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Sequalitchew Creek Watershed Ecosystem Restoration

ANCHOR QEA

Preliminary Basis of Design Report

Prepared for South Puget Sound Salmon Enhancement Strategy

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ABBREVIATIONS

cfs	cubic foot per second
CalPortland	CalPortland Company
City	City of DuPont
Corps	U.S. Army Corps of Engineers
DMC	City of DuPont Municipal Code
Ecology	Washington State Department of Ecology
foot	foot North American Vertical Datum of 1988
JARPA	Joint Aquatic Resources Permit Application
LWM	large woody material
SEPA	State Environmental Policy Act
SPSSEG	South Puget Sound Salmon Enhancement Group
WDFW	Washington Department of Fish and Wildlife
WSE	water surface elevation

1 Introduction

1.1 Purpose

The Sequalitchew Creek Watershed Restoration Plan (Aspect 2018) arose from a process defined in a settlement agreement between CalPortland Company (CalPortland), the City of DuPont (City), the Washington State Department of Ecology (Ecology), and a coalition of environmental groups collectively known as the Environmental Caucus. In 2012, these groups signed an agreement called the 2011 Settlement Agreement for DuPont Mine, Restoration of Sequalitchew Creek Watershed, and Preservation of Puget Sound Shorelands and Adjacent Open Space. The project activities described in this design report are a part of this plan and are identified in Figure 1.

In developing the Restoration Plan, the South Puget Sound Salmon Enhancement Group (SPSSEG) led a year-long process, involving a Core Group of eight stakeholders (the City, Ecology, the Environmental Caucus, CalPortland, the Nisqually Indian Tribe, the Sequalitchew Creek Watershed Council, Joint Base Lewis McChord, and Pierce County) and multiple opportunities for public comment.

The Restoration Plan is intended to restore ecological function to the Sequalitchew Creek Watershed. Human activities have greatly modified watershed hydrology since European settlement began two centuries ago. European settlement accelerated in the 1800s when the Hudson Bay Company established Fort Nisqually. Around this time Sequalitchew Creek was channelized and the area was drained for farming.

The authors of the plan, at the direction of the parties to the Settlement Agreement, developed an extensive monitoring and adaptive management program to facilitate a phased implementation of the identified projects. The projects were sequenced to first restore flows from Lake Sequalitchew to Puget Sound. The projects in the second part of the sequence focus on maintaining and enhancing those flows. The third set of projects are focused on habitat restoration in Edmonds Marsh and the portion of Sequalitchew Creek downstream of Edmonds Marsh. Several species were considered in setting habitat restoration, but the primary species are cutthroat trout, chum salmon, and coho salmon. The projects span the length of stream, from the outlet of Lake Sequalitchew to the mouth at Puget Sound.

1.2 Alterations to the Watershed

The source of Sequalitchew Creek is a lake on the military reserve, now called Joint Base Lewis McChord, which was established in the early 1900s. Through the 1980s, the hydrology of the Sequalitchew Creek Watershed was altered to provide drinking water, reduce flooding, stabilize lake levels, provide fish passage for hatchery-reared salmon, and accommodate increased stormwater drainage from highway development. The lower reaches of Sequalitchew Creek and its buffer were

used by the DuPont explosives manufacturing company; those manufacturing activities ended in 1970 when the land was sold to the Weyerhaeuser Company. In 1996 the area surrounding Edmonds Marsh began to be developed for the Northwest Landing planned community. Increased development with associated stormwater runoff continues to affect hydrology, as does ongoing beaver activity (SPSSEG 2014).

The combination of human and beaver activities in the Sequalitchew Creek Watershed has altered the primary direction of flows: instead of flowing from Sequalitchew Lake into the creek, water flows out through the Diversion Canal to Puget Sound. A beaver dam at the western outlet of Sequalitchew Lake blocks flows and redirects them to the Diversion Canal. Other beaver dams in the system keep water levels in Edmonds Marsh higher than they were historically, and the fill beneath the DuPont Railroad Trail further slows flows. This redirection of flows, in combination with highly permeable soils, creates a dry reach just west of Edmonds Marsh and greatly reduces the flow through the spring-fed Sequalitchew Creek ravine.

The Restoration Plan, of which this project is a part, was developed to sequentially restore flows in Sequalitchew Creek, improve the sustainability of flows through the system, and restore aquatic habitat by removing flow-related fish passage barriers and increasing the habitat available to aquatic species. When the Restoration Plan is fully implemented, the benefits would be noticeable over a large portion of the stream and wetland habitats in the basin and would largely restore lost and reduced ecosystem functions including the movement of water, sediment, nutrients, biota, and dissolved gasses through the watershed from the headwater springs on Sequalitchew Lake to Puget Sound. Flows will be restored to a reach of Sequalitchew Creek that currently experiences little to no consistent flow, re-establishing a functioning stream in the now frequently dry channel, providing new aquatic and riparian habitat, and connecting the Sequalitchew Creek ravine and the marshes.

The Restoration Plan will restore fish passage from Sequalitchew Creek to East and West Edmonds marshes. Two fish-barrier culverts will be replaced by fish-passable structures, which in combination with increased flows, will allow migratory fish access above the ravine springs and into Edmonds Marsh.

1.3 Restoration Plan Elements

The restoration plan includes a total of 12 elements (Table 1): 11 individual project actions and one policy change related to the City of DuPont Municipal Code (DMC) 25.105. This change was recently made to the Critical Areas Ordinance that clearly allows for restoration to occur. Three elements, and part of a fourth, occur on Joint Base Lewis McChord. This includes all work on the base related to flow restoration. Currently, project designs are being finalized, and construction of a project to direct all but the highest flows from Lake Sequalitchew to Sequalitchew Creek is scheduled to occur within

2 years. Joint Base Lewis McChord has not released details of the design, but it is assumed that the existing flows from Lake Sequalitchew will flow to and through the DuPont-Steilacoom Road culvert, which crosses from the base to the City of DuPont. Only when exceptionally high flows are encountered would water be diverted to the diversion canal that now carries all of the flow from the lake.

Five Restoration Plan elements identified in the Sequalitchew Creek Ecosystem Restoration Plan are on City of DuPont property and included in this project. (The final two projects are also on City property but are not being implemented at this time.)

The Restoration Plan and the 2012 Settlement Agreement between the Environmental Caucus and CalPortland lay out procedures related to the funding, implementation, monitoring, adaptive management, and permitting of these five actions (as well as the other actions being implemented by others or in the future as required). The agreement envisions that these five actions will be permitted together and then implemented in a process established in the Restoration Plan. The parties to the agreement recognized that these five elements are conceptual and are identified as components of an overall watershed restoration strategy. The five elements are as follows:

- Management of beavers and beaver dams to manage pond elevations and flow through Edmonds Marsh
- A new pedestrian (light vehicle) bridge on the Robison Rail Trail that bisects Edmonds Marsh to allow unimpeded flow from East Edmonds Marsh to West Edmonds Marsh
- Restoration of the habitat elements in the "losing reach" between Edmonds Marsh and the Center Drive culvert
- Replacement of the City Hall Culvert with a fish-passable structure
- Rehabilitation of the existing City Hall Culvert to improve fish passage and habitat conditions

Table 1
Restoration Plan Elements

Element	Components	Element # SPSSEG 2014
1. Regulatory Actions		
A DuPont CAR	**Update the City of DuPont's Critical Areas Regulations**	**0.1**
2. Flow Restoration		
B Beavers	**Manage beaver and beaver dams** Monitor flows and adaptively manage flexible levelers	**1.2** 1.3
C Seq. Lake levels	**Seasonally manage water levels in Sequalitchew Lake** while preserving Joint Base Lewis McChord's ability to meet its water demands at Sequalitchew Springs.	**1.1**
D Lake outlet area part 1	**Planning for repair of cross-over culverts** Reduce barriers to flow at lake outlet area	**1.5** 4.1
3. Flow Maintenance and Enhancement		
E Hamer Marsh	**Install weir at Hamer Marsh outlet** **Evaluate water quality in Hamer Marsh** Replace Hamer-Edmonds Marsh culvert (?)	**2.6** **2.6** 4.2
F Railroad Trail bridge	**Planning for DuPont Railroad Trail bridge** Install DuPont Railroad Trail bridge	**1.5 and 3.1** 3.2
G Losing Reach	**Remove trash and invasive vegetation** Monitor Losing Reach Seal Losing Reach (?) and restore habitat	**1.4** 1.4 2.1
4. Habitat Restoration		
H City Hall Culvert	Replace the culvert near City Hall	2.2
I Center Drive Culvert	Evaluate Center Drive culvert Modify Center Drive culvert (?)	2.3 2.3
J Ravine habitat	Monitor habitat changes after flow restoration *Add large woody debris (LWD) to ravine (?)* *Replace footbridge/remove berm (?)*	2.4 *2.4* *2.4*
K Lake outlet area PART 2	Repair lake outlet area to improve wetland habitat	4.1
L Southern alignment	**Evaluate scope and feasibility of southern alignment** Southern alignment implementation (?)	**1.5** 3.3

Notes:
(?): action contingent on prior monitoring/evaluation.
Bold font indicates initial actions.
Underlined font indicates the second stage of actions (following partial restoration of flows).
Italic font indicates the final stage of actions (following full restoration of flow.

2 Existing Conditions

The five project elements described previously will be referred to as "the project" from here forward in this document and are the only elements to which this Basis of Design Report applies directly. The project site is located in the Sequalitchew Creek Frontal Cormorant Passage watershed (hydrologic unit code 171100190304) of the Puget Sound basin (USGS 2022) and in the Chambers-Clover Water Resource Inventory Area 12 (Ecology 2022). The Sequalitchew Creek Watershed covers approximately 38 square miles.

Sequalitchew Lake is the headwaters of Sequalitchew Creek (Exhibit 1). Historically, springs at the east end of the lake would flow into Sequalitchew Creek, through Edmonds Marsh, and into a steep ravine to Puget Sound. Construction of a Diversion Canal and beaver activity have changed the creek hydrology such that continuous flow from the lake through the marshes to Puget Sound seldom occurs. Currently a portion of Sequalitchew Creek and the adjacent marsh drain eastward into a Diversion Canal rather than westward along their historical paths (Aspect 2022).

The Diversion Canal is an engineered channel that conveys stormwater from Fort Lewis through Bell, McKay, and Hamer marshes before crossing through culverts under Sequalitchew Creek. The Diversion Canal then skirts the perimeter of Fort Lewis and continues north, where it flows in a concrete-lined channel to Puget Sound near Tatsolo Point (Aspect 2022).

2.1 Previous Uses

The Nisqually Tribe has used the Sequalitchew Creek area for thousands of years, residing primarily along the Puget Sound shoreline and major rivers and obtaining resources from both the waters and upland areas. European settlement accelerated in the 1800s when the Hudson Bay Company established Fort Nisqually. Around this time Sequalitchew Creek was channelized and the area drained for farming. The military reserve now called Joint Base Lewis McChord was established in the early 1900s. From that time through the 1950s, the hydrology of the Sequalitchew Creek Watershed was altered to provide water supply, reduce flooding, stabilize lake levels, and accommodate highway development. The project site itself was used by the DuPont explosives manufacturing company; those activities ended in 1970 when the land was sold to Weyerhaeuser. In 1996 the area surrounding Edmonds Marsh began to be developed for the Northwest Landing planned community. Increased development with associated stormwater runoff continues to affect hydrology, as does ongoing beaver activity (SPSSEG 2014).

2.2 Current Uses

The property is currently undeveloped and is used for passive recreational activities such as walking and wildlife viewing. An existing gravity sewer line crosses Edmonds Marsh within the Robison Trail

berm. The site is surrounded by single- and multi-family housing developments to the north, west, and south, and a commercial and industrial center to the northeast.

2.3 Endangered Species

No federally listed species are known to occur on the project site. The site is within the range of several listed prairie-associated species that occur in southern Puget Sound (pocket gopher, streaked horned lark, Taylor's checkerspot, golden paintbrush, or marsh sandwort). However, no suitable prairie habitat is present on site to support these species, and they would not be affected by the project.

Sequalitchew Creek joins Puget Sound approximately 1 mile northwest of the project site. This part of Puget Sound is within the state-designated Nisqually Reach Aquatic Reserve. Marine habitat in this area likely provides foraging opportunities for marbled murrelets; however, there is no mature forest on the project site that would provide a nesting habitat for this species. Similarly, the project site is not currently known to be used by federally listed salmonid species (Chinook salmon, steelhead, and bull trout), but the aquatic reserve likely provides nearshore areas where these species can migrate and forage. The project would not directly affect any federally listed aquatic species; however, it is intended to increase the area of available freshwater fish habitat and may thereby result in an indirect benefit to salmonids (and to marbled murrelet by increasing their prey base in Puget Sound; Anchor QEA 2023).

Table 2 lists Washington state priority habitats and species that occur within approximately 1 mile of the project vicinity based on Washington Department of Fish and Wildlife (WDFW) mapping (WDFW 2023b). The three bat species, which are not state or federally listed, typically occupy mature trees. The project site and vicinity include some trees that may provide roosting habitat for these bat species, as well as surface waters that may provide insect foraging opportunities for bats.

Table 2
State Priority Species and Habitats in Project Vicinity

Common Name	Scientific Name	Location in Project Area
Coho salmon	*Oncorhynchus kisutch*	Sequalitchew Creek
Cutthroat trout	*Oncorhynchus clarkii*	Sequalitchew Creek
Big brown bat	*Eptesicus fuscus*	Vicinity
Little brown bat	*Myotis lucifugus*	Vicinity
Yuma myotis	*Myotis yumanensis*	Vicinity
Waterfowl concentrations	N/A	Vicinity
Freshwater forested/shrub wetlands	N/A	Vicinity
Wetlands	N/A	Vicinity

2.4 Wetlands

The project site is undeveloped except for roadways and trails. The area east of Center Drive is almost entirely occupied by the following wetlands (Appendix A).

Anchor QEA biologists identified two wetlands (Edmonds Marsh and Wetland 1-D) totaling approximately 135 acres on the project site. Edmonds Marsh is divided into east and west portions by a raised gravel multiuse trail grade. East and West Edmonds marshes are hydrologically connected through a culvert within the trail prism. Center Drive crosses Sequalitchew Creek west of Edmonds Marsh via a bridge. A concrete sidewalk parallels the stream crossing through a box culvert under the bridge). The *Edmonds Marsh Wetland Delineation Report* (Appendix A) describes the methods and results of the wetland evaluation conducted on the project site in 2022. Table 1 summarizes the wetland characteristics. Category II wetlands in DuPont have a standard buffer width of 100 feet (feet North American Datum of 1988; DMC 25.105.050[1][b]).

2.4.1 Edmonds Marsh

Edmonds Marsh is an approximately 134-acre wetland complex associated with Sequalitchew Creek. The wetland includes a mosaic of active channels (with Sequalitchew Creek flowing in an east-west direction); forested, scrub-shrub, and emergent wetland vegetation communities; seasonal open water; and large upland hummocks supporting forested upland vegetation communities. Edmonds Marsh is a forested, scrub-shrub, and herbaceous wetland dominated by Pacific willow, red alder, black cottonwood, Pacific crabapple, Douglas' spirea, red osier dogwood, salmonberry, black twinberry, vine maple, reed canarygrass, broadleaf cattail, water parsley, false lily-of-the-valley, starry false Solomon's seal, lady fern, creeping buttercup, stinging nettle, slough sedge, and soft rush.

2.4.2 Wetland 1-D

Wetland 1-D is located north of Edmonds Marsh and is an approximately 1.83-acre depressional wetland containing forested, scrub-shrub, and emergent wetland vegetation communities. The wetland is dominated by red alder, black cottonwood, Douglas' spirea, Pacific crabapple, red osier dogwood, salmonberry, black twinberry, lady fern, false lily-of-the-valley, starry false Solomon's seal, and water parsley.

2.5 Upland

The upland areas surrounding the wetlands are largely forested with Douglas fir (*Pseudotsuga menziesii*), big-leaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), black cottonwood (*Populus balsamifera*), western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), Garry oak (*Quercus garryana*), western crabapple (*Malus fusca*), Douglas hawthorn (*Crataegus douglasii*), and beaked hazelnut (*Corylus cornuta*).

3 Sequalitchew Creek Flows

This section is a summary of Section 4.5 of Aspect Consulting's *Earth and Water Resources Technical Report* (Appendix B). This analysis assumes that water levels throughout Edmonds Marsh are essentially a static gradient from the outlet of Lake Sequalitchew to the west end of West Edmonds Marsh. Achieving that condition would require the removal of beaver impoundments and creating a broad enough channel to prevent high flows from backwatering. These conditions are not the goal or end result anticipated as a result of this project. Therefore, these flow predictions are higher than those expected after implementing this plan. Flow restoration as a result of beaver management is discussed in Section 4.4.

These predictions do describe the upper limits of flows available for flow restoration. Currently the flows from Sequalitchew Springs are either used as part of the Joint Base Lewis McChord water supply or end up flowing through a diversion canal to Puget Sound. Successful restoration will allow up to 100% of the water not used by the base to flow through Edmonds Marsh to Sequalitchew Creek. The diversion canal would then only be used to convey water when very high stormwater discharges are great enough to potentially raise Lake Sequalitchew water surface elevation (WSE), which could threaten the water quality of the base's drinking water. The predicted flows used in this report take a conservative approach and are based on 100% of flow being conveyed into Edmonds Marsh and down the Sequalitchew Creek Ravine. This is done to ensure that bridges, channels, and other project elements have sufficient capacity to convey that flow without flooding surrounding areas. Analysis of a surface water budget and the history of flows since construction of the Diversion Canal were used to compare water surface elevations before and after implementation of the restoration plan (Figure 2).

Target WSEs for beaver management were developed based on creating a more consistent gradient between the outlet of Sequalitchew Lake and the west end of West Edmonds Marsh (Figure 3). Currently, this gradient slopes up from the outlet of the lake to East Edmonds Marsh, reversing the flow and directing to the diversion canal. Successful beaver management would result in the following WSEs:

- East Edmonds Marsh on Joint Base Lewis McChord property: 214.0 feet
  - Current range at the outlet of Lake Sequalitchew is 214.7 to 215.3 feet.
  - Current average is 215.9 feet at staff gage EM-3W at Dupont-Steilacoom Road, which indicates that flow is to the east toward the diversion canal.
- East Edmonds Marsh in the City of DuPont: 212.5 feet
  - Current average is 215.7 feet at staff gage EM-2E east of the Robison Trail and downstream of at least one beaver dam with approximately 1.5 feet of drop (i.e., other parts of East Edmonds Marsh in the city of DuPont average about 215.8 feet).
- West Edmonds Marsh: 210.0 feet

- Current average is 210.2 feet at staff gage EM-1A just above the westernmost beaver dam, which controls the outlet of the marsh.

These changes would all reduce the water elevations and subsequently reduce flooding around Edmonds Marsh. Beaver management efforts would not only reduce WSE, but also provide additional flow capacity and water storage to reduce peak flows downstream. WSEs could be capped by creating adequately wide notches in key beaver dams that allow high flows to pass, while minimizing the increase in WSE.

Below Edmonds Marsh in the dry reach, flows are predicted to average 12.1 cubic feet per second (cfs). Monthly average flows would range between 2.2 cfs in August and 25.5 cfs in March. Peak flows could be as high as 60 cfs if no flow is routed to the diversion canal. The reach could still go dry unless beaver management includes measures to store water in Edmonds Marsh during the spring and allow it to discharge slowly through the summer. (The model used in the flow predictions above did not consider the effects of seasonal change in WSE once beaver management is implemented.)

These flow predictions also consider changes in groundwater elevations related to a proposed gravel mine expansion in the area. If that project is not constructed, flows would be very similar in the dry reach, but groundwater would contribute to flows farther downstream. Flows downstream increase due to the contribution of groundwater. These flows are predicted to be similar to the dry reach, with monthly averages ranging from a low of 2.2 cfs in August to a high of 26.2 cfs in March. Without the mine expansion, the flows would be further increased by about 0.5 cfs in summer to 2.5 cfs in winter.

Groundwater connections to surface water are stronger in East Edmonds Marsh than in West Edmonds Marsh. Data from groundwater wells in and around Edmonds Marsh indicate that an influx of surface water in the wet season fills the wetland area. Currently beaver dams help to maintain marsh surface water levels higher than groundwater levels beneath the marshes during the wet season. During the dry season, the surface water and groundwater levels drop. The west end of Edmonds Marsh completely dries out each year by the late spring. Additional flow resulting from other elements of the restoration plan would lead to better connectivity between surface water and groundwater in West Edmonds Marsh by providing more persistent inundation of the marsh during the dry season.

Downstream of West Edmonds Marsh in the dry reach, there is a change in geology. Beneath Edmonds Marsh, fine-grained, low-permeability peat and silt deposits slow the infiltration of surface water. This layer is not known to be present in the dry reach. This could mean that flows in the dry reach may infiltrate rapidly. Rapid infiltration is also likely as the channel of the dry reach appears to be human-made and lacks normal channel morphology, which often includes fine-grained deposits that hold water. Furthermore, the DuPont Mine South Parcel Project would lower existing groundwater levels in this reach up to 2 feet, further increasing infiltration in the reach. Due to these

concerns, the placement of a low-permeability material below the streambed would help to maintain surface flows in the dry reach.

4 Preliminary Design Alternatives

4.1 Robison Trail

The DuPont Railroad Trail crosses through Edmonds Marsh from north to south and contains a below-grade sanitary sewer line. In existing conditions, a series of small (48 inches or less) pipe culverts convey surface water from the east side of the trail to the west. Groundwater flow through the trail appears to be limited, as evidenced by the perched water levels on the east side of the trail. Improving the hydraulic connectivity between East and West Edmonds marshes would increase surface flows to the losing reach, create a more direct route for fish passage, and lower water levels in East Edmonds Marsh. A topographic survey was conducted in support of this effort in April 2015 (Anchor QEA 2015).

The current Robison Trail is acting as a dam, metering the flow of water from East Edmonds Marsh to West Edmonds Marsh. To restore flow and connectivity between East and West Edmonds marshes, an evaluation of means to increase flow and fish passage through the embankment was used. Several options evaluated included:

- Place a series of culverts through the embankment.
- Remove a section of the embankment.
- Remove the embankment, replace with a bridge.

Between these options only the bridge option was carried forward into design. There is currently a series of small culverts within the Robison Trail embankment. Of these culverts, several have been crushed, some cannot be found, and others are clogged. With the embankment only a few feet above the seasonal high water level of the wetland, a series of many culverts would be needed to allow unrestricted flow between the sides of the marshes. So many culverts so close to each other would create very difficult passage conditions for salmonids because the culverts would have to be at most 24 inches in diameter to keep from silting in. Further, keeping so many culverts free of debris is a maintenance issue that cannot be easily solved. Permanently removing a section of embankment also is not viable. Pierce County owns an 8-inch PVC gravity sewer line within the embankment that must remain in service. Because the line is gravity operated, it cannot be easily rerouted to another alignment.

The purpose the bridge is to remove a fill prism from under the DuPont Railroad Trail and continue to provide trail recreation and maintenance access by installing a vehicular bridge. Opening a wide gap in the embankment would provide the most reliable connection between East and West Edmonds marshes. The bridge is intended to be sufficiently long to discourage beaver activity from blocking the channel as it flows under the bridge. The broad opening would also facilitate unimpeded fish passage and allow for natural channel dynamics. On the drawings (Appendix A) the

bridge is shown in a location near the southern end of the marsh to maximize bridge clearance above the anticipated surface water levels.

Flows at the Robison Trail bridge site are predicted to average around 12 cfs annually and could reach a peak of 60 cfs based on existing flows from Lake Sequalitchew and a water budget model of Edmonds Marsh. This estimate does not consider two key factors that would reduce these numbers. First, Edmonds Marsh is approximately 150 acres in size and can store about 6.5 million cubic feet of water for every 1 foot rise in WSE. Second, it is presumed that the WSE at the lake outlet (east end of East Edmonds Marsh) would not be allowed to exceed 215.3 feet. As water levels rise, flow would be routed to the diversion canal to protect the Joint Base Lewis McChord drinking water supply. Beaver management will focus on passing base flow and is not anticipated to provide conveyance of high flows. This would divert higher flows to the diversion canal, and flow through Edmond Marsh would remain controlled by the capacity of flexible levelers and other beaver management strategies in place. Al. To avoid attracting beavers to the site, velocity under the bridge needs to be minimized. At low flows, the WSE at the bridge could be as low as 209.5 feet or only 0.5 foot deep. With increased flows, the WSE will rise.

The bridge would also serve to suspend a replacement section of sewer pipe. The bridge would include pipe hangers and an encasement to properly support and protect the exposed sewer pipe. Two new manholes would be installed at either end of the bridge, to facilitate junctions with the existing sewer line. This location allows the sewer line to be maintained at its current gravity operation.

4.2 Losing Reach and Center Drive

The Losing Reach of Sequalitchew Creek extends from Edmonds Marsh under Center Drive and downstream to the trail crossing at DuPont City Hall. It is a straight, low-complexity reach above the water table through the highly permeable Vashon Recessional Outwash. Additionally, the reach is within the backwater of the former DuPont Dam and has limited valuable riparian vegetation. Given the current physical and hydrological conditions, this reach typically lacks surface flow. Surface flow in the reach has occasionally been observed after removal of large beaver dams and after large, intense precipitation events. When water does spill from Edmonds Marsh, it is assumed that a substantial fraction of the flow easily infiltrates this short (approximately 1,400-foot) reach.

To maintain the flow of water in the losing reach and aid in fish passage the following options were evaluated:

- Reconstruct streambed with bentonite.
- Reconstruct streambed with geotextile.
- Reconstruct streambed with fines.

Lining the streambed with bentonite is a possibility; however, it is not without drawbacks. Bentonite clay in the amounts required would have to be sourced and trucked onto the site. This creates a logistical issue, as source sites may be very far from the project area. Bentonite may also crack with settling of the in-situ material over time, leading to leaks. Bentonite also is erodible, with some maintenance required over the lifetime of this type of liner. Geotextile for this size of site is also not feasible. The high cost associated with geotextile liners and the heavy requirements for sealing and stitching together in a non-uniform channel would create too many issues. Geotextile liners work well in geometric, highly controlled systems, such as off-channel reservoirs. Compactable and plastic fines are locally available at nearby mix plants. These types of materials are locally sourced, free of weeds, easily attainable, and cheaper than other methods of lining. This option was carried forward into the design.

All options included the enhancement of the channel to increase aquatic habitat diversity and improve stream channel and riparian conditions through the following:

- Creating bank-full elevation benches along the channel
- Installing large woody material (LWM) in the channel if depth and velocity for fish passage are limited by lack of channel complexity
- Clearing out invasive vegetation and trash
- Adding streambed gravels above any bed liner materials

4.3 City Hall Culvert

The City Hall Culvert begins a short walk away from DuPont City Hall and is a gathering place for locals. There is a pedestrian trail that runs along the northern side of the reach, which is regularly used by area residents. A short pedestrian footbridge crosses the creek downstream of the City Hall Culvert. Additionally, an existing borrow pit and berm is located near the footbridge. With current flow conditions, the footbridge and borrow pit do not disrupt or impede flow in the channel, but they could limit channel and floodplain function during larger peak flow events. The following replacements of this embankment and existing culvert were evaluated to meet peak flow events:

- Culvert or series of culverts
- Pedestrian bridge

The existing culvert is likely not fish passable during the restored conditions high flow events. Either option of pedestrian bridge or culvert replacement would require a complete excavation of the existing embankment. With the stream being so wide at this point, either a large arc-type culvert or bridge would be required for pedestrian passage over the creek and fish passage. Because the trail is only accessible by pedestrians and no vehicular use is necessary a pedestrian bridge becomes much more attractive. The bridge would allow unimpeded pedestrian access to the Sequalitchew Trail, an uninterrupted stream section below the bridge for flow and fish passage, as well as the ability to

permanently remove fill placed in the creek during the original placement of the culvert and trail. This option was moved forward into the design.

4.4 Beaver Management

The goal of managing beaver activity in Sequalitchew Creek Watershed is to increase east-to-west flows from Sequalitchew Lake through Edmonds Marsh to Puget Sound, rather than out through the Diversion Canal. Flow is largely inhibited by the very low gradient in the creek. Consultation with Beavers Northwest presented an initial and contingent set of beaver management strategies designed to work with the existing beavers to achieve the desired flow gradients. Depending on how the beaver population responds to initial actions, the beaver management strategies could transition into more aggressive treatments. See Appendix G for the Beaver Management Plan.

Beaver management would consist of the following activities, implemented sequentially:

- Survey existing beaver dams, install digital data-logging water level gauges upstream and downstream of each, and monitor them over time.
- Clear the culvert at Steilacoom DuPont Road of beaver debris, install beaver exclusion devices, and regularly maintain the exclusion.
- Install flexible pond levelers near the outlet of West Edmonds Marsh and in East Edmonds Marsh, just upstream of the Robison Trail.

Adaptive management of beaver exclusions and flexible pond levelers will be of paramount importance to the entire project. These features will ultimately determine the flow rates in Sequalitchew Creek and the WSEs in Edmonds Marsh. Table 3 and Figure 4 describe target elevations at the existing staff gages and target flow regimes at locations in the system. Additional actions to manage WSE and flow will be needed until these conditions are met or these targets are revised.

Table 3
Target Water Surface Elevations with Beaver Management (feet)

Staff Gage	Location	October WSE	March WSE
SG-EM-1	West end of West Edmond Marsh	210.0	211.5
SG-EM-1A	Outlet of West Edmond Marsh	210.0	211.5
SG-EM-2W	West of Robison Trail	212.5	214.0
SG-EM-2E	East of Robison Trail	212.5	214.0
SG-EM-3W	West of DuPont-Steilacoom Road	214.0	214.2
SG-EM-3E	East of DuPont Steilacoom Road	214.0	214.2

Table 3 shows that when there is the most water in the system (March) the WSE across all of East Edmonds Marsh is relatively consistent (214.0 to 214.2 feet). This serves two purposes. First, it

reduces the risk of flooding by lowering the water level, which is currently around 216.0 feet. Second, it will reduce peak flows, which is important for keeping water velocities low in the flexible levelers and at the Robison Trail Bridge. Should more flow be desired, additional flexible levelers could be installed.

Most of the predicted high flow of 60 cfs described in Section 2 would be diverted to the canal. Peak flows in the system would ideally be limited to about 25 cfs. With additional information about the design and management of Joint Base Lewis McChord's proposed diversion structure, the beaver management approach can be refined. Beaver management will target flows above the performance thresholds and the aspirational thresholds (0.5 cfs from May to November and 4.0 cfs from December to April). Table 4 shows the range of flows from the performance threshold (minimum flow) to the aspirational threshold (optimal flow).

Table 4
Flow Targets at Sequalitchew Creek Mid Ravine Gage

Month	Performance Threshold (Monthly Average cfs)	Aspirational Threshold (Monthly Average cfs)	Peak Flow (cfs)
January	4.0	22.0	30.0 cfs
February	4.0	25.0	
March	4.0	22.0	
April	4.0	22.0	
May	0.5	15.0	
June	0.5	10.0	
July	0.5	4.0	
August	0.5	2.0	
September	0.5	2.0	
October	0.5	8.0	
November	0.5	12.0	
December	4.0	18.0	

Note: The aspirational threshold is stated in the Restoration Plan as flow under the Center Drive culvert that is greater than or equal to the flow leaving Sequalitchew Lake on a monthly average basis from October to June, except when necessary to prevent damage to private property or city infrastructure from flooding. From July to September, the flow under Center Drive culvert is not less than 75% of the flow leaving Sequalitchew Lake.

The hydraulic head difference at each flexible leveler will determine the flow rate in a pipe of a given diameter. By installing multiple flexible levelers with a variety of invert elevations between the target minimum and maximum, flows will increase as WSE rises and decrease as WSE falls. After an initial set of beaver management features are installed, monitoring for about 12 months is recommended. This will inform where changes are needed to meet the target WSE ranges and flows. To achieve

flows in the range of 25 to 30 cfs would require 15 or more 8-inch-diameter flexible levelers at each beaver dam. To facilitate higher flows, the use of larger diameter pipes with check valves (Tideflex 35 or similar) that would open under specific head pressures may be warranted.

5 Preferred Alternative

The project is part of a Restoration Plan to restore ecological function to the Sequalitchew Creek Watershed (Aspect 2018). It includes the following preferred alternatives.

5.1 Robison Rail Bridge

The trail berm will be breached, and a new steel bridge will be installed to restore a surface water connection between the East and West Edmonds marsh areas (Appendix C)). The bridge will be 70 feet long and 12 feet wide, large enough to allow periodic maintenance vehicle access but primarily intended for pedestrian use. An existing buried sewer pipe will remain in place, with new manholes installed in the trail on either end of the bridge. A new section of sewer pipe will be attached to the bridge superstructure above the anticipated range of potential water levels. The existing trail berm will be graded to match the bridge elevations; graded areas adjacent to the bridge will be replanted with native upland, wetland, and riparian plant species.

5.2 Losing Reach/Center Drive

Project activities in this area, shown in Figures 6a to 6j, will improve in-stream and riparian habitat and support restoration of year-round flows in Sequalitchew Creek. The existing concrete sidewalk along the creek will be removed to provide more space for the stream where it crosses under Center Drive and to improve riparian habitat on both sides of Center Drive. The existing concrete box culvert under Center Drive will not be modified. Approximately 1,400 linear feet of stream channel will be regraded to create in-stream pools and floodplain areas and a low-flow channel. The regraded channel will be lined with low-permeability materials and streambed gravels. LWM will be installed in the channel and anchored with driven piles. Channel-spanning sill logs (anchored by chains) will also be added in the channel to create pools. Riparian areas along the restored channel will be replanted with native tree, shrub, and emergent species, and disturbed soils will be reseeded.

5.3 City Hall Culvert

Sequalitchew Creek passes through an existing 56-inch metal culvert under the pedestrian trail west of Center Drive. The existing culvert is perched above the stream channel and would not meet WDFW requirements for fish passage with increased water flows. The culvert and adjacent fill material supporting the trail will be removed and replaced with a new bridge that is 60 feet long and 6 feet wide (Figures 7a, 7b, and 7c). Adjacent portions of the trail will be regraded. Additionally, an existing timber diversion dam structure and a wire fence will be removed from the stream channel east of the new bridge. Approximately 200 linear feet of stream channel in this area will be regraded, and LWM will be added to create pools and improve in-stream habitat. All disturbed areas will be reseeded or replanted with native species to improve riparian habitat.

5.4 Beaver Management

Active management of beaver activities in Edmonds Marsh is proposed to maintain the hydraulic gradients that provide flows through the watershed. Proposed activities (Appendix C) include notching an existing beaver dam and installing two flexible pond levelers, a beaver dam analog, and a beaver exclusion device.

6 Design Considerations and Preliminary Analysis

6.1 Robison Trail Bridge

6.1.1 Sewer

The sewer system needed to be kept a gravity system. On either side of the proposed bridge two new manholes will be cut into the existing sewer line. This will create a place for the new gravity line to penetrate the bridge abutments and connect back with the existing sewer. The section of pipe to be suspended from the bridge will attempt be tucked into the bottom chord of the truss/girder to protect them from debris. A larger steel sleeve encasement would be placed around the pipe to protect it from any floating debris that may come under the bridge and collect near the pipe. The pipe would be hung from the bridge with clevis-type pipe hangers from the truss/girder.

6.1.2 Bridge and Abutments

Please find the detailed Basis of Design Report for the Robison Trail bridge and abutments in Appendix C.

6.2 Losing Reach and Center Drive

Restoring surface water flow from Edmonds Marsh is anticipated to raise water temperatures in Sequalitchew Creek downstream of the wetland complex (Aspect 2016). The overall benefit of restoring a perennial connection between Sequalitchew Lake and Puget Sound is anticipated to have benefits to the ecosystem in general and to the fishery in particular that outweigh the impacts of higher summer temperatures. However, temperatures could be high enough to limit the growth of some species (e.g., coho salmon and cutthroat trout). To mitigate that impact the design of the loosing reach is intended to increase the hyporheic exchange and cool the water. Cooling would occur when surface water is driven into the hyporheic zone at pools and then pushed back to the surface by engineered wood structures that span the channel in the hyporheic zone. Water will be kept perched above the deeper gravels (below the hyporheic zone) by a low-permeability layer. Because groundwater (including hyporheic flow) maintains a more constant temperature through the year the proposed design will help to limit peak summer water temperatures.

Monthly average flows in the reach are anticipated to be between 0.5 and 10 cfs with a peak flow of 30 cfs or less. Widening of the floodplain is not required to accommodate fish passage at flows of this magnitude but would pose a risk of flooding outside of the channel. Widening of the floodplain would improve habitat by providing low-velocity refugia during high-flow events. Due to the uncertainty that flows greater than 5 to 10 cfs can even be achieved, a phased approach to construction is logical.

Phase 1 would include excavating the existing channel to sub-grade and placing a compacted low-permeability liner under stream gravels. The basic channel configuration and log sills would be installed to help minimize summer water temperature. Riparian restoration would include invasive species removal, hydroseeding, and planting in limited areas.

A low-permeability liner is necessary due to the texture of the native soils in the reach. Data collected by Anchor QEA (Appendix D) indicate the presence of loose and medium-density gravels with some sand and silt. Benchmark infiltration rates for this type of material were used to determine losses in the first 2,000-foot reach from Edmonds Marsh to just below the City Hall Culvert. At the low-flow performance standard of 0.4 cfs, the loss to infiltration could be 0.2 cfs or more. Infiltration of more than 1 cfs is possible at higher flows. Some but not all of this flow would rejoin the surface flows at the Olympia bed cutoff, but at lower flows the reach would be impassable to fish for more of the year.

Phase 2 would include widening of the floodplain to create terraces and side channels. Installation of LWM with root wads would provide fish habitat and promote habitat-forming processes. Riparian restoration would include additional invasive species removal as needed and planting of the entire buffer.

6.3 City Hall Culvert

6.3.1 Bridge and Abutments

Please find the detailed Basis of Design Report for the Robison Trail bridge and abutments in Appendix E.

6.4 Beaver Management

Design development would require a basic site topographic survey and water level data analysis. Locations of flexible levelers would be adjusted and modified to ensure efficient placement. Preliminarily, five flexible levelers and three exclusion devices (i.e., Beaver Deceivers), will be placed in various locations including the eastern end of Edmonds Marsh.

A flexible leveler consists of 8- to 12-inch, high-density polyethylene pipe fed into a bull panel fencing structure. The bull panel fencing structure serves to hide the pipe inlet and prevent beavers from blocking water flow into the pipe. The downstream end of the pipe is fed through the beaver dam at a designated elevation to the outlet downstream. T-posts are used to hold the pipe and bull panel in place. Hog rings are used to secure the 6- by 6-inch bull panel into a cylindrical structure that hides the flow into pipe and prevents beavers from blocking the inlet. The beaver exclusion devices were assumed to be comparable in cost to flexible levelers for this stage of the project.

A programmatic approach to design and permitting should allow design of individual flexible levelers to be flexible in terms of pipe length and inlet and outlet elevations.

6.4.1 Adaptive Management

Flexible levelers require maintenance at least annually on a long-term basis. After installation, there is an initial, more intense, monitoring and adaptive management period to assess and respond to the beavers' reaction to the new pond level. This period of monitoring and adaptive management is crucial to the success of the flexible leveler strategy. This period can help identify the need for more aggressive beaver management techniques. Once the beavers and flexible levelers reach equilibrium, the flexible levelers should require only routine maintenance (annually). Implementation may require state water quality review.

The implementation team could monitor flows from Sequalitchew Lake through Edmonds Marsh and record water elevations in the marshes using the staff gauges. If the flexible levelers are insufficient to maintain positive flows through the system, the implementation team should re-evaluate the beaver management plan to determine whether to use more aggressive methods, such as lowering flexible pond levelers, removing more key dams, trapping and relocation of beavers, or lethal removal.

Contingent actions include the installation of three additional flexible levelers or beaver exclusion devices, which would increase the total to 11 beaver devices at new or existing beaver dams and culverts. Additionally, costs for potential beaver trapping and relocation are included. It is important to note that these costs would be better assessed once the number of beavers to be relocated and potential receiving sites are identified.

6.5 Construction Methods

Construction methods and equipment include the following:

- Workers and equipment will access the site from Steilacoom DuPont Road, Center Drive, and the existing trail berms (Robison Trail and trail crossing the City Hall Culvert).
- Equipment and materials will be staged in upland areas near the project site.
- An excavator will be used for removal of trail berm and other fill materials, the City Hall Culvert, and the timber diversion dam, and for grading of the creek channel, installation of low-permeability materials and gravel in the streambed, and installation of LWM. A jackhammer will be used to breakup concrete prior to removal.
- Beaver management devices will be installed using hand equipment such as shovels and handheld power tools.
- A crane and pile driver will be used to place the two new bridge structures. Concrete will be delivered by truck.

6.6 Best Management Practices

The following best management practices will be implemented to avoid water quality and habitat impacts during construction:

- All applicable permits for the project will be obtained prior to construction. All work will be performed according to the requirements and conditions of these permits.
- Prior to construction, all work areas will be clearly marked with high-visibility fencing, and vegetation disturbance will not occur outside these areas. Work areas will be the minimum size needed to complete the work safely and efficiently while minimizing impacts to vegetation and soils in surrounding areas.
- Concrete sidewalk and other materials removed as part of the project will be transported off site to a permitted landfill. Some of the existing gravel trail berm fill material to be removed will be reused as part of installing the Robison Trail bridge and regrading the adjacent trail segments.
- All areas disturbed by construction will be stabilized as soon as possible to prevent erosion. The contractor will be required to prepare and implement a Temporary Erosion and Sediment Control Plan.
- The contractor will be required to develop and implement a spill plan to be used for the duration of the project to safeguard against unintentional release of fuel, lubricants, or hydraulic fluid from construction equipment.
- The contractor will be required to properly maintain construction equipment and vehicles to prevent them from leaking fuel or lubricants; if there is evidence of leakage, the further use of such equipment will be suspended until the deficiency has been satisfactorily corrected.
- Uncured concrete for bridge footings will not be allowed to enter or contact nearby surface waters.
- The project will require a Construction Stormwater General Permit due to land disturbance exceeding 1 acre. All elements of the permit will be complied with during construction.
- All areas outside of the stream channel that are disturbed during construction will be reseeded and revegetated to minimize the potential for soil erosion.
- Dewatering may or may not be necessary, but there is no documented fish use that would necessitate fish exclusion during construction.
- A silt curtain may be used, if required, for any in water work occurring near the Robison Trail bridge construction.

7 Permitting and Stakeholder Consultation

In developing the Restoration Plan, the SPSSEG led a year-long process, involving a Core Group of eight stakeholders (the City, Ecology, the Environmental Caucus, CalPortland, the Nisqually Indian Tribe, the Sequalitchew Creek Watershed Council, Joint Base Lewis McChord, and Pierce County) and multiple opportunities for public comment.

SPSSEG held the first meeting of the Core Group, called the Visioning Meeting, to establish guidance for the Restoration Plan process. Following this meeting, SPSSEG held a stakeholder and public meeting to solicit input on the Restoration Plan elements and sequencing from the larger community.

SPSSEG then convened a series of Core Group workshops to develop the Restoration Plan content. At the first three workshops, the Core Group developed and reviewed options to address each of the elements specified in the Settlement Agreement. After the second workshop, the Core Group requested that SPSSEG commission Ecosystem Diagnosis and Treatment modeling of the watershed to estimate the effects of different restoration options on winter chum and coho salmon. The Core Group voted unanimously to adopt the set of recommendations described in this draft conceptual plan at its fourth workshop on June 20, 2013.

SPSSEG released the draft conceptual plan for public review and comment on August 13, 2013, and held a stakeholder and public meeting on August 27, 2013, to collect additional input on the draft. SPSSEG incorporated these public comments, and the Core Group adopted the final set of recommendations on December 17, 2013. The *Final Briefing Memo and Core Group Recommendations for a Restoration Plan* (January 14, 2014) presents the adopted set of recommended actions. In accordance with the Settlement Agreement, the Environmental Caucus and CalPortland developed the Restoration Plan.

Anchor QEA and SPSSEG have participated in pre-application meetings with the U.S. Army Corps of Engineers (Corps), Ecology, WDFW, and the City of DuPont. The following permit application materials are being prepared and will be submitted to these agencies:

- Joint Aquatic Resources Permit Application (JARPA) submittal to the Corps to obtain a permit under Section 404 of the Clean Water Act for proposed alterations to wetlands and streams
- Pre-application filing to Ecology to obtain a Water Quality Certification under Section 401 of the Clean Water Act
- Critical Areas Report submittal to the City in compliance with DMC 25.105 for proposed alterations to wetlands and Fish and Wildlife Conservation Areas
- Cultural Resources Study to be submitted with JARPA for compliance with the National Historic Preservation Act, and to the City as required under DMC 25.90
- Arborist's report addressing proposed tree removal in compliance with DMC 25.120
- State Environmental Policy Act (SEPA) checklist submittal to the City
- Project drawings to be submitted along with all permit applications

8 Construction Quantities and Preliminary Construction Cost Estimate

A preliminary opinion of probable construction costs was prepared for the improvements and related appurtenances shown in the preliminary design drawings (Appendix A). A summary of the preliminary opinion of probable construction costs for key project elements is included in Table 5. The purpose of this cost estimate is to provide a basis for further decision making regarding the configuration of the watershed improvements.

The estimates in Table 5 were provided in accordance with the Association for the Advancement of Cost Engineering Class 4 estimating procedures. Class 4 estimates are generally prepared based on limited information and subsequently have wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval (AACE 2005). Typical accuracy ranges for Class 4 estimates are -15% to -30% on the low side and +20% to 50% on the high side. Ranges could exceed those shown in unusual circumstances.

Table 5
Opinion of Probable Costs: Dungeness Off-Channel Reservoir Key Elements

Cost Item	Opinion of Cost
General	$194,000
Planting and Irrigation	$360,112
Losing Reach Area	$793,633
Construction Site Restoration	$15,915
Bridges	$1,574,600
Robison Trail	$30,232
City Hall Culvert	$32,719
Beaver Management	$26,052
Project Elements Subtotal	**$3,027,000**
Contingency (30%)	$908,000
Construction Management (25%)	$757,000
Construction Subtotal	**$4,692,000**
Sales Tax (10.0%)	$469,000
Total Project Cost	**$5,161,000**

Notes:

1. Design, permitting, land acquisition, legal, and administrative costs are not included in this summary.
2. This opinion of cost was completed in January 2023. Actual construction costs will vary based on materials and labor costs at the time of construction.
3. The subtotals and construction total are rounded to the nearest $1,000.
4. Adaptive management and monitoring are not included in this estimate.

9 References

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USGS (United States Geological Survey), 2022. Hydrologic Unit Maps. Accessed December 2, 2022. Available at https://water.usgs.gov/GIS/huc.html.

Figures

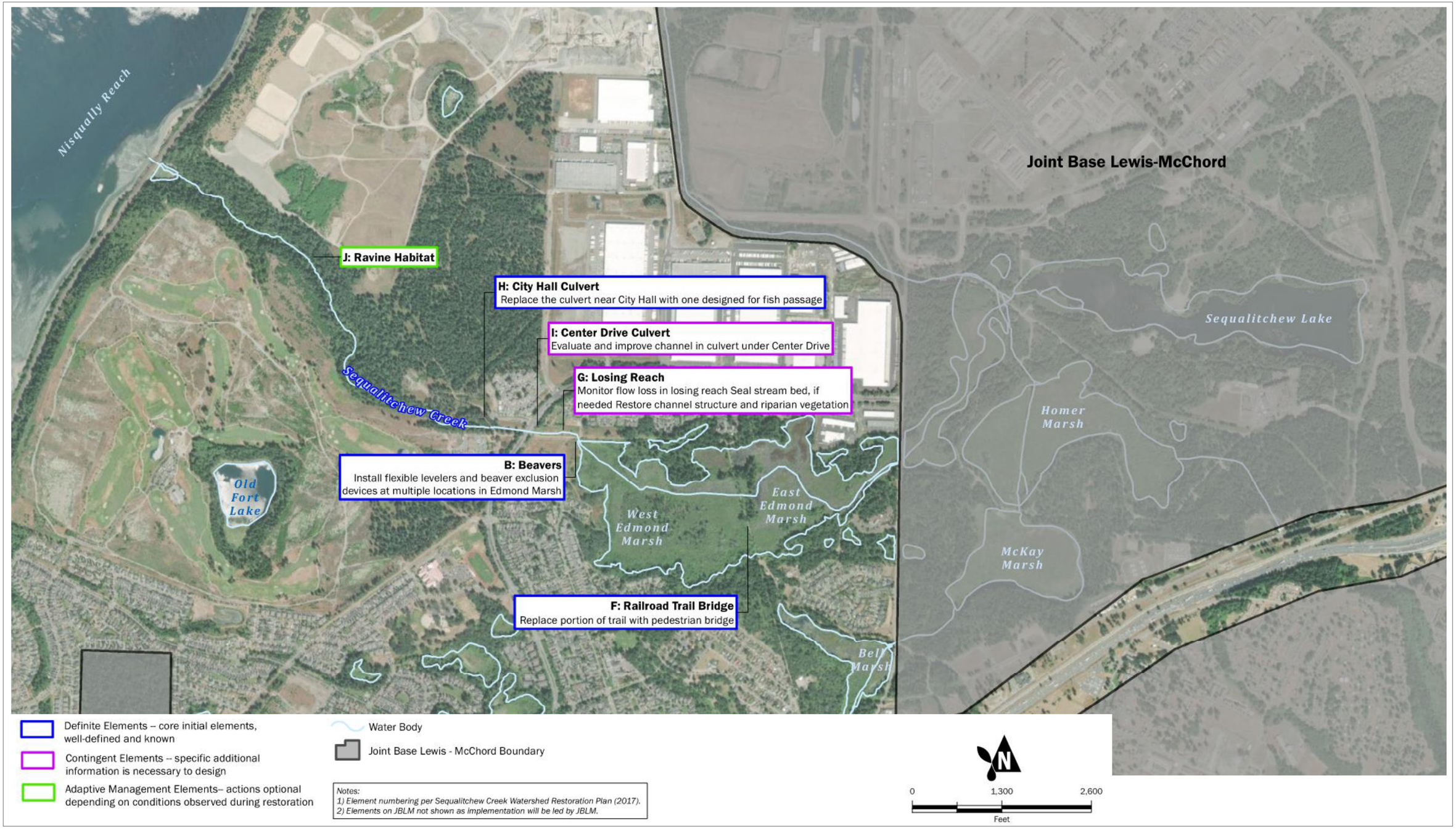

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Figure 1
Sequalitchew Creek Watershed Restoration Overview
Preliminary Basis of Design Report
Sequalitchew Creek Watershed Ecosystem Restoration

OURCE(S):
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

EXISTING AND PROPOSED WATER SURFACE ELEVATIONS (WSE)
NAVD88
EXISTING WSE
PROPOSED WSE

400 0 400
Feet

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Figure 2
Existing and Proposed Water Surface Elevations

Preliminary Basis of Design Report
Sequalitchew Creek Watershed Ecosystem Restoration

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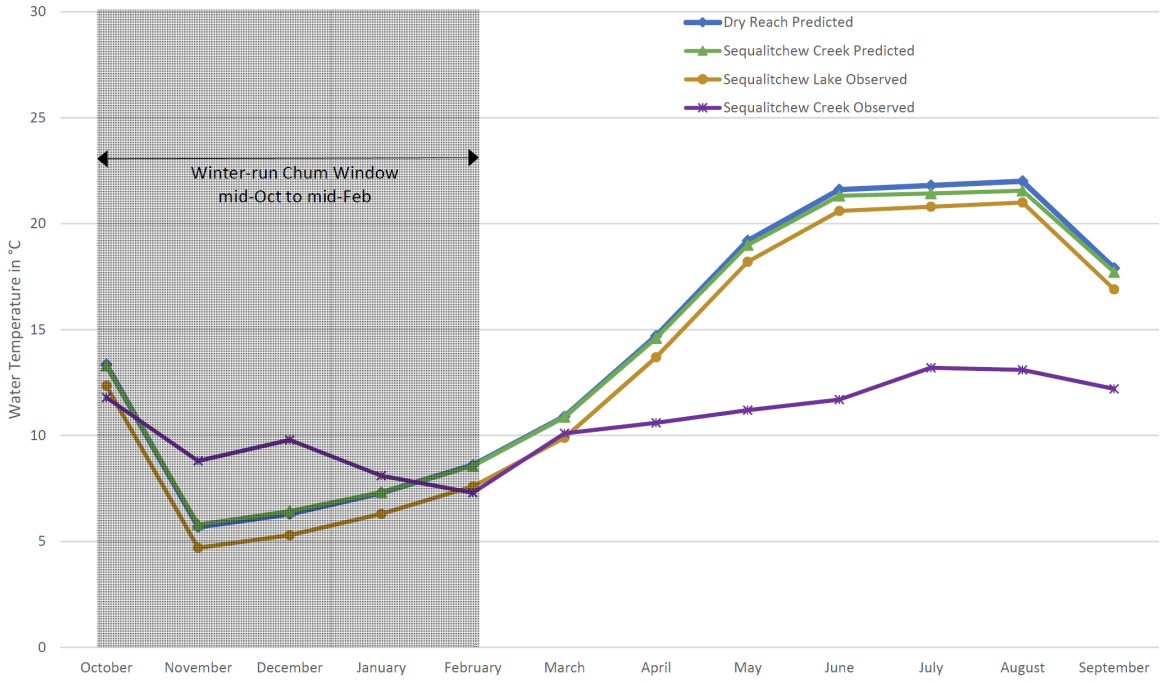
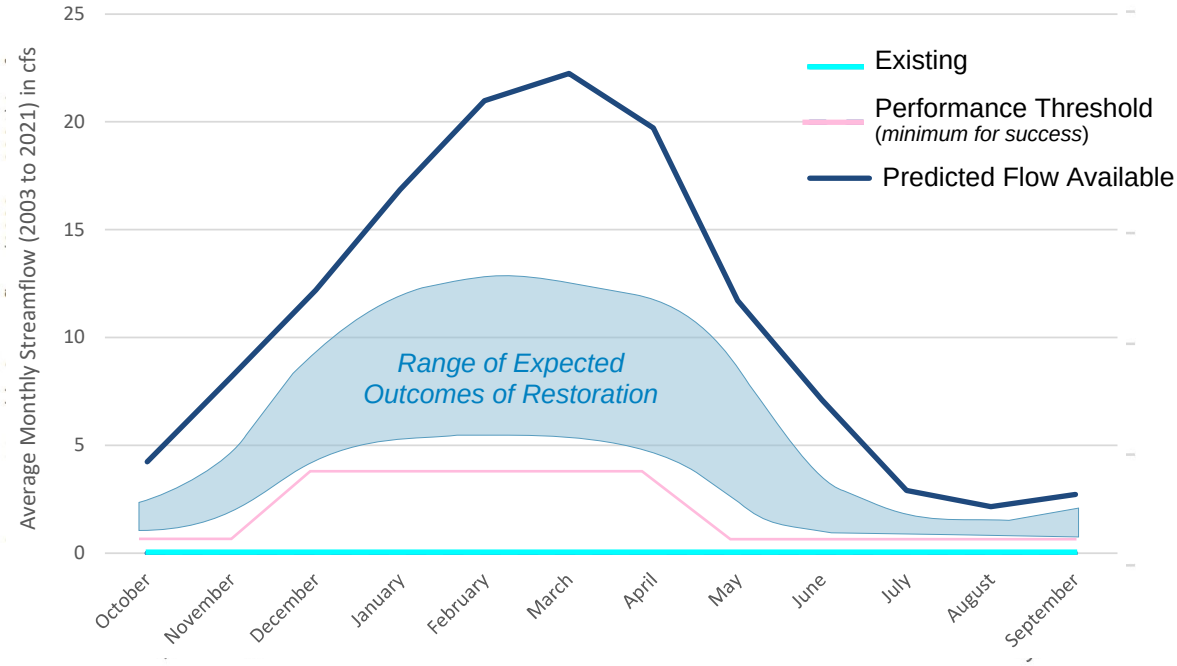
Figure 3
Target Water Surface Elevation Ranges

Preliminary Basis of Design Report
Sequalitchew Creek Watershed Ecosystem Restoration

Existing and Predicted Monthly Average Water Temperature in the Sequalitchew Creek Watershed



Existing and Predicted Monthly Average Flows in the Sequalitchew Creek Watershed



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Appendix A
Wetland Delineation Report

August 2022
South Puget Sound Salmon Enhancement Group

ANCHOR QEA

Edmond Marsh Wetland Delineation Report

Prepared for South Puget Sound Salmon Enhancement Group

August 2022
South Puget Sound Salmon Enhancement Group

Edmond Marsh Wetland Delineation Report

Prepared for
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Project Number: 190217-01.01

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APPENDICES

Appendix A Precipitation Data
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ABBREVIATIONS

1987 Manual	*Corps of Engineers Wetland Delineation Manual*
2010 Regional Supplement	*Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region*
DMC	City of DuPont Municipal Code
Ecology	Washington State Department of Ecology
FAC	facultative
FACU	facultative upland
FACW	facultative wetland
HGM	hydrogeomorphic
N/A	not applicable
NAVD88	North American Vertical Datum of 1988
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
OBL	obligate wetland
PEM	palustrine emergent
PFO	palustrine forested
PHS	Priority Habitats and Species
PSS	palustrine scrub-shrub
redox	redoximorphic
UPL	obligate upland
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife

1 Introduction

Anchor QEA, LLC, was retained by South Puget Sound Salmon Enhancement Group to prepare a wetland delineation report for Edmond Marsh in DuPont, Pierce County, Washington, to support the City of DuPont Critical Areas Ordinance permit for the Sequalitchew Creek Watershed Restoration Project (Figure 1). The study area consists of an approximately 135-acre site located in east DuPont that includes 15 city-owned parcels (Figures 2 and 3).

Specific location information for the project site is as follows:

City/County/State:	DuPont, Pierce County, Washington
General Location:	South of Center Drive, west of DuPont-Steilacoom Road
Tax Parcels:	3001000030, 3000791020, 3000580640, 3000580650, 3000410680, 0119253003, 0119252010, 3001100820, 3000060200, 0119256003, 0119256004, 0119256005, 3001000110, 3001000120, 3001000130
Latitude/Longitude[1]:	47.104419° North/-122.630814° West
Public Land Survey System:	Section 25, Township 19 North, Range 1 East; Section 26, Township 19 North, and Range 2 East
Street Address:	N/A
Approximate Area:	135 acres
Waterways:	Sequalitchew Creek

Note:
1. Latitude and longitude shown are for the approximate centroid of the study area.

This wetland delineation report presents the results of wetland delineation field work performed for the study area on April 18, 19, and 20, 2022. It describes the existing site conditions observed on the study area at the time of the site visits, presents the methods used to complete the delineation, describes the wetlands and other waters identified in the study area, and provides ratings for the identified wetland based on the *Washington State Wetland Rating System – Western Washington: 2014 Update* (Hruby 2014).

Supporting information is provided in the following appendices:

- Appendix A: Precipitation Data
- Appendix B: Wetland Determination Forms
- Appendix C: Wetland Rating Forms
- Appendix D: Site Photographs

1.1 Review of Existing Information

As part of the Edmond Marsh delineation analysis, Anchor QEA biologists reviewed the following sources of information to support the 2022 field observations and preparation of this wetland delineation report:

- Natural Resources Conservation Service (NRCS) Web Soil Survey (USDA 2022a)
- U.S. Fish and Wildlife Service (USFWS) Wetlands Mapper for National Wetlands Inventory (NWI) map information (USFWS 2022)
- DuPont City Code (City of DuPont 2022)
- Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) maps (WDFW 2022)
- Aerial photograph, Google Earth, June 2021
- United States Geological Survey topographical maps (USGS 2020a)
- Pierce County PublicGIS maps (Pierce County 2022)

2 Landscape Setting and Land Use

2.1 Landscape Setting

The study area is situated in the Southern Puget Prairies subregion of the Puget Lowland ecoregion (EPA 2010). This subregion is characterized by nearly level to rolling glacial outwash plains and ground moraines. It contains the Nisqually and Deschutes rivers and generally has well-drained soils that promote a historic land cover mosaic of Douglas fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) forests, prairies, and oak woodlands. Today, some forests, prairies, oak woodlands, streams, and wetlands still occur, but overall, the watershed is dominated by urban and suburban development characterized by a combination of residential, industrial, commercial, military, forestry, and agricultural land uses. The Puget Lowland ecoregion has a Mediterranean-like climate, with warm, dry summers, and mild, wet winters.

Hydrologically, the study area is located in the Sequalitchew Creek Frontal Cormorant Passage watershed (hydrologic unit code 171100190304) of the Puget Sound basin (USGS 2022b) and in the Chambers-Clover Water Resource Inventory Area 12 (Ecology 2022).

2.2 Study Area Conditions and Land Use

The current conditions and land use of the study area are depicted in the June 2021 aerial photograph provided on Figure 4. The study area is surrounded by planned housing developments to the north, west, and south and a commercial and industrial center to the northeast. The study area is bounded by DuPont-Steilacoom Road, which runs in a north-south direction.

Much of the study area wetlands are surrounded by a forested buffer strip with diverse, layered upland vegetation communities. Common tree species found within the buffer area include Douglas fir, big-leaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), black cottonwood (*Populus balsamifera*), western hemlock, western red cedar (*Thuja plicata*), Garry oak (*Quercus garryana*), western crabapple (*Malus fusca*), Douglas hawthorn (*Crataegus douglasii*), and beaked hazelnut (*Corylus cornuta*). Common shrub species include salal (*Gaultheria shallon*), snowberry (*Symphoricarpos albus*), salmonberry (*Rubus spectabilis*), osoberry (*Oemleria cerasiformis*), black twinberry (*Lonicera involucrata*), vine maple (*Acer circinatum*), Oregon grape (*Mahonia nervosa*), stink currant (*Ribes bracteosum*), bald-hip rose (*Rosa gymnocarpa*), oceanspray (*Holodiscus discolor*), evergreen huckleberry (*Vaccinium ovatum*), red huckleberry (*Vaccinium parvifolium*), and trailing blackberry (*Rubus ursinus*). Herbaceous species include sword fern (*Polystichum munitum*), bracken fern (*Pteridium aquilinum*), false lily-of-the-valley (*Maianthemum dilatatum*), and Pacific trillium (*Trillium ovatum*). Vegetation observed at each of the wetland delineation data plots established during the site visits is presented on the field data forms in Appendix A.

2.3 Geology, Topography, and On-Site Drainage

Geologically, Edmond Marsh was formed during glacial retreat, when the stagnant melting ice sheet left large blocks of stranded glacial ice called "dead ice." An ablation till (a loose, relatively permeable earthy material) was formed when stagnant ice evaporated, leaving the glacial fines once contained in the ice as a low-permeability deposit.

Topography within the study area varies across the study area and ranges from approximately 220 feet North American Vertical Datum of 1988 (NAVD88) to 240 feet NAVD88 (USGS 2020). The lowest elevations are associated with the active channel of Sequalitchew Creek, which crosses through the entirety of Edmond Marsh, and associated side channels (Figure 3). The higher elevations are associated with upland hummocks and the embankments along the wetland edge. Edmond Marsh drainage flows west through Sequalitchew Creek towards the Nisqually Reach of Puget Sound. At the time of the site visit, Sequalitchew Creek went subsurface approximately 200 feet northwest of the Edmond Marsh boundary.

3 Methods

This section describes the methodology used to perform the 2022 wetland delineation field investigation procedures. These methods are consistent with current federal and state agency requirements, as well as local (City of DuPont) jurisdiction requirements, for performing wetland delineations and identifying protective wetland buffer widths.

3.1 Field Data Collection

As specified by the City of DuPont Municipal Code (DMC; City of DuPont 2022), the Edmond Marsh boundary was identified, delineated, and verified according to the methods defined in the *Corps of Engineers Wetland Delineation Manual* (1987 Manual; Environmental Laboratory 1987); the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0)* (2010 Regional Supplement; USACE 2010); and *Field Indicators of Hydric Soils in the United States: A Guide for Identifying and Delineating Hydric Soils, Version 8.2, 2018* (USDA and NRCS 2018). Soil colors were classified by their numerical description as identified using the Munsell Soil Color System (Munsell Color 2009).

The U.S. Army Corps of Engineers (USACE) 1987 Manual (Environmental Laboratory 1987) defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

In accordance with that definition, the method for delineating wetlands is based on the presence of three parameters: hydrophytic vegetation, hydric soils, and wetland hydrology. These parameters are defined in the 1987 Manual (Environmental Laboratory 1987) as follows:

- Hydrophytic vegetation is "the macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present."
- Hydric soils are "formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part."
- Wetland hydrology "encompasses all hydrologic characteristics of areas that are periodically inundated or have soils saturated to the surface for a sufficient duration during the growing season."

Data collection methods for each of these parameters are described in the following subsections.

A total of 16 paired data plots were sampled and recorded in the field. Vegetation, soils, and hydrology information was collected at each of the plots and recorded on field data forms

(Appendix A). The Edmond Marsh boundary was determined based on paired plot data and visual observations of wetland conditions. Delineated wetland boundaries and data plots were flagged in the field and surveyed using a Trimble Geo7x GPS receiver. Location data collected with the GPS were then differentially corrected in the office to submeter accuracy.

3.1.1 Vegetation

Plant species occurring in each plot were recorded on field data forms using one data form per plot (Appendix A). At each plot, trees within a 30-foot radius, shrubs within a 15-foot radius, and herbs within a 5-foot radius from the center of the plot were identified and recorded. Species were listed by both common and scientific name, and the percent absolute cover for each species was estimated and recorded for each strata (trees, shrubs, herbs, and woody vines). Dominant plant species were identified based on observed cover and the "50/20 Rule." A wetland plant indicator status that describes the probability of individual plant species occurring in wetlands in the United States was assigned using the *2020 National Wetland Plant List for the Western Mountains, Valleys, and Coasts Region* (USACE 2020). Using the estimated cover information and indicator status, a determination was made as to whether the vegetation in the plot was hydrophytic. To meet the hydrophytic parameter, more than 50% of the dominant species, with 20% or greater cover, must have an indicator of obligate wetland (OBL), facultative wetland (FACW), or facultative (FAC). Table 1 provides the wetland indicator status categories.

Table 1
Wetland Plant Indicator Definitions

Indicator Status	Description
Obligate wetland (OBL)	Plant species occur almost always in wetlands (estimated probability greater than 99%) under natural conditions
Facultative wetland (FACW)	Plant species usually occur in wetlands (estimated probability 67% to 99%) but are occasionally found in non-wetlands
Facultative (FAC)	Plant species are equally likely to occur in wetlands or non-wetlands (estimated probability 34% to 66%)
Facultative upland (FACU)	Plant species usually occur in non-wetlands (estimated probability 67% to 99%) but are occasionally found in wetlands
Obligate upland (UPL)	Plant species occur almost always in non-wetlands (estimated probability greater than 99%) under natural conditions

Source: Reed 1988

3.1.2 Soils

Soils were sampled in each plot and evaluated for the presence of hydric soil indicators in their upper (i.e., top 12 inches) horizons. Soil pits were dug to a depth of 18 inches, unless prevented by

impenetrable substrate. The soil profile at each pit was described on the data forms by its texture, predominant matrix color, and the prevalence and color of any redoximorphic features or gleying present in the profile. Soil colors were classified by their numerical description under the Munsell Soil Color System (Munsell Color 2009). Soil profile descriptions were compared with the hydric soil indicators provided in the 2010 Regional Supplement (USACE 2010) and *Field Indicators of Hydric Soils in the United States: A Guide for Identifying and Delineating Hydric Soils, Version 8.2, 2018* (USDA and NRCS 2018). If any one of these indicators was determined to be met, the soil was considered hydric. Generally, hydric soil indicators include low soil matrix chroma, gleying, and redoximorphic (or "redox") features. Redox features are spots of contrasting color that occur within the soil matrix (the predominant soil color). Gleyed soils are predominantly bluish, greenish, or grayish in color.

3.1.3 Hydrology

Wetland hydrology was evaluated at each data plot to determine if the site experiences 14 or more consecutive days of flooding or ponding or has a water table 12 inches or less below the soil surface during the growing season at a minimum frequency of 5 years out of 10 (50% or higher probability; USACE 2010). Indicators of wetland hydrology are typically divided into primary and secondary indicators. Examples of primary indicators include the presence of surface water, saturation in the upper 12 inches of the soil column, water marks or lines on adjacent stationary objects (e.g., trees), sediment deposits or drift lines on vegetation, and oxidized rhizospheres along living roots, among others. Examples of secondary indicators include, but are not limited to, observable drainage patterns on the ground surface, visible saturation on aerial photography, geomorphic position, and raised ant mounds. According to the methods presented in the 1987 Manual (Environmental Laboratory 1987) and the 2010 Regional Supplement (USACE 2010), wetland hydrology is confirmed by the presence of one or more primary indicators or two or more secondary indicators.

At each plot, the presence or absence of primary and secondary wetland hydrology indicators was recorded on the data forms. If present, the depth of any inundation was recorded in inches above the soil surface. The presence of current or recent saturation was determined using the pits excavated for soil samples. Within each pit, the depth to the saturated zone (if present) was recorded in inches from the soil surface, as was the depth to any free water (i.e., water that naturally entered from the bottom or sides of the pit after the hole had been opened) that collected in the pit during sampling. Wetland hydrology was determined to be present if one or more of the primary indicators, or two or more of the secondary indicators, listed on the data form were present.

3.2 Wetland Classifications

Wetland community types are discussed according to the USFWS classification developed by Cowardin et al. (1979) for use in the NWI. This system, published in 1979 by a team of USFWS scientists led by L.M. Cowardin, bases the classification of wetlands on their physical characteristics,

such as where a wetland is located in the landscape (e.g., inland, along a river, adjacent to a lake, or near the ocean), the general type of vegetation in the wetland (e.g., trees, shrubs, or grass) and how often and how much water is typically present in the wetland (e.g., permanently flooded, intermittently flooded, seasonally flooded/saturated, or temporarily flooded).

The Cowardin system provides a classification for every known wetland type that occurs throughout the United States. Under this system, a wetland can be classified as having one or more wetland classification types. Edmond Marsh contained the following Cowardin wetland classification types:

- **Palustrine forested (PFO):** These wetlands have at least 30% cover of woody vegetation that is at least 20 feet high.
- **Palustrine scrub-shrub (PSS):** These wetlands have at least 30% cover of woody vegetation that is less than 20 feet high.
- **Palustrine emergent (PEM):** These wetlands have erect, rooted, herbaceous vegetation present for most of the growing season in most years.

3.3 State Hydrogeomorphic Classification System

Scientists have come to understand that wetlands can perform functions in different ways. The way a wetland functions depends to a large degree on hydrologic and geomorphic conditions. To recognize these differences among wetlands, scientists have developed and alternative way to classify them into categories or types based on the geomorphic and hydrologic characteristics that control many of their functions. This classification system, called the hydrogeomorphic (HGM) classification, is based on a wetland's position in the landscape (i.e., geomorphic setting) and the way that water moves into, out of, and through them (i.e., hydrology).

The *Washington State Wetland Rating System – Western Washington: 2014 Update* (Hruby 2014) incorporates the HGM classification system as part of the questionnaire for characterizing a wetland's functions. The rating system uses only the highest grouping in the HGM classification system (i.e., wetland class). Wetland classes are based on geomorphic settings, such as Riverine, Slope, Lake Fringe, or Depressional. A classification key is provided within the rating form to help identify which of the following HGM classifications apply to the wetland: Riverine, Depressional, Slope, Lake Fringe, Tidal Fringe, or Flats.

3.4 Wetland Ratings

Wetland ratings were determined using the most current version of the *Washington State Wetland Rating System – Western Washington: 2014 Update* (Hruby 2014) and the City of DuPont wetland rating criteria, as defined in the DMC (City of DuPont 2022). The Washington rating system was updated by the Washington State Department of Ecology (Ecology) as of January 1, 2015.

The rating system developed by Ecology is used to differentiate wetlands based on their sensitivity to disturbance, significance in the watershed, rarity, ability to be replaced, and the beneficial functions they provide to society. The Ecology rating system requires the user to collect specific information about the wetland in a step-by-step process. Three major functions are analyzed (water quality improvement, hydrologic functions, and habitat). Ratings are based on a point system, where points are given if a wetland meets specific criteria related to the wetland's potential and the opportunity to provide certain benefits.

Per Ecology's rating system, wetlands are categorized according to the following criteria and to points given by the rating process:

- **Category I wetlands (23 or more points)** represent a unique or rare wetland type, are more sensitive to disturbance, or are relatively undisturbed and contain ecological attributes that are impossible to replace within a human lifetime.
- **Category II wetlands (20 to 22 points)** are difficult, though not impossible, to replace and provide high levels of some functions.
- **Category III wetlands (16 to 19 points)** have moderate levels of functions. They have been disturbed in some ways and are often less diverse or more isolated from other natural resources in the landscape than Category II wetlands.
- **Category IV wetlands (less than 16 points)** have the lowest levels of functions and are often heavily disturbed.

3.5 Wetland Functional Assessment

Wetland functions were assessed as part of the wetland rating process using the methods presented in *Washington State Wetland Rating System – Western Washington: 2014 Update* (Hruby 2014) and its most recent update from January 1, 2015. Using Ecology's rating system, wetlands were assigned points in three functional categories (water quality, hydrologic functions, and wildlife habitat) based on their physical characteristics (site potential), their surrounding environment (landscape potential), and their importance to humans (value). Points were assigned by ranking the wetland's performance in multiple aspects of each category as being high, medium, or low. These qualitative values were then converted to numeric scores for each category based on the wetland's HGM type.

4 Wetland Delineation Results

Anchor QEA biologists delineated two wetlands (Edmond Marsh and Wetland 1-D) totaling approximately 135 acres within the study area (Figure 3). This section describes the wetland delineation results of the 2022 wetland delineation. The individual characteristics of each of these areas are summarized in Table 2 and described in more detail in the following subsections. Wetland determination data forms are provided in Appendix B, wetland rating forms and figures are provided in Appendix C, and site photographs showing these features are included in Appendix D.

Table 2
Wetlands Delineated Within the Study Area

Wetland/Other Water	Surface Connection to Other Waters	Classification System		On-Site Area	
		Cowardin	HGM	Square Feet	Acres
Edmond Marsh	Sequalitchew Creek	PFO/PSS/PEM	Depressional/ Riverine	5,820,487	133.62
Wetland 1-D	None	PFO/PSS	Depressional	79,715	1.83
			Total Area of Wetlands	**5,900,202**	**135.45**

4.1 Edmond Marsh

Edmond Marsh is an approximately 134-acre wetland complex associated with Sequalitchew Creek (Figure 3). The wetland includes a mosaic of active channel (with Sequalitchew Creek flowing in an east-west direction); forested, scrub-shrub, and emergent wetland vegetation communities; seasonally open water; and large upland hummocks supporting forested upland vegetation communities. Edmond Marsh is divided in two (East and West Edmond Marsh) by a raised gravel multiuse trail grade that also encircles the perimeter of the wetland. East and West Edmond Marsh are hydrologically connected through a culvert within the trail prism. The outlet of Edmond Marsh is in the northwest corner, through Sequalitchew Creek. Edmond Marsh is classified as a PFO/PSS/PEM wetland with a seasonally flooded water regime under the Cowardin system and as a Depressional and Riverine wetland under the HGM classification system.

4.1.1 Vegetation

Edmond Marsh is a forested, scrub-shrub, and herbaceous wetland dominated by Pacific willow (*Salix lasiandra*; FACW), red alder (FAC), black cottonwood (FAC), Pacific crabapple (FACW), Douglas' spirea (*Spiraea douglasii*; FACW), red osier dogwood (*Cornus sericea*; FACW), salmonberry (FAC), black twinberry (FAC), and vine maple (FAC) in the tree or sapling/scrub-shrub layer and reed canarygrass (*Phalaris arundinacea*; FACW), broadleaf cattail (*Typha latifolia*; OBL), water parsley (*Oenanthe sarmentosa*; OBL), false lily-of-the-valley (FAC), starry false Solomon's seal (*Maianthemum stellatum*;

FAC) lady fern (*Athyrium cyclosorum*; FAC), creeping buttercup (*Ranunculus repens*, FAC), stinging nettles (*Urtica dioica*; FAC), slough sedge (*Carex obnupta*; OBL), and soft rush (*Juncus effusus*; FACW), in the herbaceous layer. Vegetation in Wetland A meets the Dominance Test hydrophytic vegetation indicator and satisfies the hydrophytic vegetation criteria of the 2010 Regional Supplement (USACE 2010).

4.1.2 Soils

The NRCS maps four soil series within Edmond Marsh (USDA 2022a): Dupont muck (63.1%); Spanaway gravelly sandy loam (27.3%); Semiahmoo muck, 0% to 1% slopes (1.6%); and Everett-Spanaway-Spana complex, 0% to 30% slopes (8.0%).

- The Dupont muck series generally consists of very deep, very poorly drained soils formed in organic deposits. They tend to be found in depressions or basins in the glaciated uplands.
- The Spanaway series generally consists of very deep, somewhat excessively drained soils formed in glacial outwash. They tend to be found on terraces and plains.
- The Semiahmoo series generally consists of very deep, very poorly drained soils formed in herbaceous organic deposits. The Semiahmoo soils are typically found in depressions, on glacial outwash plains, and on broad floodplains.
- The Everett-Spanaway-Spana complex series is composed of the Everett, Spanaway, and Spana series and generally are very deep, somewhat excessively drained soils formed in glacial outwash terraces and escarpments. They tend to be found on glacial drift plains.

Of the aforementioned soils series, Dupont and Semiahmoo are listed as hydric by NRCS (USDA 2022b). Mapped soils are shown on Figure 5.

Edmond Marsh soil characteristics generally consisted of a thick layer (6 to 18 inches) of black mucky loam. The mucky loam contained low chroma (less than 1) with fragments of slightly decomposed wood indicative of extended periods of inundation. Soils below the thick, black layer varied and generally consisted of redox depletions within a black layer or a layer of depleted lower-permeability silty gravely clay. It's likely that soils along the edges of the wetland where soil plots were taken are transitional between the surrounding loamy soils and the mucky soils in the central portions of the marsh.

Upland soils adjacent to the wetland boundary generally consisted of higher-chroma (greater than or equal to 2), dry, brown Spanaway gravelly sandy loam. The wetland boundary corresponded with a clear topographic shift and a change in soils from black mucky loams to gravelly sandy loam in the surrounding upland. Data plot soils are presented in the field data forms in Appendix B.

4.1.3 Hydrology

Edmond Marsh is hydrologically supported through flows from Sequalitchew Creek, a seasonal high water table, precipitation, and runoff from the adjacent uplands. Primary wetland hydrology indicators included High Water Table (A2), Saturation (A3), Inundation Visible on Aerial Imagery (B7), and Water-Stained Leaves (B9). Secondary indicators of wetland hydrology include Saturation Visible on Aerial Imagery (C9), Geomorphic Position (D2), and FAC-Neutral Test (D5). The presence of these indicators satisfies the wetland hydrology criteria of the 2010 Regional Supplement (USACE 2010). Additionally, although not included in any of the determination plots, numerous raised ant mounds were observed near the wetland boundary. Data plot hydrology is presented in the field data forms in Appendix A. Based on existing data and field observations, the primary water regime of Edmond Marsh was determined to be seasonally flooded, with areas of saturation around the outer edges of the wetland.

4.1.4 Wetland Function Scores and Rating

Edmond Marsh was rated as a Category II wetland, with a score of 8 for water quality functions, a score of 5 for hydrologic functions, and a score of 8 for habitat functions. The ratings are discussed in more detail in the following sections, and the wetland rating form for Edmond Marsh is provided in Appendix C.

4.1.4.1 Improving Water Quality Functions

Overall, Edmond Marsh has high and moderate functions for improving water quality. Factors that contribute to this function rating include the presence of true organic soils, the amount of persistent vegetation and seasonal ponding, moderate potential for pollutants to enter the wetland, and the high potential to improve water quality functions within the basin for society.

4.1.4.2 Hydrologic Functions

Edmond Marsh has moderate and low hydrologic functions. Factors that contribute to this function include an unconstricted permanently flowing outlet, high water storage depth above the bottom of the outlet, moderate storage potential compared to the size of the watershed, moderate potential for pollutants to enter the wetland, and a lack of flooding issues in close proximity downstream of the wetland.

4.1.4.3 Habitat Functions

Edmond Marsh has high and moderate habitat functions. Factors that contribute to the function include the presence of multiple plant community layers and hydroperiods, high plant species richness, a moderate amount of accessible and undisturbed surrounding habitat, and multiple special and priority habitat features.

4.2 Wetland 1-D

Wetland 1-D, located north of Edmond Marsh, is an approximately 1.83-acre depressional wetland (Figure 6). The wetland includes forested, scrub-shrub, and emergent wetland vegetation communities. Wetland 1-D is divided in two by the same raised gravel multiuse trail grade that encircles the perimeter of Edmond Marsh. The two portions do not appear to be hydrologically connected, and no culvert was observed. Wetland 1-D does not have an outlet. Wetland 1-D is classified as a PFO/PSS wetland with a seasonally flooded water regime under the Cowardin system and as a Depressional wetland under the HGM classification system.

4.2.1 Vegetation

Wetland 1-D is a forested and scrub-shrub wetland dominated by red alder (FAC), black cottonwood, Douglas' spirea, Pacific crabapple, red osier dogwood, salmonberry, and black twinberry in the tree or sapling/scrub-shrub layer and lady fern, false lily-of-the-valley, starry false Solomon's seal, and water parsley in the herbaceous layer. Vegetation in Wetland 1-D meets the Dominance Test hydrophytic vegetation indicator and satisfies the hydrophytic vegetation criteria of the 2010 Regional Supplement (USACE 2010).

4.2.2 Soils

The NRCS maps one soil series within Wetland 1-D (Figure 5; USDA 2022a): Spanaway gravelly sandy loam (100%). The Spanaway series generally consists of very deep, somewhat excessively drained soils formed in glacial outwash. They tend to be found on terraces and plains. This soil series is not listed as hydric or known to contain hydric inclusions by NRCS (USDA 2022b).

Wetland 1-D soil characteristics generally consist of a thick layer (5 to 18 inches) of black mucky loam. The mucky loam contained low chroma (less than 1) with partially decomposed organic material and fragments of slightly decomposed wood indicative of extended periods of inundation. Soils below the thick black layer varied and generally consisted of redox concentrations within a layer of depleted higher-permeability gravelly, sandy loam. A layer of split-matrix, depleted gravelly, silty sandy loam was present in one soil plot. The wetland boundary corresponded with a clear topographic shift and a change in soils from black mucky loam to gravelly sandy loam in the surrounding upland. Data plot soils are presented in the field data forms in Appendix B.

4.2.3 Hydrology

Wetland 1-D is hydrologically supported through a seasonal high water table, precipitation, and runoff from the adjacent uplands. Approximately 4 to 8 inches of inundation was observed throughout most of Wetland 1-D at the time of the field visits. It is likely that Wetland 1-D is hydrologically connected to Edmond Marsh through groundwater due to the seasonal high water table; however, a direct surface water connection to Edmond Marsh was not observed. Primary wetland hydrology indicators included

High Water Table (A2), Saturation (A3), Iron Deposits (B5), and Water-Stained Leaves (B9). Secondary indicators of wetland hydrology include Geomorphic Position (D2) and FAC-Neutral Test (D5). The presence of these indicators satisfies the wetland hydrology criteria of the 2010 Regional Supplement (USACE 2010). Data plot hydrology is presented in the field data forms in Appendix B. Based on existing data and field observations, the primary water regime of Wetland 1-D was determined to be primarily seasonally flooded with a small outer band of saturated only.

4.2.4 Wetland Function Scores and Rating

Wetland 1-D was rated as a Category II wetland, with a score of 8 for water quality functions, a score of 5 for hydrologic functions, and a score of 7 for habitat functions. The ratings are discussed in more detail in the following subsections, and the wetland rating form for Wetland 1-D is provided in Appendix C.

4.2.4.1 Improving Water Quality Functions

Overall Wetland 1-D has high and moderate functions for improving water quality. Factors that contribute to this function rating include the absence of an outlet, the amount of persistent vegetation and seasonal ponding, moderate potential for pollutants to enter the wetland, and the high potential to improve water quality functions within the basin for society.

4.2.4.2 Hydrologic Functions

Wetland 1-D has moderate and low hydrologic functions. Factors that contribute to this function include the absence of an outlet, moderate storage depth, low storage potential within the watershed, moderate potential for pollutants to enter the wetland, and a lack of flooding issues in close proximity downstream of the wetland.

4.2.4.3 Habitat Functions

Wetland 1-D has moderate and high habitat functions. Factors that contribute to the function include the presence of multiple plant community layers and hydroperiods, moderate plant species richness, low invasive species cover, a moderate amount of accessible and undisturbed surrounding habitat, and multiple special and priority habitat features.

5 Deviation from National Wetlands Inventory or Priority Habitats and Species Maps

The delineated locations of Edmond Marsh and Wetland 1-D generally correspond to one large PFO and PSS wetland (Table 3) and shown on the NWI map (Figure 6) and the mapped PHS resource (Table 4) in the study area. The maps do not distinguish between the main Edmond Marsh area and the smaller depressional Wetland 1-D to the north. The NWI map units even extend into a housing development north of Wetland 1-D.

Table 3
Mapped NWI with Delineated Wetlands Within the Study Area

Wetland/Other Water	NWI Code	NWI Code Description
Edmond Marsh	PFOC	Palustrine forested wetland with a seasonally flooded water regime
	PFOA	Palustrine forested wetland with a temporarily flooded water regime
	PSSC	Palustrine scrub-shrub wetland with a seasonally flooded water regime
	PSSF	Palustrine emergent, persistent wetland with a semipermanently flooded water regime
Wetland 1-D	PFOA	Palustrine forested wetland with a temporarily flooded water regime
	PSSA	Palustrine scrub-shrub wetland with a temporarily flooded water regime

Table 4
PHS Resources Within the Study Area

Common Name	Scientific Name	Location in Study Area
Coho salmon	*Oncorhynchus kisutch*	Sequalitchew Creek
Cutthroat trout	*Oncorhynchus clarkii*	Sequalitchew Creek
Big brown bat	*Eptesicus fuscus*	Vicinity
Little brown bat	*Myotis lucifugus*	Vicinity
Yuma myotis	*Myotis yumanensis*	Vicinity
Waterfowl concentrations	N/A	Vicinity
Freshwater forested/shrub wetlands	N/A	Vicinity
Wetlands	N/A	Vicinity

6 Mapping Method

Wetland boundary and data plot locations for Edmond Marsh and Wetland 1-D were plotted in the field using World Geodetic System 1984 datum. GPS points were plotted on a base map in ArcGIS to create the wetland delineation map shown on Figure 7. Much of the wetland has a very abrupt boundary based on topography or a change in vegetation from wetland vegetation to upland forested vegetation.

7 City of DuPont Wetland Buffer Guidance

Required wetland buffers have been identified according to the current DMC Chapter 25.105.050 (City of DuPont 2022). The DMC identifies minimum protective buffer widths based on the wetland category, per the 2014 Ecology rating system (Hruby 2014). Table 5 summarizes DMC ratings and buffer widths based on the 2014 Ecology rating system. Wetland boundaries with associated buffers are shown on Figure 7.

Table 5
Wetland Rating and Standard Buffer Widths

Wetland	2014 State Rating (Ecology)	Local Rating (City of DuPont)	Buffer Width (feet)[1]
Edmond Marsh	II	II	100
Wetland 1-D	II	II	100

Source: City of DuPont 2022

8 Results and Conclusions

Anchor QEA wetland biologists delineated two wetlands (Edmond Marsh and Wetland 1-D) in the study area during site visits on April 18, 19, and 20, 2022 (Figure 7). The total area of wetlands was estimated to be 5,900,202 square feet (135.45 acres). Both Edmond Marsh and Wetland 1-D are Category II wetlands and provide moderate to high water quality, hydrologic, and habitat functions.

9 Wetland Delineation and Typing Limitations

Wetland identification is an inexact science, and differences of professional opinion occasionally occur between trained individuals. Final determinations for wetland boundaries and typing concurrence or adjustments to these are the responsibility of the regulating resource agency. Wetlands are, by definition, transitional areas; their boundaries can be altered by changes in hydrology or land use. In addition, the definition of jurisdictional wetlands may change. If a physical change occurs in the basin, or if 3 years pass before the proposed project is undertaken, another wetland survey should be conducted. The results and conclusions expressed herein represent Anchor QEA's professional judgment based on the information available.

10 References

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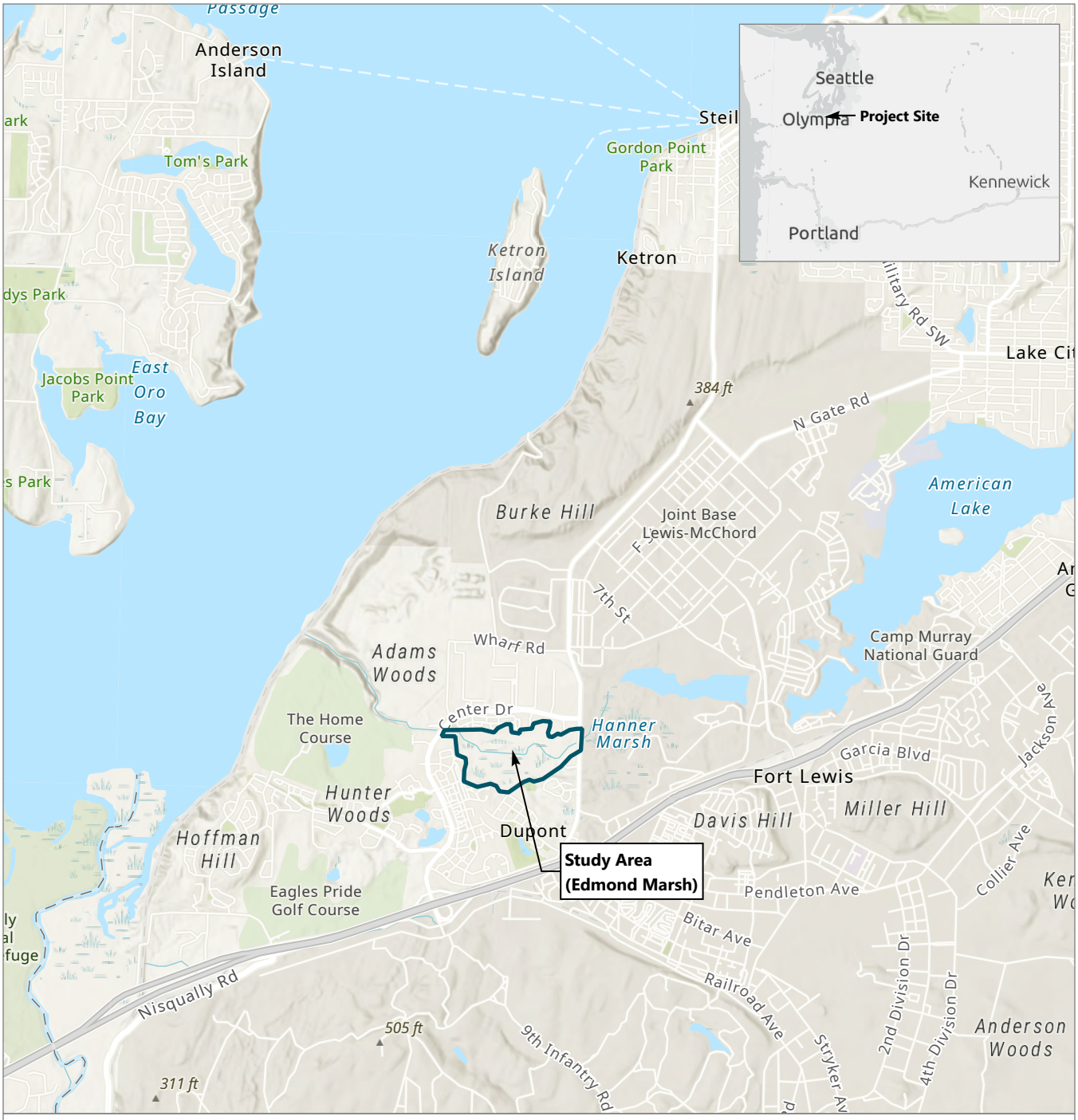
Figures



LEGEND:

Study Area

NOTE:

1. Basemap provided by Esri streaming services.

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ANCHOR QEA

Figure 1
Vicinity Map
Wetland Delineation Report
Edmond Marsh

LEGEND:

- Study Area
- Tax Parcel Within Study Area
- Tax Parcels

NOTE:

1. Basemap provided by USGS Topographic Maps, Fort Lewis, WA and Nisqually, WA quadrangles. Sourced by Esri streaming services.

