoration project
1. Focused on swans but became somewhat of an oversight committee
2. No one had looked to see what actually existed in the system pre-restoration
3. What's on Ebey Island, and what will be lost?
    a. Do we need to mitigate for what will be lost?
    b. Whether socioeconomic or biological
    c. Doesn't see anywhere that is being examined
4. As at Elwha, doesn't think baseline has been well characterized
    a. Maybe we'll lose 400 acres of forest, but what's in that forest?
    b. Need to build that evaluation into the process
    c. Its lack is a huge red flag no one is talking about
5. Characterization at Elwha changed a lot of things for the better

V. Shirlee Holmes – re. trees dying
1. Tide gates malfunctioned in the summer

2. Ebey Island Tree Farm under 1 foot of water
3. Lost 500 Doug firs
4. Previously lost 1,000 noble firs to flooding
5. Casey: Were any of those Sitka spruce under natural tidal conditions?
    a. Monty: I have 5,000 spruce out there
    b. Blue spruce are best. Grand fir are second.

W. [Man at back]:
1. Purpose is to increase fish production of watershed by survivability of juveniles
2. Used to be on Stilly-Sno Enhancement Task Force
3. Real problem is clearcutting upper regins of forest
    a. Then floods are worse
    b. And redds are silted up
    c. Won't get more production without addressing that
4. Mike Blackbird
    a. It's an old-growth Sitka spruce forest
    b. Was there before the dikes
    c. Expects it will certainly survive flooding
    d. Cleve: It's worth looking into further

X. Steve Arbaugh
1. Study sounds really incomplete
2. [Something I didn't understand about barring the gates and sending everybody back to California where they came from]
3. Need to do more study, ask for more money
    a. To evaluate socioeconomics, etc.
    b. Instead of putting up a map and saying
        i. "This is the dike…
        ii. "This is what we're gonna do…
        iii. "Tomorrow morning at eight o'clock we start digging
    c. Cleve: Nobody said that
    d. Steve: That's what it looks like to me

Y. [Man toward back]: Will more water come down Ebey Slough N of US2?
1. Matt: [answer partially garbled over phone] Yes, more water down Ebey
2. [Another man at back]: Did the model include cross dike at French Slough
3. Cleve: No, nor DD6

Z. Russell Link, WDFW Program Manager
1. Manages the staff that manages WDFW's Ebey Island property
2. He's in charge of how things are managed for foreseeable future
3. Leaving now to catch ferry, but encourages folks to contact him
4. 425.775.1311x110
5. russell.link@dfw.wa.gov

AA. [Man on left, save as VII.H.]:
1. Obama healthcare plan was discovered to have counted things twice
    a. That seems to be how government does things
    b. Unimpressed with bureaucracies and how they don't work together
2. This is a hell of a project—has anyone looked at the Nisqually?
    a. That was turned back to God
    b. Has fish production increased?
    c. It would be nice to see some answers
    d. Rather than these fantasies where the gentleman says there's zero Chinook
        i. Knows there's more to the explanation than that

        ii. It turns out there *are* Chinook in the river
    3. Casey: He's talking about something that's unconnected to where fish come from
        a. There aren't going to be fish there
        b. [Woman next to man]: I asked about how many are there now
            i. He said none
            ii. Then you said you'd been fishing it and there are
            iii. Cleve: I think there was a misunderstanding of your questions
            iv. [Man]: I think that's probably correct
    4. Point is, before this goes forward, let's have government prove its worth
        a. Let's see what the Nisqually does
        b. Not convinced taking a lot of arable land out of production…
        c. in the river basin made a hell of a lot of sense
    5. We all get our pet projects and want to ram them through
        a. It's about time government folks recognize they're spending others' money
        b. On their pet fantasies
    6. [several people talking over each other]

BB. Casey
    1. Doesn't like implicating motives of the people doing the work
    2. The documents exist; suggest people read them
    3. Nisqually is being monitored
    4. Trying to make little money go a long way to answer questions
    5. No one is personally gratified by trying to take your stuff

CC. Cleve: [addressing the group]
    1. You've done a great job being civil up to now
    2. Expect the same for 3 more minutes
    3. Going forward
        a. Gentleman on right will be allowed to speak
        b. Everett Alexander will say something
        c. Richard Tveten will end the meeting
    4. Project team will be here after
        a. Shake him by lapels if you have to
        b. But let's treat everyone in the room in a decent way

DD. Ed Moats
    1. I'm sure many of you feel this is surreal
        a. Landowners hearing plans for their own land
        b. DD same thing – told of a plan for their DD
    2. With Snohomish County Farm Bureau, and has same surreal feeling
        a. Like in some Kafkaesque short story
    3. Growth Management Act requires County to designate and protect ag land
    4. Ebey is 100% designated ag – it's against the law to destroy it
    5. Rich / powerful / connected once found legal ways to change laws they didn't like
        a. Now they just disregard the law when it's an impediment
        b. Bulldozing aside anyone with contrary ideas
        c. As with landowners and the DD

EE. Everett Alexander
    1. The whole project is within the Ebey Island diking district
    2. DD has easements or ownership of the dikes and must approve any changes
    3. All the plans so far, the DD has said no
    4. Won't approve any of them

FF. [Man at front]: What about the pipeline? Any concerns?

    1. Ryan: Full tidal would make it impossible for them to do their work
    2. Muted has some potential; they already work around wetted periods
  GG. Walker Stanovsky
    1. Please talk to me if you want to be sure your comments go with your name
    2. Also sign in on sign-in sheets if you haven't

VIII. Closure: Richard Tveten
  A. Please send comments by end of month
  B. Link to report is in handout
  C. Thanks to everyone who came, especially with strongly-felt concerns
  D. Not hell-bent on doing a project on Ebey Island
    1. Was asked to investigate the possibilities
    2. Get some idea of difficulty and expense
    3. And roughly how many fish, and how much uncertainty
    4. Don't have funding for project, and don't know if ever will
  E. This will help those with the money and the clout weigh against other options
    1. Don't know where it would rank
    2. We've collected the info to help do something without charging blindly ahead
  F. If a project happens 10-15-20 years down the road
    1. There will be ample opportunity for comment then
    2. Nothing like this ever proceeds without federal permits
    3. That process always includes lots of human / socioeconomic impact analysis