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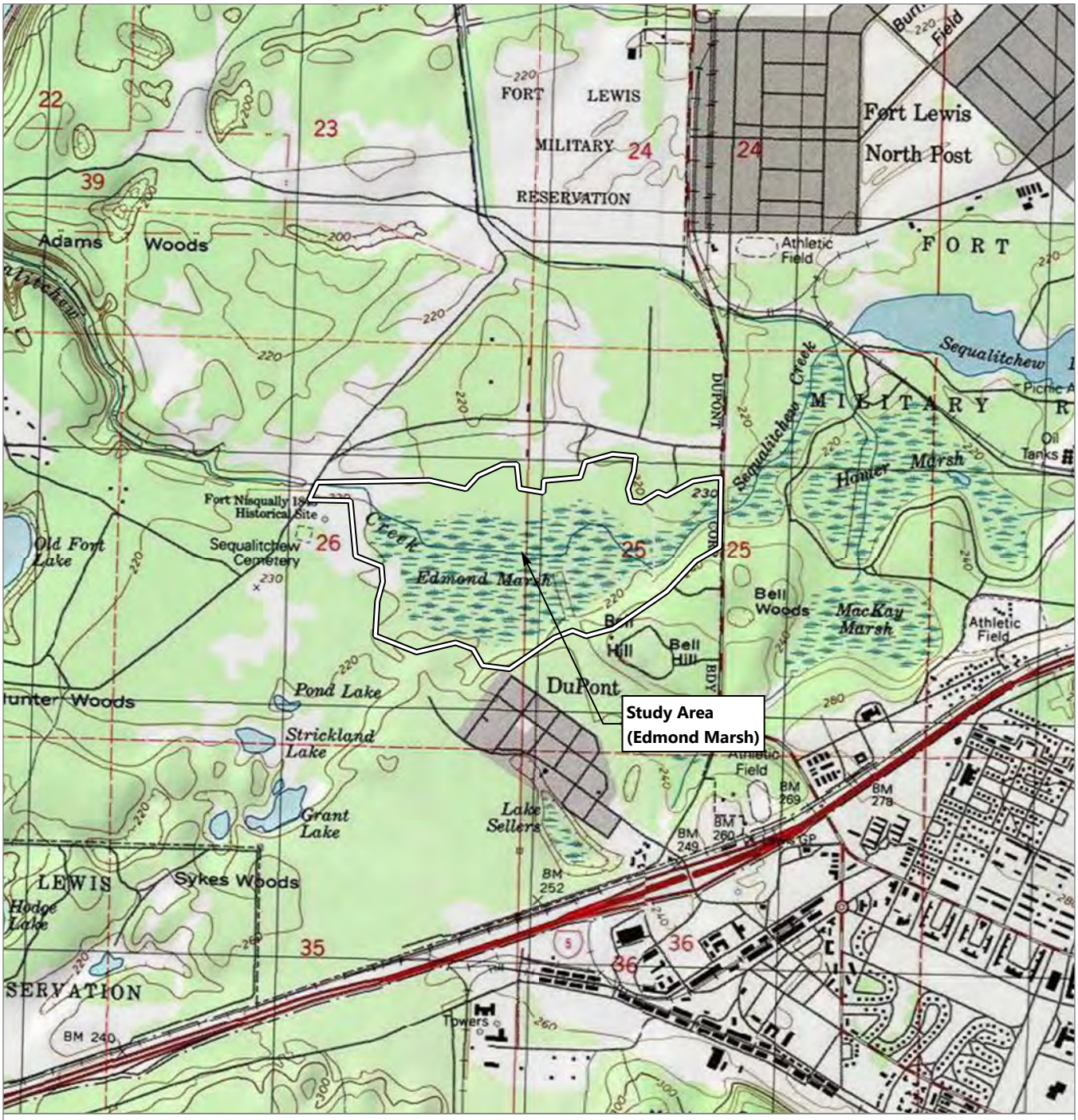
ANCHOR QEA

Figure 2
Tax Parcel Map
Wetland Delineation Report
Edmond Marsh



LEGEND:

Study Area

NOTE:

1. Basemap provided by USGS Topographic Maps, Fort Lewis, WA and Nisqually, WA quadrangles. Sourced by Esri streaming services.

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ANCHOR QEA

Figure 3
Study Area
Wetland Delineation Report
Edmond Marsh

LEGEND:

Study Area

NOTE:
1. Basemap provided by Esri streaming services. Aerial imagery collected April 2021.

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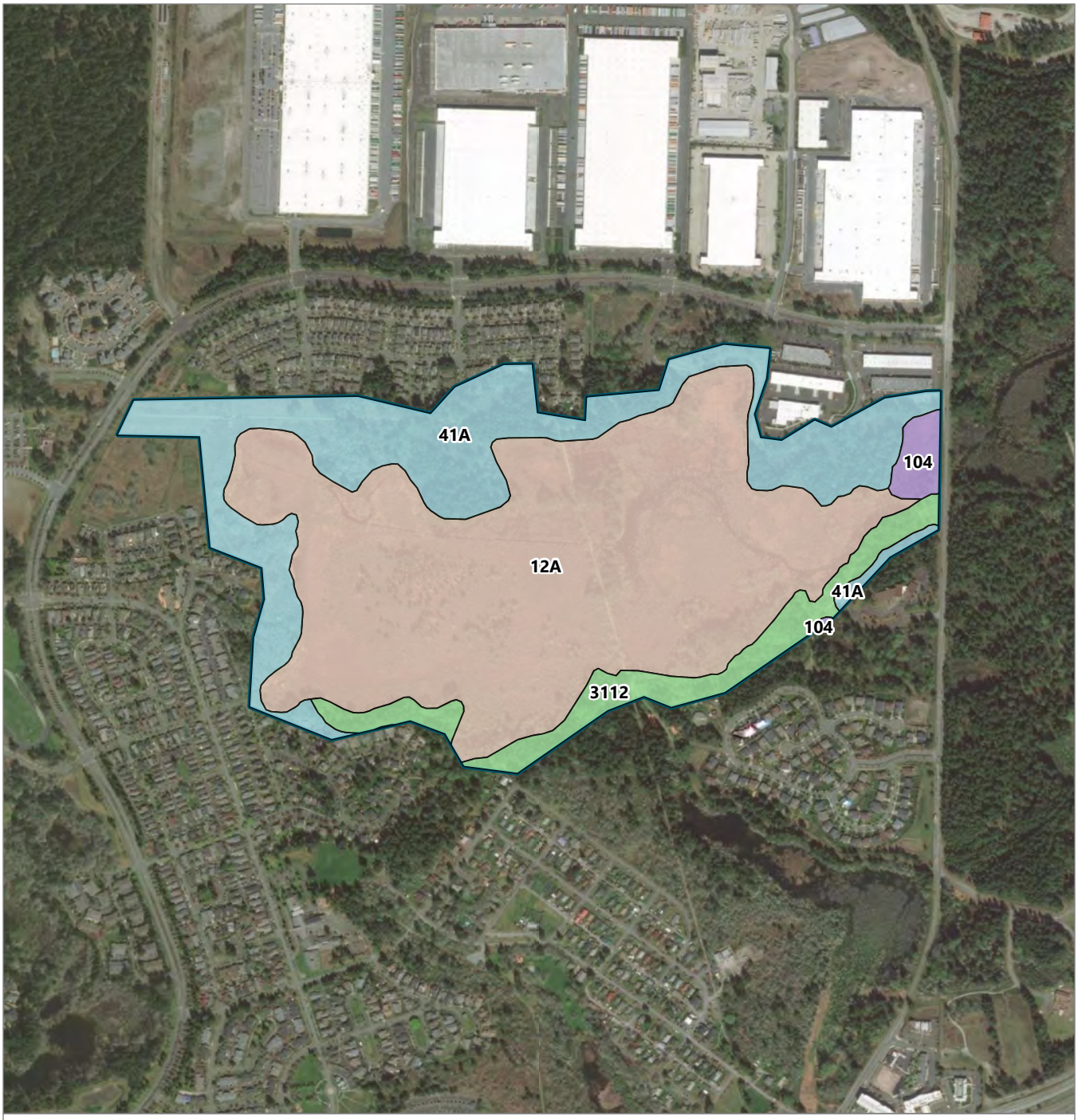
ANCHOR QEA

Figure 4
Current Conditions and Land Use of the Study Area
Wetland Delineation Report
Edmond Marsh



LEGEND:

NRCS Soils

- Semiahmoo muck, 0 to 1 percent slopes (104)
- Spanaway gravelly sandy loam (41A)
- Dupont muck (12A)
- Everett-Spanaway-Spana complex, 0 to 30 percent slopes (3112)

Study Area

NOTES:
1. Basemap provided by Esri streaming services.
2. Soil data from US Department of Agriculture NRCS Soils.

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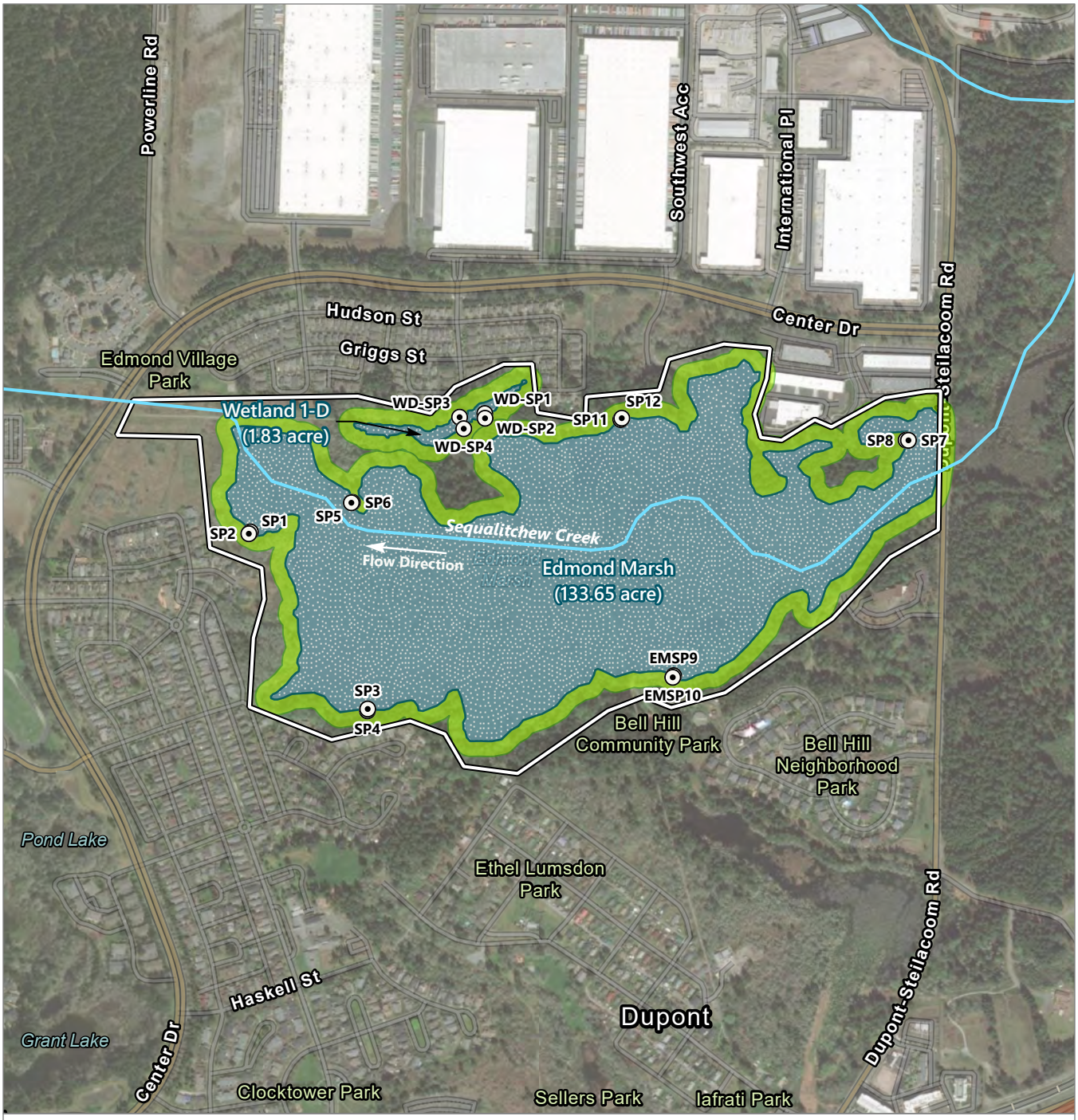
ANCHOR QEA

Figure 5
NRCS Soil Map
Wetland Delineation Report
Edmond Marsh



LEGEND:

- Soil Plot Location
- Study Area
- Wetland
- 100-foot Wetland Buffer
- Streams

NOTES:

1. Basemap provided by Esri streaming services.
2. Streams from NHD.
3. Tax Parcels from Pierce County GIS.
4. Flow direction arrow indicates flow direction of Sequalitchew Creek.

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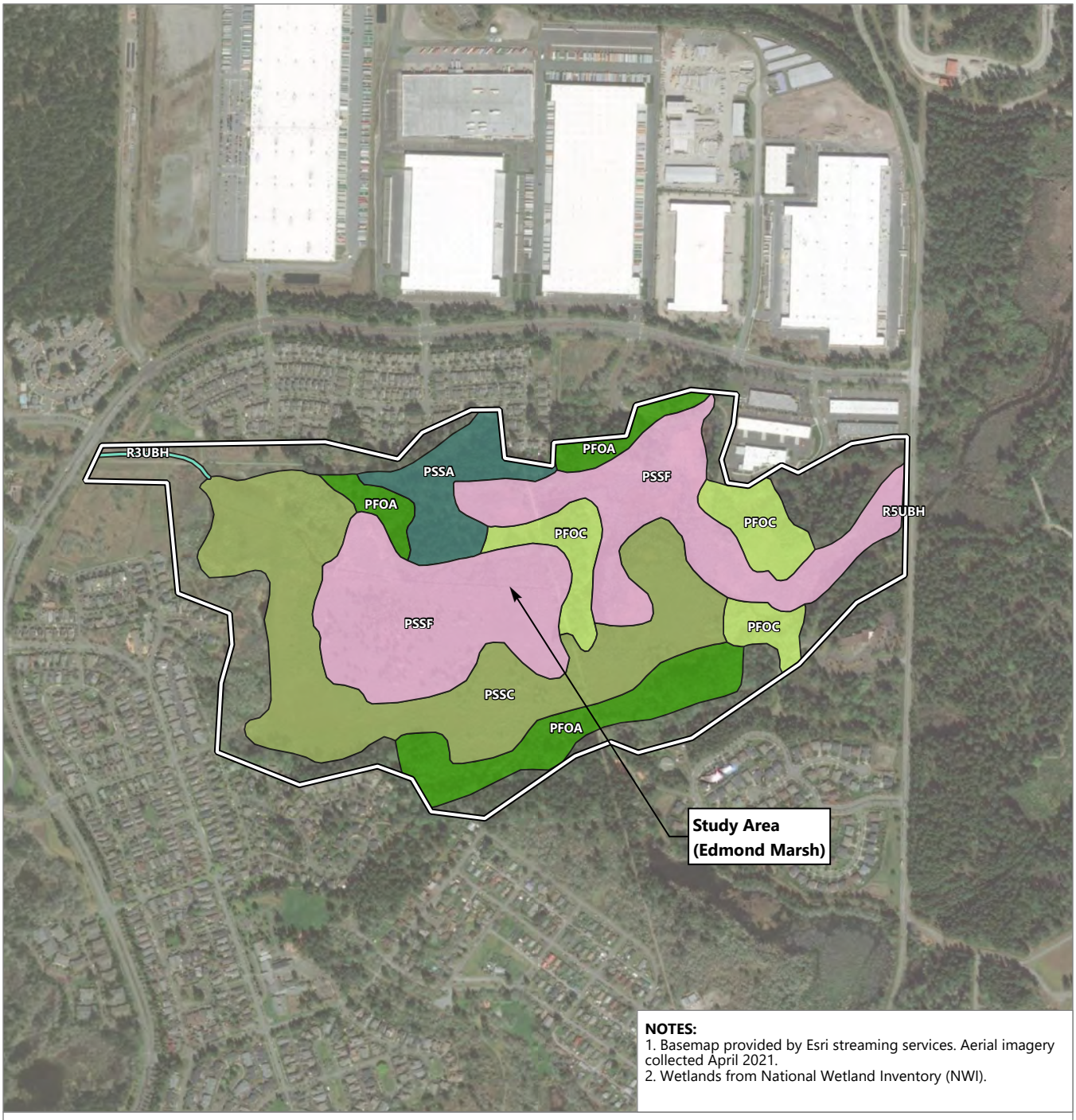
ANCHOR QEA

Figure 6
Wetland Delineation Map
Wetland Delineation Report
Edmond Marsh



NOTES:
1. Basemap provided by Esri streaming services. Aerial imagery collected April 2021.
2. Wetlands from National Wetland Inventory (NWI).

LEGEND:

- Study Area

NWI Wetlands

- Palustrine Forested Wetland, Temporarily Flooded (PFOA)
- Palustrine Forested Wetland, Seasonally Flooded (PFOC)
- Palustrine Scrub-Shrub Wetland, Temporarily Flooded (PSSA)
- Palustrine Scrub-Shrub Wetland, Seasonally Flooded (PSSC)
- Palustrine Scrub-Shrub Wetland, Semipermanently Flooded (PSSF)
- Riverine, Upper Perennial, Unconsolidated Bottom, Permanently Flooded (R3UBH)
- Riverine, Unknown Perennial, Unconsolidated Bottom, Permanently Flooded (R5UBH)

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ANCHOR QEA

Figure 7
National Wetland Inventory Map
Wetland Delineation Report
Edmond Marsh

Appendix A
Precipitation Data

WETS Table

WETS Station: OLYMPIA AP, WA								
Requested years: 1971 - 2022								
Month	Avg Max Temp	Avg Min Temp	Avg Mean Temp	Avg Precip	30% chance precip less than	30% chance precip more than	Avg number days precip 0.10 or more	Avg Snowfall
Jan	45.8	32.5	39.1	7.79	5.27	9.31	14	3.0
Feb	49.0	32.3	40.7	5.49	3.58	6.60	12	2.5
Mar	53.9	34.3	44.1	5.39	3.91	6.36	13	0.6
Apr	59.1	36.8	48.0	3.50	2.46	4.15	9	0.1
May	65.8	42.4	54.1	2.30	1.33	2.80	7	0.0
Jun	71.0	47.0	59.0	1.66	1.00	2.02	5	0.0
Jul	77.4	50.2	63.8	0.65	0.25	0.76	2	0.0
Aug	78.0	50.2	64.1	1.01	0.31	1.18	3	0.0
Sep	72.0	45.8	58.9	2.17	1.00	2.53	5	0.0
Oct	60.5	39.9	50.2	4.67	2.78	5.67	9	0.0
Nov	50.4	35.6	43.0	8.25	5.70	9.83	15	0.9
Dec	44.7	32.3	38.5	7.85	5.84	9.19	14	2.1
Annual:					45.96	54.70		
Average	60.6	39.9	50.3	-	-	-	-	-
Total	-	-	-	50.75			106	9.3

GROWING SEASON DATES			
Years with missing data:	24 deg = 1	28 deg = 1	32 deg = 1
Years with no occurrence:	24 deg = 0	28 deg = 0	32 deg = 0
Data years used:	24 deg = 51	28 deg = 51	32 deg = 51
Probability	24 F or higher	28 F or higher	32 F or higher
50 percent *	2/28 to 11/23: 268 days	4/13 to 10/28: 198 days	5/4 to 10/10: 159 days
70 percent *	2/19 to 12/3: 287 days	4/6 to 11/4: 212 days	4/29 to 10/15: 169 days
* Percent chance of the growing season occurring between the Beginning and Ending dates.			

STATS TABLE - total precipitation (inches)													
Yr	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annl
1941					M2.11	0.93	0.33	2.49	4.26	2.74	5.16	8.25	26.27
1942	4.09	3.38	2.63	1.16	1.38	2.59	1.53	0.11	0.10	3.78	11.33	5.31	37.39
1943	2.65	3.41	6.09	3.08	1.47	1.60	0.53	1.27	0.39	4.59	2.04	3.62	30.74
1944	4.13	2.82	1.90	3.25	1.33	0.46	T	0.50	2.37	2.87	4.81	2.06	26.50
1945	4.93	6.60	4.09	2.10	2.73	0.08	0.19	0.65	3.19	2.46	7.30	6.88	41.20
1946	6.30	6.12	4.11	2.73	0.54	4.09	1.06	0.12	2.26	4.92	5.88	5.91	44.04
1947	5.88	3.87	2.90	2.15	0.28	2.34	2.14	0.47	1.73	6.66	3.79	5.74	37.95
1948	5.87	7.64	4.69	4.78	5.83	1.35	1.10	2.27	3.92	4.35	10.19	12.11	64.10
1949	0.69	9.96	3.75	1.52	1.54	0.72	0.51	0.82	1.	5.	12.	10.	49.

									39	24	33	73	20
1950	9.31	9.66	10.13	3.10	0.79	0.86	1.35	1.47	2.19	9.20	9.49	9.16	66.71
1951	10.59	11.28	5.89	0.54	1.91	0.05	0.28	0.54	2.83	6.95	7.32	5.80	53.98
1952	5.65	3.96	3.13	2.25	0.85	1.22	0.10	0.74	0.43	1.55	1.39	8.65	29.92
1953	19.84	5.12	3.55	2.58	2.72	1.50	0.27	1.63	2.68	6.85	7.79	9.42	63.95
1954	11.96	8.40	3.13	4.07	1.63	3.36	0.82	1.74	1.89	3.38	7.87	6.99	55.24
1955	3.01	5.23	4.76	4.19	1.35	0.71	2.68	0.02	1.84	9.31	12.18	12.59	57.87
1956	10.75	3.93	8.27	0.37	0.30	2.57	0.38	0.88	2.30	9.52	2.81	9.36	51.44
1957	3.02	5.88	7.43	1.72	1.42	1.78	0.97	0.87	0.66	4.74	4.05	8.91	41.45
1958	7.87	6.40	2.29	4.39	1.47	1.65	T	0.62	1.52	5.41	12.35	8.43	52.40
1959	8.91	4.53	4.63	4.51	1.45	1.85	0.30	0.70	4.26	3.92	10.36	7.50	52.92
1960	6.35	5.93	6.12	4.53	3.50	0.59	T	1.16	1.21	5.84	11.33	3.89	50.45
1961	8.69	13.18	6.26	3.29	2.93	1.05	0.80	1.01	0.33	4.97	6.78	8.25	57.54
1962	3.22	3.72	3.82	4.50	1.81	0.89	0.14	3.17	2.45	6.00	15.51	5.81	51.04
1963	3.47	6.42	5.10	4.13	1.76	0.63	1.48	0.79	2.16	5.98	10.32	5.55	47.79
1964	15.13	2.54	4.47	1.58	0.98	2.35	1.07	1.47	2.26	1.79	9.18	9.11	51.93
1965	9.37	4.93	0.48	3.61	1.89	0.33	0.48	2.05	0.60	3.30	5.84	7.81	40.69
1966	7.89	3.38	7.28	1.71	1.30	1.28	1.34	0.68	1.95	4.83	8.16	11.53	51.33
1967	12.21	3.58	4.31	2.88	0.25	1.49	0.02	T	1.36	10.08	3.90	5.94	46.02
1968	9.04	7.83	6.53	3.02	2.57	2.43	0.89	5.45	2.51	6.07	7.96	9.95	64.25
1969	9.45	3.41	2.90	3.44	2.07	1.68	0.50	0.18	5.23	2.69	3.60	7.24	42.39
1970	12.48	4.30	3.07	4.76	1.21	0.14	0.16	0.15	3.20	2.71	7.40	14.32	53.90
1971	11.15	4.41	9.11	2.78	1.50	3.00	0.78	0.71	3.06	4.43	7.59	9.18	57.70
1972	12.43	11.06	10.01	5.87	0.83	1.07	1.72	0.70	5.04	0.85	4.17	10.66	64.41
1973	5.66	1.71	3.02	2.23	2.66	2.60	0.05	0.59	2.18	4.60	12.95	11.61	49.86
1974	10.57	5.68	6.65	4.77	2.65	1.57	2.29	0.07	0.50	1.38	7.44	8.86	52.43
1975	9.70	5.61	4.32	1.88	1.51	0.72	0.25	3.97	T	8.38	9.54	11.42	57.30
1976	9.40	7.25	4.24	2.79	2.66	1.07	1.26	2.71	1.22	2.64	1.37	3.00	39.61
1977	1.55	3.70	4.44	1.27	5.21	0.64	0.32	4.17	4.58	3.40	9.30	12.36	50.94
1978	6.61	4.39	3.45	3.97	2.90	1.54	1.49	1.47	7.59	0.78	6.81	2.95	43.95
1979	2.67	9.25	2.73	2.21	1.40	1.11	1.58	1.56	2.72	6.20	2.38	13.01	46.82
1980	6.27	6.18	3.98	4.14	0.93	2.46	0.41	0.36	2.21	1.84	9.77	10.92	49.47
1981	2.54	9.19	3.86	4.77	1.81	2.96	0.36	0.85	2.44	8.17	7.22	8.60	52.77
1982	7.79	9.91	4.67	3.89	0.51	1.15	0.54	0.55	1.89	6.12	5.74	10.64	53.40
1983	9.99	7.09	6.63	2.26	1.51	2.80	3.00	2.18	1.	1.	12.	7.28	59.

									89	66	84		13
1984	6.97	5.49	6.42	3.67	5.48	3.74	T	0.21	1.76	5.13	12.19	4.97	56.03
1985	0.29	3.54	4.10	2.65	0.94	2.48	0.37	0.70	2.65	9.86	4.99	2.50	35.07
1986	12.14	6.84	2.29	2.87	3.20	0.92	1.11	0.01	3.38	4.12	11.09	5.20	53.17
1987	8.38	3.55	7.14	3.11	2.71	0.32	0.84	0.24	0.29	0.39	3.65	9.14	39.76
1988	5.18	2.35	5.66	4.94	3.36	2.06	0.42	0.43	1.93	2.26	10.14	5.16	43.89
1989	5.41	4.19	7.88	2.49	1.99	1.47	0.70	0.55	0.49	2.42	8.50	5.66	41.75
1990	14.53	8.52	3.54	3.29	2.06	2.86	0.32	1.79	0.03	6.34	15.06	5.05	63.39
1991	5.35	5.85	4.32	7.80	1.69	1.30	0.33	2.31	T	2.20	7.00	4.28	42.43
1992	9.45	4.19	1.50	5.15	0.19	1.15	0.36	0.82	2.44	2.80	6.82	5.28	40.15
1993	5.36	0.22	4.95	6.67	4.57	1.77	1.35	0.15	T	1.63	2.86	6.02	35.55
1994	3.80	6.38	4.83	1.82	1.44	1.90	0.29	0.80	1.52	7.65	7.75	11.49	49.67
1995	5.76	6.10	6.73	2.70	1.16	1.10	1.71	1.22	1.97	5.20	13.56	7.69	54.90
1996	M7.22	11.07	2.65	7.61	3.14	1.14	0.71	0.42	2.21	5.46	6.25	M11.40	59.28
1997	9.22	5.03	11.79	4.80	3.10	2.94	1.18	2.45	4.57	8.18	6.07	5.50	64.83
1998	10.43	5.04	5.71	1.21	2.11	1.29	0.18	T	0.31	3.41	15.28	12.99	57.96
1999	12.25	15.50	6.95	1.42	1.54	1.84	0.58	0.69	0.12	3.85	11.93	9.97	66.64
2000	8.13	5.83	5.09	2.40	3.28	2.51	0.06	0.41	1.98	4.27	3.64	3.88	41.48
2001	3.45	2.60	3.84	3.49	1.92	2.63	0.18	2.28	0.53	3.98	13.31	11.86	50.07
2002	11.42	4.32	5.24	4.02	2.04	1.59	0.35	0.10	0.59	0.46	3.96	7.39	41.48
2003	9.60	2.17	7.62	4.72	1.14	0.28	0.14	0.34	1.17	10.72	8.67	5.99	52.56
2004	7.85	2.95	2.83	1.33	2.00	0.93	0.03	3.93	3.88	4.63	3.76	5.30	39.42
2005	5.86	1.01	6.17	4.14	4.06	1.64	0.93	0.19	1.76	5.72	7.21	8.88	47.57
2006	15.86	3.44	3.57	1.89	2.36	1.64	0.15	0.13	0.69	1.43	19.68	9.10	59.94
2007	6.04	5.52	7.00	2.33	1.22	1.30	1.85	0.67	2.24	4.88	4.04	11.71	48.80
2008	6.69	4.01	4.83	2.33	0.48	1.41	0.42	1.86	0.27	3.36	9.36	5.05	40.07
2009	8.58	1.60	5.75	3.13	4.68	0.22	0.15	1.22	2.49	5.32	10.08	4.58	47.80
2010	6.78	4.53	5.07	3.34	4.14	3.34	0.16	0.51	5.79	6.21	6.20	9.35	55.42
2011	7.27	4.46	9.00	4.11	4.16	0.67	1.42	0.25	1.62	4.26	8.78	4.69	50.69
2012	8.72	5.01	8.57	4.35	2.73	2.31	0.90	0.04	T	8.07	9.15	9.74	59.59
2013	3.91	4.04	3.88	4.52	3.21	1.86	T	1.84	9.36	2.13	4.69	2.02	41.46
2014	4.69	8.35	9.17	4.26	3.34	0.88	0.27	1.45	3.07	6.91	6.12	6.00	54.51
2015	6.68	5.28	5.94	1.92	0.67	0.14	0.15	2.84	0.90	6.68	11.82	14.50	57.52
2016	8.47	6.67	8.51	1.58	0.15	1.24	0.62	0.40	1.73	12.43	9.28	6.39	57.47
2017	3.82	9.18	11.35	5.53	3.07	1.33	0.05	0.11	1.	6.	12.	6.90	61.

									24	58	28		44
2018	9.87	3.63	2.59	7.24	0.24	0.88	0.07	0.17	2.06	4.34	5.89	8.34	45.32
2019	4.88	5.16	1.39	2.68	0.90	0.17	1.23	0.80	3.43	5.26	1.74	9.44	37.08
2020	15.56	3.38	3.35	1.40	2.87	2.24	0.18	0.37	3.33	4.04	9.07	7.32	53.11
2021	12.22	7.84	3.01	0.92	1.81	3.30	0.00	0.01	3.31	5.39	11.88	9.11	58.80
2022	10.78	5.37	3.07	5.35	4.33	3.04	0.09	M0.05					32.08

Notes: Data missing in any month have an "M" flag. A "T" indicates a trace of precipitation.

Data missing for all days in a month or year is blank.

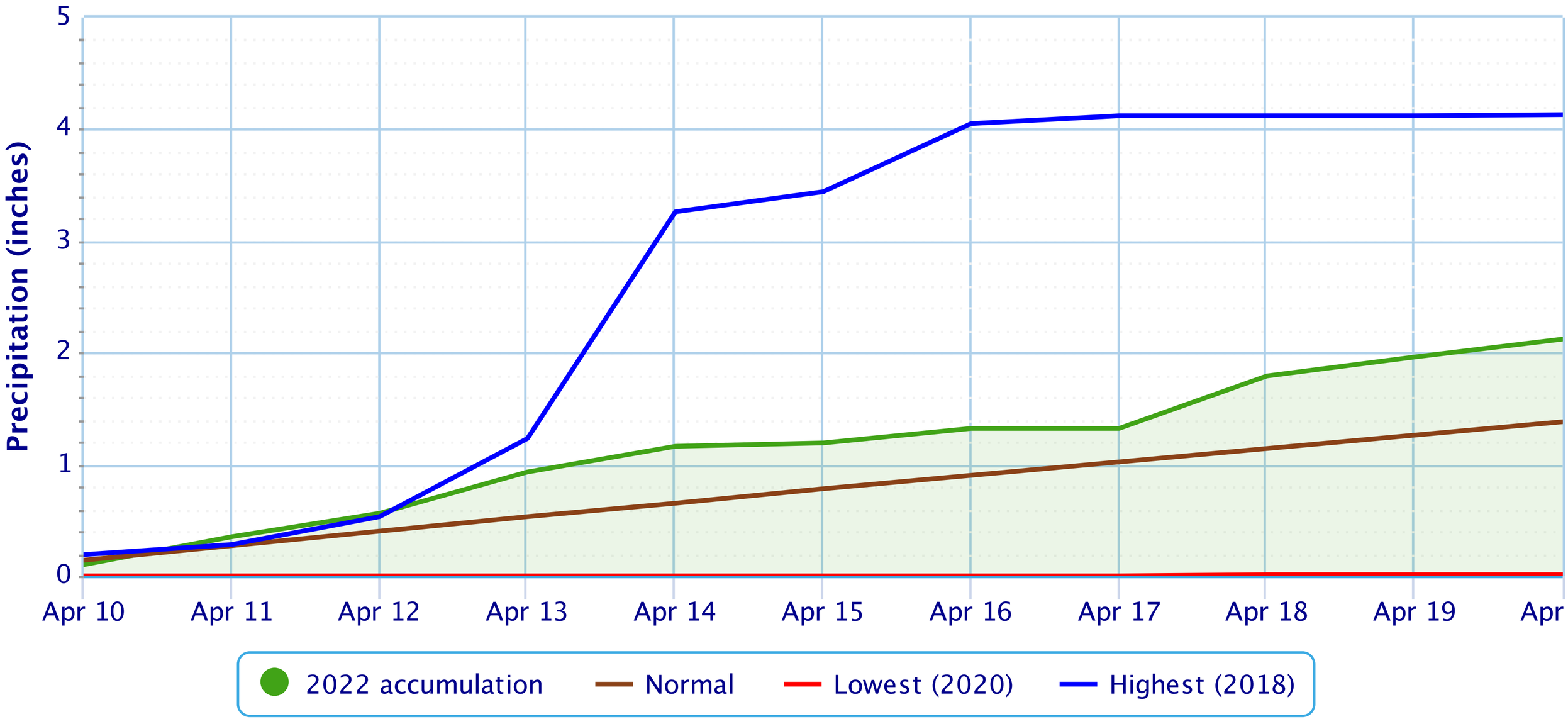
Creation date: 2022-08-29

Almanac for OLYMPIA AP, WA
April 20, 2022

Daily Data	Observed	----	Normal	Record Highest	Record Lowest
Max Temperature	51		60	83 in 2016	44 in 2008
Min Temperature	32		38	50 in 1965	26 in 1951
Avg Temperature	41.5		48.8	63.5 in 2016	36.5 in 2008
Precipitation	0.16		0.12	0.71 in 1960	0.00 in 2021
Snowfall	M		0.0	T in 1960	0.0 in 2021
Snow Depth	M		-	0 in 2021	0 in 2021
HDD (base 65)	23		16	28 in 2008	1 in 2016
CDD (base 65)	0		0	0 in 2022	0 in 2022
Month-to-Date Summary	Observed	----	Normal	Record Highest	Record Lowest
Avg Max Temperature	52.6		57.7	68.1 in 2016	51.4 in 2011
Avg Min Temperature	32.8		36.9	42.0 in 2019	31.4 in 1975
Avg Temperature	42.7		47.3	54.1 in 2016	42.7 in 2022
Total Precipitation	3.87		2.66	7.17 in 1991	0.01 in 1951
Total Snowfall	M		0.0	2.2 in 1972	0.0 in 2021
Max Snow Depth	M		-	T in 1970	0 in 2021
Total HDD (base 65)	441		354	443 in 1972	213 in 2016
Total CDD (base 65)	0		0	1 in 2016	0 in 2022
Year-to-Date Summary	Observed	----	Normal	Record Highest	Record Lowest
Avg Max Temperature	50.9		51.1	55.5 in 2015	44.9 in 1950
Avg Min Temperature	33.6		34.0	36.9 in 1958	29.4 in 1949
Avg Temperature	42.3		42.6	45.9 in 2015	37.3 in 1950
Total Precipitation	23.09		21.23	38.26 in 1972	8.43 in 1985
Total Snowfall (since July 1)	T		3.9	81.5 in 1969	0.0 in 2008
Max Snow Depth (since July 1)	0		-	24 in 1969	0 in 2021
Total HDD (since July 1)	4582		4712	5470 in 1949	3898 in 2015
Total CDD (since Jan 1)	0		0	1 in 2016	0 in 2022

Accumulated Precipitation - OLYMPIA AP, WA

Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



Powered by ACIS

Climatological Data for OLYMPIA AP, WA - January 2022

Date	Max Temperature	Min Temperature	Avg Temperature	GDD Base 40	GDD Base 50	Precipitation	Snowfall	Snow Depth
2022-01-01	36	7	21.5	0	0	0.00	M	M
2022-01-02	44	35	39.5	0	0	1.15	M	M
2022-01-03	44	30	37.0	0	0	0.89	M	M
2022-01-04	41	33	37.0	0	0	0.17	M	M
2022-01-05	40	34	37.0	0	0	0.58	M	M
2022-01-06	53	34	43.5	4	0	3.99	M	M
2022-01-07	50	37	43.5	4	0	0.78	M	M
2022-01-08	47	29	38.0	0	0	T	M	M
2022-01-09	48	28	38.0	0	0	0.00	M	M
2022-01-10	51	27	39.0	0	0	0.20	M	M
2022-01-11	54	48	51.0	11	1	1.14	M	M
2022-01-12	61	41	51.0	11	1	0.80	M	M
2022-01-13	56	39	47.5	8	0	0.36	M	M
2022-01-14	54	38	46.0	6	0	0.00	M	M
2022-01-15	45	39	42.0	2	0	0.00	M	M
2022-01-16	44	42	43.0	3	0	0.00	M	M
2022-01-17	52	40	46.0	6	0	0.00	M	M
2022-01-18	53	42	47.5	8	0	0.01	M	M
2022-01-19	53	41	47.0	7	0	0.03	M	M
2022-01-20	55	35	45.0	5	0	0.29	M	M
2022-01-21	50	36	43.0	3	0	0.00	M	M
2022-01-22	48	36	42.0	2	0	0.00	M	M
2022-01-23	42	39	40.5	1	0	0.00	M	M
2022-01-24	41	35	38.0	0	0	0.00	M	M
2022-01-25	42	37	39.5	0	0	0.00	M	M
2022-01-26	43	32	37.5	0	0	0.00	M	M
2022-01-27	49	26	37.5	0	0	0.00	M	M
2022-01-28	56	24	40.0	0	0	0.00	M	M
2022-01-29	56	29	42.5	3	0	0.02	M	M
2022-01-30	51	37	44.0	4	0	0.33	M	M
2022-01-31	49	32	40.5	1	0	0.04	M	M
Average|Sum	48.6	34.3	41.5	89	2	10.78	M	M

Climatological Data for OLYMPIA AP, WA - February 2022

Date	Max Temperature	Min Temperature	Avg Temperature	GDD Base 40	GDD Base 50	Precipitation	Snowfall	Snow Depth
2022-02-01	44	26	35.0	0	0	0.00	M	M
2022-02-02	42	25	33.5	0	0	0.00	M	M
2022-02-03	49	41	45.0	5	0	0.04	M	M
2022-02-04	47	39	43.0	3	0	0.07	M	M
2022-02-05	49	29	39.0	0	0	0.00	M	M
2022-02-06	43	30	36.5	0	0	0.00	M	M
2022-02-07	51	33	42.0	2	0	0.01	M	M
2022-02-08	48	32	40.0	0	0	0.00	M	M
2022-02-09	54	34	44.0	4	0	0.00	M	M
2022-02-10	47	33	40.0	0	0	0.00	M	M
2022-02-11	51	29	40.0	0	0	0.00	M	M
2022-02-12	56	26	41.0	1	0	0.00	M	M
2022-02-13	61	23	42.0	2	0	0.00	M	M
2022-02-14	49	31	40.0	0	0	0.35	M	M
2022-02-15	52	29	40.5	1	0	0.00	M	M
2022-02-16	52	29	40.5	1	0	0.00	M	M
2022-02-17	48	28	38.0	0	0	0.00	M	M
2022-02-18	50	36	43.0	3	0	0.00	M	M
2022-02-19	47	39	43.0	3	0	0.03	M	M
2022-02-20	50	35	42.5	3	0	T	M	M
2022-02-21	44	32	38.0	0	0	0.04	M	M
2022-02-22	38	27	32.5	0	0	T	M	M
2022-02-23	40	14	27.0	0	0	0.00	M	M
2022-02-24	42	21	31.5	0	0	0.00	M	M
2022-02-25	48	16	32.0	0	0	0.00	M	M
2022-02-26	41	23	32.0	0	0	0.38	M	M
2022-02-27	50	39	44.5	5	0	1.33	M	M
2022-02-28	55	50	52.5	13	3	3.12	M	M
Average|Sum	48.1	30.3	39.2	46	3	5.37	M	M

Climatological Data for OLYMPIA AP, WA - March 2022

Date	Max Temperature	Min Temperature	Avg Temperature	GDD Base 40	GDD Base 50	Precipitation	Snowfall	Snow Depth
2022-03-01	59	43	51.0	11	1	0.45	M	M
2022-03-02	52	43	47.5	8	0	0.22	M	M
2022-03-03	51	35	43.0	3	0	0.02	M	M
2022-03-04	52	34	43.0	3	0	0.15	M	M
2022-03-05	53	30	41.5	2	0	0.00	M	M
2022-03-06	53	28	40.5	1	0	0.00	M	M
2022-03-07	50	29	39.5	0	0	0.00	M	M
2022-03-08	47	42	44.5	5	0	0.08	M	M
2022-03-09	49	23	36.0	0	0	0.00	M	M
2022-03-10	48	21	34.5	0	0	0.00	M	M
2022-03-11	58	34	46.0	6	0	0.00	M	M
2022-03-12	57	30	43.5	4	0	0.02	M	M
2022-03-13	53	38	45.5	6	0	0.28	M	M
2022-03-14	48	43	45.5	6	0	0.71	M	M
2022-03-15	54	40	47.0	7	0	0.34	M	M
2022-03-16	54	36	45.0	5	0	T	M	M
2022-03-17	52	36	44.0	4	0	0.01	M	M
2022-03-18	56	41	48.5	9	0	0.13	M	M
2022-03-19	52	37	44.5	5	0	0.27	M	M
2022-03-20	49	34	41.5	2	0	0.10	M	M
2022-03-21	48	41	44.5	5	0	0.17	M	M
2022-03-22	65	44	54.5	15	5	0.00	M	M
2022-03-23	56	36	46.0	6	0	0.08	M	M
2022-03-24	57	34	45.5	6	0	0.00	M	M
2022-03-25	60	37	48.5	9	0	0.00	M	M
2022-03-26	62	43	52.5	13	3	0.02	M	M
2022-03-27	66	41	53.5	14	4	0.00	M	M
2022-03-28	62	46	54.0	14	4	T	M	M
2022-03-29	55	39	47.0	7	0	0.00	M	M
2022-03-30	57	40	48.5	9	0	0.01	M	M
2022-03-31	56	34	45.0	5	0	0.01	M	M
Average|Sum	54.5	36.5	45.5	190	17	3.07	M	M

Appendix B
Wetland Determination Forms

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmond Marsh City/County: DuPont/Pierce County Sampling Date: 4/20/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: EMSP-9
Investigator(s): R. Mathonnet, G. Allen Section, Township, Range: T19-0N R1-0E S25
Landform (hillslope, terrace, etc.): Lowland Local relief (concave, convex, none): none Slope: 1%
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.101999 Long: -122.629508 Datum: NAD83
Soil Map Unit Name: Dupont muck NWI Classification: PFOA
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" Present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes **X** No
Hydric Soil Present? Yes **X** No
Wetland Hydrology Present? Yes **X** No

Is the Sampled Area within a Wetland? **Yes X** **No**

Remarks:
Lowland near East marsh south boundary

VEGETATION

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status?
1. *Alnus rubra*	85	Yes	FAC
2.			
3.			
4.			
5.			
50%= 42.5 20%= 17 Total Cover: **85**			
Sapling/Shrub Stratum (Plot size:)			
1. *Acer circinatum*	70	Yes	FAC
2. *Rubus spectabilis*	15	No	FAC
3.			
4.			
5.			
50%= 42.5 20%= 17 Total Cover: **85**			
Herb Stratum (Plot size:)			
1. *Maianthemum canadense*	95	Yes	FACU
2. *Maianthemum racemosum*	2	No	FAC
3. *Urtica dioica*	2	No	FAC
4.			
5.			
6.			
7.			
8.			
9.			
50%= 49.5 20%= 19.8 Total Cover: **99**			
Woody Vine Stratum (Plot size:)			
1.			
2.			
Total Cover: **0**			
% Bare Ground in Herb Stratum **1** % Cover of Biotic Crust			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **3** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **67%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x1 =	**0**
FACW species	**0**	x2 =	**0**
FAC species	**174**	x3 =	**522**
FACU species	**95**	x4 =	**380**
UPL species	**0**	x5 =	**0**
Column Totals:	**269** (A)		**902** (B)

Prevalence Index = B/A = **3.4**

Hydrophytic Vegetation Indicators:

- 1 - Rapid Test for Hydrophytic Vegetation
- **X** 2 - Dominance Test is >50%
- 3 - Prevalence Index is ≤3.0[1]
- 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
- 5 - Wetland Non-Vascular Plants[1]
- Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes X** **No**

Remarks:

SOIL

Sampling Point: EMSP-9

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 2/1	100					SiL	
6-8	10YR 2/2	100					SiL	
8-16	10YR 4/1	60	2.5Y 7/1	10	D	M	SiL	Moist, crumbly texture silty
8-16	10YR 5/1	30					SiL	Silty, blocky, crumbly friable soil texture

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- X Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Thick, dense roots

Depth (inches): 16

Hydric Soil Present? **Yes** X **No** ___

Remarks:
Refusal met a 16 inches due to thick roots, layer is permeable and does not perch water

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- X Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___

Water table Present? Yes ___ No X Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes X No ___ Depth (inches): 0-4 in.

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Saturation to 4 in., water seeping through sides above depleted layer

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmond Marsh City/County: DuPont/Pierce County Sampling Date: EMSP-10
Applicant/Owner: SPSSEG State: WA Sampling Point: 4/20/2022
Investigator(s): R. Mathonnet, G. Allen Section, Township, Range: T19-0N R1-0E S25
Landform (hillslope, terrace, etc.): gentle slope Local relief (concave, convex, none): convex Slope: 1-3
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.101969 Long: -122.62953 Datum: NAD83
Soil Map Unit Name: Everett-Spanaway-Spana complex NWI Classification: PFOA
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks)
Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" Present? Yes X No _____
Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No **X**	**Is the Sampled Area within a Wetland?** Yes _____ No **X**
Hydric Soil Present?	Yes _____	No **X**	
Wetland Hydrology Present?	Yes _____	No **X**	

Remarks:
Lowland south boundary near East Marsh

VEGETATION

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status?
1. *Acer macrophyllum*	65	Yes	FACU
2. *Thuja plicata*	50	Yes	FAC
3.			
4.			
5.			
50%= 57.5 20%= 23 Total Cover: **115**			
Sapling/Shrub Stratum (Plot size: _____)			
1. *Acer circinatum*	50	Yes	FAC
2. *Rubus spectabilis*	10	No	FAC
3. *Oemleria cerasiformis*	30	Yes	FACU
4. *Mahonia nervosa*	3	No	FACU
5.			
50%= 46.5 20%= 18.6 Total Cover: **93**			
Herb Stratum (Plot size: _____)			
1. *Polystichum munitum*	20	Yes	FACU
2. *Trillium ovatum*	5	No	FACU
3. *Maianthemum canadense*	10	Yes	FACU
4. *Maianthemum racemosum*	3	No	FAC
5. *Urtica dioica*	2	No	FAC
6.			
7.			
8.			
9.			
50%= 20 20%= 8 Total Cover: **40**			
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
Total Cover: **0**			
% Bare Ground in Herb Stratum **60** % Cover of Biotic Crust _____			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)
Total Number of Dominant Species Across All Strata: **6** (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: **33%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x1 =	**0**
FACW species	**0**	x2 =	**0**
FAC species	**115**	x3 =	**345**
FACU species	**133**	x4 =	**532**
UPL species	**0**	x5 =	**0**
Column Totals:	**248** (A)		**877** (B)

Prevalence Index = B/A = **3.5**

Hydrophytic Vegetation Indicators:

_____ 1 - Rapid Test for Hydrophytic Vegetation
_____ 2 - Dominance Test is >50%
_____ 3 - Prevalence Index is ≤3.0[1]
_____ 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
_____ 5 - Wetland Non-Vascular Plants[1]
_____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes _____ No **X**

Remarks:

SOIL

Sampling Point: EMSP-10

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 3/1	100					L	Large cobble

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Cobble

Depth (inches): 12

Hydric Soil Present? **Yes** _____ **No** **X**

Remarks:
Refusal at 12 in., cobble, fist to egg size, likely fill material from road prism, layer is permeable and does not perch water

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes _____ No **X** Depth (inches): _____

Water table Present? Yes _____ No **X** Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No **X** Depth (inches): _____

Wetland Hydrology Present? **Yes** _____ **No** **X**

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmonds Marsh City/County: DuPont/ Pierce County Sampling Date: 4/18/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: SP1
Investigator(s): R. Mathonnet, C. Douglas, G. Allen Section, Township, Range: T19-0N R1-0E S26
Landform (hillslope, terrace, etc.): gentle slope Local relief (concave, convex, none): none Slope: 1-3
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.104395 Long: -122.640693 Datum: NAD83
Soil Map Unit Name: Spanaway gravelly sandy loam NWI Classification: PSSC
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" Present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes **X** No
Hydric Soil Present? Yes **X** No
Wetland Hydrology Present? Yes **X** No

Is the Sampled Area within a Wetland? **Yes X** **No**

Remarks:
Soil plot located at southwestern edge of marsh.

VEGETATION

Tree Stratum (Plot size: 30 ft r)	Absolute % Cover	Dominant Species?	Indicator Status?
1.			
2.			
3.			
4.			
5.			
50%= 0 20%= 0 Total Cover: **0**			
Sapling/Shrub Stratum (Plot size: 15 ft r)			
1. *Spiraea douglasii*	40	Yes	FACW
2. *Salix lasiandra*	30	Yes	FACW
3.			
4.			
5.			
50%= 35 20%= 14 Total Cover: **70**			
Herb Stratum (Plot size: 5 ft r)			
1. *Phalaris arundinacea*	100	Yes	FACW
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
50%= 50 20%= 20 Total Cover: **100**			
Woody Vine Stratum (Plot size: 15 ft r)			
1.			
2.			
Total Cover: **0**			

% Bare Ground in Herb Stratum **0** % Cover of Biotic Crust

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **3** (A)
Total Number of Dominant Species Across All Strata: **3** (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x1 =	**0**
FACW species	**170**	x2 =	**340**
FAC species	**0**	x3 =	**0**
FACU species	**0**	x4 =	**0**
UPL species	**0**	x5 =	**0**
Column Totals:	**170** (A)		**340** (B)

Prevalence Index = B/A = **2.0**

Hydrophytic Vegetation Indicators:

X 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0[1]
4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
5 - Wetland Non-Vascular Plants[1]
Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes X** **No**

Remarks:

SOIL

Sampling Point: SP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR 2/1	100					SiL	mucky
8-18	10YR 2/1	90	10YR 6/2	10	D	M	SiL	gravelly

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- X Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** _____

Remarks:

Prominent redox depletions from 8 to 18 inches BGS.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water table Present? Yes X No _____ Depth (inches): 0

Saturation Present? (includes capillary fringe) Yes X No _____ Depth (inches): 0

Wetland Hydrology Present? **Yes** X **No** _____

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmonds Marsh City/County: DuPont/ Pierce County Sampling Date: 4/18/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: SP2
Investigator(s): R. Mathonnet, C. Douglas, G. Allen Section, Township, Range: T19-0N R1-0E S26
Landform (hillslope, terrace, etc.): gentle slope Local relief (concave, convex, none): none Slope: 1-3
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.104363 Long: -122.640733 Datum: NAD83
Soil Map Unit Name: Spanaway gravelly sandy loam NWI Classification: PSSC
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" Present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No
Hydric Soil Present? Yes No X
Wetland Hydrology Present? Yes No X

Is the Sampled Area within a Wetland? Yes No X

Remarks: Soil plot located at southwestern edge of marsh approximately 12 feet upslope

VEGETATION

Tree Stratum (Plot size: 30 ft r)	Absolute % Cover	Dominant Species?	Indicator Status?
1.			
2.			
3.			
4.			
5.			
50%= 0 20%= 0 Total Cover: **0**			
Sapling/Shrub Stratum (Plot size: 15 ft r)			
1. *Malus fusca*	50	Yes	FACW
2. *Symphoricarpos albus*	40	Yes	FACU
3. *Crataegus douglasii*	15	No	FAC
4. *Mahonia nervosa*	10	No	FACU
5. *Oemleria cerasiformis*	5	No	FACU
50%= 60 20%= 24 Total Cover: **120**			
Herb Stratum (Plot size: 5 ft r)	**CHECK RANKED VALUES**		
1. *Phalaris arundinacea*	100	Yes	FACW
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
50%= 50 20%= 20 Total Cover: **100**			
Woody Vine Stratum (Plot size: 15 ft r)			
1.			
2.			
Total Cover: **0**			

% Bare Ground in Herb Stratum **0** % Cover of Biotic Crust

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)
Total Number of Dominant Species Across All Strata: **3** (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: **67%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x1 =	**0**
FACW species	**150**	x2 =	**300**
FAC species	**15**	x3 =	**45**
FACU species	**55**	x4 =	**220**
UPL species	**0**	x5 =	**0**
Column Totals:	**220** (A)		**565** (B)

Prevalence Index = B/A = **2.6**

Hydrophytic Vegetation Indicators:

- 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- X 3 - Prevalence Index is ≤3.0[1]
- 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
- 5 - Wetland Non-Vascular Plants[1]
- Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No

Remarks:

SOIL

Sampling Point: SP2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR 2/1	100					SiL	gravelly
8-12	10YR 4/1	100					SCL	
12-18	10YR 4/1	100					SiL	gravelly

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** _____ **No** X

Remarks: Soils crumbly.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water table Present? Yes _____ No X Depth (inches): 0

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): 0

Wetland Hydrology Present? **Yes** _____ **No** X

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmonds Marsh City/County: DuPont/ Pierce County Sampling Date: 4/18/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: SP3
Investigator(s): R. Mathonnet, C. Douglas, G. Allen Section, Township, Range: T19-0N R1-0E S26
Landform (hillslope, terrace, etc.): gentle slope Local relief (concave, convex, none): none Slope: 1-3
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.101275 Long: -122.637508 Datum: NAD83
Soil Map Unit Name: Dupont muck NWI Classification: PSSC
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks)
Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" Present? Yes X No _____
Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes **X** No _____
Hydric Soil Present? Yes **X** No _____
Wetland Hydrology Present? Yes **X** No _____

Is the Sampled Area within a Wetland? **Yes X** **No** _____

Remarks: Soil plot located along southern edge of marsh north of housing development.

VEGETATION

Tree Stratum (Plot size: 30 ft r)	Absolute % Cover	Dominant Species?	Indicator Status?
1. *Alnus rubra*	20	Yes	FAC
2.			
3.			
4.			
5.			
50%= 10 20%= 4 Total Cover:	**20**		
Sapling/Shrub Stratum (Plot size: 15 ft r)			
1. *Cornus alba*	40	Yes	FACW
2. *Lonicera involucrata*	15	Yes	FAC
3. *Crataegus douglasii*	10	No	FAC
4. *Malus fusca*	5	No	FACW
5. *Salix lasiandra*	5	No	FACW
50%= 37.5 20%= 15 Total Cover:	**75**		
Herb Stratum (Plot size: 5 ft r)			
1. *Athyrium cyclosorum*	10	Yes	FAC
2. *Oenanthe sarmentosa*	5	Yes	OBL
3. *Maianthemum dilatatum*	5	Yes	FAC
4. *Ranunculus repens*	2	No	FAC
5.			
6.			
7.			
8.			
9.			
50%= 11 20%= 4.4 Total Cover:	**22**		
Woody Vine Stratum (Plot size: 15 ft r)	**CHECK RANKED VALUES**		
1.			
2.			
Total Cover:	**0**		

% Bare Ground in Herb Stratum **78** % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **6** (A)

Total Number of Dominant Species Across All Strata: **6** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**5**	x1 =	**5**
FACW species	**50**	x2 =	**100**
FAC species	**62**	x3 =	**186**
FACU species	**0**	x4 =	**0**
UPL species	**0**	x5 =	**0**
Column Totals:	**117** (A)		**291** (B)

Prevalence Index = B/A = **2.5**

Hydrophytic Vegetation Indicators:

_____ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0[1]
_____ 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
_____ 5 - Wetland Non-Vascular Plants[1]
_____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes X** **No** _____

Remarks:

SOIL

Sampling Point: SP3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-10	10YR 2/1	100					SiL	mucky
10-18	10YR 2/1	65	10YR 7/2	10	D	M	SiL	split matrix
	10YR 3/2	25						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- X Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** _____

Remarks: Distinct band of 10YR 3/2 at 11 inches BGS and also diffused throughout matrix.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): _____

Water table Present? Yes X No ___ Depth (inches): 1

Saturation Present? (includes capillary fringe) Yes X No ___ Depth (inches): 0

Wetland Hydrology Present? **Yes** X **No** _____

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmonds Marsh City/County: DuPont/ Pierce County Sampling Date: 4/18/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: SP4
Investigator(s): R. Mathonnet, C. Douglas, G. Allen Section, Township, Range: T19-0N R1-0E S26
Landform (hillslope, terrace, etc.): gentle slope Local relief (concave, convex, none): none Slope: 1-3
Subregion (LRR): Northwest Forests and Coast (LRA A) Lat: 47.101243 Long: -122.637514 Datum: NAD83
Soil Map Unit Name: Dupont muck NWI Classification: PSSC
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks)
Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" Present? Yes X No _____
Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No **X**	**Is the Sampled Area within a Wetland?** Yes _____ No **X**
Hydric Soil Present?	Yes _____	No **X**	
Wetland Hydrology Present?	Yes **X**	No _____	

Remarks: Soil plot located along southern edge of marsh north of housing development. Approximately 8 feet uphill from SP3

VEGETATION

Tree Stratum (Plot size: 30 ft r)	Absolute % Cover	Dominant Species?	Indicator Status?
1. *Alnus rubra*	40	Yes	FAC
2. *Pseudotsuga menziesii*	30	Yes	FACU
3. *Acer macrophyllum*	20	Yes	FACU
4.			
5.			
50%= 45 20%= 18 Total Cover:	**90**		
Sapling/Shrub Stratum (Plot size: 15 ft r)	**CHECK RANKED VALUES**		
1. *Oemleria cerasiformis*	30	Yes	FACU
2. *Ilex aquifolium*	25	Yes	FACU
3. *Crataegus douglasii*	20	Yes	FAC
4. *Malus fusca*	15	No	FACW
5. *Rubus ursinus*	5	No	FACU
50%= 47.5 20%= 19 Total Cover:	**95**		
Herb Stratum (Plot size: 5 ft r)	**CHECK RANKED VALUES**		
1. *Maianthemum dilatatum*	65	Yes	FAC
2. *Athyrium cyclosorum*	5	No	FAC
3. *Maianthemum stellatum*	5	No	FAC
4.			
5.			
6.			
7.			
8.			
9.			
50%= 37.5 20%= 15 Total Cover:	**75**		
Woody Vine Stratum (Plot size: 15 ft r)			
1.			
2.			
Total Cover:	**0**		

% Bare Ground in Herb Stratum **25** % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **3** (A)

Total Number of Dominant Species Across All Strata: **7** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **43%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x1 =	**0**
FACW species	**15**	x2 =	**30**
FAC species	**135**	x3 =	**405**
FACU species	**110**	x4 =	**440**
UPL species	**0**	x5 =	**0**
Column Totals:	**260** (A)		**875** (B)

Prevalence Index = B/A = **3.4**

Hydrophytic Vegetation Indicators:

_____ 1 - Rapid Test for Hydrophytic Vegetation
_____ 2 - Dominance Test is >50%
_____ 3 - Prevalence Index is ≤3.0[1]
_____ 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
_____ 5 - Wetland Non-Vascular Plants[1]
_____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes _____ No **X**

Remarks:

SOIL

Sampling Point: SP4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-4	2.5Y 2.5/1	100					SiL	gravelly
4-16	2.5Y 2.5/1	55					SiL	split matrix
	10YR 2/1	45						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Thick, dense roots

Depth (inches): 16

Hydric Soil Present? **Yes** ___ **No** X

Remarks:
Refusal met a 16 inches due to thick roots, layer is permeable and does not perch water

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___

Water table Present? Yes X No ___ Depth (inches): 5

Saturation Present? (includes capillary fringe) Yes X No ___ Depth (inches): 2

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
High water table in the adjacent marsh due to recent and ongoing heavy rainfall.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmond Marsh City/County: DuPont/ Pierce County Sampling Date: 4/19/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: SP5
Investigator(s): R. Mathonnet, G. Allen Section, Township, Range: T19-0N R1-0E S26
Landform (hillslope, terrace, etc.): depression Local relief (concave, convex, none): concave Slope: 1-3
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.104961 Long: -122.638063 Datum: NAD83
Soil Map Unit Name: Dupont muck NWI Classification: PSSF
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks)
Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" Present? Yes X No _____
Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes **X** No _____
Hydric Soil Present? Yes **X** No _____
Wetland Hydrology Present? Yes **X** No _____

Is the Sampled Area within a Wetland? **Yes X** **No** _____

Remarks: Soil plot located along northwest boundary in lobe located 2 feet away from waterline.

VEGETATION

Tree Stratum (Plot size: 30 ft r)	Absolute % Cover	Dominant Species?	Indicator Status?
1.			
2.			
3.			
4.			
5.			
50%= 0 20%= 0 Total Cover: **0**			
Sapling/Shrub Stratum (Plot size: 15 ft r)			
1. *Cornus alba*	40	Yes	FACW
2. *Spiraea douglasii*	20	Yes	FACW
3. *Lonicera involucrata*	5	No	FAC
4. *Oemleria cerasiformis*	5	No	FACU
5.			
50%= 35 20%= 14 Total Cover: **70**			
Herb Stratum (Plot size: 5 ft r)			
1. *Phalaris arundinacea*	20	Yes	FACW
2. *Maianthemum dilatatum*	15	Yes	FAC
3. *Typha latifolia*	10	Yes	OBL
4. *Maianthemum stellatum*	5	No	FAC
5.			
6.			
7.			
8.			
9.			
50%= 25 20%= 10 Total Cover: **50**			
Woody Vine Stratum (Plot size: 5 ft r)	**CHECK RANKED VALUES**		
1.			
2.			
Total Cover: **0**			
% Bare Ground in Herb Stratum **50** % Cover of Biotic Crust _____			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **5** (A)
Total Number of Dominant Species Across All Strata: **5** (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**10**	x1 =	**10**
FACW species	**80**	x2 =	**160**
FAC species	**25**	x3 =	**75**
FACU species	**5**	x4 =	**20**
UPL species	**0**	x5 =	**0**
Column Totals:	**120** (A)		**265** (B)

Prevalence Index = B/A = **2.2**

Hydrophytic Vegetation Indicators:

_____ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0[1]
_____ 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
_____ 5 - Wetland Non-Vascular Plants[1]
_____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes X** **No** _____

Remarks:

SOIL

Sampling Point: SP5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-5	10YR 2/1	100					SiL	peat ; decomposing wood
5-12	7.5YR 2.5/1	100					SiL	peat; decomposing wood
12-16	10YR 2/1	85	10YR 5/4	15	C	M	SiL	mucky

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- X Histic Epipedon (A2)
- ___ Black Histic (A3)
- X Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Thick, dense roots

Depth (inches): 16

Hydric Soil Present? Yes X No ___

Remarks:
Refusal met a 16 inches due to thick roots.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- X Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- X Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___

Water table Present? Yes X No ___ Depth (inches): 1

Saturation Present? (includes capillary fringe) Yes X No ___ Depth (inches): 0

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmonds Marsh City/County: DuPont/ Pierce County Sampling Date: 4/19/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: SP6
Investigator(s): R. Mathonnet, G. Allen Section, Township, Range: T19-0N R1-0E S26
Landform (hillslope, terrace, etc.): slope Local relief (concave, convex, none): convex Slope: 5-7
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.104968 Long: -122.638036 Datum: NAD83
Soil Map Unit Name: Dupont muck NWI Classification: PSSF
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks)
Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" Present? Yes X No _____
Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No _____	
Hydric Soil Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** Yes _____ No X
Wetland Hydrology Present?	Yes _____	No X	

Remarks: Soil plot located along northwest boundary in lobe located 10 feet uphill from SP5.

VEGETATION

Tree Stratum (Plot size: 30 ft r)	Absolute % Cover	Dominant Species?	Indicator Status?
1. *Salix lasiandra*	50	Yes	FACW
2. *Alnus rubra*	10	No	FAC
3.			
4.			
5.			
50%= 30 20%= 12 Total Cover:	60		
Sapling/Shrub Stratum (Plot size: 15 ft r)			
1. *Cornus alba*	65	Yes	FACW
2. *Symphoricarpos albus*	45	Yes	FACU
3. *Oemleria cerasiformis*	15	No	FACU
4. *Crataegus douglasii*	3	No	FAC
5. *Rubus ursinus*	3	No	FACU
50%= 65.5 20%= 26.2 Total Cover:	131		
Herb Stratum (Plot size: 5 ft r)	**CHECK RANKED VALUES**		
1. *Polystichum munitum*	15	Yes	FACU
2. *Maianthemum stellatum*	15	Yes	FAC
3. *Galium aparine*	10	Yes	FACU
4. *Pteridium aquilinum*	5	No	FACU
5.			
6.			
7.			
8.			
9.			
50%= 22.5 20%= 9 Total Cover:	45		
Woody Vine Stratum (Plot size: _____)	**CHECK RANKED VALUES**		
1.			
2.			
Total Cover:	0		
% Bare Ground in Herb Stratum 55 % Cover of Biotic Crust			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)
Total Number of Dominant Species Across All Strata: 6 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 50% (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x1 =	0
FACW species	115	x2 =	230
FAC species	28	x3 =	84
FACU species	93	x4 =	372
UPL species	0	x5 =	0
Column Totals:	236 (A)		686 (B)

Prevalence Index = B/A = 2.9

Hydrophytic Vegetation Indicators:

_____ 1 - Rapid Test for Hydrophytic Vegetation
_____ 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0[1]
_____ 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
_____ 5 - Wetland Non-Vascular Plants[1]
_____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No _____

Remarks:

SOIL

Sampling Point: SP6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 2/1	100					L	gravel and cobble throughout profile

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Thick, dense roots

Depth (inches): 16

Hydric Soil Present? **Yes** ___ **No** **X**

Remarks:
Refusal met a 16 inches due to thick roots.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No **X** Depth (inches): ___

Water table Present? Yes ___ No **X** Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No **X** Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** **X**

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmond Marsh City/County: Dupont/Pierce County Sampling Date: 4/18/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: SP-7
Investigator(s): R. Mathonnet, G. Allen Section, Township, Range: T19-0N R1-0E S25
Landform (hillslope, terrace, etc.): Marsh edge Local relief (concave, convex, none): none Slope: 1%
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.106 Long: -122.624 Datum: NAD83
Soil Map Unit Name: Semiahmoo muck NWI Classification: none
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" Present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes **X** No
Hydric Soil Present? Yes **X** No
Wetland Hydrology Present? Yes **X** No

Is the Sampled Area within a Wetland? **Yes X** **No**

Remarks:
Northeast side of East Marsh

VEGETATION

Tree Stratum (Plot size: 30 ft r)	Absolute % Cover	Dominant Species?	Indicator Status?
1.			
2.			
3.			
4.			
5.			
50%= 0 20%= 0 Total Cover: **0**			
Sapling/Shrub Stratum (Plot size: 15 ft r)			
1. *Rubus Spectabilis*	40	Yes	FAC
2. *Spiraea douglasii*	10	Yes	FACW
3.			
4.			
5.			
50%= 25 20%= 10 Total Cover: **50**			
Herb Stratum (Plot size: 5 ft r)			
1. *Athyrium cyclosorum*	15	Yes	FAC
2. *Gaultheria shallon*	2	No	FACU
3. *Ranunculus repens*	15	Yes	FAC
4. *Phalaris arundinacea*	5	No	FACW
5. *Maianthemum canadense*	15	Yes	FACU
6.			
7.			
8.			
9.			
50%= 26 20%= 10.4 Total Cover: **52**			
Woody Vine Stratum (Plot size: 15 ft r)	**CHECK RANKED VALUES**		
1.			
2.			
Total Cover: **0**			
% Bare Ground in Herb Stratum **48** % Cover of Biotic Crust			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **4** (A)
Total Number of Dominant Species Across All Strata: **5** (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: **80%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x1 =	**0**
FACW species	**15**	x2 =	**30**
FAC species	**70**	x3 =	**210**
FACU species	**17**	x4 =	**68**
UPL species	**0**	x5 =	**0**
Column Totals:	**102** (A)		**308** (B)

Prevalence Index = B/A = **3.0**

Hydrophytic Vegetation Indicators:

- 1 - Rapid Test for Hydrophytic Vegetation
- **X** 2 - Dominance Test is >50%
- 3 - Prevalence Index is ≤3.0[1]
- 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
- 5 - Wetland Non-Vascular Plants[1]
- Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes X** **No**

Remarks:

SOIL

Sampling Point: SP-7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-12	N2.5/_	90	10YR 3/4	10	C	M	L	Mucky, large organic features
12-15	2.5Y 4/3	100					CL	
15-18	N2.5/_	100					SL	Mucky

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- X Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** _____

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- X Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water table Present? Yes X No _____ Depth (inches): 3 in.

Saturation Present? (includes capillary fringe) Yes X No _____ Depth (inches): 1 in.

Wetland Hydrology Present? **Yes** X **No** _____

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Standing water 4 ft. away

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmond Marsh City/County: DuPont/Pierce County Sampling Date: 4/18/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: SP-8
Investigator(s): R. Mathonnet, G. Allen Section, Township, Range: T19-0N R1-0E S25
Landform (hillslope, terrace, etc.): gentle slope Local relief (concave, convex, none): none Slope: 1
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.106 Long: -122.624 Datum: NAD83
Soil Map Unit Name: Semiahmoo muck, 0 to 1 percent slopes NWI Classification: none
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" Present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes	No	X
Hydric Soil Present?	Yes	No	X
Wetland Hydrology Present?	Yes	No	X

Is the Sampled Area within a Wetland? Yes No X

Remarks:
Uphill slightly from SP-7 10-12 ft.

VEGETATION

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status?
1. *Alnus rubra*	35	Yes	FAC
2. *Pseudotsuga menziesii*	60	Yes	FACU
3. *Tsuga heterophylla*	20	No	FACU
4.			
5.			
50%= 57.5 20%= 23	Total Cover:	115	
Sapling/Shrub Stratum (Plot size:)			
1. *Corylus cornuta*	60	Yes	FACU
2. *Oemleria cerasiformis*	10	No	FACU
3. *Rubus spectabilis*	5	No	FAC
4. *Rosa nutkana*	5	No	FAC
5. *Holodiscus discolor*	10	No	FACU
50%= 45 20%= 18	Total Cover:	90	
Herb Stratum (Plot size:)			
1. *Polystichum munitum*	80	Yes	FACU
2. *Pteridium aquilinum*	5	No	FACU
3.			
4.			
5.			
6.			
7.			
8.			
9.			
50%= 42.5 20%= 17	Total Cover:	85	
Woody Vine Stratum (Plot size:)			
1.			
2.			
Total Cover:	0		
% Bare Ground in Herb Stratum 15	% Cover of Biotic Crust		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 25% (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x1 =	0
FACW species	0	x2 =	0
FAC species	45	x3 =	135
FACU species	245	x4 =	980
UPL species	0	x5 =	0
Column Totals:	290 (A)		1115 (B)

Prevalence Index = B/A = 3.8

Hydrophytic Vegetation Indicators:

- 1 - Rapid Test for Hydrophytic Vegetation
- 2 - Dominance Test is >50%
- 3 - Prevalence Index is ≤3.0[1]
- 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
- 5 - Wetland Non-Vascular Plants[1]
- Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes No X

Remarks:

SOIL

Sampling Point: SP-8

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-5	10YR 2/1	100			D	M	SiL	
5-16	10YR 4/3	60	2.5YR 5/2	30	D	M	SiL	Dry, crumbly soil
			5Y 5/2	10	D	M	SiL	Gravel throughout

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Thick, dense roots

Depth (inches): 16

Hydric Soil Present? **Yes** ___ **No** **X**

Remarks:
Refusal met a 16 inches due to thick roots, layer is permeable and does not perch water

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No **X** Depth (inches): ___

Water table Present? Yes ___ No **X** Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No **X** Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** **X**

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmond Marsh City/County: DuPont/Pierce County Sampling Date: 4/20/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: SP-11
Investigator(s): R. Mathonnet, G. Allen Section, Township, Range: T19-0N R1-0E S25
Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): none Slope: <1
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.106563 Long: -122.63105 Datum: NAD83
Soil Map Unit Name: Spanaway gravelly sandy loam NWI Classification: PSSF
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks)
Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" Present? Yes X No _____
Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes **X** No _____
Hydric Soil Present? Yes **X** No _____
Wetland Hydrology Present? Yes **X** No _____

Is the Sampled Area within a Wetland? **Yes X** **No** _____

Remarks:
Soil plot located along East Marsh waters edge, north boundary

VEGETATION

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status?
1.			
2.			
3.			
4.			
5.			
50%= 0 20%= 0 Total Cover: **0**			
Sapling/Shrub Stratum (Plot size: _____)			
1. *Salix sitchensis*	30	Yes	FACW
2. *Spiraea douglasii*	75	Yes	FACW
3. *Lonicera involucrata*	15	No	FAC
4. *Malus sp.*	5	No	-
5.			
50%= 62.5 20%= 25 Total Cover: **125**			
Herb Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
50%= 0 20%= 0 Total Cover: **0**			
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
Total Cover: **0**			

% Bare Ground in Herb Stratum **100** % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)

Total Number of Dominant Species Across All Strata: **2** (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x1 =	**0**
FACW species	**105**	x2 =	**210**
FAC species	**15**	x3 =	**45**
FACU species	**0**	x4 =	**0**
UPL species	**0**	x5 =	**0**
Column Totals:	**120** (A)		**255** (B)

Prevalence Index = B/A = **2.1**

Hydrophytic Vegetation Indicators:

_____ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0[1]
_____ 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
_____ 5 - Wetland Non-Vascular Plants[1]
_____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes X** **No** _____

Remarks:

SOIL

Sampling Point: SP-11

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-9	10YR 2/1	100					SL	Mucky
9-15	10YR 4/2	100					LS	Gravelly

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- X Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** _____

Remarks:
Refusal at 15 in., gravelly till, layer is permeable and does not perch water

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- X Surface Water (A1)
- ___ High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- X Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- X Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes X No _____ Depth (inches): 0.5 in.

Water table Present? Yes X No _____ Depth (inches): 0 in.

Saturation Present? (includes capillary fringe) Yes X No _____ Depth (inches): 0 in.

Wetland Hydrology Present? **Yes** X **No** _____

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmond Marsh | City/County: DuPont/Pierce County | Sampling Date: 4/20/2022
Applicant/Owner: SPSSEG | State: WA | Sampling Point: SP-12
Investigator(s): R. Mathonnet, G. Allen | Section, Township, Range: T19-0N R1-0E S25
Landform (hillslope, terrace, etc.): gentle slope | Local relief (concave, convex, none): none | Slope: 1-3
Subregion (LRR): Northwest Forests and Coast (LRR A) | Lat: 47.106589 | Long: -122.631025 | Datum: NAD83
Soil Map Unit Name: Spanaway gravelly sandy loam | NWI Classification: PSSF
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks)
Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" Present? Yes X No _____
Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No **X**	**Is the Sampled Area within a Wetland?** Yes _____ No **X**
Hydric Soil Present?	Yes _____	No **X**	
Wetland Hydrology Present?	Yes _____	No **X**	

Remarks:
10-12 ft. upslope from SP-11

VEGETATION

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status?
1. *Pseudotsuga menziesii*	60	Yes	FACU
2. *Salix sitchensis*	20	Yes	FACW
3.			
4.			
5.			
50%= 40 20%= 16 Total Cover: **80**			
Sapling/Shrub Stratu (Plot size: _____)			
1. *Malus sp.*	30	Yes	-
2. *Ilex aquifolium*	5	No	FACU
3. *Corylus cornuta*	15	No	FACU
4. *Mahonia aquifolium*	3	No	FACU
5 *Oemleria cerasiformis*	3	No	FACU
6 *Rosa nutkana*	3	No	FAC
7 *Frangula purshiana*	25	Yes	FAC
8 *Symphoricarpos albus*	40	Yes	FACU
50%= 62 20%= 24.8 Total Cover: **124**			
Herb Stratum (Plot size: _____) **CHECK RANKED VALUES**			
1. *Linnaea borealis*	60	Yes	FACU
2. *Trillium ovatum*	2	No	FACU
3. *Pteridium aquilinum*	3	No	FACU
4. *Cirsium vulgare*	3	No	FACU
5. *Polystichum munitum*	5	No	FACU
6.			
50%= 36.5 20%= 14.6 Total Cover: **73**			
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
Total Cover: **0**			
% Bare Ground in Herb Stratum **27** % Cover of Biotic Crust _____			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **1** (A)
Total Number of Dominant Species Across All Strata: **4** (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: **25%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x1 =	**0**
FACW species	**20**	x2 =	**40**
FAC species	**0**	x3 =	**0**
FACU species	**196**	x4 =	**784**
UPL species	**0**	x5 =	**0**
Column Totals:	**216** (A)		**824** (B)

Prevalence Index = B/A = **3.8**

Hydrophytic Vegetation Indicators:

_____ 1 - Rapid Test for Hydrophytic Vegetation
_____ 2 - Dominance Test is >50%
_____ 3 - Prevalence Index is ≤3.0[1]
_____ 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
_____ 5 - Wetland Non-Vascular Plants[1]
_____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes _____ No **X**

Remarks:
(Internal Note: more species were noted on field notes than can fit in this form, how should we prioritize species for this form)

SOIL

Sampling Point: SP-12

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-11	10YR 2/1	100					L	
11-12	7.5Y 3/3	100					SL	Coarse, gravel and cobble

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Compacted gravel

Depth (inches): 12

Hydric Soil Present? **Yes** ___ **No** X

Remarks:
Refusal at 12 in. due to compacted gravelly till

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No **x** Depth (inches): ___

Water table Present? Yes ___ No **x** Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No **x** Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Moist, but not saturated

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmond Marsh City/County: DuPont/Pierce County Sampling Date: 4/20/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: WD SP-1
Investigator(s): R. Mathonnet, G. Allen Section, Township, Range: T19-0N R1-0E S26
Landform (hillslope, terrace, etc.): depression Local relief (concave, convex, none): concave Slope: <1
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.106618 Long: -122.634635 Datum: NAD83
Soil Map Unit Name: Spanaway gravelly sandy loam NWI Classification: PSSA
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks)
Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" Present? Yes X No _____
Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes **X** No _____
Hydric Soil Present? Yes **X** No _____
Wetland Hydrology Present? Yes **X** No _____

Is the Sampled Area within a Wetland? **Yes X** **No** _____

Remarks:
Wetland D north of path

VEGETATION

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status?
1. *Alnus rubra*	30	Yes	FAC
2.			
3.			
4.			
5.			
50%= 15 20%= 6 Total Cover:	**30**		
Sapling/Shrub Stratum (Plot size: _____)			
1. *Malus sp.*	15	No	-
2. *Cornus alba*	45	Yes	FACW
3. *Salix sitchensis*	55	Yes	FACW
4. *Spiraea douglasii*	15	No	FACW
5. *Lonicera involucrata*	15	No	FAC
50%= 72.5 20%= 29 Total Cover:	**145**		
Herb Stratum (Plot size: _____)	**CHECK RANKED VALUES**		
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
50%= 0 20%= 0 Total Cover:	**0**		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
Total Cover:	**0**		

% Bare Ground in Herb Stratum **100** % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **3** (A)
Total Number of Dominant Species Across All Strata: **3** (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: **100%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x1 =	**0**
FACW species	**115**	x2 =	**230**
FAC species	**45**	x3 =	**135**
FACU species	**0**	x4 =	**0**
UPL species	**0**	x5 =	**0**
Column Totals:	**160** (A)		**365** (B)

Prevalence Index = B/A = **2.3**

Hydrophytic Vegetation Indicators:

_____ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0[1]
_____ 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
_____ 5 - Wetland Non-Vascular Plants[1]
_____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes X** **No** _____

Remarks:

SOIL

Sampling Point: WD SP-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-5	10YR 2/1	100					SiL	
5-14	10Y 5/1	65	10YR 5/8	10	C	M	SL	Gravel, split matrix
5-14	2.5Y 4/1	20	7.5YR 3/4	5	C	M	SL	Gravel, split matrix

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- X Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Dense, thick roots

Depth (inches): 14

Hydric Soil Present? Yes X No ___

Remarks:
Refusal at 14 in. due to thick roots. Layer is permeable and does not perch water.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- X Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___

Water table Present? Yes X No ___ Depth (inches): 4 in.

Saturation Present? (includes capillary fringe) Yes X No ___ Depth (inches): 0 in.

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Slightly uphill of surface water

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmond Marsh City/County: DuPont/Pierce County Sampling Date: 4/20/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: WD SP-2
Investigator(s): R. Mathonnet, G. Allen Section, Township, Range: T19-0N R1-0E S26
Landform (hillslope, terrace, etc.): gentle slope Local relief (concave, convex, none): none Slope: 1-3
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.106535 Long: -122.634625 Datum: NAD83
Soil Map Unit Name: Spanaway gravelly sandy loam NWI Classification: PSSA
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks)
Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" Present? Yes X No _____
Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No **X**	**Is the Sampled Area within a Wetland?** Yes _____ No **X**
Hydric Soil Present?	Yes _____	No **X**	
Wetland Hydrology Present?	Yes **X**	No _____	

Remarks:
Wetland D north of path

VEGETATION

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status?
1. *Pseudotsuga menziesii*	55	Yes	FACU
2. *Alnus rubra*	20	Yes	FAC
3.			
4.			
5.			
50%= 37.5 20%= 15 Total Cover: **75**			
Sapling/Shrub Stratum (Plot size: _____)			
1. *Corylus cornuta*	70	Yes	FACU
2. *Oemleria cerasiformis*	5	No	FACU
3. *Rubus ursinus*	5	No	FACU
4. *Symphoricarpos albus*	30	Yes	FACU
5. *Frangula purshiana*	2	No	FAC
50%= 56 20%= 22.4 Total Cover: **112**			
Herb Stratum (Plot size: _____)			
1. *Maianthemum canadense*	85	Yes	FACU
2. *Trillium ovatum*	5	No	FACU
3. *Polystichum munitum*	5	No	FACU
4. *Athyrium cyclosorum*	5	No	FAC
5.			
6.			
7.			
8.			
9.			
50%= 50 20%= 20 Total Cover: **100**			
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
Total Cover: **0**			
% Bare Ground in Herb Stratum **0** % Cover of Biotic Crust _____			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **1** (A)
Total Number of Dominant Species Across All Strata: **5** (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: **20%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x1 =	**0**
FACW species	**0**	x2 =	**0**
FAC species	**27**	x3 =	**81**
FACU species	**260**	x4 =	**1040**
UPL species	**0**	x5 =	**0**
Column Totals:	**287** (A)		**1121** (B)

Prevalence Index = B/A = **3.9**

Hydrophytic Vegetation Indicators:

_____ 1 - Rapid Test for Hydrophytic Vegetation
_____ 2 - Dominance Test is >50%
_____ 3 - Prevalence Index is ≤3.0[1]
_____ 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
_____ 5 - Wetland Non-Vascular Plants[1]
_____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes _____ No **X**

Remarks:

SOIL

Sampling Point: WD SP-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR 2/1	100					L	Slight gravel
8-14	2.5Y 4/1	95					SL	Cobbles, gravel
8-14	10YR 4/4	5					SL	Cobbles, gravel, split matrix

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Cobbles and gravel

Depth (inches): 14

Hydric Soil Present? **Yes** ___ **No** X

Remarks:
Refusal at 14 in. cobbles and gravel, layer is permeable and does not perch water

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___

Water table Present? Yes X No ___ Depth (inches): 14 in.

Saturation Present? (includes capillary fringe) Yes X No ___ Depth (inches): 12 in.

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Heavy rain occurred for several days before and during the collection of data at WD SP-2

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmond Marsh City/County: DuPont/Pierce County Sampling Date: 4/20/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: WD SP-3
Investigator(s): R. Mathonnet, G. Allen Section, Township, Range: T19-0N R1-0E S26
Landform (hillslope, terrace, etc.): depression Local relief (concave, convex, none): none Slope: <1
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.106544 Long: -122.635293 Datum: NAD83
Soil Map Unit Name: Spanaway gravelly sandy loam NWI Classification: PSSA
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks)
Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" Present? Yes X No _____
Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes **X** No _____
Hydric Soil Present? Yes **X** No _____
Wetland Hydrology Present? Yes **X** No _____

Is the Sampled Area within a Wetland? **Yes X** **No** _____

Remarks:
South section of wetland D, north of trail

VEGETATION

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status?
1. *Alnus rubra*	15	Yes	FAC
2.			
3.			
4.			
5.			
50%= 7.5 20%= 3 Total Cover: **15**			
Sapling/Shrub Stratum (Plot size: _____)			
1. *Rubus spectabilis*	20	No	FAC
2. *Lonicera involucrata*	15	No	FAC
3. *Malus fusca*	80	Yes	FACW
4.			
5.			
50%= 57.5 20%= 23 Total Cover: **115**			
Herb Stratum (Plot size: _____)			
1. *Athyrium cyclosorum*	10	Yes	FAC
2. *Maianthemum canadense*	5	Yes	FACU
3.			
4.			
5.			
6.			
7.			
8.			
9.			
50%= 7.5 20%= 3 Total Cover: **15**			
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
Total Cover: **0**			
% Bare Ground in Herb Stratum **85** % Cover of Biotic Crust _____			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **3** (A)
Total Number of Dominant Species Across All Strata: **4** (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: **75%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x1 =	**0**
FACW species	**80**	x2 =	**160**
FAC species	**60**	x3 =	**180**
FACU species	**5**	x4 =	**20**
UPL species	**0**	x5 =	**0**
Column Totals:	**145** (A)		**360** (B)

Prevalence Index = B/A = **2.5**

Hydrophytic Vegetation Indicators:

_____ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
X 3 - Prevalence Index is ≤3.0[1]
_____ 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
_____ 5 - Wetland Non-Vascular Plants[1]
_____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes X** **No** _____

Remarks:

SOIL

Sampling Point: WD SP-3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-3	7.5YR 2.5/1	100					SiL	Mucky, sandy
3-11	2.5Y 2.5/1	97	10YR 6/1	3	D	M	SL	Gravelly

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- X Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Dense, thick roots

Depth (inches): 11

Hydric Soil Present? **Yes** X **No** ___

Remarks:
Refusal at 11 in. due to thick roots

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- X Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- X Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___

Water table Present? Yes X No ___ Depth (inches): 2

Saturation Present? (includes capillary fringe) Yes X No ___ Depth (inches): 0

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Iron deposits and oil looking sheen in surface water 3 ft. from plot

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: Edmond Marsh City/County: DuPont/Pierce County Sampling Date: 4/20/2022
Applicant/Owner: SPSSEG State: WA Sampling Point: WD SP-4
Investigator(s): R. Mathonnet, G. Allen Section, Township, Range: T19-0N R1-0E S26
Landform (hillslope, terrace, etc.): gentle slope Local relief (concave, convex, none): convex Slope: 1-3
Subregion (LRR): Northwest Forests and Coast (LRR A) Lat: 47.106339 Long: -122.635177 Datum: NAD83
Soil Map Unit Name: Spanaway gravelly sandy loam NWI Classification: PSSA
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks)
Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" Present? Yes X No _____
Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No **X**	**Is the Sampled Area within a Wetland?** Yes _____ No **X**
Hydric Soil Present?	Yes _____	No **X**	
Wetland Hydrology Present?	Yes _____	No **X**	

Remarks:
South section of Wetland D 6 ft upload of WD SP-1

VEGETATION

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status?
1. *Pseudotsuga menziesii*	40	Yes	FACU
2. *Alnus rubra*	25	Yes	FAC
3.			
4.			
5.			
50%= 32.5 20%= 13 Total Cover: **65**			
Sapling/Shrub Stratum (Plot size: _____)			
1. *Corylus cornuta*	30	Yes	FACU
2. *Lonicera involucrata*	20	Yes	FAC
3. *Rubus spectabilis*	10	No	FAC
4. *Oemleria cerasiformis*	3	No	FACU
5. *Ilex aquifolium*	15	No	FACU
50%= 39 20%= 15.6 Total Cover: **78**			
Herb Stratum (Plot size: _____) **CHECK RANKED VALUES**			
1. *Polystichum munitum*	35	Yes	FACU
2. *Maianthemum canadense*	30	Yes	FACU
3. *Rubus ursinus*	5	No	FACU
4. *Athyrium cyclosorum*	15	No	FAC
5.			
6.			
7.			
8.			
9.			
50%= 42.5 20%= 17 Total Cover: **85**			
Woody Vine Stratum (Plot size: _____) **CHECK RANKED VALUES**			
1.			
2.			
Total Cover: **0**			
% Bare Ground in Herb Stratum **15** % Cover of Biotic Crust _____			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: **2** (A)
Total Number of Dominant Species Across All Strata: **6** (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: **33%** (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL species	**0**	x1 =	**0**
FACW species	**0**	x2 =	**0**
FAC species	**70**	x3 =	**210**
FACU species	**158**	x4 =	**632**
UPL species	**0**	x5 =	**0**
Column Totals:	**228** (A)		**842** (B)

Prevalence Index = B/A = **3.7**

Hydrophytic Vegetation Indicators:

_____ 1 - Rapid Test for Hydrophytic Vegetation
_____ 2 - Dominance Test is >50%
_____ 3 - Prevalence Index is ≤3.0[1]
_____ 4 - Morphological Adaptation[1] (Provide supporting data in Remarks or on a separate sheet)
_____ 5 - Wetland Non-Vascular Plants[1]
_____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes _____ No **X**

Remarks:

SOIL

Sampling Point: WD SP-4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-10	10YR 2/1	100					L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Muck Mineral (S1)
- ___ Sandy gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) (**except MLRA 1**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Thick roots and cobble

Depth (inches): 10

Hydric Soil Present? **Yes** ___ **No** **X**

Remarks:
Refusal at 10 in., large roots and cobble, layer is permeable and does not perch water

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) (**except MLRA 1, 2, 4A and 4B**)
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Plowed Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A and 4B**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? Yes ___ No **X** Depth (inches): ___

Water table Present? Yes ___ No **X** Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No **X** Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** **X**

Describe Recorded Data (Unnamed Tributary gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Appendix C
Wetland Rating Forms

Wetland name or number: Edmond Marsh

RATING SUMMARY - Western Washington

Name of wetland (or ID#): Edmond Marsh **Date of site visit:** 04/18/2022
Rated By: Gabriel Allen **Trained by Ecology? Yes** [X] **No** [ ] **Date of Training:** 06/03/2022
HGM Class used for rating: Depressional
Wetland has multiple HGM classes? Yes [ ] **No** [X]

NOTE: Form is not complete without the figures requested *(figures can be combined).*
Source of base aerial photo/map:

OVERALL WETLAND CATEGORY: [**Category II**] (based on functions [X] or special characteristics [ ])

1. Category of wetland based on FUNCTIONS

[ ] **Category I** - Total score = 23 - 27
[X] **Category II** - Total score = 20 - 22
[ ] **Category III** - Total score = 16 - 19
[ ] **Category IV** - Total score = 9 - 15

FUNCTION	Improving Water Quality	Hydrologic	Habitat	
Site Potential	**H**	**M**	**H**	
Landscape Potential	**M**	**M**	**M**	
Value	**H**	**L**	**H**	**Total**
Score Based on Ratings	**8**	**5**	**8**	**21**

Score for each function based on three ratings (order of ratings is not important)
9 = H,H,H
8 = H,H,M
7 = H,H,L
7 = H,M,M
6 = H,M,L
6 = M,M,M
5 = H,L,L
5 = M,M,L
4 = M,L,L
3 = L,L,L

2. Category based on SPECIAL CHARACTERISTICS of wetland

CHARACTERISTIC	CATEGORY
Estuarine	
Wetland of High Conservation Value	
Bog	
Forested	
Coastal Lagoon	
Interdunal	
None of the above	**Not Applicable**

Wetland name or number: Edmond Marsh

Maps and figures required to answer questions correctly for Western Washington

Depressional Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	D 1.3, H 1.1, H 1.4	
Hydroperiods	D 1.4, H 1.2	
Location of outlet *(can be added to map of hydroperiods)*	D 1.1, D 4.1	
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	D 2.2, D 5.2	
Map of the contributing basin	D 4.3, D 5.3	
1km Polygon: Area that extends 1km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	D 3.1, D 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	D 3.3	

Wetland name or number: Edmond Marsh

DEPRESSIONAL AND FLATS WETLANDS

Water Quality Functions - Indicators that the site functions to improve water quality

D 1.0 Does the site have the potential to improve water quality?

D 1.1 What are the characteristics of surface water outflows from the wetland?		
Wetland has no surface water outlet.	points = 3	
Wetland has an intermittently flowing, or highly constricted, outlet.	points = 2	
Wetland has an unconstricted, or slightly constricted, surface outlet that is permanently flowing	points = 1	
Wetland is a flat depression whose outlet is a permanently flowing ditch.	points = 1	**Score: 1**
D 1.2 Can the soil 2in below the surface be identified as true clay or organic soil?		
Mapped as true clay or organic (muck or peat)	points = 4	
Soil texture identified as clay or organic in field	points = 4	
Soil texture identified as clay or organic by laboratory test	points = 4	
None of the above	points = 0	**Score: 4**
D 1.3 What are the characteristics and distribution of persistent plants?		
Wetland has persistent, ungrazed, plants > 95% of area	points = 5	
Wetland has persistent, ungrazed, plants > 50% of area	points = 3	
Wetland has persistent, ungrazed plants > 10% of area	points = 1	
Wetland has persistent, ungrazed plants < 10% of area	points = 0	**Score: 5**
D 1.4 What are the characteristics of seasonal ponding or inundation in the wetland area?		
Area seasonally ponded is > 50% total area of wetland	points = 4	
Area seasonally ponded is > 25% total area of wetland	points = 2	
Area seasonally ponded is < 25% total area of wetland	points = 0	**Score: 4**
	Total for D 1:	**14**

Rating of Site Potential [X] **12-16 = H** [ ] **6-11 = M** [ ] **0-5 = L** *Record the rating on the first page*

D 2.0 Does the landscape have the potential to support the water quality function of the site?

D 2.1 Does the wetland unit receive stormwater discharges?		
Yes	points = 1	
No	points = 0	**Score: 1**
D 2.2 Is >10% of the area within 150ft of the wetland in land uses that generate pollutants in surface runoff?		
Yes	points = 1	
No	points = 0	**Score: 0**
D 2.3 Are there septic systems within 250ft of the wetland?		
Yes	points = 1	
No	points = 0	**Score: 0**
D 2.4 Are there other sources of pollutants coming into the wetland that are not listed in questions D 2.1-D 2.3?		
Yes	points = 1	
No	points = 0	**Score: 0**

Wetland name or number: Edmond Marsh

D 2.5 What are the other sources of pollutants coming into the wetland?	
Total for D 2:	**1**

Rating of Landscape Potential [ ] **3-4 = H** [X] **1-2 = M** [ ] **0 = L** *Record the rating on the first page*

D 3.0 Is the water quality improvement provided by the site valuable to society?		
D 3.1 Does the wetland discharge directly (i.e., within 1 mi) to a stream, river, lake, or marine water that is on the 303(d) list?		
Yes	points = 1	
No	points = 0	**Score: 0**
D 3.2 Is the wetland in a basin or sub-basin where an aquatic resource is on the 303(d) list?		
Yes	points = 1	
No	points = 0	**Score: 1**
D 3.3 Has the site been identified in a watershed or local plan as important for maintaining water quality?		
Yes	points = 2	
No	points = 0	**Score: 2**
Total for D 3:		**3**

Rating of Value [X] **2-4 = H** [ ] **1 = M** [ ] **0 = L** *Record the rating on the first page*

DEPRESSIONAL AND FLATS WETLANDS

Hydrologic Functions - Indicators that the site functions to reduce flooding and stream degradtion

D 4.0 Does the site have the potential to reduce flooding and erosion?		
D 4.1 What are the characteristics of surface water outflows from the wetland?		
Wetland has no surface water outlet.	points = 4	
Wetland has an intermittently flowing, or highly constricted, outlet.	points = 2	
Wetland is a flat depression whose outlet is a permanently flowing ditch.	points = 1	
Wetland has an unconstricted, or slightly constricted, surface outlet that is permanently flowing	points = 0	**Score: 0**
D 4.2 What is the depth of storage during the wet periods?		
Marks of ponding are 3ft or more above the surface or bottom of the outlet.	points = 7	
Marks of ponding are between 2ft to <3ft from the surface or bottom of the outlet.	points = 5	
Marks of ponding are at least 0.5ft to <2ft from the surface or the bottom of the outlet.	points = 3	
The wetland is a "headwater" wetland.	points = 3	
The wetland is flat but has small depressions on the surface that trap water.	points = 1	
Marks of ponding are less than 0.5ft (6in).	points = 0	**Score: 7**

Wetland name or number: Edmond Marsh

D 4.3 What is the contribution of the wetland to storage in the watershed?		
The area of the basin is less than 10 times the area of the unit	points = 5	
The area of the basin is 10 to 100 times the area of the unit	points = 3	
The area of the basin is more than 100 times the area of the unit	points = 0	
Entire wetland is in the Flats class	points = 5	**Score: 3**
	Total for D 4:	**10**

Rating of Site Potential [ ] **12-16 = H** [X] **6-11 = M** [ ] **0-5 = L** *Record the rating on the first page*

D 5.0 Does the landscape have the potential to support hydrologic functions of the site?		
D 5.1 Does the wetland unit receive stormwater discharges?		
Yes	points = 1	
No	points = 0	**Score: 1**
D 5.2 Is >10% of the area within 150 ft of the wetland in land uses that generate excess runoff?		
Yes	points = 1	
No	points = 0	**Score: 0**
D 5.3 Is more than 25% of the contributing basin of the wetland covered with intensive human land uses?		
Yes	points = 1	
No	points = 0	**Score: 1**
	Total for D 5:	**2**

Rating of Landscape Potential [ ] **3 = H** [X] **1-2 = M** [ ] **0 = L** *Record the rating on the first page*

D 6.0 Are the hydrologic functions provided by the site valuable to society?		
D 6.1 Is the wetland in a landscape that has flooding problems?		
Flooding occurs in a sub-basin that is immediately down-gradient of the wetland.	points = 2	
Surface flooding problems are in a sub-basin farther down-gradient.	points = 1	
Flooding from groundwater is an issue in the basin.	points = 1	
The existing or potential outflow from the wetland is so constrained that water cannot reach areas that flood.	points = 0	
There are no problems with flooding downstream of the wetland.	points = 0	**Score: 0**
D 6.2 Has the site been identified as important for flood storage or flood conveyance in a regional flood control plan?		
Yes	points = 2	
No	points = 0	**Score: 0**
	Total for D 6:	**0**

Rating of Value [ ] **2-4 = H** [ ] **1 = M** [X] **0 = L** *Record the rating on the first page*

Wetland name or number: Edmond Marsh

HABITAT FUNCTIONS

These questions apply to wetlands of all HGM classes - Indicators that the site functions to provide important habitat

H 1.0 Does the wetland have the potential to provide habitat for many species?

H 1.1 What is the structure of the plant community?

- [ ] Aquatic Bed
- [x] Emergent
- [x] Scrub-shrub
- [x] Forested
- [x] Multiple strata within the Forested class (canopy, sub-canopy, shrubs, herbaceous, moss/ground cover)

4 structures or more	points = 4	
3 structures	points = 2	
2 structures	points = 1	
1 structure	points = 0	
No structures present	points = 0	**Score: 4**

H 1.2 What are the hydroperiods that meet the size thresholds in the wetland?

- [ ] Permanently flooded or inundated
- [x] Seasonally flooded or inundated
- [ ] Occasionally flooded or inundated
- [x] Saturated only
- [ ] Permanently flowing stream or river in, or adjacent to, the wetland
- [ ] Seasonally flowing stream in, or adjacent to, the wetland
- [ ] Lake Fringe wetland
- [ ] Freshwater Tidal wetland

4 or more types present	points = 3	
3 types present or Lake Fringe / Freshwater Tidal Fringe	points = 2	
2 types present	points = 1	
1 type present	points = 0	
None present	points = 0	**Score: 1**

H 1.3 What is the richness of the plant species in the wetland?

>19 species	points = 2	
5-19 species	points = 1	
<5 species	points = 0	**Score: 2**

Wetland name or number: Edmond Marsh

H 1.4 What is the interspersion of habitats?

High	points = 3	
Moderate	points = 2	
Low	points = 1	
None	points = 0	**Score: 3**

H 1.5 What are the special habitat features in the wetland?

- [✓] Large, downed, woody debris within the wetland (>4in diameter and 6ft long).
- [✓] Standing snags (dbh >4in) within the wetland
- [✓] Undercut banks are present for at least 6.6ft (2m) and/or overhanging plants extend at least 3.3ft (1m) over open water or a stream (or ditch) in, or contiguous with the wetland, for at least 33ft (10m)
- [✓] Stable steep banks of fine material that might be used by beaver or muskrat for denning (>30 degree slope) OR signs of recent beaver activity are present (cut shrubs or trees that have not yet weathered where wood is exposed)
- [✓] At least 0.25ac of thin-stemmed persistent plants or woody branches are present in areas that are permanently or seasonally inundated (structures for egg-laying by amphibians)
- [ ] Invasive plants cover less than 25% of the wetland area in every stratum of plants (see H 1.1 for list of strata)

6 habitats selected	points = 6	
5 habitats selected	points = 5	
4 habitats selected	points = 4	
3 habitats selected	points = 3	
2 habitats selected	points = 2	
1 habitat selected	points = 1	
No habitats selected	points = 0	**Score: 5**

Total for H 1: **15**

Rating of Site Potential [X] **15-18 = H** [ ] **7-14 = M** [ ] **0-6 = L** *Record the rating on the first page*

H 2.0 Does the landscape have the potential to support habitat functions of the site?

H 2.1 What is the percentage of accessible habitat within 1km of the wetland?

>33% of 1km Polygon	points = 3	
20-33% of 1km Polygon	points = 2	
10-19% of 1km Polygon	points = 1	
<10% of 1km Polygon	points = 0	**Score: 1**

H 2.2 What is the percentage of total habitat in a 1km polygon around the wetland?

Total habitat is >50% of the Polygon	points = 3	
Total habitat is 10-50% of the Polygon and in 1-3 patches	points = 2	
Total habitat is 10-50% of the Polygon and in >3 patches	points = 1	
Total habitat is <10% of the Polygon	points = 0	**Score: 1**

Wetland name or number: Edmond Marsh

H 2.3 What is the land use intensity in the 1km polygon?

50% of the Polygon is high intensity land use	points = -2	
<50% of the Polygon is high intensity land use	points = 0	**Score: 0**
	Total for H 2:	**2**

Rating of Landscape Potential [ ] **4-6 = H** [X] **1-3 = M** [ ] **0 = L** *Record the rating on the first page*

H 3.0 Is the habitat provided by the site valuable to society?

H 3.1 Does the site provide habitat for species valued in laws, regulations, or policies?

- [ ] Aspen Stands
- [ ] Biodiversity Areas and Corridors
- [ ] Herbaceous Balds
- [ ] Old-growth/Mature Forests
- [✓] Oregon White Oak
- [✓] Riparian
- [ ] Westside Prarie
- [ ] Fresh Deepwater
- [✓] Instream
- [ ] Nearshore (Coastal, Open Coast, Puget Sound)
- [ ] Caves
- [ ] Cliffs
- [✓] Snags and Logs
- [ ] Talus

The following criteria automatically score 2 points:

- [ ] The wetland provides habitat for Threatened or Endangered species
- [ ] The wetland is mapped as a location for an individual WDFW priority species
- [ ] The wetland is a Wetland of High Conservation Value
- [ ] The wetland has been categorized as an important habitat site in a local plan

The wetland has 3 or more WDFW priority habitats within 100m, or meets the criteria for societal value	points = 2	
The site has 1 or 2 WDFW priority habitats within 100m	points = 1	
The site does not meet any of the criteria for societal value	points = 0	**Score: 2**
	Total for H 3:	**2**

Rating of Value [X] **2 = H** [ ] **1 = M** [ ] **0 = L** *Record the rating on the first page*

Wetland name or number: Edmond Marsh

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

SC 1.0 Estuarine Wetlands

SC 1.1 Does the wetland meet all of the following criteria for Estuarine wetlands?

☐ The dominant water regime is tidal
☐ The wetland is vegetated
☐ The water salinity is greater than 0.5 ppt

Yes - Go to SC 1.2
No - Not an Estuarine Wetland **Result:**

SC 1.2 Is the wetland within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-30-151?

Yes - Category I Estuarine Wetland
No - Go to SC 1.3 **Result:**

SC 1.3 Is the wetland unit at least 1ac in size and meets at least two of the following three conditions?

☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 10% cover of non-native plant species.
☐ At least 75% of the landward edge of the wetland has a 100ft buffer of shrub, forest, or un-grazed or un-mowed grassland
☐ The wetland has at least two of the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands.

Yes - Category I Estuarine Wetland
No - Category II Estuarine Wetland **Result:**

SC 2.0 Wetlands of High Conservation Value

SC 2.1 Is the wetland listed by Washington Natural Heritage Program WDNR as a Wetland of High Conservation Value (WHCV)?

Yes - Category I Wetland of High Conservation Value
No - Go to SC 2.2 **Result: Go to SC 2.2**

SC 2.2 Does the wetland have a rare plant species, rare plant community, or high-quality common plant community that may qualify the site as a WHCV?

Yes - Category I Wetland of High Conservation Value

No - Not a Wetland of High Conservation Value **Result: Not a Wetland of High Conservation Value**

Wetland name or number: Edmond Marsh

SC 3.0 Bogs

SC 3.1 Does an area within the wetland unit have organic soil horizons, either peats or mucks, that compose 16in or more of the first 32in of the soil profile?

Yes - Go to SC 3.3
No - Go to SC 3.2 **Result: Go to SC 3.2**

SC 3.2 Does an area within the wetland unit have organic soils, either peats or mucks, that are less than 16 in deep over bedrock, or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond?

Yes - Go to SC 3.3

No - Not a Bog Wetland **Result: Not a Bog Wetland**

SC 3.3 Does an area with peats or mucks have more than 70% cover of mosses at ground level, AND at least 30% cover of plant species listed in the table provided in the instructions?

Yes - Category I Bog Wetland
No - Go to SC 3.4 **Result:**

SC 3.4 Is an area with peats or mucks forested (>30% cover) with Sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Engelmann Spruce, or western white pine AND any of the species (or combinations of species) listed in the table found in the instructions provide more than 30% of the cover under the canopy?

Yes - Category I Bog Wetland
No - Not a Bog Wetland **Result:**

SC 4.0 Forested Wetlands

SC 4.1 Does the wetland have at least 1 contiguous acre of forest that meets one of the following criteria?

☐ Old-growth forests
☐ Mature forests

Yes - Category I Forested Wetland

No - Not a Forested Wetland **Result: Not a Forested Wetland**

Wetland name or number: Edmond Marsh

SC 5.0 Wetlands in Coastal Lagoons

SC 5.1 Coastal Lagoons: Does the wetland meet all of the following criteria of a wetland in a coastal lagoon?

☐ The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or rocks

☐ The depression in which the wetland is located contains ponded water that is saline or brackish (>0.5 ppt) during most of the year in at least a portion of the open water area (measured near the bottom)

Yes - Go to SC 5.2

No - Not a Coastal Lagoon Wetland **Result: Not a Coastal Lagoon Wetland**

SC 5.2 Does the wetland meet all of the following three conditions?

☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of aggressive, opportunistic plant species (see list of species).

☐ At least 75% of the landward edge of the wetland has a 100ft buffer of shrub, forest, or un-grazed or un-mowed grassland.

☐ the wetland is larger than 0.10ac (4350 sqft)

Yes - Category I Coastal Lagoon

No - Category II Coastal Lagoon **Result:**

SC 6.0 Interdunal Wetlands

SC 6.1 Is the wetland west of the 1889 line (also called the Western Boundary of Upland Ownership WBUO)?

Yes - Go to SC 6.2

No - Not an Interdunal Wetland **Result: Not an Interdunal Wetland**

SC 6.2 Is the wetland 1ac or larger in size, or a mosaic that is 1ac or larger in size?

Wetland is larger than 1ac in size - Go to SC 6.3

Wetland is a mosaic larger than 1ac is size - Category II Interdunal Wetland

No - Go to SC 6.4 **Result:**

SC 6.3 Does the wetland score 8 or 9 points for the habitat functions?

Yes - Category I Interdunal Wetland

No - Category II Interdunal Wetland **Result:**

SC 6.4 Is the wetland unit between 0.1ac and 1ac, or in a mosaic of wetlands that is between 0.1ac and 1ac in size?

Yes - Category III Interdunal Wetland

No - Category IV Interdunal Wetland **Result:**

Wetland name or number: Edmond Marsh

Category of wetland based on Special Characteristics	
If you answered No for all types, enter "Not Applicable" on Summary Form	**Final Category: Not Applicable**

Legend | Wetland Tools | Zoom | Tools

Add/Remove map data layers

Location of Outlet Items

- Wetland
- Outlet location

Project: **Edmond Marsh** Wetland: **Edmond Marsh** (Depressional) Date: **08/11/2022**

Legend | Wetland Tools | Zoom | Tools

Add/Remove map data layers

Cowardin Plant Class Items

Cowardin Classes

- Forested
- Scrub-shrub
- Emergent
- Aquatic bed
- Open water
- Wetland/Unmapped wetland

Project: **Edmond Marsh** Wetland: **Edmond Marsh** (Depressional) Date: **08/11/2022**

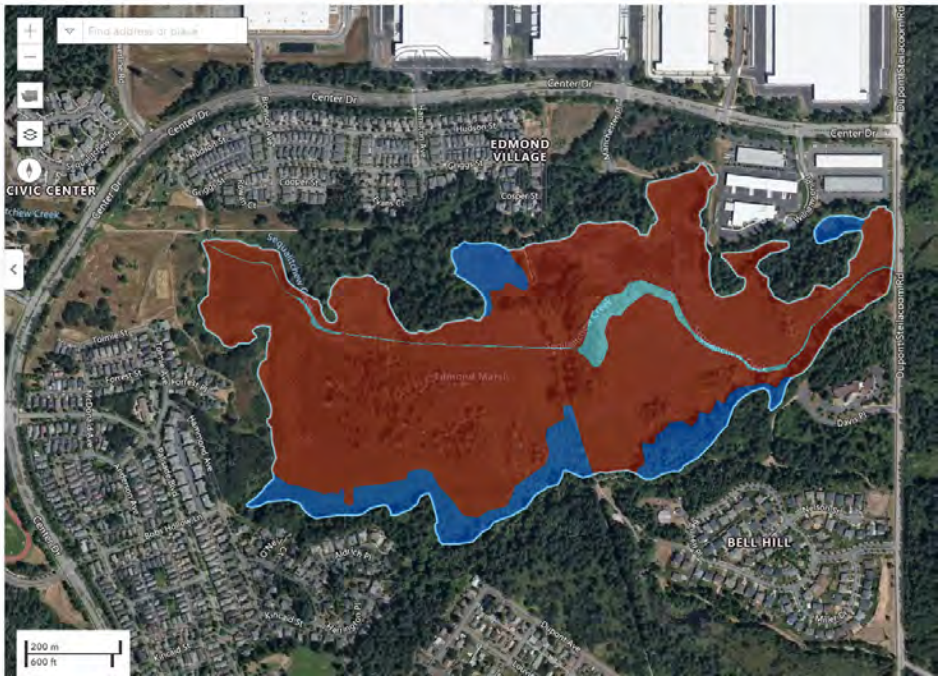
Legend | Wetland Tools | Zoom | Tools

Add/Remove map data layers

Hydroperiod Items

- Permanent Stream
- Seasonal Stream
- Permanently
- Seasonally
- Ocasionally
- Saturated only
- Wetland/Unmapped wetland

Project: **Edmond Marsh** Wetland: **Edmond Marsh** (Depressional) Date: **08/11/2022**



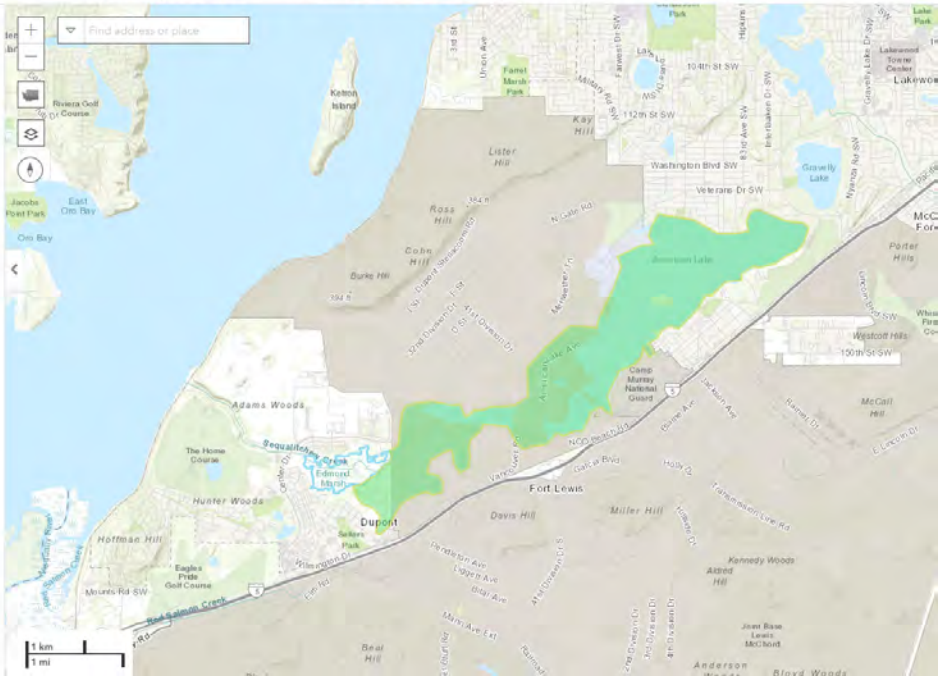
Legend | Wetland Tools | Zoom | Tools

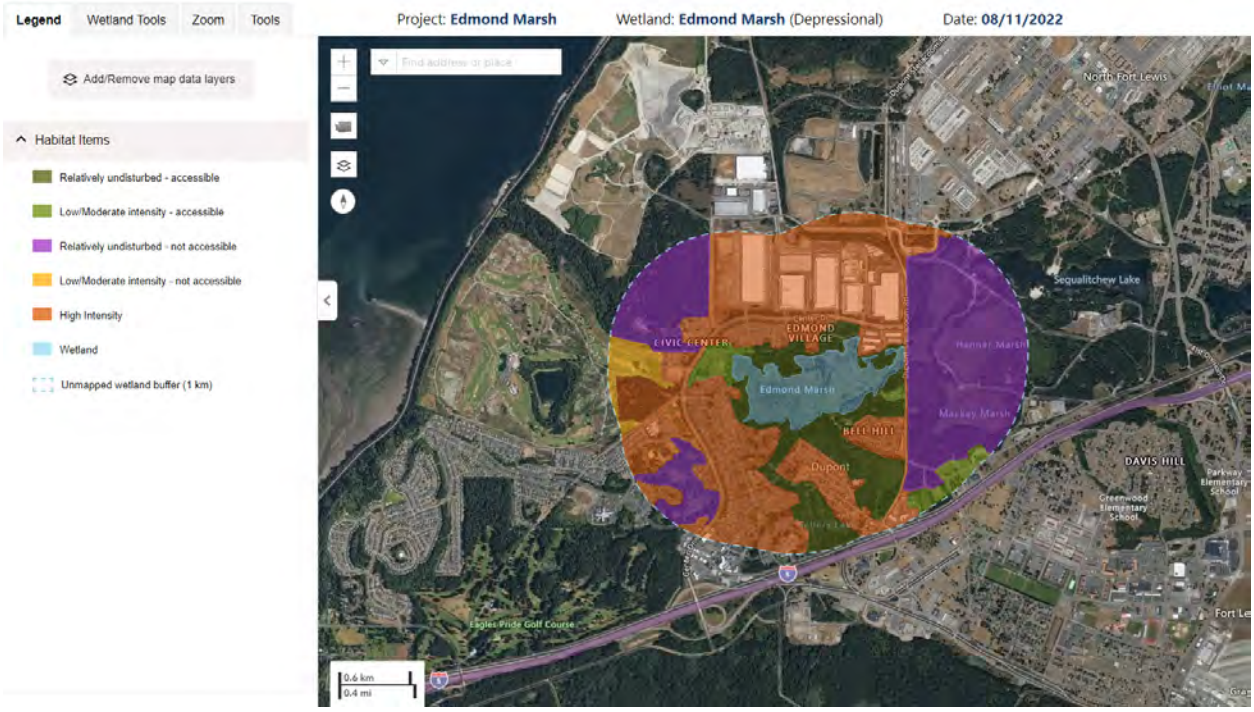
Add/Remove map data layers

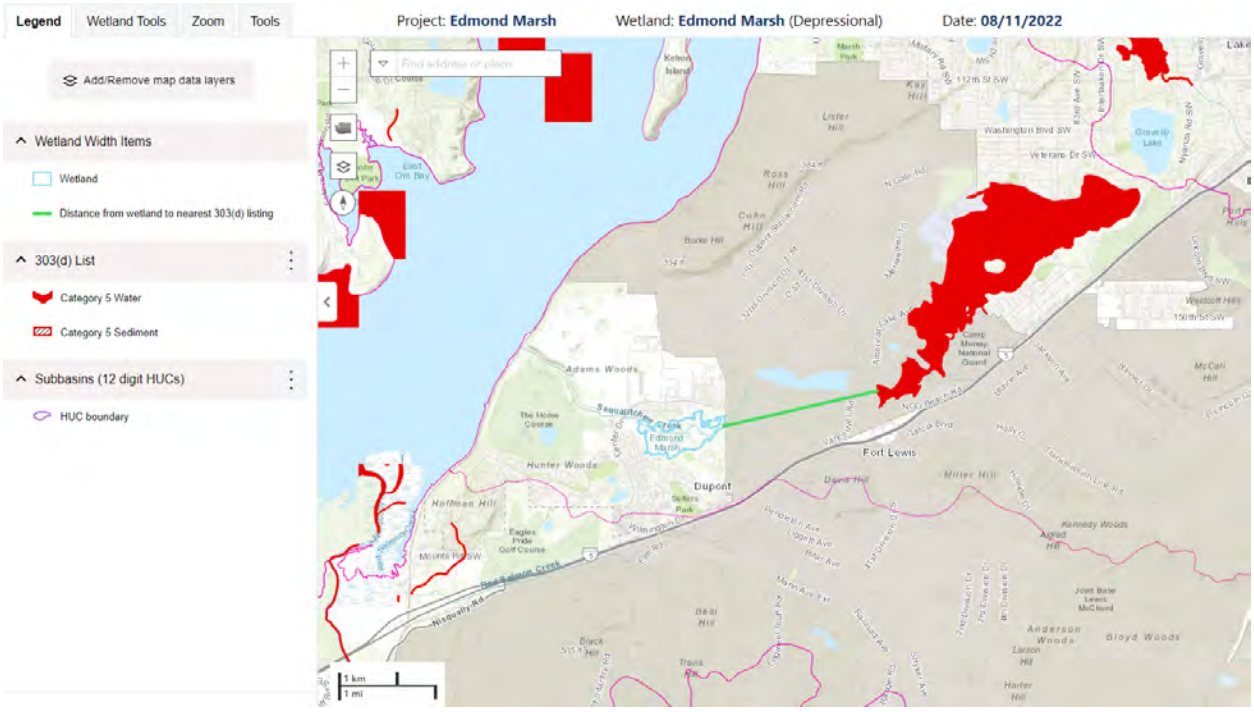
Contributing Basin Items

- Wetland
- Contributing basin

Project: **Edmond Marsh** Wetland: **Edmond Marsh** (Depressional) Date: **08/11/2022**




Legend
Wetland Tools
Zoom
Tools
Add/Remove map data layers
Habitat Items
Relatively undisturbed - accessible
Low/Moderate intensity - accessible
Relatively undisturbed - not accessible
Low/Moderate intensity - not accessible
High Intensity
Wetland
Unmapped wetland buffer (1 km)
Project: Edmond Marsh
Wetland: Edmond Marsh (Depressional)
Date: 08/11/2022
Find address or place
North Fort Lewis
Sequalitchew Lake
CIVIC CENTER
EDMOND VILLAGE
Edmond Marsh
BELL HILL
Dupont
Hanner Marsh
Mackey Marsh
DAVIS HILL
Parkway Elementary School
Greenwood Elementary School
Eagles Pride Golf Course
0.6 km
0.4 mi

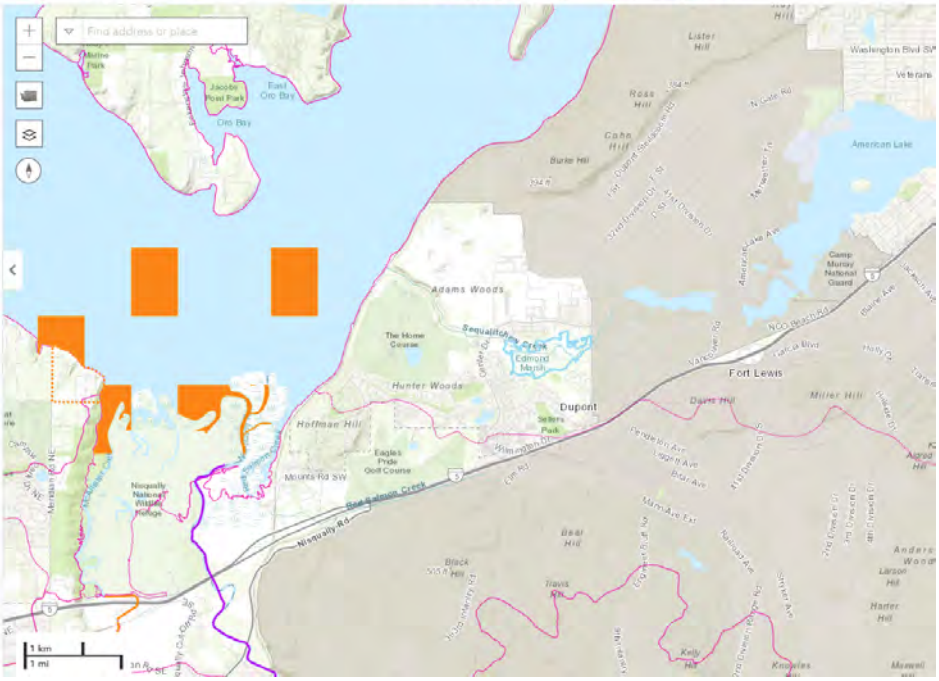

Legend
Wetland Tools
Zoom
Tools
Add/Remove map data layers
Wetland Width Items
Wetland
Distance from wetland to nearest 303(d) listing
303(d) List
Category 5 Water
Category 5 Sediment
Subbasins (12 digit HUCs)
HUC boundary
Project: Edmond Marsh
Wetland: Edmond Marsh (Depressional)
Date: 08/11/2022
Find address or place
Fort Lewis
Dupont
Adams Woods
Hunter Woods
Hoffman Hill
Eagles Pride Golf Course
Sequalitchew Creek
Edmond Marsh
Ross Hill
Lister Hill
Burke Hill
Cohn Hill
Miller Hill
Kennedy Woods
Bloyd Woods
Anderson Woods
Bear Hill
Black Hill
Travis
Harter Hill
McCarr Hill
Camp Murray National Guard
Joint Base Lewis McChord
1 km
1 mi

Legend | Wetland Tools | Zoom | Tools

Add/Remove map data layers

- TMDL Items
  - Wetland
- 305(b) List
  - Category 4A Water
  - Category 4A Sediment
  - Category 4B Water
  - Category 4B Sediment
  - Category 4C Water
- Subbasins (12 digit HUCs)
  - HUC boundary

Project: **Edmond Marsh** Wetland: **Edmond Marsh** (Depressional) Date: **08/11/2022**



Legend | Wetland Tools | Zoom | Tools

Add/Remove map data layers

- Habitat Items
  - Generates exessive runoff
  - Generates pollutants
  - Generates exessive runoff and pollutants
  - Upland within 150' wetland buffer
  - Wetland
  - Wetland buffer (150')

Project: **Edmond Marsh** Wetland: **Edmond Marsh** (Depressional) Date: **08/11/2022**

Wetland name or number: Wetland 1-D

RATING SUMMARY - Western Washington

Name of wetland (or ID#): Wetland 1-D **Date of site visit:** 04/20/2022
Rated By: Gabriel Allen **Trained by Ecology? Yes** [X] **No** [ ] **Date of Training:** 06/08/2022
HGM Class used for rating: Depressional
Wetland has multiple HGM classes? Yes [ ] **No** [X]

NOTE: Form is not complete without the figures requested *(figures can be combined).*
Source of base aerial photo/map:

OVERALL WETLAND CATEGORY: [**Category II**] (based on functions [X] or special characteristics [ ])

1. Category of wetland based on FUNCTIONS

[ ] **Category I** - Total score = 23 - 27
[X] **Category II** - Total score = 20 - 22
[ ] **Category III** - Total score = 16 - 19
[ ] **Category IV** - Total score = 9 - 15

FUNCTION	Improving Water Quality	Hydrologic	Habitat	
Site Potential	**H**	**M**	**M**	
Landscape Potential	**M**	**M**	**M**	
Value	**H**	**L**	**H**	**Total**
Score Based on Ratings	**8**	**5**	**7**	**20**

Score for each function based on three ratings (order of ratings is not important)
9 = H,H,H
8 = H,H,M
7 = H,H,L
7 = H,M,M
6 = H,M,L
6 = M,M,M
5 = H,L,L
5 = M,M,L
4 = M,L,L
3 = L,L,L

2. Category based on SPECIAL CHARACTERISTICS of wetland

CHARACTERISTIC	CATEGORY
Estuarine	
Wetland of High Conservation Value	
Bog	
Forested	
Coastal Lagoon	
Interdunal	
None of the above	**Not Applicable**

Wetland name or number: Wetland 1-D

Maps and figures required to answer questions correctly for Western Washington

Depressional Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	D 1.3, H 1.1, H 1.4	
Hydroperiods	D 1.4, H 1.2	
Location of outlet *(can be added to map of hydroperiods)*	D 1.1, D 4.1	
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	D 2.2, D 5.2	
Map of the contributing basin	D 4.3, D 5.3	
1km Polygon: Area that extends 1km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	D 3.1, D 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	D 3.3	

Wetland name or number: Wetland 1-D

DEPRESSIONAL AND FLATS WETLANDS

Water Quality Functions - Indicators that the site functions to improve water quality

D 1.0 Does the site have the potential to improve water quality?

D 1.1 What are the characteristics of surface water outflows from the wetland?		
Wetland has no surface water outlet.	points = 3	
Wetland has an intermittently flowing, or highly constricted, outlet.	points = 2	
Wetland has an unconstricted, or slightly constricted, surface outlet that is permanently flowing	points = 1	
Wetland is a flat depression whose outlet is a permanently flowing ditch.	points = 1	**Score: 3**
D 1.2 Can the soil 2in below the surface be identified as true clay or organic soil?		
Mapped as true clay or organic (muck or peat)	points = 4	
Soil texture identified as clay or organic in field	points = 4	
Soil texture identified as clay or organic by laboratory test	points = 4	
None of the above	points = 0	**Score: 0**
D 1.3 What are the characteristics and distribution of persistent plants?		
Wetland has persistent, ungrazed, plants > 95% of area	points = 5	
Wetland has persistent, ungrazed, plants > 50% of area	points = 3	
Wetland has persistent, ungrazed plants > 10% of area	points = 1	
Wetland has persistent, ungrazed plants < 10% of area	points = 0	**Score: 5**
D 1.4 What are the characteristics of seasonal ponding or inundation in the wetland area?		
Area seasonally ponded is > 50% total area of wetland	points = 4	
Area seasonally ponded is > 25% total area of wetland	points = 2	
Area seasonally ponded is < 25% total area of wetland	points = 0	**Score: 4**
	Total for D 1:	**12**

Rating of Site Potential [X] **12-16 = H** [ ] **6-11 = M** [ ] **0-5 = L** *Record the rating on the first page*

D 2.0 Does the landscape have the potential to support the water quality function of the site?

D 2.1 Does the wetland unit receive stormwater discharges?		
Yes	points = 1	
No	points = 0	**Score: 1**
D 2.2 Is >10% of the area within 150ft of the wetland in land uses that generate pollutants in surface runoff?		
Yes	points = 1	
No	points = 0	**Score: 0**
D 2.3 Are there septic systems within 250ft of the wetland?		
Yes	points = 1	
No	points = 0	**Score: 0**
D 2.4 Are there other sources of pollutants coming into the wetland that are not listed in questions D 2.1-D 2.3?		
Yes	points = 1	
No	points = 0	**Score: 1**

Wetland name or number: Wetland 1-D

D 2.5 What are the other sources of pollutants coming into the wetland? Dogs on trails in and around the wetland	
Total for D 2:	**2**

Rating of Landscape Potential [ ] **3-4 = H** [X] **1-2 = M** [ ] **0 = L** *Record the rating on the first page*

D 3.0 Is the water quality improvement provided by the site valuable to society?		
D 3.1 Does the wetland discharge directly (i.e., within 1 mi) to a stream, river, lake, or marine water that is on the 303(d) list?		
Yes	points = 1	
No	points = 0	**Score: 0**
D 3.2 Is the wetland in a basin or sub-basin where an aquatic resource is on the 303(d) list?		
Yes	points = 1	
No	points = 0	**Score: 1**
D 3.3 Has the site been identified in a watershed or local plan as important for maintaining water quality?		
Yes	points = 2	
No	points = 0	**Score: 2**
Total for D 3:		**3**

Rating of Value [X] **2-4 = H** [ ] **1 = M** [ ] **0 = L** *Record the rating on the first page*

DEPRESSIONAL AND FLATS WETLANDS

Hydrologic Functions - Indicators that the site functions to reduce flooding and stream degradtion

D 4.0 Does the site have the potential to reduce flooding and erosion?		
D 4.1 What are the characteristics of surface water outflows from the wetland?		
Wetland has no surface water outlet.	points = 4	
Wetland has an intermittently flowing, or highly constricted, outlet.	points = 2	
Wetland is a flat depression whose outlet is a permanently flowing ditch.	points = 1	
Wetland has an unconstricted, or slightly constricted, surface outlet that is permanently flowing	points = 0	**Score: 4**
D 4.2 What is the depth of storage during the wet periods?		
Marks of ponding are 3ft or more above the surface or bottom of the outlet.	points = 7	
Marks of ponding are between 2ft to <3ft from the surface or bottom of the outlet.	points = 5	
Marks of ponding are at least 0.5ft to <2ft from the surface or the bottom of the outlet.	points = 3	
The wetland is a "headwater" wetland.	points = 3	
The wetland is flat but has small depressions on the surface that trap water.	points = 1	
Marks of ponding are less than 0.5ft (6in).	points = 0	**Score: 3**

Wetland name or number: Wetland 1-D

D 4.3 What is the contribution of the wetland to storage in the watershed?		
The area of the basin is less than 10 times the area of the unit	points = 5	
The area of the basin is 10 to 100 times the area of the unit	points = 3	
The area of the basin is more than 100 times the area of the unit	points = 0	
Entire wetland is in the Flats class	points = 5	**Score: 3**
	Total for D 4:	**10**

Rating of Site Potential [ ] **12-16 = H** [X] **6-11 = M** [ ] **0-5 = L** *Record the rating on the first page*

D 5.0 Does the landscape have the potential to support hydrologic functions of the site?		
D 5.1 Does the wetland unit receive stormwater discharges?		
Yes	points = 1	
No	points = 0	**Score: 1**
D 5.2 Is >10% of the area within 150 ft of the wetland in land uses that generate excess runoff?		
Yes	points = 1	
No	points = 0	**Score: 0**
D 5.3 Is more than 25% of the contributing basin of the wetland covered with intensive human land uses?		
Yes	points = 1	
No	points = 0	**Score: 1**
	Total for D 5:	**2**

Rating of Landscape Potential [ ] **3 = H** [X] **1-2 = M** [ ] **0 = L** *Record the rating on the first page*

D 6.0 Are the hydrologic functions provided by the site valuable to society?		
D 6.1 Is the wetland in a landscape that has flooding problems?		
Flooding occurs in a sub-basin that is immediately down-gradient of the wetland.	points = 2	
Surface flooding problems are in a sub-basin farther down-gradient.	points = 1	
Flooding from groundwater is an issue in the basin.	points = 1	
The existing or potential outflow from the wetland is so constrained that water cannot reach areas that flood.	points = 0	
There are no problems with flooding downstream of the wetland.	points = 0	**Score: 0**
D 6.2 Has the site been identified as important for flood storage or flood conveyance in a regional flood control plan?		
Yes	points = 2	
No	points = 0	**Score: 0**
	Total for D 6:	**0**

Rating of Value [ ] **2-4 = H** [ ] **1 = M** [X] **0 = L** *Record the rating on the first page*

Wetland name or number: Wetland 1-D

HABITAT FUNCTIONS

These questions apply to wetlands of all HGM classes - Indicators that the site functions to provide important habitat

H 1.0 Does the wetland have the potential to provide habitat for many species?

H 1.1 What is the structure of the plant community?

- [ ] Aquatic Bed
- [ ] Emergent
- [x] Scrub-shrub
- [x] Forested
- [x] Multiple strata within the Forested class (canopy, sub-canopy, shrubs, herbaceous, moss/ground cover)

4 structures or more	points = 4	
3 structures	points = 2	
2 structures	points = 1	
1 structure	points = 0	
No structures present	points = 0	**Score: 2**

H 1.2 What are the hydroperiods that meet the size thresholds in the wetland?

- [ ] Permanently flooded or inundated
- [x] Seasonally flooded or inundated
- [ ] Occasionally flooded or inundated
- [x] Saturated only
- [ ] Permanently flowing stream or river in, or adjacent to, the wetland
- [ ] Seasonally flowing stream in, or adjacent to, the wetland
- [ ] Lake Fringe wetland
- [ ] Freshwater Tidal wetland

4 or more types present	points = 3	
3 types present or Lake Fringe / Freshwater Tidal Fringe	points = 2	
2 types present	points = 1	
1 type present	points = 0	
None present	points = 0	**Score: 1**

H 1.3 What is the richness of the plant species in the wetland?

>19 species	points = 2	
5-19 species	points = 1	
<5 species	points = 0	**Score: 1**

Wetland name or number: Wetland 1-D

H 1.4 What is the interspersion of habitats?

High	points = 3	
Moderate	points = 2	
Low	points = 1	
None	points = 0	**Score: 2**

H 1.5 What are the special habitat features in the wetland?

- [x] Large, downed, woody debris within the wetland (>4in diameter and 6ft long).
- [x] Standing snags (dbh >4in) within the wetland
- [ ] Undercut banks are present for at least 6.6ft (2m) and/or overhanging plants extend at least 3.3ft (1m) over open water or a stream (or ditch) in, or contiguous with the wetland, for at least 33ft (10m)
- [ ] Stable steep banks of fine material that might be used by beaver or muskrat for denning (>30 degree slope) OR signs of recent beaver activity are present (cut shrubs or trees that have not yet weathered where wood is exposed)
- [x] At least 0.25ac of thin-stemmed persistent plants or woody branches are present in areas that are permanently or seasonally inundated (structures for egg-laying by amphibians)
- [x] Invasive plants cover less than 25% of the wetland area in every stratum of plants (see H 1.1 for list of strata)

6 habitats selected	points = 6	
5 habitats selected	points = 5	
4 habitats selected	points = 4	
3 habitats selected	points = 3	
2 habitats selected	points = 2	
1 habitat selected	points = 1	
No habitats selected	points = 0	**Score: 4**

Total for H 1: **10**

Rating of Site Potential [ ] **15-18 = H** [X] **7-14 = M** [ ] **0-6 = L** *Record the rating on the first page*

H 2.0 Does the landscape have the potential to support habitat functions of the site?

H 2.1 What is the percentage of accessible habitat within 1km of the wetland?

>33% of 1km Polygon	points = 3	
20-33% of 1km Polygon	points = 2	
10-19% of 1km Polygon	points = 1	
<10% of 1km Polygon	points = 0	**Score: 2**

H 2.2 What is the percentage of total habitat in a 1km polygon around the wetland?

Total habitat is >50% of the Polygon	points = 3	
Total habitat is 10-50% of the Polygon and in 1-3 patches	points = 2	
Total habitat is 10-50% of the Polygon and in >3 patches	points = 1	
Total habitat is <10% of the Polygon	points = 0	**Score: 1**

Wetland name or number: Wetland 1-D

H 2.3 What is the land use intensity in the 1km polygon?

50% of the Polygon is high intensity land use	points = -2	
<50% of the Polygon is high intensity land use	points = 0	**Score: -2**
	Total for H 2:	**1**

Rating of Landscape Potential [ ] **4-6 = H** [X] **1-3 = M** [ ] **0 = L** *Record the rating on the first page*

H 3.0 Is the habitat provided by the site valuable to society?

H 3.1 Does the site provide habitat for species valued in laws, regulations, or policies?

- [ ] Aspen Stands
- [ ] Biodiversity Areas and Corridors
- [ ] Herbaceous Balds
- [ ] Old-growth/Mature Forests
- [ ] Oregon White Oak
- [x] Riparian
- [ ] Westside Prarie
- [ ] Fresh Deepwater
- [x] Instream
- [ ] Nearshore (Coastal, Open Coast, Puget Sound)
- [ ] Caves
- [ ] Cliffs
- [x] Snags and Logs
- [ ] Talus

The following criteria automatically score 2 points:

- [ ] The wetland provides habitat for Threatened or Endangered species
- [ ] The wetland is mapped as a location for an individual WDFW priority species
- [x] The wetland is a Wetland of High Conservation Value
- [ ] The wetland has been categorized as an important habitat site in a local plan

The wetland has 3 or more WDFW priority habitats within 100m, or meets the criteria for societal value	points = 2	
The site has 1 or 2 WDFW priority habitats within 100m	points = 1	
The site does not meet any of the criteria for societal value	points = 0	**Score: 2**
	Total for H 3:	**2**

Rating of Value [X] **2 = H** [ ] **1 = M** [ ] **0 = L** *Record the rating on the first page*

Wetland name or number: Wetland 1-D

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

SC 1.0 Estuarine Wetlands

SC 1.1 Does the wetland meet all of the following criteria for Estuarine wetlands?

☐ The dominant water regime is tidal
☐ The wetland is vegetated
☐ The water salinity is greater than 0.5 ppt

Yes - Go to SC 1.2

No - Not an Estuarine Wetland

Result: Not an Estuarine Wetland

SC 1.2 Is the wetland within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-30-151?

Yes - Category I Estuarine Wetland

No - Go to SC 1.3

Result:

SC 1.3 Is the wetland unit at least 1ac in size and meets at least two of the following three conditions?

☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 10% cover of non-native plant species.

☐ At least 75% of the landward edge of the wetland has a 100ft buffer of shrub, forest, or un-grazed or un-mowed grassland

☐ The wetland has at least two of the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands.

Yes - Category I Estuarine Wetland

No - Category II Estuarine Wetland

Result:

SC 2.0 Wetlands of High Conservation Value

SC 2.1 Is the wetland listed by Washington Natural Heritage Program WDNR as a Wetland of High Conservation Value (WHCV)?

Yes - Category I Wetland of High Conservation Value

No - Go to SC 2.2

Result: Go to SC 2.2

SC 2.2 Does the wetland have a rare plant species, rare plant community, or high-quality common plant community that may qualify the site as a WHCV?

Yes - Category I Wetland of High Conservation Value

No - Not a Wetland of High Conservation Value

Result: Not a Wetland of High Conservation Value

Wetland name or number: Wetland 1-D

SC 3.0 Bogs

SC 3.1 Does an area within the wetland unit have organic soil horizons, either peats or mucks, that compose 16in or more of the first 32in of the soil profile?

Yes - Go to SC 3.3
No - Go to SC 3.2 **Result: Go to SC 3.2**

SC 3.2 Does an area within the wetland unit have organic soils, either peats or mucks, that are less than 16 in deep over bedrock, or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond?

Yes - Go to SC 3.3

No - Not a Bog Wetland **Result: Not a Bog Wetland**

SC 3.3 Does an area with peats or mucks have more than 70% cover of mosses at ground level, AND at least 30% cover of plant species listed in the table provided in the instructions?

Yes - Category I Bog Wetland
No - Go to SC 3.4 **Result:**

SC 3.4 Is an area with peats or mucks forested (>30% cover) with Sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Engelmann Spruce, or western white pine AND any of the species (or combinations of species) listed in the table found in the instructions provide more than 30% of the cover under the canopy?

Yes - Category I Bog Wetland
No - Not a Bog Wetland **Result:**

SC 4.0 Forested Wetlands

SC 4.1 Does the wetland have at least 1 contiguous acre of forest that meets one of the following criteria?

☐ Old-growth forests
☐ Mature forests

Yes - Category I Forested Wetland

No - Not a Forested Wetland **Result: Not a Forested Wetland**

Wetland name or number: Wetland 1-D

SC 5.0 Wetlands in Coastal Lagoons

SC 5.1 Coastal Lagoons: Does the wetland meet all of the following criteria of a wetland in a coastal lagoon?

☐ The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or rocks

☐ The depression in which the wetland is located contains ponded water that is saline or brackish (>0.5 ppt) during most of the year in at least a portion of the open water area (measured near the bottom)

Yes - Go to SC 5.2

No - Not a Coastal Lagoon Wetland **Result: Not a Coastal Lagoon Wetland**

SC 5.2 Does the wetland meet all of the following three conditions?

☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of aggressive, opportunistic plant species (see list of species).

☐ At least 75% of the landward edge of the wetland has a 100ft buffer of shrub, forest, or un-grazed or un-mowed grassland.

☐ the wetland is larger than 0.10ac (4350 sqft)

Yes - Category I Coastal Lagoon

No - Category II Coastal Lagoon **Result:**

SC 6.0 Interdunal Wetlands

SC 6.1 Is the wetland west of the 1889 line (also called the Western Boundary of Upland Ownership WBUO)?

Yes - Go to SC 6.2

No - Not an Interdunal Wetland **Result: Not an Interdunal Wetland**

SC 6.2 Is the wetland 1ac or larger in size, or a mosaic that is 1ac or larger in size?

Wetland is larger than 1ac in size - Go to SC 6.3

Wetland is a mosaic larger than 1ac is size - Category II Interdunal Wetland

No - Go to SC 6.4 **Result:**

SC 6.3 Does the wetland score 8 or 9 points for the habitat functions?

Yes - Category I Interdunal Wetland

No - Category II Interdunal Wetland **Result:**

SC 6.4 Is the wetland unit between 0.1ac and 1ac, or in a mosaic of wetlands that is between 0.1ac and 1ac in size?

Yes - Category III Interdunal Wetland

No - Category IV Interdunal Wetland **Result:**

Wetland name or number: Wetland 1-D

Category of wetland based on Special Characteristics	
If you answered No for all types, enter "Not Applicable" on Summary Form	**Final Category: Not Applicable**

Legend | Wetland Tools | Zoom | Tools

Add/Remove map data layers

Cowardin Plant Class Items

Cowardin Classes

- Forested
- Scrub-shrub
- Emergent
- Aquatic bed
- Open water
- Wetland/Unmapped wetland

Project: **Wetland 1-D** Wetland: **Wetland 1-D** (Depressional) Date: **08/10/2022**

Legend | Wetland Tools | Zoom | Tools

Add/Remove map data layers

Hydroperiod Items

- Permanent Stream
- Seasonal Stream
- Permanently
- Seasonally
- Occasionally
- Saturated only
- Wetland/Unmapped wetland

Project: **Wetland 1-D** Wetland: **Wetland 1-D** (Depressional) Date: **08/10/2022**

Legend | Wetland Tools | Zoom | Tools

Project: **Wetland 1-D** Wetland: **Wetland 1-D** (Depressional) Date: **08/10/2022**

Add/Remove map data layers

Contributing Basin Items

- Wetland
- Contributing basin

Legend | Wetland Tools | Zoom | Tools

Project: **Wetland 1-D** Wetland: **Wetland 1-D** (Depressional) Date: **08/10/2022**

Add/Remove map data layers

Habitat Items

- Relatively undisturbed - accessible
- Low/Moderate intensity - accessible
- Relatively undisturbed - not accessible
- Low/Moderate intensity - not accessible
- High intensity
- Wetland
- Unmapped wetland buffer (1 km)

Legend | Wetland Tools | Zoom | Tools

Project: **Wetland 1-D** Wetland: **Wetland 1-D** (Depressional) Date: **08/10/2022**

Add/Remove map data layers

Wetland Width Items

Wetland

Distance from wetland to nearest 303(d) listing

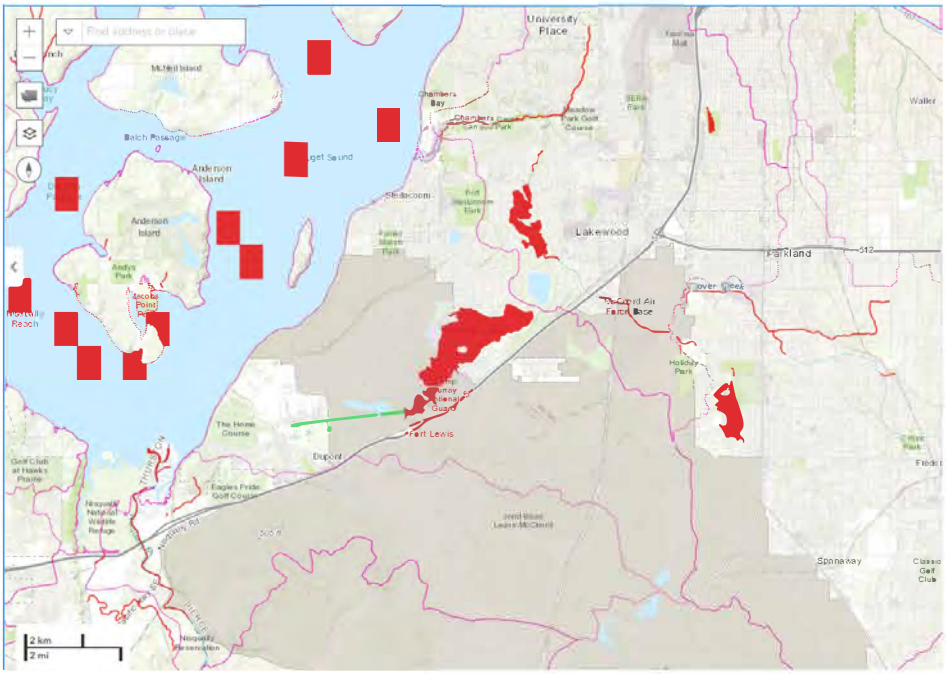
303(d) List

Category 5 Water

Category 5 Sediment

Subbasins (12 digit HUCs)

HUC boundary



Legend | Wetland Tools | Zoom | Tools

Project: **Wetland 1-D** Wetland: **Wetland 1-D** (Depressional) Date: **08/10/2022**

Add/Remove map data layers

TMDL Items

Wetland

305(b) List

Category 4A Water

Category 4A Sediment

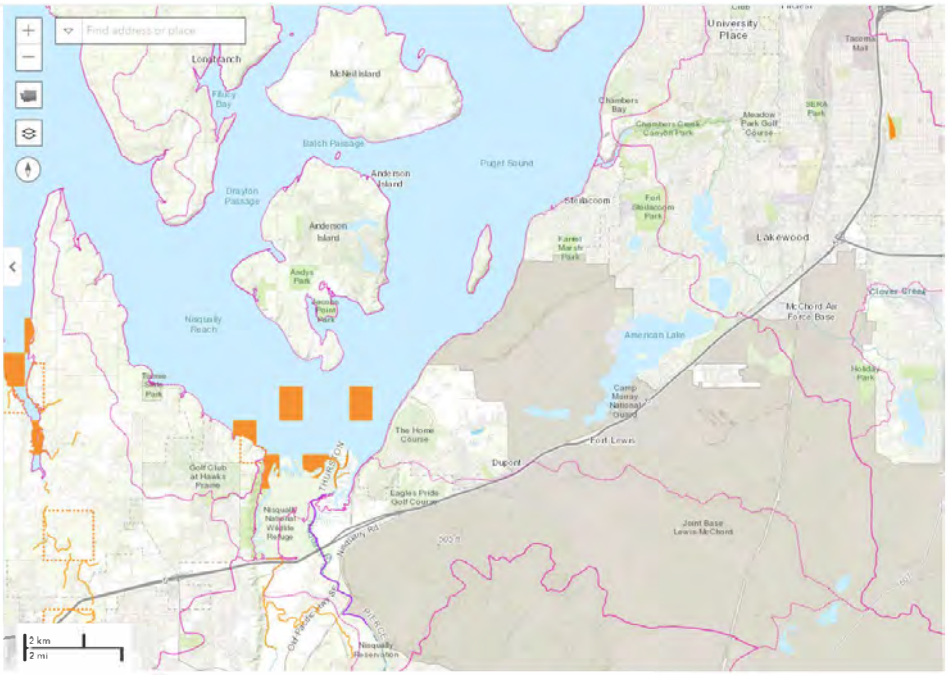
Category 4B Water

Category 4B Sediment

Category 4C Water

Subbasins (12 digit HUCs)

HUC boundary



Legend | Wetland Tools | Zoom | Tools

Project: **Wetland 1-D** Wetland: **Wetland 1-D** (Depressional) Date: **08/10/2022**

Add/Remove map data layers

Habitat Items

- Generates excessive runoff
- Generates pollutants
- Generates excessive runoff and pollutants
- Upland within 150' wetland buffer
- Wetland
- Wetland buffer (150')

Appendix D
Site Photographs

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Appendix B
Earth and Water Resources Technical Report, DuPont Mine South Parcel Project

EARTH AND WATER RESOURCES REPORT

Pioneer Aggregates South Parcel Project

Prepared for: CalPortland

Project No. 040001-018 • November 11, 2022 FINAL

Aspect CONSULTING

earth + water

EARTH AND WATER RESOURCES REPORT

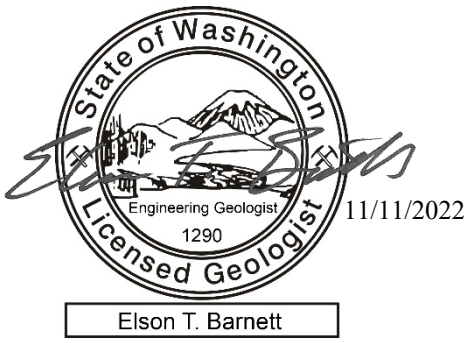
Pioneer Aggregates South Parcel Project

Prepared For: CalPortland

Project No. 040001-018 • November 11, 2022 FINAL

Aspect Consulting, LLC

11/11/2022



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1 Introduction

Glacier Northwest, Inc. dba CalPortland is seeking regulatory approvals for the Pioneer Aggregates South Parcel Project ("South Parcel Project"), which proposes to extend sand and gravel mine operations to the southeast of existing activities at the Pioneer Aggregates Mine in DuPont, Washington. Figure 1 provides an overview map of the South Parcel Project.

This document evaluates the environmental conditions and potential impacts of the South Parcel Project, and potential alternative actions, on earth and water resources. These analyses are being conducted as a component of the State Environmental Policy Act (SEPA) evaluation for the South Parcel Project.

The report is divided into three main sections: Geology, Groundwater, and Surface Water. The Geology section summarizes the geologic conditions and geologic hazards, and analyzes the stability of the existing and proposed slopes. The Groundwater and Surface Water sections describe the existing systems, identify the effects of mining on water resources, and provide preliminary design concepts for stormwater and erosion controls.

1.1 Description of the Proposed Action

Consistent with the 2012 Settlement Agreement (discussed further below), the South Parcel Project (Proposed Action) includes horizontal expansion of mining into approximately 188 acres previously undisturbed by mining, and vertical expansion of approximately 125 acres where re-mining would deepen a portion of the existing mine. The South Parcel Project would extend mining at the current rate for approximately 14 additional years.

The proposed South Parcel Project activities would be focused southeast of the existing Pioneer Aggregates Mine in the City of DuPont (City), southwestern Pierce County, sections 22, 23, and 26, Township 19 North, Range 1 East of the Willamette Meridian. The South Parcel Project is bordered to the north and west by the existing Pioneer Aggregates mine; to the east by industrial/distribution facilities including Amazon, Dania, Pier 1 Imports, and FedEx; and to the south by Sequalitchew Creek and the Creekside Village residential development. The South Parcel Project would occur on lands owned by Weyerhaeuser Company and leased to CalPortland.

The South Parcel Project includes mining within areas previously undisturbed by mining (termed the "Expansion Area") and mining deeper within a portion of existing mine, referred to as the "Re-Mine Area." The Expansion Area is approximately 188 acres and is comprised of three subareas, shown on Figure 2. The Kettle Area is a 10.8-acre previously undisturbed area that includes the Kettle Wetland. The 9.2-acre Buffer Strip is a strip of vegetation that was retained along the inside of the originally permitted mine bordering the South Parcel. The South Parcel is 167.5 acres located southeast of the

original mine and inside the Mineral Resource Overlay in the City's adopted Comprehensive Plan.

The Re-Mine Area consists of 125 acres in the southeastern portion of the existing mine where groundwater limits the depth of current mining activities.

The South Parcel Project was developed consistent with a 2012 Settlement Agreement between CalPortland, the City of DuPont, the Washington State Department of Ecology (Ecology), and a coalition of environmental groups collectively referred to as the Environmental Caucus. The Settlement Agreement describes a process for a Restoration Plan for the Sequalitchew Creek watershed to be permitted and implemented contemporaneously with mining of the South Parcel. The Restoration Plan is designed "to help restore and enhance the Sequalitchew Creek watershed, including flows along the entire length of the Creek." The Restoration Plan is not intended solely as mitigation for the South Parcel Project, and the benefits of implementing would more than mitigate for the impacts of the mine. The Restoration Plan is described in Section 4.4.3.

1.1.1 Existing Mine

CalPortland's original sand and gravel mine was permitted in 1996 (355 acres). As provided under the Settlement Agreement, CalPortland applied for permits in 2013 for the North Parcel Mine Expansion to allow mining of approximately 142 acres within the North Parcel. Following the publication of a Final EIS in June 2013, the North Parcel mining expansion was permitted in 2014.

Activities at the existing site include mining and reclamation, processing, transport of sand and gravel, and manufacturing of concrete. The processing area is located adjacent to the mine site on a 52-acre parcel owned by Glacier Northwest (Glacier). Sand and gravel is removed from the mine by bulldozers and wheel loaders and transferred to the processing area by conveyor belts. At the processing facility, the material from the mine is crushed, washed, and separated into different size gradations. Aggregate products are stored in stockpiles in the processing area for distribution.

After completion of the production process, the majority (approximately 80 percent) of the finished aggregate products are transported from the plant area by conveyors and placed onto barges at Glacier's dock and barge-loading facility at Tatsolo Point. The remainder (approximately 20 percent) is sold as aggregate or used to make concrete on-site; in both cases it is transported by truck.

Water used to wash gravel during processing is recycled through a clarifying process to remove silt and clay. This fine material is run through a belt press to remove excess water, transported by truck, and then placed in holding cells in the mine, where it is allowed to dry for up to 3 years.

After drying, fines may be used to raise the floor of the mine by placing the material in cells separated by rock curtains to facilitate drainage. The material is placed in approximately 6-inch lifts and compacted to a material dry density of 90 percent (ASTM D1557) or greater. Once filled to the desired height with fines from the belt press in this manner, a gravel cap of not less than 10 feet is placed over the compacted fines to mitigate potential for settlement and facilitate drainage.

1.1.2 South Parcel Project

The proposed South Parcel Project includes expansion of the mine footprint by approximately 188 acres and extension of the existing rate of mining for an additional approximate 14-year period (depending on market conditions), increasing the available sand and gravel resources by 30 to 40 million tons. The Expansion Area is located within a Mineral Resource Overlay applied by the City's Comprehensive Plan. The purpose of the overlay is to conserve mineral resources of long-term commercial significance, as required by the Growth Management Act.

The South Parcel Project would involve six primary activities: logging, clearing and topsoil removal, groundwater management, mining, processing and transport, and reclamation. These activities would overlap, with multiple actions occurring in different portions of the mine at any one time. For example, while active mining is occurring in one portion of the mine, earlier-mined areas may be reclaimed, and other areas to be mined next could be cleared and having topsoil stockpiled.

The following sections provide descriptions of each of the primary activities involved in mining sand and gravel.

1.1.2.1 Logging

Timber was last logged from the South Parcel several decades ago, but tree cutting would still be needed prior to clearing and mining in the Expansion Area. A substantial portion of the proposed mining would occur within previously reclaimed areas of the existing mine (i.e., the Re-Mine Area) or in previously unmined areas where Scot’s broom shrub dominates the landscape. The Expansion Area would be logged at a single time prior to initiating mining.

1.1.2.2 Clearing and Topsoil Removal

Prior to mining, excavators would remove stumps and vegetation. This material would then be processed through a portable tub grinder and used to amend topsoil for use in reclamation. Clearing and topsoil removal would occur in the mine area, in segments as mining advances into the Expansion Area, over the life of the project.

The Expansion Area is located downwind of the former Asarco copper smelter and refinery in Ruston, Washington. Airborne pollution emitted from the former smelter has resulted in a 1,000-square-mile, area-wide plume of arsenic- and lead-contaminated soil known as the Tacoma Smelter Plume (TSP). Surficial soils in the Expansion Area that have been undisturbed since the mid-1980s may contain arsenic and lead at concentrations above cleanup levels. These soils would be cleaned up under an approved plan developed in consultation with Ecology through the Voluntary Cleanup Program (VCP). The plan incorporates the same process that is being successfully implemented on the North Parcel.

1.1.2.3 Groundwater Management

An existing aquifer is present in the sands and gravels to be mined under the South Parcel Project. Wells would be installed and pumped in advance of mining to intercept groundwater and dry out the gravels for mining. The mining plan is designed to minimize the amount of time that active dewatering by pumping wells is required.

Mining under the South Parcel Project would proceed slowly from the north to the south over a period of 5 to 8 years, extracting gravel to create a broad trough along the eastern property boundary. Once mining of each section of trough is completed, the adjacent wells can be turned off, allowing groundwater to passively seep from the stable mine slope and flow by gravity to an infiltration facility on the floor of the existing mine. After mining the trough along the perimeter, gravel would be extracted from the interior area over an approximately 6- to 9-year period.

A dewatering plan has been developed and is described in detail in the Monitoring Plan (Aspect, 2017a). The dewatering plan involves four steps, occurring over very different time scales. The four steps are:

The initial step is a 60-day pumping test that is completely reversible (i.e., no gravel would be extracted during the test). The results of that test would be analyzed to confirm predictions from the groundwater drawdown model and used to adjust the dewatering plan (well spacing, well screening, etc.) as necessary prior to commencing the next phase. Depending on seasonal timing, the Kettle Wetland (described in Section 4.1.2.1) may be dewatered during the pumping test, but the water level would return after completion of the test. Total duration that Kettle Wetland levels may be dewatered is less than 120 days.

The second step involves installing and pumping additional dewatering wells to lower water levels in the first mine segment in preparation for mining. This step would last about 6 months and functions as a greatly expanded pumping test. As with the initial step, it is also completely reversible. Groundwater observations during pumping would be compared to model predictions to confirm that actual changes in groundwater are within the range predicted during project planning, when potential impacts from the project are evaluated. This step would confirm model predictions before any gravel is removed from the Expansion Area. The Kettle Wetland would be dewatered shortly after commencing this dewatering step and would remain dewatered through the duration of this step, estimated at 180 days.

The third step – active dewatering during mining – involves mining the trough described above. Additional dewatering wells would be installed and pumped as mining progresses. Mining would begin at the location farthest from the Edmond Marsh and Sequalitchew Creek and proceed slowly south. Completing the trough would require 5 to 8 years depending on market conditions and the success in meeting predicted groundwater levels. The potential impact on groundwater levels builds slowly over time as wells are added and mining progresses to the south. This allows ample opportunity to monitor, confirm model predictions, and adapt to the conditions observed before mining proceeds into each dewatered segment.

The Kettle Wetland would be removed in the early mining of this dewatering step. The wetland soils and seed bank would be used in construction of the mitigation wetland, as described in the Wetland Mitigation Plan (Anchor QEA, 2021).

The final step – passive dewatering – begins when mining of the trough described above is complete and the last dewatering well is turned off. Passive dewatering represents the groundwater condition that would continue in perpetuity. Groundwater, no longer intercepted by wells, would form seeps at the toe of the eastern mine slope. It would flow by gravity through a conveyance ditch to newly created wetlands on the bottom of the

existing mine and eventually to an infiltration pond. Once this step has begun, further mining activities in the interior of the South Parcel would not affect groundwater outside the footprint of the mine.

In each of the four steps, water generated from dewatering would be conveyed to the floor of the existing mine and infiltrated. Water from the northern portion of the dewatering system would be routed directly to an infiltration pond located in the northern portion of the original mine parcel. Water from the southern portion of the dewatering system would be routed to a constructed mitigation wetland in the southwest corner of the existing mine, then flow north to the same infiltration pond.

1.1.2.4 Mining

The method of mining for the South Parcel Project would be identical to that currently used in the permitted mine area. A bulldozer would push excavated material from the top of the mine face to two front-end loaders working on the mine floor. The front-end loaders would scoop up the sand and gravel and dump it into portable hoppers that feed conveyors leading to the processing area.

The mine face of each sequence area would be a maximum of 80 feet high and would decrease as mine activities progress. During reclamation, the graded side slopes and mine areas would be revegetated and stabilized in accordance with the mine reclamation plan.

A conveyor would start at the north end of the Expansion Area and would be extended south as mining progresses. The conveyor is comprised of a 48-inch-wide rubberized belt supported by a series of rollers, called idlers, mounted on steel-framed segments that support the conveyor about 5 feet off the ground.

As mentioned above, clearing of the Expansion Area would occur in sequences lasting approximately 1 year, in coordination with mining and construction activities. Mass clearing of the site would not occur.

A 20-foot-high noise berm would be constructed along the southern boundary of the South Parcel behind retained vegetation to reduce potential noise associated with mining for adjacent land uses. The berm would be constructed prior to clearing in the adjacent portion of the South Parcel.

The project would directly impact an approximately 1.78-acre Kettle Wetland located within the existing mine just west of the South Parcel. The Kettle Wetland would be impacted by dewatering in preparation for mining, then removed during the initial phases of mining of the South Parcel Project. Impacts to the Kettle Wetland would be mitigated by creation of a larger wetland, referred to in this report as the constructed mitigation wetland, within the existing mine. Detailed analysis of the wetland impacts and mitigation are described in the Wetland Mitigation Plan (Anchor QEA, 2021).

1.1.2.5 Processing and Transport

Material mined under the South Parcel Project would be conveyed from the mine to the existing processing facility and processed in the same general manner as at present. The material extracted under the South Parcel Project is anticipated to have a higher moisture content and fines content than the aggregate currently being extracted. As a result, there

may be minor adjustments to some of the equipment used in the processing area, but the overall process and most of the equipment would remain unchanged.

Water is used to wash the raw material conveyed from the mine to remove silt and clay. Sand and gravel smaller than 1.5 inches pass through a screening and classifying process that separates and conveys the material to a series of stockpiles sorted by size and stacked on the south side of the processing plant. Stones larger than 1.5 inches are crushed, sorted by size, and conveyed to a series of crushed-rock stockpiles sorted by size north of the processing plant. Screening equipment, rock crushers, and other processing equipment are located between the stockpiles of sorted rock products. Custom blended rock products are also made to customer specifications.

More than 95 percent of water used to process the mined material is recycled through a treatment system where silt and clay is removed so the water can be reused to process more raw material from the mine.

The mode and extent of transporting aggregate products from the site would not change relative to existing operations. Approximately 80 percent of the product would be loaded onto barges at the existing dock at Tatsolo Point and transported to the Puget Sound regional market by barges. Approximately 20 percent of the product would be transported to the local market by truck. Some material would continue to be incorporated into concrete at the existing on-site concrete batch plant serving the local market.

1.1.2.6 Reclamation

As mining progresses, completed mine segments would be reclaimed. The reclamation plan would be reviewed by the Washington State Department of Natural Resources (DNR) for consistency with the Surface Mining Act (RCW 78.44). In general, reclamation would consist of regrading, replacement of topsoil, and revegetation. Glacier is in the process of preparing an application to revise the existing reclamation plan incorporated into the surface mining permit. DNR cannot approve the revised reclamation plan until after the City's permits are issued. The proposed reclamation plan would be similar to the plan approved by DNR for the existing mine.

A summary of the change in land uses that would occur as a result of the South Parcel Project mine reclamation is presented in Table 1. As shown in Table 1, the primary change occurring as a result of the South Parcel Project is the conversion of existing wooded areas into areas reclaimed as forest and as grass. Generally, the steeper slope areas would be reclaimed as forest and flat and gently sloping areas would be reclaimed as grass lands to support future redevelopment. This is true for areas within the South Parcel as well as the Kettle Area, Buffer Area, and the Re-Mine Area.

1.1.2.7 Estimated Volume and Extraction Rates

Estimated mining quantities are shown in Table 2. Based on past market demand, material would be extracted at an average rate of approximately 2.8 million cubic yards per year. An estimated 30 to 40 million cubic yards of material would be extracted as part of the South Parcel Project, which would extend the life of the current operation by about 14 years. The actual extraction rate and life of the mine would depend on the market demand for materials.

Table 2. Estimated Annual Quantities and Timing of Aggregate Mining

Timing	Existing Mine[1]	South Parcel Project
Years 1 through 14	1.4 million cy	1.4 million cy
Years 15 through 19	0	2.8 million cy

Notes: cy = cubic yards. [1] Existing mine includes North Parcel.

1.2 Description of No Action Alternative

This document also evaluates the No Action alternative, which is required by SEPA. No Action can be interpreted in two ways. It could mean that nothing happens on the site, which would essentially continue existing conditions. "No action" is also commonly interpreted to mean that the City would take no action on the mining proposal, but that does not necessarily mean that nothing would happen on the subject site. Although the South Parcel property would not be mined, it could be developed consistent with existing land use and zoning designations. Development potential under applicable zoning is described below.

Portions of the South Parcel are zoned for Manufacturing and Research Park (MRP; 136.2 acres), Residential-4 (R-4; 16.1 acres), Residential Reserve (RR; 22.3 acres), and Open Space (3.8 acres) uses. The MRP zoned areas are currently subject to restrictive covenants related to the Former DuPont Works Cleanup Site, which restrict use of the property to industrial uses. Remediation and rezoning are considered speculative, however, and would not be consistent with a "No Action" scenario.

The extent of development could vary considerably depending on zoning/density, site planning, economic considerations, and numerous site-specific, project-specific, and regulatory requirements including setbacks, open space, and the presence of critical areas. The following is intended to be a general estimate of the possible intensity of development for purposes of analysis only and is based primarily on zoned density and permitted site coverage. The development scenario for the South Parcel is reflected in Table 1. Development estimates are based on assumptions of building and parking areas as a percentage of developable area and do not represent a specific, or detailed, development proposal.

Areas zoned MRP would be available for development of up to 112 acres of light manufacturing and research park. Buildings may be up to 65 to 70 feet tall, and there are no maximum lot coverage requirements other than necessary to meet required setback (25 feet on the front property line, 15 feet on the sides and rear) and landscaping (20 percent of lot area) requirements. This zoned area could yield approximately 109 acres of impervious area at up to 80 percent lot coverage. The areas of the South Parcel zoned R-4 could be developed at a density of up to 4.5 single-family residences per gross acre[1], resulting in a total of approximately 76 residences and 69 percent impervious coverage[2]. An additional four single-family residences could be developed in the smaller portion

[1] "Gross acre" means land designated for residential purposes in the comprehensive plan, inclusive of related streets and neighborhood parks. DMC 25.10.040.

[2] Impervious area estimates for residential development are based on the density based impervious surface coefficient (ISCs) published by California's Environmental Protection Agency (2010).

zoned for Residential Reserve density (one dwelling unit per 5 gross acres) and 34 percent impervious coverage.

There would be no changes in the use of the areas of the South Parcel zoned for Open Space; these areas are currently the naturally vegetated slope of the Sequalitchew Creek ravine and the Sequalitchew Creek pedestrian trail.

A summary of the parcels, zoning, and development potential of the South Parcel is presented in Table 3 and illustrated on Figure 3.

Table 3. Parcels, Zoning, and Potential Development for No Action Alternative

Parcel No.	Zoning	Parcel Area (in acres)	Potential Development
0119262015	MRP	21.0	16.8 acres MRP
	OS	3.7	None
	Total	24.7	16.8 acres MRP
0119262016	MRP	34.0	27.3 acres MRP
0119233016	MRP	19.9	16.0 acres MRP
0119233017	MRP	20.1	16.3 acres MRP
0119233014	MRP	20.3	16.3 acres MRP
0119233015	MRP	20.3	16.4 acres MRP
0119233011	R-4	16.0	72 residences
	R-R	21.9	4 residences
	Total	38.0	76 residences

There would be no change in use of the areas within the existing mine under the No Action alternative scenario; however, once the existing mine is reclaimed it would likely be redeveloped according to its underlying zoning, similar to the South Parcel.

The Kettle Wetland within the existing mine would remain intact, the buffers would remain vegetated, and mining operations would continue in other portions of the existing mine.

2 Geology and Slope Stability

Geologic and geotechnical analyses were performed to determine geologic conditions beneath the existing ground surface of the Proposed Action. These analyses were completed to evaluate the stability of proposed cut slopes and identify areas prone to geologic hazards, such as slope failure or seismically induced soil liquefaction. The analyses rely on geologic investigations conducted over a period of more than 30 years, notably including over 109 borings completed in the late 1980s to facilitate planning of the initial Pioneer Aggregates mine.

Mining of the South Parcel Project would extract sand and gravel from a thick deposit Vashon Recessional Outwash (Qgog) deposit, including the Steilacoom Gravel (Qvs) subunit. These deposits are consistent with the existing mine to the west and north. The planned mining proposed for the South Parcel Project would result in a reduction in groundwater seepage and springs that are observed within the north Sequalitchew Creek ravine slope that will result in making the slopes more stable. Slope stability analyses results indicate proposed mining cut slopes would be relatively stable for static and seismic conditions.

The following Sections 2.1 through 2.6 have been developed using key references that include the Geotechnical Engineering Report (Aspect, 2021a), Critical Areas Report (Anchor and Aspect, 2021), and Groundwater Model Update Report (Aspect, 2017b). A summary of the key data and our analyses are presented below.

2.1 Affected Environment

2.1.1 Topography and Landform Geography

The South Parcel Project includes the Expansion Area, which is previously undisturbed by mining, and the Re-Mine Area, which is a portion of the existing mine that would be mined deeper. Existing topography of both areas is shown on Figure 4. The Expansion Area is generally flat at an elevation of approximately 200 feet.[3] The Re-Mine Area has a rolling slope toward the west down to the floor of the existing mine (western boundary of the expansion). The slopes to the west within the Re-Mine Area vary between a grade of 10 percent to 70 percent locally.

The Sequalitchew Creek ravine is located south and southwest of the South Parcel Project; this ravine forms most of the southern boundary of the existing mine. The ravine deepens as it approaches Puget Sound to a maximum depth of 175 feet below the plateau elevation. Slopes along the northern side of the Sequalitchew Creek Ravine range from approximately 30 percent to 75 percent. A narrow-gauge railroad associated with the former E.I. DuPont de Nemours Company munitions facility was constructed on a bench cut in the northern slope of the ravine; it has since been converted to a public trail.

[3] Elevation relative to the National Geodetic Datum of 1929 (NGVD 29). Unless otherwise noted, all elevations in this report are relative to NGVD 29.

2.1.2 Regional Tectonic Setting

The South Parcel Project lies within the Puget Sound Lowland, between the Cascade and Olympic Mountain ranges. The Cascade and Olympic Mountains and the Puget Sound Lowland result from tectonic forces acting on the oceanic plates and continental plates that constitute the landmass of western North America. Higher-density offshore oceanic plates are being subducted (pulled under) beneath the lower density and more buoyant North American continental plate. The interaction of the oceanic and continental plates puts generally compressive stress on the margins of the plates.

Over the past tens of millions of years, these east-to-west oriented compressive stresses have resulted in uplift of the Olympic and Cascade Mountains, along with volcanism that has further increased the height of the Cascades. The tectonic forces that resulted in uplift of the Cascades and Olympics have also resulted in creation of a basin that lies below the Puget Lowland. Subsidence of the Puget Lowland allowed thick sedimentary sequences to collect in the basin for the last 35 million years. More recently, the sediments in the Puget Lowland have been subjected to north-to-south compressive stresses that have folded and faulted them and created a series of basins and uplifts within the Puget Lowland. These basins extend from the Chehalis area to the Fraser lowland which extends north of the Canadian border.

Tectonic forces that created these lowlands, mountain ranges, and basins remain active today and result in the moderate-size earthquakes that are frequently felt throughout the region as well as infrequent large earthquakes.

2.1.3 Regional Geology and Geologic History

Geologic nomenclature in this report is primarily based on Borden and Troost (2001) and Walsh et al. (2003a and 2003b), which provide the most recent comprehensive regional understanding of Pleistocene stratigraphy in the south-central Puget Lowland. We also reference other nomenclature where previous studies use a different name for the same or similar geologic units.

The most recent ice-sheet glaciation of the Puget Lowland is termed the Vashon Stade of the Fraser Glaciation. Global and regional scientific observations indicate that there were many cooler climatic periods prior to the Vashon glaciation that produced ice-sheet glaciations, and geologists have identified deposits from a number of these pre-Vashon glacial and nonglacial periods in the Puget Lowland (Borden and Troost, 2001).

During the southward advance of the Vashon ice sheet, ice blocked the normal northward drainage of water from the Puget Sound Lowland, creating a pro-glacial lake into which silt, clay, and fine sand were deposited. As the Vashon ice sheet advanced farther southward, meltwater streams and rivers filled the remaining low areas with a blanket of sand and gravel that extended throughout the lowland. These subglacial troughs are visible today as the major waterways of Puget Sound, Hood Canal, Lake Washington, and Lake Sammamish, and many of the broad river valley bottoms in the Puget Lowland. A discontinuous layer of basal till (commonly described as lodgment till in older studies) was deposited where the glacial ice sheet contacted previously deposited sediment.

The Vashon ice sheet was short-lived in the lowland and the glacial ice appears to have stagnated abruptly. Sediment that was entrained on or within the ice was deposited on the

landscape when the ice melted. These deposits are called ablation till and are found largely intact where they were deposited on the uplands. Ablation till deposited in low areas was reworked by meltwater streams that flowed from the melting glaciers to form recessional outwash. In places, the deposits were influenced by shifting ice margins creating highly variable ice contact deposits, which contain both water-worked sands and gravels, and interbeds and lenses of silt and clay and till-like deposits.

These recessional sand and gravel deposits and interbedded ice contact deposits are collectively identified as Vashon Recessional Outwash (Qvr) on the geologic map and profiles. The recessional outwash generally consists of clean (containing very little silt and clay) sand and gravel, or sand and gravel with variable amounts of silt and interbeds and lenses of silty sands and gravels.

As the glaciers melted and receded, a lobe of ice blocked the northward drainage of the Puyallup valley, creating Glacial Lake Puyallup. A prominent late recessional gravelly outwash member called the Steilacoom Gravel is interpreted to have formed when a series of ice dam bursts (jokulhlaups) released the glacially impounded water in Glacial Lake Puyallup (Troost, 2007; and Troost and Sofield, 2011). Floodwaters spilled and transported coarse-grained sediments into a broad outwash plain in the Sequalitchew Creek area. These coarse-grained deposits created thick deltas where the outburst channels flowed into a lower elevation lake (Glacial Lake Russell) that had formed behind the remaining Vashon glacial ice.

Glacial Lake Russell (which is now partially occupied by modern Puget Sound) was deep and had steep sided walls in the area of the South Parcel, similar to those of the modern coastal bluffs. The contact between the sediments exposed in the former walls of Glacial Lake Russell and the overlying late glacial delta and flood deposits derived from Glacial Lake Puyallup is similarly steep and exhibits a marked change in soil types. The contact is called the “Olympia Beds Truncation” (referred to as the “Kitsap cutoff” in some older reports). The location of the Olympia Beds Truncation (Figure 6) is a key geologic and hydrologic feature at the South Parcel Project.

2.1.4 Site Geology

Geologic units of glacial and nonglacial origin were deposited at the South Parcel Project vicinity before, during, and after the Vashon glaciation. The understanding of site geologic conditions was further informed through the boring and monitoring well explorations that are shown on Figure 5 and presented in Appendix A of the Geotechnical Engineering Report (Aspect 2021a). A regional geologic map is shown on Figure 6 and a surficial geologic map of the South Parcel Project is provided on Figure 7. Well and boring logs were used to develop a cross section shown on Figure 8 that provides greater detail and shows the extent of the geologic units. Key well and boring logs are included in Appendix A.

The surface geology of the South Parcel Project area consists primarily of Vashon-age recessional sand and gravel (Qgog) that includes the Steilacoom Gravel (Qvs). The recessional glacial unit is underlain by older Vashon-age glacial deposits that may locally consist of glacial till (very dense consolidated diamict typically comprised of very dense

silty sand with gravel), pre-Vashon nonglacial deposits, and pre-Vashon glacial deposits – all comprised primarily of sand and gravel.

The uppermost pre-Vashon non-glacial sequence at the South Parcel Project area is identified as the Olympia beds. These nonglacial deposits are generally marked by an increase in silt, organics, and wood fragments and are observed in borings. They are termed the Olympia beds since being age-dated by Troost (Borden and Troost, 2001). Strata now known as Olympia beds were previously included within the informally named Kitsap formation (Walters and Kimmel, 1968).

Older unnamed glacial and nonglacial deposits lie below the Olympia beds. These are identified as pre-Olympia nonglacial deposits (Qpon) and a pre-Olympia glacial deposits (Qpog).

Steilacoom Gravel, which is comprised of the late-glacial delta and flood deposits, is a member of the Vashon Recessional Outwash unit and is identified as Qgog on the Project Geologic Map (Figure 7). The proposed mining of the South Parcel Project will occur within the Steilacoom Gravel and is the same geologic unit currently being mined in the existing mine area.

After the end of the Vashon glaciation, nonglacial conditions resumed in the South Parcel Project area. Post-glacial geologic units deposited in the area included beach and shallow marine deposits, colluvium on slopes, and alluvium in drainage bottoms. Topsoil developed on soils in stable and forested uplands areas.

2.1.4.1 Site Reconnaissance and Subsurface Explorations

A site reconnaissance was conducted on November 1, 2019, and later on December 21, 2021. The reconnaissance focused on examining the areas on the north slope of the Sequalitchew Creek ravine for indications of springs, seepage, and instability. Slopes within the existing pit were also evaluated for seeps and springs, and the general nature of the soils exposed in natural and mined excavations. Springs encountered within the Sequalitchew Creek ravine are shown on Figure 7. Natural and mined slope angles were measured and the behavior of historical mine slopes on the active and reclaimed mine slopes in the vicinity was examined. We also looked for evidence of concentrated surface water on the uplands of the Expansion Area and made general observations of surficial soil types.

Field observations were noted on a topographic map, and locations of specific features were recorded with a field GPS for plotting on topographic base maps. Results of the reconnaissance (including observations of hydrology, geology, and slope stability) are incorporated in subsequent sections and figures of this report.

Figure 5 shows the locations of existing subsurface explorations at the site from previous reports and investigation efforts, which were used to inform this study. No subsurface explorations were conducted specifically for this study; logs of previous borings and wells are provided in Appendix A as well as in the Geotechnical Engineering Report (Aspect, 2021a).

2.1.4.2 South Parcel Project Subsurface Conditions

Subsurface conditions for the South Parcel Project were inferred from review of the existing soil boring and well logs, published geologic data and maps, and our geological reconnaissance. Based on the available information, the inferred geologic units at the site are described below.

Topsoil

Topsoil, including up to several inches of forest duff (organic debris), is present in the South Parcel Project area. The duff layer is primarily present within upland forested areas. The South Parcel Project is vegetated with conifer and deciduous trees that will be cleared. The Re-Mine Area has been previously cleared and is vegetated with shrubs and grasses. Undisturbed, native topsoil is generally not present in the Re-Mine Area; however, topsoil has been placed over portions of the Re-Mine Area as a component of mine reclamation.

Steilacoom Gravel subunit of Vashon Recessional Outwash

The majority of near-surface Vashon recessional outwash in the area is composed of the Steilacoom Gravel subunit (Qvs) of the Vashon Recessional Outwash (Qgog) deposit. Soils from the Steilacoom Gravel account for most, if not all, of the soils that will be excavated during mining operations. This soil consists of sandy gravel and gravelly sand with minor amounts of silt, ranging between 2 and 6 percent. Where exposed in the adjacent working mine slopes and on road cuts in the active areas of the existing mine, this unit often has a relatively open matrix between gravel clasts. In other areas, the interstices are filled with sand.

This unit has not been glacially overridden and is anticipated to be medium dense at the surface, grading to dense at depth. Like most outwash deposits, Steilacoom Gravel possesses a minor degree of cohesion apparently resulting from silt and clay binding and slight iron oxide cementation at the grain contacts. This cohesion gives it a good intermediate-term standup time that is exhibited by the near vertical temporary cuts up to 70 feet high in the active area of the existing mine.

2.1.4.3 Olympia Beds

The Olympia Bed (Qob) deposits were observed below the Steilacoom Gravel. This unit is generally composed of interbedded lacustrine (lake sediments) and fluvial (river and stream sediments) deposits. Lacustrine deposits consist of silt and clay. The fluvial deposits consist primarily of sand but may contain oxidized gravelly lenses and layers. Interbed thickness of this unit ranges from inches up to about 10 feet. Some organic silt and peat layers that were deposited in wetlands and bogs are also generally present in this unit. The Olympia Bed unit has been overridden by the Vashon ice sheet and is generally very dense to hard in its natural state. Where exposed to seepage or weathering, its surface degrades and loosens.

The Olympia Bed deposits generally are considerably finer grained than the Vashon deposits above and can perch groundwater. Seepage has been noted at the top of the Olympia Bed unit where exposed in the road cut and natural ravine slopes along Sequalitchew Creek. If a lacustrine bed perches groundwater and is intersected by the surface of the slope, it could result in seepage onto the slope.

The contact between the top of the Olympia Beds and the overlying outwash deposits is understood through an extensive exploration conducted in the 1980s during initial geologic and groundwater studies for the Pioneer Aggregates mine (see Figure 5). Those borings generally encountered the Olympia Beds at 80 to 140 feet below the ground surface.[4] None of the borings encountered the Olympia Beds near the ground surface.

2.1.5 Hydrogeology

Surficial soils in the South Parcel Project area are generally highly transmissive to water. Stormwater will tend to infiltrate into the natural soil surface rather than collect as runoff. The Steilacoom Gravel is generally highly transmissive to groundwater flow and stormwater will infiltrate until it encounters the regional groundwater table, or until it encounters a silty interbed that locally perches groundwater. Additional information on groundwater presence within the Steilacoom Gravel is provided in Section 3.

2.1.6 Geologically Hazardous Areas

Geologically hazardous areas (GHAs) are areas "susceptible to erosion, sliding, or other potentially hazardous geological events" as described in Section 25.105.030 of the DuPont Municipal Code (DMC). The DMC defines four types of GHAs:

- Landslide Hazard Areas
- Steep Slopes
- Erosion Hazard Areas
- Seismic Hazard Areas

Aspect evaluated the presence of GHAs within the South Parcel Project and in surrounding areas as a component of the Critical Areas Report (Anchor and Aspect, 2021). This section summarizes the findings of that report.

GHAs were delineated based on our regional and local geologic knowledge of the area, reconnaissance of the South Parcel, review of published documents, and experience with similar mine sites operating elsewhere, and with reference to DMC.

A key criterion for identifying GHAs is the slope angle. Slopes greater than 15 percent can be Landslide Hazard Areas and Steep Slopes if they also have a geologic contact with a permeable unit overlying a relatively impermeable unit and presence of groundwater seeps or springs. Slopes of 40 percent or greater are GHAs unless they are comprised of competent bedrock or are a properly engineered slope. Slope angles at the South Parcel Project were evaluated using publicly available Light Detection and Ranging (LiDAR) topographic data. There are also other criteria defined in the DMC, but they are generally less applicable to conditions within the South Parcel Project area.

[4] Olympia Beds are found between 87 to 139 feet below the ground surface in the borings closest to Edmond Marsh. Several of the borings closest to the marsh did not encounter the Olympia Beds at their completion depths of 65 to 103 feet. These borings are located in the southeast corner of the South Parcel and in the southern portion of the parcel now occupied by the Amazon Fulfillment Center. In 2002, a boring was completed in the western end of Edmond Marsh and encountered the Olympia Beds at a depth of 84 feet. Boring logs for these explorations are provided in Appendix A.

Although not considered a GHA, aquifer recharge areas used for potable water are included in the list of critical areas in DMC 25.105.030.055, with regulations and performance standards for development within an aquifer recharge area defined in DMC 25.105.050(4). An Aquifer Recharge Area, as defined by the DMC, is not present within the South Parcel Project because the aquifers underlying the project area are not used for potable water.

2.1.6.1 Evaluation of Existing Conditions

This section assesses existing conditions within the South Parcel Project as well as two nearby areas: the Sequalitchew Creek ravine and the reclaimed slopes of the existing mine. The nearby areas would not be modified or impacted by the South Parcel Project, but were evaluated because their soils, geology, and other conditions are similar to those in the South Parcel Project and as such are a good predictor of the performance of the proposed conditions.

Expansion Area

Existing conditions in the Expansion Area do not meet the definition of GHAs (Figure 9). Topography is generally characterized by level ground or gentle slopes, typically inclined at gradients less than 15 percent that do not fall under the GHA criteria.

Aspect observed areas interpreted as old rail grade cut and fill slopes steeper than 40 percent that locally exceed more the 10 feet of vertical relief in the southeast portion of the South Parcel. These do not qualify as GHAs because they do not intersect a geologic contact with relatively impermeable sediment or bedrock and do not have spring or groundwater seepage (DMC 25.105.030.345) and they are stable constructed slopes that have historically performed well.

There are no channels, channel-forming processes, or areas subject to coastal erosion within the Expansion Area so there are no erosion hazard areas as defined by the City.

The existing Expansion Area does not include soils on slopes greater than 40 percent that are expected to be seasonally or perpetually saturated that pose a specific risk of settlement, movement, or liquefaction for seismic hazard areas as defined by the City.

Re-Mine Area

Existing conditions in the Re-Mine Area do not meet the definition of GHAs, although there are areas with slopes steeper than 15 percent (Figure 9). The topography of the Re-Mine Area generally consists of a gentle slope to the northwest descending toward the floor of the existing mine. Steeper slopes are present to the northwest of the Kettle Wetland, where the slope is greater than 40 percent, and along the westernmost portion of the Re-Mine Area, where it typically varies between 15 to 40 percent. Some of the steeper slopes shown on Figure 9 within the Re-Mine Area represent temporary stockpiles or fill placement.

The areas of steeper slopes within the Re-Mine Area do not qualify as GHAs as they are either temporary slopes within an active mine, or were designed and approved by a qualified professional experienced with the site, and are thus exempted from being a GHA.

There are no channels, channel-forming processes, or areas subject to coastal erosion within the Re-Mine Area, so there are no erosion hazard areas as defined by the City.

The Re-Mine Area does not contain seismic hazard areas because the soils on slopes greater than 40 percent are not expected to be seasonally or perpetually saturated and do not pose a specific risk of settlement, movement, or liquefaction.

Existing Mine

The existing mine includes constructed slopes on the south and west sides that have been graded to their final configuration and reclaimed with topsoil and planting. The west slope is about 175 feet high and is smoothly graded at about 30 percent up to 50 percent, as shown on Figure 9. The subsurface soil under the topsoil of the west slope is sand and gravel with a trace of fines. The slope has been planted with grasses and conifer trees.

The west slope has a slope gradient of greater than 40 percent with a vertical relief greater than 10 feet, but it does not meet GHA criteria because it was designed and approved by a qualified professional experienced with the site, and thus is exempted from being a GHA.

During the reconnaissance of the west slope on November 1, 2019, Aspect observed no indication of past or imminent slope failure, landsliding, or erosion. There are no concave or convex topographic features that would suggest slumping or calving, and there are no areas of exposed soil. The vegetation shows no evidence of disturbance from slope instability or erosion.

There are no channels, channel-forming processes, or areas subject to coastal erosion within the existing mine so there are no erosion hazard areas as defined by the City.

The existing mine does not contain seismic hazard areas because the soils on slopes greater than 40 percent are not expected to be seasonally or perpetually saturated and do not pose a specific risk of settlement, movement, or liquefaction.

Sequalitchew Creek Ravine

The Sequalitchew Creek ravine lies outside of the South Parcel Project area, along the southern boundary of the existing mine and the South Parcel. A small portion of the Sequalitchew Creek ravine is located within the South Parcel property boundary, but outside the proposed mining area. The ravine runs westward for about 1.5 miles down to the creek confluence with Puget Sound. The majority of the ravine is outside of the South Parcel. The slopes on the northern side of the ravine range from approximately 30 percent to 75 percent.

The north slope of the Sequalitchew Creek ravine includes a bench cut for a former railroad grade that ran down the full length of the ravine. The railroad grade has been redeveloped into the Sequalitchew Creek Trail, surfaced with asphalt on the upper portion and crushed rock lower down.

Perennial groundwater seeps from the ravine's north slope at several locations, as shown on Figure 9. On the eastern two-thirds of the ravine, the subsurface soil in the upper part of the slope (from the top of the ravine at approximate elevation 200 feet down to about elevation 110 feet) is permeable sand and gravel with minor silt; below approximately elevation 110 feet, the soil is silty and relatively impermeable. In the western third of the

ravine, the subsurface soil is permeable sand and gravel for the entire height of the ravine valley wall.

The channel of Sequalitchew Creek is relatively confined channel formed by historically higher flows (see Section 4). It currently experiences limited flow and thus has limited channel-forming processes. We observed no indication of an active channel migration zone from our reconnaissance or aerial photograph review.

The existing Sequalitchew Creek ravine does include areas with soils on slopes greater than 40 percent that are expected to be seasonally or perpetually saturated that pose a specific risk of settlement, movement, or liquefaction for seismic hazards as defined by the City.

Based on the slope steepness, the presence of the seeps, and the contact between permeable and impermeable soils, the north slope or the Sequalitchew Creek ravine qualifies as a Landslide Hazard Area, Steep Slope, and Seismic Hazard under DMC GHA criteria. The slope is identified by the DNR (Mickelson et al. 2017) as susceptible to shallow landslides.

2.2 Effects of the Proposed Action

2.2.1 Changes in Topography

2.2.1.1 South Parcel Project

Topography within the Expansion Area would be significantly altered as a result of mining as illustrated in the comparison between Figures 9 and 10. The slopes on the eastern edge of the South Parcel would be about 80 to 120 ft tall and would be inclined at 3H:1V (33 percent). Benches would be excavated in the southeast corner of the Expansion Area. The bottom surface of the Expansion Area would generally follow the contours of the top of the Olympia Beds. A thin layer of gravel, several feet thick, would likely be left on top of the Olympia Beds to provide a stable working surface.

Within the Re-Mine Area, topography would also significantly change as the current rolling slopes would be mined down to the Olympia Beds. As with the Expansion Area, a working surface of gravel would be left atop the Olympia Beds. Slopes within the Re-Mine Area would be inclined at 3H:1V (horizontal:vertical; 33 percent), where groundwater is expected to emanate from the toe of the slope and 2H:1V (50 percent), where the slopes are anticipated to be dry.

The proposed finished slopes would be less steep than other areas that have been mined and reclaimed to the west. As observed during the site visit within the reclaimed mine areas, the slopes steeper than 40 percent (up to 50 percent) and the slopes along the Sequalitchew Creek Trail exceeding 60 percent are all performing well. The soils are fairly homogenous across the active mine area and Re-Mine Area, and are expected to perform similarly in general.

2.2.1.2 Existing Mine

There would be no change to the topography of the slopes of the existing mine as a result of the South Parcel Project. However, these slopes may be modified under the current permits as mining activity continues and have already been evaluated for potential

impacts. Changes to the existing slopes under the current permits are not evaluated in this report.

A constructed mitigation wetland has been proposed near the toe of the west slope at the base of area where mining has already been completed, as shown on Figure 10. The constructed wetland slopes will be at gradients less than 15 percent.

Other minor changes within the existing mine include the construction of stormwater conveyance, treatment and infiltration facilities, and groundwater conveyance and infiltration facilities.

2.2.1.3 Sequalitchew Creek Ravine

Topography in the Sequalitchew Creek ravine will not be altered as a result of mining activities (compare Figures 9 and 10).

The dewatering and grading associated with the South Parcel Project will reduce groundwater flow toward the steep slopes of Sequalitchew Creek ravine along the east portion of the South Parcel. The proposed mine expansion will also route groundwater that would potentially flow toward the creek instead toward the mined areas. Ultimately, this will reduce the potential for landsides and slope failures within the Sequalitchew Creek ravine. The seeps and springs identified on Figure 9 are expected to be reduced or dewatered in their entirety, which may reduce the level of landslide hazard susceptibility within the ravine.

2.2.2 Slope Stability

Aspect completed a geotechnical analysis to evaluate the stability of the proposed cut slopes of the South Parcel Project, as documented in the Geotechnical Engineering Report (Aspect, 2021a). This section summarizes the findings of that report.

The static and seismic stability of proposed slopes was analyzed using the two-dimensional, limit-equilibrium slope stability software program Slide by RocScience and stratigraphy and proposed 3H:1V grading shown on cross section A-A' through D-D'. The locations where stability analyses were performed are shown on Figure 11 and were selected as being representative of critical permanent slope configurations. The slope stability results are presented graphically in Appendix B of the Geotechnical Engineering Report (Aspect, 2021a).

The stability analysis software program performs slope stability computations based on the modeled slope conditions, and calculates a factor of safety (FOS) against slope failure. FOS is defined as:

$$FOS = s/\tau$$

where "s" is the available shear strength of the soil and "τ" is the shear stress generated from gravitational forces acting on the slope mass.

A "just-stable" equilibrium condition would result in a FOS of 1.0, while an unstable condition would result in a FOS less than 1.0, implying failure is imminent or is already occurring.

For static and seismic conditions, FOS of 1.5 and 1.1, respectively, are the recommended minimums for permanent slopes that could affect adjacent structures and property. Soil properties and strength parameters, groundwater and seismic input for the slope stability model are provided in detail in the Geotechnical Engineering Report (Aspect, 2021a).

2.2.2.1 Slope Stability Results

Slope stability results are presented in Table 4 below and also shown on Figure 11. The results are presented graphically in Appendix B in the Geotechnical Engineering Report (Aspect, 2021a).

Table 4. Summary of Factor of Safety Values for Slope Stability Analysis Results

Profile	Static [1]	Seismic [2]
A-A’	2.53	1.19
B-B’	1.69	1.17
C-C’	2.01	1.14
D-D’	2.92	1.30

Notes:
1. Limit equilibrium minimum factor of safety found using Spencer’s method in SLIDE
2. Pseudostatic seismic analysis with a reduced PGA due to wave scattering from Table 2 of Geotechnical Engineering Report (Aspect, 2021a)

The results show acceptable FOS values that exceed 1.5 static and 1.1 for seismic conditions for slope stability for the mined condition within the South Parcel Project area and the adjacent Sequalitchew Creek ravine.

2.2.2.2 Effect of Reclamation of Slopes on Stability

Under a reclamation plan approved by DNR (see Section 1.1.2.6), the mine slopes would be progressively reclaimed over the life of the proposed mine development. Mine slopes will be graded to 3H:1V or flatter where groundwater seepage is expected (i.e., on the eastern and southern slopes of the Expansion Area) or flatter once the slope is no longer being mined. Slopes where groundwater is not anticipated to be present, such as along the southern boundary of the Re-Mine Area, will be graded to 2H:1V.

Backfill is not required to achieve the reclaimed configuration; however, backfill may be used to enhance reclamation and has been done elsewhere within the existing mine to improve vegetation performance. The backfill would consist of retained finer South Parcel material and imported clean fill. The proposed slope angles are flatter than the natural angle of repose of the remaining *in situ* soils and would provide the long-term erosion control and landscape base for planting. After establishment of the vegetation growth, any long-term slope stability impact to earth-related features is expected to be low. The already high stability of newly created slopes will generally increase with establishment of vegetation.

2.2.3 Erosion Potential

Due to their generally coarse-grained nature and good infiltration characteristics, the soils in the South Parcel Project area possess a low erosion risk and are generally not moisture

sensitive. The erosion potential is increased by the removal of vegetation and construction of mine slopes; however, with proper stormwater management techniques in place, even these conditions are unlikely to result in significant erosion of the coarse soils. The main area of the South Parcel Project potentially susceptible to erosion is the placement of loose topsoil for revegetation on the final cut slopes.

The Olympia Beds are finer-grained and more susceptible to erosion; however, they will not be exposed by mine activity. An approximately 10-foot-thick layer of the overlying outwash will be left in place as an operating surface for heavy equipment. This layer will protect against erosion of the Olympia Beds.

The South Parcel Project, together with the existing mine, will be excavated as a closed depression and all surface runoff will drain internally. Therefore, erosion does not have the potential to cause harm to surface water bodies or aquatic resources; however, management of erosion remains important for establishment of vegetation during reclamation, visual appearance of the slopes, and the long-term performance of the infiltration ponds. The proposed activities included in the South Parcel Project (refer to Pioneer Aggregates South Parcel Project Engineering Plan Set; Aspect, 2021b) include erosion control Best Management Practices (BMPs) consistent with Ecology's Sand and Gravel General Permit and City of Dupont requirements as defined in section 25.105.030.25 (DMC, 2021) that will reduce the potential for offsite transport of sediment.

To reduce the risk for erosion impacts to the Sequalitchew Creek ravine slopes south of the South Parcel Project area, and in general accordance with DMC 25.105.070(2), the Geotechnical Engineering Report (Aspect, 2021a) recommended maintaining at least a 50-foot buffer from the top of steep slopes. Consistent with the 2012 Settlement Agreement, the South Parcel Project includes a 100-foot buffer along the top of the slope along the Sequalitchew Creek ravine. The 100-foot buffer provides ample protection for erosion of steep slopes along with other recommended mitigation measures and BMPs in Section 2.4.

The City requires preparation of an erosion control plan per DMC 22.01.180 for all sites disturbing more than 1 acre. The erosion control plan will identify the specific BMPs to be used during and after mining for erosion and sediment control. The existing wheel wash will continue to be operated and maintained in compliance with City and Ecology requirements.

2.2.4 Steep Slope Buffer

The South Parcel Project includes a 100-foot buffer along the top of the Sequalitchew Creek ravine slope (Figure 10). This buffer exceeds that required by the DMC, which requires a 50-foot buffer between proposed development activity and hillslopes of 40 percent (22 degrees or approximately 2.5H:1V). It is also greater than the buffer recommended in the Geotechnical Engineering Report (Aspect, 2021a) and therefore provides greater protection.

2.2.5 Topsoil Removal and Replacement

Topsoil contains fines and organic material that is not suitable for construction aggregate and has physical characteristics that are not compatible with efficient use of the

equipment used to transport and process saleable materials extracted from the mine. Topsoil is also generally the most fertile part of the soil column, containing soil structure, organic matter, and microorganisms beneficial to plants and an essential component for successful reclamation of the mine.

Washington's laws governing Surface Mine Reclamation (RCW 78.44) require the conservation of topsoil as a critical component of reclaiming surface mines for future uses. The Proposed Action includes the steps typically used to conserve topsoil on aggregate mines. Topsoil would be stripped and stockpiled as the mining operation advances into the property, and topsoil would be replaced as the mined areas are reclaimed following extraction.

Past industrial activities have resulted in elevated metals concentrations in portions of the South Parcel. The Former DuPont Works Site is a cleanup site associated with historical explosives and commercial munitions facility that operated from 1909 through 1976 (Hart Crowser, 1994). The primary contaminants are arsenic and lead in surface soils. Cleanup activities were completed in 1993 to address the highest concentrations of lead, generally found along the foundations of the former buildings. Weyerhaeuser entered a Consent Decree with Ecology that required implementation of a restrictive covenant (Weyerhaeuser, 1997) limiting land use on the Former DuPont Works Site to industrial uses, which is the origin of the Manufacturing and Research Park zoning for much of the South Parcel.

In addition, the South Parcel is located within the Tacoma Smelter Plume (TSP) in an area where Ecology predicts concentrations of arsenic in surface soils may range between 40 and 100 parts per million (ppm). Ecology has established cleanup levels for properties within the TSP. The cleanup levels are conservative and support residential use. The cleanup level for arsenic in soil is 20 ppm and the cleanup level for lead in soil is 250 ppm (Ecology, 2012). As a basis for comparison, the United States Environmental Protection Agency (EPA) has established an action level of 230 ppm for arsenic and 500 ppm for lead to guide cleanup decisions in areas near the former smelter. Ecology has pre-approved certain approaches to achieve the established cleanup levels at properties within the TSP. Mixing of impacted surface soils with deeper clean soils is one of the approved approaches under the Final Interim Action Plan (Ecology, 2012).

The proposed mining and reclamation activities would serve as a permanent and final remedy for any lead- and arsenic-impacted soils within the Expansion Area. Under the Proposed Action, topsoil within the Expansion Area would be removed to facilitate extraction, and be conserved and maintained on site to be incorporated into the reclaimed mine landscape and support revegetation and reclamation of mined areas consistent with the anticipated subsequent residential land use identified in the City of DuPont Comprehensive Land Use Plan (City, 2001).

Stripping, stockpiling, and replacement of topsoil would be completed using methods and procedures that are generally the same as those used in the existing mine area, including employment of BMPs to control erosion and fugitive dust. Samples would be collected from stockpiled topsoil for each mine segment and analyzed in accordance with a Cleanup Action Plan developed for the South Parcel Project (Aspect, 2020). If the sample results indicate the topsoil does not contain arsenic in concentrations exceeding 20 ppm

(the conservative cleanup level established by Ecology for the TSP) or lead in concentrations exceeding 250 ppm, then the topsoil would be used in reclamation. If the sample results indicate the topsoil contains arsenic in concentrations equal to or greater than 20 ppm, then clean soil would be mixed with the topsoil to reduce the arsenic concentration. Stockpiled topsoil would not be used for reclamation until sample results confirm the concentrations of arsenic and lead meet cleanup criteria.

2.2.6 Effects on Geologically Hazardous Areas

The effects of the Proposed Action relative to landslide and steep slope hazards, seismic hazards and liquefaction hazards are presented below and as shown on Figure 10. Additional discussion is provided in the Geotechnical Engineering Report (Aspect, 2021a).

2.2.6.1 Landslide and Steep Slope Hazards

Landslide and Steep Slope hazards are not present within the South Parcel Project area but are present nearby in the Sequalitchew Creek ravine. The mined slopes have been designed by a geotechnical engineer and are contoured to drain away from the ravine as shown on Figure 10. The slope stability analysis shows acceptable factor-of-safety values (greater than 1.5) for each of the profiles in the Expansion Area and Re-Mine Area as shown on Figure 11. Thus, the mined slopes will not be Landslide or Steep Slope Hazards.

The Proposed Action locally reduce the expression of seeps and springs that have been observed in the ravine as shown on Figure 9, resulting in an improvement in slope stability. The Sequalitchew Creek ravine slope would also have an FOS greater than 1.5 as shown on Figure 11.

The hazard mitigation recommendations listed below in Section 2.4 are intended to protect landslide and steep slope hazards located outside of, but nearby, the South Parcel Project area.

2.2.6.2 Erosion Hazards

DMC 25.105.050 (3) defines erosion hazards as including coastal erosion zones and channel migration zones (areas along a river or stream where the channel can be reasonably predicted to migrate over time) and coastal erosion zones. Coastal erosion zones are not relevant to the Proposed Action.

The channel migration zone within the Sequalitchew Creek ravine will not be impacted by the Proposed Action. The flows from ravine springs will be reduced by the dewatering process, which will reduce the potential for channel migration.

No adverse impacts are anticipated to erosion hazards from the Proposed Action at the South Parcel or adjacent areas.

2.2.6.3 Seismic Hazards

No adverse impacts are anticipated to seismic hazards from the Proposed Action at the South Parcel or adjacent areas. The slope stability analysis for seismic condition shows acceptable factor-of-safety values (greater than 1.1) for each of the profiles in the Expansion Area, Re-Mine Area, and Sequalitchew Creek ravine

Topography at the Expansion Area would be permanently altered as a result of mining activities. These changes are illustrated by comparing Figures 9 and 10. The proposed conditions would include finished slopes inclined at 3H:1V (33 percent) toward the interior of the existing mine (Figure 10). A 20-foot-high soil berm would be constructed with side slopes at 2H:1V (50 percent) along the south side of the Expansion Area.

The proposed finished slopes would be less steep than other areas that have been mined and reclaimed to the west. As observed during the site visit within the reclaimed mine areas, the slopes steeper than 40 percent (up to 50 percent) and the slopes along the Sequalitchew Creek Trail exceeding 60 percent are all performing well.

Groundwater is anticipated to seep from the toe of graded slopes in the east portion of the Expansion Area. The presence of seepage on slopes greater than 15 percent (proposed at 33 percent) with a potential underlying contact with lower-permeability Olympia Beds does meet the DMC criteria for landslide hazards and steeps slopes. The approximate locations of the potential Geologically Hazardous Areas are mapped on Figure 10.

In general, the proposed graded slopes of 33 percent are far below the angle of repose for sand and gravel that reduce the risk of active landslide or steep slope hazards. Slope stability analysis and mitigation for this potential hazard is provided in the following sections.

The soils are fairly homogenous across the active mine area and Expansion Area, and are expected to perform similarly in general.

There would be no Seismic Hazard Areas created, as slopes in the Expansion Area will be below the 40-percent threshold.

2.3 Effects of the No Action Alternative

Under the No Action alternative, the individual parcels that comprise the South Parcel would be developed under their existing zoning. Mining and reclamation would continue within the currently permitted footprint of the existing mine. The Kettle Wetland and its buffer would remain undisturbed.

Development of the South Parcel would likely occur over time on one or more individual parcels at a time. As each parcel is developed, it would likely be mostly logged and cleared, then graded and developed consistent with applicable zoning regulations. Logging and clearing along with the development would likely leave only a 50-foot buffer along the top of the Sequalitchew Creek ravine as authorized under the DMC rather than the 100-foot buffer required for the mine under the Settlement Agreement. Topography would be expected to remain relatively flat, with the minor topographic depressions filled to level building sites. Under the existing zoning, a portion of each parcel would need to remain vegetated, either as the existing forest or as landscaped areas.

Clearing would increase the potential for surface erosion during construction; however, standard erosion and sediment control BMPs would be sufficient to avoid adverse impacts. Future development would be required to comply with City of DuPont Sensitive Areas Code, and state and local erosion and sediment control requirements.

Development would also increase the volume of stormwater generated as permeable soils with established vegetation (forest) are replaced with the impervious areas, building roofs and pavement, and landscaped areas. Stormwater would likely be managed through infiltration, which would result in an increased volume of groundwater flow, though the change would likely be minor relative to the groundwater flow in the aquifer.

Individual development of the parcels would not be likely to address the metals-contaminated soils as comprehensively as the Proposed Action. It is more likely that capping would be used as a remedy given the lower cost compared with mixing and consistency with the likely developed condition (e.g., paved parking lots and building footprints). The use of capping as, combined with differences in parcel remediation extent and approach as individual parcels are developed separately, would likely prevent lifting of the restrictive covenants from the Former DuPont Works site and rezoning of the Manufacturing and Research Park area.

2.4 Mitigation Measures

The following mitigation measures have been included in the Proposed Action to reduce impacts on slope stability and erosion:

- Preparation and implementation of a reclamation plan under a Surface Mining Act (RCW 78.44). The reclamation plan would be submitted to DNR for review and approval prior to mining.
- Mining would occur in segments; no mass clearing of the South Parcel would occur.
- Preparation and implementation of an erosion and sediment control plan in accordance with the requirements of DMC 22.01.180 and the Sand and Gravel General Permit, a National Pollution Discharge Elimination System (NPDES) and State Waste Discharge Permit issued by Ecology that regulates stormwater management on aggregate mines. Erosion control features would include stormwater drainage into the interior of the South Parcel and on-site stormwater disposal.
- Maintenance of a vegetated buffer between the mine area and the top of steep slopes in accordance with the City of DuPont's Sensitive Areas Code [DMC 25.105.070(2)].
- Maintain the 100-foot setback from the top of slopes greater than 40 percent within the Sequalitchew Creek ravine, consistent with the conditions for the existing mine and the 1994 and 2012 Settlement Agreements.
- Earthwork for excavation and reclamation would be in accordance with the federal and state statutes of the Mine Safety and Health Act and the Surface Mining Act.
- Topsoil would be stockpiled and used for reclamation of mined areas. Consistent with the approved Reclamation Plan, the Cleanup Action Plan developed for the South Parcel Project (Aspect, 2020) and published Ecology guidance (Ecology,

2012), samples would be collected from stockpiled topsoil to confirm arsenic concentrations meet Ecology standards.

- After application of the topsoil, slopes would be revegetated by planting with trees and grass. When reclamation is complete, heavy equipment would generally not operate on the reclaimed slopes except for construction or maintenance of pedestrian paths, access roads, utilities, or other permitted facilities.
- The South Parcel would be cleared in segments corresponding to the mining plan.
- Internal drainage would be maintained during mining.
- Mine slopes would be track-walked to tamp soils and create surface roughness to encourage infiltration of stormwater on the slope.
- Mine slopes would be reclaimed with soil amendments and vegetation according to the DNR-approved Reclamation Plan.
- The existing wheel wash would continue to be used and maintained for vehicles exiting the mine.
- Settling ponds would be constructed upstream of the infiltration ponds.
- Mine slopes would be periodically inspected and repaired or revegetated to reduce erosion or improve surface stability.

2.5 Cumulative Impacts of Proposed Action and Restoration Plan

Cumulative impacts of the Proposed Action and Restoration Plan are described below.

The Proposed Action will reduce the potential for groundwater seepage and spring flow from the northern slope of the Sequalitchew Creek ravine. This will effectively reduce the potential for slope instability within the Sequalitchew Creek ravine.

Following implementation of the Restoration Plan, we anticipate higher streamflows in the Sequalitchew Creek ravine that could locally impact channel bank stability. This represents the return of channel-forming flows to Sequalitchew Creek and is a desired outcome of implementation of the Restoration Plan.

The return of higher flows is not anticipated to result in instability of the ravine side slopes because the restored flows would be similar to the flows present historically that did not impact global ravine stability. Similar flows were historically present during periods of land use disturbance in the ravine (e.g., during the period of railroad grade construction and initial logging of the ravine slope) and did not result in large-scale slope instability.

2.6 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts to geology and slope stability are anticipated from the Proposed Action. There are two general anticipated impacts described below; however, neither rises to the level of significant unavoidable adverse impacts:

1. Natural deposits of sand and gravel would be removed from a 313-acre area, altering the topography and leaving an irregular-shaped bowl feature where the mine operated.
2. Additional slopes would be created in an area where slopes did not previously exist, thus providing more opportunity for shallow slope instability and erosion. However, proper reclamation and erosion control measures as planned for in the Proposed Action would limit any potential slope instability and erosion impacts.

The first impact (removal of material) is significant and unavoidable, but not adverse. The second impact (creation of slopes) is unavoidable, but with the proposed mitigation is not expected to be a significant adverse impact. Therefore, no significant unavoidable adverse impacts are anticipated.

3 Groundwater

Groundwater conditions were examined to understand its occurrence in the vicinity of the Proposed Action. A groundwater monitoring network was established in 1999 and expanded in 2003 to assess aquifer parameters and water level fluctuations. The well network has been monitored approximately monthly since then, and monthly monitoring is ongoing. Table 5 lists the groundwater monitoring wells and current monitoring status. Figure 5 shows the monitoring well locations within the South Parcel, and Figure 12 shows well locations throughout the watershed. Observed groundwater level elevations are shown in time-series graphs on Figure 13. All available groundwater data were compiled and reviewed for this analysis.

Groundwater saturates the aggregate of the South Parcel Project area to within 20 feet of the ground surface. Under the Proposed Action, mining will require pumping groundwater to dewater the gravels that are currently saturated. Dewatering and removal of the aggregate will result in localized changes in groundwater elevations around the South Parcel. Under the No Action alternative, mining of aggregate above the water table will continue to occur within the existing mine without substantially influencing groundwater levels.

The foundation of the groundwater analysis is a numerical groundwater model (DuPont model) developed specifically for the project (Aspect, 2017b). The DuPont model is based on the conceptual model for the groundwater system developed from extensive analysis of project-specific borings and data, as well as compilation and review of other geologic and hydrogeologic data in the surrounding DuPont area. The hydrostratigraphic units are summarized in Table 6.

The DuPont model represents an update to previous groundwater modeling analysis developed for the South Parcel (CH2M Hill, 2003; Aspect, 2004a; Aspect, 2009a; and Aspect, 2009b). The layout of the numerical groundwater model is mapped on Figure 18. It incorporates proposed revisions to the mining plan, expansion of the model area, inclusion of seasonal and annual variability in climate and groundwater levels, and elements of the United State Geological Survey (USGS) groundwater model for the Chambers-Clover Creek watershed, including model boundary conditions and hydrogeologic layers at depth (Savoca et al., 2010; Johnson et al., 2011). The USGS groundwater model was not fully integrated with the DuPont model because the regional scale of the USGS model does not reflect the more detailed information collected for the South Parcel Project. Specifically, the regional groundwater flow direction in the shallow aquifer of the USGS model does not match local observations, the DuPont model incorporates higher stratigraphic data density in the focus area resulting from the borings and wells installed by CalPortland, and the DuPont model offers more refined wetland and surface water body discretization. The model simulates the groundwater/wetland hydraulic connection as detailed in Sections 4.6.3 and 4.6.4 of the Groundwater Model Update Report (Aspect, 2017b).

The DuPont model was first developed and calibrated to match a complete set of existing conditions measured between 2004 and 2010, and then validated to the monitoring data

collected through 2015. A representative range of wet- and dry-season conditions were observed between 2004 and 2015; observed groundwater levels since 2015 (shown on Figure 13) generally fall within this range. Calibrated aquifer parameter values are summarized in Table 6. A comparison of observed and calculated groundwater levels is provided on Figure 19.

While the groundwater model calibration is good (with calculated water levels generally following observed water levels as shown on Figure 19), model results were further refined to better address disagreement between observed and calculated water levels. Please see the Groundwater Model Update Report (Aspect, 2017b) for details on model calibration, validation, and refinement of model results. The model simulation of existing conditions formed the baseline from which changes in future groundwater levels under proposed scenarios can be measured.

Once the DuPont model was able to reliably reproduce historical conditions, the calibrated and validated model was then used to predict the changes in groundwater levels during four different steps of dewatering during the proposed mining plan. The model-calculated groundwater dewatering rates necessary to achieve the target groundwater levels within the mine are listed by step in Table 7 and based on the entire simulation period. The maximum predicted groundwater level changes for each dewatering step are provided by well in Table 8 and based on the entire simulation period. Details on the model uncertainty and the values in Table 8 are provided in Sections 5.5 and 6.5 the Groundwater Model Update Report (Aspect, 2017b).

3.1 Affected Environment

3.1.1 Primary Data Sources

Groundwater conditions in the area around the South Parcel Project have been extensively studied by Woodward-Clyde Consultants (WWC) (1991), Hart Crowser (1990 and 1991), CH2M Hill (2000 and 2003) and Aspect (2004a, 2004b, 2007, and 2017b), to name a few of the larger studies. These investigations focused primarily on concerns about impacts from Fort Lewis's Landfill 5 (WWC, 1991), water supply for the Pioneer Aggregates operations (Hart Crowser, 1991) and obtaining information on the aquifer system in the vicinity of the South Parcel Project (Aspect reports refenced above).

Borings drilled on 500-foot centers throughout the proposed mining area provide valuable data on stratigraphy and depth to water. These data and studies helped to define the occurrence and characteristics of the groundwater and the aquifers in the area of the South Parcel Project. The USGS published information on groundwater conditions in the Chambers-Clover Creek Watershed (Savoca et al., 2010; Johnson et al., 2011).

3.1.1.1 Well Data Inventory

A total of 22 wells in the vicinity of the South Parcel Project have been monitored to assess groundwater conditions, including previously existing monitoring wells and new wells installed for this project. The locations of the monitoring wells are shown on Figure 12. Table 5 presents the construction information for those wells where available.

3.1.1.2 Water Level Monitoring

Monitoring of groundwater levels began in 2000 with a series of groundwater monitoring wells installed within and around the South Parcel. Groundwater monitoring occurs monthly and the program is ongoing. The wells included in the groundwater monitoring program are listed in Table 5. Figures illustrating the groundwater monitoring data collected through September 2022 at key locations are included in Appendix B.

Groundwater levels in the Vashon Aquifer (detailed in Section 3.1.2) typically fluctuate in response to seasonal precipitation patterns and annual variations in precipitation. Figure 14 maps the groundwater level elevations inferred from observations and calculated using the DuPont model for the May 2010 time period, which represents mid-range water level conditions. Figure 15 maps the range in groundwater level fluctuations, showing both observed ranges at specific wells and model calculated ranges as contours. Groundwater levels in the central marsh area fluctuate over a limited range of 2 to 3 feet, whereas groundwater levels in monitoring well CHMW-3S, on the south end of the South Parcel, fluctuate by more than 10 feet. Monitoring conducted for the adjacent Fort Lewis Landfill 5 and DuPont Works Consent Decree area indicate groundwater level variations on the order of 10 feet (URS, 2000; URS, 2003). Seasonal variability in groundwater levels is inferred to be lower near surface water features (such as Sequalitchew Lake and the wetland complex) and greater near drainage features (such as the Sequalitchew Creek ravine and the Olympia Bed Truncation).

3.1.2 Primary Hydrogeologic Units

The primary hydrogeologic units are described in detail in the Groundwater Model Update Report (Aspect, 2017b) and are summarized in Table 6 and the sections below. Cross-section A-A' showing the sequence of hydrogeologic units on a northwest to southeast alignment is presented on Figure 16. Cross section B-B' on Figure 17 shows the hydrogeologic units on a southwest to northeast alignment crossing the Sequalitchew Creek ravine.

The South Parcel Project area lies within a thick glacial outwash sequence near Puget Sound, just north of the Sequalitchew Creek ravine, and east-southeast of the existing mine. The outwash sequence includes the surficial, coarse-grained Steilacoom Gravel flood deposits, an upper confining unit, and an older Vashon outwash. The outwash sequence overlies the low-permeability Olympia Beds (Qob) interglacial unit. The Sea Level Aquifer is composed of pre-Olympia glacial drift deposits consisting of sand and gravel.

For purposes of developing the numerical groundwater model, the Vashon Aquifer is represented by two principal zones with distinct permeabilities, separated by a relatively lower permeability zone. The upper zone is comprised of the Steilacoom Gravel, which occurs from groundwater surface to an elevation of approximately 180 to 168 feet. At that elevation, there is a lithologic change sometimes indicated by a slightly siltier zone or a slight increase in density during drilling. Below this siltier zone lies the deeper portion of the Vashon Aquifer, comprised of sand and gravel. The deeper outwash zone occurs to the depth of the Olympia Beds, which occurs at an average elevation of 110 to 120 feet.

Beneath the Olympia Beds is the regionally extensive and highly productive Sea Level Aquifer, which occurs throughout the DuPont area between elevations of roughly 50 and -100 feet relative to mean sea level. The Sea Level Aquifer is generally confined beneath the Olympia Beds aquitard and has very limited hydraulic connection with the shallower Vashon Aquifer. West of the Olympia Bed Truncation described below, the Sea Level Aquifer becomes unconfined and its groundwater merges with flow from the Vashon Aquifer in the accumulation of Steilacoom Gravel extending below mean sea level (sometimes referred to as the unconfined Sea Level Aquifer; URS, 2003). Groundwater in the Sea Level Aquifer discharges to Puget Sound via intertidal and subtidal seeps. The Sea Level Aquifer is the City of DuPont's primary water supply source (their Bell Hill wells No. 1 and No. 3 and Hoffman Hill wells No. 1 and No. 2 are completed in it [refer to Section 3.1.5]).

Below the Sea Level Aquifer and underlying aquitard unit is a deeper glacial aquifer unit, sometimes termed the Lakewood Aquifer, in which the City of DuPont's Bell Hill No. 2 well is completed. Below the Lakewood Aquifer, two deeper glacial aquifer units separated by interglacial aquitard units were observed during drilling of CalPortland's 1,000-foot-deep water well (TW-1) for the aggregate processing plant. CalPortland's well is completed in the deepest observed aquifer unit, screened between elevations of -685 and -770 feet (Hart Crowser, 1991).

3.1.2.1 Olympia Bed Truncation

The underlying Olympia Beds are absent west of a line (termed Olympia Bed Truncation) located on the order of 1,500 to 3,000 feet inland from the current Puget Sound shoreline. Steilacoom Gravel extends from ground surface to below sea level west of the Olympia Bed Truncation, where they are in contact with the Sea Level Aquifer.

The occurrence/non-occurrence of the Olympia Beds creates a unique hydrogeologic condition. Groundwater in the outwash east of the Olympia Bed Truncation is held up by the occurrence of the thick, low permeability Olympia Bed deposits. A steep hydraulic gradient occurs where the groundwater drops over this feature within the current mine site. As the groundwater flows westerly over the Olympia Bed Truncation, it drops roughly 160 feet vertically in 800 feet horizontally through the permeable gravels to near sea level. Therefore, the water table is typically found at relatively shallow depths of 15 to 25 feet below ground surface (or approximately 185 to 195 feet elevation) in the South Parcel area. West of the Olympia Bed Truncation, the water table is found at a depth of roughly 190 feet below the former ground surface (or at elevation of approximately 15 feet) in the existing mine.

3.1.2.2 Aquifer Testing

Five pumping tests were conducted in wells located along the east side of the proposed South Parcel mine expansion area to determine hydraulic properties of the outwash aquifer throughout its depth (CH2M Hill, 2000). These testing data, along with studies conducted for Fort Lewis Landfill 5 (WCC, 1991) and the Former DuPont Works site (URS, 2003), provide baseline hydraulic parameters for the Vashon Aquifer used as a starting point in development of the numerical groundwater flow model. Table 6 provides the calibrated aquifer parameters used in groundwater simulations.

3.1.3 Groundwater Elevations and Flow Patterns

Observed groundwater elevations in the South Parcel Project area are shown in timeseries graphs on Figure 13. A map with contours of groundwater level elevations for May 2010, which represents mid-range water levels during a typical transition from the high water levels of winter toward the lower water levels of summer, is shown on Figure 14. Seven other groundwater contour maps representing a range of seasonal high and low water levels and antecedent precipitation conditions are included in Appendix C.

A map showing the seasonal range in groundwater levels during wet and dry seasons is shown on Figure 15. These data show that groundwater levels have been seasonally variable with the range dependent on proximity to the wetland complex, in general.

Groundwater underlying the South Parcel Project area primarily originates from upgradient areas in western Pierce County where precipitation (as rainfall and snow) infiltrates the ground surface and forms aquifers. Infiltration from the Fort Lewis Diversion Canal also offers a continuous groundwater source. Seasonal groundwater sources include the Edmond and Bell/McKay/Hamer marsh complex, in addition to rain falling across the South Parcel Project area. Groundwater drainage features include Sequalitchew Creek, the Diversion Canal, and the wetland complex (seasonally).

The surficial Steilacoom Gravel is highly permeable and are known to rapidly infiltrate precipitation and stormwater; the veneer of topsoil covering the Steilacoom Gravel is finer grained (can contain volcanic ash) and thus has lower infiltration capacity. The gravels form a relatively flat outwash plain in the area, in the center of which is a series of large wetlands—referred to as Bell, McKay, Hamer, and Edmond Marshes (Figure 27). These wetlands occur in areas where large ice blocks, stranded during the glacial flood outbursts, later melted and formed kettle depressions lined with finer-grained, lower-permeability materials. These features store water for a much longer time relative to the rapidly infiltrating gravel outwash around these features. The wetland sediments from throughout the wetland complex were sampled and lab tested for permeability, and these data were used for simulating the wetland areas in the numerical groundwater model.

3.1.3.1 Groundwater Interaction with Wetland Complex and Lakes

Since 2000, monitoring data have been collected to understand the hydraulic connection of the groundwater system with the area wetlands and Sequalitchew Creek system (Appendix B). The monitoring data indicate hydraulic connection between surface water and groundwater through the wetland complex within the upper Sequalitchew Creek drainage. Hydraulic connection is observed by similar water elevations, fluctuations, and time-trends at paired surface water and groundwater monitoring stations. Hydraulic connection is also indicated in the middle reaches of Sequalitchew Creek where springs (groundwater) discharge to the ravine throughout most of the year. Sequalitchew Creek infiltrates water to the groundwater system in its lowermost reaches. Details of the conceptual model for the groundwater/wetland connection are provided in Section 3.2 of the Groundwater Model Update Report (Aspect, 2017b).

In Bell, McKay, and Hamer Marshes, surface water levels are typically higher than groundwater levels indicating an influx of surface water in the wet season from

stormwater generated on Joint Base Lewis-McChord (JBLM). Surface water and groundwater monitoring data from these marshes is shown in Figures B-5a through B-5c in Appendix B. In Bell Marsh (Figure B-5a), the surface water level is similar to, but slightly above groundwater level. In McKay Marsh (Figure B-5b), the surface water level was uniformly higher than groundwater until 2011, then the surface water level tracked closely with groundwater until 2019 when seasonal surface water highs started being lower than groundwater. These changes over time are interpreted as associated with removal of beaver dams at the box culvert connecting McKay Marsh to Hamer Marsh.

The relationship between groundwater and surface water in Hamer Marsh varies within the marsh. There are three groundwater wells near Hamer Marsh: MW-HM-1 on the south, SRC-MW-2 on the east, and MW-SL-1 near the Lake Outlet Area (Figure 12). Groundwater level in MW-SL-1 is 1 to 3 feet lower than the surface water level in Hamer Marsh, indicating that the marsh is recharging groundwater along the northwestern edge. On the southern edge, the groundwater level in MW-HM-1 is typically higher than the surface water level, which would result in groundwater discharge to the marsh. On the eastern side, groundwater in SRC-MW-2 is higher in winter and lower in summer. This complicated pattern in Hamer Marsh is largely driven by Sequalitchew Lake and the Diversion Canal acting as large areas of groundwater discharge.

Throughout Edmond Marsh, there is connection between surface water and groundwater; however, the connection is greater in the more easterly monitoring stations than in the west marsh area. In the central and eastern areas, stations EM-3 and EM-2 are located adjacent to roadways that, during their construction, may have excavated out the peat deposits. In addition, the creation and maintenance of a channel for Sequalitchew Creek through Edmond Marsh during the years when a fish hatchery operated in Sequalitchew Lake likely disturbed or removed portions of the peat deposits. The westernmost station EM-1 has the least amount of hydraulic connection, presumably because the underlying peat materials are still in place.

These monitoring data indicate that an influx of surface water in the wet season fills the wetland area. Beaver dams help to maintain marsh surface water levels higher than groundwater levels beneath the marshes during the wet season. During the dry season, the surface water and groundwater levels drop. In the west end of West Edmond Marsh, the groundwater level drops below the marsh bottom (i.e., it becomes perched) and the marsh completely dries each year by late spring. The west end of West Edmond Marsh is typically perched from May through October or later and is dry for most of that period. This condition is interpreted as affecting the western two-thirds of West Edmond Marsh, as water is present year-round at the staff gage west of Robinson Trail. Beaver activity in West Edmond Marsh likely defines the boundary between the areas to the west that become perched and the areas near Robinson Trail that remain in contact with groundwater year-round.

The monitoring data also indicate that the core wetland areas are generally underlain by fine-grained, low-permeability peat and silt deposits that hold water (Aspect, 2004a). Where these peat deposits occur, the amount and rate of surface water that can leak into the groundwater system due to potential future groundwater drawdown would be limited by the natural low permeability of the underlying silts and peats. In other areas, development has removed the naturally low-permeability soils from historical wetland

areas; the removal of peat and/or the natural heterogeneity of the soil materials can create an avenue for greater hydraulic connection and thus wetland response to groundwater level change.

A group of lakes (e.g., Grant Lake, Pond Lake, Old Fort Lake, and several others) are located a few thousand feet south of Sequalitchew Creek (Figure 12). Monitoring data indicates these are water table lakes whose surfaces fluctuate with the groundwater level.

3.1.4 Groundwater Quality

The unconfined Sea Level Aquifer was tested for water quality in late 1991 by Hart Crowser as part of water supply exploration work for the mine, and by Woodward-Clyde Consultants as part of Landfill 5 monitoring. In 2005, samples were collected from selected wells completed in the Steilacoom Gravel for analysis of nitrate (Aspect, 2005).

The data indicate generally good groundwater quality. Nitrate as nitrogen concentrations were below the primary standard for drinking water (i.e., the Maximum Contaminant Levels–MCLs). Secondary MCLs (based on aesthetics) for drinking water were exceeded for iron and manganese. Hart Crowser (1991) indicated it to be a regional phenomenon as it was seen in other wells in the area.

During permitting of the existing mine, there was a concern about water quality because the mine was downgradient of Landfill 5, a portion of which had been listed as a Superfund Site. Since that time, the landfill was closed in accordance with applicable laws and regulations and removed from the Superfund Site listing in 1992, with a Record of Decision that indicated “no further remedial action required”. During subsequent groundwater quality monitoring conducted in wells located in and around the landfill, iron and manganese generally exceeded secondary drinking water quality standards in several of the downgradient monitoring wells. In 2010, iron and manganese exceeded standards in several of the upgradient monitoring wells as well. No other drinking water standards were exceeded in the monitoring wells downgradient of the landfill (Versar, 2011).

The City of DuPont and the South Parcel are within an area of the Tacoma Smelter Plume for which Ecology has determined the predicted arsenic concentrations (less than 200 ppm) are unlikely to pose a threat to groundwater (Ecology, 2012).

3.1.5 Drinking Water Supplies

There are two significant public water supplies in the general area: the City of DuPont’s and JBLM’s. The characteristics of these water supplies are described below.

3.1.5.1 City of DuPont

The City of DuPont uses six wells for its municipal water supply. The closest water supply wells to the South Parcel Project are Bell Hill Wells No. 1, No. 2, and No. 3, located on Bell Hill roughly 1 mile south-southeast (regionally upgradient) of the South Parcel. The Bell Hill No. 1 and No. 3 wells are completed in the deep confined Sea Level Aquifer beneath the Olympia Beds. The Bell Hill No. 2 well is completed in a still-deeper confined aquifer. The City’s Hoffman Hill wells No. 1 and No. 2 are located more than 1 mile southwest of the South Parcel and are also completed in the Sea Level Aquifer. Each of the City’s water supply wells withdraw groundwater from deep confined aquifers that

are hydraulically isolated from surface influence and are at locations hydraulically upgradient (Bell Hill) or cross-gradient (Hoffman Hill) of the Proposed Action.

The City of DuPont holds water right authorizations to withdraw up to 5,390 gallons per minute (gpm), and 3,360 acre-feet per year. In 2020, the City's actual water production was 1,359 acre-feet. The City has a pending water right application with a priority date of December 15, 2004, on file with Ecology. The proposed source for the new water right is two future wells to be situated near Center Drive within the NW ¼ NE ¼ of Section 35, T. 19 N., R. 1 E.W.M. and/or the SE ¼ SW ¼ of Section 26, T. 19 N., 1 E.W.M. These locations in the general vicinity of Grant Lake or Pond Lake, respectively. The wells will withdraw water from the Sea Level Aquifer. As with the existing wells, the City's proposed new wells will be constructed in a unit that is hydraulically isolated from surface influence and upgradient.

The City has additionally filed an Application for Change of Water Right (G2-GWC 170@2) requesting that a portion of Water Right Certificate 170 be transferred to the Hoffman Hill wells. This change would result in an increase of 450 gpm, and 320 acre-feet of water that could be produced from the Hoffman sources.

3.1.5.2 Joint Base Lewis-McChord

JBLM receives most of its water supply from Sequalitchew Springs (see Section 3.1.6.1), which are reported to yield as much as 9,000gpm, or approximately 20 cubic feet per second. Other portions of JBLM are supplied by groundwater wells that range widely in depth and are completed in all three of the area's major aquifer.

JBLM's legal access to water is embedded in the base's federal status as a military base, as such it is allowed to access water for the base's primary purposes which includes the drinking water system that serves its population. Sequalitchew Springs generally provides more flow that needed by JBLM for water supply.

3.1.6 Springs

There are three identified sets of springs in the general vicinity of the South Parcel Project, including Sequalitchew Springs at the east end of Sequalitchew Lake (on JBLM), springs along the Sequalitchew Creek ravine, and intertidal springs observed along the shoreline of Puget Sound. Each set of springs is described below.

3.1.6.1 Sequalitchew Springs

The Sequalitchew Springs are located on the eastern shore of Sequalitchew Lake, just west of American Lake and are formed where the water table between American Lake and Sequalitchew Lake intersects ground surface. American Lake is maintained at an elevation of approximately 224 feet through an overflow channel near Sequalitchew Springs, and Sequalitchew Lake is maintained at an elevation of approximately 211 feet controlled by a weir at the west end of the lake.

As mentioned above, Sequalitchew Springs are the principal water supply for JBLM. Most of the time the springs provide more flow than needed by JBLM for water supply, resulting in surface water outflow from Sequalitchew Lake passing over the Diversion Weir and into the Diversion Canal. There are periods, typically in dry summers, when spring flow is fully consumed by JBLM and no water flows over the Diversion Weir. The periods occurred approximately 7.7 percent of the time during the monitoring period as

described in Section 4.5.3.1. The DuPont model tracks overflow from Sequalitchew Springs.

3.1.6.2 Springs in Sequalitchew Creek Ravine

Groundwater discharges from the Vashon Aquifer as springs in the Sequalitchew Creek ravine below elevations of approximately 195 feet down to the top elevation of the Olympia Bed deposits at elevation between approximately 100 to 120 feet, which spans a creek reach of approximately 0.7 miles. These springs provide baseflow to Sequalitchew Creek. Based on stream gaging data, this groundwater discharge to the creek varies between approximately 0.5 cubic feet per second (cfs) in the summer to 1.5 cfs in the winter. Progressing downstream past the Olympia Bed Truncation, Sequalitchew Creek becomes a losing stream as the water table drops through the outwash to near sea level.

3.1.6.3 Intertidal Springs

Springs are located at multiple points along the shoreline of the Nisqually Reach. Two springs are located along the beach just north of the Sequalitchew Creek estuary and directly west of the area of the proposed South Parcel mine development (Figure 27). The largest of these springs, the Large Spring, was reported to flow between 11 and 18 cfs based on monthly data collected by the USGS in 1942. Spot measurements by CH2M HILL in 1999 and 2000 indicated flows of 9.1 and 14.9 cfs, respectively (CH2M HILL, 2001). The makeup of the water (saltwater versus freshwater) discharging from the springs is influenced by tidal stage and season. The sources of freshwater to the intertidal springs are summarized in Table 9. It is estimated that the Vashon Aquifer contributes up to approximately 15 percent of the intertidal spring discharge and the Sea Level Aquifer contributes up to approximately half of the intertidal spring discharge, with the remainder being salt water (Aspect, 2015; Aspect, 2004b).

Table 9. Sources of Water to the Intertidal Springs

Source	Estimated Percentage of Intertidal Spring Flow
Vashon Aquifer	0–2 - 14
Sea Level Aquifer	0–8 - 49
Puget Sound	–6 - 99

3.2 Effects of the Proposed Action

3.2.1 Groundwater Elevations and Flow Patterns

The groundwater table will be significantly lowered in the vicinity of the South Parcel Project area as a result of the dewatering activities included in the Proposed Action. Following calibration and validation, the DuPont model was used to predict decreases in groundwater levels during the four sequential future steps of proposed dewatering and mining activity in the South Parcel. A summary of the model predictions for all four dewatering steps is shown on Figure 20. As described in Section 4.6.5, dewatering Steps

1, 2, and 3 simulated 10, 24, and 66 active dewatering wells, respectively. Step 4 simulated the post-mining condition with pumping terminated and groundwater passively discharging at the toe of the newly mined slope. For direct comparison with baseline model results, predictive models used the same baseline boundary conditions as the validation model, except for pumping at active dewatering wells or drainage at the toe of the newly mined slope.

Model results indicate that pumping rates will equilibrate within 1 month, and water levels will largely equilibrate within 60 days, of a change in pumping rates. Baseline groundwater levels are sensitive to seasonal and longer-term precipitation patterns (e.g., see Figure 9 in the Groundwater Model Update Report [Aspect, 2017a]), and groundwater levels during the four dewatering phases are predicted to likewise remain sensitive to precipitation patterns.

Results of the predictive models are discussed below by dewatering phase, in terms of predicted decreases in groundwater levels compared to baseline conditions. To support the discussion, predicted decreases in groundwater levels are presented in a table, graphs, and maps.

3.2.1.1 Future Mining Step 1: Initial 10-well Dewatering Test

Step 1 dewatering will include 10 active wells located in the northern portion of the South Parcel, as shown on Figure 21. To simulate Step 1, the validated model was modified by adding 10 wells screened across the Steilacoom Gravel and Vashon Recessional Outwash. Wells were simulated to pump up to 1 cfs each unless the available drawdown in the well limited the pumping rate. After the first month of pumping all 10 wells, the combined pumping rate is predicted to be approximately 3.6 cfs, on average, and up to approximately 5.5 cfs during the wet season. See Table 7 for average monthly, overall average, and minimum and maximum dewatering rates.

Groundwater level decreases are predicted to stabilize within approximately 60 days after pumping starts based on model results. During Step 1, the model-predicted decreases in groundwater levels shown on Figure 22 are most evident at monitoring wells CHMW-2S and CHMW-2D, which are the closest monitoring wells to the proposed location of the Step 1 dewatering wells. At more distant monitoring wells, the predicted groundwater level decreases are less than half the observed range in baseline groundwater levels.

Table 8 lists the maximum decrease in groundwater level at each well during Step 1. For the purposes of communicating refined model results, we focus on the values on the left half of Table 8, which are the maximum decreases in groundwater level without including model uncertainty. The maximum groundwater level decrease at CHMW-2D is predicted to be approximately 8.8 feet, which is more than half the range in observed water levels during baseline monitoring. The maximum groundwater level decrease at upgradient monitoring well MW-D-3 (adjacent to the Diversion Canal east of the mine expansion) is predicted to be approximately 1.8 feet. The maximum groundwater level decrease at monitoring wells MW-EM-1D and MW-EM-2D (in Edmond Marsh) is predicted to be approximately 0.5 foot and 0.1 foot, respectively. Note that the maximum predicted groundwater levels changes shown on Figure 22 at individual wells reflect the incorporation of model uncertainty and correspond with the values presented in the righthand columns of Table 8.

During Step 1, little or no effects on wetlands or groundwater discharge to Sequalitchew Creek were predicted by the model (see Figure 21 in the Groundwater Model Update report [Aspect, 2017b]). The overall average wetland infiltration rate is predicted to remain similar to baseline conditions. The predicted average rates of wetland infiltration to groundwater, and discharge from wetland to surface water, are similar to baseline conditions. The timing of net wetland flow (wetland infiltration to groundwater plus discharge from the wetland to surface water) is predicted to be approximately the same as baseline conditions. During Step 1, the JBLM water supply overflow showed no significant change in flow rates compared to baseline conditions.

3.2.1.2 Future Mining Step 2: Active Dewatering in Preparation for Mining

During Step 2, the dewatering well network will be expanded to the south along the South Parcel mine perimeter as well as adding a few wells in the interior as shown on Figure 21. To simulate Step 2, the validated model was modified by adding 24 wells screened across the Steilacoom Gravel and Vashon Recessional outwash. The dewatering wells are arranged in two lines on either side of the initial mine trough, with 19 boundary wells and 5 inner wells. Wells were simulated to pump up to 1 cfs each unless the available drawdown in the well limited the pumping rate. After the first month of pumping all 24 wells, the combined pumping rate is predicted to be approximately 5.2 cfs, on average, and up to approximately 8.8 cfs during the wet season as shown in Table 7.

Groundwater level decreases at upgradient monitoring wells are predicted to stabilize within approximately 60 days after pumping starts based on model results. As shown in Table 8 and on Figure 23, the maximum groundwater level decreases during Step 2 at CHMW-2D and CHMW-1 are predicted to be approximately 45 feet and 5.2 feet, respectively. At this step, monitoring well CHMW-2D will be interior to the dewatering well network. The maximum groundwater level decrease at upgradient monitoring well MW-D-3 is predicted to be approximately 4.3 feet. The maximum groundwater level decreases at MW-EM-1D and MW-EM-2D are predicted to be approximately 1.5 feet and 0.2 feet, respectively. The maximum predicted groundwater levels changes shown on Figure 23 at individual wells reflect the incorporation of model uncertainty and correspond with the values presented in the righthand columns of Table 8.

During Step 2, the predicted overall wetland infiltration rate will be approximately 0.2 cfs greater than baseline conditions, assuming wetland water levels are maintained (see Figure 21 in the Groundwater Model Update Report [Aspect, 2017b]). Most of the predicted changes in infiltration will occur in the East Edmond Marsh area. The predicted timing of net wetland flow will remain approximately the same as baseline conditions. Groundwater discharge to Sequalitchew Creek during Step 2 is predicted to remain similar to baseline conditions. During Step 2, the JBLM water supply overflow showed no significant change in flow rates compared to baseline conditions.

3.2.1.3 Future Mining Step 3: Active Dewatering During Mining

Step 3 dewatering was simulated with 66 active wells along the eastern and southern South Parcel mine boundary, as shown on Figure 21. The dewatering wells are arranged in two lines on either side of the initial mine trough, with 54 boundary wells and 12 interior wells. The combined pumping rate is predicted to be approximately 6.9 cfs, on

average, and up to approximately 12.2 cfs during the wet season as shown in Table 7. It may not be necessary to operate all dewatering wells as the mine trough progresses once an alternative (passive) dewatering system is in place. However, for the purposes of evaluating the maximum effects of dewatering during Step 3, the DuPont model simulated all dewatering wells operating simultaneously as a conservative assumption.

Groundwater level decreases are predicted to stabilize within approximately 60 days after pumping starts, based on model results. The maximum predicted decreases summarized in this paragraph are shown in the Step 3 column on the left side of Table 8. The maximum groundwater level decreases during Step 3 at CHMW-2D, CHMW-1, CHMW-4D, and CHMW-3D are predicted to be approximately 51 feet, 60 feet, 15 feet, and 57 feet, respectively. The maximum groundwater level decreases at MW-EM-1D and MW-EM-2D are predicted to be approximately 5.1 feet and 0.4 feet, respectively. The maximum groundwater level decreases at upgradient monitoring wells MW-D-3 and MW-93-MFS-C-5 are predicted to be approximately 7.7 feet and 4.2 feet, respectively. The groundwater levels during Step 3 are predicted to be approximately 10 to 20 feet above the Olympia Beds along the mine trough. The maximum predicted groundwater levels changes shown on Figure 24 at individual wells reflect the incorporation of model uncertainty and correspond with the values presented in the righthand columns of Table 8.

During Step 3, the predicted overall wetland infiltration rate will be approximately 0.6 cfs greater than baseline conditions, assuming wetland water levels are constant (see Figure 21 in the Groundwater Model Update Report [Aspect, 2017b]). Most of the predicted changes in infiltration will occur in the East Edmond Marsh area. Based on model results, the lower groundwater levels under West Edmond Marsh will reduce groundwater discharge to surface water during Step 3. Groundwater discharge to Sequalitchew Creek during Step 3 is predicted to be 83 percent less than baseline conditions, on average, with the greatest decreases during the dry season. As with Steps 1 and 2, the JBLM water supply overflow showed no significant change in flow rates in Step 3 compared to baseline conditions.

3.2.1.4 Future Mining Step 4: Post-Mining Conditions

During Step 4, pumping from the dewatering well network will cease, and groundwater will emanate from the toe of the mined slope. Groundwater emanating from the southern portion of the slopes will be collected and conveyed to provide the primary water source for a constructed wetland in the southwest corner of the existing mine. Groundwater seeping from the toe of the northern slopes will be collected and conveyed to an infiltration pond on the floor of the existing mine. Overflow from the wetland will flow to this same infiltration pond. The Step 4 ground surface (model top) elevation was modified to reflect the final mine grade to simulate passive groundwater discharge into the mine. The flow rate of groundwater discharging into the mine is predicted to be 6.9 cfs, on average, and up to 13.7 cfs during the wet season. Collected groundwater discharging into the mine will be re-infiltrated in the western portion of the mine area. The re-infiltration of collected groundwater seeping into the mine will recharge the Sea Level Aquifer and will not affect groundwater levels in the Vashon outwash aquifer. As such, re-infiltration was not simulated in the DuPont model.

Groundwater levels within the Vashon aquifer are predicted to recover slightly relative to the active pumping of Step 3. Those changes within the Vashon aquifer are predicted to stabilize within approximately 60 days after pumping stops based on model results. As shown in Table 8, the maximum groundwater level decreases at monitoring wells along the mine trough (CHMW-2D, CHMW-1, CHMW-4D, and CHMW-3S), are predicted to be approximately 32 feet, 30 feet, 14 feet, and 50 feet, respectively. The maximum groundwater level decreases at upgradient monitoring wells MW-D-3 and MW-93-MFS-C-5 are predicted to be approximately 6.6 feet and 3.6 feet, respectively. The maximum groundwater level decreases at MW-EM-1D and MW-EM-2D are predicted to be approximately 4.7 feet and 0.4 feet, respectively (see Figure 25). The maximum predicted groundwater levels changes shown on Figure 25 at individual wells reflect the incorporation of model uncertainty and correspond with the values presented in the righthand columns of Table 8. Figure 20 presents the calculated groundwater level elevations, the monthly ranges in calculated water levels, and the monthly change in calculated water levels. Model uncertainty is graphically presented by the error bars on Figure 20.

During Step 4, the predicted overall wetland infiltration rate will be approximately 0.5 cfs greater than baseline conditions, assuming stream restoration efforts maintain wetland water levels (see Figure 21 in the Groundwater Model Update Report [Aspect, 2017b]). Most of the predicted changes in infiltration will occur in the East Edmond Marsh area. Based on model results, the lower groundwater levels under West Edmond Marsh during Step 4 will reduce groundwater discharge to surface water. Groundwater discharge to Sequalitchew Creek during Step 4 is predicted to be 79 percent less than baseline conditions, on average, with the greatest decreases during the dry season.

During Step 4, the JBLM water supply overflow showed no significant change in flow rates compared to baseline conditions.

3.2.1.5 Comparison of Water Levels during Mining Steps 1 through 4

Figure 20 provides a collection of graphs comparing groundwater levels (elevations) for each dewatering step by monitoring well. The upper graphs on Figure 20 compare time-series of baseline groundwater levels and predicted groundwater levels for each of the four dewatering phases. The lower ends of the whiskers illustrate the minimum groundwater levels including model uncertainty.

The middle graphs on Figure 20 show the ranges in monthly groundwater level elevations for baseline conditions and each of the four dewatering phases. The color bars reflect the potential effects of annual hydrologic variability. The lower ends of the whiskers illustrate the minimum groundwater level including model uncertainty.

The lower graphs on Figure 20 show the range in monthly groundwater levels decrease from baseline for each of the four dewatering steps. The color bars reflect the potential effects of annual hydrologic variability. The lower ends of the whiskers illustrate the minimum groundwater level including model uncertainty.

During Step 3, it likely will not be necessary to continue operating all of dewatering wells as the mine trough progresses. As the passive groundwater conveyance ditches are installed in areas mined earlier, the wells upgradient of these areas can be turned off

allowing groundwater to passively discharge from the toe of the mined slope. However, for the purposes of evaluating the maximum possible effects of dewatering during Step 3, the DuPont model simulated all dewatering wells operating simultaneously as a conservative assumption.

3.2.1.6 Model Uncertainty

The DuPont model validation timeframe was 11 years, including a 6-year calibration timeframe. This is a longer calibration and validation timeframe than typically incorporated in similar groundwater models. By comparison, the USGS model calibration timeframe was 2 years with no validation timeframe.

Model uncertainty for the DuPont model results was calculated as the 95-percent confidence interval using the 1-tailed test and the well-specific standard deviation of residuals from the residual statistics for the entire 11-year model validation period. For predictive model results, the 95-percent confidence interval was increased proportional to the average water level decrease at that location. Additional discussion of model uncertainty is provided in Section 6.5 of the Groundwater Model Update Report (Aspect, 2017b).

Model uncertainty was incorporated into predictions of the minimum groundwater levels for each month in each dewatering Step. These values are shown in Table 10 and are used as thresholds in the Monitoring Plan (Aspect, 2017a) for triggering the adaptive management process during dewatering. A similar approach was also used for calculating the groundwater levels with mining used in the marsh water balances described in Section 4.2.3.2.

3.2.2 Groundwater Quality

Groundwater quality in the South Parcel Project area will not be significantly affected if BMPs are responsibly implemented throughout the Proposed Action. Groundwater quality impacts are rare at properly managed aggregate mining sites. The principal concern relates to the direct access to highly permeable aggregate materials. Current mining permits require that best management practices include implementation of stormwater pollution prevention, spill control and cleanup procedures, frequent monitoring of stormwater quality, and management of operations to minimize the use of materials in the mine that could generate potential contaminants.

3.2.2.1 Dewatering

Dewatering is not anticipated to have an impact on upgradient water quality. Installation, operation, and decommissioning of dewatering wells, pumps, conveyance lines, and supporting infrastructure will be conducted in accordance with the mine plan to protect both surface water and groundwater resources. Dewatering will not introduce new potential sources of groundwater contamination. Engineering controls at nearby JBLM Landfill 5 (including landfill gas collection and treatment from a lined and covered landfill) will not be affected by water level decreases from dewatering. For existing or future upgradient sources, the steeper hydraulic gradient associated with groundwater level declines will accelerate groundwater velocity before the groundwater enters the dewatering system. Groundwater captured by the dewatering system will be thoroughly mixed before being discharged to constructed wetlands or ponds for infiltration.

3.2.2.2 Chemical Spills, Leaks, and Drips within the Mine

Spills, leaks, and drips of chemical products are not typically a significant groundwater quality concern for mining sites like the South Parcel Project because of the limited use of chemicals, and small number of heavy equipment operating in a large area. Petroleum products (diesel fuel, motor oil, and hydraulic fluid) used to operate the mining equipment are the only chemical constituents used within the mining area and mining companies are uniquely able to excavate and contain small spills because heavy equipment is always on site. Thus, in the event of a spill they can quickly excavate contaminated soil and contain it in the bed of a dump truck.

To assess the risk of an accidental fuel spill from a piece of mining equipment, numerical modeling was performed using the EPA Hydrocarbon Spill Screening Model (HSSM). The model was setup to evaluate a reasonable thickness for an unsaturated soil buffer zone that would protect the groundwater should an accidental release of petroleum hydrocarbons occur on the floor of the existing mine. This is a conservative assumption because the mining of the South Parcel Project will occur in areas underlain by the lower permeability Olympia Beds, which are much less conducive to transport of spilled hydrocarbons. The modeling evaluated the migration of light, non-aqueous phase liquids (LNAPL) through the unsaturated zone to the water table. This modeling analysis was conducted for equivalent mining conditions during permitting for the North Parcel mine expansion, and the HSSM model setup and results for that permitting process (Aspect, 2013) are adopted here.

HSSM model results indicate it would take approximately 3 days for a release of 500 gallons of diesel to migrate to a depth of 5 feet below the base of the active aggregate mine. If a scenario existed where the spill was not cleaned up, the modeling indicates the diesel front would reach a depth of 8.5 feet in 30 days, and a depth of 10 feet in 89 days. It is unlikely that a full diesel tank would rupture. In accordance with the mine's Spill Response Plan, required under the Sand and Gravel General NPDES/SWD permit, any spills would be cleaned up immediately so it is unlikely that a spill would go without a cleanup response for more than 1 day.

3.2.3 Drinking Water Supplies

Drinking water supplies identified near the South Parcel Project area will not be significantly affected by the Proposed Action. Figures 22 through 25 show little to no effect on groundwater conditions in the unconfined aquifer at the southwestern model boundary. Based on the proximity of the City of DuPont water supply wells to the model boundary condition, and the completion of those wells in the Sea Level Aquifer, we anticipate no effect of the Proposed Action on groundwater conditions at these water supply wells.

JBLM's water supply at Sequalitchew Springs would also not be affected by the Proposed Action. Figures 22 through 25 show the drawdown effects of dewatering and post-mining condition do not extend to Sequalitchew Springs or its source American Lake. The model calculates a decrease of approximately 0.03 cfs (15 gallons per minute) in overflow from Sequalitchew Springs to Sequalitchew Lake, which is small relative to the 10 cfs outflow (on average) from the lake measured at the Diversion Weir. While

there would be a minor decrease in the overflow volume, the amount withdrawn for water supply would not be affected.

3.2.4 Springs

The predicted effects of the Proposed Action on spring flow in the vicinity of the South Parcel Project vary. The following sections describe the predicted effects on Sequalitchew Springs, the spring along Sequalitchew Creek ravine, and intertidal springs observed along the shoreline.

3.2.4.1 Sequalitchew Springs

As described above, the model predicts no effect of the Proposed Action on the water supply from Sequalitchew Springs. Figures 22 to 25 show the drawdown effects of dewatering and post-mining condition do not extend to the east end of Sequalitchew Lake or the Springs' source, American Lake.

3.2.4.2 Springs in Sequalitchew Creek Ravine

The model predicts that the Proposed Action will decrease flow rates from some of the springs in Sequalitchew Creek ravine. The affected springs in Sequalitchew Creek ravine are those sourced by the Vashon Aquifer where dewatering and the post-mining condition results in lower groundwater levels.

3.2.4.3 Intertidal Springs

The model predicts that the Proposed Action will not have a significant impact on intertidal springs flows because there is no consumptive use of groundwater as water produced during dewatering and the post-mining condition is reinfiltrated within the mine upgradient of these springs. Because the total quantity of groundwater flowing westward from the re-infiltration pond area would not change, the Proposed Action would not markedly change the makeup of water (freshwater versus saltwater) discharging from the intertidal springs, which is controlled primarily by tidal stage and season (Aspect, 2015, included in Appendix D; Aspect, 2004b).

3.3 Effects of the No Action Alternative

Under the No Action alternative, the individual parcels that comprise the South Parcel would most likely be cleared and developed for manufacturing and research and/or residential land use based on existing land use and zoning designations, as detailed in Section 1.2.

Manufacturing and research and residential development would replace vegetated areas with impervious surfaces, which decreases evapotranspiration and increases stormwater runoff. Assuming that all stormwater is infiltrated, given the porous surficial soils, there would be an increase in groundwater recharge. Any water obtained from the City of DuPont water supply and used within the future South Parcel developments for irrigation or other outdoor purposes could also increase recharge.

Risks to groundwater quality in the South Parcel would increase during future development; however, a 10- to 20-foot-thick unsaturated zone of sand and gravel would remain, providing some protection for the aquifer.

3.4 Mitigation Measures

Mitigation measures have been included in the Proposed Action to reduce impacts to groundwater quantity and quality:

- Steps 1 and 2 of the Dewatering Plan are completely reversible and allow for real-world testing of the groundwater model predictions and impacts to groundwater quantity at scale.
- The Dewatering Plan is structured to begin dewatering at the locations furthest from sensitive receptors, then slowly proceed closer only if the changes in groundwater are consistent with predictions.
- The Monitoring Plan details a series of adaptive management actions during each step of dewatering to monitor water levels, assess results by comparing with predictions, and take corrective actions, if necessary. Dewatering would not proceed if impacts to groundwater are not consistent with predictions.
- The Sequalitchew Creek Watershed Restoration Plan would mitigate for the impacts of the Proposed Action on Edmond Marsh and flows in Sequalitchew Creek (see Section 4).
- Re-infiltration of collected groundwater within the floor of the existing mine preserves the flow to the intertidal springs.
- Erosion and sediment controls and stormwater treatment, described in the Geology and Surface Water sections respectively, would protect groundwater quality and long-term performance of the proposed infiltration ponds.
- Revegetation of the proposed mine slopes and floor as a part of reclamation would stabilize soils and reduce effects on quantity and timing of groundwater recharge

3.5 Significant Unavoidable Adverse Impacts

3.5.1 Groundwater Elevations and Flow Patterns

The unavoidable impact of the Proposed Action's dewatering and post-mining condition is that the groundwater table will be lowered in the vicinity of the South Parcel Project. Edmond Marsh is located closest to the South Parcel Project. At the center of Edmond Marsh, the model-predicted maximum decreases in groundwater levels are 0.52 feet, 0.63 feet, 0.87 feet, and 0.84 feet during mining Steps 1, 2, 3, and 4, respectively. For the entire wetland complex, seepage rates to groundwater will increase 0.0 cfs, 0.2 cfs, 0.6 cfs, and 0.5 cfs during dewatering Steps 1, 2, 3, and 4, respectively, based on DuPont model results.

3.5.2 Groundwater Quality

No significant unavoidable adverse impacts on groundwater quality are anticipated if best management practices are responsibly implemented throughout the Proposed Action. Best management practices include implementing stormwater pollution prevention, spill

control and cleanup procedures, monitoring stormwater quality, and managing operations to minimize the use of materials in the mine that could generate potential contaminants.

3.5.3 Drinking Water Supplies

No significant unavoidable adverse impacts from the Proposed Action to the drinking water supplies of the City of DuPont or JBLM are anticipated, as the wells and springs tapped for supply either withdraw water from a different aquifer or are outside the area that would be affected by dewatering.

3.5.4 Springs

The Proposed Action will cause no significant unavoidable adverse impacts to flows at Sequalitchew Spring or at the intertidal springs. The Proposed Action will cause significant unavoidable adverse impacts to some springs and seeps in the Sequalitchew Creek ravine as the water table is lowered during dewatering and during the post-mining condition.

4 Surface Water and Stormwater

The effects of the South Parcel Project on surface water hydrology were evaluated from three perspectives:

1. The effects within the South Parcel Project resulting from mining activities, which generally focused on stormwater management and changes in the site water balance
2. The effects of mine dewatering on Sequalitchew Creek and the upgradient watershed
3. The cumulative effects of mining and watershed restoration on the creek and marshes.

Within the South Parcel Project area, existing conditions were examined through several site reconnaissance visits, hydrologic modeling, and compilation of other available data sources (climatic data, NPDES discharge data, etc.) Proposed conditions were simulated using the same hydrologic model to simulate the proposed changes in land use and the stormwater management system.

Within the broader Sequalitchew Creek watershed, the understanding of existing conditions is based primarily on monitoring data collected monthly from staff gages, wells, and flow monitoring stations since 2004. These data inform the groundwater analyses discussed in Section 3 as well as a marsh water balance model used to predict effects on the marshes and Sequalitchew Creek. This water balance model is used for predicting the effects of mining alone and the cumulative effects with watershed restoration.

4.1 Affected Environment

4.1.1 Climate

The existing mine and proposed South Parcel Project are located on the eastern shoreline of Puget Sound and experience the mild marine climate typical of the Puget Sound region. Average temperatures are typically in the mid-50s to upper 70s (in degrees Fahrenheit) during the summer months, and mid-30s to upper 40s during the winter months (Figure 26).

Precipitation tends to fall predominantly as rain with occasional snowfall during winter storms. The closest long-term precipitation gage to the North Parcel is Tacoma Public Utilities' McMillin Reservoir station (NCDC COOP ID# 455224) located about 20 miles northeast of the North Parcel. Beginning in January 2013, the McMillin Reservoir weather station became less reliable as measurements were not taken as frequently and there are significant data gaps. After that date, the best available precipitation data is from the Oregon State University's Parameter Regression against Slopes Model (PRISM), which spatially interpolates between weather station observations, accounting for elevation and aspect among other factors. A timeseries of daily precipitation data for the

McMillin Reservoir location was used to extend the precipitation record beyond December 2012.

Average annual precipitation from the combination of the McMillin Reservoir observations and the PRISM timeseries for the same location from 1941 to 2021 was 41.58 inches. Monthly precipitation totals vary from around 6 inches per month in November through January down to around 1 inch per month in July and August, as shown on Figure 26.

The potential for evaporation was estimated using long-term pan evaporation data from the Puyallup 2W Experimental Station (NCDC COOP ID# 456803) from 1931 to 1995. The Puyallup station was one of few long-term evaporation stations in the Puget Sound region until it ceased operations in 1995 and historical data from that station is often used for representing evaporation in the region. Mean annual pan evaporation measured at the Puyallup station was 28.7 inches for the period of record. Applying a pan coefficient of 0.8 (NOAA, 1982), converts the measured pan evaporation into potential evaporation of 23 inches per year.

Precipitation from McMillin Reservoir and potential evaporation based on Puyallup 2W Experimental Station are the key climatic inputs into the hydrologic model used to simulate hydrology within the South Parcel Project and the water balance model used to evaluate the marshes and Sequalitchew Creek under existing and proposed conditions

4.1.2 Surface Water Features

This section provides a description of the surface water features within the South Parcel Project area and existing mine, then within the Sequalitchew Creek watershed.

4.1.2.1 South Parcel Project Area and Existing Mine

The Kettle Wetland is the only notable surface water feature within the South Parcel Project area (Figure 27). Generally, the coarse recessional outwash soils present within the South Parcel and Existing Mine result in rapid infiltration of precipitation, so no surface water features form from rainfall and runoff.

The Kettle Wetland is a 1.78-acre wetland located within a glacial kettle in the Expansion Area, outside of the mining limits of the existing mine. Kettles form during glacial retreat, where glacial meltwater deposits its river-borne sediments around a large block of stranded glacial ice. When the ice block eventually melts, the kettle is left in the former footprint of the ice block as a closed topographic depression. The kettle where the Kettle Wetland formed is deep enough that it encounters the Vashon Aquifer, and the hydrology of the Kettle Wetland is driven by the seasonal fluctuations of the Vashon Aquifer. There are no tributaries or other surface water inputs to the Kettle Wetland. The Kettle Wetland is described in additional detail in the Plants and Animals Technical Report (Anchor QEA, 2022).

No streams or natural drainage channels were identified within the South Parcel Project area during site reconnaissance or on the DNR Forest Practices Application Mapping Tool (DNR, 2022) for the area.

Stormwater drainage features are present within the existing mine, particularly in the area of active backfill on the floor of the existing mine. CalPortland incorporates infiltration

facilities consisting of curtains of coarse rock to infiltrate stormwater and encourage drainage from backfilled areas. Ditches and small infiltration areas are also present in other portions of the existing mine. Generally, precipitation infiltrates within the mine without requiring significant stormwater infrastructure.

A kettle in the southeast corner of the North Parcel is used by CalPortland as an infiltration pond for discharge of treated process water from their water treatment system under Sand and Gravel General Permits #501178 and #501406, which permit discharges from the aggregate wash plant and concrete batch plant, respectively. This kettle is located west of the Olympia Bed truncation and does not encounter groundwater. It is not a wetland and would be dry if not for its use as an infiltration facility.

4.1.2.2 Sequalitchew Creek Watershed

The South Parcel Project is located within the Sequalitchew Creek subbasin of Water Resource Inventory Area (WRIA) 2–Chambers-Clover Watershed. The Sequalitchew Creek watershed is relatively complex because of the interaction between groundwater and surface water. The dominant features of the watershed are flat terrain, coarse outwash soils, and a series of wetlands and lakes that have formed in depressions and areas of lower permeability soils left by the receding glaciers.

Figure 27 presents an overview of the multiple waterbodies and channels located in the Sequalitchew Creek watershed. Geologic cross sections of Edmond Marsh and Bell, McKay, and Hamer Marshes are shown on Figures 28 and 29, respectively. Water surface elevations within the Sequalitchew Creek watershed are primarily understood through a monthly monitoring program that has been ongoing since 2004. Surface water monitoring locations are shown on Figure 12 and are summarized in Table 11.

Sequalitchew Lake is the headwaters of Sequalitchew Creek. Historically, springs at the east end of the lake would flow into the relatively low-gradient channel of Sequalitchew Creek that wandered through Edmond Marsh before entering a steep ravine leading to Puget Sound. Construction of the Diversion Canal (running from north to south as shown on Figure 27) and beaver activity has changed the creek hydrology such that continuous flow from the lake through the marshes to Puget Sound seldom occurs. Currently, a portion of Sequalitchew Creek and the adjacent marsh flow eastward into the Diversion Canal, rather than westward along their historical path.

The Diversion Canal is an engineered channel that conveys stormwater from JBLM through Bell, McKay, and Hamer Marshes before crossing under Sequalitchew Creek via culverts and picking up additional flow from the Sequalitchew Lake Diversion Weir. The Diversion Canal then skirts the perimeter of Fort Lewis Landfill 5 and continues north, where it descends in a concrete-lined channel to reach the Puget Sound near Tatsolo Point.

Bell, McKay, and Hamer Marshes are connected to Edmond Marsh through one culvert and several interpreted subsurface flow pathways. Bell, McKay, and Hamer Marshes are at higher elevations than the other marshes, and the influx of Fort Lewis stormwater encourages shallow subsurface flow to the lower elevation Edmond Marsh.

The waterbodies and channels that comprise the surface water system are discussed in subsequent sections, starting from the headwaters of the watershed and working downstream to Puget Sound.

4.1.2.3 Sequalitchew Lake

Sequalitchew Lake is an approximately 85-acre lake located on JBLM between American Lake and Hamer Marsh and Sequalitchew Creek. The lake is fed by the springs at its eastern end that provide the primary water supply for JBLM (see Section 3.1.5.2). At normal water level of 211.5 feet, Sequalitchew Lake has an average depth of about 6 feet and a maximum depth of 11.5 feet (Western Engineers, 1952).

The Washington State Department of Fish and Wildlife (WDFW) operated a salmon rearing facility in Sequalitchew Lake from 1976 (Mills, 1994) to about 1997 (Anteon, 2003). During this period, approximately 1 to 2.3 million coho salmon were reared in the lake. In spring, the fish would migrate out Sequalitchew Creek to Puget Sound. Mills (1994) noted that beaver dams would occasionally dam Sequalitchew Creek sufficiently to reverse the flow of the creek, similar to recent observations. The beaver dams were removed by hand during the 2- to 4-week period of smolt outmigration. In addition, a "cookie cutter" machine was used on at least two occasions to clear Sequalitchew Creek of thick wetland vegetation through Edmond Marsh.

Sequalitchew Lake has one surface water outlet at its western end, leading to a moderately complex culvert and weir configuration constructed in the 1950s to control the water elevation in Sequalitchew Lake and bypass flow from Hamer Marsh to the Diversion Canal. The flows in this area are controlled by four structures:

- **Sequalitchew Creek culverts:** Four 42-inch-diameter culverts connect the lake outlet with Sequalitchew Creek. These culverts were intended to convey the normal outflow from the lake to Sequalitchew Creek.
- **Diversion Weir:** An 18-foot-wide concrete structure with wooden stop logs that can be raised or lowered to adjust the elevation of the lake. The Diversion Weir was intended to divert water from Sequalitchew Creek to the Diversion Canal during periods of high flow to prevent high water in the lake from affecting the Sequalitchew Springs water supply. The current elevation of the top of the Diversion Weir is about 210.2 feet.
- **Diversion Canal culverts:** Three 48-inch-diameter culverts cross under the four Sequalitchew Creek culverts. These culverts convey the outflow from Hamer Marsh to the Diversion Canal.
- **Beaver Dams:** Beavers have constructed a large dam across Sequalitchew Creek. This dam retains water in the easternmost portion of Edmond Marsh at an elevation typically 1 or more feet higher than the lake. This dam and the higher elevations behind prevent flow from the lake to Sequalitchew Creek. Several other beaver dams in the area also influence water levels.

As originally designed, outflow from Sequalitchew Lake would continue to flow into Sequalitchew Creek and would only overflow to the Diversion Canal if the lake elevation

exceeded 211.15 feet. However, the construction of beaver dams in Sequalitchew Creek has prevented flow from the lake to the creek and instead all of the outflow from the lake is flowing to the Diversion Canal.

Since 2003, flow over the Diversion Weir has been monitored at a flow monitoring station installed immediately upstream of the outlet diversion weir. A hydrograph of measured streamflow at the Diversion Weir gage is presented on Figure 30.

Average monthly flows vary seasonally from a low of 2.4 cfs in September to a high of 21.5 cfs in March. In some drier years (e.g., 2005 and 2015), there are periods with no flow over the weir in late summer and early fall. Peak flows have exceeded 40 cfs on multiple occasions.

4.1.2.4 Bell, McKay and Hamer Marshes

Bell, McKay, and Hamer Marshes are three naturally occurring marshes that were significantly altered by the construction of the Diversion Canal in the 1950s. The primary surface water outlet of all three marshes is now the Diversion Canal.

Bell Marsh is an approximately 18-acre L-shaped marsh located within the City of DuPont, between Bell Hill, the historic Village of DuPont, and DuPont-Steilacoom Road (Figure 27). Bell Marsh receives stormwater runoff from 1,928 acres of the main cantonment area of JBLM into the marsh (Washington Engineering, 2001). Prior to entering Bell Marsh, the runoff passes through an infiltration pond and water quality treatment facility operated by JBLM to remove sediments and oil and grease and reduce peak flows prior to discharge into the marsh. Washington Engineering (2001) estimated that 4 to 7 percent of the total runoff would be infiltrated with the remainder being discharged into Bell Marsh.

The northwestern tip of Bell Marsh is located approximately 800 feet from the center of Edmond Marsh. The water level in Edmond Marsh is typically 6 to 7 feet lower than that of Bell Marsh, and as Bell Marsh receives a high volume of stormwater inflow, it is likely water infiltrates from Bell Marsh and flows beneath the ground surface into Edmond Marsh.

McKay Marsh is an approximately 37-acre marsh located on JBLM between DuPont-Steilacoom Road and I-5. A series of four small wetlands lead from the eastern portion of Edmond Marsh toward McKay Marsh. Shapiro and Associates (1991) concluded that these four wetlands were "probably hydrologically connected" to Edmond Marsh. Although surface topography suggests that it is unlikely that Edmond and McKay were previously connected, it is possible that subsurface flow from McKay to Edmond occurs along a path indicated by the chain of wetlands.

Hamer Marsh is an approximately 69-acre marsh located on JBLM immediately downstream of McKay Marsh. There are two main inflows to Hamer Marsh: the box culvert from McKay Marsh and a stormwater outfall from JBLM.

The stormwater outfall from JBLM collects runoff from 1,675 acres of JBLM including a portion of main cantonment area and Grays Army Airfield (Washington Engineering,

2001). The inflow to Hamer Marsh passes through a stormwater treatment and infiltration facility before being discharged to the marsh.

The main outflow from Hamer Marsh is the Diversion Canal. There is significant beaver activity in this section of the Diversion Canal with numerous active beaver dams controlling water levels between Hamer Marsh and the Lake Outlet Area. The first of these beaver dams is the primary control of the water level in Hamer Marsh.

A small culvert leading from the western tip of Hamer Marsh to the easternmost portion of East Edmond Marsh provides a secondary outlet. The culvert is set relatively high and is partially obstructed by debris, which only allows flow when the water surface elevation in Hamer Marsh is at higher levels 214 feet.

The area near the small culvert is also of interest from a subsurface connection perspective. In this area, Hamer Marsh is separated from East Edmond Marsh by approximately 125 feet that includes a gravel roadway. The roadway dips right at the location of the small culvert, which is also where the two marshes are closest together. It is suspected that this area may have been a former surface connection between the two marshes that was filled to allow construction of the roadway. A 1940 U.S. Army Corps of Engineers map (Figure A-6 in Appendix A of Aspect 2004a) shows the two marshes connected in this location. The difference in water levels between the marshes is approximately 2 feet, which given the close proximity is enough to allow subsurface flows from Hamer Marsh to Eastern East Edmond Marsh.

The marshes have a seasonal water pattern, with a high wet season water level typically from November through June or July followed by a lower water period through summer. The typical seasonal range in water levels is 2 to 3 feet. Water levels step down from Bell to McKay to Hamer Marsh as summarized in Table 12. The average water level in Bell Marsh is 218.58 feet. McKay Marsh is about 3 feet lower, with an average water level of 215.43 feet. Hamer Marsh is a little over 1 foot lower than McKay Marsh with an average water level of 214.02 feet.

4.1.2.5 Edmond Marsh

Edmond Marsh extends from the outlet of Sequalitchew Lake to about 700 feet east of Center Drive and is located on JBLM and within the City of DuPont. For discussion purposes in this report, Edmond Marsh is divided into three segments:

- Eastern East Edmond Marsh is located on JBLM east of DuPont-Steilacoom Road.
- East Edmond Marsh is located in DuPont between the Robinson Trail and DuPont-Steilacoom Road.
- West Edmond Marsh is located in DuPont west of the Robinson Trail.

Eastern East Edmond Marsh

Eastern East Edmond Marsh is approximately 32 acres in size and has an open channel through the center of the marsh. It is bounded by uplands on the north and south and DuPont-Steilacoom Road on the west. The east end of the marsh is the outlet area for Sequalitchew Lake. A large beaver dam separates the marsh from the lake outlet. A series of small beaver dams along an abandoned road grade form the northeast edge of the

marsh. Water flows over these beaver dams into the Diversion Canal, a reversal of the original flows down Sequalitchew Creek to Puget Sound. At the west end, a box culvert under DuPont-Steilacoom Road connects the marsh with East Edmond Marsh and allows flow in either direction through the culvert.

Eastern East Edmond Marsh receives inflow from Hamer Marsh via the 12-inch culvert and potential subsurface connection with Hamer Marsh. It also may receive inflow from East Edmond Marsh through the connecting culvert discussed above. No other inflows are known. With the beaver dam retaining water levels the marsh above the elevation of Sequalitchew Lake, it is not possible for outflow from the lake to enter the marsh.

Water has been observed flowing over the beaver dams on the eastern end of the marsh and into the Diversion Canal. The only other potential surface water outflow is the connecting culvert to East Edmond Marsh. At times, water levels have been higher in East Edmond Marsh, indicating flow back through this culvert toward the Diversion Canal. Water levels in East Edmond Marsh have been lower at other periods, indicating westward flow from the connecting culvert.

The water level in the Eastern East Edmond Marsh is monitored at staff gages behind the beaver dam on the eastern end and at DuPont-Steilacoom Road on the western end. The average water level is about 212.40 feet, with little difference between the two locations. This water level is over 1 foot higher than the average water level in Sequalitchew Lake.

East Edmond Marsh

The East Edmond Marsh segment is approximately 55 acres and includes scrub-shrub and open water habitats between DuPont-Steilacoom Road to the west and Robinson Trail (a public trail built on a former railroad grade) to the west. Sequalitchew Creek follows a meandering channel through East Edmond Marsh that has been previously excavated and cleared. Generally, the channel is more open on the eastern end of the marsh and becomes brushy close to the trail.

Inflows to East Edmond Marsh include the culvert under DuPont-Steilacoom Road, the potential subsurface inflows from Bell Marsh and McKay Marsh described in previous sections, and inflow from a small stormwater system draining a portion of Center Drive where roadside ditches and catch basins convey runoff to a drainage swale that leads directly into the northern boundary of the marsh.

The outflows from East Edmond Marsh are either to West Edmond Marsh through a culvert (often blocked by beavers),through the railroad grade itself, or eastward to through the culvert under DuPont-Steilacoom Road.

A significant beaver dam is located approximately 150 feet east of Robinson Trail and controls the water level in East Edmond Marsh. This beaver dam connects two upland areas and impounds water behind it to the east, forming the western end of a continuous body of water with roughly the same water surface elevation that extends to the east end of Eastern East Edmond Marsh. The beaver dam was breached in 2016 and water levels remained lower for multiple years before returning to similar levels in 2010 to 2011.

Two staff gages are used to monitor water levels in East Edmond Marsh: one on the westside of DuPont-Steilacoom Road (SG-EM-3W), and one located just north of an upland area near Robinson Trail (SG-EM-2E).

Water levels in East Edmond Marsh average 212.39 feet at SG-EM-3W and 212.20 feet at SG-EM-2E, indicating a slight gradient toward the west on average. There is little difference between water levels at the staff gages on the east and west sides of DuPont-Steilacoom Road. The water level in East Edmond Marsh is typically high from November or December through May or June, then declines gradually to a low typically in September before refilling as rains return.

West Edmond Marsh

West Edmond Marsh is an approximately 80-acre wetland bounded by the railroad grade on the east, historic DuPont to the south, and ringed by recent development on the north and west. Sequalitchew Creek follows a relatively straight path along the northern boundary of the marsh.

Multiple beaver dams actively control water levels in West Edmond Marsh and several inactive dams can be found throughout the marsh. The water level steps down typically around a foot at each beaver dam. The most significant of the beaver dams is the westernmost dam, which defines the western extent of the marsh.

Outflow from this beaver dam typically only occurs during the winter months and infiltrates in the broad grassy channels of Sequalitchew Creek on both sides of Center Drive. Outflow from West Edmond Marsh has only been observed flowing under Center Drive on rare occasions and seldom extends to the downstream reaches of Sequalitchew Creek.

West Edmond Marsh receives inflow from East Edmond Marsh through the culvert under Robinson Trail and likely from flow through the trail grade as well. In addition, several stormwater infiltration ponds that infiltrate runoff from the adjacent developments are located near the marsh perimeter. Infiltrated runoff may reach West Edmond Marsh through shallow subsurface pathways. No direct stormwater discharges into West Edmond Marsh are known.

Water levels in West Edmond Marsh are monitored at two locations: SG-EM-2W, which is at the outlet of the culvert under Robinson Trail, and a pair of staff gages (SG-EM-1 and -1A) which are located on the western end behind the westernmost beaver dam. The average water level at SG-EM-2W is 211.35 feet, which is slightly higher than the average water level in Sequalitchew Lake. The average water level at SG-EM-1/1A is 207.91 feet. The seasonal variability in water levels is more amplified in the western portion of West Edmond Marsh, with a typical range of 1 foot or less observed near Robinson Trail and 4 to 5 feet at the westernmost end. The westernmost portion of West Edmond Marsh becomes dry in the summer of most years.

4.1.2.6 Wetland 1D

Wetland 1D is an approximately 2.1-acre wetland, located immediately north of West Edmond Marsh, with no surface water connection between it and Edmond Marsh. Water levels in Wetland 1D have ranged from 208.6 to 211 feet, with a typical seasonal range of

1 to 2 feet. The water levels typically peak in December or January and begin to decline earlier than West Edmond Marsh.

4.1.2.7 Isolated Kettle Wetlands (Pond, Strickland, Grant, Old Fort Lake, and Wetlands #8 through #11)

Isolated wetlands, typically forming in kettles created during the recessional period of the Vashon glaciation, are present in the Sequalitchew Creek watershed. Most notably, a group of kettle lakes and wetlands, including Pond Lake, Strickland Lake, Grant Lake, Old Fort Lake, and Wetlands #8 through #11, lies south of Sequalitchew Creek and west of the historic village of DuPont (Figure 27).

Water level data collected as a component of the stormwater management program for the Northwest Landing development indicate that the southern group of kettle wetlands have large seasonal variations in water levels and most go dry during extended dry periods (Shapiro, 1991; Hart Crowser, 1999; ESM Consulting Engineers, 2004). They also fluctuate similarly to the water table fluctuations, and have been inferred by numerous investigators to be expressions of the water table of the Vashon Aquifer in their respective project areas (WCC, 1991; Hart Crowser, 1999; and URS, 2003).

However, as with the wetlands around Sequalitchew Creek, silts, clays and organics build up over time in the stagnant water leaving a layer of low permeability peat and silty muck soils at the bottom of the pond areas. These accumulating fine-grained materials were observed in the kettle lake wetland bottoms (Newling and Smith, 2004). As such, it is likely that the hydraulic connection between the aquifer and wetland water levels is reduced with some delay in the response time of the surface water to groundwater changes.

A couple of the kettle wetlands are interconnected by culverts, but otherwise, the kettle wetlands do not have outlet drainages. Water leaves the kettle wetlands only through evapotranspiration or infiltration to groundwater.

4.1.2.8 Sequalitchew Creek

Sequalitchew Creek is a 3.3-mile-long creek traveling from the eastern end of East Edmond Marsh through Edmond Marsh and down a steep ravine to Puget Sound. Historically, Sequalitchew Lake was the headwaters of Sequalitchew Creek; however, construction and maintenance of the Diversion Weir restricts the potential flows to the creek, and beaver dams further prevent outflow from the lake to the creek. Through the marshes, the creek is a channel of open water or less dense vegetation, but little flow is present. After leaving the marshes, the creek channel maintains its broad width but becomes dry and grassy. Outflow from West Edmond Marsh typically infiltrates in this grassy reach upstream of Center Drive.

Downstream of the grassy reach is a road grade and culvert near the remains of the wooden dam for the old DuPont Works hydropower facility. Downstream of the culvert, springs from the Vashon Aquifer return flow to Sequalitchew Creek as it begins its descent through a 1.3-mile steep ravine to Puget Sound. Multiple springs are present in the upper half of the ravine (see Figure 7). After the stream crosses through the Olympia Beds and the Kitsap Cutoff midway through the ravine, no more springs are present. Near Puget Sound, the ravine widens and gradient decreases. The creek discharges to Puget

Sound through a 5-foot by 5-foot box culvert under the BNSF railroad grade. Construction of the railroad grade limited the connection of the mouth of the creek to Puget Sound. A brackish marsh is located immediately upstream of the railroad grade.

Currently, streamflow is monitored continuously at two locations in the ravine (Figure 12): the mid-ravine gage (formerly referred to as the "upper gage"), which is located just above the Olympia Beds truncation approximately 3,900 feet upstream of the mouth, and the lower gage located approximately 700 feet upstream of the mouth. The lower gage was installed in 1999 and the mid-ravine gage was installed in 2003.

Average annual streamflow is about 2.8 cfs at the lower gage and 1.6 cfs at the mid-ravine gage over their common period of record (calendar years 2004 to 2021). The hydrograph of measured stream flows (Figure 30) indicates seasonally varying baseflow that ranges from 0.5 cfs in late summer up to around 2.5 cfs in wet winters. Individual storm peaks are present in rainy periods, but the peaks are not particularly flashy. The highest observed daily average flow was 13.8 cfs in December 1999.

Comparison of recent flow monitoring results with earlier gaging efforts in 1977-1978 (Thut et al., 1978) and 1984-1987 (Firth, 1991) indicates that the streamflow is about 75 percent lower now. Those periods correspond with WDFW's use of Sequalitchew Lake for fish rearing, so it is likely that the higher flows in the 1970s and 1980s represent a higher portion of the outflow from Sequalitchew Lake reaching Sequalitchew Creek instead of the Diversion Canal, particularly in winter and spring months. Average monthly flow rates near the mouth of Sequalitchew Creek are shown in Table 13.

4.1.3 Surface Water Quality

4.1.3.1 South Parcel and Existing Mine

The only surface water body within the South Parcel Project area is the Kettle Wetland, which has not been monitored for water quality. Because the hydrology of the Kettle Wetland is driven by the Vashon Aquifer, the water quality is anticipated to be similar to the that of the aquifer, but slightly modified by wetland processes and direct exposure to the atmosphere. Water temperature in the Kettle Wetland can be anticipated to be slightly warmer in summer and slightly cooler in winter. Turbidity is likely marginally higher because of natural processes in the wetland (e.g., disturbance of marsh sediments by biota). Dissolved oxygen (DO) could be higher or lower than in the aquifer depending on the season and balance between of different factors. Exposure to the atmosphere would act to increase DO as would lower winter temperatures and growth of aquatic plants; however, higher summer temperatures, plant respiration, and the decay of organic material would act to lower DO. Regardless, the water quality in the Kettle Wetland is likely quite good.

4.1.3.2 Sequalitchew Creek Watershed

This section reviews the regulatory status and water quality criteria applicable to the natural water bodies within the Sequalitchew Creek watershed, then summarizes existing water quality based on the results of several water quality monitoring programs.

Regulatory Status

Washington State water quality standards for surface waters consist of designated uses and criteria and other provisions (e.g., anti-degradation) to protect those uses. Chapter

173-201A of the Washington Administrative Code (WAC) water quality standards are based on the designated uses (type of aquatic life, recreation, water supply, etc.) of a surface water body.

Sequalitchew Creek and Sequalitchew Lake have a designated aquatic life use of "core summer salmonid habitat" as they are tributary to a marine water designated for "extraordinary aquatic life" per WAC 173-201A-600 (1)(a)(iv). The State Water Quality Standards for core summer salmonid habitat for key parameters are shown in Table 14.

Table 14. State Water Quality Standards Applicable to Sequalitchew Creek and Sequalitchew Lake

Parameter	Criterion	Allowable Change
Temperature (7-DADMax)	16.0 °C	0.3 °C when T >= 16.0 °C, else 28/T+7 Total change not to exceed 2.8 °C
Dissolved Oxygen (1-day minimum)	9.5 mg/L	<0.2 mg/L
Turbidity	NA	5 NTU over background when <= 50 NTU, otherwise 10%.
pH	6.5 to 8.5	< 0.5 within range

Notes:
7-DADMax is the 7-day average of daily maximum temperatures.
T = background temperature unaffected by project.
NTU = nephelometric turbidity units; mg/L = milligrams per liter

Ecology has published supplement spawning/incubation criteria (Ecology, 2011) that modifies the temperature criteria applicable to some fresh water bodies. Sequalitchew Creek and Sequalitchew Lake have not been identified for supplemental temperature criteria.

Sequalitchew Creek and Sequalitchew Lake are not on Ecology's EPA-approved 2012 list of impaired waterways ("303(d) list") for any parameters, nor on the draft 2018 303(d) list that is with EPA for review.

Water Quality Monitoring Results

Surface water quality in the natural waterbodies of the Sequalitchew Creek watershed is primarily understood through four studies and monitoring efforts:

- Ongoing monitoring for CalPortland - monthly monitoring for key aquatic life parameters at the Diversion Weir and upper Sequalitchew Creek.
- Citizen monitoring data collected from 2008 to 2012 by Don Russell – periodic monitoring in and downstream of Edmond Marsh for key aquatic life parameters and select metals and nutrients.
- Surface Water Investigation Report, North Sequalitchew Creek Project (CH2M Hill, 2001) – monitoring of the Diversion Canal and Sequalitchew Creek ravine for a broader suite of parameters.

- Fort Lewis Landfill No. 5 Remedial Investigation/Feasibility Study (WCC, 1991) –monitoring multiple locations in Sequalitchew Creek, isolated wetlands, and intertidal springs for a broader suite of parameters.

At a broad level, water quality in the watershed can be understood by grouping waterbodies in three categories: Sequalitchew Creek, the marshes, and Sequalitchew Lake. A summary of water quality monitoring results is shown in Table 15. These samples were collected by multiple parties and are instantaneous grab samples.

Sequalitchew Creek generally has excellent and very consistent water quality, with cool temperatures (< 15 °C), high dissolved oxygen levels (> 9 milligrams per liter [mg/L]), and low turbidity (< 15 NTU). These results are representative of a steady groundwater input and shaded forest setting. The seasonal variation in temperature is much less in the reaches of Sequalitchew Creek in the ravine than in the marshes or lake. Metals concentrations in Sequalitchew Creek are consistently low.

Water quality in the marshes is more typical of stagnant water bodies exposed to the life cycle of aquatic plants. Dissolved oxygen concentrations are lower (typically < 4 mg/L), pH is slightly acidic (median of 6.5), and temperature highs and lows are more extreme, ranging from 2.7 to 22.2 °C. Turbidity is still low (< 10 NTU). Generally, the individual marshes have similar water quality, although East and West Edmond Marshes have elevated iron concentrations, particularly in the vicinity of the railroad grade trail where groundwater seeps entering the marsh; where concentrations have been measured above 1 mg/L. Concentrations of other metals important as indicators of potential stormwater pollution, such as copper and zinc, have been low, even in marshes receiving direct stormwater inputs.

Water quality in Sequalitchew Lake is generally representative of groundwater, except that temperature is warmer in summer (typically above 20 °C) and cooler in winter (below 6 °C) due to exposure to the atmosphere during the longer retention time in the lake. Dissolved oxygen concentrations are generally high (typically > 9 mg/L). pH is neutral and turbidity is low. Metals have not been measured in the lake, with the exception of one sample analyzed for iron at 0.13 mg/L.

Earlier sampling (CH2M Hill, 2001 and WCC, 1991) for broader suites of parameters did not identify significant or unusual pollutant issues in surface waters of the watershed.

4.2 Effects of the Proposed Action

This section examines the effects of the South Parcel Project on issues with surface water quantity and quality that are typically evaluated in permitting of mine sites.

Gravel mining has the potential to change the hydrology of an area by altering topography, changing the size and shape of drainage basins, removing vegetation, and exposing or placing deposits of lower permeability material. These changes generally result in increased stormwater runoff and a decrease in evapotranspiration. Depending on the stormwater management system used, mining can either increase groundwater recharge (if infiltration facilities are used to discharge stormwater to ground) or decrease groundwater recharge (if detention ponds are used to release stormwater to surface waters).

This section describes the changes in site water balance that would occur with the South Parcel Project and predicts stormwater volumes and peak flow rates, then presents a preliminary design of a stormwater system for the Proposed Action. We then evaluate the effects of the stormwater system on groundwater mounding and water quality.

4.2.1 Site Water Balance

A water balance is an approximate accounting of the hydrologic inputs and outputs from a project area. The inputs can include precipitation (as both rain and snow), groundwater discharge from springs, or surface water inflows from streams or rivers or stormwater run-on. The outflows include evapotranspiration, groundwater recharge, and stormwater runoff or stream flow leaving a site.

Three water balances related to the South Parcel Project have been developed to answer different questions about the surface water and groundwater bodies. The water balances were developed using different modeling techniques and software, and are focused on different water bodies. For clarity, the three water balances are:

1. A groundwater water balance developed as part of the groundwater modeling effort and described in the Groundwater Model Update Report (Aspect, 2017b).
2. A site water balance that focuses on the fate of precipitation falling on the South Parcel Project area, presented in this section, and the changes that would occur with mining. This water balance is primarily focused on stormwater within the mine site.
3. A wetland water balance, presented in Section 4.2.3.2, that was developed in Excel with the focus of predicting changes in water levels in the marshes with mining and restoration.

The site water balance for the South Parcel Project was calculated for existing and proposed conditions using the Western Washington Hydrologic Model (WWHM). WWHM is a complex hydrologic model developed by Clear Creek Systems for Ecology. It simulates watershed hydrology based on land use characteristics and historical meteorologic records. The primary purpose of WWHM is to predict stormwater flows for the design of stormwater management facilities, but it can also provide other elements of the water balance, such as groundwater recharge, evaporation, and changes in soil moisture.

Within Pierce County, WWHM uses a 158-year synthetic precipitation series with a mean annual precipitation of 42 inches per year. Because it is a synthetic precipitation record, the period of record does not represent a specific range of actual years. Evaporation data in WWHM is based on pan evaporation measurements from the Puyallup 2W Experimental Station.

Three scenarios were analyzed representing existing conditions along with the Proposed Action and No Action alternatives. For each scenario, the land use characteristics are entered into WWHM to represent the different soil types, vegetative cover, and slope characteristics created by that scenario. A summary of the land use information entered into WWHM to represent existing and proposed conditions is shown in Table 16.

The existing scenario represents the current state of the South Parcel Project area, which consists of a flat, forested land with coarse surface soils in the South Parcel, the Kettle Wetland and buffer, and the vegetated areas of the eastern slope of the existing mine.

The Proposed Action scenario represents the maximum potential for the South Parcel Project to affect surface hydrology. It assumes that the area has been completely mined to the topography shown on Figure 31, but limited vegetation has regrown. This condition was assumed in the model as a worst case and represents a situation that would never occur because segmental reclamation will be used to limit the amount of time any cleared land is not reclaimed. For the proposed model scenario, the bottom of the mine was modeled as till soils to represent the Olympia Beds, even though in practice a layer of sand and gravel approximately 10 feet thick would be left in place. Mine side slopes were simulated as outwash soils with a lawn cover (the vegetative cover that generates the highest runoff) to represent bare soils during mining, or recently seeded slopes in reclamation.

These three scenarios were analyzed in WWHM, which simulates site hydrology on a 15-minute time step for the 158-year period of record of the synthetic precipitation time series. The results were exported as annual averages for each of the 158 years and an overall average calculated. Annual results are presented in Appendix E and the overall average results are described below.

The water balance distinguishes between direct groundwater recharge and infiltrated stormwater. Direct groundwater recharge is defined as precipitation that infiltrates to groundwater at or near the location it falls, thus providing diffuse recharge. In contrast, infiltrated stormwater occurs where precipitation generates stormwater that is conveyed to an infiltration facility providing focused recharge. Direct groundwater recharge and stormwater infiltration were separated in WWHM using separate points of compliance: direct recharge was calculated as the groundwater generated from the site drainage basins; infiltrated stormwater was calculated as the surface runoff and interflow that infiltrates in the stormwater facilities.

Groundwater inflows at the toe of the mined slope were included in the site water balance by adding an annual average of 6.9 cfs (based on Step 3 results in Table 7) as an inflow and adding a corresponding outflow to the volume of total groundwater recharge to create the groundwater outflow.

Results from the WWHM model indicate that under existing conditions, an average of approximately 744 acre-feet of water (or 44 percent of precipitation) evaporates or is transpired by vegetation (Table 17) on an annual basis and 944 acre-feet (or 56 percent of precipitation) recharges groundwater either as direct groundwater recharge or infiltration of stormwater. WWHM predicts that a very small amount of stormwater runoff (104 acre-feet, or 6 percent of precipitation) is generated under existing conditions. This stormwater is infiltrated within the existing mine.

The Proposed Action would cause a minor reduction in evapotranspiration as the forested South Parcel and Kettle and Buffer Areas are cleared for mining. Under the Proposed Action, 706 acre-feet (or 42 percent of precipitation) would evaporate or be transpired. The reduction in evapotranspiration results in an increase in stormwater volume. Because all stormwater will be infiltrated, the Proposed Action results in increased groundwater

recharge. The Proposed Action would result in 982 acre-feet of groundwater recharge per year from direct recharge and infiltrated stormwater compared to 944 acre-feet under the existing condition, a 3.8 percent increase. The nature of groundwater recharge would shift with less distributed recharge and greater infiltration of stormwater in discrete locations.

4.2.2 Mine Stormwater Management

CalPortland has prepared a Preliminary Stormwater Management Report (Aspect, 2021) documenting the preliminary design of the stormwater management system for the proposed South Parcel Project. This section summarizes the hydrologic calculations used in the preliminary design and the key components of the resulting proposed drainage system.

4.2.2.1 Peak Flows and Volumes

WWHM was also used to predict the peak flow rates and volumes of stormwater generated under the existing conditions and Proposed Action. To analyze stormwater volumes, the South Parcel Project area was divided into three drainage basins—Basins C, D, and E—based on the proposed stormwater facilities and conveyance network (Figure 31).

Basins C and D include about 390 acres of the existing mine and South Parcel Project area. When mining is completed, each basin will include mine side slopes, large areas of rolling terrain where sand and gravel will be excavated exposing the lower-permeability Olympia Beds, and a relatively flat area at elevation 25 to 50 feet in the bottom of the existing mine. These basins will drain to new stormwater management facilities to be located on the floor of the existing mine. These facilities will expand on, and replace, the existing stormwater management system.

Basin E consists of 92.6 acres of the mine side slopes and mitigation wetland which drain to the ditches designed to capture and convey groundwater emanating from the toe of the mined slope once active dewatering has ceased. Basin E was further divided into three subbasins, E1 through E3, to allow for calculation of peak flows for conveyance design purposes. All three subbasins ultimately drain to the same infiltration facility, which also receives intercepted groundwater and overflow from the constructed mitigation wetland. Basin E1 consists of the slopes on the southern and southwestern corner of the mine as well as the mitigation wetland itself. Basin E1 drains to the mitigation wetland, then eventually infiltration pond E. Basin E2 includes the western slopes that will drain to the ditch that conveys outflow from the wetland to the infiltration pond; it also includes infiltration pond E. Basin E3 consists of the eastern slopes that drain to the groundwater capture trench running along the toe of those slopes.

Peak flow output from WWHM is shown in Table 18 and indicates that the South Parcel Project would increase stormwater peak flows relative to existing conditions. For example, the 100-year return period flow could increase from 23.5 cfs to 66.5 cfs in Basin C, and from 20.2 cfs to 94.6 cfs in Basin D. The primary reason that mining activity causes an increase in peak flows is the removal of the porous outwash soils (which do not generate much runoff) down to the level of the Olympia Beds (which are lower permeability and generate more runoff). Peak stormwater flows would be managed

through infiltration, resulting in the increase in groundwater charge described in Section 4.2.1.

4.2.2.2 Proposed Drainage System

As the area is mined, it will expand the closed depression of the existing mine so all stormwater generated within the South Parcel Project area will either infiltrate or evaporate. Stormwater runoff will be collected and conveyed to stormwater ponds in permeable soils on the floor of the existing mine for treatment and infiltration.

Each stormwater pond group will consist of a two-celled lined wetpond designed to remove sediments and provide spill control and an infiltration pond to dispose of stormwater and recharge groundwater. Pond locations and the conceptual drainage patterns are shown on Figure 31.

Two-celled wetponds are proposed as the water quality treatment technology because they are low maintenance, and well suited for removal of suspended solids, which are the primary potential stormwater pollutant at mining operations. The two-celled design improves the sediment removal efficiency and allows for spill control and trapping of floatables in the first cell.

The wetponds were designed to treat 91 percent of the total runoff under developed conditions in accordance with Ecology guidance (Ecology, 2014). Key pond dimensions are shown in Table 19. The ponds were designed to be 7 feet deep, which includes one foot of sediment storage at the bottom of the first cell, and 1 foot of freeboard in both cells.

Table 19. Summary of Proposed Stormwater Water Quality Ponds

Pond	Cell	Depth (feet)	Volume Provided (cubic feet)	Volume Required (cubic feet)
C	1	6	79,704	79,453
	2	7	187,614	185,391
D	1	6	111,816	111,731
	2	7	263,739	260,707

The infiltration ponds were designed to infiltrate all stormwater generated within the mine. Pond E was also designed to infiltrate intercepted groundwater during and after active dewatering. Key dimensions of the infiltration ponds are summarized in Table 20. For preliminary design, the ponds were assumed to be rectangular, with 3H:1V slopes, and a total depth of 5 feet (4 feet of active depth and 1 foot of freeboard).

The infiltration properties of soils in the pond areas were estimated based on grain size data from borings at the location and depth closest to the proposed pond locations following guidance in the *Stormwater Management Manual for Western Washington* (Ecology, 2014). A correction factor of 0.12 was applied to adjust the infiltration rate estimated from grain-size properties to a long-term design infiltration rate. The resulting long-term design infiltration rates were 8.1 to 8.2 inches per hour for all three ponds.

Table 20. Summary of Proposed Infiltration Ponds

Pond	Depth in feet (without freeboard)	Bottom Area (square feet)	Top Area at Max Water Level (square feet)	Side Slopes
C	5	50,762	66,748	3H:1V
D	5	37,655	68,755	3H:1V
E	6	57,807	82,120	3H:1V

The drainage system would be constructed as mining advances according to the following general sequence:

1. During active mining, temporary, often informal, drainage facilities would be used to treat and infiltrate stormwater. During the early stages of each segment, little runoff would be generated as mine side slopes are very pervious, allowing for infiltration. Overtime, the mine bottom would be compacted by equipment traffic, increasing runoff.
2. Permanent drainage facilities would be constructed when mining had reached final grade near the pond location.
3. Drainage facilities would continue to function throughout the life of the mine. CalPortland would be responsible for maintenance of drainage facilities through mining and completion of reclamation.
4. After reclamation of each segment, the drainage facilities would remain on-site and continue to function. Long-term maintenance of the drainage facilities would be the responsibility of the landowner. The volume of runoff entering the drainage facilities would decrease as vegetation planted during reclamation matures.

4.2.2.3 Water Quality

CalPortland would manage water quality for the North Parcel under a Sand and Gravel General Permit issued by Ecology. The Sand and Gravel General Permit combines the protections of an NPDES Permit for surface water discharge and a State Waste Discharge Permit for discharges to groundwater. The existing mine currently operates under two separate Sand and Gravel Permits: permit #501178 covers discharges from the aggregate wash plant, processing area, and mine; and permit #501406 covers discharges from the concrete batch plant. Permit #501178 would be expanded to include the Expansion Area.

Under the Sand and Gravel General Permit, CalPortland would take the following actions:

- Implement a Stormwater Pollution Prevention Plan (SWPPP) specific to the North Parcel
- Implement BMPs to prevent stormwater pollution

- Meet water quality standards for stormwater discharged to any surface water or groundwater through infiltration ponds
- Monitor surface water quality in stormwater ponds at least quarterly
- Monitor process water discharges monthly
- Frequently inspect the facility for erosion and oil sheen

Mines constructed as closed depressions typically have little impact on surface water quality as all water is contained internally. The remaining water quality concerns relate to preventing stormwater contamination that could impact groundwater. Two areas of potential concern are spills from heavy equipment and sediment from erosion. These concerns are managed through implementation of BMPs described in the SWPPP and erosion and sediment control plan.

Spills

Spills, leaks, and drips of chemical products are not typically a significant problem for mining sites like the existing mine because of limited use of chemicals and the small number of pieces of heavy equipment operating in a large area. However, the potential exists that spills, if not quickly cleaned up, could contaminate stormwater and groundwater (either directly or through the infiltration of stormwater).

Petroleum products (diesel fuel, motor oil, and hydraulic fluid) are the primary chemicals used on-site. Chemical storage and equipment maintenance areas are already established in the existing processing area, and would continue to be used.

CalPortland's spill plan, developed under the Sand and Gravel NPDES permit, includes controls to be used on-site that significantly reduce the likelihood that a small spill or leak would impact water quality. Mining companies are uniquely able to respond to excavate and contain small spills because heavy equipment is always on-site. In the event of a spill, they can quickly excavate contaminated soil and contain it in the bed of a dump truck.

In addition, the stormwater system includes spill control devices in the wetponds to prevent floatable contaminants, such as oil or grease, from reaching the infiltration pond. Finally, the mining plan includes a soil buffer above the water table. The 10-foot thickness provides sufficient time for cleanup of a spill before contaminants could reach groundwater, as evaluated in Section 3.2.2.

Erosion

Removal of vegetation and creation of slopes by mining increases the potential for soil erosion. Erosion within the closed depression of the mine would not affect Sequalitchew Creek or Puget Sound, but could affect the constructed wetland or the long-term performance of the stormwater and groundwater infiltration ponds. It could also affect the ability to successfully reclaim mine slopes. Soil erosion is typically managed through a combination of source control BMPs to prevent erosion and treatment BMPs to remove sediments suspended in stormwater.

Source control BMPs, such as segmental clearing and revegetation of slopes, will be the primary technique for preventing soil erosion, and are discussed in Section 2.2.3. The

Proposed Action also includes runoff treatment BMPs as a secondary step to prevent impacts from erosion. Each infiltration pond will be proceeded by a two-cell wetpond to remove sediment and prevent clogging of the infiltration pond. In the long term, erosion and sediment control would be provided through implementation of the Reclamation Plan in accordance with surface mine reclamation permit conditions issued and enforced by DNR.

Topsoil would be stripped and stockpiled for reuse for reclamation on completed mine areas. BMPs (such as surface roughening, mulching, temporary cover, or longer-term vegetative cover) will be used to prevent erosion from stockpiles. These BMPs would also protect against erosion of topsoil potentially containing metals attributable to the former Asarco smelter. Samples would be collected from the stockpiled topsoil to confirm arsenic concentrations meet cleanup levels before the topsoil is placed on mined areas for reclamation. After application of the topsoil, erosion control BMPs such as surface roughening and permanent vegetative cover would be implemented as with any newly created slope. The preceding measures combined with the fact that no stormwater discharge to surface water is proposed or would be authorized for the Proposed Action, eliminate any risk of the topsoil contaminating surface waters.

4.2.3 Sequalitchew Creek Watershed

4.2.3.1 Sequalitchew Lake and Marshes on JBLM

Sequalitchew Lake would not be affected by the South Parcel Project for three reasons:

1. The lake is located well east of the area of appreciable change in groundwater levels (see the 0.5-foot drawdown contours on Figures 22 through 25). Model predictions for all dewatering steps indicate the 0.5-foot drawdown contour would be located west of DuPont-Steilacoom Road.
2. The water level in the lake is controlled by the Diversion Weir and there is typically discharge from the lake throughout the year.
3. The lake is an area of groundwater discharge throughout the year, which means that groundwater levels around the lake are higher than the lake water surface.

There also would be no change in the flow from Sequalitchew Springs as the springs are located at the far eastern end of Sequalitchew Lake.

4.2.3.2 Marsh Water Levels

The effects of mining on wetland hydrology of the Bell-McKay-Hamer and Edmond Marsh complexes were investigated by developing a water balance model of the key wetland areas.

Water Balance Overview

A water balance is a method of accounting for the individual hydrologic processes that add water to, or take water away from, the area being studied. The basic concept of a water balance is that the change in the volume of water in a waterbody over a period of time can be calculated as the difference between the amount of water that entered and left the waterbody during that time. The challenging part of a water balance is quantifying the individual inflows and outflows. For the key elements of the Sequalitchew Creek

watershed surface-water network (i.e., the wetlands), the following individual inflows and outflows need to be quantified:

Inflows:

- Precipitation falling directly on the water surface
- Surface water inflows such as stormwater or creeks
- Shallow subsurface inflows from nearby higher waterbodies
- Groundwater seeping into the marsh

Outflows:

- Evapotranspiration from open water and marsh vegetation
- Surface water outflows
- Shallow subsurface outflows to other nearby lower waterbodies
- Groundwater recharge

The water balance simulated the six main interconnected wetlands, grouping the upper marshes and simulating the lower marshes individually as shown on Figure 32:

- Bell, McKay and Hamer Marshes, with a focus on Hamer Marsh for calibration
- East Edmond Marsh, both east and west of DuPont-Steilacoom Road
- West Edmond Marsh

The water balance simulates the individual hydrologic processes based on fundamental data sources (e.g., measured precipitation and evaporation data) and scientific approaches. Precipitation is based on the PRISM data series for McMillin Reservoir as described in Section 4.1.1.

The primary surface water inflows under existing conditions are the stormwater inputs to Bell and Hamer Marshes from JBLM. These were estimated using WWHM and a correlation between monthly stormwater discharge and monthly precipitation that was developed to extend the stormwater predictions beyond WWHM's period of record. More minor stormwater inputs, including a small portion of Center Drive that drains to East Edmond Marsh, were estimated using a similar approach. Under Restoration Scenarios, the historical record of outflow from Sequalitchew Lake to the Diversion Canal was used as an input to East Edmond Marsh.

Shallow subsurface inflows between the higher marshes (Bell, McKay, and Hamer) and East and West Edmond Marsh were calculated using Darcy's law, which estimates groundwater flow based on the gradient, cross sectional area of the flow path and hydraulic conductivity. Gradient was calculated as the difference in water levels in the marshes divided by the distance between them. Gradient changed monthly and between water balance scenarios based on the water levels predicted by the water balance. Hydraulic conductivity was estimated at 400 feet per day, which is about the lower 25th percentile of the hydraulic conductivities for Steilacoom Gravel used in the DuPont groundwater model (see Table 1 in Aspect, 2017a). The cross-sectional area of the flow

path was estimated based on width of topographic channels at locations where the marshes are closest and a depth of flow equal to the difference in marsh elevations.

Groundwater discharge into a marsh was also calculated with Darcy's law where the vertical gradient is based on the difference in the marsh water level and the underlying groundwater elevation, hydraulic conductivity is based on the marsh sediments, and cross-sectional area is the wetted area of the marsh. Wetted area for each marsh varies based on water level and was estimated from topographic information.

Potential Evapotranspiration (PET) is calculated based on the pan evaporation data from the Puyallup Experimental Station (described in Section 4.1.1) and a pan coefficient of 0.8 to convert pan evaporation to open water evaporation. PET from vegetation assumed a "crop" coefficient of 1.

Surface water outflows were calculated by estimating the hydraulic properties of the structures (typically beaver dams or a culvert) controlling the water level in a marsh. Beaver dams were composite structures, with some leakage occurring through the dam itself according to Darcy's law, and flow over the top as a partially obstructed broad-crested weirs. Weir elevations were modified during calibration of the water balance model to match observed water levels. Only a couple changes over the period of record were used.

Shallow subsurface outflows were calculated using the same approach as shallow subsurface inflows, with the outflow from the upgradient marshes being the same as the inflow to a downgradient marsh.

Groundwater recharge (i.e., flow from a marsh into groundwater) was calculated using the same approach as groundwater discharge into a marsh. Groundwater recharge only occurs when the marsh water level is higher than groundwater. Similarly, groundwater discharge into a marsh only occurs when the marsh water level is lower than groundwater. Thus, groundwater recharge/discharge is calculated as a single term in the water balance, and either occurs as recharge or discharge, but not both, in any given month.

The water balance model simulates wetland hydrology on a monthly time step for the period from March 2003 (the start of the monitoring program) to September 2021 (the end of the most recent water year).

The water balance model was calibrated by qualitative comparison of predicted marsh water levels with the observed water levels from the monitoring period. The water balance model was able to reproduce the seasonal trends in water levels and capture differences between wetter and drier years under existing conditions. Figures 33 and 34 compare the observed water level measurements with the model predictions for existing conditions for Hamer and East Edmond Marsh, and West Edmond Marsh, respectively. For example, the model simulated years where West Edmond Marsh was completely dry in summer versus years where some water remained; however, in some years the period that West Edmond Marsh was dry was underestimated. Generally, the model fit is best for East and West Edmond Marshes and weakest for Hamer Marsh.

The combination of scientific basis for the model construction and good success of the model at simulating existing conditions provides a credible basis for using the model to evaluate the consequences of the mining and restoration projects operating simultaneously.

The primary outputs from the water balance are:

1. Predictions of marsh water levels on a monthly time step
2. An estimate of the losses/gains that occur when the flow from Sequalitchew Lake is directed through the marshes under the Mining and Restoration scenario

Water Balance Scenarios

Following calibration to existing conditions, the model was used to simulate three scenarios:

- **Existing Conditions:** This scenario simulates existing conditions in the marshes using observed groundwater levels from the monitoring network.
- **With Mining – Low Groundwater:** This scenario simulates the effects of the predicted groundwater drawdown at Step 4 (i.e., the long-term condition after active dewatering has ceased). The groundwater levels used are the model results for Step 4.[5] It also subtracts the model uncertainty from the groundwater levels, providing a lower bound estimate of the predicted water levels. Only the groundwater levels beneath the marshes are changed in this scenario.
- **With Mining and Restoration – Low Groundwater:** This scenario and its results are described in the Cumulative Effects discussion in Section 4.5.1.

The marsh water balance model was not used to evaluate a No Action scenario because there is no mechanism by which the No Action alternative would affect marsh water levels.

Marsh Water Balance Results

The water balance indicates that mining, if done without the Restoration Plan, would result in lower water levels in the marshes, with the greatest change occurring in West Edmond Marsh, followed by Hamer Marsh, then East Edmond Marsh. Average monthly water levels for the 19-year period of record for the existing and mining scenarios are shown on Figure 35 and presented in Appendix F, along with results for each individual month. These results are based on the conservatively low estimate of groundwater levels resulting from mining.

On average the water level in West Edmond Marsh would be 1.9 feet lower with mining. Hamer Marsh would be 0.3 feet lower, and East Edmond Marsh would be 0.1 feet lower. The magnitude of the change would vary seasonally. For West Edmond Marsh, the greatest change in water levels would occur during the spring months, when the decrease in water level would be up to almost 3 feet in May. The smallest difference would be

[5] The monthly average of the groundwater model results was for groundwater levels beyond the end of the period of record of the DuPont groundwater model.

0.35 feet in the late summer when West Edmond Marsh is typically dry under existing condition in most, but not all, years.

Conversely, the predicted change in Hamer and East Edmond Marsh water levels, which typically retain water year-round under existing conditions, is greatest in the summer. The average decrease in Hamer Marsh water levels would be over 0.5 feet from June to November, peaking at 0.8 feet in September. The minimum decrease would be about 0.2 feet in March. Hamer Marsh receives a high volume of stormwater input in winter months, which dampens the change. The decrease in East Edmond Marsh water levels ranges from 0.13 feet in June down to 0.005 feet in February.

The water balance model predicts that Hamer Marsh would experience a greater decrease in water level than East Edmond Marsh for two reasons. First, Hamer Marsh and East Edmond Marsh have different water sources and different relationships to the groundwater table. Groundwater levels near Hamer Marsh are typically higher than the marsh by a foot or more through the winter, whereas groundwater levels are typically below the marsh water level at the east and west ends of East Edmond Marsh and similar to the marsh water level in the middle. As a result, Hamer Marsh is more dependent on groundwater inflows, particularly during the dry season. Secondly, the DuPont model uncertainty is greater in the vicinity of Hamer Marsh. Model uncertainty in the vicinity of Hamer Marsh is 0.67 feet compared with 0.18 feet for East Edmond Marsh, which results in a relatively lower groundwater elevation for Hamer Marsh under the With Mining–Low Groundwater scenario since uncertainty is subtracted from the model-predicted groundwater elevation estimates.

4.2.3.3 Sequalitchew Creek Flow

Under existing conditions, the only regularly flowing reach of Sequalitchew Creek occurs in the ravine, where springs provide the primary water source to the creek. The effect of mining on Sequalitchew Creek flows was evaluated by predicting streamflows at two locations in the ravine: the mid-ravine gage (formerly termed the “upper gage”) located approximately 2,500 feet downstream from the top of the ravine and the lower gage, located just before the creek enters the brackish marsh near its mouth.

As described in Section 3.1.6.2, dewatering conducted as part of the South Parcel Project would reduce the flow of springs in the Sequalitchew Creek ravine. The groundwater model results indicate that there would be no observable change in spring flows during the initial 10-well test (Step 1). During preparation for mining/expanded pumping test (Step 2), the reduction in spring flow is predicted to be 9 to 14 percent, with the greater reduction generally occurring in summer months and the smaller reductions occurring in winter.

At the peak of active dewatering during mining (Step 3), the reduction in spring flow would average 83 percent, ranging from 76 percent in January up to 86 percent in summer. Spring flow would return slightly in the ravine after active dewatering has ceased. The predicted reduction in Step 4 is an average of 79 percent, varying from 73 percent in January to 86 percent in summer (Aspect, 2017b). Reductions in spring flow are assumed to result in a 1:1 reduction in streamflow.

The effect of these reductions on flow in Sequalitchew Creek was accounted for by scaling the average daily flow records from the mid-ravine gage record by the corresponding monthly percent reductions in spring flow. This analysis conservatively overestimates the impact of mining on streamflows, particularly during winter months, as the entire flow in the creek is assumed to result from a spring source and was scaled down accordingly. The hydrograph indicates that surface and stormwater contribute a portion of the flows in Sequalitchew Creek during rainy periods. These inflows would not be affected by mining, but nonetheless were scaled down in this analysis.

The resulting hydrograph of predicted flows in Sequalitchew Creek at the mid-ravine gage if mining were to occur without mitigation is shown on Figure 36. This hydrograph represents long-term conditions after the cessation of active dewatering (Step 4). The average flow in Sequalitchew Creek would be reduced from 1.6 cfs to 0.34 cfs.

4.2.3.4 Isolated Lake and Wetland Water Levels

Wetland 1D and the isolated kettle water bodies, such as Old Fort Lake, Pond Lake, and the similar lakes and wetlands located farther south, would potentially be affected by the change in groundwater levels associated with mining. The effects on these water bodies would vary depending on the proximity to the South Parcel Project.

Surface water levels in Wetland 1D and the isolated kettle wetlands have generally been identified as fluctuating with the groundwater system. Since these wetlands do not have surface water outlets, for simplicity sake, the change in surface water levels in them can conservatively be assumed to be comparable to the decline in groundwater level. In actuality, lower permeability sediments in the water bodies will likely dampen and delay the magnitude of the change in groundwater levels.

Wetland 1D is the closest isolated water body to the South Parcel Project. The groundwater model predicts that groundwater levels beneath Wetland 1D would decrease by about 3 feet in the long term (Figure 25). The surface water level in Wetland 1D is, thus, expected to be lowered by about 3 feet with the Proposed Action. The change in water levels would be negligible in Step 1 of dewatering, about 1 foot in Step 2, and about 3 feet in Step 3 (see Figures 22 to 24, respectively)

There is also the potential for aquifer drawdown to extend south to the isolated kettle wetlands. For the long term/post-mining dewatering scenario (Step 4), the groundwater model predicts about 2 feet of aquifer drawdown beneath Pond Lake decreasing to closer to 1 foot near Wetlands #8 through #11. Old Fort Lake would experience about 0.5 feet of groundwater drawdown. As with Wetland 1D, these changes in groundwater levels are expected to result in essentially equivalent changes in surface water levels in the water bodies.

Figure 37 presents the hydrographs for Pond Lake and Old Fort Lake illustrating the existing water levels and predictions with the Proposed Action. Pond Lake typically dries up in spring and summer. With the Proposed Action, Pond Lake would go dry earlier and refill later in some years depending on the amount of rainfall in that particular year. In addition, the high water levels would be lowered by the change in groundwater. Old Fort Lake retains water year-round. With the Proposed Action, its water level would be lowered by the change in groundwater levels, predicted to be 0.5 feet or less in the long

term. Because of the large natural fluctuation, the analysis indicates the predicted change will be effectively masked by natural variability.

4.3 Effects of the No Action Alternative

Under the No Action alternative, the South Parcel could be developed for a manufacturing and research park or residential land use based on existing zoning. There would be no changes to use of the existing mine under the No Action alternative; the Kettle Wetland and Buffer Area would remain intact.

If built out under existing zoning, the No Action alternative would result in creation of a substantial amount of impervious area within the South Parcel from roads and building roofs. Presumably, given the extremely porous soils, all stormwater from this development would be managed with infiltration. The land use characteristics for the No Action alternative are shown in Table 16.

A water balance was developed for the No Action alternative using WWHM similar to the approach described in Section 4.2.1. Results from the water balance are shown in Table 17. The water balance indicates that the No Action alternative would reduce evapotranspiration by about 25 percent relative to existing conditions (i.e., from 744 to 595 acre-feet per year) as forest is replaced with impervious areas and landscaping. Precipitation that is not evaporated or transpired either recharges groundwater directly or generates stormwater. Because all stormwater is assumed to be infiltrated, the total groundwater recharge increases from 944 acre-feet per year under existing conditions to 1,093 acre-feet per year with the No Action alternative. This is also higher than recharge that would occur under the Proposed Action. As with the Proposed Action, the nature of the groundwater recharge would shift from broadly distributed recharge under existing conditions to focused infiltration in discrete locations.

Potential impacts to stormwater quality include increased sediment during construction or land disturbing activity and potential contamination from future uses. Standard source control measures (construction BMPs, education efforts, proper storage, etc.) would reduce the potential for impacting stormwater quality. All stormwater generated would likely be infiltrated. The large separation between the land surface and the aquifer would provide significant protection for the aquifer. That separation would likely be reduced, but not eliminated, under any future mining actions.

4.4 Mitigation Measures

This section describes the mitigation measures included in the Proposed Action to mitigate impacts to surface water and stormwater. The mitigation measures are presented in three subsections:

- **Mine Best Management Practices**–Describes the BMPs used within the mine to manage stormwater and prevent erosion.
- **Monitoring Plan**–Summarizes the monitoring and adaptive management plan developed to ensure that the impacts of dewatering on groundwater levels are consistent with the model predictions.

- **Sequalitchew Creek Watershed Restoration Plan**–Provides an overview of the restoration plan that more than mitigates for the impacts to surface water of the Proposed Action through watershed-wide action to restore flows in Sequalitchew Creek from Sequalitchew Lake to Puget Sound.

4.4.1 Mine Best Management Practices

The following mitigation measures within the mine area are included in the Proposed Action:

- The mine area would be excavated as a closed depression, preventing off-site runoff of stormwater.
- Mine stormwater would be infiltrated in ponds located on the mine bottom.
- A minimum vertical separation of at least 5 feet would be maintained between the pond bottom and the seasonal high groundwater table.
- Water quality treatment facilities would be provided upstream of the infiltration ponds to protect their long-term infiltration capacity.
- The proposed stormwater management system must comply with Ecology and City of DuPont stormwater regulations.
- A Reclamation Plan, pursuant to the Surface Mining Act (RCW 78.44), would be prepared and implemented. The Reclamation Plan would be submitted to DNR for review and approval prior to issuing a revised surface mine reclamation permit required for mining. Implementation of the reclamation plan is guaranteed by posting of financial security required by RCW 78.44.
- An erosion and sediment control plan would be prepared and implemented in accordance with the requirements of DMC 22.01.180.
- Compliance with the NPDES Sand and Gravel General Permit would continue. Required actions include preparation and implementation of a SWPPP, erosion and sediment controls, monitoring, compliance with effluent limits, and specific BMPs for industrial activities. These actions would be subject to inspection and review by Ecology as required by the Sand and Gravel General Permit.

4.4.2 Monitoring Plan

The South Parcel Monitoring Plan (Monitoring Plan; Aspect, 2017a) defines the groundwater monitoring program and adaptive management plan aimed at ensuring that the actual changes in groundwater levels during dewatering are consistent with predicted values. The Monitoring Plan is part of the Proposed Action.

The overall goal of the Monitoring Plan, as specified in the 2011 Settlement Agreement, is to *"…include a series of monitoring actions to allow a comparison of predicted and actual changes in groundwater draw-down levels, and a process for the Parties to meet and confer if groundwater monitoring results do not meet the criteria provided in the Monitoring Plan."*

The Monitoring Plan articulates a series of goals, objectives, and performance thresholds. Goals are the overarching principles behind the Monitoring Plan. Objectives identify specific, measurable elements that are undertaken to meet the goals of a project. The performance threshold defines the measure of success used to assess whether an objective is met. Failure to meet a performance threshold will trigger the adaptive management process and require iterative additional actions until it is met.

The goals, objectives and performance thresholds of the Monitoring Plan for the South Parcel Project are:

Goal 1. Maintain groundwater at or above predicted levels beneath Edmond Marsh and Sequalitchew Creek.

- **Objective 1A.** Groundwater levels at monitoring wells near Edmond Marsh and Sequalitchew Creek are at or above predicted levels.
- **Performance Threshold.** Monthly groundwater level measurements are at or above target levels established for each step of the dewatering process at each well and for each month of the year, based on statistical analysis of groundwater model predictions over a range of historical climate conditions. Initial target levels are included in Appendix A of the Monitoring Plan.

Goal 2. Maintain groundwater conditions conducive to safe and efficient mining and processing of the South Parcel aggregates.

- **Objective 2A**. Moisture content of mined aggregate is at appropriately low levels for safe and efficient mining and processing.

Groundwater levels will be monitored during dewatering. The monitoring network will include 18 of the existing monitoring wells and the proposed new dewatering wells and observation wells to be installed as a component of the Proposed Action. The existing monitoring wells are located throughout the Sequalitchew Creek watershed as shown on Figure 12 and include wells in DuPont and on JBLM, near each of the major marshes, and on the South Parcel itself. Water level monitoring will vary during the different dewatering steps but will generally consist of continuous monitoring in the wells on the South Parcel and the closest marsh wells, and monthly or twice monthly manual measurements in the remaining wells.

The groundwater levels observed during dewatering will be compared with predicted groundwater elevations for the appropriate dewatering step. The Monitoring Plan defines the predicted groundwater levels at each well during each month of the year for each dewatering step in Appendix A of the Monitoring Plan. The predictions were developed from the DuPont model results for the maximum decrease in water level for the relevant dewatering step plus an estimate of model uncertainty. As such they represent a conservatively low set of groundwater levels on which to base the assessment of environmental impacts to surface water bodies. As long as actual groundwater levels remain above these thresholds during mining, reviewers can be confident that impacts to surface water will be less than or equal to what was predicted.

The Monitoring Plan (Aspect, 2017a) also defines an adaptive management process for the key parties to follow throughout the dewatering and mining. The process is based on five steps:

A. Assess – Information is compiled from monitoring data, geologic investigations, groundwater modeling, and other available sources. The compiled information is used to identify issues, refine objectives, and screen potential alternative approaches. Predictions of the potential effects of the action on groundwater levels are developed.

B. Design – Based on the results of the assessment stage, design of the Proposed Action proceeds. Design will result in a specific plan of action, and supporting evaluations to ensure that the anticipated results are consistent with the identified objectives, the Monitoring Plan, and prior environmental assessments. Predictions of groundwater levels are refined as the design evolves. Analyses conducted during the design stage could result in an iterative process of assessment and design. Any required permitting is also included in the design stage.

C. Implement & Monitor – The approved plan is put into action, concurrently with monitoring focused on key indicators tied to the identified objectives. Monitoring data indicating conditions worse than forecasted are acted on rapidly, moving into the evaluation and adjustment stages.

D. Evaluate – Monitoring data are evaluated relative to the objectives and forecasted results developed in the assessment and design stages. Differences between forecasts and results are identified and the causes for those differences investigated.

E. Adjust – Information learned in previous steps is used to adjust the actions, if necessary. The Monitoring Plan provides an initial identification of potential adjustments in each dewatering step, but additional adjustments could be developed to fit specific situations.

The adaptive management process is iterative and would repeat until the South Parcel Project is completed. If an adjustment is identified, the process would begin again from the assessment and design stages, followed by implementation of the adjustment and associated monitoring, then evaluation and further response (if necessary). If an adjustment is not necessary, then the process still repeats. In this case, the assessment and design stages would largely rely on the previously approved plans, but there is still potential for more minor refinements based on the information learned.

Throughout the adaptive management process, status updates, monitoring data, and final reports will be shared. If adjustments are unsuccessful in meeting predicted groundwater levels, the Monitoring Plan defines the Meet and Confer process required under the 2011 Settlement Agreement for determining the appropriate additional steps.

The adaptive management process is a little different during each step of the dewatering process, as, for example, Steps 1 and 2 are completely reversible and more limited in extent than the later steps. The Detailed Adaptive Management Plan section of the Monitoring Plan outlines the specifics of how adaptive management would be implemented during each step of the mining and dewatering process.

4.4.3 Sequalitchew Creek Watershed Restoration Plan

The Sequalitchew Creek Watershed Restoration Plan (Restoration Plan; 2018) was developed as a component of the 2011 Settlement Agreement to restore flows and ecological functions in Sequalitchew Creek and Edmond Marsh. The Settlement Agreement articulates five required components of the Restoration Plan:

1. Improvement of gradients so water discharges from Hamer and Bell Marshes flow into Edmond Marsh rather than into the diversion canal.
2. Improvements to create significant flows from Sequalitchew Lake into the Edmond Marsh complex to support a functional creek ecosystem, and provide for the passage of migratory fish in the Sequalitchew Creek system. To achieve this goal, the Parties to the 2011 Settlement Agreement will consider, at minimum, modification of the diversion canal flood control structure and gradients.
3. Rehabilitation of Edmond Marsh by removal of sufficient fill and other flow impediments to provide the hydraulic gradients and capacity necessary to achieve and maintain adequate flows through the Marsh.
4. Rehabilitation of Sequalitchew Creek below Edmond Marsh to reduce seepage, improve fish habitat, and help restore year-round flows.
5. Active management of beaver activities to maintain the hydraulic gradients that provide flows through Hamer, Bell, and Edmond Marshes.

Through a public process, led by the South Puget Sound Salmon Enhancement Group (SPSSEG) followed by work with the Environmental Caucus and CalPortland, the required components were honed into 12 specific restoration elements, listed in Table 21 for elements within the City of DuPont and Table 22 for elements on JBLM. The locations of Restoration Plan elements throughout the watershed are shown on Figure 38.

The elements of the Restoration Plan can be grouped into five categories of actions:

1. Regulatory Actions
2. Flow Restoration
3. Flow Maintenance and Enhancement
4. Habitat Restoration

Regulatory actions are a precursor to implementation of the Restoration Plan, involving updates to the City of DuPont's critical areas ordinance to support the restoration activities. This element has been completed in June 2021 through the City's update to the Critical Areas code (Ordinance 21-1094).

The next three categories directly align with the objectives of the Restoration Plan. Restoring flows would primarily occur through beaver management and modifications in the lake outlet area to seasonally raise the Sequalitchew Lake level and remove potential channel obstructions. Flow maintenance and enhancement involves removal of channel constrictions (e.g., replacing a portion of the trail that bisects Edmond Marsh with a pedestrian bridge) to reduce the potential for ongoing beaver obstructions and evaluation

of Hamer Marsh as a potential source of additional water. Habitat restoration would remove several potential barriers to fish passage and restore or enhance aquatic habitat in important portions of the watershed.

4.5 Cumulative Effects of Proposed Action and Restoration Plan

This section describes the cumulative effects of the Proposed Action and implementation of the related Restoration Plan on surface water bodies in the Sequalitchew Creek watershed. The effects of the Proposed Action alone were previously described in Section 4.2.

4.5.1 Marsh Water Levels

The cumulative effects of Mining and Restoration scenario on marsh water levels were estimated using the water balance model described in Section 4.2.3.2. The water balance model was run with an additional scenario representing the combination of mining and implementation of the Restoration Plan and includes the following:

- **Low Groundwater Levels** – The Mining and Restoration scenario uses the estimates of groundwater levels for Step 4 that incorporate uncertainty (i.e., are conservatively low) described in Section 3.2.1.
- **Beaver Management** – Consistent with element 2.B of the Restoration Plan, flexible levelers are installed with the goal of maintaining marsh water levels at the following targets, recommended in SPSSEG (2014). For the model run, these elevations are assumed to represent fixed spillways throughout the year:
  - East Edmond Marsh, east of DuPont-Steilacoom Road = 210.5 feet
  - East Edmond Marsh, west of DuPont-Steilacoom Road = 209 feet
  - West Edmond Marsh = 206.5 feet
- **Sequalitchew Lake** – The monthly observed outflows from the lake are routed into Eastern East Edmond Marsh.
- **Hamer Marsh Weir** – Consistent with element 3.E of the Restoration Plan, a weir is installed in the main outlet of Hamer Marsh. Prior documents are not specific about the target elevation of the weir, so it was assumed to be at elevation 215 feet, which is about 0.5 feet higher than winter water levels at the start of the monitoring period and about the same as later winter water levels.
- **Hamer Marsh Culvert to Edmond Marsh** – Since replacing the Hamer Marsh culvert connecting to Edmond Marsh is a contingent action, depending on a study of water quality in Hamer Marsh, it was assumed not to be replaced. No additional surface water flow was assumed to be routed from Hamer Marsh to Edmond Marsh.
- **Dry Reach** – Consistent with element 3.G of the Restoration Plan, infiltration of flowing water into the channel bottom of the normally dry reach was assumed to be zero, either through natural or constructed lining of this reach.

Results from the marsh water balance analysis of the with Mining and Restoration – Low Groundwater scenario are included in Appendix F.

Marsh Water Levels with Mining and Restoration

The water balance model predicts that the water levels in East and West Edmond Marshes would generally be controlled at their restoration target elevations (see Figure 35) under the Mining and Restoration scenario. These elevations are significantly lower than the current water levels in these marshes. The decrease in marsh water levels is primarily influenced by beaver management under the Restoration Plan aimed at achieving water levels necessary to ensure east-to-west flow through the marsh system into Sequalitchew Creek. The changes in water surface elevations in the marshes are necessary to allow for flow from Sequalitchew Lake to reach Sequalitchew Creek ravine. Currently, the water levels in East Edmond Marsh are higher than the typical lake level of about 210.5 to 211.5 feet, preventing any outflow from the lake from reaching the marshes.

Generally, there would be little variation in marsh water levels, as there would almost always be more than enough flow from Sequalitchew Lake to keep the wetlands full to their target elevations. However, there are several summers during the simulation period when water levels in Edmond Marsh would dip below the target elevations for a month or more. These events are visible on Figure 35 as the slight dips in July and August below the relatively constant elevation line. The hydraulic gradient through the marshes would always be maintained, however, as the water level in East Edmond never dips below the water level in East Edmond Marsh.

The target water levels of the Mining and Restoration scenario achieve a difference in water surface elevations of 4 to 5 feet between the lake (typically 210.5 to 211.5 feet) and West Edmond Marsh (target elevation 206.5 feet). Over the 8,700-foot flow path through the marshes, these water levels would result in a hydraulic gradient of 0.0006 feet per foot. This is a very low gradient; however, one or more broad (20+ feet), shallow (< 2 feet) channels at this gradient would have sufficient capacity to convey the peak outflows from Sequalitchew Lake. Flow velocities in this system would be low (<1 foot per second).

The water balance may overestimate the change in marsh water levels because it treats large areas of the marsh as single, contiguous water body with the same elevation. When implementing the Restoration Plan, the restoration managers could adaptively manage wetland water levels through the use of flexible levelers and other beaver management devices at more locations throughout the marshes, creating smaller steps in water level. In addition, beaver ponds off the main channel through the marshes from Sequalitchew Lake could be maintained at higher elevations without impeding flow along the channel.

Gains/Losses in the Marshes

Under the Mining and Restoration scenario, the outflow from Sequalitchew Lake would once again enter the marshes, given that the barriers to flow have been removed or lowered to provide a positive gradient to the Sequalitchew Creek ravine. As water travels through the marshes, it would still be subject to potential gains from precipitation, stormwater inflows, or discharge from groundwater, as wells as losses to evapotranspiration or infiltration to groundwater.

Gains and losses to flow from Sequalitchew Lake as it passes through the marshes varies throughout the year. In wetter months (November to March), the marsh system would add a small amount of water to the flow as shown in Table 23. In drier months (April to October), some flow would be lost in the wetlands (up to 24 percent) to evapotranspiration or infiltration. Losses during the drier months balanced with gains during the winter result in an average annual loss of 3 percent. Summertime losses are also important because they occur at times when less water is present in the system and so highlight periods of net reduction in flow through the marsh system.

Table 23. Average Gains/Losses in Wetlands with Proposed Action and Restoration Plan

Month	Average Inflow from Sequalitchew Lake in cfs	Average Outflow to Sequalitchew Creek in cfs	Gain (+) or Loss (-)	
			in cfs	percent
January	17.8	18.5	0.7	4%
February	21.6	22.0	0.4	2%
March	25.6	24.3	-1.3	-5%
April	23.6	21.9	-1.7	-7%
May	16.5	14.6	-1.9	-12%
June	9.5	8.5	-1.0	-11%
July	4.5	3.5	-1.1	-24%
August	2.9	2.4	-0.5	-17%
September	2.2	2.4	0.2	8%
October	4.7	4.7	0.0	-1%
November	8.5	8.8	0.3	4%
December	12.1	13.2	1.1	9%
Average	12.46	12.05	-0.4	-3%

Note: cfs = cubic feet per second

4.5.2 Edmond Marsh Water Quality

The proposed mining and restoration projects would affect water quality in East Edmond and West Edmond Marsh through flushing with a high volume of water with better quality than the water in the marshes under existing conditions. The anticipated changes were evaluated qualitatively by comparing the water quality conditions in the outflow from Sequalitchew Lake with water quality conditions in the marshes.

The residence time in the wetlands would reduce significantly, decreasing from weeks to months under existing conditions to days with the Mining and Restoration scenario. As a result, the water quality in the wetlands would be dominated by the input from Sequalitchew Lake. Dissolved oxygen would be higher and the pH slightly more neutral. Temperature and turbidity have been about the same between the lake and the marshes, so little change would be anticipated.

It is anticipated that the elevated iron concentrations observed in the center of Edmond Marsh would be resolved through flushing and dilution with Sequalitchew Lake water. The iron concentration in the outflow from Sequalitchew Lake has been measured on only one occasion (at 0.13 mg/L), well below the elevated levels of 3 to 5 mg/L observed in Edmond Marsh near the railroad trail bridge and related seeps. Iron concentrations in

the marshes receiving flow from Sequalitchew Lake could be expected to have iron concentrations near, but slightly above, the concentration in the lake.

Iron is necessary for aquatic life but can be toxic at higher concentrations. There is no state water quality criterion for iron in surface waters, but British Columbia has established a water quality guideline for total iron of 1 mg/L in surface water (Phippen et al, 2008). As the iron concentration in Sequalitchew Lake outflow is nearly an order of magnitude lower that this criterion, the iron concentration in the Edmond Marsh during and after mining and restoration is anticipated to be well below 1 mg/L.

4.5.3 Sequalitchew Creek Streamflow

The cumulative effects of the Proposed Action and Restoration Plan were predicted for two reaches of Sequalitchew Creek: the normally dry reach between the outlet of West Edmond Marsh and the top of the ravine, and the upper portion of the ravine.

4.5.3.1 Dry Reach

Under existing conditions, the reach of Sequalitchew Creek between the outlet of West Edmond Marsh and the top of the ravine experiences no consistent flow passing through the entire reach. This occurs because there is little outflow from West Edmond Marsh and the bottom of the channel in this reach is above the groundwater levels and has been disturbed by prior human activity, so any outflow readily infiltrates into the coarse native soils.

Together, the Proposed Action and Restoration Plan are predicted to result in an average flow of 10.8 cfs in the dry reach. The flow would vary seasonally from a monthly average of 2.2 cfs in August to 22.3 cfs in March as shown on Figure 39. Peak flows could be as high as 60 cfs if all water is routed through the wetlands during peak flow events. To avoid flooding during peak flows, JBLM may seek to continue to route a portion of peak flows to the Diversion Canal. The results presented here do not account for the diversion of peak flows.

With the Proposed Action and Restoration, there would be some periods when water would not flow from West Edmond Marsh or in the dry reach. Water balance model results, based on hydrologic conditions observed over the 19-year period of record, indicate that water would not flow through the dry reach due to dry conditions on 401 days (or 7.7 percent of the time). These dry periods were predicted to last for multiple weeks to several months and occurred in five of the 19 years simulated by the model (2004, 2005, 2015, 2017, and 2018). These reflect periods in the historical record when there was no flow over the Diversion Canal weir.

Streamflow in the dry reach was calculated by adjusting the daily average outflows from Sequalitchew Lake from 2003 to 2021 by the estimates of the gains or losses that would occur in the wetlands based on the results of the water balance model. The dry reach was assumed to have a sealed bed under restored conditions (either naturally or through contingent restoration actions), so no gains or losses were assumed to occur within the dry reach.

The predictions of streamflow in the dry reach are subject to uncertainty resulting from several sources including: (1) the historical measurement of streamflow at the Diversion

Weir, (2) the estimates of gains and losses from the water balance model, and (3) the temporal effects of streamflow routing as water travels through the marshes. The uncertainty associated with streamflow measurement at the weir is anticipated to be low (<10 percent) as weirs provide a reliable hydraulic section for streamflow measurement. However, as the outflow from Sequalitchew Creek is by far the largest factor affecting streamflow in Sequalitchew Creek, once the Restoration Plan is implemented even low uncertainty in the flow measurement can be important.

Uncertainty in the water balance stems from multiple factors including the application of precipitation and evaporation historical observations to the project site; challenges in estimating hydraulic conductivity throughout a large, submerged area; errors with estimating the storage-surface area-elevation relationships of the marshes; changing hydraulic controls over time through beaver activity, difficulties estimating parameters like the hydraulic conductivity of beaver dams or the locations where shallow subsurface flow between marshes may occur; and uncertainties in the estimates of groundwater levels with mining (see discussion in Section 3.2.1.6).

To reduce the potential impact of these uncertainties, several conservative assumptions (i.e. assumptions which overestimate losses in the marshes, or otherwise underestimate flow through the marshes) were used:

1. Low Groundwater Levels – The groundwater level subtract the estimate of model uncertainty, resulting in a low estimate of groundwater levels and thus higher losses from the marshes. In addition, no additional surface water flow was assumed to come from Hamer Marsh under the Restoration Plan.

2. Monthly Average Losses\Gains Applied to High Flows – During peak flow events, it is unlikely that the magnitude of losses in the wetland would be the same as under average conditions; however, for simplicity the same losses\gain percentages were applied regardless of the flow magnitude. As losses occur most months of the year, this results in a net conservative bias, particularly during spring and fall months.

3. Restoration of Surface Flows from Hamer Marsh Not Included – Additional surface water flow from Hamer Marsh was not included in the With Mining and Restoration – Low Groundwater scenario because it is a contingent element. If this element is implement, and initial indications are that JBLM plans to route surface water outflows from Hamer Marsh to Eastern East Edmond Marsh, additional flow would pass through the marshes and benefit Sequalitchew Creek.

Finally, these predictions do not account for the effects of storage in the wetlands as flow from Sequalitchew Lake is routed through them. This uncertainty only affects the With Mining and Restoration – Low Groundwater scenario. The effects of storage will likely be beneficial to streamflow by attenuating flows and spreading it over multiple days, which in some cases may reduce the number of days of periods without flow in the Dry Reach.

4.5.3.2 Upper Sequalitchew Creek Ravine

Streamflow passing through the dry reach of Sequalitchew Creek would continue into the top of the Sequalitchew Creek ravine. In this reach groundwater discharges from the

ravine springs, augmenting flow in the creek. The dewatering component of the Proposed Action would significantly decrease the flow from the springs as described in Sections 3.2.4.2 and 4.2.3.3, but there would continue to be some spring discharge to the creek.

Streamflow in Sequalitchew Creek with the Proposed Action and Restoration Plan can be predicted by starting with the flows in Sequalitchew Creek from the dry reach (see Section 4.5.3.1) and adding the predicted flows in upper Sequalitchew Creek with the Proposed Action alone. The Restoration Plan would have no effect on the ravine spring flows.

The annual average flow in upper Sequalitchew Creek ravine would be 11.2 cfs and the monthly average would vary from a low of 2.2 cfs in August to a high of 22.9 cfs in March. The resulting hydrograph of predicted flows in the upper Sequalitchew Creek ravine with the Proposed Action and Restoration Plan is shown on Figure 40.

There would be periods when the cumulative effects of the Proposed Action and Restoration Plan are predicted to result in a reduction in flows at the mid-ravine gage when compared with the observed existing condition. Post-project flows are predicted to be lower during 45 periods, lasting a total of 547 days over the 19 years evaluated, or about 10.5 percent of the time. During 24 of those days, there would be no flow at the mid-ravine gage. Under observed existing conditions, there were 7 days with no measurable flow at the gage.

The median duration of a period when flows would be lower with the Proposed Action and Restoration Plan (hereafter referred to as a “lower flow event”) would be 3 days, but there were 9 lower flow events lasting more than 2 weeks long. The longer events occurred in six of the 19 years simulated (2004, 2005, 2015, 2016, 2017, and 2018). The longest single lower flow event was 99 days ending in October 2017. However, lower flow events dominated the summer and fall of 2005, when there were five lower flow events between July 20 and December 23 lasting a total of 136 days. Lower flow events occurred most commonly in July, August, September, and October, but occasionally occurred in all months except March. The average streamflow during lower flow events was 0.8 cfs under existing conditions and would be 0.4 cfs with the Proposed Action and Restoration Plan. The decrease in streamflow during lower flow events ranged from less than 0.1 cfs up to 1.3 cfs.

Streamflow in the lower reach of Sequalitchew Creek can be expected to be similar to the upper reach. Once Sequalitchew Creek crosses the truncation of the Olympia Beds, neither the Proposed Action nor the Restoration Plan would affect the spring discharge to the creek nor infiltration from the creek to groundwater. Flows in the lower ravine reach are higher than in the upper ravine reach as gains from stormwater and spring discharge exceed losses to infiltration. This condition can be expected to continue, though the magnitude of the gains will be minor relative to the restored flow.

4.5.4 Sequalitchew Creek Water Quality

The Mining and Restoration projects would affect stream temperature in the Sequalitchew Creek ravine by introducing a large quantity of water of different temperature. The effects would vary seasonally as the volume of water from

Sequalitchew Lake, and its associated temperature varies. In summer, the outflow from Sequalitchew Lake is warmer than Sequalitchew Creek; in winter, it is colder.

The change in stream temperature was evaluated quantitatively by using a linear mixing equation to calculate average monthly temperatures based on observed temperature data and predicted streamflows from the outflow from the marshes and the groundwater discharge from the ravine springs. Generally, the outflow from Sequalitchew Lake has higher summer temperatures and lower winter temperatures due to exposure to the atmosphere.

The outflow from the marshes was represented by the monthly average flow rates from West Edmond Marsh from the water balance and the observed temperature data for Sequalitchew Lake plus an additional 1°C added to conservatively account for warming that may occur in the marshes (even though monitoring data indicate that water temperatures in the marshes are generally similar to lake temperatures). The groundwater discharge to Sequalitchew Creek was based on the estimate of post-mining spring discharges to the ravine and the observed Sequalitchew Creek temperature data.

This analysis is limited by the quality of the available temperature data. Grab samples are representative of the specific time and location they were taken, but do not represent the diurnal temperature variation, or spatial variations within a water body. As such, care should be taken in comparing the results of this analysis with temperature criteria based on multiple day averages of daily maximum temperatures.

Sequalitchew Creek would experience warm temperatures in June, July, and August, with temperatures reaching up to 21°C and cool temperatures in winter, down to 5 to 6°C. The seasonal pattern of average monthly temperatures in Sequalitchew Creek with mining and restoration are shown on Figure 41. The predicted stream temperatures would be considerably warmer than the current spring discharge in the creek for most of the year. The surface water quality criterion for temperature applicable to Sequalitchew Creek is 16°C for the 7-day average of daily maximums. The analysis based on grab samples suggests that this threshold may be exceed from May through September.

The change in stream temperature reflects a return toward historical conditions when the warmer outflow from Sequalitchew Lake would pass through marshes before flowing down the Sequalitchew Creek ravine.

4.6 Significant Unavoidable Adverse Impacts

The Proposed Action in conjunction with the Restoration Plan would result in the following significant, unavoidable adverse impacts to surface waters within the Sequalitchew Creek watershed:

- Water levels in Edmond Marsh would be lower than existing conditions by up to 3 feet. This impact is primarily attributable to the Restoration Plan and is necessary to achieve flow from Sequalitchew Lake to the Sequalitchew Creek ravine. However, the change in water level also includes the impact of changes in groundwater levels from dewatering for mining.
- Water levels in isolated lakes and kettle wetlands would be lower by the amount of the change in groundwater levels from dewatering. The decrease would be 3

feet for Wetland 1D, 2 feet for Pond Lake, 1 foot for Wetlands #8 to #11, and 0.5 feet for Old Fort Lake.

- There would be periods, approximately 10.5 percent of the time, when flows in Sequalitchew Creek with the Proposed Action and Restoration Plan would be lower than under existing conditions.
- Water temperature in Sequalitchew Creek would be warmer than under existing conditions from April through September and would likely exceed the 7-day average of daily maxima criterion of 16°C in multiple months between May and September.

No significant unavoidable adverse impacts to surface waters are anticipated from direct effects of the Proposed Action (i.e., activities within the mine area acting directly on stormwater or surface water).

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6 Limitations

Work for this project was performed for the CalPortland (Client), and this report was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

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TABLES

Table 1. Summary of Existing and Post-Reclamation Land Uses for Proposed Action

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Land Use	Area [1] in Acres									
	Existing Conditions					Proposed Action - Post-Reclamation				
	Expansion Area			Re-Mine Area	Total	Expansion Area			Re-Mine Area	Total
	South Parcel	Kettle Area	Buffer Strip			South Parcel	Kettle Area	Buffer Strip		
Built Areas										
Buildings	--	--	--	--	0.00	--	--	--	--	0.00
Roads, Access, and Parking	--	--	0.4	9.2	9.55	--	--	--	--	0.00
Processing Areas	--	--	0.2	17.9	18.08	--	--	--	--	0.00
Active Mining	--	--	--	--	0.00	--	--	--	--	0.00
Active Reclamation	--	--	0.2	20.5	20.62	--	--	--	--	0.00
Cleared for Mining	--	--	--	--	0.00	--	--	--	--	0.00
Water Management Ponds	--	--	--	--	0.00	--	--	--	--	0.00
Total Built Areas	0	0	0.8	47.5	48.26	0	0	0.00	0.00	0.00
Natural & Reclaimed Areas										
Areas Reclaimed as Forest	--	--	--	3.3	3.3	29.4	0.6	0.6	35.8	66.3
Areas Reclaimed as Grass	--	--	--	68.5	68.5	138.2	10.2	8.6	89.4	246.4
Wooded Areas	146.2	5.6	7.4	5.8	165.1	--	--	--		0.0
Grass Areas	21.3	--	1.0	0.21	22.5	--	--	--		0.0
Wetland	--	1.8	--		1.8	--	--	--		0.0
Wetland Buffer	--	3.4	--		3.4	--	--	--		0.0
Total Natural & Reclaimed Areas	167.5	10.8	8.4	77.7	264.5	167.5	10.8	9.2	125.2	312.7
Total	167.5	10.8	9.2	125.2	312.7	167.5	10.8	9.2	125.2	312.7

Notes:

-- Indicates no area of this type.

1) Totals may not exactly equal the sum of their components due to rounding.

Table 5. Well Data Inventory

Project No. 040001-I-018, Pioneer Aggregates South Parcel Project, DuPont, Washington

Name	Owner	Installation Date	Easting (ft, WA State Plane South, NAD83)	Northing (ft, WA State Plane South, NAD83)	Measurement Point Elevation (ft, NGVD29)	Ground Surface Elevation (ft, NGVD29)	Total Depth (ft, bgs)	Total Depth Elevation (ft, NGVD 29)	Bottom of screen elevation (ft, NGVD29)	Top of screen elevation (ft, NGVD29)	Monitoring Status
CHMW-1	CalPortland	9/24/1999	1106696.99	656314.27	211.41	209.41	85	124.41	124.91	136.41	Active
CHMW-2D	CalPortland	11/18/1999	1106700.16	658200.38	209	207.2	73	134.2	134.7	146	Active
CHMW-2S	CalPortland	11/19/1999	1106705.29	658216.29	209.39	207.94	43	164.94	165.44	176.39	Active
CHMW-3D	CalPortland	11/5/1999	1105047.94	655341.87	218.35	216	85	131	131.5	140.5	Active
CHMW-3S	CalPortland	11/5/1999	1105040.23	655354.29	218.49	216	40	176	176.5	185.5	Active
CHMW-4D	CalPortland	11/11/1999	1106579.69	654911.11	215.91	214	85	129	129.5	138.5	Active
CHMW-4S	CalPortland	11/23/1999	1106568.15	654917.67	215.765	214	37	177	177.5	186.5	Active
OB-1	CalPortland	2/15/1991	1106246.36	661167.18	210.72	208.72	239.5	-30.78	-20.58	-0.18	Active
MW-BM-1	CalPortland	8/3/2004	1110307.50	651349.59	232.32	229.37	25	204.37	204.37	214.37	Active
MW-93-MFS-C5-3	JBLM	2/23/1993	1108505.09	659437.53	219.32	216.52	30.2	186.32	186.52	196.32	Active
MW-D-3	JBLM	8/5/1996	1108925.35	657457.41	212.47	209.94	24	185.94	185.94	195.94	Active
MW-EM-1D	CalPortland	12/11/2002	1107470.10	653789.74	210.29	207.3	32	175.3	175.3	185.3	Active
MW-EM-1S	CalPortland	12/11/2002	1107470.10	653789.74	210.23	207.3	5	202.3	202.3	204.8	Active
MW-EM-2D	CalPortland	12/2/2002	1109620.41	653048.09	214.2	212.1	50	162.1	162.1	172.1	Active
MW-EM-2S	CalPortland	12/2/2002	1109620.41	653048.09	214.95	212.1	5	207.1	207.1	209.6	Active
MW-EM-3	CalPortland	3/11/2004	1111866.67	653569.41	217.38	214.63	20	194.63	194.63	204.63	Inactive*
MW-HM-1	CalPortland	8/2/2004	1113393.29	652867.84	221.06	217.75	20.3	197.45	197.75	207.45	Active
MW-PL-1	CalPortland	7/26/2006	1106163.60	651040.56	205.51	202.76	4.15	198.61	198.61	201.61	Active
MW-SRC-2	JBLM	NA	1116574.08	653674.67	234.62	232.76					Active
88-2-VD	JBLM	11/17/1988	1111621.47	657093.03	221.74	219.31	49	170.31	181.31	173.74	Inactive
MW-SL-1	CalPortland	3/11/2004	1113520.44	655737.40	217.74	214.94	20.3	194.64	194.94	199.64	Active
MW-WL1D-1	CalPortland	7/26/2006	1108902.03	653804.55	212.31	209.56	3.9	205.66	205.66	208.66	Active

Note:

* EM-3 is temporarily inaccessible due to unknown lock.

Table 6. Summary of Hydrostratigraphic Units and Calibrated Parameter Values

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Hydrostratigraphic Unit in DuPont Model	Correlated USGS Hydrogeologic Unit and Partial Description	Principal Layers in DuPont Model	Horizontal Hydraulic Conductivity (feet/day)					Vertical Anisotropy (-)	Specific Yield (-)	Specific Storage (1/foot)	for Horizontal Hydraulic Conductivity (feet per day)	
			Max.	75 percentile	Average	25 percentile	Min.	horizontal: vertical			USGS median	Dupont Works RI
Steilacoom Gravel	A1 – "recessional outwash…sand and gravel deposited by large meltwater streams…"	1,2	3,900	1,600	1,100	350	36	2.7	0.07	6.1E-05	933	18
Upper Confining Unit	A2 – "low-permeability unit composed of Vashon till and lesser amounts of ice-contact, moraine and fine-grained glaciolacustrine deposits…"	3	1.61	0.47	0.33	0.16	0.017	1.0	0.07	5.0E-05	18	
Vashon Outwash	A3 – "aquifer composed of Vashon advance outwash…"	4,5	49	11	7.7	2.4	0.27	15.1	0.09	2.7E-05	122	34
Olympia Beds (Qob)	B – "low-permeability unit composed of fine-grained silts and clays deposited during the Olympia interglacial…"	6,7	0.018 (uniform)					10.0	0.09	1.1E-04	21	
Sea Level Aquifer	C – "aquifer composed of pre-Olympia glacial drift deposits consisting of sand and gravel…"	8,9	690 (uniform)					6.3	0.18	6.0E-05	96	63

Notes:

1 USGS reference: Savoca et al., 2010.

2 Dupont Works RI reference: Hart Crowser, 1994.

Table 7. Predicted Groundwater Dewatering Rates by Step

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Month	Dewatering Pumping Rate in cfs			
	Step 1	Step 2	Step 3	Step 4
January	4.1	6.2	8.2	0
February	3.9	5.7	7.6	0
March	3.9	5.7	7.6	0
April	3.8	5.6	7.4	0
May	3.6	5.3	7.0	0
June	3.4	4.9	6.5	0
July	3.1	4.4	5.8	0
August	3.0	4.2	5.5	0
September	3.0	4.2	5.6	0
October	3.3	4.6	6.0	0
November	4.0	5.9	7.8	0
December	4.1	6.1	8.1	0
Average	3.6	5.2	6.9	0
Minimum	2.6	3.6	4.7	0
Maximum	5.5	8.8	12.2	0

Notes:

1. Monthly values represent average for that month throughout the simulation period.
2. Average row represents the average of all months in the simulation period.
3. Minimum and maximum represent the lowest and highest individual values from the entire simulation period.

Table 8. Well-Specific Maximum Water Level Changes

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Well	Predictive Model Results													
	Maximum Decrease in Water Level in feet based on Refined Model Results				Calculating Adjustment for Model Uncertainty						Maximum Decrease in Water Level in feet based on Refined Model Results and including Model Uncertainty			
					Standard Deviation	Range in Observed Values	Model Uncertainty in Feet							
	Step 1	Step 2	Step 3	Step 4			Step 1	Step 2	Step 3	Step 4	Step 1	Step 2	Step 3	Step 4
MW-EM-1S	0.50	1.61	5.44	5.00	1.75	7.56	2.39	2.72	3.86	3.73	2.90	4.33	9.29	8.73
MW-EM-1D	0.47	1.51	5.12	4.71	0.98	7.90	1.34	1.50	2.08	2.01	1.81	3.01	7.20	6.72
MW-EM-2S	0.06	0.15	0.35	0.33	0.35	2.39	0.46	0.48	0.52	0.51	0.52	0.63	0.87	0.84
MW-EM-2D	0.07	0.17	0.39	0.36	0.30	2.54	0.39	0.41	0.44	0.43	0.46	0.58	0.83	0.80
MW-EM-3	0.01	0.02	0.02	0.02	0.14	3.00	0.19	0.19	0.19	0.19	0.20	0.21	0.21	0.21
CHMW-1	1.30	5.23	59.79	30.47	0.92	9.48	1.34	1.83	8.62	4.97	2.64	7.06	68.41	35.44
CHMW-2S	7.37	45.45	50.98	29.92	0.71	7.55	1.79	6.37	7.04	4.50	9.17	51.82	58.01	34.43
CHMW-2D	8.80	45.20	50.79	31.76	0.66	6.89	1.91	6.35	7.03	4.71	10.71	51.55	57.83	36.47
CHMW-3S	0.83	3.24	53.86	52.76	1.55	10.80	2.14	2.58	11.87	11.67	2.97	5.82	65.73	64.43
CHMW-3D	0.10	2.70	57.02	50.29	1.51	10.43	1.96	2.44	12.53	11.28	2.05	5.14	69.56	61.57
CHMW-4S	0.95	3.14	14.33	13.79	1.03	9.54	1.45	1.76	3.31	3.23	2.40	4.90	17.64	17.02
CHMW-4D	0.76	2.96	15.03	14.01	0.92	9.40	1.27	1.55	3.06	2.94	2.03	4.51	18.10	16.95
MW-SRC-2	0.29	0.33	0.30	0.34	0.61	6.70	0.82	0.82	0.82	0.82	1.11	1.15	1.12	1.16
MW-D-3	1.79	4.27	7.68	6.55	0.97	7.77	1.54	1.93	2.48	2.30	3.33	6.20	10.16	8.85
MW-93-MFS-C5-3	1.40	2.73	4.21	3.63	1.01	7.26	1.55	1.79	2.05	1.95	2.96	4.52	6.27	5.58
88-2-VD	0.40	0.57	1.41	1.35	0.69	2.85	1.01	1.06	1.31	1.30	1.41	1.63	2.72	2.64
MW-BM-1	0.21	0.35	0.39	0.74	0.46	5.72	0.62	0.63	0.64	0.67	0.83	0.98	1.03	1.41
MW-HM-1	0.25	0.41	0.27	0.41	0.59	5.95	0.78	0.80	0.79	0.80	1.03	1.21	1.05	1.22
MW-PL-1	0.10	0.35	1.10	1.01	1.55	6.04	2.02	2.10	2.34	2.32	2.11	2.45	3.44	3.33

Notes:

1. Model predictions are presented at the typical field-measurement precision (0.01 ft).
2. Refined model results correct for calibration offset.
3. Model uncertainty calculated for 95% lower confidence interval for 1-tailed test.
4. Shaded values indicate forecasted change in water level exceeds half the range in observed values.
5. Calculated water levels may be below bottom of well.

Table 10. Minimum Predicted Groundwater Levels for Each Dewatering Step

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Step 1 - Initial Pumping Test

Well	Groundwater Elevation in Feet (NGVD 29)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MW-EM-1S	203.6	202.4	202.9	202.2	202.3	201.4	200.4	200.4	199.5	199.5	202.1	202.9
MW-EM-1D	204.6	203.4	203.9	203.2	203.3	202.5	201.5	201.5	200.7	200.7	203.1	203.9
MW-EM-2S	210.6	210.3	210.4	210.3	210.2	210.0	209.7	209.6	209.3	209.5	210.2	210.4
MW-EM-2D	210.8	210.4	210.6	210.5	210.4	210.2	209.8	209.7	209.4	209.6	210.4	210.5
MW-EM-3	212.1	211.9	211.8	211.9	212.0	211.6	211.4	210.8	210.2	210.3	211.5	211.9
MW-SRC-2	213.2	212.4	212.7	212.6	212.8	212.0	211.4	210.2	209.6	210.5	212.3	212.7
MW-BM-1	218.0	217.0	216.6	217.4	217.3	216.6	216.1	213.1	213.3	214.2	216.8	217.4
MW-HM-1	214.2	213.5	213.3	213.8	213.6	212.7	211.8	211.2	210.6	211.1	213.1	213.6
MW-PL-1	200.8	200.1	200.4	200.1	200.0	199.4	198.6	198.7	198.0	197.7	199.6	200.2
CHMW-1	191.3	189.9	190.4	189.6	189.7	189.0	188.1	188.0	187.4	187.5	190.0	190.7
CHMW-2S	184.6	183.3	183.7	183.0	183.0	182.5	181.7	181.6	181.2	181.4	183.5	184.0
CHMW-2D	183.4	181.8	182.4	181.4	181.5	180.8	179.8	179.7	179.3	179.4	182.1	182.7
CHMW-3S	193.3	191.7	192.4	191.3	191.5	190.6	189.6	189.5	188.7	188.8	191.7	192.6
CHMW-3D	193.2	191.5	192.2	191.1	191.3	190.4	189.2	189.1	188.3	188.4	191.5	192.5
CHMW-4S	196.1	194.7	195.3	194.4	194.6	193.7	192.7	192.6	191.9	191.9	194.6	195.5
CHMW-4D	194.3	192.9	193.5	192.6	192.7	191.9	190.9	190.8	190.1	190.1	192.8	193.6
MW-D-3	196.5	195.3	195.7	195.0	195.1	194.6	193.9	193.7	193.3	193.5	195.6	195.9
MW-93-MFS-C5-3	192.3	191.2	191.7	191.0	191.0	190.5	190.0	189.9	189.5	189.8	191.6	191.7

Table 10. Minimum Predicted Groundwater Levels for Each Dewatering Step

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Step 2 - Preparation for Mining/Expanded Dewatering Test

Well	Groundwater Elevation in Feet (NGVD 29)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MW-EM-1S	202.3	201.1	201.6	200.9	201.1	200.1	199.1	199.2	198.4	198.3	200.8	201.5
MW-EM-1D	203.4	202.3	202.8	202.2	202.3	201.4	200.5	200.5	199.7	199.7	202.0	202.7
MW-EM-2S	210.6	210.2	210.3	210.2	210.1	210.0	209.6	209.5	209.2	209.4	210.1	210.3
MW-EM-2D	210.8	210.4	210.5	210.4	210.3	210.1	209.7	209.6	209.3	209.5	210.3	210.5
MW-EM-3	212.1	211.9	211.8	211.9	212.0	211.6	211.4	210.8	210.2	210.3	211.5	211.9
MW-SRC-2	213.2	212.4	212.6	212.6	212.8	212.0	211.4	210.2	209.5	210.5	212.0	212.7
MW-BM-1	218.0	217.0	216.5	217.3	217.2	216.6	216.1	213.0	213.3	214.1	216.8	217.3
MW-HM-1	214.2	213.4	213.3	213.8	213.6	212.7	211.8	211.2	210.5	211.1	213.0	213.6
MW-PL-1	200.4	199.7	200.1	199.8	199.8	199.1	198.2	198.4	197.7	197.4	199.2	199.8
CHMW-1	187.0	185.7	186.3	185.5	185.6	184.9	184.0	184.0	183.3	183.4	185.8	186.4
CHMW-2S	143.8	141.4	142.2	141.0	141.0	140.1	139.1	138.9	138.3	138.6	141.8	142.9
CHMW-2D	142.5	141.0	141.6	140.7	140.7	140.0	139.1	138.9	138.3	138.5	141.2	141.9
CHMW-3S	190.6	189.0	189.8	188.8	189.0	188.1	187.0	187.0	186.2	186.2	189.0	189.8
CHMW-3D	190.2	188.6	189.4	188.3	188.5	187.5	186.3	186.3	185.4	185.3	188.4	189.3
CHMW-4S	193.7	192.3	193.0	192.1	192.3	191.4	190.4	190.4	189.6	189.6	192.2	193.0
CHMW-4D	191.8	190.5	191.2	190.3	190.5	189.6	188.6	188.6	187.8	187.8	190.4	191.1
MW-D-3	193.7	192.5	193.0	192.3	192.3	191.9	191.2	191.1	190.7	190.9	192.9	193.4
MW-93-MFS-C5-3	190.8	189.8	190.3	189.6	189.6	189.1	188.7	188.5	188.2	188.5	190.2	190.5

Table 10. Minimum Predicted Groundwater Levels for Each Dewatering Step

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Step 3 - Active Dewatering during Mining

Well	Groundwater Elevation in Feet (NGVD 29)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MW-EM-1S	197.5	196.4	196.9	196.4	196.5	195.6	194.7	194.8	194.1	194.1	196.1	196.8
MW-EM-1D	199.4	198.4	198.9	198.3	198.4	197.6	196.8	196.9	196.2	196.2	198.1	198.7
MW-EM-2S	210.3	210.0	210.1	209.9	209.9	209.7	209.4	209.3	209.0	209.2	209.9	210.0
MW-EM-2D	210.5	210.1	210.3	210.1	210.0	209.8	209.5	209.4	209.1	209.3	210.0	210.2
MW-EM-3	212.1	211.9	211.8	211.9	212.0	211.6	211.4	210.8	210.2	210.3	211.5	211.8
MW-SRC-2	213.2	212.4	212.7	212.6	212.8	212.0	211.4	210.2	209.5	210.5	212.0	212.7
MW-BM-1	217.8	216.8	216.4	217.2	217.1	216.4	215.9	212.8	213.1	213.9	216.7	217.2
MW-HM-1	214.2	213.4	213.3	213.8	213.6	212.7	211.8	211.2	210.4	211.1	213.0	213.6
MW-PL-1	199.4	198.7	199.0	198.8	198.7	198.0	197.1	197.3	196.6	196.2	198.1	198.8
CHMW-1	129.8	129.1	129.4	128.9	128.9	128.5	127.8	127.8	127.3	127.4	129.2	129.5
CHMW-2S	136.0	134.5	135.0	134.1	134.1	133.5	132.9	132.8	132.3	132.5	134.9	135.5
CHMW-2D	135.9	134.7	135.1	134.3	134.2	133.7	133.1	132.9	132.4	132.6	134.9	135.5
CHMW-3S	131.1	128.4	130.3	128.9	129.2	127.9	126.6	127.0	126.2	126.3	129.0	130.2
CHMW-3D	128.3	127.4	127.9	127.6	127.6	126.8	125.8	126.1	125.4	125.1	127.0	127.6
CHMW-4S	181.0	179.7	180.4	179.6	179.7	178.8	177.7	177.8	176.9	176.9	179.5	180.3
CHMW-4D	178.5	177.3	178.0	177.1	177.3	176.4	175.3	175.4	174.5	174.4	177.1	177.8
MW-D-3	189.9	188.6	189.1	188.4	188.4	187.9	187.4	187.3	186.9	187.3	189.1	189.6
MW-93-MFS-C5-3	189.5	188.5	189.0	188.4	188.3	187.9	187.5	187.4	187.2	187.5	189.0	189.3

Table 10. Minimum Predicted Groundwater Levels for Each Dewatering Step

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Step 4 - Cessation of Active Dewatering

Well	Groundwater Elevation in Feet (NGVD 29)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MW-EM-1S	198.1	197.0	197.6	197.0	197.1	196.2	195.4	195.3	194.8	194.7	196.8	197.4
MW-EM-1D	199.9	198.9	199.4	198.8	199.0	198.2	197.3	197.3	196.7	196.7	198.7	199.3
MW-EM-2S	210.3	210.0	210.1	210.0	209.9	209.7	209.4	209.3	209.0	209.2	209.9	210.1
MW-EM-2D	210.5	210.2	210.3	210.1	210.1	209.9	209.5	209.4	209.1	209.3	210.1	210.2
MW-EM-3	212.1	211.9	211.8	211.9	212.0	211.6	211.4	210.8	210.2	210.3	211.5	211.8
MW-SRC-2	213.2	212.4	212.7	212.6	212.8	212.0	211.4	209.9	209.4	210.4	212.0	212.7
MW-BM-1	217.9	216.9	216.4	217.2	217.1	216.5	216.0	212.3	213.0	213.8	216.7	217.2
MW-HM-1	214.2	213.4	213.3	213.8	213.6	212.7	211.8	211.0	210.3	211.1	213.0	213.6
MW-PL-1	199.5	198.8	199.2	198.9	198.9	198.2	197.3	197.5	196.8	196.4	198.2	198.9
CHMW-1	163.2	162.7	162.9	162.7	162.6	162.4	162.1	162.1	161.8	162.0	162.9	163.1
CHMW-2S	169.3	165.0	168.1	163.2	162.8	158.9	157.1	157.2	156.2	156.9	167.9	168.8
CHMW-2D	160.3	158.5	159.2	158.1	157.9	156.9	155.4	155.5	154.6	155.2	159.1	159.8
CHMW-3S	140.4	140.2	140.3	140.2	140.2	140.0	139.7	139.7	139.5	139.7	140.3	140.3
CHMW-3D	141.9	141.6	141.8	141.6	141.6	141.4	141.1	141.1	140.9	141.0	141.6	141.8
CHMW-4S	183.0	181.9	182.5	181.8	181.9	181.3	180.5	180.5	179.9	180.0	181.9	182.4
CHMW-4D	181.0	180.0	180.6	179.9	180.0	179.4	178.7	178.7	178.2	178.2	180.0	180.5
MW-D-3	191.4	190.2	190.7	190.0	189.9	189.5	188.9	188.8	188.5	188.9	190.7	191.1
MW-93-MFS-C5-3	190.1	189.1	189.5	188.9	188.8	188.4	187.9	187.9	187.6	188.0	189.6	189.9

Table 11. Surface Water Monitoring Station Inventory

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

	Name	Water Body	Equipment Owner	Installation Date	Type of Station	Easting (ft, WA State Plane South, NAD83)	Northing (ft, WA State Plane South, NAD83)	Elevation Reference Point		Monitoring Status
								Elevation (ft, NGVD29)	Description	
Existing	SC-Lower	Sequalitchew Creek	CalPortland	Jul-1999	Flow (Continuous)	1101642.74	657543.91	NA	NA	Active
	SC-MidRavine*	Sequalitchew Creek	CalPortland	Nov-2003	Flow (Continuous)	1103973.25	655338.83	NA	NA	Active
	SG-PL-1	Pond Lake	CalPortland	Nov-2006	Stage	1106120.45	651239.82	201.52	0 ft stage	Active
	SG-WL1D-1	Wetland 1D	CalPortland	Jul-2006	Stage	1108981.52	653867.36	208.69	0 ft stage	Active
	SG-EM-1A	West Edmond Marsh	CalPortland	May-2004	Stage	1107329.98	653655.47	210.98	0 ft stage	Active
	SG-EM-1	West Edmond Marsh	CalPortland	Mar-2004	Stage	1107490.44	653659.66	209.87	3.0 ft mark on gage plate	Active
	SG-EM-2W	West Edmond Marsh	CalPortland	Mar-2004	Stage	1109561.81	653049.07	211.48	3.0 ft mark on gage plate	Active
	SG-EM-2E	East Edmond Marsh	CalPortland	Mar-2004	Stage	1109729.75	653546.46	213.43	2.0 ft mark on gage plate	Active
	SG-EM-3W	East Edmond Marsh	Unknown	Unknown	Stage	1111778.38	653532.65	212.31	33 3/4" mark on gage plate	Active
	SG-EM-3E	Eastern Edmond Marsh	CalPortland	Mar-2004	Stage	1111965.63	653528.97	213.43	3.0 ft mark on gage plate	Active
	SG-SCM-1	Eastern Edmond Marsh	CalPortland	Mar-2004	Stage	1113265.44	655679.85	213.20	3.0 ft mark on gage plate	Inactive*
	Diversion Weir	Sequalitchew Lake Outlet	CalPortland	Jul-1999	Flow (Continuous)	1113401.28	655929.72	NA	NA	Active
	SG Bubbler	Sequalitchew Lake Outlet	CalPortland	Jul-1999	Stage	1113401.28	655929.72	213.43	3.0 ft mark on gage plate	Active
	SG-DC-1	Diversion Canal	CalPortland	Mar-2004	Stage and Flow (Spot)	1111721.14	656276.19	207.15	3.0 ft mark on gage plate	Active
	SG-DC-2	Diversion Canal	CalPortland	Mar-2004	Stage and Flow (Spot)	1108840.82	657413.52	205.80	3.0 ft mark on gage plate	Active
	SG-DC-3	Diversion Canal	CalPortland	Mar-2004	Stage and Flow (Spot)	1108512.74	659518.19	202.60	3.0 ft mark on gage plate	Active
	SG-HM-1	Hamer Marsh	CalPortland	Mar-2004	Stage	1113805.80	654636.68	215.25	3.0 ft mark on gage plate	Active
	SG-MKM-1	McKay Marsh	CalPortland	Mar-2004	Stage	1113599.35	652792.46	216.27	3.0 ft mark on gage plate	Active
	SG-BM-1	Bell Marsh	CalPortland	Aug-2004	Stage	1110518.87	651232.41	215.31	2.0 ft mark on gage plate	Active

Notes:

NA - Not applicable

1) Mid-Ravine gage was formerly known as SC-Upper.

2) Staff gage has been stolen or removed by unknown party.

3) Future monitoring locations are identified in the Monitoring Plan or Reclamation Plan.

Table 12. Surface Water Elevations in Sequalitchew Creek Watershed

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Water Body	Monitoring Location	Water Surface Elevation in ft NGVD 29		
		Average	Minimum	Maximum
Sequalitchew Lake	SG at Bubbler	211.17	209.51	211.91
Bell Marsh	SG-BM-1	218.58	213.31	219.91
McKay Marsh	SG-MKM-1	215.43	213.27	217.35
Hamer Marsh	SG-HM-1	214.02	211.67	215.58
Eastern East Edmond Marsh	SG-SCM-1	212.44	210.20	213.46
	SG-EM-3E	212.39	211.07	213.54
East Edmond Marsh	SG-EM-3W	212.39	210.44	213.29
	SG-EM-2E	212.10	210.20	212.93
West Edmond Marsh	SG-EM-2W	211.35	209.64	212.14
	SG-EM-1/1A	207.91	205.27	210.22
Pond Lake	SG-PL-1	203.90	201.65	207.36
Wetlands 1D	SG-WL1D-1	209.98	208.63	211.00

Notes:

Period of record varies by location, but most began in March 2004 and include data through January 2022

Table 13. Summary of Surface Water Flows in Sequalitchew Creek

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Month	Average Flow in cfs				
	Diversion Weir	Mid-Sequalitchew Creek Ravine	Lower Sequalitchew Creek Ravine		
	2003 to 2021	2004 to 2021	1977 to 1978	1984 to 1987	1999 to 2021
January	15.6	2.5	9.7	5.9	4.0
February	19.6	2.6	12.8	8.5	4.2
March	21.5	2.2	12.2	8.7	3.8
April	19.8	2.0	0.7	9.4	3.2
May	12.7	1.6	1.6	7.8	2.7
June	7.4	1.2	1.5	3.7	1.9
July	3.2	0.9	0.2	1.3	1.3
August	2.8	0.8	0.1	1.0	1.1
September	2.4	0.8	0.1	1.0	1.1
October	3.7	0.8	0.1	1.4	1.4
November	7.1	1.3	2.4	3.7	2.6
December	10.9	1.9	10.5	5.1	3.5
Mean Annual Flow	10.5	1.6	4.3	4.8	2.7

Note: cfs = cubic feet per second

Table 15. Summary of Surface Water Quality in Sequalitchew Creek Watershed

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Location	Temperature in °C			Dissolved Oxygen in mg/L			pH			Turbidity in NTU			Iron in µg/L		
	Median	Range	n	Median	Range	n	Median	Range	n	Median	Range	n	Median	Range	n
Sequalitchew Lake	12.8	3.2 to 26.4	100	9.2	0 to 14.3	99	6.9	5.6 to 8.9	97	3.0	0 to 121	92	130	--	1
Marshes	10.5	2.7 to 22.2	74	4.0	0.0 to 11.3	58	6.5	5.6 to 8.1	72	1.85	0.7 to 7.7	41	409	5 to 5000	35
Sequalitchew Creek	10.8	4 to 16.5	157	10.6	0 to 14.3	152	7.0	4.1 to 8.2	162	1.4	0 to 10.1	136	16	5 to 617	21

Notes:
n = number of samples
mg/L = milligrams per liter
µg/L = micrograms per liter

Table 16. Land Use Scenarios Used in Mine Area Water Balance

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

	Area in Acres												
	Till Lawn			Outwash Forest			Outwash Pasture	Outwash Lawn			Saturated, Forest, Flat	Impervious		
Scenario	Flat	Mod.	Steep	Flat	Mod.	Steep	Flat	Flat	Mod.	Steep		Flat	Steep	Total
Existing Conditions	38.5	0.0	0.0	145.9	10.0	3.3	21.7	60.6	74.0	109.6	1.8	13.6	3.4	482.4
Proposed Action	79.2	193.4	47.0	0.0	0.0	0.0	0.0	25.7	41.5	90.4	4.3	0.0	1.0	482.5
No Action	38.5	0.0	0.0	13.8	10.0	3.3	1.2	94.8	74.0	109.6	1.8	131.9	3.4	482.4

Notes:

The total area represents basins C, D,E which include the disturbed area of the South Parcel Project as well as portions of the existing mine that drain to the proposed stormwater facilities. The same total area was used for each scenario to allow for consistency in comparison between scenarios

Till Lawn is used to represent portions of the floor of the existing mine, as well as the Olympia Beds in the Proposed Action

Outwash Forest is used for the undisturbed South Parcel

Outwash Lawn represents bare and reclaimed mine slopes (prior to tree growth) as well as lawn and landscaping under No Action.

Saturated Forest Flat represents the Kettle Wetland and the constructed mitigation wetland

Impervious areas are used for the main access road in the Proposed Action and paved roads and buildings under No Action.

Table 17. Annual Average Mine Area Water Balance

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Water Balance Component	Water Quantity in Acre Feet and Percent of Annual Precipitation			Basis for Estimate
	Existing	Proposed Action	No Action	
Water Sources				
Precipitation	1688 (25%)	1688 (25%)	1688 (25%)	WWHM - Pierce County158-year synthetic precipitation series
Run-on/Springs	0 (0%)	4995 (75%)	0 (0%)	Field observations, topography and geology for Existing and No Action; groundwater model for Proposed Action
Groundwater Inflow	4995 (75%)	0 (0%)	4995 (75%)	Groundwater model predictions
Water Losses				
Evapotranspiration	744 (10%)	706 (6%)	595 (8%)	Calculated by balance
Direct Groundwater Recharge	840 (11%)	542 (4%)	648 (8%)	WWHM model results
Infiltrated Stormwater	104 (1%)	440 (3%)	445 (6%)	WWHM model results, assuming all stormwater is infiltrated under development scenarios
Inflitrated Groundwater	0 (0%)	4995 (39%)	0 (0%)	Groundwater model predictions
Total Groundwater Recharge	944 (12%)	5977 (47%)	1093 (14%)	Sum of direct groundwater recharge, infiltrated stormwater, and infiltrated groundwater
Groundwater Outflow	5939 (78%)	5977 (47%)	6088 (78%)	Equal to groundwater inflow + total groundwater recharge

Notes:

1) Quantities presented for precipitatoin, evapotranspiration, direct groundwater recharge and infiltrated stormwater represent the overall average from the 158-year WWHM model runs.

2) Quantities presented for run-on/springs and groundwater inflow are based on the estimated annual average of dewatering water during Step 3 from the DuPont groundwater model.

Table 18. Peak Surface Runoff Flows

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Recurrence Interval	Annual Exceedance Probability	Peak Flow in cfs								
		Basin C			Basin D			Basin E		
		Existing Conditions	Proposed Action	No Action	Existing Conditions	Proposed Action	No Action	Existing Conditions	Proposed Action	No Action
2 year	0.5	4.3	9.6	8.1	3.6	13.9	39.5	1.7	0.9	7.3
5 year	0.2	7.2	18.4	12.1	6.1	26.9	53.3	3.4	2.5	10.5
10 year	0.1	9.9	26.5	15.4	8.3	38.6	63.4	5.0	4.5	13.0
25 year	0.04	14.2	39.6	20.4	12.1	57.3	77.2	8.0	8.9	16.8
50 year	0.02	18.4	51.9	24.7	15.7	74.4	88.4	11.0	14.2	19.9
100 year	0.01	23.5	66.5	29.7	20.2	94.6	100.2	15.0	22.2	23.4

cfs = cubic feet per second

Table 21. Restoration Plan Elements in City of DuPont

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Element	Components
1. Regulatory Actions	
A. DuPont CAR	Update the City of DuPont's Critical Areas Regulations - Completed in June 2021
2. Flow Restoration	
B. Beaver Management	Manage beaver and beaver dams Monitor flows and adaptively manage flexible levelers
3. Flow Maintenance and Enhancement	
F. Railroad Trail Bridge	Planning for DuPont Railroad Trail bridge Install DuPont Railroad Trail bridge
G. Losing Reach	Remove trash and invasive vegetation Monitor Losing Reach Seal Losing Reach (?) and restore habitat
4. Habitat Restoration	
H. City Hall Culvert	Replace the culvert near City Hall
I. Center Drive Culvert	Evaluate Center Drive culvert Modify Center Drive culvert (?)
J. Ravine Habitat	Monitor habitat changes after flow restoration *Add large woody debris (LWD) to ravine (?)* *Replace footbridge/remove berm (?)*
L. Southern alignment	Evaluate scope and feasibility of southern alignment Southern alignment implementation (?)

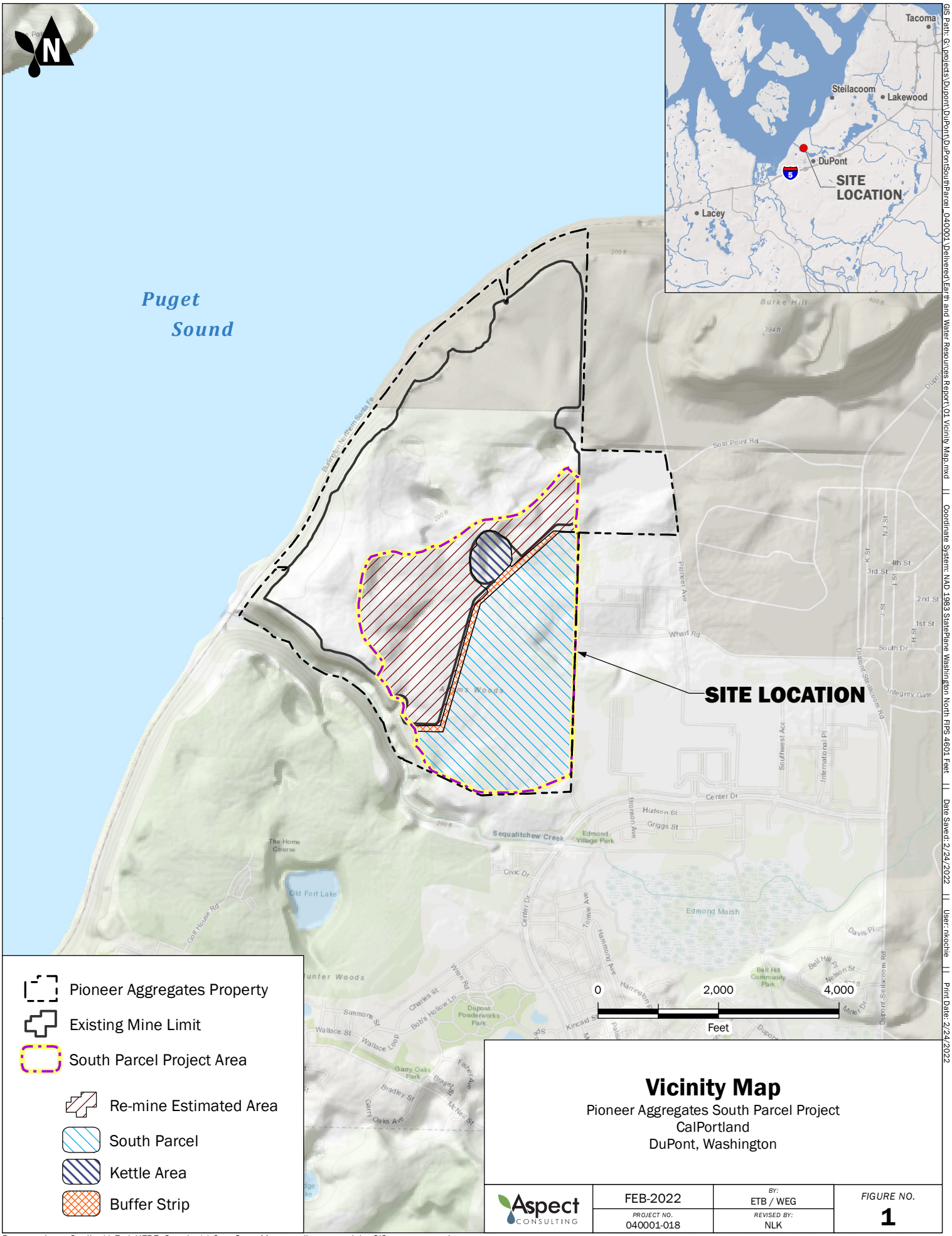
Notes:
(?) = action contingent on prior monitoring/evaluation.
Bold font indicates initial actions.
Underlined font indicates the second stage of actions (following partial restoration of flows).
Italic font indicates the final stage of actions (following full restoration of flow

Table 22. Restoration Plan Elements on JBLM

Project No. 040001, Pioneer Aggregates South Parcel Project, DuPont, Washington

Element	Components
2. Flow Restoration	
B. Beaver Management	Remove dam at east end of Edmond Marsh
	Clear culverrt at DuPont-Steilacoom Road and install beaver exclusion device
C. Adjustment of Sequalitchew Lake Levels	Install an additional stop log in weir or gate valve to allow for seasonal adjustment of lake water level
D. Improvements in Lake Outlet Area (Part 1)	Planning for removal of crossover culverts
	Repair cross-over culverts by replacing the bottom set and replacing the top set with an open channel. Remove some fill to increase channel width and reduce obstructions
3. Flow Maintenance and Enhancement	
E. Hamer Marsh	Install weir at outlet
	Study water quality in Hamer Marsh
	Repair culvert between Hamer Marsh and Edmond Marsh if water quality is adequate
4. Habitat Restoration	
K. Improvements in Lake Outlet Area (Part 2)	Repair Lake Outlet Area by relocating diversion weir a few hundred feet downstream then improving wetland area behind it by removing old weir and secondary weir, extending lower set of cross-over culverts, removing fill, and regrading and planting wetland vegetation.

FIGURES



Vicinity Map

Pioneer Aggregates South Parcel Project
CalPortland
DuPont, Washington

Aspect CONSULTING	FEB-2022	BY: ETB / WEG	FIGURE NO. 1
	PROJECT NO. 040001-018	REVISED BY: NLK	

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GIS Path: G:\projects\Dupont\DuPont\DuPontSouthParcel_040001\Delivered\Earth and Water Resources Report\01 Vicinity Map.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 2/24/2022 || User: nkochle || Print Date: 2/24/2022

GIS Path: G:\projects\Dupont\DuPont\DuPontSouthParcel_040001\Delivered\Earth and Water Resources Report\02 Project Site Plan.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 2/17/2022 || User: nkochie || Print Date: 2/17/2022

N

Puget Sound

Infiltration Ponds

Stormwater Treatment Ponds

Processing Area

Proposed Constructed Mitigation Wetland

Existing Mine

Infiltration Pond

Stormwater Treatment Ponds

South Parcel Project

Noise/Visual Screening Berm

Sequalitchew Creek

CENTER DRIVE

- Existing Mine Limit
- Ponds
- South Parcel
- Proposed Constructed Mitigation Wetland
- South Parcel Project Area
- Pierce County Tax Parcel
- 10-ft. Contour
- Proposed Mine 25-ft Contour

Note: Existing topography based on aerial photogrammetric survey conducted on 10/30/2021 by David C. Smith & Associates, Inc. Vertical datum = NGVD29

0 600 1,200
Feet

Project Site Plan

Pioneer Aggregates South Parcel Project
CalPortland
DuPont, Washington

Aspect Consulting	FEB-2022	BY: ETB / WEG	FIGURE NO. 2
	PROJECT NO. 040001-18	REVISED BY: NLK	

No Action Site Plan

Pioneer Aggregates South Parcel Project
CalPortland
DuPont, Washington

Aspect CONSULTING	FEB-2022	BY: ETB / WEG	FIGURE NO. 3
	PROJECT NO. 040001-18	REVISED BY: NLK	

GIS Path: G:\projects\Dupont\DuPont\DuPontSouthParcel_040001\Delivered\Earth and Water Resources Report\03 No Action Site Plan.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 2/24/2022 || User: nkochie || Print Date: 2/24/2022

Existing Mine Limit
South Parcel
South Parcel Project Area
Pierce County Tax Parcel
20-ft. Contour

Note: Existing topography based on aerial photogrammetric survey conducted on 10/30/2021 by David C. Smith & Associates, Inc. Vertical datum = NGVD29

0 600 1,200
Feet

Existing Topography

Pioneer Aggregates South Parcel Project
CalPortland
DuPont, Washington

Aspect CONSULTING	FEB-2022	BY: ETB / WEG	FIGURE NO. 4
	PROJECT NO. 040001-18	REVISED BY: NLK	

GIS Path: G:\projects\Dupont\DuPont\DuPontSouthParcel_040001\Delivered\Earth and Water Resources Report\04 Existing Topography.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 2/24/2022 || User: nkochle || Print Date: 2/24/2022

GIS Path: G:\projects\Dupont\DuPont\DuPontSouthParcel_040001\Delivered\Earth and Water Resources Report\05 Site Explorations Map.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 2/17/2022 || User: nkochie || Print Date: 2/17/2022

Puget Sound

0B-1
TW-1
NW013
NW018
NW025
NW023
NW024
WY014
WY018
WY016
WY024
WY022
WY023
WY063
WY010
WY015
WY019
WY020
WY025
WY028
WY061
84-PA-264
WY062
WY009
WY011
WY027
WY021
WY017
WY057
WY087
WY088
WY126
WY127
WY013
WY008
WY012
WY026
WY059
WY058
WY073
WY030
WY089
WY066
WY128
WY005
WY007
WY074
WY078
WY060
WY056
WY072
WY093
WY081
WY083
WY124
CHMW-2S
CHTW-2
TW-2
WY004
WY006
WY075
WY076
WY077
WY079
WY080
WY055
WY064
WY082
WY129
WY039
WY041
WY042
WY045
WY112
WY110
WY071
WY070
WY067
WY068
WY111
WY114
WY040
WY044
WY048
WY047
WY103
WY104
WY117
WY116
WY113
WY043
WY046
WY049
WY101
WY102
WY118
WY122
WY123
TW-1
CHMW-1
WY052
WY100
WY050
WY119
WY121
WY035
WY053
TW-3
WY099
WY105
WY107
WY036
WY037
WY051
CHMW-3S
CHTW-3
CHMW-3D
TW-4S
WY108
WY106
WY120
WY032
CHMW-4S
WY038
TW-4D
CHTW-4D
Sequalitchew Creek

0 500 1,000
Feet

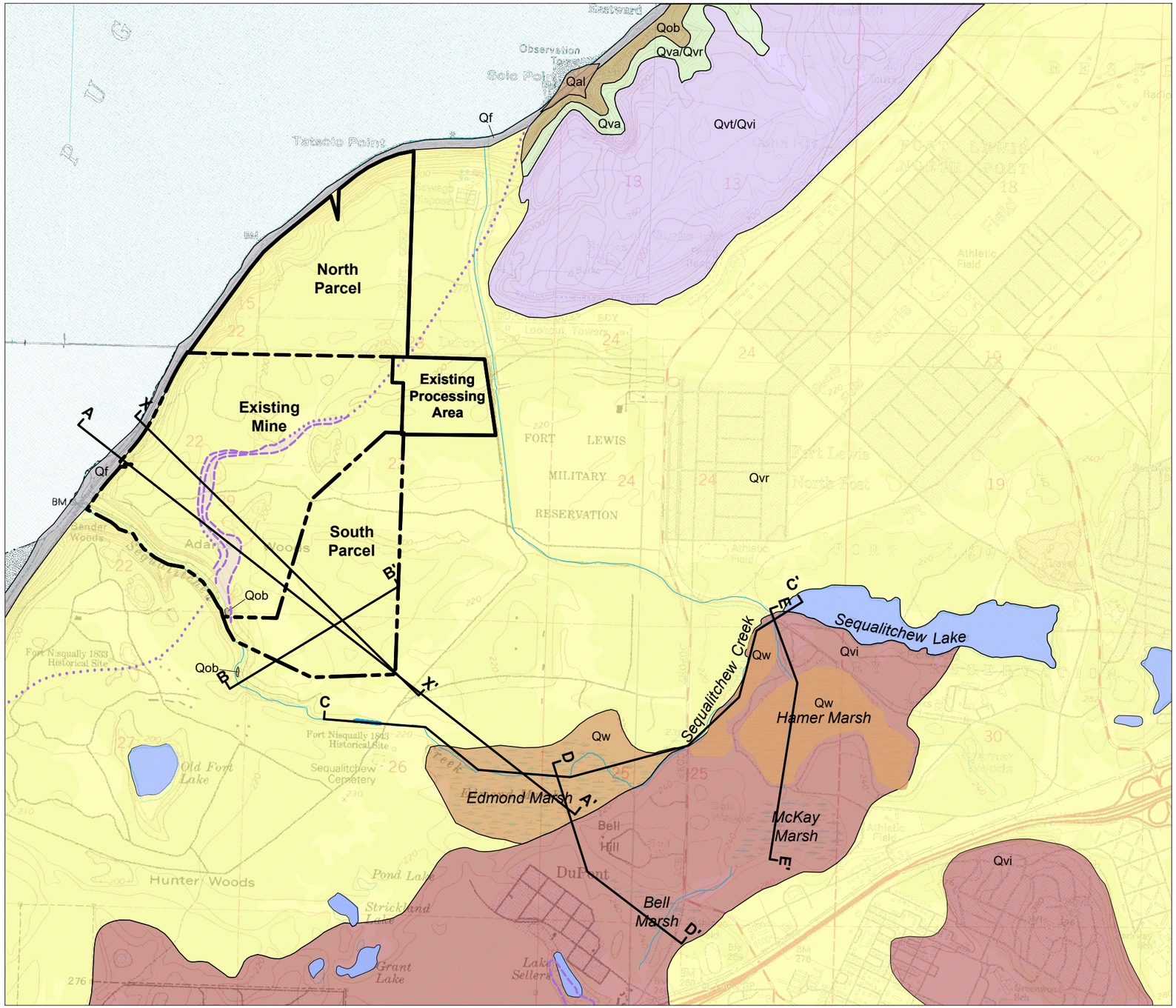
- Boring
- Monitoring Well
- Test Well
- Water Supply Well
- South Parcel Project Area
- South Parcel

Note: Existing topography based on aerial photogrammetric survey conducted on 10/30/2021 by David C. Smith & Associates, Inc.

Site Explorations Map

Earth and Water Resources Report
Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect Consulting	FEB-2022	BY: ETB / WEG	FIGURE NO. 5
	PROJECT NO. 040001-I-018-02	REVISED BY: ---	



Legend

- **Qf (Fill)** — Artificial fill. Likely consists primarily of crushed rock and rip-rap placed for railroad embankment.
- **Qw (Wetland Deposits)** — Peat, organic-rich muck, silt and clay.
- **Qal (Recent Alluvium)** — Silt, sand, gravel, and peat deposited in stream beds and estuaries, includes some lacustrine and beach deposits.
- **Qvr (Vashon Recessional Glacial Outwash)** — Medium dense to dense, slightly silty to clean sand and gravel. Includes some silty beds. The majority of near-surface Vashon recessional outwash on the Project Site is made up of the Steilacoom Gravel member, which is composed of sandy gravel and gravelly sand, with minor amounts of silt.
- **Qvi (Ice-Contact Deposits)** — Water-worked sands and gravels with interbeds and lenses of silty, till-like deposits.
- **Qvt/Qvi (Till and Ice Contact Deposits)** — Dense to very dense discontinuous layers of silty, sandy, and gravelly basal till. Ice contact deposits contain water-worked sands and gravels with interbeds and lenses of silty, till-like deposits.
- **Qva (Vashon Advance Glacial Outwash)** — Sand and gravel, and lacustrine clay, silt, and sand of northern source, deposited during Vashon glacial advance.
- **Qob (Olympia Beds)** — The Olympia Beds Qob unit is generally composed of interbedded lacustrine silt and clay and fluvial deposits.
- **Olympia Beds Truncation (Surface Projection)** — Approximate surface projection line showing the northwestward lateral subcrop extent of the Olympia Beds unit. Dashed where approximate, dotted where inferred.

Note: Map modified based on subsurface data and geologic interpretation from Walsh, Logan and Polenz 2003; Walsh et al. 2003, Walters and Kimmel, 1968, and Troost, Booth, and Borden, in review.

N

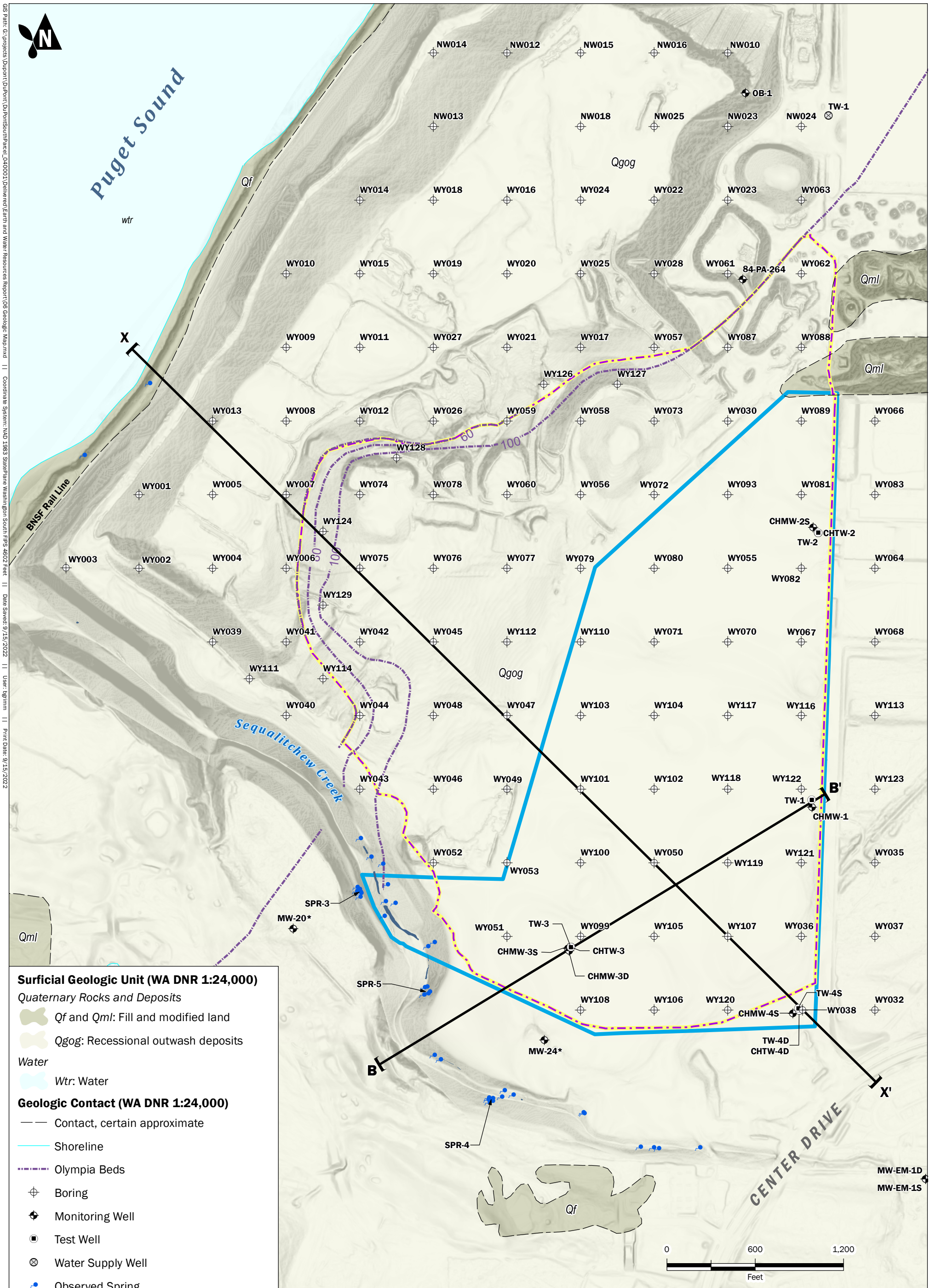
0 2000 4000
Feet

Regional Geologic Map

Earth and Water Resources Report
Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect Consulting	Oct-2022	BY: DFR/SCC	FIGURE NO. 6
	PROJECT NO. 040001-I-018	REV BY: OGR/SCC	

CAD Path: Q:\CalPortland\040001 DuPont Hydrologic Study\2022-10 Earth and Water Resources Report\040001-05 Geologic Map.dwg 05 Regional Geologic Map 11x17 L || Date Saved: Oct 25, 2022 3:31pm || User: scudd



Surficial Geologic Unit (WA DNR 1:24,000)

Quaternary Rocks and Deposits

- *Qf* and *Qml*: Fill and modified land
- *Qgog*: Recessional outwash deposits

Water

- *Wtr*: Water

Geologic Contact (WA DNR 1:24,000)

- Contact, certain approximate
- Shoreline
- Olympia Beds
- Boring
- Monitoring Well
- Test Well
- Water Supply Well
- Observed Spring
- Observed Seepage Area
- Generalized Geologic Cross-Section
- South Parcel Project Area
- South Parcel

Notes:
- Existing topography based on aerial photogrammetric survey conducted on 10/30/2021 by David C. Smith & Associates, Inc.
* Locations of MW-20 and MW-24 are approximate.

Project Geologic Map

Earth and Water Resources Report
Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect Consulting	SEP-2022	BY: ETB / WEG	FIGURE NO. 7
	PROJECT NO. 040001-I-018-02	REVISED BY: ETB / SJG / WEG	

GIS Path: G:\projects\Dupont\DuPont\DuPontSouthParcel_040001\Delivered\Earth and Water Resources Report\06 Geologic Map.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 9/15/2022 || User: bgrimm || Print Date: 9/15/2022

X Northwest — Southeast X'

South Parcel Project

Existing Mine | Re-Mine Area | Mine Expansion Area

Elevation in Feet (NGVD 29)

Puget Sound

BNSF Rail Line

Olympia Beds Truncation

Existing Mine Pit

Center Drive

WY013 WY07 WY0124 WY075 WY045 WY047 WY101 WY050 WY107 WY038 CHMW-4

Qf Qb Qvs Qvi Qgog/Qva Qob Qpog Qpon

Note: Topography from Pierce County LiDAR, 2011.

Legend

Qf	Fill	Qvi	Silty Lenses and/or Ice Contact Till-like Deposits
Qb	Beach and Shallow Marine Deposits	Qob	Olympia Beds
Qvs	Steilacoom Gravel Member of Vashon Recessional Outwash (Qgog)	Qpog	Pre-Olympia glacial Deposits
Qgog/Qva	Vashon Recessional Outwash and/or Advance Outwash	Qpon	Pre-Olympia Non glacial Deposits

Existing Ground Surface
Proposed Mined Surface
Existing Groundwater Level
Explorations

0 600 1,200 Feet

Horizontal Scale (1" = 600')
Vertical Scale (1" = 60')
Vertical Exaggeration x 10

Generalized Geologic Cross Section X-X'

Earth and Water Resources Report
Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect Consulting	Oct-2022	BY: DHM/PMB/CMV	FIGURE NO. 8
	PROJECT NO. 040001	REV BY: CMV/OGR/SCC	

CAD Path: Q:\CalPortland\040001 DuPont Hydrologic Study\2022.10 Earth and Water Resources Report\040001-XX.dwg || Date Saved: 10/24/2022 2:36:50 PM || User: scudd

GIS Path: G:\projects\Dupont\DuPont\DuPontSouthParcel_040001\Delivered\Earth and Water Resources Report\08 Geologic Hazards Map - Existing Conditions.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 2/24/2022 || User: nkochie || Print Date: 2/24/2022

Puget Sound

Oversteepened slope from historical mining

Active Railroad Corridor

Active Mining Slope

West Slope

East Slope

Reclaimed Slopes

Sequalitchew Creek

Approximate contact with a permeable sediment over an impermeable sediment

Localized Cut and Fill Slopes for Old Rail Grade

Old Rail Grade/ Sequalitchew Creek Trail

100

200

300

0 500 1,000

Feet

Note: Existing topography of the mined based on aerial photogrammetric survey conducted on 10/30/2021 by David C. Smith & Associates, Inc.

Existing topography in forested areas outside the existing mine (e.g., South Parcel, Sequalitchew Creek Ravine, and Puget Sound bluffs) is based on 2011 LiDAR topography from the Puget Sound LiDAR Consortium.

Aerial photograph dated 10/30/2021.

Vertical Datum = NGVD 29

- Geologically Hazardous Area
- Slope 40% or Greater
- Slope Between 15% and 40%
- Observed Spring
- Observed Seepage Area
- South Parcel
- Clearing Limits for Mine Expansion
- South Parcel Project Area
- 20-ft. Contour
- Watercourse Centerline (WA DNR)
- Pierce County Tax Parcel

Geologic Hazards Map Existing Conditions

Earth and Water Resources Report
Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect Consulting	FEB-2022	BY: ETB / MAV / WEG	FIGURE NO. 9
	PROJECT NO. 040001-I-018-02	REVISED BY: NLK	

GIS Path: G:\projects\Dupont\DuPont\DuPontSouthParcel_040001\Delivered\Earth and Water Resources Report\09 Geologic Hazards Map - Proposed Conditions.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 2/24/2022 || User: nkochie || Print Date: 2/24/2022

Puget Sound

Active Railroad Corridor

Reclaimed West Slope

East Slope

Proposed Constructed Mitigation Wetland

Sequalitchew Creek

Proposed Mine Slopes (Graded into Pit) are not GHAs because they are engineered slopes and have been evaluated for stability.

Old Rail Grade/ Sequalitchew Creek Trail

Noise/Visual Screening Berm

Recommended Minimum 50-ft. Setback from Top of Sequalitchew Creek Ravine Slopes

0 500 1,000 Feet

- Geologically Hazardous Area
- Slope 40% or Greater
- Slope Between 15% and 40%
- Watercourse Centerline (WA DNR)
- Recommended Minimum 50-ft Setback
- Proposed Mine 25-ft Contour
- Proposed Mine 5-ft Contour
- South Parcel
- Clearing Limits for Mine Expansion
- South Parcel Project Area
- Pierce County Tax Parcel

Note: Existing topography of the mined based on aerial photogrammetric survey conducted on 10/30/2021 by David C. Smith & Associates, Inc.

Existing topography in forested areas outside the existing mine (e.g., South Parcel, Sequalitchew Creek Ravine, and Puget Sound bluffs) is based on 2011 LiDAR topography from the Puget Sound LiDAR Consortium.

Aerial photograph dated 10/30/2021.

Vertical Datum = NGVD 29

Geologic Hazards Map
Proposed Conditions

Earth and Water Resources Report
Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect Consulting	FEB-2022	BY: ETB / MAV / WEG	FIGURE NO. 10
	PROJECT NO. 040001-I-018-02	REVISED BY: SCC / EAC / NLK	

GIS Path: G:\projects\Dupont\DuPont\DuPontSouthParcel_040001\Delivered\Earth and Water Resources Report\10 Slope Stability Sections.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 2/24/2022 || User: nkochie || Print Date: 2/24/2022

Puget Sound

Static FOS = 2.92
Seismic FOS = 1.30

Static FOS = 1.69
Seismic FOS = 1.17

Static FOS = 2.01
Seismic FOS = 1.14

Static FOS = 2.53
Seismic FOS = 1.19

Sequalitchew Creek

0 500 1,000
Feet

Slope Stability Section
Factors of Safety (FOS) from slope stability analysis are indicated alongside each section, see Table 1 in Section 2.2.

Geotechnical Recommended 50-ft Setback from Top of Slope

Olympia Beds

South Parcel Project Area

South Parcel

Proposed Mine 25-ft Contour

20-ft Contour

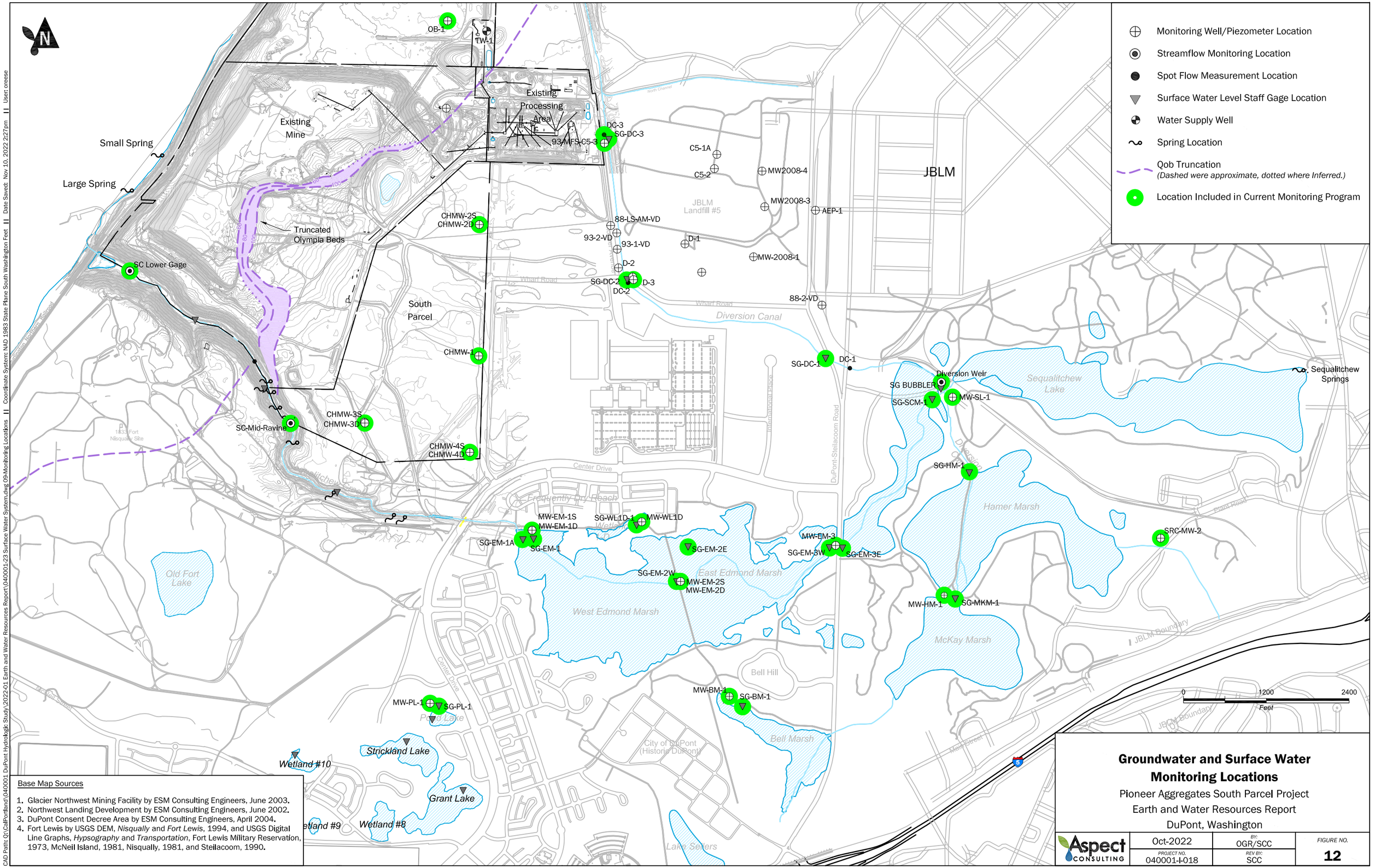
Pierce County Tax Parcel

Note: Existing topography based on aerial photogrammetric survey conducted on 10/30/2021 by David C. Smith & Associates, Inc. Vertical Datum = NGVD29

Slope Stability Sections
Proposed Conditions

Earth and Water Resources Report
Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect Consulting	FEB-2022	BY: CRS / WEG	FIGURE NO. 11
	PROJECT NO. 040001-I-018-02	REVISED BY: ETB / WEG / NLK	



Base Map Sources

1. Glacier Northwest Mining Facility by ESM Consulting Engineers, June 2003.
2. Northwest Landing Development by ESM Consulting Engineers, June 2002.
3. DuPont Consent Decree Area by ESM Consulting Engineers, April 2004.
4. Fort Lewis by USGS DEM, *Nisqually* and *Fort Lewis*, 1994, and USGS Digital Line Graphs, *Hypsography* and *Transportation*, Fort Lewis Military Reservation, 1973, McNeil Island, 1981, Nisqually, 1981, and Steilacoom, 1990.

Groundwater and Surface Water Monitoring Locations

Pioneer Aggregates South Parcel Project
Earth and Water Resources Report
DuPont, Washington

Aspect Consulting	Oct-2022	BY: OGR/SCC	FIGURE NO. 12
	PROJECT NO. 040001-I-018	REV BY: SCC	

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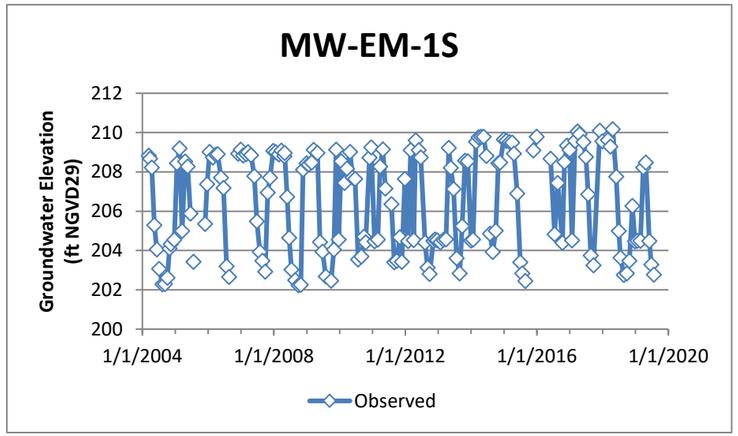
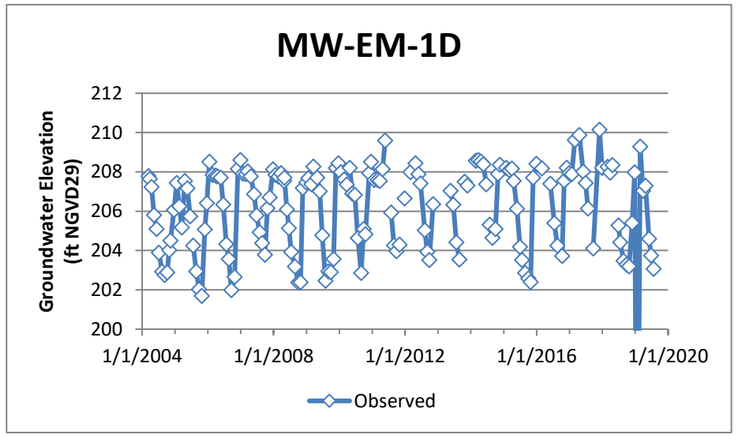
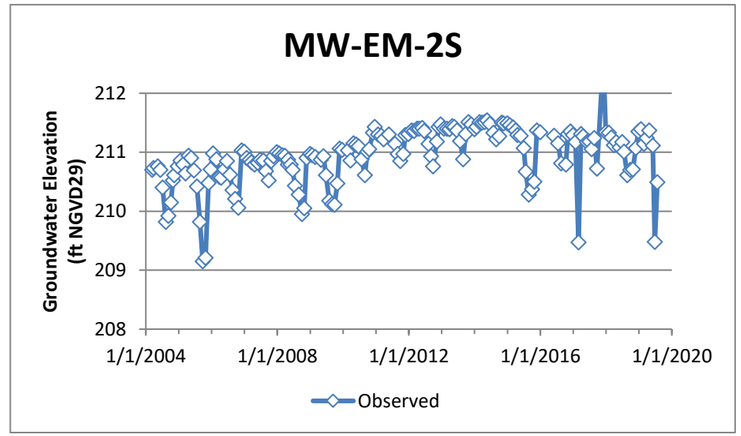
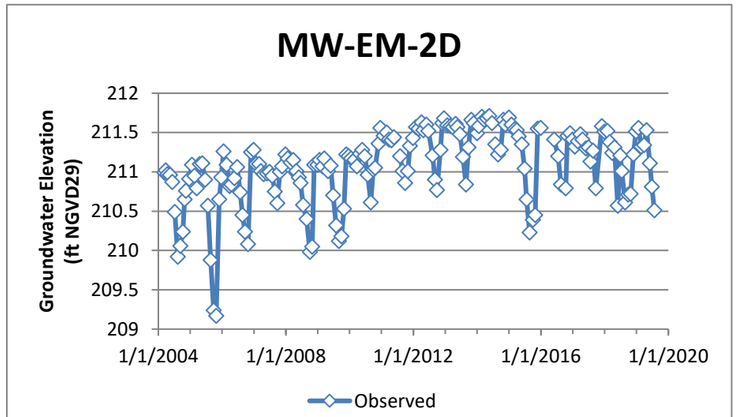
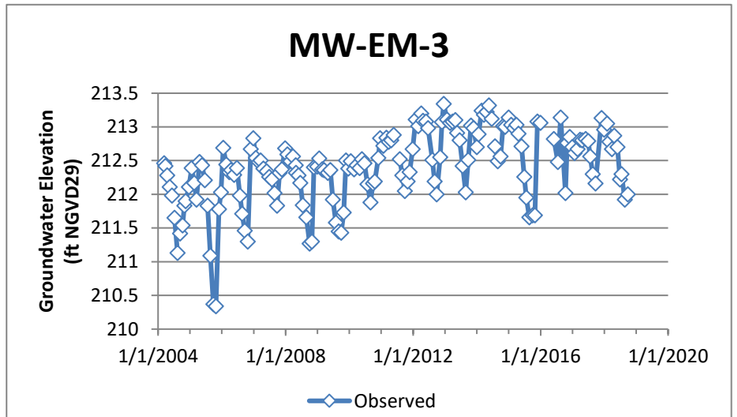
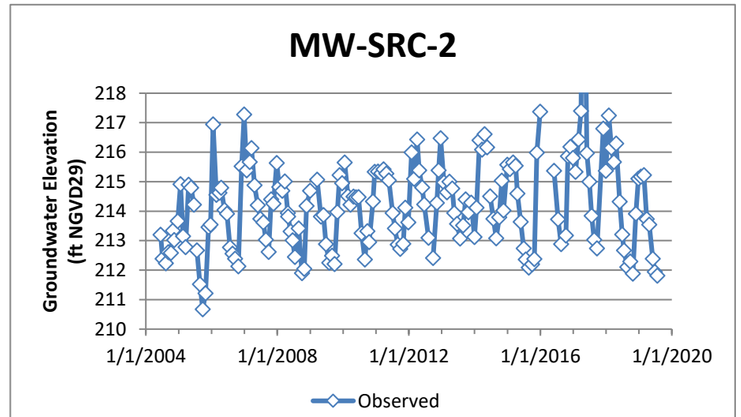


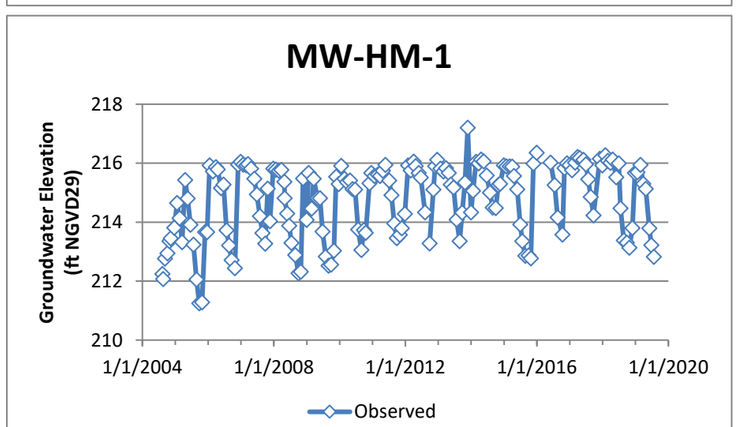


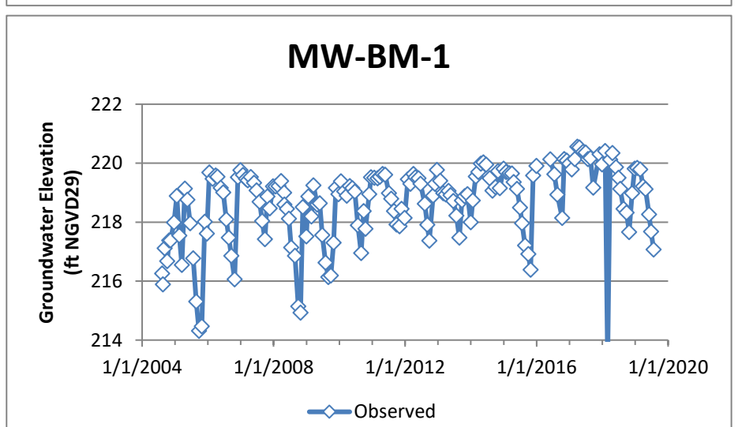


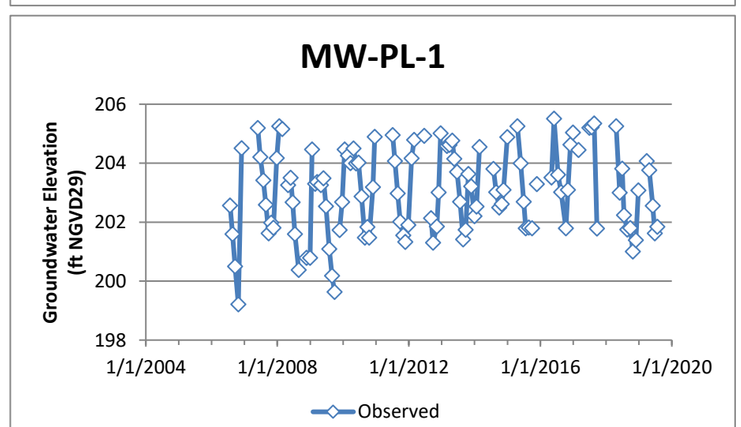






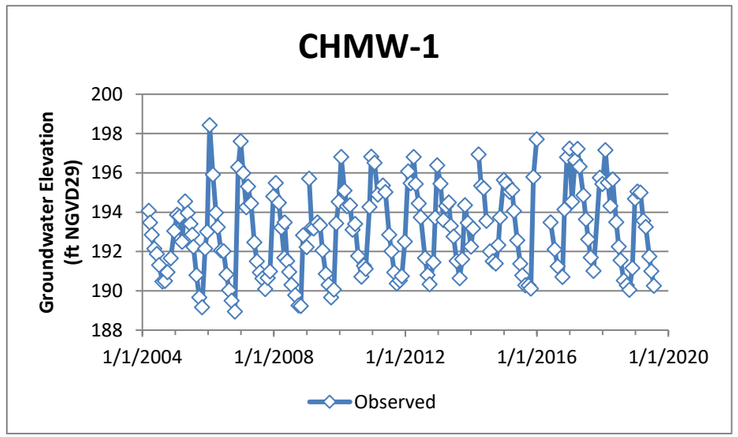


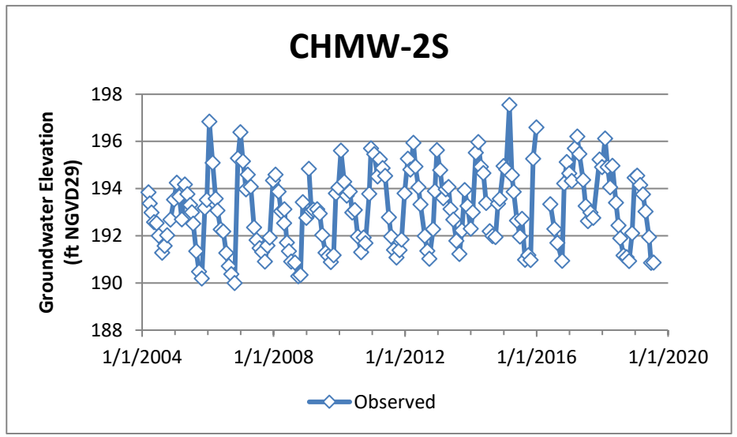


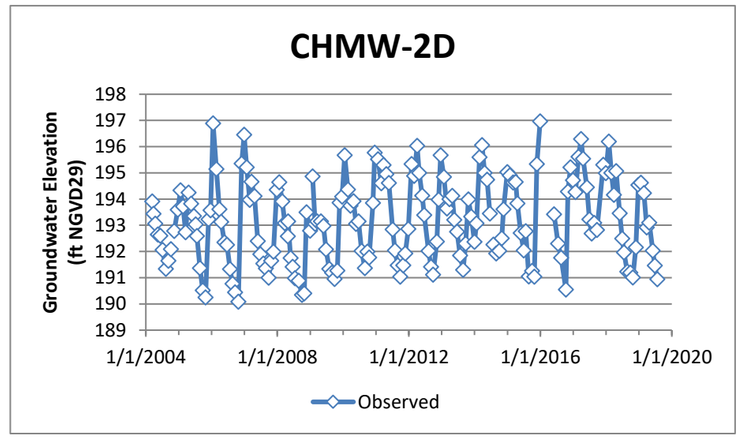


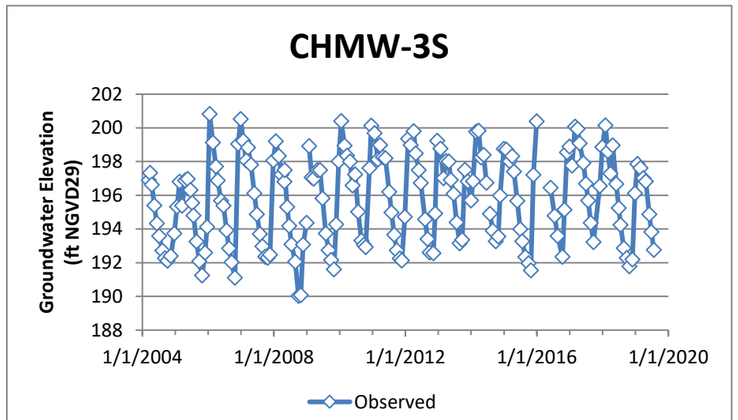
Aspect Consulting, LLC
1/27/2022
S:\CalPortland\DuPont\South Parcel\Groundwater Modeling\DRAFT_20170327\StatusUpdate_20211122.xlsm

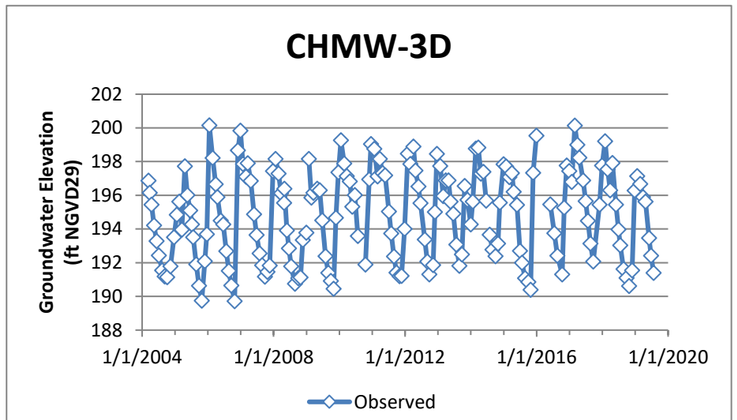
Figure 13
Observed Groundwater Levels
Earth and Water Resources Report

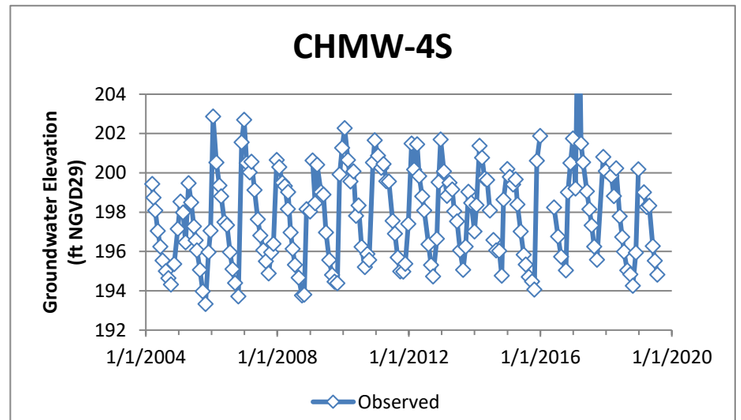

CHMW-1
Groundwater Elevation (ft NGVD29)
200
198
196
194
192
190
188
1/1/2004
1/1/2008
1/1/2012
1/1/2016
1/1/2020
Observed

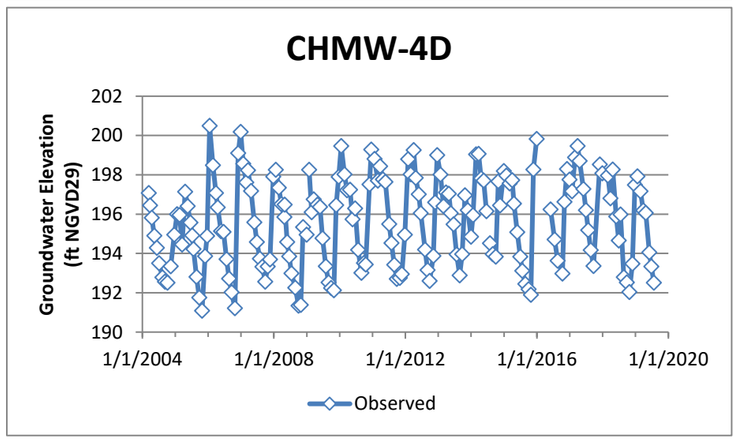

CHMW-2S
Groundwater Elevation (ft NGVD29)
198
196
194
192
190
188
1/1/2004
1/1/2008
1/1/2012
1/1/2016
1/1/2020
Observed

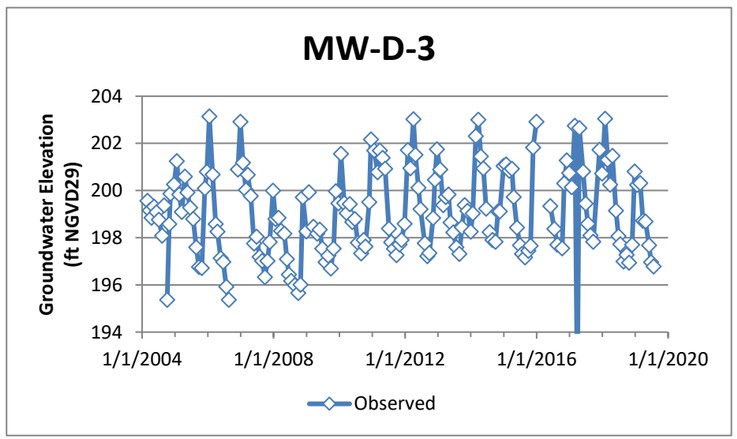

CHMW-2D
Groundwater Elevation (ft NGVD29)
198
197
196
195
194
193
192
191
190
189
1/1/2004
1/1/2008
1/1/2012
1/1/2016
1/1/2020
Observed

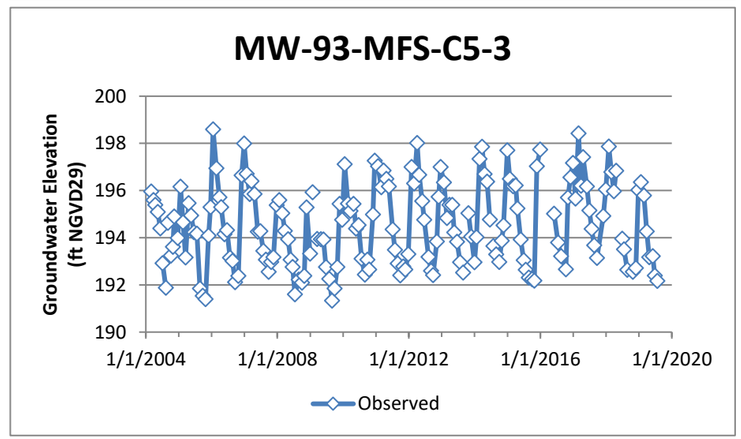

CHMW-3S
Groundwater Elevation (ft NGVD29)
202
200
198
196
194
192
190
188
1/1/2004
1/1/2008
1/1/2012
1/1/2016
1/1/2020
Observed

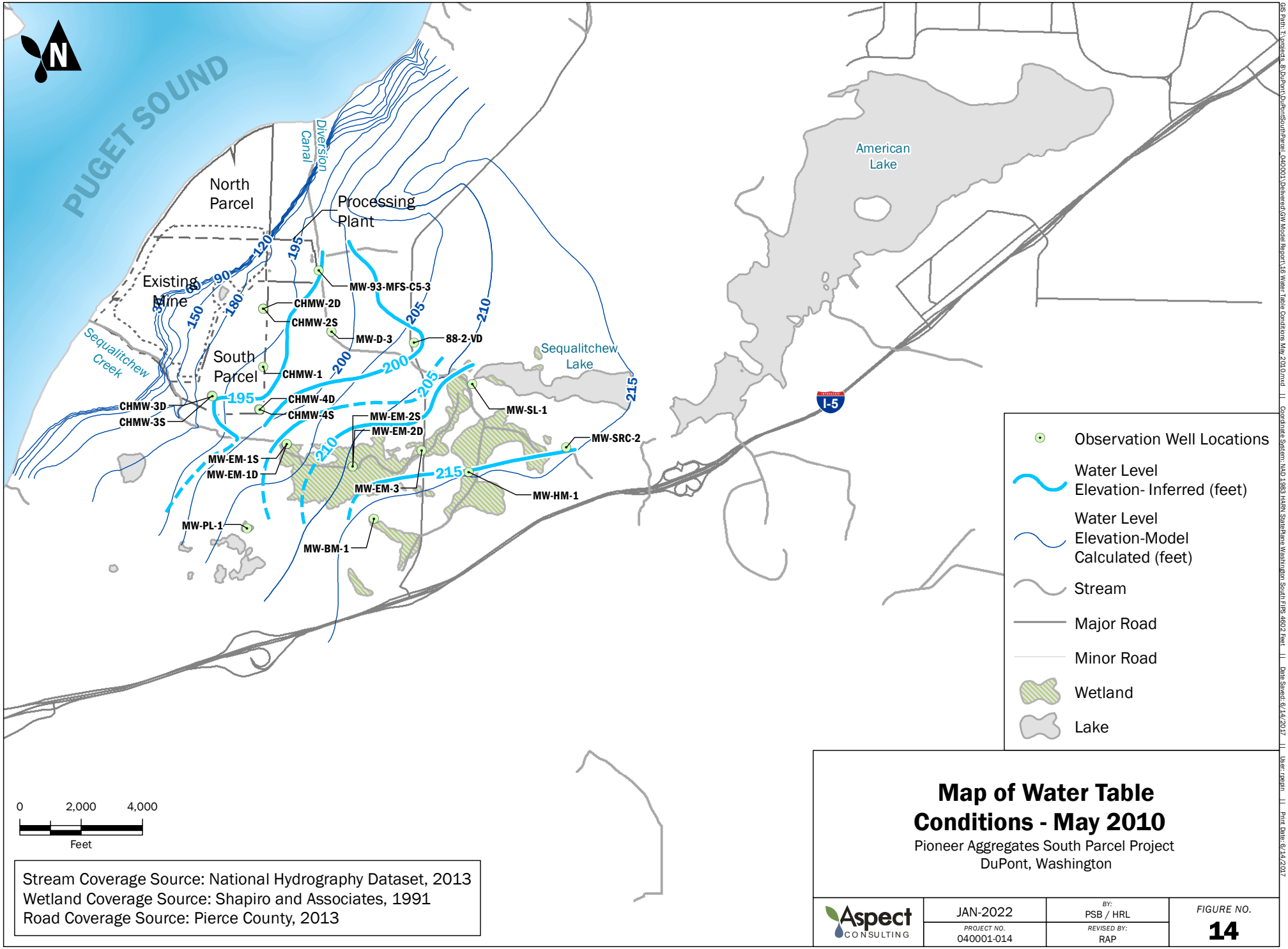

CHMW-3D
Groundwater Elevation (ft NGVD29)
202
200
198
196
194
192
190
188
1/1/2004
1/1/2008
1/1/2012
1/1/2016
1/1/2020
Observed


CHMW-4S
Groundwater Elevation (ft NGVD29)
204
202
200
198
196
194
192
1/1/2004
1/1/2008
1/1/2012
1/1/2016
1/1/2020
Observed


CHMW-4D
Groundwater Elevation (ft NGVD29)
202
200
198
196
194
192
190
1/1/2004
1/1/2008
1/1/2012
1/1/2016
1/1/2020
Observed


MW-D-3
Groundwater Elevation (ft NGVD29)
204
202
200
198
196
194
1/1/2004
1/1/2008
1/1/2012
1/1/2016
1/1/2020
Observed


MW-93-MFS-C5-3
Groundwater Elevation (ft NGVD29)
200
198
196
194
192
190
1/1/2004
1/1/2008
1/1/2012
1/1/2016
1/1/2020
Observed

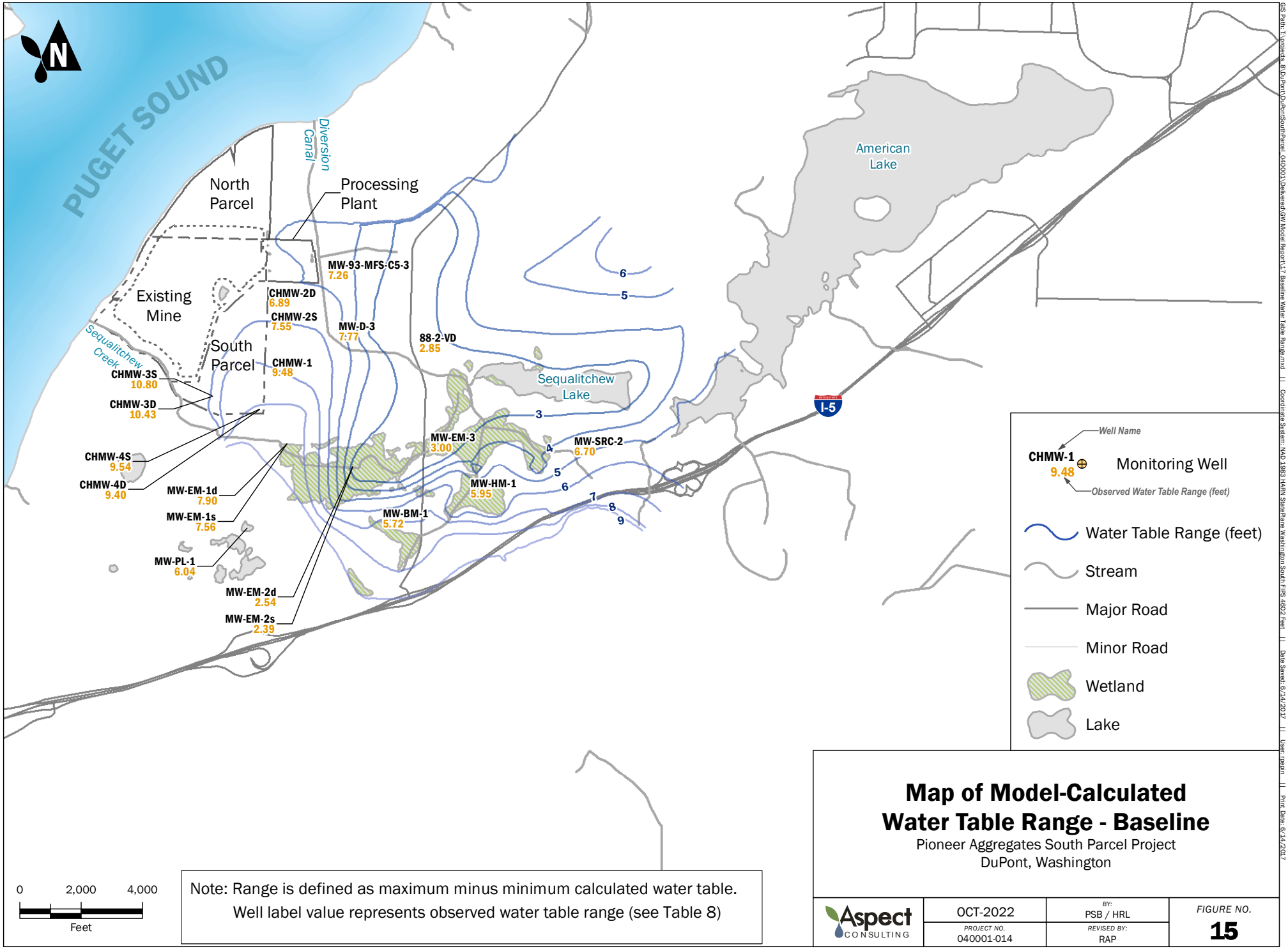


Map of Water Table Conditions - May 2010

Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect CONSULTING	JAN-2022	BY: PSB / HRL	FIGURE NO. 14
	PROJECT NO. 040001-014	REVISED BY: RAP	

GIS Path: T:\projects_8\DuPont\DuPontSouthParcel_040001\Delivered\GW Model Report\16 Water Table Conditions May 2010.mxd LL Coordinate System: NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet LL Date Saved: 6/14/2017 LL User: rpegin LL Print Date: 6/14/2017



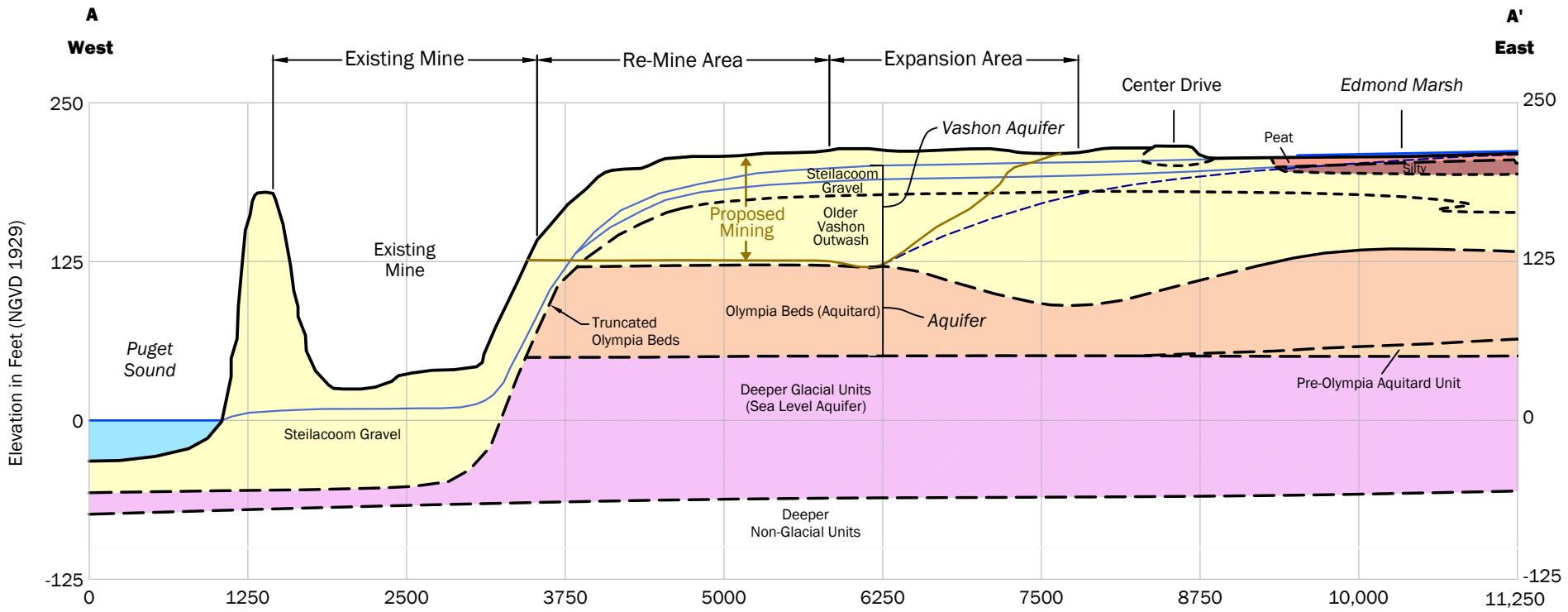
Note: Range is defined as maximum minus minimum calculated water table.
Well label value represents observed water table range (see Table 8)

Map of Model-Calculated Water Table Range - Baseline

Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect Consulting	OCT-2022	BY: PSB / HRL	FIGURE NO. 15
	PROJECT NO. 040001-014	REVISED BY: RAP	

GIS Path: T:\projects_8\DuPont\DuPontSouthParcel_040001\Delivered\GW Model Report\17 Baseline Water Table Range.mxd || Coordinate System: NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet || Date Saved: 6/14/2017 || User: rpain || Print Date: 6/14/2017



Legend

Existing Groundwater Table (range indicates seasonal variation)

Predicted Groundwater Table with South Parcel Project

Note: 10x Vertical vs. Horizontal Exaggeration for Illustration

Horizontal Scale: 0 — 1250 Feet

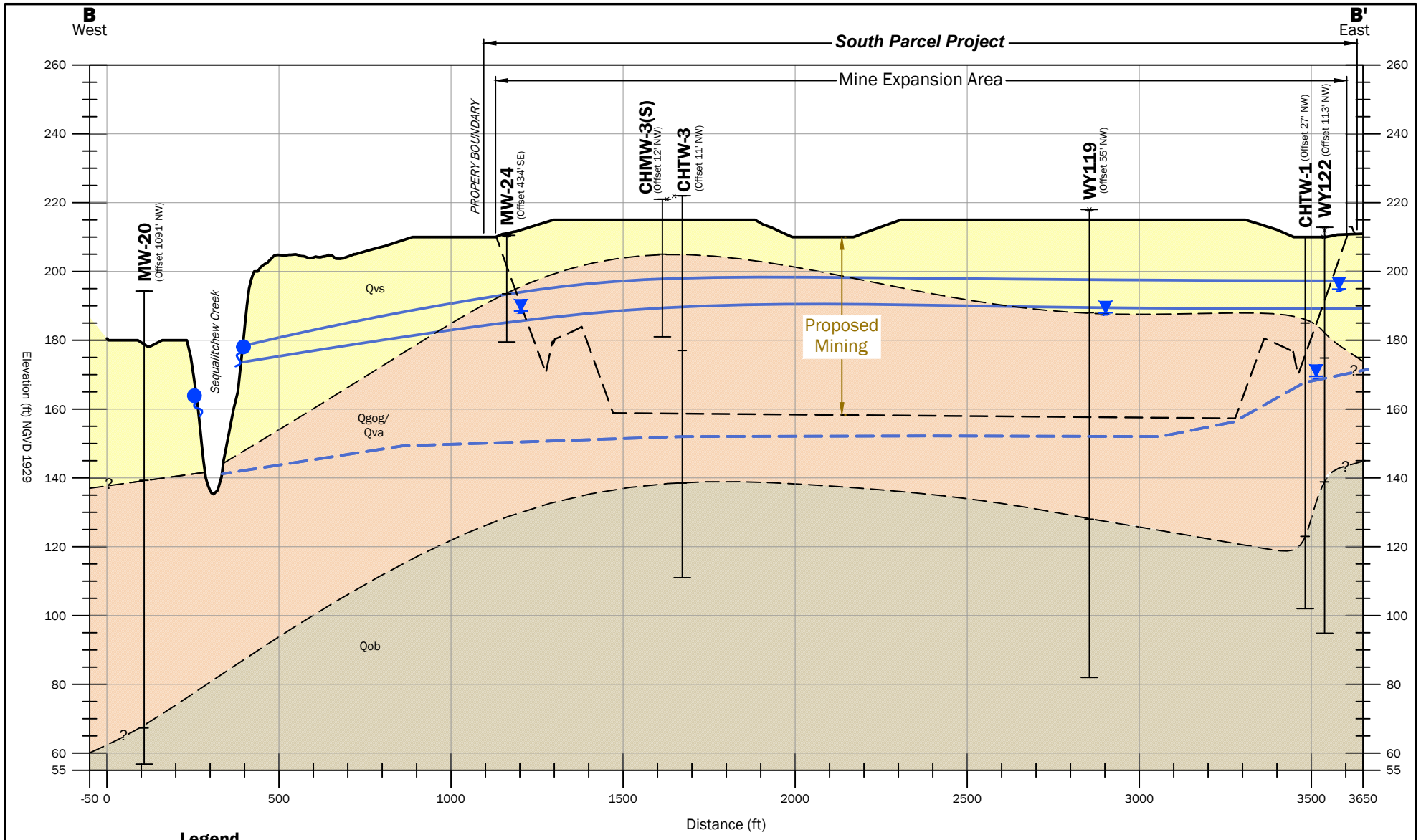
Vertical Scale: 0 — 125 Feet

Hydrogeologic Cross Section - A-A'

Pioneer Aggregates South Parcel Project
Earth and Water Resources Report
DuPont, Washington

Aspect Consulting	Feb-2022	BY: OGR/SCC/CMV	FIGURE NO. 16
	PROJECT NO. 040001-014	REVISED BY: -	

CAD Path: Q:\CalPortland\040001 DuPont Hydrologic Study\2022-01 Earth and Water Resources Report\040001-14 Hydrogeologic x-sec.dwg || Date Saved: 2/24/2022 12:48:27 PM || User: cvanslyke



Legend

- Geologic Contact
- ***Qvs*** — Steilacoom Gravel Member of Vashon Recessional Outwash
- ***Qgog/Qva*** — Vashon Recessional Outwash and/or Advance Outwash
- ***Qob*** — Olympia Beds
- Existing Water Level at Time of Drilling (ATD)
- Seep
- Existing Groundwater Table (range indicates seasonal variation)
- Predicted Groundwater Table with South Parcel Project

Horizontal Scale: 0 — 400 Feet

Vertical Scale: 0 — 40 Feet

Note: 10x Vertical vs. Horizontal Exaggeration for Illustration

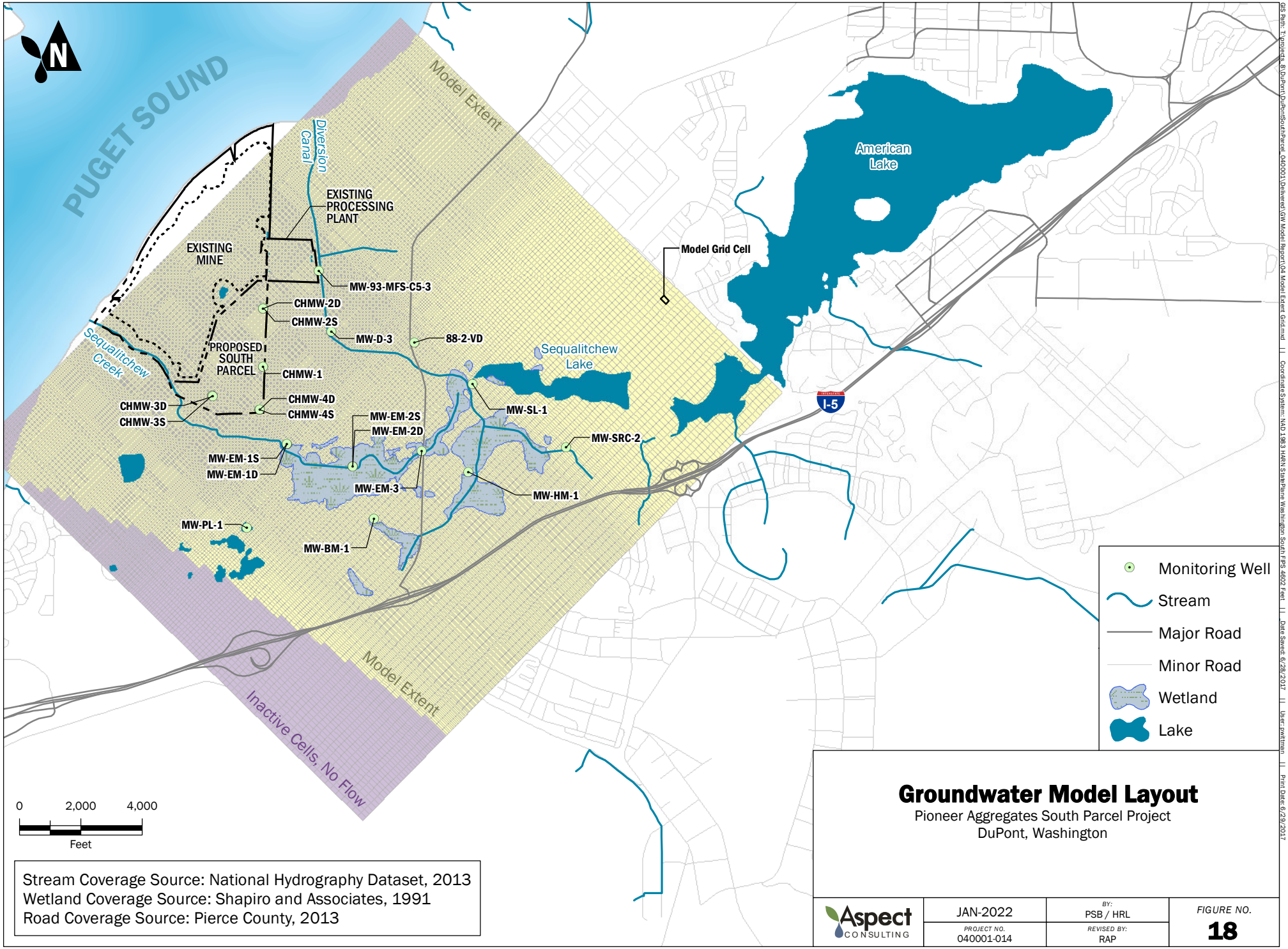
Source: Topography from Pierce County LiDAR, 2011.

Hydrogeologic Cross Section

Pioneer Aggregates South Parcel Project
Earth and Water Resources Report
DuPont, Washington

Aspect Consulting	Oct-2022	BY: ETB/CMV	FIGURE NO. 17
	PROJECT NO. 040001	REVISED BY: -	

CAD Path: Q:\CalPortland\040001 DuPont Hydrologic Study\2022-09 E&WR Report\040001-14A SecYY.dwg Layout: Section YY || Date Saved: 10/10/2022 3:25:46 PM || User: cvanslyke



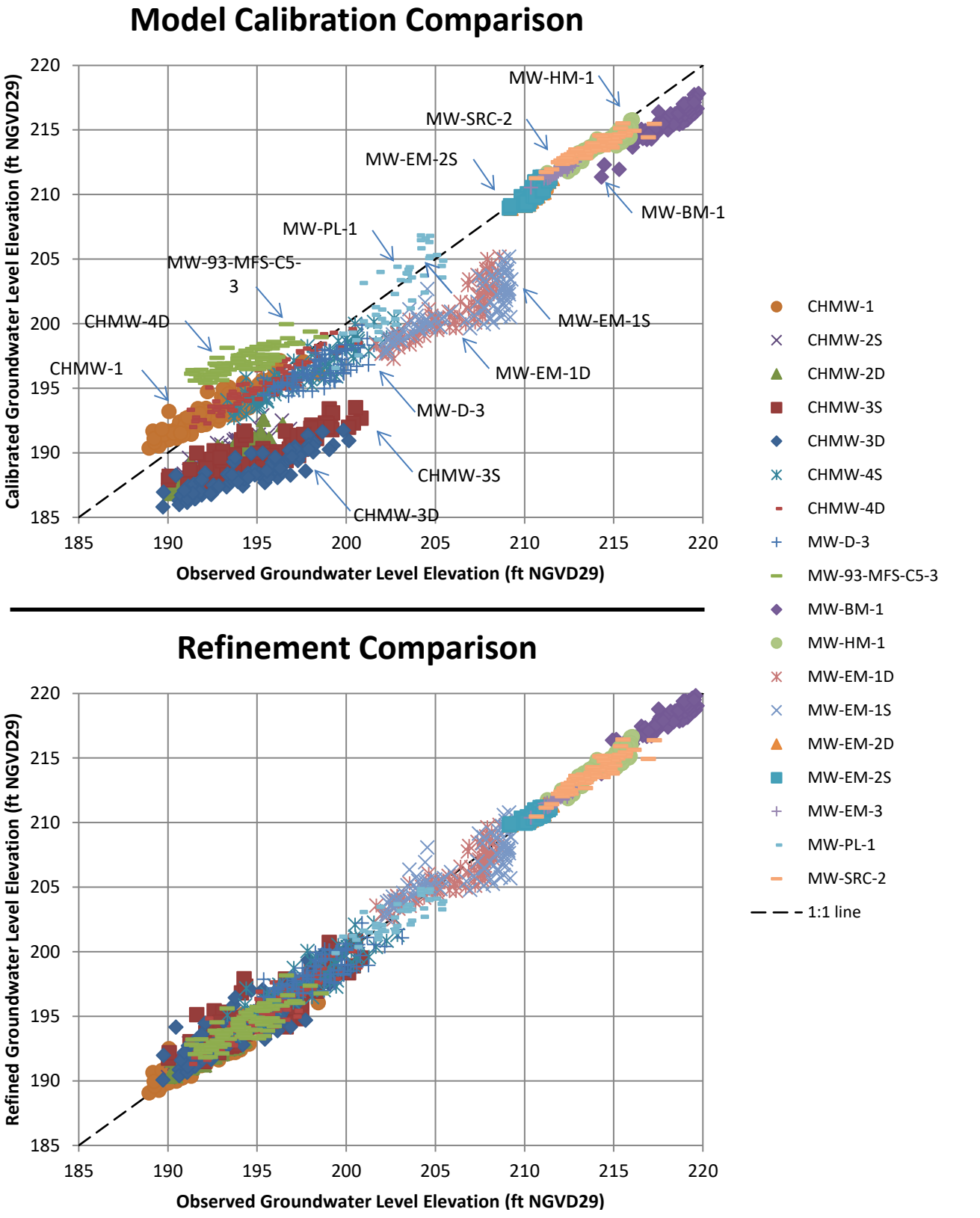
Stream Coverage Source: National Hydrography Dataset, 2013
Wetland Coverage Source: Shapiro and Associates, 1991
Road Coverage Source: Pierce County, 2013

Groundwater Model Layout

Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect CONSULTING	JAN-2022	BY: PSB / HRL	FIGURE NO. 18
	PROJECT NO. 040001-014	REVISED BY: RAP	

GIS Path: T:\projects_8\DuPont\DuPontSouthParcel_040001\Deliverest\GW Model Report\04 Model Extent Grid.mxd LL Coordinate System: NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet LL Date Saved: 6/28/2017 LL User: pwitman LL Print Date: 6/29/2017



Aspect Consulting, LLC

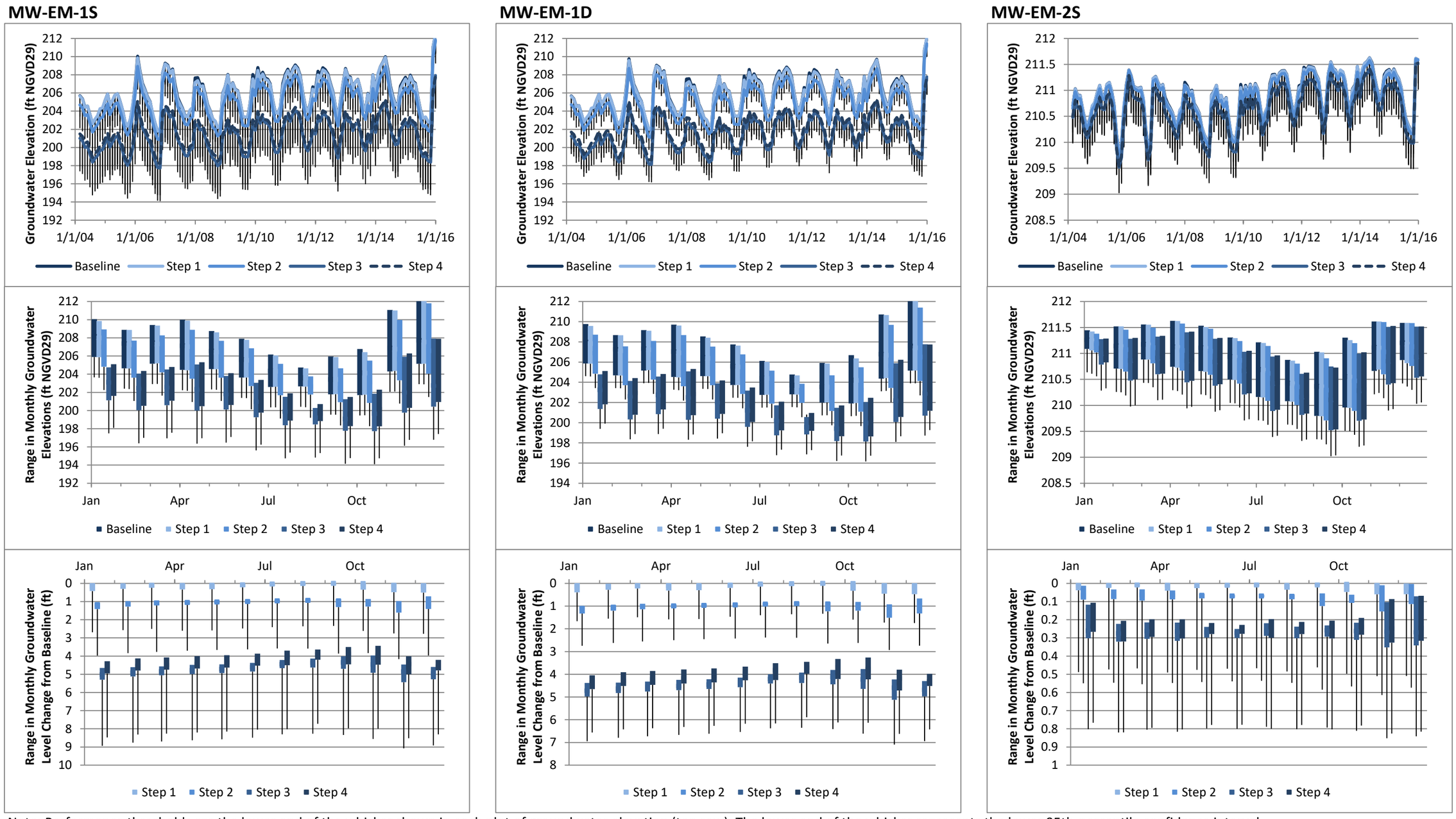
1/27/2022

S:\CalPortland\DuPont\South Parcel\Groundwater Modeling\DRAFT_20170327\StatusUpdate_20211122.xlsm

Figure 19

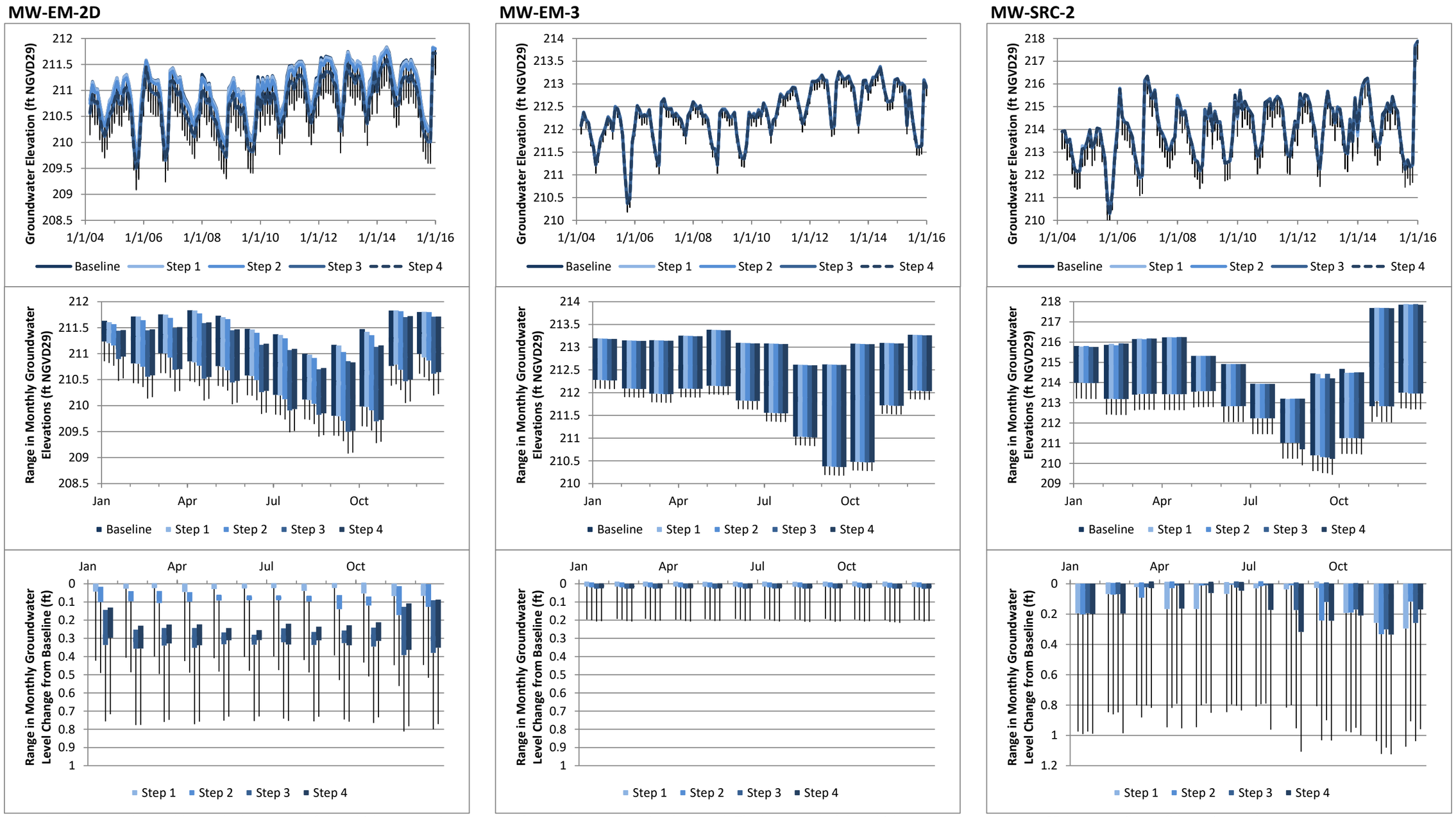
Comparison of Observed and Calculated Groundwater Levels

Earth and Water Resources Report



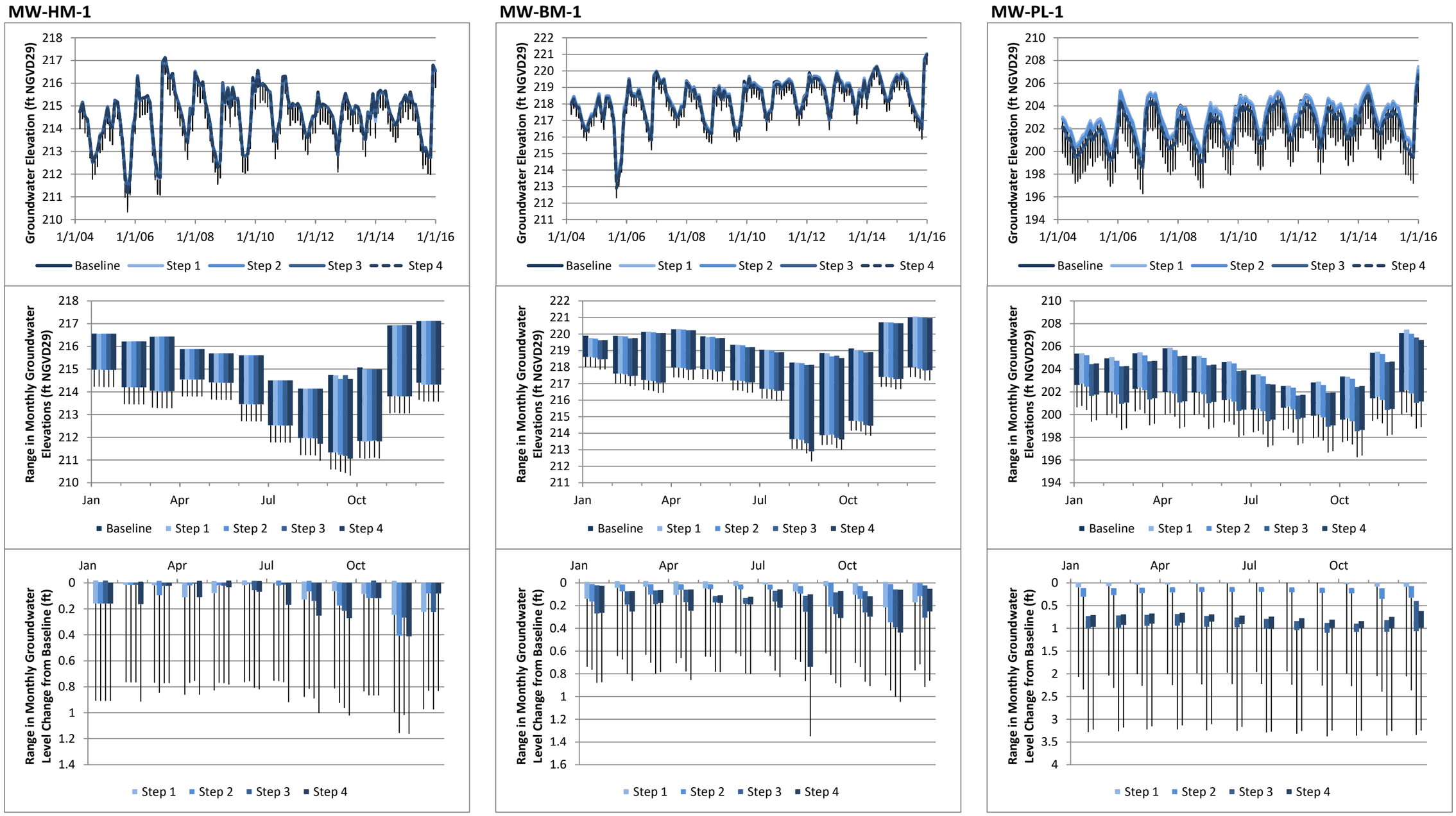
Note: Performance thresholds are the lower end of the whisker shown in each plot of groundwater elevation (top row). The lower end of the whisker represents the lower 95th-percentile confidence interval.

Figure 20
Predicted Changes and Ranges in Groundwater Levels
Earth and Water Resources Report



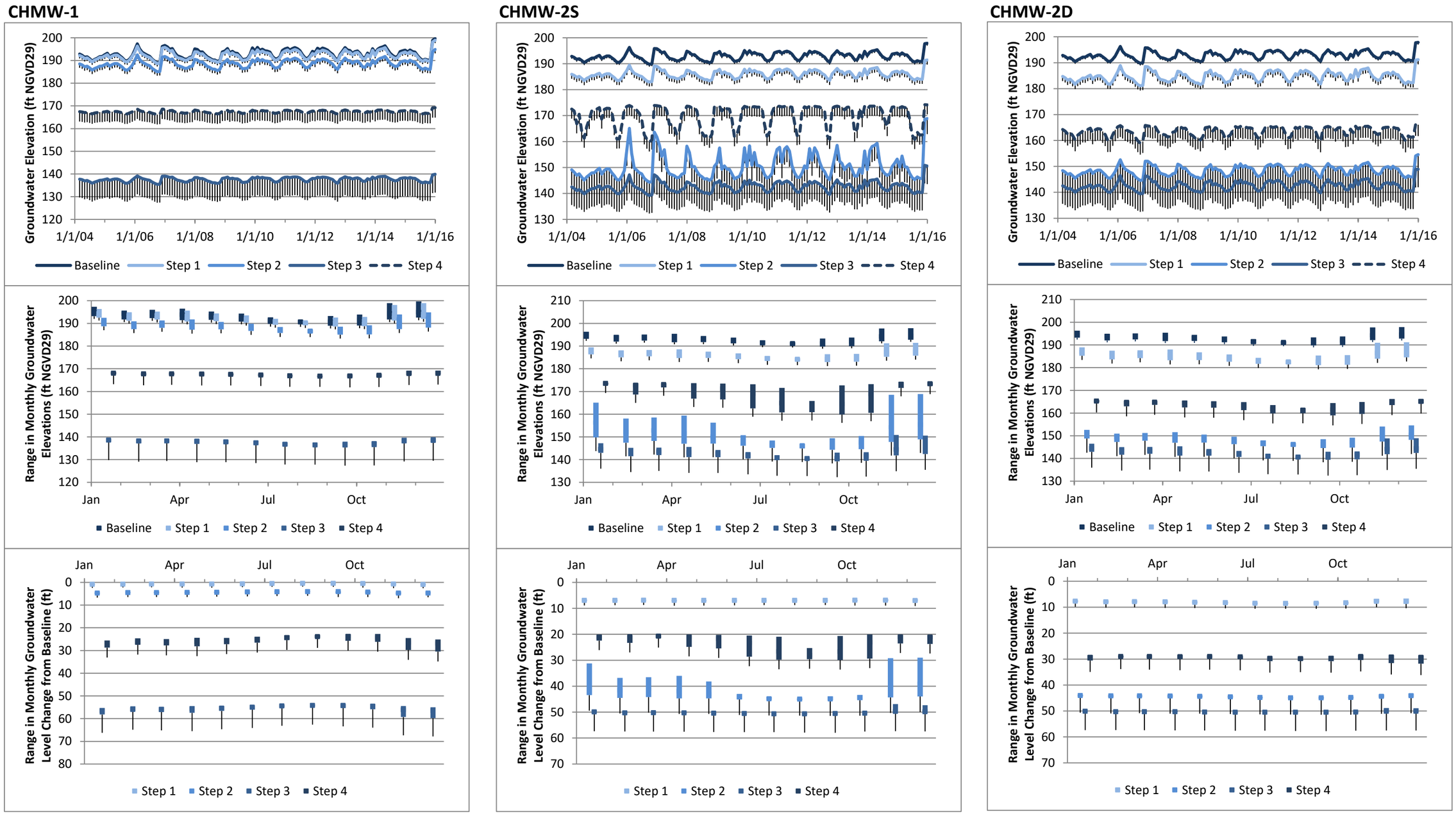
Note: Performance thresholds are the lower end of the whisker shown in each plot of groundwater elevation (top row). The lower end of the whisker represents the lower 95th-percentile confidence interval.

Figure 20
Predicted Changes and Ranges in Groundwater Levels
Earth and Water Resources Report



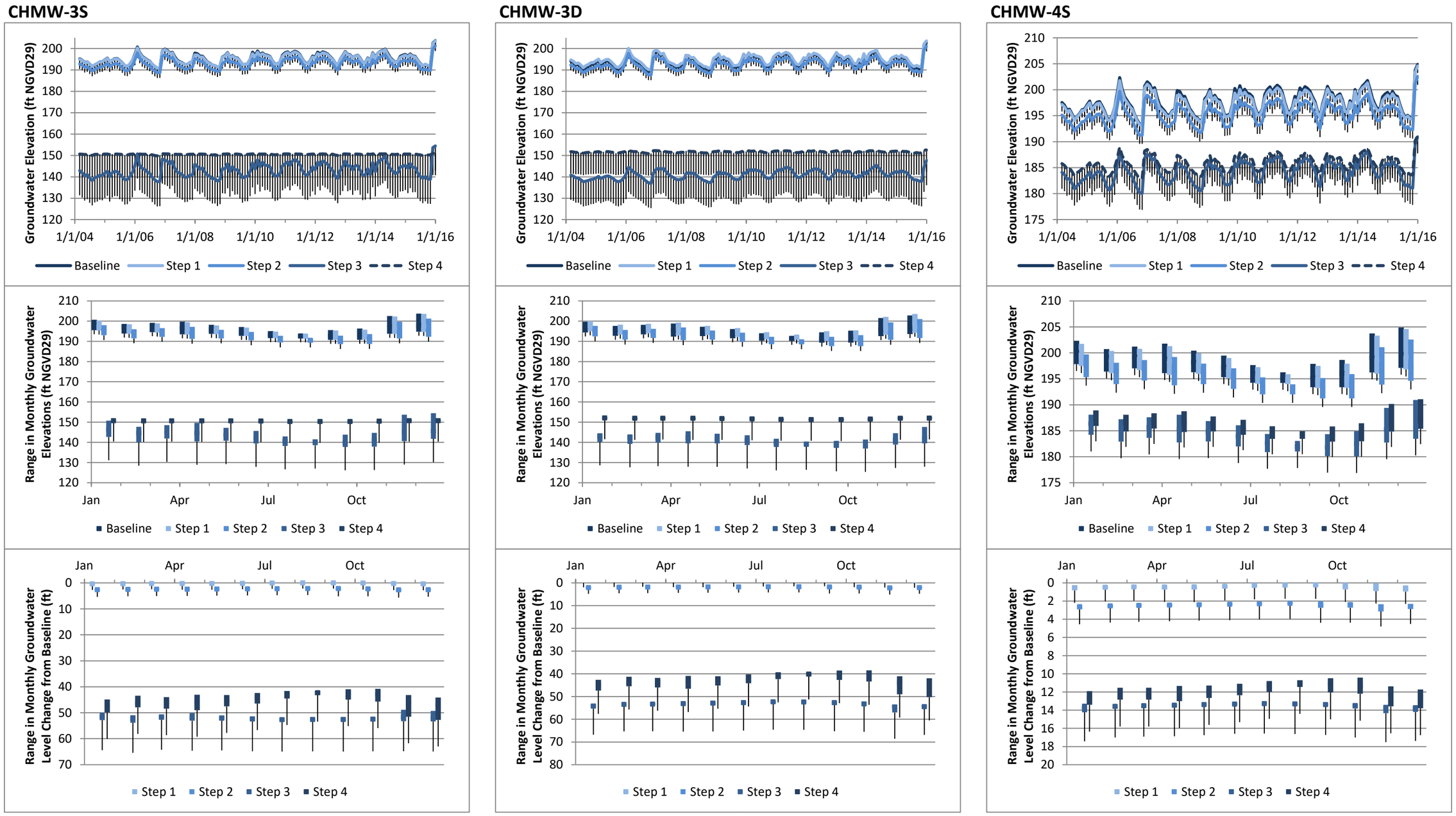
Note: Performance thresholds are the lower end of the whisker shown in each plot of groundwater elevation (top row). The lower end of the whisker represents the lower 95th-percentile confidence interval.

Figure 20
Predicted Changes and Ranges in Groundwater Levels
Earth and Water Resources Report



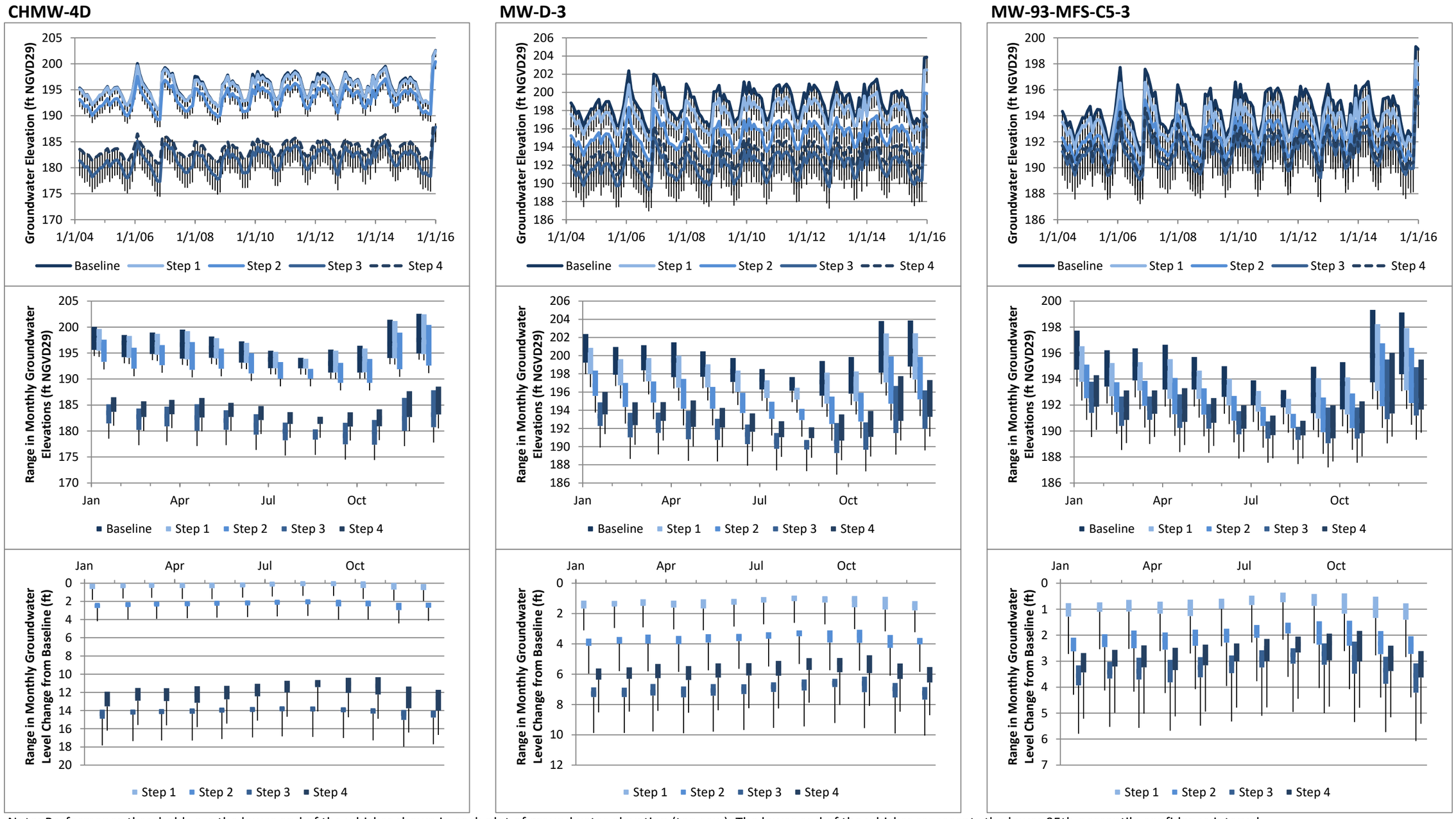
Note: Performance thresholds are the lower end of the whisker shown in each plot of groundwater elevation (top row). The lower end of the whisker represents the lower 95th-percentile confidence interval.

Figure 20
Predicted Changes and Ranges in Groundwater Levels
Earth and Water Resources Report



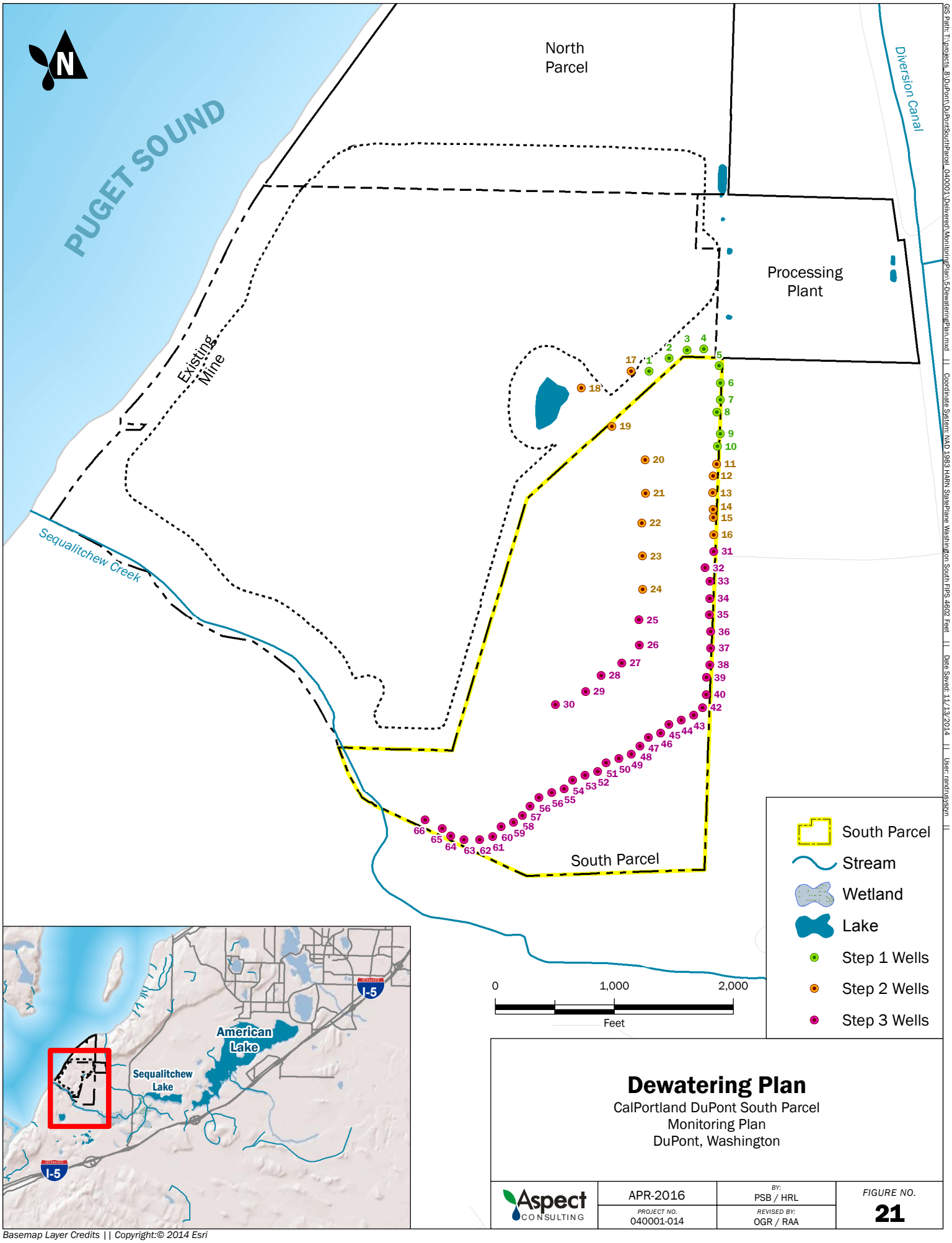
Note: Performance thresholds are the lower end of the whisker shown in each plot of groundwater elevation (top row). The lower end of the whisker represents the lower 95th-percentile confidence interval.

Figure 20
Predicted Changes and Ranges in Groundwater Levels
Earth and Water Resources Report



Note: Performance thresholds are the lower end of the whisker shown in each plot of groundwater elevation (top row). The lower end of the whisker represents the lower 95th-percentile confidence interval.

Figure 20
Predicted Changes and Ranges in Groundwater Levels
Earth and Water Resources Report



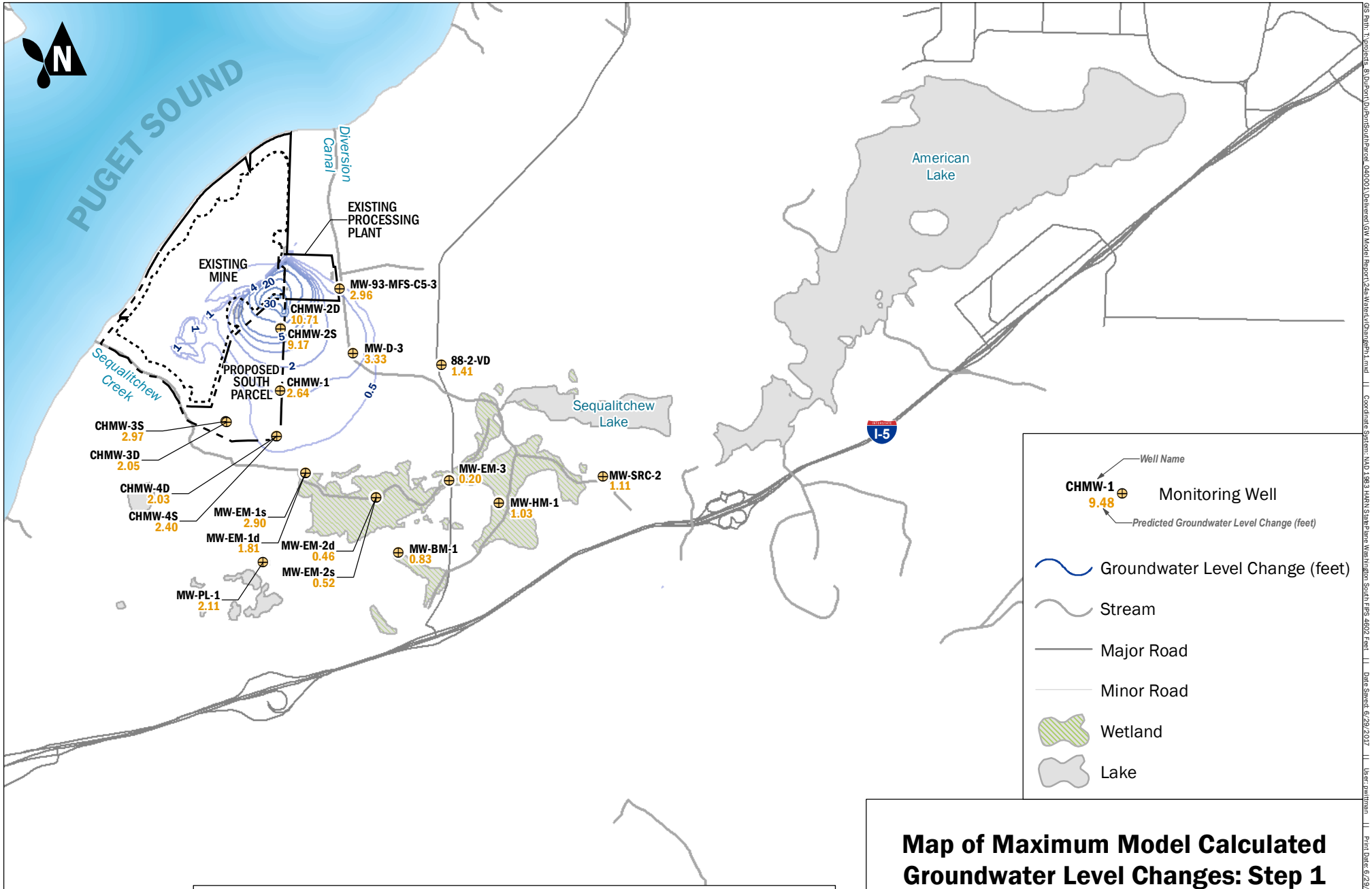
Dewatering Plan

CalPortland DuPont South Parcel
Monitoring Plan
DuPont, Washington

Aspect CONSULTING	APR-2016	BY: PSB / HRL	FIGURE NO. 21
	PROJECT NO. 040001-014	REVISED BY: OGR / RAA	

Basemap Layer Credits || Copyright:© 2014 Esri

GIS Path: T:\projects_8\DuPont\DuPontSouthParcel_040001\Delivered\MonitoringPlan\5DewateringPlan.mxd || Coordinate System: NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet || Date Saved: 11/13/2014 || User: randrusyszyn ||



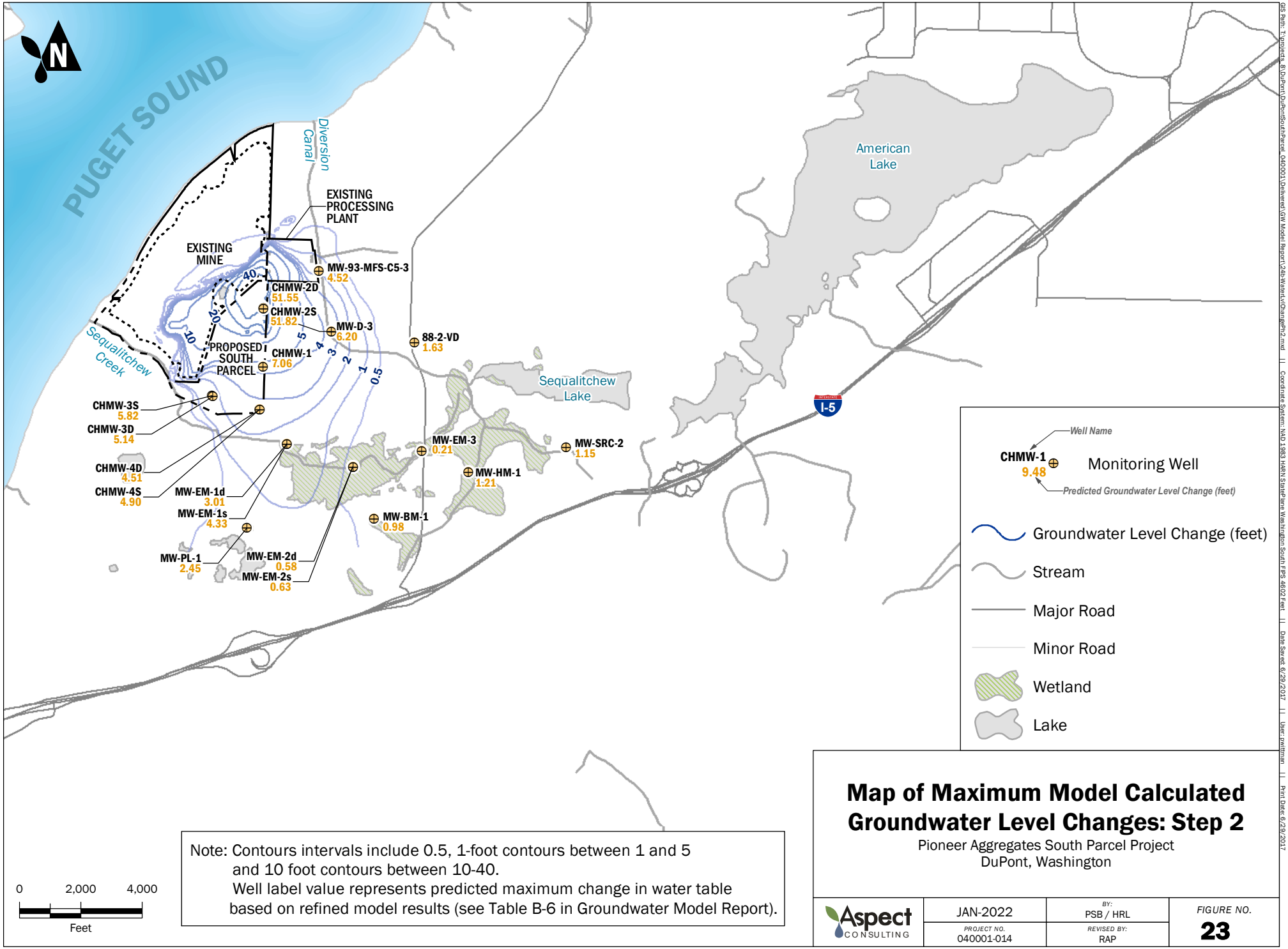
Note: Contours intervals include 0.5, 1-foot contours between 1 and 5 and 10 foot contours between 10-40.
Well label value represents predicted maximum change in water table based on refined model results (see Table B-6 in Groundwater Model Report).

Map of Maximum Model Calculated Groundwater Level Changes: Step 1

Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect CONSULTING	JAN-2022	BY: PSB / HRL	FIGURE NO. 22
	PROJECT NO. 040001-014	REVISED BY: RAP	

GIS Path: T:\projects_8\DuPont\DuPontSouthParcel_040001\Deliverable\GW Model Report\24a-WaterLvlChangePh1.mxd || Coordinate System: NAD 1983 HARN State Plane Washington South FIPS 4602 Feet || Date Saved: 6/29/2017 || User: pwittman || Print Date: 6/29/2017



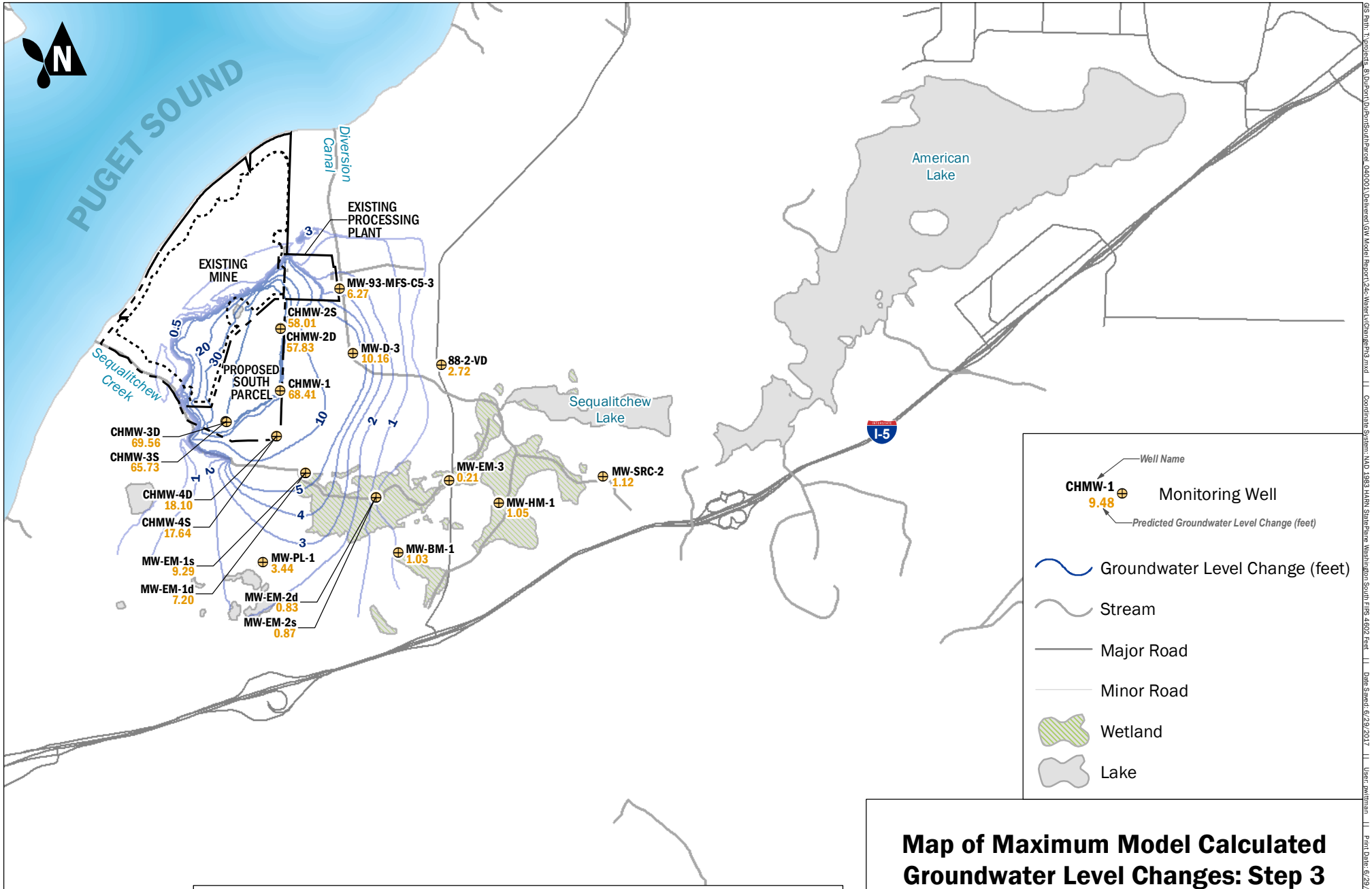
Note: Contours intervals include 0.5, 1-foot contours between 1 and 5 and 10 foot contours between 10-40.
Well label value represents predicted maximum change in water table based on refined model results (see Table B-6 in Groundwater Model Report).

Map of Maximum Model Calculated Groundwater Level Changes: Step 2

Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect CONSULTING	JAN-2022	BY: PSB / HRL	FIGURE NO. 23
	PROJECT NO. 040001-014	REVISED BY: RAP	

GIS Path: T:\projects_8\DuPont\DuPontSouthParcel_040001\Deliverable\GW Model Report\24b Waterlvl\ChangePh2.mxd || Coordinate System: NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet || Date Saved: 6/29/2017 || User: jwitman || Print Date: 6/29/2017



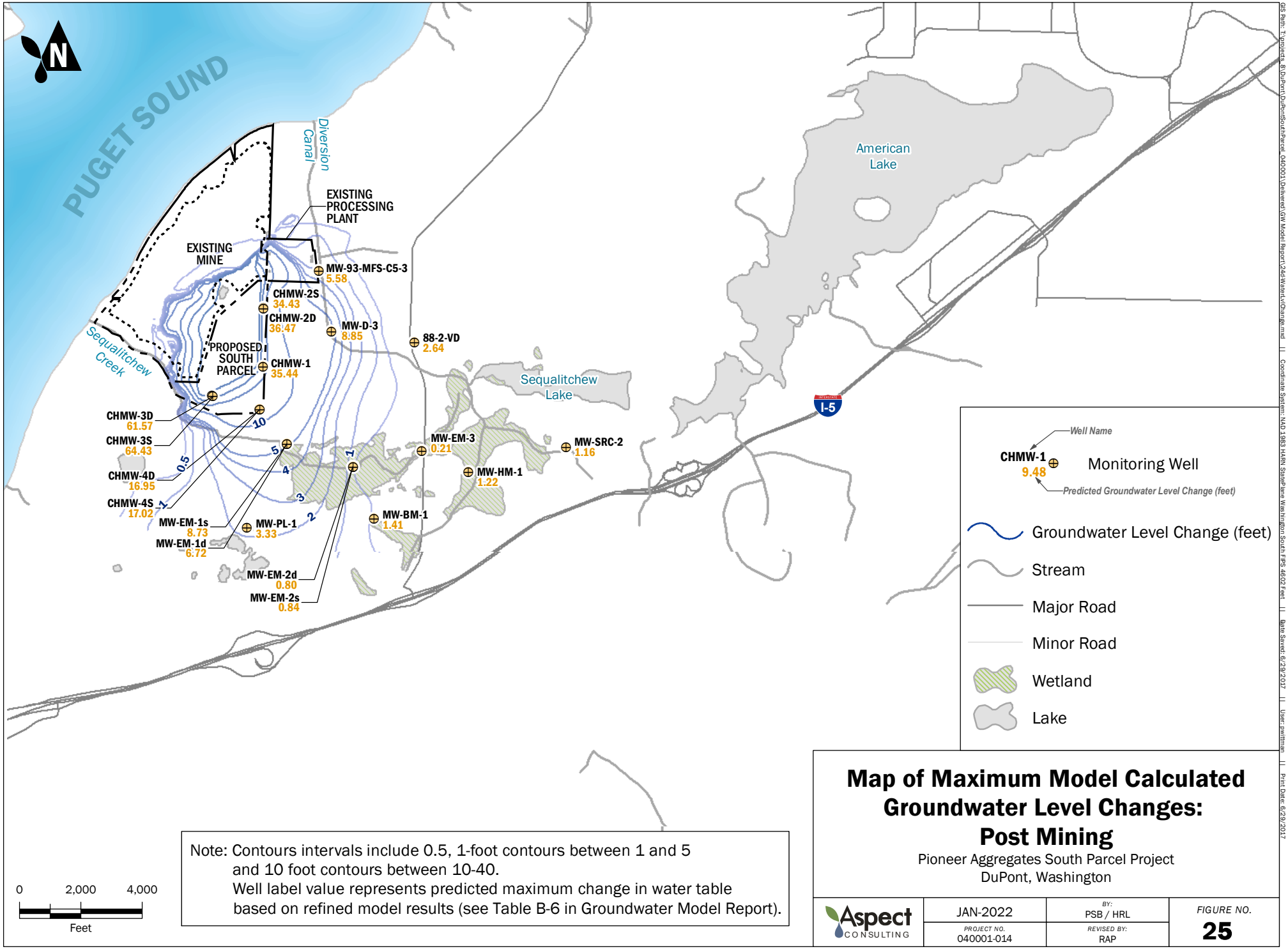
Note: Contours intervals include 0.5, 1-foot contours between 1 and 5 and 10 foot contours between 10-40.
Well label value represents predicted maximum change in water table based on refined model results (see Table B-6 in Groundwater Model Report).

Map of Maximum Model Calculated Groundwater Level Changes: Step 3

Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect CONSULTING	JAN-2022	BY: PSB / HRL	FIGURE NO. 24
	PROJECT NO. 040001-014	REVISED BY: RAP	

GIS Path: T:\projects_8\DuPont\DuPontSouthParcel_040001\Deliverest\GW Model Report\24c-WaterLvlChangeStp3.mxd LL Coordinate System: NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet LL Date Saved: 6/29/2017 LL User: pwittman LL Print Date: 6/29/2017



Note: Contours intervals include 0.5, 1-foot contours between 1 and 5 and 10 foot contours between 10-40.
Well label value represents predicted maximum change in water table based on refined model results (see Table B-6 in Groundwater Model Report).

Map of Maximum Model Calculated Groundwater Level Changes: Post Mining

Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect CONSULTING	JAN-2022	BY: PSB / HRL	FIGURE NO. 25
	PROJECT NO. 040001-014	REVISED BY: RAP	

GIS Path: T:\projects_8\DuPont\DuPontSouthParcel_040001\Deliverable\GW Model Report\24d\WaterLvlChange.mxd || Coordinate System: NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet || Date Saved: 6/29/2017 || User: pwittman || Print Date: 6/29/2017

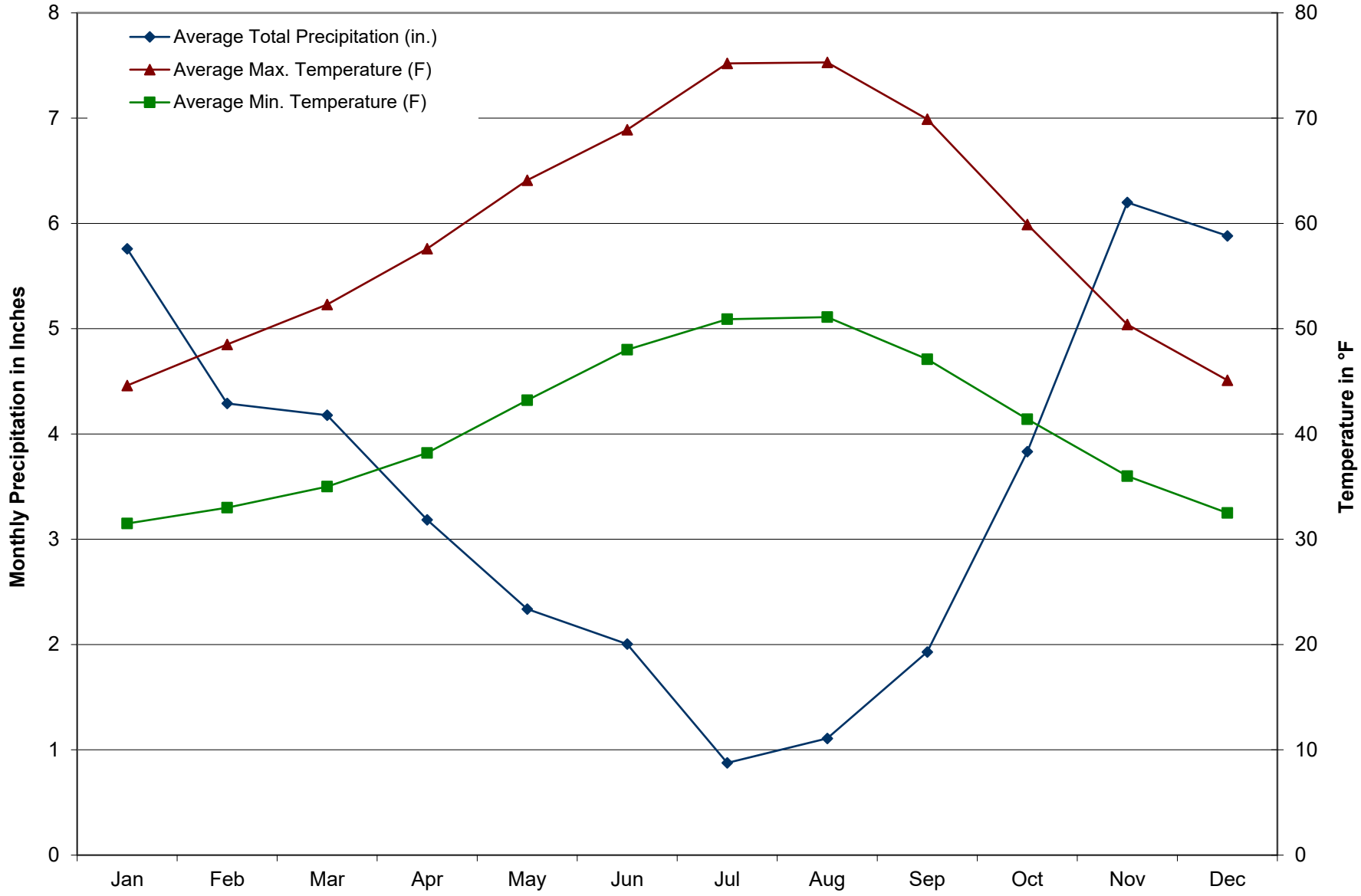


Figure 26

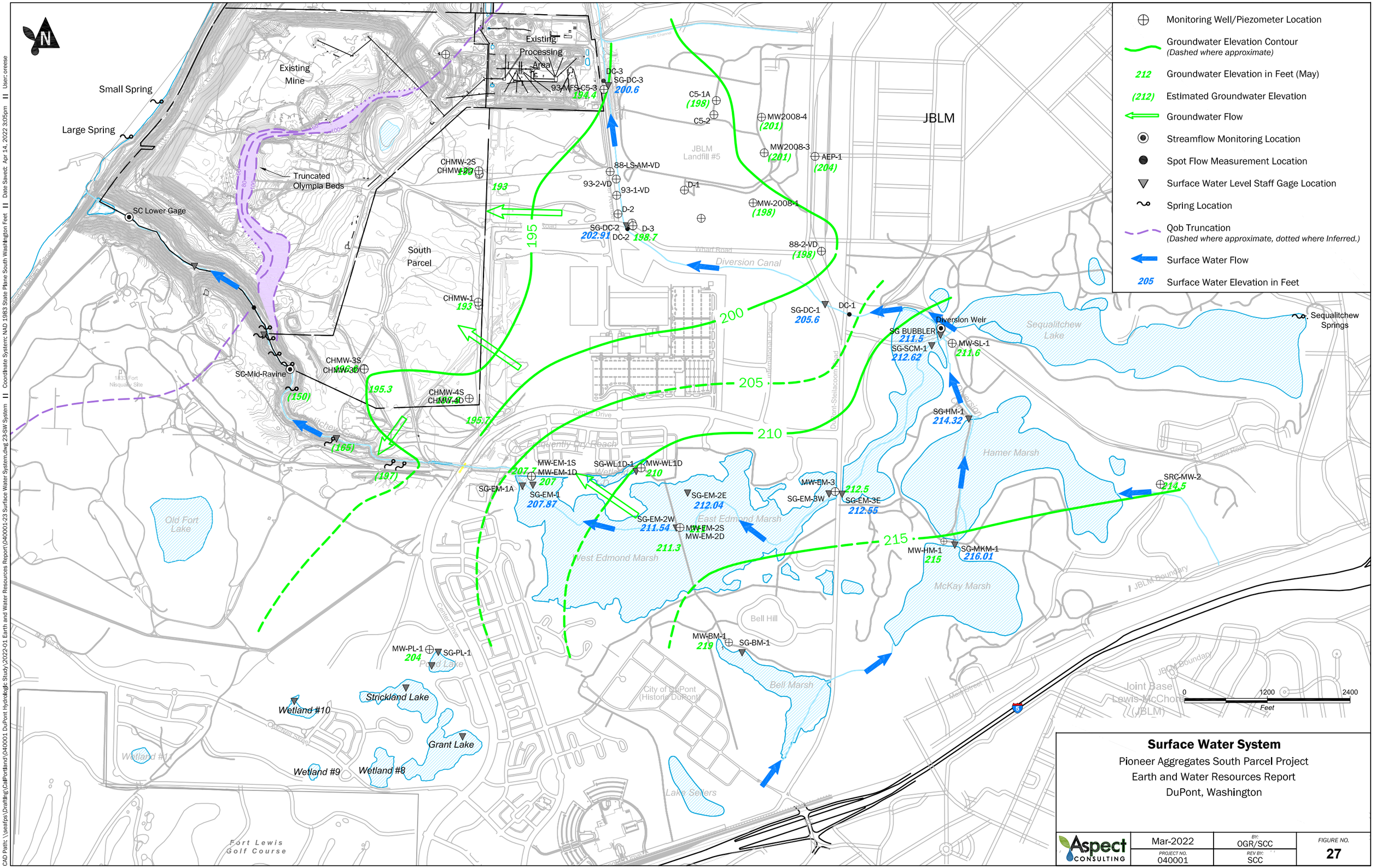
Average Precipitation and Temperature by Month

Pioneer Aggregates South Parcel Project

Aspect Consulting

02/23/22

S:\CalPortland\DuPont\South Parcel\Report Drafts\Earth and Water Resources Report 2021\Analysis\Water Balance\Figure 22.xlsm



Surface Water System

Pioneer Aggregates South Parcel Project

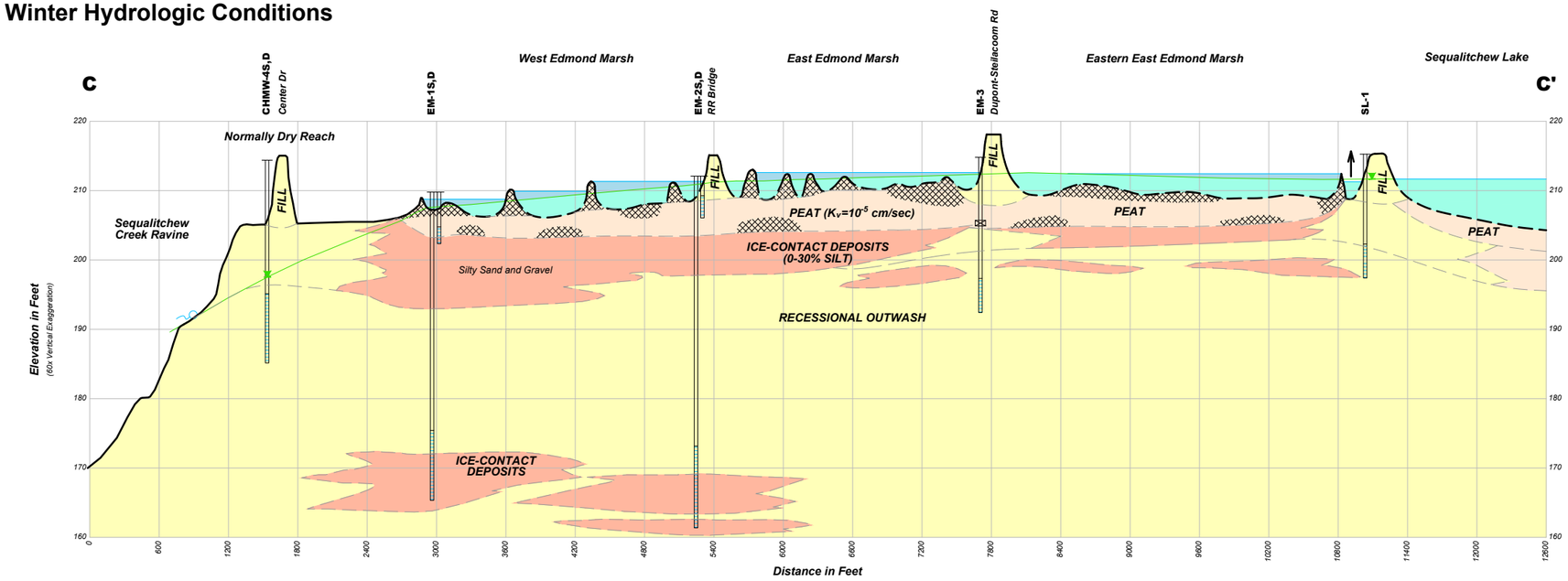
Earth and Water Resources Report

DuPont, Washington

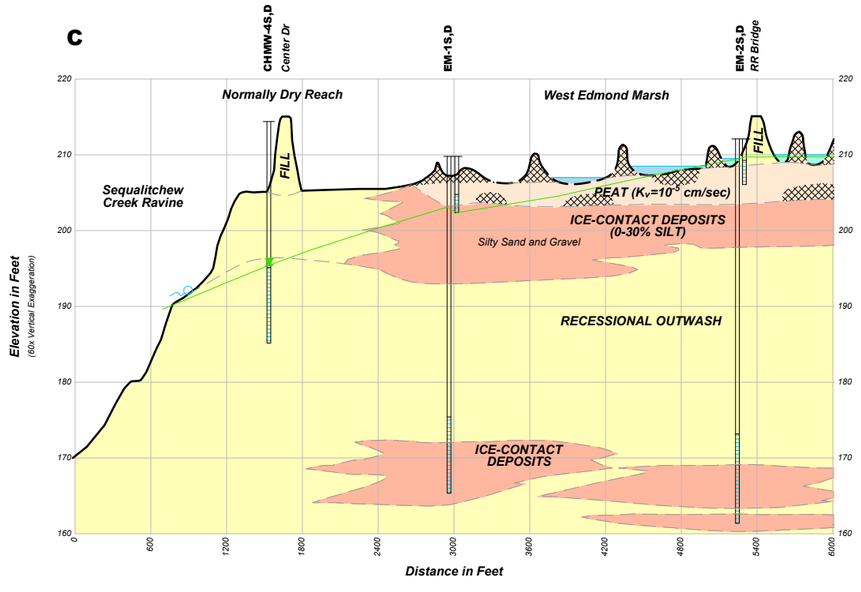
Aspect Consulting	Mar-2022	BY: OGR/SCC	FIGURE NO. 27
	PROJECT NO. 040001	REV BY: SCC	

CAD Path: \\seafps\Drafting\CalPortland\040001 DuPont Hydrologic Study\2022-01 Earth and Water Resources Report\040001-23 Surface Water System.dwg 23-SW System || Coordinate System: NAD 1983 State Plane South Washington Feet || Date Saved: Apr 14, 2022 3:05pm || User: oreese

Winter Hydrologic Conditions



Summer Hydrologic Conditions
West Edmonds



Legend

- Groundwater Elevation
- Surface Water Elevation
- Beaver Dam

0 1200 2400
Horizontal Feet

0 20 40
Vertical Feet

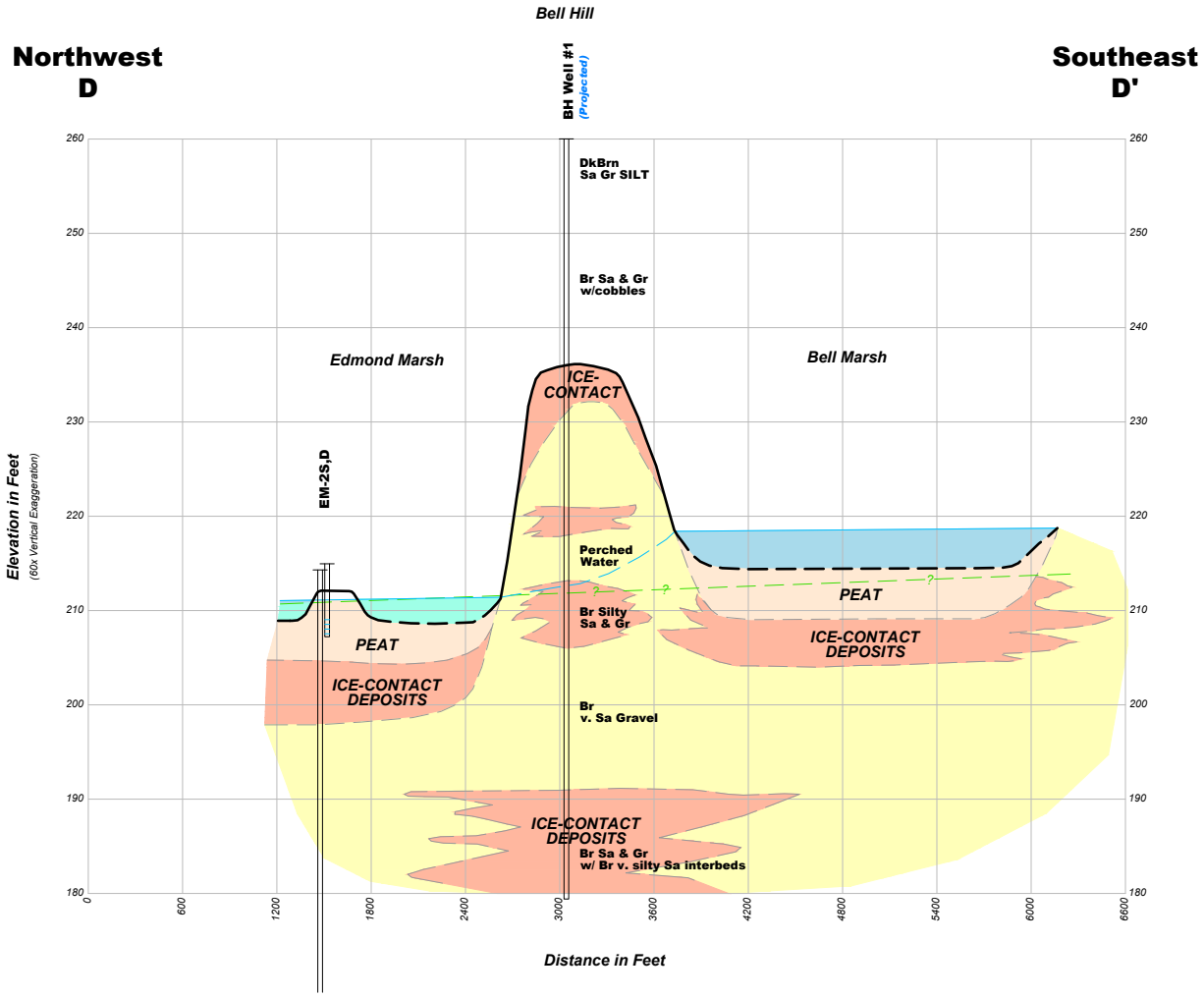
Edmond Marsh Cross Section - C-C'

Earth and Water Resources Report
Pioneer Aggregates South Parcel Project
DuPont, Washington

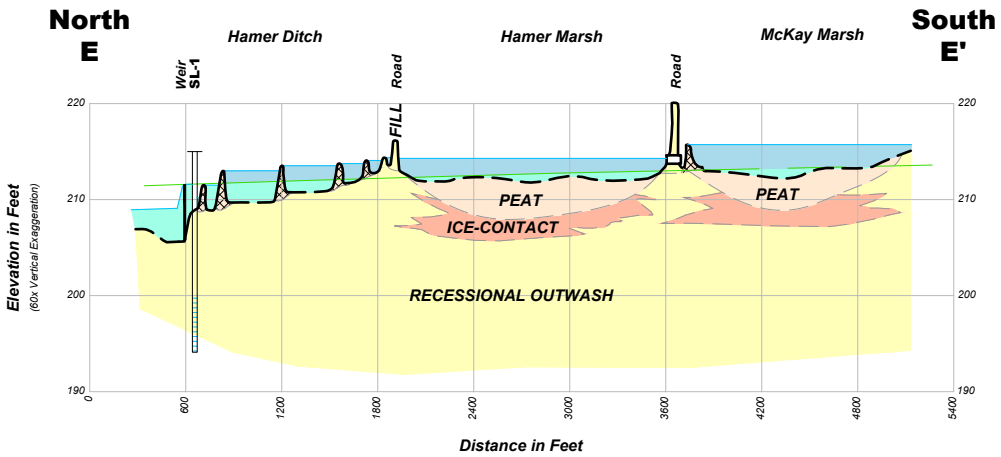
Aspect CONSULTING	Oct-2022	BY: OGR/SCC	FIGURE NO. 28
	PROJECT NO. 040001-I-018	REVISED BY: -	

CAD Path: Q:\CalPortland\040001 DuPont Hydrologic Study\2022-10 Earth and Water Resources Report\040001-08.dwg 27 Edmond Marsh Cross Section - C-C' || Date Saved: Oct 24, 2022 4:25pm || User: scudd

Winter Hydrologic Conditions - Bell/Edmond Marsh



Winter Hydrologic Conditions - Hamer/McKay Marsh



Legend

- Groundwater Elevation
- Surface Water Elevation
- Beaver Dam

0 1200 2400
Horizontal Feet

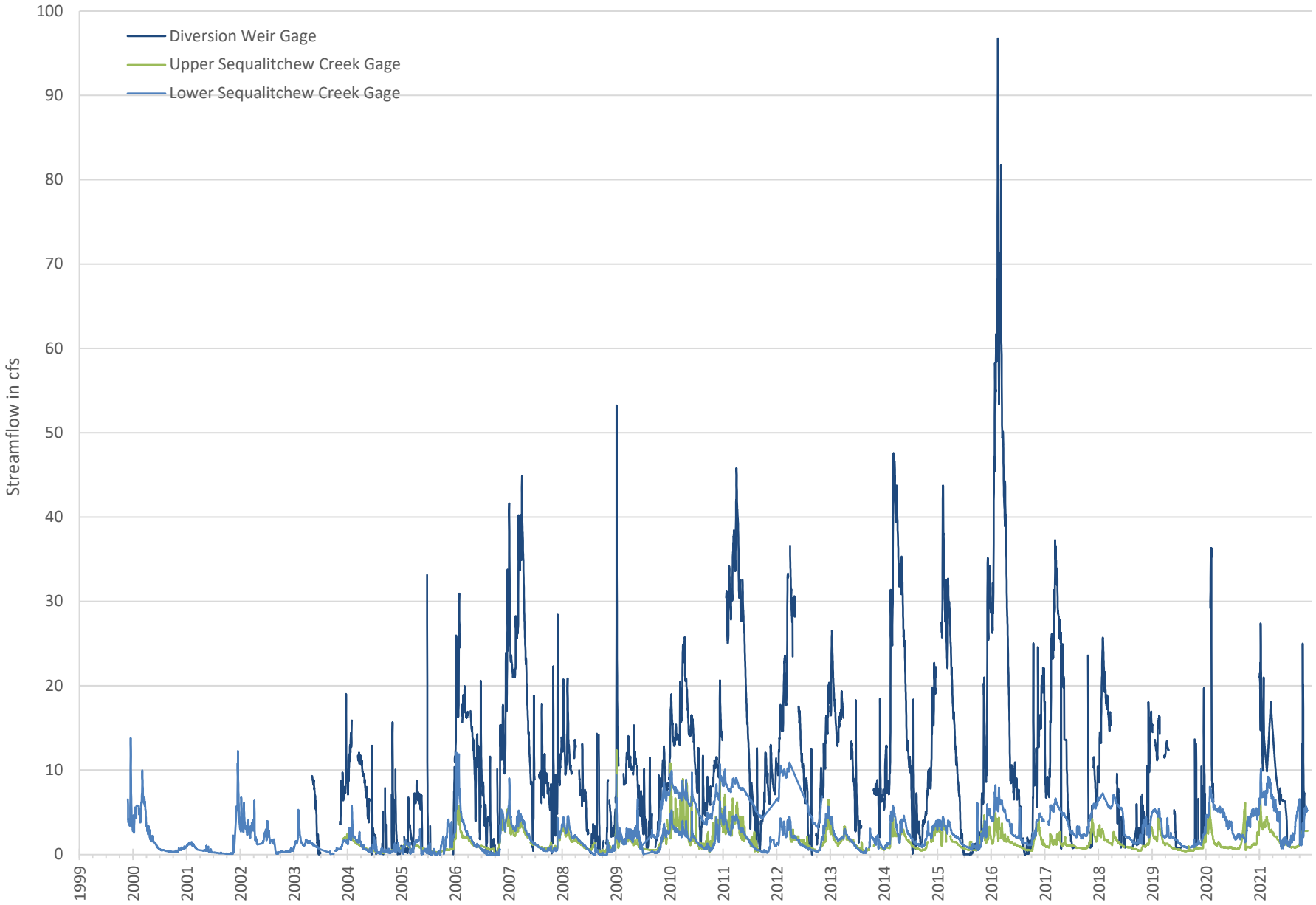
0 20 40
Vertical Feet

Bell, McKay and Hamer Marsh Cross Sections - D-D' and E-E'

Earth and Water Resources Report
Pioneer Aggregates South Parcel Project
DuPont, Washington

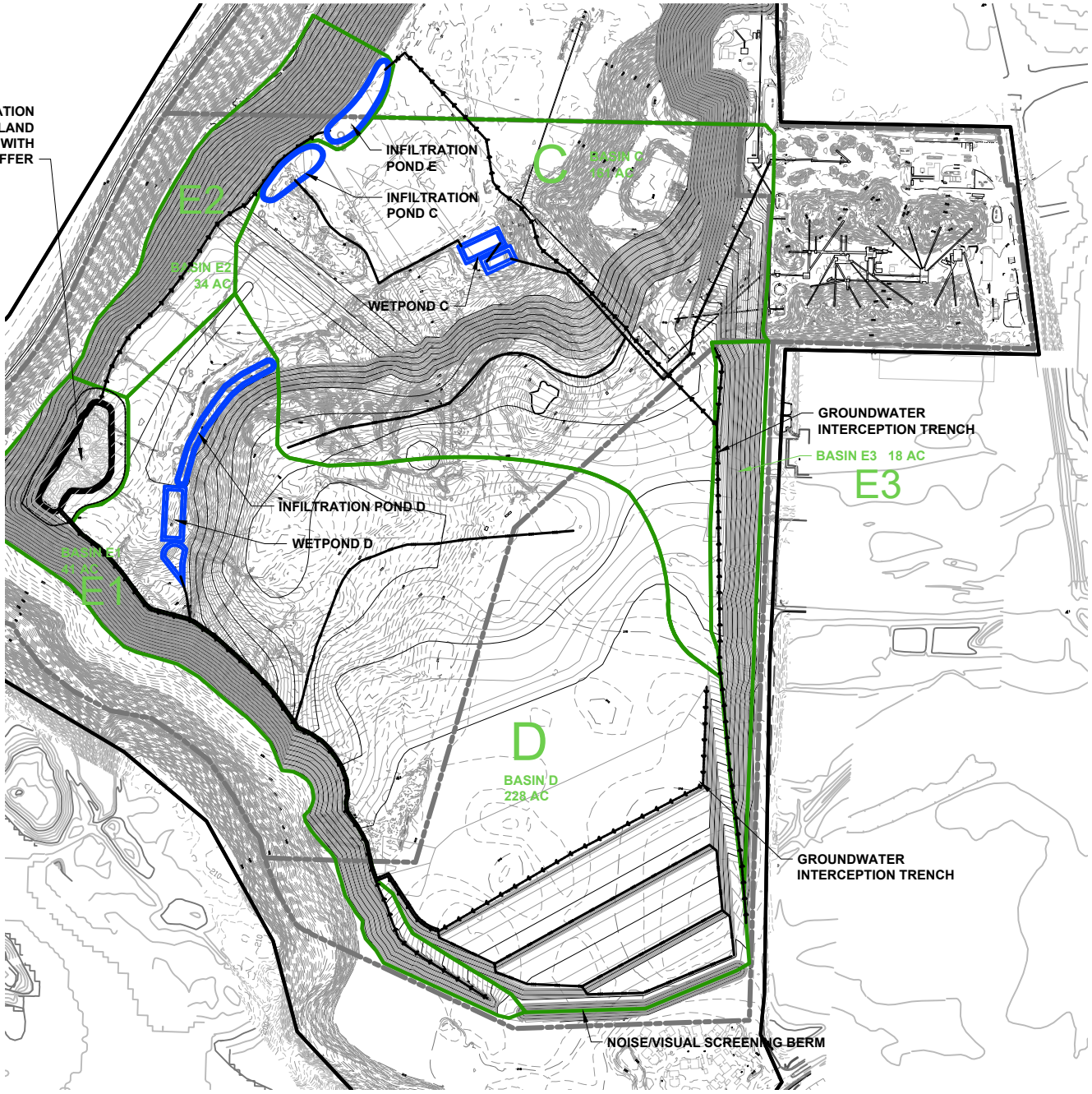
Aspect Consulting	Oct-2022	BY: OGR/SCC	FIGURE NO. 29
	PROJECT NO. 040001-I-018	REVISED BY: -	

CAD Path: Q:\CalPortland\040001 DuPont Hydrologic Study\2022-10 Earth and Water Resources Report\040001-08.dwg 28 Bell-McKay-Hamer Marsh Cross Sections - D-D' and E-E' || Date Saved: Oct 26, 2022 11:58am || User: scudd



Aspect Consulting
02/27/2022
S:\CalPortland\DuPont\South Parcel\Data\Flows\Flow Data Summary 3_v1.2.xlsm

Figure 30
Streamflow Hydrograph for Diversion Weir and Sequalitchew Creek
South Parcel Project



Legend

- Stormwater Management Facility
- Groundwater Interception Trench
- Drainage Ditch
- 8 — Location and Identifier of Soil Borings Used in Assessing Infiltration Rates
- A — Drainage Basin Label
- Drainage Basin Boundary

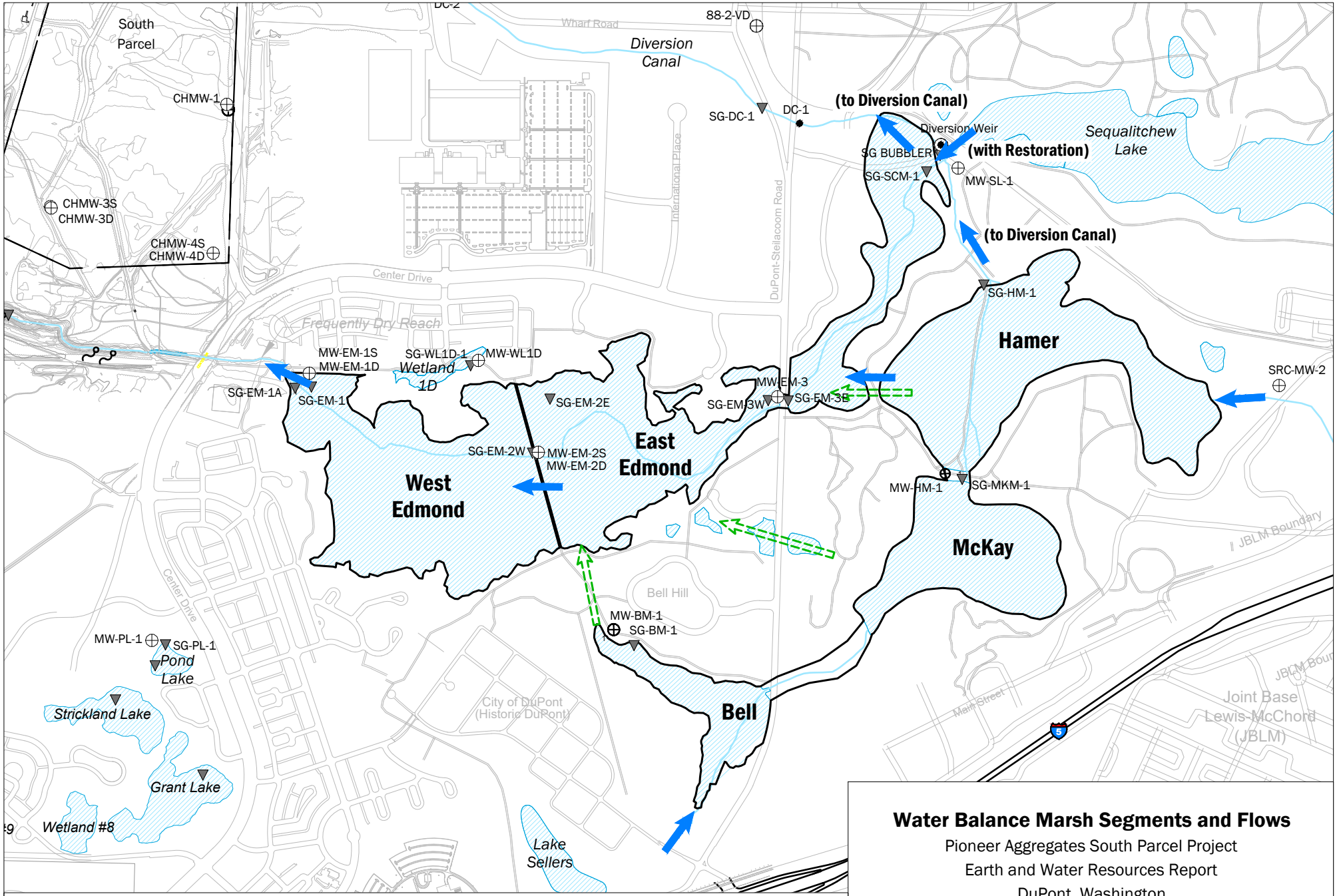
0 1000 2000 Feet

Proposed Drainage Basins and Stormwater Management Facilities

Pioneer Aggregates South Parcel Project
CalPortland
Dupont, Washington

Aspect CONSULTING	Feb-2022	BY: BMG/CMV	FIGURE NO. 31
	PROJECT NO. 040001	REVISED BY: -	

CAD Path: Q:\CalPortland\040001 DuPont Hydrologic Study\2022-01 Earth and Water Resources Report\040001-03 Prop Drainage&SW_Mgmt.dwg || Date Saved: 2/15/2022 4:46:30 PM || User: cvanslyke



Water Balance Marsh Segments and Flows

Pioneer Aggregates South Parcel Project
Earth and Water Resources Report
DuPont, Washington

Aspect Consulting	Oct-2022	BY: OGR/SCC	FIGURE NO. 32
	PROJECT NO. 040001-I-018	REV BY: -	

CAD Path: Q:\CalPortland\040001 DuPont Hydrologic Study\2022-10 Earth and Water Resources Report\040001-03 Water Balance Marsh Segments and Flows.dwg 31 Water Balance Marsh Segments and Flows || Date Saved: Oct 26, 2022 12:18pm || User: scudd

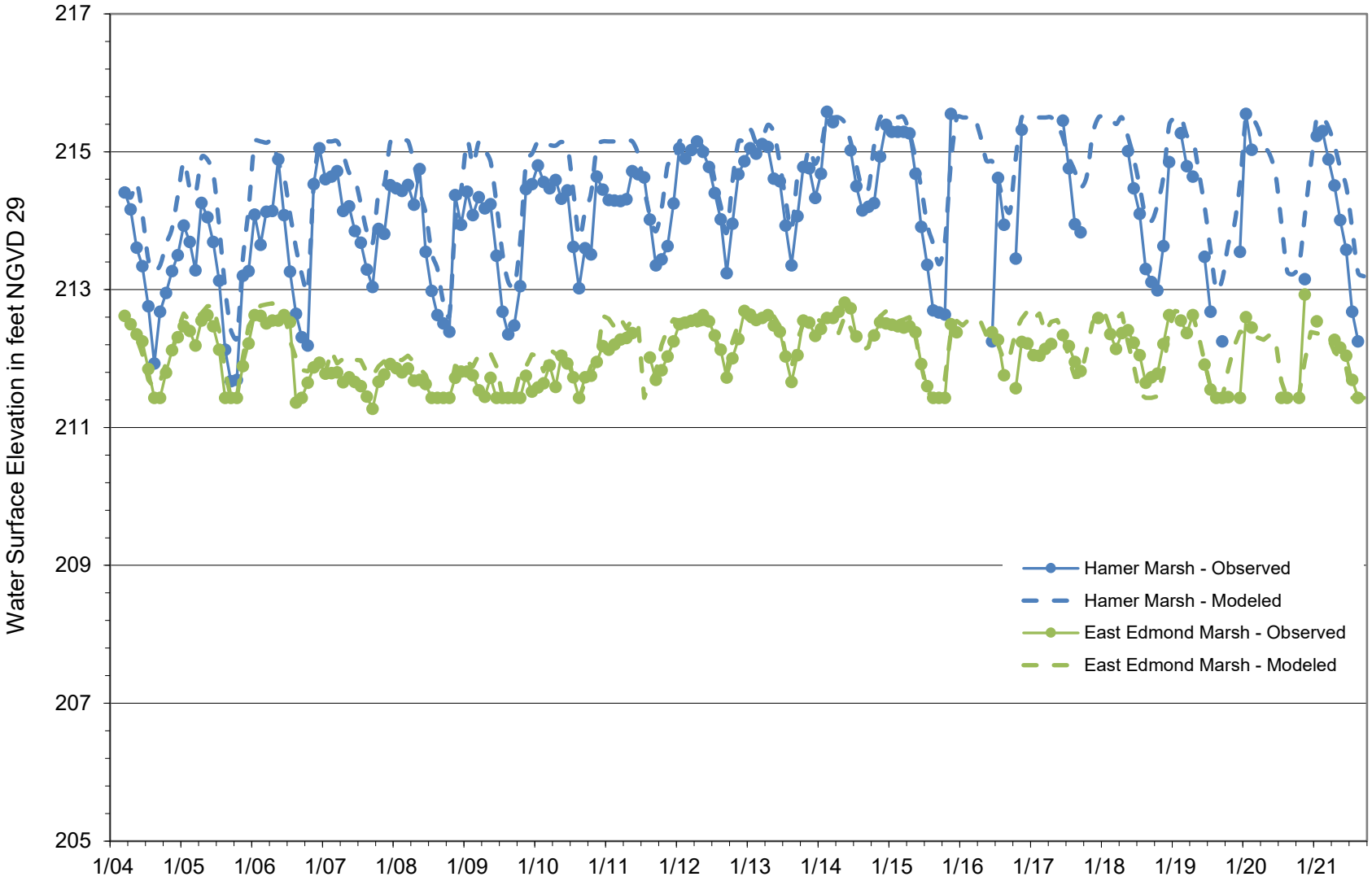


Figure 33

Water Balance Calibration for Hamer and East Edmond Marshes

Pioneer Aggregates South Parcel Project

Aspect Consulting

11/5/2022

S:\CalPortland\DuPont\South Parcel\Water Balance Analyses\Water Balance -2022 - Existing.xlsm

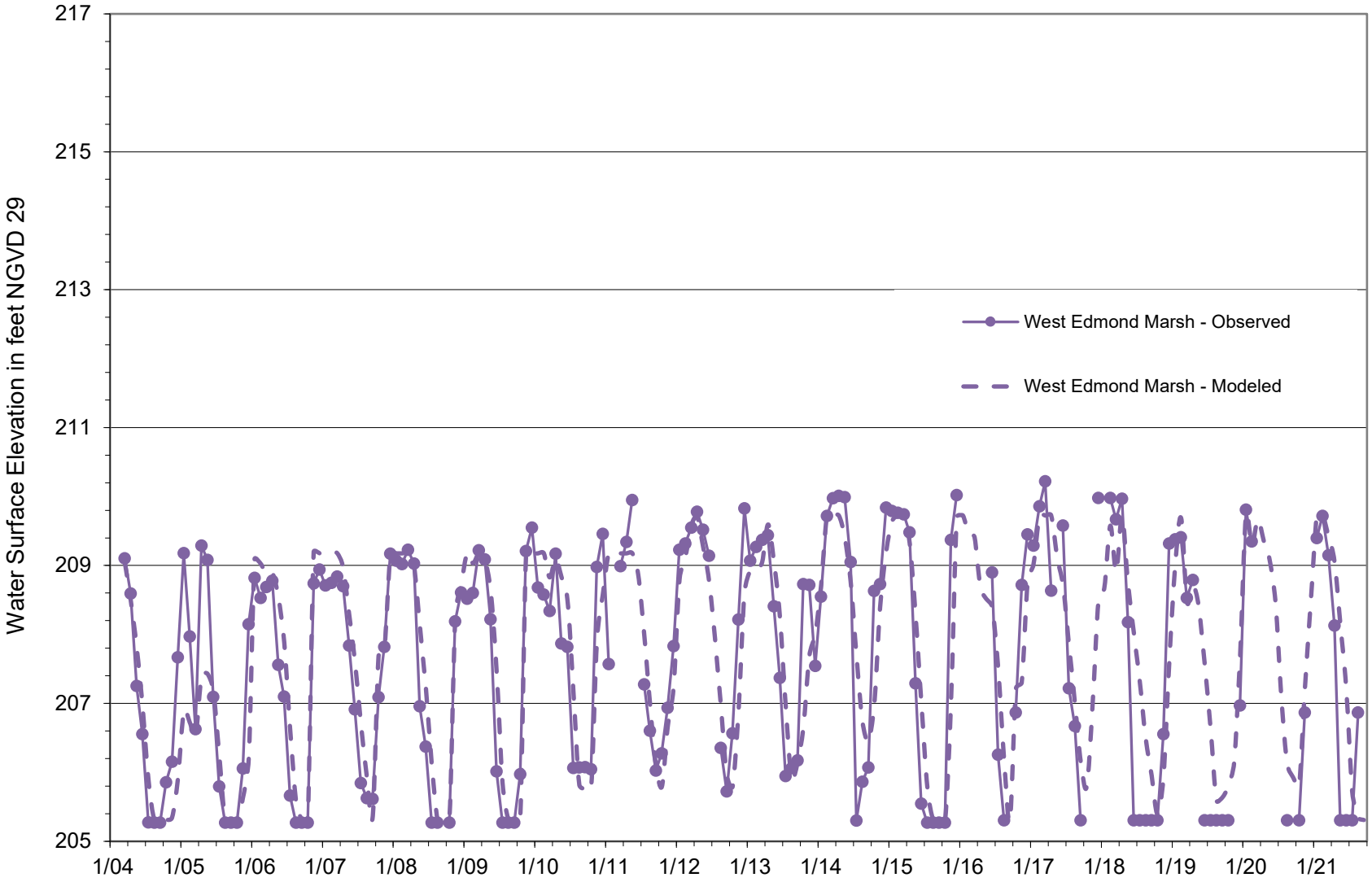
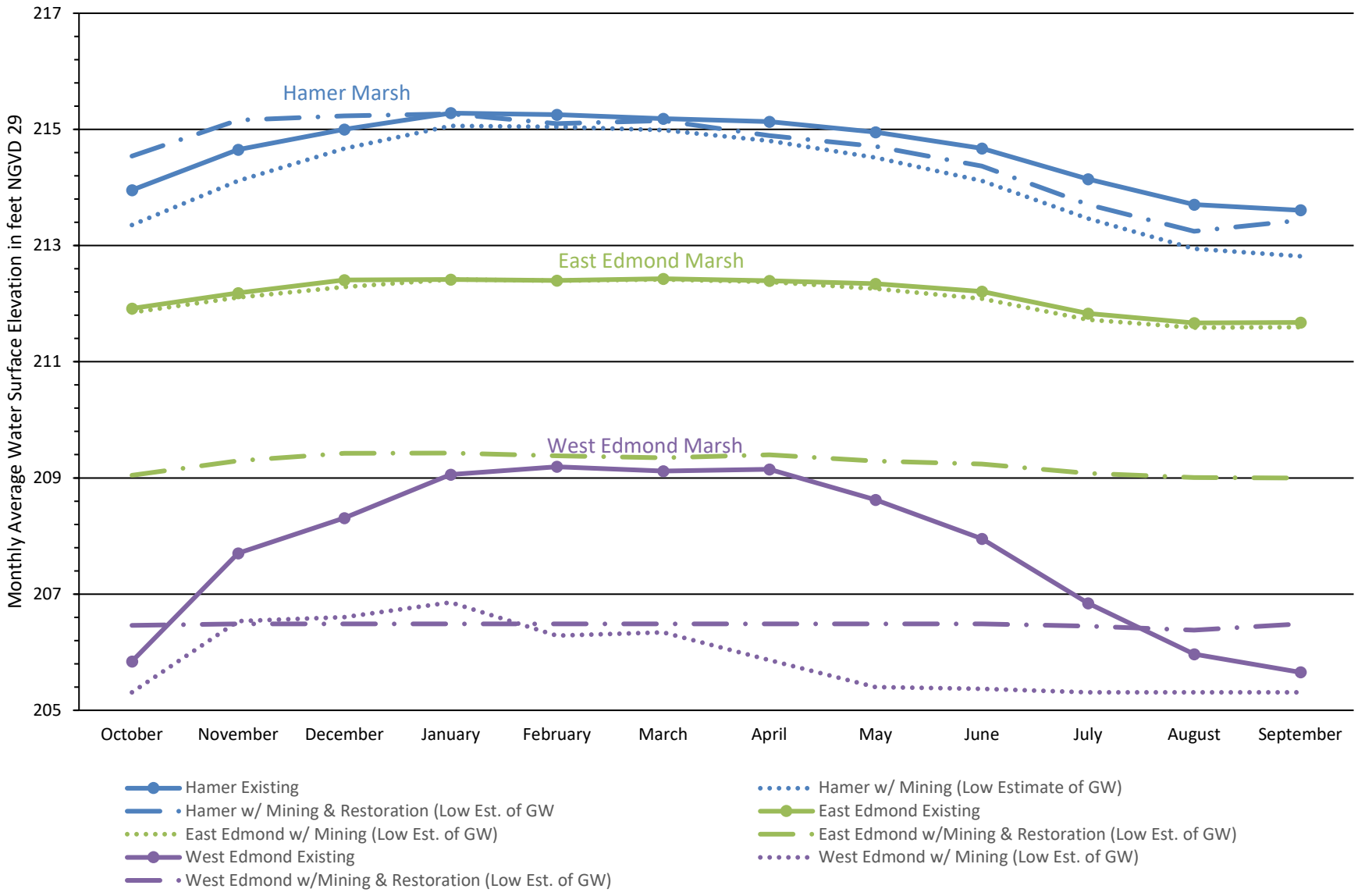


Figure 34

Water Balance Calibration for West Edmond Marsh Under Existing Conditions



Aspect Consulting
11/1/2022
S:\CalPortland\DuPont\South Parcel\Water Balance Analyses\Water Balance -2022 - Mining&Restoration.xlsm

Figure 35
Predicted Marsh Hydrographs with Mining and Restoration
Pioneer Aggregates South Parcel Project

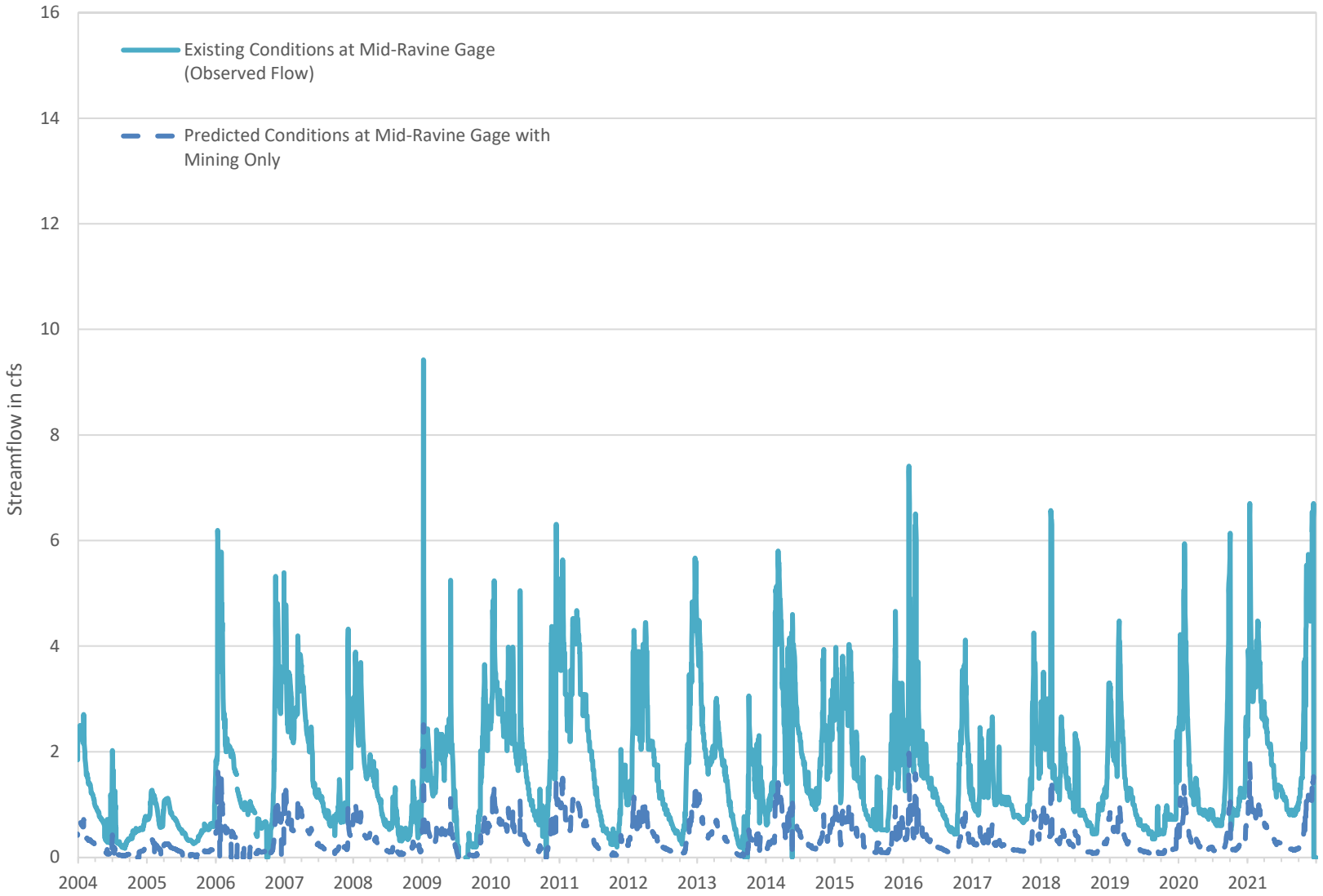


Figure 36

Predicted Streamflow Hydrograph for Sequalitchew Creek with Mining Only

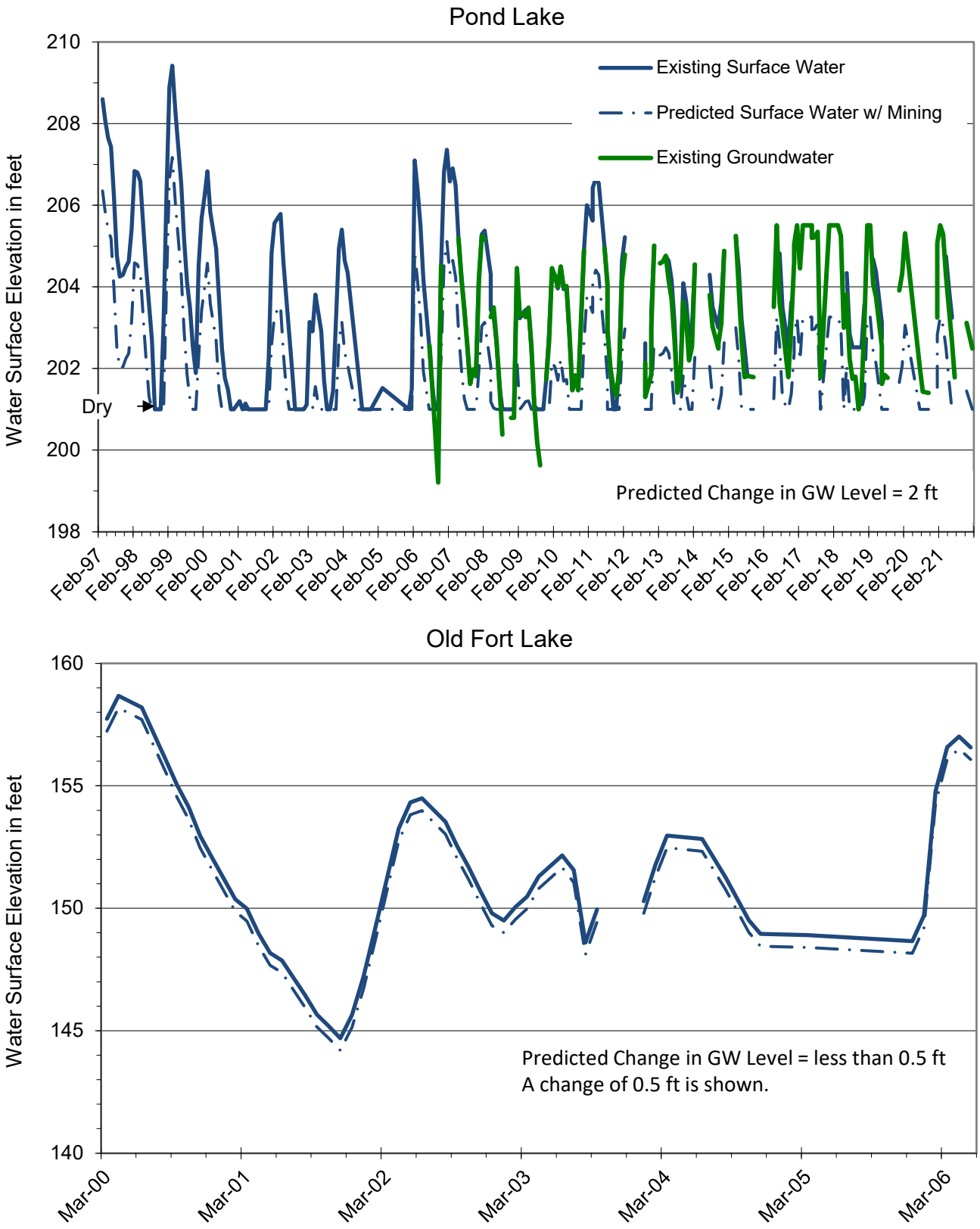


Figure 37

Predicted Hydrographs for Pond and Old Fort Lakes

Aspect Consulting
03/23/2022
S:\CalPortland\DuPont\South Parcel\Report Drafts\Earth and Water Resources Report 2021\Analysis\WetlandWLs.xlsx

Nisqually Reach

Joint Base Lewis-McChord

J: Ravine Habitat

H: City Hall Culvert
Replace the culvert near City Hall with one designed for fish passage

I: Center Drive Culvert
Evaluate and improve channel in culvert under Center Drive

G: Losing Reach
Monitor flow loss in losing reach Seal stream bed, if needed Restore channel structure and riparian vegetation

K: Lake Outlet Area - Part 2
Improve wetland habitat

C: Sequalitchew Lake Water Levels
Seasonally manage lake levels

Sequalitchew Lake

D: Lake Outlet Area - Part 1
Remove crossover culverts and reduce barriers to flow

Sequalitchew Creek

Homer Marsh

E: Hamer Marsh
Install weir in Hamer Marsh

B: Beavers
Install flexible levelers and beaver exclusion devices at multiple locations in Edmond Marsh

Old Fort Lake

West Edmond Marsh

East Edmond Marsh

E: Hamer Marsh
Replace the 12-inch culvert btwn Hamer and Edmond Marsh if water quality meets standards

B: Beavers
Install flexible levelers and beaver exclusion devices at multiple locations in Edmond Marsh

F: Railroad Trail Bridge
Replace portion of trail with pedestrian bridge

Bell Marsh

Definite Elements – core initial elements, well-defined and known

Contingent Elements -- specific additional information is necessary to design

Adaptive Management Elements– actions optional depending on conditions observed during restoration

Restored Flow Direction

Water Body

Joint Base Lewis - McChord Boundary

Notes:
1. Element numbering per Sequalitchew Creek Watershed Restoration Plan (2017).
2. Implementation of elements on JBLM will be permitted and led by JBLM.

N

0 1,300 2,600

Feet

Restoration Plan Elements

Earth and Water Resources Report
Pioneer Aggregates South Parcel Project
DuPont, Washington

Aspect CONSULTING	FEB-2022	BY: OR / SBM	FIGURE NO. 38
	PROJECT NO. 040001-I-018-02	REVISED BY: NLK	

Basemap Layer Credits || Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

GIS Path: G:\projects\Dupont\DuPont\DuPont\SouthParcel_040001\Delivered\Earth and Water Resources Report\28 Restoration Plan Elements.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 2/17/2022 || User: nkochie || Print Date: 2/17/2022

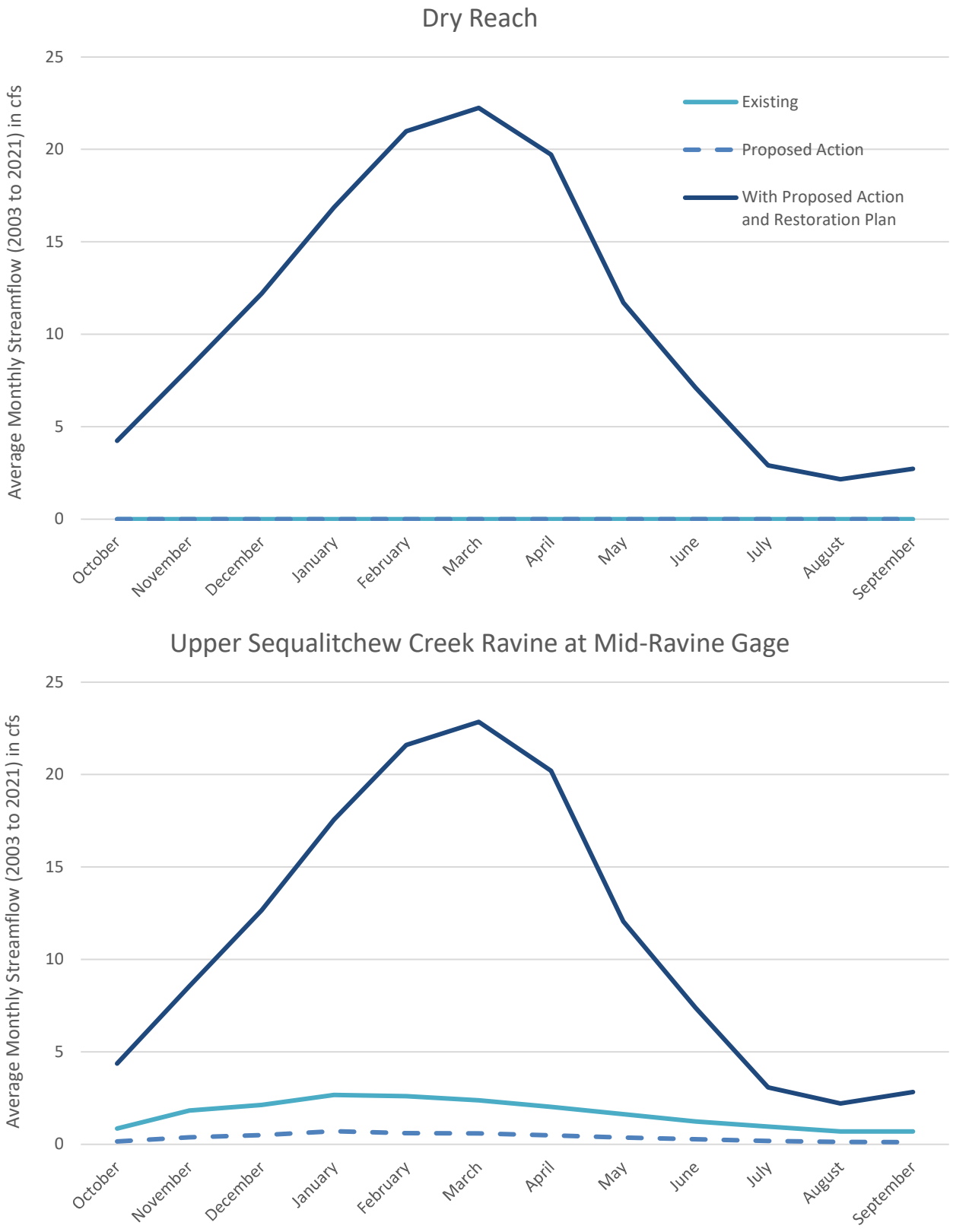


Figure 39
Predicted Average Monthly Streamflow Hydrograph for Sequalitchew Creek

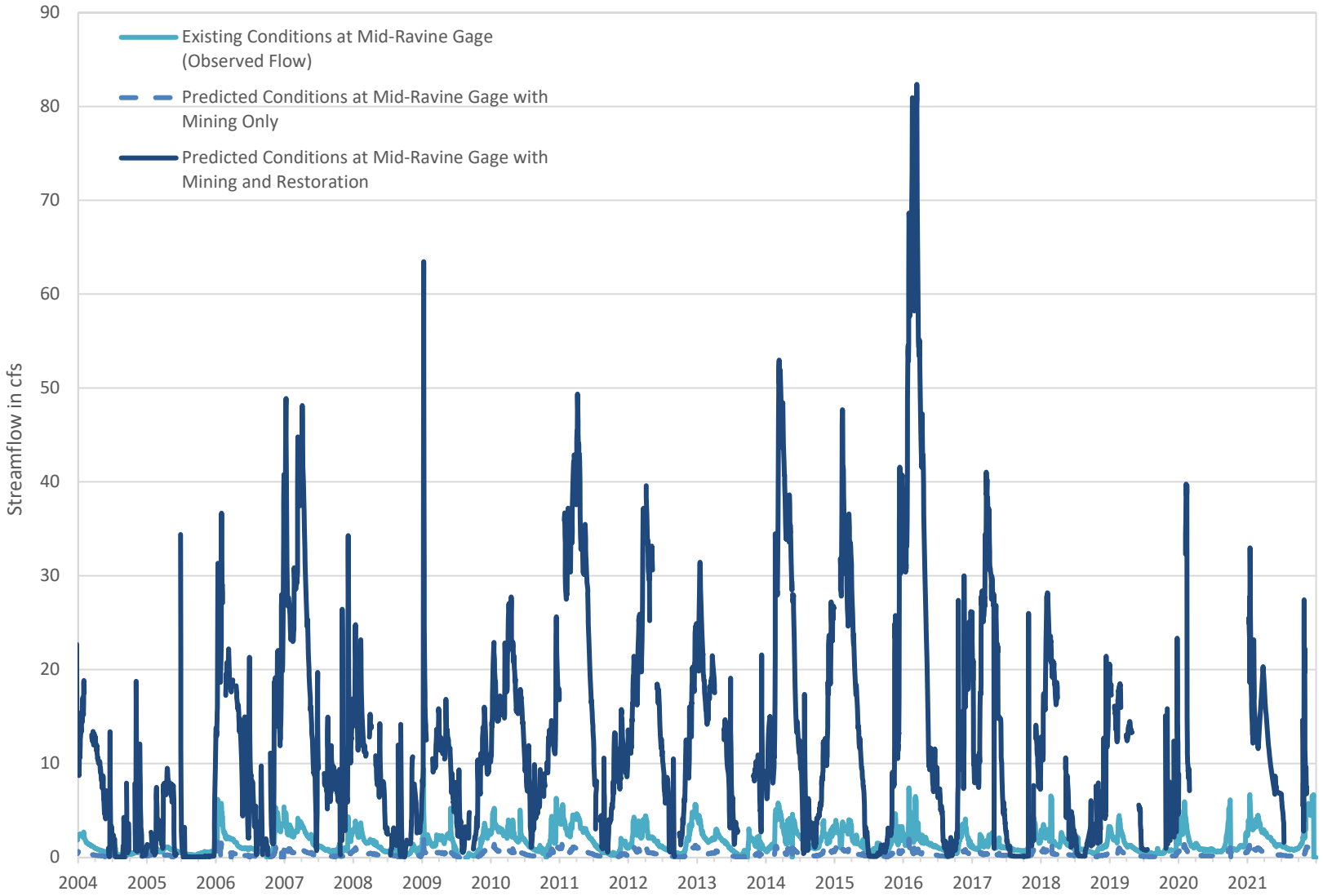
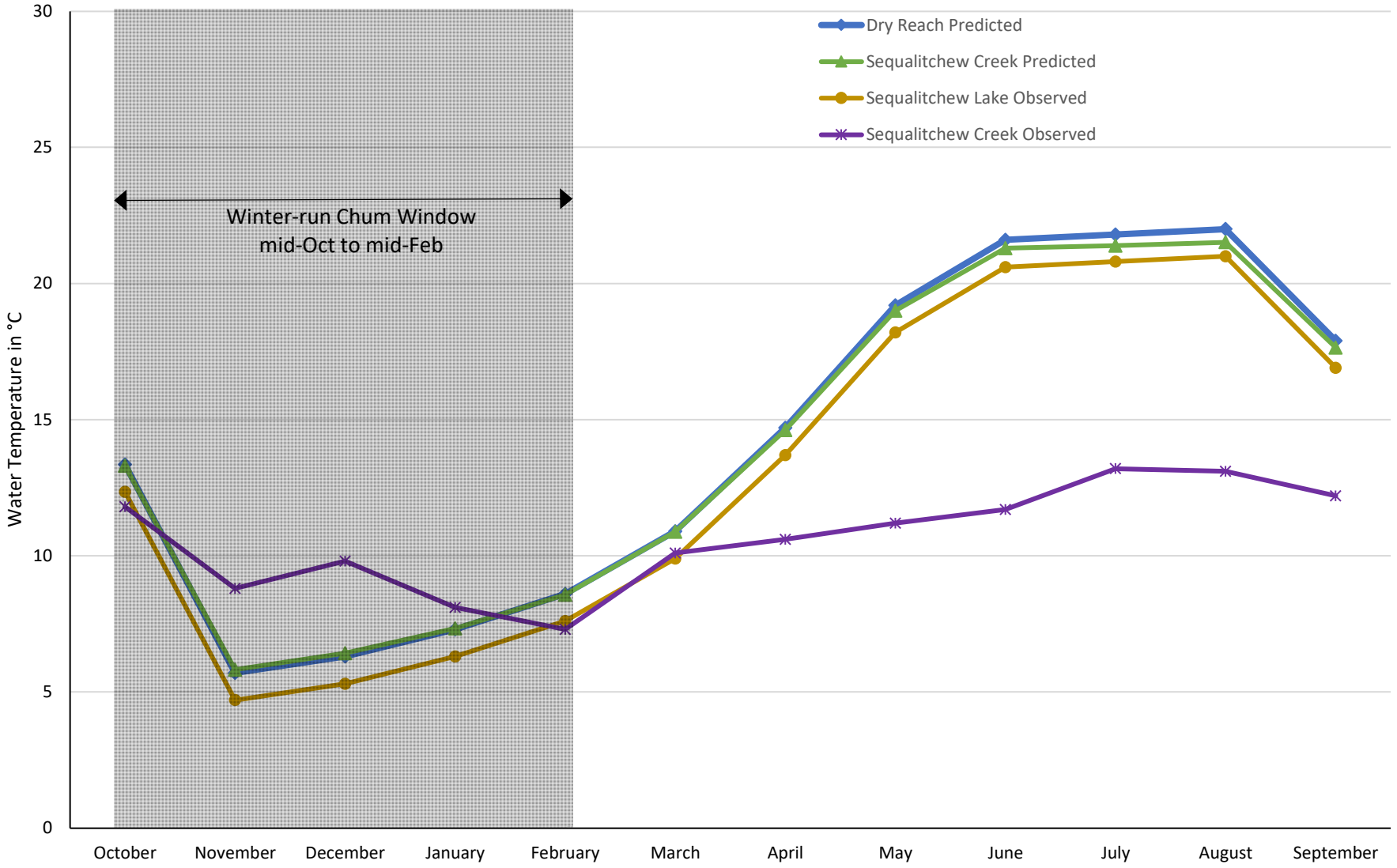


Figure 40

Predicted Streamflow Hydrograph for Sequalitchew Creek with Mining and Restoration



Aspect Consulting
10/28/2022
S:\CalPortland\DuPont\South Parcel\Report Drafts\Earth and Water Resources Report 2021\Analysis\WQCalcs-r2.xlsx

Figure 41
Predicted Effects on Stream Temperature in Sequalitchew Creek
Pioneer Aggregates South Parcel Project

APPENDIX A

Select Boring Logs

Aspect consulting
IN-DEPTH PERSPECTIVE

Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
040001	BM-MW-1	1 of 1

Project Name: North Sequalitchew Creek
Location: DuPont, Washington
Drilling Method: Hollow Stem Auger - 4" ID ; Holt Drilling
Sampling Method: 3" Diameter D&M

Top of Casing Elev. (ft mllw): 232.32
Ground Surfave Elev. (ft): 229.37
Depth to Water (ft bgs): 12.5
Start Date: August 3, 2004
Finish Date: August 3, 2004

Depth feet	Well Construction	Tests\Remarks	Blows/ 6"	Sample ID	Mtl. Graphic	Description
1	5" diameter steel monument, cement seal 0'-1.5'					Brown, dry, GRAVEL, trace silt; gravel fine to coarse, predominantly coarse; abundant cobbles, subrounded to rounded (GW)
2						
3						(Road fill)
4	Natural Fill 1.5'-5'					
5		18"/4"	11	5-6.5		Brown to tan, moist sandy GRAVEL, trace silt; gravel fine to coarse, subrounded to rounded; sand predominantly medium to coarse.
6			12			
7			10			
8		18"/12"	4	7.5-9		Brown to reddish brown, moist, slightly gravelly SAND, trace silt; sand fine to coarse, predominantly medium; gravel fine, subangular to rounded (SP)
9	Bentonite Chips 5'-12'		10			
10			16			
11		18"/5"	9	10-11.5		Occasional coarse gravel and grades medium to coarse sand.
12		8/3/04	15			
13		18"/6"	19			
			8	12.5-14		Brown to red-brown, wet, gravelly SAND, trace silt; sand predominantly coarse; gravel fine to coarse, predominantly fine.
	10/20 silica sand filter pack 12'-26.5'		14			
15		18"/10"	15			
16			9	15-16.5		
17			10			
18		18"/8"	16			Yellowish-green to brown, highly oxidized, wet, slightly to trace silt; sandy GRAVEL; gravel fine to coarse; sand predominantly coarse (GW-GM)
19			5	17.5-19		Yellow brown, highly oxidized, wet, slightly gravelly SAND, trace silt; sand medium to coarse, predominantly coarse; gravel predominantly fine (SP)
20	20-slot screen 15'-25'; slip cap with SS screw 25'-25.3'	18"/12"	8			Grades to slightly silty and gravelly in shoe (SP-SM)
21			8			
22			9	20-21.5		Gray olive, wet, SAND; trace gravel; trace to no silt; sand predominantly medium to coarse (SP)
23		18"/14"	11			Gray green, wet, slightly silty to trace silt, sandy GRAVEL; gravel fine to coarse, subrounded to rounded; sand medium to coarse. (GP-GM)
24			13	22.5-24		Gray green, wet, SAND; sand medium (SP)
25		18"/3"	25			
26			24			Gray olive, wet, sandy GRAVEL, trace silt; gravel fine to coarse, sand predominantly medium to coarse (GP)
27			28	25-26.5		Gray olive, wet, slightly silty sandy GRAVEL; gravel fine to coarse; sand medium to coarse (GP-GM)
28			19			
29			17			Total depth = 25' drilled; 26.5' driven.

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

PID - Photoionization Detector
Water Level (ATD)
Static Water Level

Logged by: ILE
Approved by: LJH
Figure No. A- 1

APPENDIX B

MW_GEOL S CRK_SEQ CRK.GPJ November 23, 2004

CH2MHILL

Well Number: CHMW-1

Sheet: 1 of 1

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Bill & Steve)
Drilling Method: Speedstar 15 Truck-Mounted Air Rotary
Sampling Method: Sand pump (water added)
Logged by: driller
Start/Finish Date: 9/23/99 - 9/24/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5		
					217		Monument (not shown)-- Lockable 6" steel protective casing in concrete.
0				Ground Surface			
				Topsoil	2		
5				Sand and gravel with silt, dry, brown	210		
10							Casing - 2" sch 40 PVC pipe
15							
20					22		
				Brown silty gravel	190		
25					26		
				Brown gravel, like till	186		
30					33		
				Brown silt	179		
35				Light brown gravel, productive water-bearing zone			
40							
45							
50							
55					57		
				Dark brown gravel and sand. Note no "soupy sand" like in CHTW-1.	155		
60							Casing Seal - Hydrated medium bent
65							
70							
75					76		Filter pack - 10-20 CSSI sand
				Dark brown sand and gravel	136		Screen - 2" sch 40 PVC, 0.020-in slot
80					82		
				Gray-blue silty sand, sand and gravel.	130		
85					85		6" end cap
					127		

CH2MHILL

PROJECT NUMBER : 151973.A1.AT

WELL NUMBER : CHMW-1

WELL CONSTRUCTION/BORING LOG

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' S. OF CHTW-1**

WATER LEVELS : **21'6 3/4" ATD**

DRILLING METHOD/EQUIPMENT : **SPEEDSTAR 15 TRUCK-MOUNTED AIR ROTARY**

START : **9/23/99** END : **9/24/99** LOGGER: **HOKKAIDO(BILL&STEVE)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
0	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
	0-2FT Topsoil
	2-22FT Sand/gravel w/silt (dry,brown)
5	
10	
15	
20	
	22-26FT Brown silty gravel
25	
	26-33FT Brown gravel (like till)
30	

CH2MHILL

PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-1 SHEET 2 OF 3

WELL CONSTRUCTION/BORING LOG

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' S. OF CHTW-1**

WATER LEVELS : **21'6 3/4" ATD**

DRILLING METHOD/EQUIPMENT : **SPEEDSTAR 15 TRUCK-MOUNTED AIR ROTARY**

START : **9/23/99** END : **9/24/99** LOGGER: **HOKKAIDO(BILL&STEVE)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
	33-35FT Brown silt
35	35-57FT Lt.brown gravel, productive water-bearing zone
40	
45	
50	
55	
	57-59FT Dk.brown gravel & sand NOTE: No "soupy sand" at 50' like in CHTW
60	

CH2MHILL

PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-1 SHEET 3 OF 3

WELL CONSTRUCTION/BORING LOG

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' S. OF CHTW-1**

WATER LEVELS : **21'6 3/4" ATD**

DRILLING METHOD/EQUIPMENT : **SPEEDSTAR 15 TRUCK-MOUNTED AIR ROTARY**

START : **9/23/99** END : **9/24/99** LOGGER: **HOKKAIDO(BILL&STEVE)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
65	
70	
75	
	76-82FT Dk.brown sand & gravel
80	
	82-83FT Gray silty sand & gravel
	83-85FT Blue sand & gravel
85	
	WELL: STICKUP=2' (2"sch 40 pvc) SCREEN=75'-84.5' (2"sch 40 pvc, 20-slot) 6" endcap 84.5 -85 fbgs ANNULUS=15 bags 10-20 cost sand (50lb. ea) 52 bags med. bentonite chips (50lbs ea) MONUMENT=6" steel protective casing in concrete
0	

CH2MHILL

Well Number: CHMW-2(D)

Sheet: 1 of 1

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Steve & Tom)
Drilling Method: Speedstar 15 & Star 71 Cable Tool
Sampling Method: Sand pump (water added)
Logged by: Driller
Start/Finish Date: 11/12/99 - 11/18/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 212		Monument (not shown): Lockable 6' steel protection casing in concrete
0				Ground Surface			
				Topsoil	4		
5				Brown silty gravel	203 9		
10				Brown gravel	198		Casing--2" sch 40 PVC pipe
15				Brown silty gravel, moist	15 192		
20					24		
25				Hard till, brown	[illegible]		
				Loose sand and gravel, water	181		
30							Casing Seal--Hydrated medium bentc
35				Brown till	35 172		
40							
45					48		
50				Loose sand and gravel, water	159		
55					58		
60				Brown silt bound sand and gravel, tight	149		
65					66		Screen - 2" sch 40 PVC, 0.020-in slot with centralizer
				no record	141		
70					73		6" end cap
75				End of Log	134		

CH2MHILL

PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-2(D) SHEET 1 OF 3

WELL CONSTRUCTION/BORING LOG

TOC elev = 209 Stickup = 1.8 grd = 207.2

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' N. OF TW-2**

WATER LEVELS :

DRILLING METHOD/EQUIPMENT: **SPEEDSTAR 15, 8" STEEL CASING(TO58") &STAR 71 CABLE TOOL, 8" CASING**

START : **11/12/99** END : **11/18/99** LOGGER: **HOKKAIDO(STEVE & TOM)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
0	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
	0-4FT Dark brown topsoil
	4-9FT Brown silty gravel
5	
	9-15FT Brown gravel
10	
	15-24FT Brown, silty gravel, moist
15	
20	
25	24-26FT Hard till, brown
	26-35FT Loose sand & gravel H20
30	

CH2MHILL

PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-2(D)
	SHEET 2 OF 3

WELL CONSTRUCTION/BORING LOG

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' N. OF TW-2**

WATER LEVELS :

DRILLING METHOD/EQUIPMENT: **SPEEDSTAR 15, 8" STEEL CASING(TO58") &STAR 71 CABLE TOOL, 8" CASING**

START : **11/12/99** END : **11/18/99** LOGGER: **HOKKAIDO(STEVE & TOM)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
35	35-48FT Brown till
40	
45	
50	48-58FT Loose sand & gravel H20
55	
60	58-66FT Brown light Silt Bound sand & gravel

CH2MHILL

PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-2(D) SHEET 3 OF 3

WELL CONSTRUCTION/BORING LOG

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' N. OF TW-2**

WATER LEVELS :

DRILLING METHOD/EQUIPMENT: **SPEEDSTAR 15, 8" STEEL CASING(TO58") &STAR 71 CABLE TOOL, 8" CASING**

START : **11/12/99** END : **11/18/99** LOGGER: **HOKKAIDO(STEVE & TOM)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
65	66-73FT NO RECORD
	Total Casing=72'-41/4"
	Well:
70	Stickup=2' (2"sch 40 pvc) w/j plug Screen= 63'-721/2' bgs (2" sch 40 pvc, 20-slot) w/centralizer 6"end cap 721/2-73 fbgs Annulus=13 50-lb bags 10-20 cssi sand 34 50-lb bags medium bentonite chips Monument= 6" steel protectivecasing in concrete
75	
80	
85	
90	

CH2MHILL

Well Number: CHMW-2(S)

Sheet: 1 of 1

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Daryl & Tom)
Drilling Method: Star 71 cable tool, 8" steel casing
Sampling Method: Sand pump (water added)
Logged by: driller
Start/Finish Date: 11/17/99 - 11/19/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 212		Monument (not shown)-- Lockable 6" steel protection casing in concrete.
0				Ground Surface Topsoil and gravel	3		
5				Brown silty sand and gravel	204		
10							Casing - 2" sch. 40 PVC pipe
15							Casing seal - Hydrated medium bentc
20					21		
25				Larger gravel and sand, slightly silty, very hard	186 26		
30				Brown silty sand, gravel Sandier with gravel	181		Sandy filterpack - 10-20 CSSI sand
35					36		
40				Clean sand and gravel, water	171		Screen - 2 centralizers, 2" sch 40 PV(0.020-inch slot width
45					43		6" end cap
50				End of Log	164		

CH2MHILL

PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-2(S)
	SHEET 1 OF 2

WELL CONSTRUCTION/BORING LOG

TOC elev = 209.39 Stickup = 1.45
grd = 207.94

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' N. OF TW-2(~15FT E.OF MW-2(D)**

WATER LEVELS :

DRILLING METHOD/EQUIPMENT: **STAR 71 CABLE TOOL, 8" STEEL CASING**

START : **11/17/99** END : **11/19/99** LOGGER: **HOKKAIDO(DARYL & TOM)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
0	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
	0-3FT Topsoil & gravels
	3-21FT Brown silty sand and gravels
5	
10	
15	
20	
	21-26FT Larger gravels & sand slightly silty, very hard
25	
	26-27FT Brown silty sand & gravel
	27-28FT Sandier w/gravel (gravel smaller)
30	

CH2MHILL

PROJECT NUMBER : 151973.A1.AT	WELL NUMBER : CHMW-2(S) SHEET 2 OF 2

WELL CONSTRUCTION/BORING LOG

PROJECT : **LONE STAR, DUPONT** LOCATION : **50' N. OF TW-2(~15FT E.OF MW-2(D)**

WATER LEVELS :

DRILLING METHOD/EQUIPMENT: **STAR 71 CABLE TOOL, 8" STEEL CASING**

START : **11/17/99** END : **11/19/99** LOGGER: **HOKKAIDO(DARYL & TOM)**

DEPTH BELOW SURFACE (FT)	CORE DESCRIPTION/COMMENTS
	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.
35	36-43FT Clean sand & gravel w/H20 Total casing=46'-81/2" Well: Stickup=2' (2" sch 40 pvc) w/j-plug Screen=33'-421/2' bgs w/2 centralizers & 6' end (2"sch 40 pvc, 20-slot) Annulus=13 50-lb bags 10-20 cgsi sand 18 50-lb bags medium bentonite chips Monument= 6"steel protecting casing in concrete (7 bags)
40	
45	
50	
55	
60	

CH2MHILL

Well Number: CHMW-3(D)

Sheet: 1 of 1

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Steve)
Drilling Method: Speedstar 15 Air Rotary Drill Rig
Sampling Method: Sand pump (water added)
Logged by: driller
Start/Finish Date: 11/4/99 - 11/5/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5		Monument (not shown): Lockable 6" steel protective casing in concrete
					221		
0				Ground Surface			
				Brown topsoil	2		
5				Loose brown gravel	214		
10							Casing - 2" sch 40 PVC pipe
15					16		
				Brown silty sand and gravel	200		
20							
25					26		
				Brown silty sand and gravel (moist)	190		Casing seal - hydrated medium bento
30					31		
				Brown sand and gravel, dirty, water	185		
35							
40					41		
				Brown till	175		
45							
					48		
50				Sand and gravel, water	168		
					54		
55				Brown till	162		
				Silt, sand and gravel, brown, wet			
60							
					64		
65				Clean sand and gravel	152		
70							
							Filter pack - 10-20 CSSI sand
75							Screen - 2" sch 40 PVC, 0.020-in slot
80							
					85		6" end cap
85				End of Log	131		
90							

CH2MHILL

Well Number: CHMW-3(S)

Sheet: 1 of 1

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Steve)
Drilling Method: Speedstar 15 Air Rotary Drill Rig
Sampling Method: Sand pump (water added)
Logged by: driller
Start/Finish Date: 11/5/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 / 221		Monument (not shown): Lockable 6" steel protection casing in concrete
0				Ground Surface			
				Brown topsoil	2		
				Loose gravel	214		
5							Casing - 2" sch 40 PVC pipe
10							
15					16		Casing seal - Hydrated medium bentc
				Silty brown sand and gravel	200		
20							
25					26		
				Moist silty brown sand and gravel	190		Filter pack - 10-30 CSSI sand
30					31		Screen - 2" sch 40 PVC, 0.020-in slot
				Clean sand and gravel, water	185		
35							
40					40		6" end cap
				End of Log	176		
45							

CH2MHILL

Well Number: CHMW-4(D)

Sheet: 1 of 1

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Steve)
Drilling Method: air rotary
Sampling Method: Sand pump (water added)
Logged by: diller
Start/Finish Date: 11/11/99

Depth (ft)	Sample info: Sample #	Sample info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 / 219		
0				Ground Surface			
				Topsoil	2		
5				Brown gravel	212		Monument: Lockable 6" steel protective casing in concrete
10							
15					15		
				Brown till	199		
20							
25							Casing - 2" sch 40 PVC pipe
30							
					34		
35				Sand, gravel, making water	180		Casing seal - hydrated medium bento
40							
45							
					48		
50				Brown till	166		
					53		
55				Sand, gravel, making water	161		
60							
65					66		
				Brownish orange silty gravel	148		
70				Sand, gravel, water			
75							Filter pack - 10-20 CSSI sand
							Screen - 2" sch 40 PVC, 0.020-in slot
80							
					85		6" end cap
85					129		

CH2MHILL

Well Number: CHMW-4(S)

Sheet: 1 of 1

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Steve)
Drilling Method: air rotary
Sampling Method: Sand pump (water added)
Logged by: driller
Start/Finish Date: 11/23/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 219		Monument (not shown): Lockable 6" steel protective casing
0				Ground Surface Topsoil with large gravel	3		
5				Brown silty sand and gravel	211		
10					11		Casing - 2" sch 40 pvc pipe w/ j-plug
				Brown silty sand and large boulders	203		
15					15		Casing seal - hydrated medium bento
				Sand and gravel with water	199 17		
				Brown silt with gravel	197		
20							
25							Filterpack - 10-20 CSSI sand
							Screen - 2" sch 40 pvc, 0.020-in slot v
30							
35							
					37		6" end cap
				End of Log	177		
40							

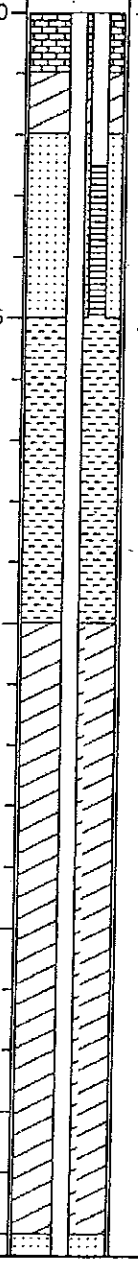
CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-1
Sheet: 1 of 2

SOIL BORING LOG

GS elev = 207.3

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~100' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/11/02 1544 **FINISH:** 12/11/02 1620 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface	Drilled down to 24 feet bgs before first sample. Two piezometers installed in one monument. EM-1(S) is the shallow piezometer, and EM-1(D) is the deep piezometer 4': Driller states in gravel and a little water 12': Sounded gravelley to 14' while drilling, rig stopped in gravel 14': Loaded hole with water 14-16': Gravelly, smoother drilling below 16' 17': Driller states cobbles about 4" in diameter, then smaller sized gravels below 17' 17-24': Smooth drilling, loaded hole with water
5						
10						
15						
20						

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-1
Sheet: 2 of 2

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~100' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/11/02 1544 **FINISH:** 12/11/02 1620 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
25		DM	12	16-20-25 (45)	POORLY GRADED SAND WITH GRAVEL (SP) Gray, wet, medium dense, fine to medium grained sand, fine to coarse round to subround gravel, est. 15-20% gravel	
		DM	0	39-50/4" (50/4")	POORLY GRADED SAND WITH GRAVEL (SP) -similar to above but fine to medium gravel	Bottom of boring at 33.5' at 1620 on 12/11/02.
30		DM	12	34-35-35 (70)	No recovery -Slough	Measured groundwater at 6.10' (EM-1(S)) and 7.47' (EM-1 (D)) below top of steel on 12/11/02
		DM	6	50/6" (50/6")	POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM) Gray, wet, very dense, fine to medium grained sand, fine to coarse gravel, gets siltier toward bottom of sample, grades to SILTY SAND WITH GRAVEL (SM) at 32' Gray, wet, very dense, fine to medium grained sand, fine to medium round to subround gravel, est. 10-20% silt, 20-25% gravel	Piezometer Construction (EM-1(S) and EM-1(D)) +3.65-0' Steel riser, locking monument 3.xx-2.5' Blank PVC (EM-1(S)) 3.xx-22' Blank PVC (EM-1(D)) 0-1' Concrete 1-2' Bentonite chips 2-5' Lapis Lustre 2/12 silica sand 2.5-5' 0.020 machine slot screen and cap (EM-1(S)) 5-10' Cuttings 10-20' Bentonite chips 20-33.5' Lapis Lustre 2/12 silica sand 22-32' 0.020 machine slot screen and cap (EM-1(D)) Note: Both piezometers are in one steel, riser monument
35					BOTTOM OF BORING	
40						

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-1A
Sheet: 1 of 5

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~100' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/11/02 **FINISH:** 12/11/02 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface	
		DM	18	1/12"-1/6" (2)	ORGANICS Dark brown, moist, very soft	
		DM	18	5-7-12 (19)	PEAT (PT) Dark brown, moist, very soft, fiberous	
		DM	8	43-40-40 (80)	SANDY SILTY GRAVEL (SM) Light brown, wet, loose, fine to coarse grained sand, coarse round to subround gravel	3': Driller states in gravel and a little water
5		DM	8	35-37-39 (76)	PEAT (PT) Dark brown, moist, very soft, fiberous, trace gravel mixed in	4.5': Sampler very wet, large gravel/small cobble jammed in shoe
					SANDY SILTY GRAVEL (GM) -Similar to above, light brown, wet, dense, fine to coarse grained sand, coarse round to subround gravel	6': Drilled in gravel from 4.5-6'.
					SILTY SAND WITH GRAVEL (SM) Gray, wet, dense, fine to coarse grained sand, fine to coarse round to subround gravel, trace round cobbles (TILL-LIKE)	
10		DM	10	28-35-39 (74)	SILTY GRAVEL WITH SAND (SM) Gray, wet, dense, fine to coarse gravel, fine to coarse grained sand, est. 30% silt, 20% sand (TILL-LIKE) In shoe: SANDY SILT (ML) Gray, moist, hard, fine to medium grained sand, est. 20-30% sand	
15		DM	12	42-35-38 (73) ?	SANDY WELL GRADED GRAVEL WITH SILT (GW-GM) Gray, wet, medium dense, fine to coarse round to subround gravel, fine to coarse sand, est. 30% sand, 10-15% fines	14': Sampler wet 17': Driller states not as much rock, large gravel 19': Water poured out of sampler 19.5': Measured groundwater through augers at 1406 on 12/11/02. Augers may be acting as a barrier.
20		DM	4	21-25-27 (52)		

PT
Qvl
Qvr
dense
med. dense

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-1A
Sheet: 2 of 5

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~100' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/11/02 **FINISH:** 12/11/02 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					GRAVELLY SAND (SW) Gray, wet, medium dense, fine to coarse grained sand, fine to coarse round to subround gravel, est. 30-40% gravel	
25		DM	10	42-33-30 (63)	POORLY GRADED SAND WITH GRAVEL (SP Gray, wet, medium dense, fine to medium grained sand, fine to coarse round to subround gravel, trace fine cobbles, est. 15-20% gravel	
30		DM	12	24-35-38 (73)	WELL GRADED SAND WITH GRAVEL (SW) Gray, wet, medium dense, fine to coarse grained sand, fine to medium round to subround gravel, trace fines, increased fines toward bottom of sampler, est. 20-30% gravel	
35		DM	6	50/6" (50/6")	POORLY GRADED SAND WITH SILT AND GRAVEL TO SILTY SAND WITH GRAVEL (SP-SM/SM) Gray, wet, very dense, fine to medium grained sand, fine to medium round to subround gravel, est. 10-20% fines, 20-25% gravel (TILL??)	34': Driller states back into a few cobbles
40		DM	4	50/4" (50/4")		

Bottom of Boring

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-1A
Sheet: 3 of 5

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~100' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/11/02 **FINISH:** 12/11/02 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM) Gray, wet, very dense, fine to medium grained sand, fine to coarse round to subround gravel, est. 10% fines, 10-15% gravel	
45		DM	4	50/5" (50/5")	POORLY GRADED SAND (SP) Gray, wet, very dense, fine to medium grained sand, trace fines	
50		DM	4	50/4" (50/4")	GRAVELLY WELL GRADED SAND WITH SILT (SW-SM) Gray, wet, very dense, fine to coarse round to subround gravel, est. 5-10% fines, 30-40% gravel	
55		DM	6	50/6" (50/6")	POORLY GRADED SAND (SP) Gray, wet, very dense, fine to medium grained sand	
60		DM	6	50/6" (50/6")		59': Driller states a little more gravel

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-1A
Sheet: 4 of 5

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~100' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/11/02 **FINISH:** 12/11/02 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM) Gray, wet, very dense, fine to medium grained sand, fine to medium round to subround gravel, est. 10-15% fines, 5-10% gravel	
65		DM	5	50/5" (50/5")	WELL GRADED SAND WITH GRAVEL TO WELL GRADED SAND WITH SILT AND GRAVEL (SW/SW-SM) Gray, wet, very dense, fine to coarse grained sand, fine to medium round to subround gravel, est. 5-10% fines, 20-30% gravel	
70		DM	5	50/5" (50/5")	POORLY GRADED SAND (SP) Gray, wet, very dense, medium to coarse grained round to subround sand, fine to medium round to subround gravel, est. <5% fines, 5-10% gravel	
75		DM	6	50/6" (50/6")	WELL GRADED SAND WITH GRAVEL TO WELL GRADED SAND WITH SILT AND GRAVEL (SW/SW-SM) Gray, wet, very dense, fine to coarse grained sand, fine round to subround gravel, est. 5-10% fines, 10-15% gravel	
80		DM	5	50/5" (50/5")		

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-1A
Sheet: 5 of 5

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~100' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/11/02 **FINISH:** 12/11/02 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM) Gray, wet, very dense, fine grained sand, fine to medium round to subround gravel, est. 10-15% fines, 20-30% gravel	
						83': Driller states into silts
85		DM	4	50/4" (50/4")	SILT (ML) Gray, moist to wet, hard	
90		DM	4	50/4" (50/4")	SILT (ML) -Similar to above, gray, moist to wet, hard, fine to medium sand seams	Bottom of boring at 89.3' at 1300 on 12/11/02.
					BOTTOM OF BORING	Driller states not much heave while drilling
						Backfilled boring with grout. Could not install piezometer in this boring. Had to move 3' north and redrill to the bottom of the piezometer installation.
95						
100						

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-2
Sheet: 1 of 3

SOIL BORING LOG

GS elev = 212.1'

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~10' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/12/02 0934 **FINISH:** 12/12/02 1228 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Ground Surface	
		DM	12	2-5-5 (10)	SILTY SAND WITH ORGANICS (SM) Dark brown, moist, loose, fine grained sand, trace fine to medium round to subround gravel, est. 30-40% fines, 20% organics (TOPSOIL)	Two piezometers installed in separate monuments. EM-2(S) is the shallow piezometer, and EM-2(D) is the deep piezometer
		DM	6	5-6-6 (12)	SANDY SILTY GRAVEL (GM) Dark brown, moist to wet, medium dense, well graded round to subround gravel, est. 20% fines, 30-40% sand, trace organics (FILL)	3': Driller states in gravel and a little water
		DM	18	3-1-1 (2)	SILTY SAND WITH GRAVEL (SM) Light brown, moist, medium dense, fine to medium grained sand, fine to medium round to subround gravel, est. 15-20% gravel, 20% fines, trace organics (FILL)	
5		DM	18	6-16-18 (34)		5': Driller states drilling in gravel
					PEAT (PT) Dark brown, wet, very soft, fiberous	
					SANDY SILTY GRAVEL (GM) Gray, moist, medium dense, well graded round to subround gravel, fine to medium grained sand, est. 20% fines, 30% sand	
		DM	12	18-21-15 (36)		8': Sampled, then loaded hole with water
10					SILTY SAND WITH GRAVEL (SM) Gray, wet, medium dense, fine to medium grained sand, fine to coarse round to subround gravel, est. 20-30% fines, 20-30% gravel, not compacted, soupy	
		DM	12	18-22-18 (40)	GRAVELLY WELL GRADED SAND (SW) Gray, wet, medium dense, round to subround sand and gravel, fine to medium gravel, trace coarse gravel, est. <5% fines, 30-40% gravel	13': Driller states from 8-13' pretty sandy, not much gravel 14': Sampler wet
15						
		DM	10	44-50/6" (50/6")	GRAVELLY WELL GRADED SAND (SW) Gray, moist to wet, very dense, fine to coarse grained sand, fine round to subround gravel, est. 30-35% gravel	18': Top of sample was heave
20						

PT
Qvl
GM/SM
Qvr

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-2
Sheet: 2 of 3

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~10' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/12/02 0934 **FINISH:** 12/12/02 1228 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		DM	12	24-26-30 (56)	GRAVELLY WELL GRADED SAND (GW) Gray, moist to wet, medium dense, fine to coarse grained sand, fine to coarse round to subround gravel, est. 30-40% gravel	20.5': Heave in sampler
		DM	12	34-50/6" (50/6")	SANDY WELL GRADED GRAVEL (GW) Gray, moist to wet, very dense, well graded sand, round to subround gravel, est. 30-35% sand	
25		DM	12	23-36-50/6" (86/12")	SANDY WELL GRADED GRAVEL (GW) -Similar to above, gray, moist to wet, dense to very dense, well graded sand, est. 30-40% sand, becomes siltier toward bottom of sample, est. up to 10% silt toward bottom of sample	25.5': Driller drained water out of samples before opening split spoon. Driller loads hole with water, difficult to determine if samples are wet from drilling water or groundwater. All heave in sample from 25.5'. Resampled.
30		DM	12	32-40-50/6" (90/12")	GRAVELLY WELL GRADED SAND (SW) Gray, moist to wet, very dense, fine to coarse grained sand, fine round to subround gravel, "clean"-little to no fines	
		DM	12	36-44-50/6" (94/12")	GRAVELLY WELL GRADED SAND (SW) -Similar to above	
35		DM	2	44-50/3" (50/3")	WELL GRADED SAND (SW) Gray, moist to wet, very dense, fine to coarse round to subround sand	
		DM	6	36-50/6" (50/6")	SANDY WELL GRADED GRAVEL (GW) Gray, moist to wet, very dense, well graded sand, round to subround gravel, est. 30-40% sand, est. 5% silt	
40		DM	3	33-40-50/6" (90/12")	POORLY GRADED SAND WITH GRAVEL (SP) Gray, moist to wet, very dense, fine to medium grained sand, coarse round to subround gravel, est. 15-20% gravel	38': 3" of heave in sampler

CH2MHILL

PROJECT NUMBER: 151973.A4.WL BORING NUMBER: EM-2
Sheet: 3 of 3

SOIL BORING LOG

PROJECT: N. Sequalitchew Creek Wetland **LOCATION:** ~10' S. of Edmond Marsh Trail
ELEVATION: **DRILLING CONTRACTOR:** Cascade Drilling
DRILLING METHOD AND EQUIPMENT: CME 75 nodwell track rig, HSA, Dames & Moore, 140lb hammer
WATER LEVELS: See log **START:** 12/12/02 0934 **FINISH:** 12/12/02 1228 **LOGGER:** S. McGinnis

DEPTH BELOW GROUND SURFACE	WELL INSTALLATION	SAMPLE TYPE	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		DM	10	16-38-50/6" (88/12")	**WELL GRAED SAND WITH GRAVEL (SW)** Gray, moist to wet, very dense, fine round to subround gravel, "clean", grades to **WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)** 42' Gray, moist to wet, very dense, fine round to subround gravel, est. 15% gravel, 10-15% silt	
		DM	12	18-28-30 (58)	**POORLY GRADED SAND (SP)** Gray, moist to wet, fine to medium grained sand, trace fine to coarse round to subround gravel, est. 5% or less gravel	
45		DM	12	29-36-42 (78)	**POORLY GRADED SAND (SP)** -Similar to above, some gravels have brown staining surrounding the gravel and within the fine grained sand, fine gravel	
Qvr		DM	12	36-50/6" (50/6")	**POORLY GRADED SAND WITH GRAVEL (SP)** Gray, moist, very dense, fine to medium grained sand, fine to coarse round to subround gravel, gravel was packed in "tight", trace dark organics?, pockets/lenses of fine sand at 48'	48': Driller states it felt more compacted
50		DM	6	(100/6")		Bottom of boring at 51.7' at 1228 on 12-12-02
Qvt		SS	6	(100/8")	**SILTY WELL GRADED SAND WITH GRAVEL (SM)** Gray, moist to wet, very dense, some is compact where the sand is finer grained, est. 20-25% gravel	**Deep Piezometer Construction (EM-2(D))** +2.55-0' Steel riser, locking monument 0-2' Concrete 2-36' Quick grout 36-38' Bentonite chips 38-51.7' Lapis Lustre 2/12 silica sand 0-40' Blank pvc 40-50' 0.020 machine slot screen and cap
					SILTY SAND WITH GRAVEL (SM) Gray, moist, very dense, fine grained sand, fine round to subround gravel, est. 20-25% gravel, compacted looking	
55					BOTTOM OF BORING	**Shallow Piezometer Construction (EM-2(S))** Drilled and installed in a separate monument about 3 feet east of deep well 0-1' Concrete and riser 1-2' Bentonite chips 2-5' Lapis Lustre 2/12 silica sand 0-2.5' Blank pvc 2.5-5' 0.020 machine slot screen and cap
60						

Aspect consulting
IN-DEPTH PERSPECTIVE

Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
040001	EM-3	1 of 1

Project Name: North Sequalichew Creek
Location: Fort Lewis, WA
Drilling Method: Hollow stem auger, 4" ID ; Holt Drilling
Sampling Method: 3" diameter D&M
Ground Elevation 214.63

Top of PVC Casing Elev. (ft mllw) 217.38
Depth to Water (ft BTC) 4.96
Start Date March 11, 2004
Finish Date March 11, 2004

Depth feet	Well Construction	Tests\Remarks	Blows/ 6"	Sample ID	Mtl. Graphic	Description
	5" diameter steel monument, 3' stickup; Concrete seal 0'-2'					Sod and dark brown organic soil
						FILL
		3/26/04 ▼				Gravel, some cobbles at 0.5'
			3 7 10	S-1		Medium dense, moist, dark brown, sandy GRAVEL with SILT and ORGANICS, trace wood
			3 6 8	S-2		Medium dense, wet, gray SAND and GRAVEL
5			6 2 1	S-3		MARSH DEPOSITS
		K Test K = 1x10^{-5} cm/s	1 1 9	S-4		Soft, wet, brown, slightly fibrous PEAT, trace gravel
			8 12 14	S-5		Medium dense, wet, brown, sandy GRAVEL to GRAVEL, trace silt
10	Bentonite chips 2'-13'		2 6 6	S-6		RECESSIONAL OUTWASH
			7 8 13	S-7		Medium dense, wet, gray SAND, trace gravel; sand fine to medium; 1/4" silt seam
			1 12 25	S-8		No recovery, coarse gravel in shoe of sampler
15			16 17 16	S-9		Dense, wet, brown, gravelly SAND to sandy GRAVEL
	10/20 silica sand filter pack 13'-20'		11 16 32	S-10		Dense, wet, sandy GRAVEL
	20-slot screen 15'-20'; slip cap with SS screw 20'-20.3'		15 25 35	S-11		
20						Bottom of boring at 20 feet.

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

PID - Photoionization Detector
▼ Water Level (ATD)
▽ Static Water Level

Logged by: RRH
Approved by: LJH
Figure No. B - 1

SEQUALICHEW CREEK.GPJ July 21, 2004

Aspect consulting
IN-DEPTH PERSPECTIVE

Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
040001	HM-MW-1	1 of 1

Project Name: North Sequalitchew Creek
Location: DuPont, Washington
Drilling Method: Hollow Stem Auger - 4" ID ; Holt Drilling
Sampling Method: 3" Diameter D&M

Top of Casing Elev. (ft mllw): 221.06
Ground Surfave Elev. (ft): 217.75
Depth to Water (ft bgs): 5
Start Date: August 2, 2004
Finish Date: August 2, 2004

Depth feet	Well Construction	Tests\Remarks	Blows/ 6"	Sample ID	Mtl. Graphic	Description
1						Brown, slightly silty GRAVEL; gravel, predominantly coarse and cobbles (observed from drill action and cuttings) (GP)
2	5" diameter steel monument, cement seal 0'-4'					
3		18"/5"	3 27 30	2.5-4		Brown, moist, slightly silty to trace silt, sandy GRAVEL; sand medium to coarse; gravel fine to coarse, abundant cobbles, subangular to rounded (GW)
4						
5		8/2/04 ▼ 18"/8"	11 23 23	5-6.5		Brown to olive gray, wet, very sandy GRAVEL, trace silt; sand medium to coarse, predominantly medium; gravel fine to coarse with cobbles, subangular to subround; no apparent organization.
6	Bentonite Chips 4'-7.5'					
7						
8		18"/11"	19 22 24	7.5-9		Color change to olive gray; grades to medium to coarse sand and predominantly fine gravel; increase in silt (still trace silt), less cobbles.
9						
10		18"/6"	22 28 32	10-11.5		Olive gray to gray-green, wet, SAND; trace gravel; sand medium to coarse, occasional zones of fine to medium; gravel fine (SP-SW)
11	10/20 silica sand filter pack 7.5'-20.3'					
12						
13		18"/12"	21 30 35	12.5-14		Olive gray, wet, slightly silty, very sandy GRAVEL; gravel fine to coarse; with cobbles; sand predominantly medium to coarse (GW-GM)
14						
15	20-slot screen 10'-20'; slip cap with SS screw 20'-20.3'	18"/10"	21 31 44	15-16.5		Gray-green to olive gray, wet, SAND, trace gravel; sand predominantly medium to coarse; gravel fine (SW)
16						Olive gray, wet, very sandy GRAVEL, trace silt, sand medium to coarse, occasional fine, predominantly coarse; gravel fine to coarse (GW)
17						
18		18"/10"	26 50/6"	17.5-19		Gray-green, wet SAND; trace gravel; sand predominantly medium to coarse (SW)
19						Olive-gray, wet, very sandy GRAVEL, trace silt; gravel fine to coarse; sand predominantly medium to coarse (GW)
20		18"/11"	26 50/6"	20-21.5		Gray to olive gray, wet SAND; sand medium; homogenous (SP)
21						
22						Olive gray to gray, wet, sandy GRAVEL, trace silt; gravel fine to coarse; subrounded to rounded; sand medium to coarse, predominantly medium (GW)
23						Total depth = 20' drilled, 22.5' driven.
24						
25						
26						
27						
28						
29						

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

PID - Photoionization Detector
▼ Water Level (ATD)
▽ Static Water Level

Logged by: ILE
Approved by: LJH
Figure No. A-2

MW_GEOL S CRK.GPJ November 23, 2004

14P1

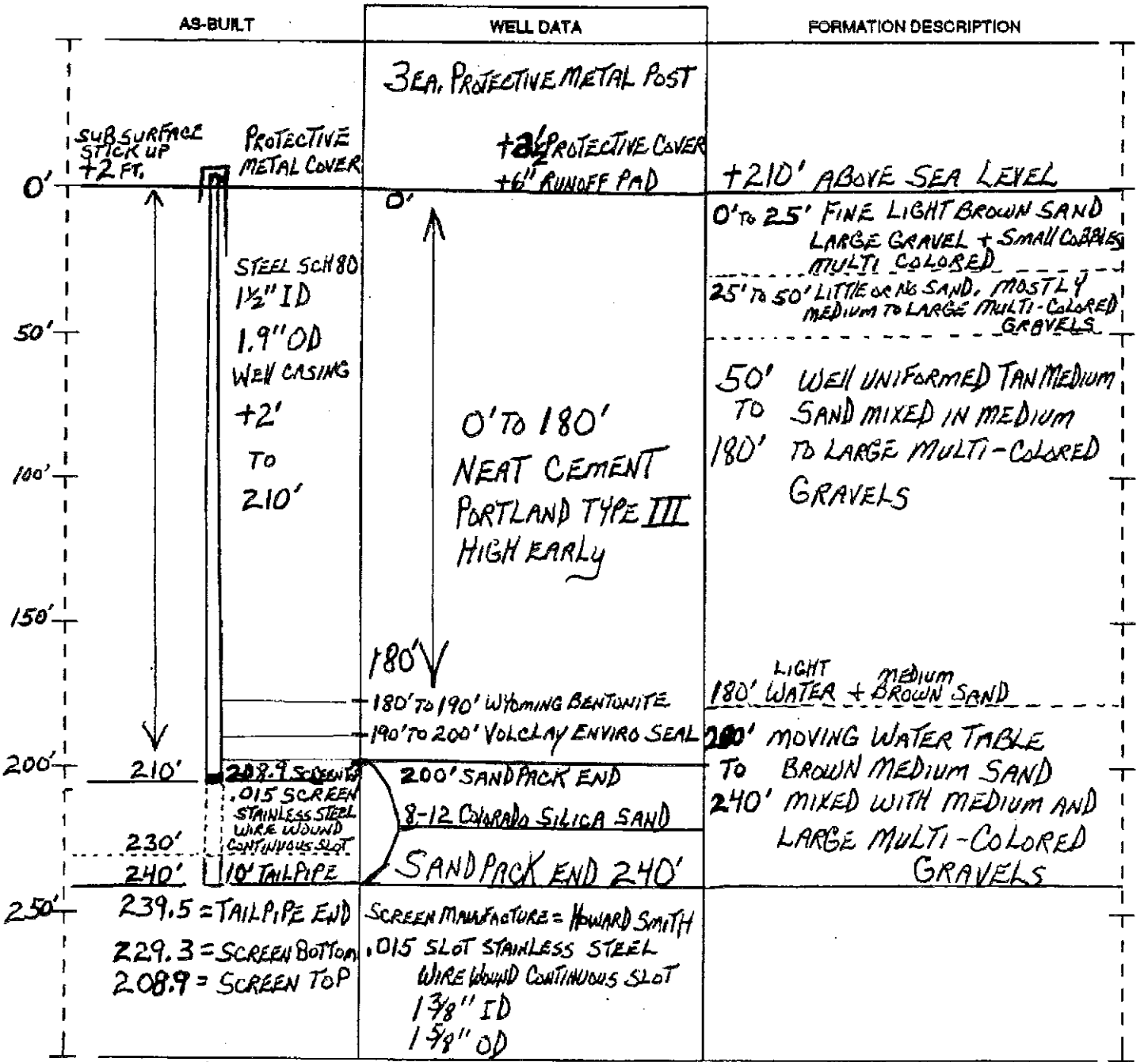
21 FEB 91

RESOURCE PROTECTION WELL REPORT

START CARD NO. 063977

PROJECT NAME: LONESTAR NW OBSERVATION WELL
WELL IDENTIFICATION NO. LONE STAR OB-1
DRILLING METHOD: REVERSE CIRCULATION ROTARY
DRILLER: DOUGLAS GRABOWSKI
FIRM: BECKER DRILLS INC.
SIGNATURE: William J. Flickey
CONSULTING FIRM: HART CROWSER
REPRESENTATIVE: TOM NOYES

COUNTY: PIERCE
LOCATION: SE¼ SW¼ Sec 14 Twn 19N R 1E
STREET ADDRESS OF WELL: NORTHWEST LANDING ANNEX DUPONT STEILACOOM ROAD DUPONT WASHINGTON
WATER LEVEL ELEVATION: 200FT. STATIC
GROUND SURFACE ELEVATION: +210
INSTALLED: FEBRUARY 15, 1991
DEVELOPED:



SCALE: 1" = 50 FEET

PAGE 1 OF 1

ECY 050-12 (Rev. 11/89)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report

Aspect consulting
IN-DEPTH PERSPECTIVE

Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
040001	SL-1	1 of 1

Project Name: North Sequalichew Creek
Location: Fort Lewis, WA
Drilling Method: Hollow stem auger, 4" ID ; Holt Drilling
Sampling Method: 3" diameter D&M
Ground Elevation 214.94

Top of PVC Casing Elev. (ft mllw) 217.74
Depth to Water (ft BTC) 6.25
Start Date March 11, 2004
Finish Date March 11, 2004

Depth feet	Well Construction	Tests\Remarks	Blows/ 6"	Sample ID	Mtl. Graphic	Description
	5" diameter steel monument, 3' stickup; Concrete seal 0'-2'					Grass, duff
						FILL
						Gravel up to 1-1/2" diameter, to a depth of 8" below ground surface
			4 3 3	S-1		Medium stiff, moist to very moist, dark brown, gravelly SILT with SAND
		3/26/04 ▼				
5			3 3 4	S-2		•Very gravelly drilling, no recovery
			9 8 11	S-3		Medium dense, wet, gray, sandy GRAVEL; sand medium to coarse, gravel fine to coarse
			4 6 6	S-4		•Low recovery, trace gravel in sampler
			7 7 7	S-5		RECESSIONAL OUTWASH Medium dense, wet, gray, very gravelly SAND; sand predominantly coarse
10	Bentonite chips 2'-13'		7 7 9	S-6		Medium dense, wet, gray-brown, sandy GRAVEL; sand predominantly coarse
			6 7 12	S-7		
			11 10 9	S-8		•Trace silt
15	10/20 silica sand filter pack 13'-20'		10 7 7	S-9		•Trace silt
	20-slot screen 15'-20'; slip cap with SS screw 20'-20.3'		4 6 7	S-10		
20						Bottom of boring at 20 feet.

Sampler Type (ST):
- 3.25" OD D & M Split-Spoon Ring Sampler
- No Recovery
- 2" OD Split-Spoon Sampler

PID - Photoionization Detector
▼ Water Level (ATD)
▽ Static Water Level

Logged by: RRH
Approved by: LJH
Figure No. B - 2

SEQUALICHEW CREEK.GPJ July 20, 2004
MW_GEOLG

CH2MHILL

Well Number: CHTW-1

Client: Glacier NW
Project: N Sequalichew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Bob, Ron)
Drilling Method: Star 72 cable tool (12" bit/12" casing)
Sampling Method: Sand pump (water added)
Logged by: TNV
Start/Finish Date: 12/13/99 - 12/15/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 215		Welded Cap with 2" capped access
0				Ground Surface **Silty Sand (SM):** Dark brown sildy sand, dry.	2		NOTE: Sounding tube for pump test water levels (since removed) was roughly 3 feet above ground surface.
5				**Well-graded Sand (SW)** light brown well-graded sand with about 30% fine to coarse gravel, moist. At 9 feet - less gravel, easier drilling.	208		
10				At 18 feet - becomes grayish brown At 21 feet - becomes darker brown, moisture increase			Surface Seal (18) 50-lb bags bentonite chips (medi
15				At 22.5 feet - gravel increases			
20							Native formation sand and gravel
25					25		
				Well-Graded Sand with Silt (SW-SM): Gray brown well-graded sand with 30 to 40% fine gravel, occasional coarse gravel; wet.	185		
30							
35					35		
				Well-Graded Sand (SW): Gray brown fine to coarse sand with about 35% fine to coarse gravel, trace silt; wet. Large amount of water at 36 feet.	175		
40				At 43 feet - increased gravel, silt At 48 feet - increased silt, less dense			
45				At 58 feet - driller reports sand with silt. Casing is falling, difficult to obtain samples			
50				At 66 feet - decreases sand At 67 feet - increased gravel			
55							

CH2MHILL

Well Number: CHTW-1

Client: Glacier NW
Project: N Sequalichew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Bob, Ron)
Drilling Method: Star 72 cable tool (12" bit/12" casing)
Sampling Method: Sand pump (water added)
Logged by: TNV
Start/Finish Date: 12/13/99 - 12/15/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
60				**Well-Graded Sand (SW):** Gray brown fine to coarse sand with about 35% fine to coarse gravel, trace silt; wet. Large amount of water at 36 feet. At 43 feet - increased gravel, silt. At 48 feet - increased silt, less dense. At 58 feet - driller reports sand with silt. Casing is falling, difficult to obtain samples. At 66 feet - decreases sand. At 67 feet - increased gravel			8" Mild steel casing
65							
70							K-Packer; Riser (6" mild steel pipe)
75					75		
				Well-Graded Sand (SW): Dark red-brown fine to coarse sand with minor gravel and trace silt, peat or wood pieces.	135		Screen - 0.100-in slot width vee-wrap 6" pipe size stainless steel
80				**Poorly-Graded Gravel (GP):** Fine gravel with medium and coarse sand, trace silt; water is clean.			
85					87		Sump (6" mild steel pipe)
				Interbedded Sand/Silt/Clay (SP/ML): Interbedded fine to medium sand with silt and clay. Silt and clay layers contain small to medium wood pieces (Olympia Beds)	123		10-20 CSSI sand (5 50-lb bags)
90							
95					99		Hydrated medium bentonite chips (12 50-lb bags)
100				**Organic Silt and Clay (ML/OL):** Dark brown organic silt and clay with wood pieces and occasional fine sand; hard.	111		
105					108		
110				End of Log	102		
115							

CH2MHILL

Well Number: CHTW-2

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Bob, Ron)
Drilling Method: Star 72 cable tool (12" bit/12"casing)
Sampling Method: Sand pump (water added)
Logged by: TNV
Start/Finish Date: 12/13/99 - 12/15/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 210		Welded cap w/ 2" NPTaccess
0				Ground Surface **Silty Sand (SM):** silty sand with gravel - topsoil; dry.	2 203		NOTE: Sounding tube for pump test water levels (temporary) was 2.15' above ground surface.
5				**Gravel with Silt (GW-GM/GP-GM):** Light grayish brown fine gravel with sand, silt ranging from trace to 5%, loose to 14.5 feet, then dense, dry. At 19 feet - becomes wet.			
10							Surface Seal (11) 50-lb bags bentonite chips (medi
15							
20					22		
25				**Well-Graded Sand (SW):** Grayish brown fine to coarse sand with fine gravel, trace to 3% silt; wet. At 23.5 feet - increased silt, harder drilling At 25 feet - increased water.	183 30		
30				**Well-Graded Gravel (GW):** Gray with blue, black, red yellow fine to coarse gravel with fine to coarse sand, trace silt. At 33 and 37 feet - increased water, clear At 39 feet - drilling "tighter"	175		8" mild steel casing w/ drive shoe
35							Native formation sand and gravel
40					43		
45				**Well-Graded Sand with Silt (SW-SM):** Brownish fine to coarse sand with silt and up to 20% fine to coarse gravel. At 45 feet - increased water, easier drilling.	162		
50							
55					55		K packer
60				**Well-Graded Gravel (GW):** Brownish fine to coarse gravel with fine to coarse sand, occasional cobbles, trace silt. Increased water.	150 60 145		Riser (6" pipe size, mild steel) Screen (6" pipe size, mild steel, vee-wrap wire, 0.150-inch slot
65				**Well-Graded Sand (SW):** Medium brown fine to coarse sand with fine gravel, less water.	66 139		

CH2MHILL

Well Number: CHTW-2

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Bob, Ron)
Drilling Method: Star 72 cable tool (12" bit/12"casing)
Sampling Method: Sand pump (water added)
Logged by: TNV
Start/Finish Date: 12/13/99 - 12/15/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
70				**Well-Graded Gravel (GW):** Greenish gray fine to coarse gravel with sand.	72		Sump (6" pipe size, mild steel)
				Silty Sand (SM): Gray fine to coarse sand with fine gravel.	133 76		
75				**Poorly-Graded Sand with Silt (SP-SM):** Gray fine sand with about 10% silt. At 78 feet - gray silt chunks. At 79 feet - water decreased	129 80		10-20 CSSI sand
80					125		Betonite chips - medium, hydrated
				Silt (ML): Gray-brown mottled silt in chunks, hard. Feels greasy (clay?).	87		
85				**Silty Sand (SM):** Dark gray silty fine sand.	118 90		
				Poorly-Graded Sand with Silt (SP-SM): Dark gray fine sand with silt, small wood pieces.	115 96		
90				**Well-Graded Sand with Silt (SW-SM):** Dark gray sand with silt, wood pieces.	109		
95				**Silt/Clay (ML/CL):** Dark reddish brown silt/clay, hard, with wood fragments. At 102 feet - becomes dry (moist)	104		
				Poorly-Graded Sand w/ Silt (SP-SM): Dark gray fine sand with occasional small gray silt chunks; wet. Interlayered with:	101 109		
100				**Silty Sand (SM):** Dark gray silty fine sand with silt chunks, wood debris.	96		
					117		
105				End of Log	88		
110							
115							
120							
125							
130							
135							

CH2MHILL

Well Number: CHTW-3

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Bob, Ron)
Drilling Method: Star 72 cable tool (12" bit/12"casing)
Sampling Method: Sand pump (water added)
Logged by: TNV
Start/Finish Date: 12/13/99 - 12/15/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
-5					5 222		Welded cap w/ 2" NPT access NOTE: Sounding tube for pump test water levels (since removed) was about 1.3 feet above ground surface
0				Ground Surface **Topsoil**	2		
5				**Well-Graded Sand with Silt (SW-SM):** Light gray brown fine to coarse sand with silt and fine gravel. At 16 feet - becomes moist	215		Surface seal 50-lb bags bentonite chips (medium)
10							
15							
20					23		
25				**Silty Sand (SM):** Gray brown fine to coarse sand with gravel; wet	194		
30							
35					35		
40				**Poorly-Graded Gravel (GP):** Fine gravel with fine to coarse sand, trace silt.	182		8" mild steel casing
45					45		
50				**Silty Sand (SM):** Gray brown fine to coarse sand with silt, fine to coarse gravel.	172 52		
55				**Well-Graded Sand with Silt (SW-SM):** Gray brown fine to coarse sand with fine to coarse gravel, silt up to 15%.	165		
60							

CH2MHILL

Well Number: CHTW-3

Sheet: 2 of 2

Client: Glacier NW
Project: N Sequalitchew Creek Aquifer Tests
Location: DuPont, Washington
Project Number: 151973.A2.AT

Driller: Hokkaido Drilling (Bob, Ron)
Drilling Method: Star 72 cable tool (12" bit/12"casing)
Sampling Method: Sand pump (water added)
Logged by: TNV
Start/Finish Date: 12/13/99 - 12/15/99

Depth (ft)	Sample Info: Sample #	Sample Info: STP (6"-6"-6")	Soil Log	Soil Description	Depth / Elev	Well Drawing	Well Construction Notes
					62		
				Well-Graded Sand with Silt (SW-SM): Gray brown fine to coarse sand with silt and fine gravel.	155		
65					68		
				Poorly-Graded Gravel with Sand (GP-GM	~~149~~ 70		
70				Blue-gray fine gravel with sand.	147		K Packer
				Well-Graded Sand (SW): Dark gray fine to coarse sand with 25% gravel, trace silt.	75		Riser (6" mild steel pipe with weldring
75				**Poorly-Graded Gravel (GP):** Dark gray fine gravel, about 20% sand, no silt.	142 80		Screen 150-slot vee-wrap 6" pipe size, stainle
80				**Well-Graded Sand with Silt (SW-SM):** Light brown fine to coarse sand with about 25% fine gravel, silt.	137 84		
85				**Silty Gravel (GM):** Medium brown-red silty fine to coarse gravel with fine to coarse sand.	133 87 130 90		Sump (6" mild steel pipe with bailbottc
90				**Silty Sand (SM):** Medium brown silty fine to medium sand with occasional gravel.	127 94		10-20 CSSI sand (6- 50 lb bags)
95				**Poorly-Graded Sand (SP):** Gray fine to medium sand with gravel.	123		
				Silty Sand (SM): Gray silty fine to medium sand, silt clumps, wood pieces.	100		Hydrated bentonite chips, medium (1'
100				**Poorly-Graded Sand with Silt (SP-SM):** Dark gray fine sand w/ silt, wood pieces.	117 107		
105				**Well-Graded Sand (SW):** Gray brown fine to coarse sand with fine gravel and wood debris, interbedded with silty fine sand.	110 110 107		Total depth = 111' BGS
110				End of Log			
115							
120							
125							

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S. NW 007

Boring Location: N 658500 E 463000

Ground Elevation: 210

Elevation Water Table: Not reached
Backfilled previously - 2-nd-89

Date Drill: Oct 12, 88
Drilling starting 8:20

Sampled by:

Depth	Strata	Sample Interval	Description/Drilling Notes
5			Brown top soil - Organic, sandy gravel.
			1' Sandy gravel, gravel co-to fn, slightly silt coating,
			subround to round, 70 to 80%; sand-md to fn, loose
		8	dry, light brown
10			8' to 10' sand 50 to 60%, md to fn
			below 12' sand to 30 to 40%
15			
		18	
20			
		24	24' Sandy gravel, gravel mostly fn (<1"), silt coating,
25			subround to round, 60 to 70%, sand co to fn
		28	100%, moist, md gray brown
30			
35			
			Few oversize, sand increasing grading to
		38	38' Gravelly sand, sand co to fn, gravel 30 to 60% mostly fn,
40			loose, moist, gray brown.
45			
		48	
50			
55			
		58	58' Grades back to sandy gravel, same as 24' to 38'
60			occasional sm cobble.
65			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 007

Boring Location: N 658500 E +6300

Ground Elevation: 210

Elevation Water Table: _____

Date Drill: [illegible]

Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
70		68	Sandy gravel as above
75			Below 78' slightly more sand; gravel slightly coarser, 50 +/- 5%
80		78	
85			
90		88	Below 90' gravel finer (<1"), 50 +/- 10% same coarse decreasing
95			
100		98	98' to 113' more sandy gravel, some small cobble, Gravel fine 50 +/- 10%, sand medium to fine
105			
110		108	Sand finer, gravel 60 +/- 10%, fine overall
115			
120		118	
125			
130		128	

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 007 Boring Location: N 658500 E 463000

Ground Elevation: 210 Elevation Water Table: _____

Date Drill: Oct. 12, 1988 Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
			Same as above
135			
		138	
140			Gravel mostly fn, silt coated, 50 to 60%; sand intervals - sand content increasing with depth
145			
		148	
150			Grading to Gravelly sand, sand mg, gravel mostly fn, loose moist, gray brown
155			
		158	
160			
			Below 160' gravel coarsing, 50 to 60%
165			
		168	
170			
175			
			subangular to rounded,
180	Kitsap Salmon Sp. 3021.	180	180' Sandy gravel, gravel co to fg, slightly silty, 75 to 80%, sand md to fg, some wood fragments; occ silty balls, mod dense moist, yellow to gray brown - Kitsap?
185		185	184' - very dense, sandy peat
		188	185' ~~Gravelly~~ Peat with silt bands
190		190	188 - Silt, compact, moist, yellow brown, below 189 gravelly sand and sandy gravel.
195			Bottom Hole 190'

210 - 180 / 30

Purple ?

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 013

Boring Location: N 650000 E 463[illegible]

Ground Elevation: 163

Elevation Water Table: -5

Date Drill: Oct 18, 19[illegible]

Sampled by: _____

Boring Drilled with Hollow Stem Auger

Depth	Strata	Sample Interval	Description/Drilling Notes
5		8	0.2' Organic topsoil, [illegible] slightly sandy [illegible] 0.2' Sandy gravel, gravel mostly fn, few lg, subround to rnd, 70 to 80% gravel mostly fn; loose, slightly moist, light brown Recovery poor to fair -
10			
15			Same as above - gravel thickly coated with silt
20		18	
25			22' Sandy gravel, gravel mostly fn, subround to round, 70 to 80%; sand co to fn, loose, moist, gray brown
30		28	
35			Gravel content increasing slightly, mostly fine (<1")
40		38	
45			Gravel coarser, few small cobbles, some oversize (+2"), all silt coated - Recovery fair
50		48	
55			48' Small pieces of organic matter; gravel mostly fn, some oversize and cobbles (broken) 20 to 30%, gravel silt coated
60		58	
65			Gravel very fine 60 to 70%, sand co to fn

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 013 Boring Location: N 659000 E 462500

Ground Elevation: 163 Elevation Water Table: -5

Date Drill: Oct. 18, 1988 Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
70		68	Gravel co to fn, thin silt coating, 60 to 70%; few small cobbles (broken)
75			
80		78	Same as above - No cobbles noted
85			
90		88	92' to 100' Gravel fine, 60 to 70%; Sand co to fn
95			
100		98	100' to 110' Gravel co to fn, 65 to 75%, silt coated thining; some drilling difficulties, recovery poor.
105			
110		108	Gravel fn, some crushing, 60 to 70% Recovery fair to poor
115			
120		118	Gravel co to fn, thin silt coating, 70 to 80%
125			
130		128	

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 013 Boring Location: N 659000 E 462500

Ground Elevation: 163 Elevation Water Table: -5

Date Drill: Oct. 17, 1988 Sampled by:

Depth	Strata	Sample Interval	Description/Drilling Notes
135			Gravel co to fn silt coated, [illegible], few small cobbles; some crushing
140		138	Gravel co to fn 60 to 70%, sand co to fn
145			
150		148	
155			Same as above, occasional cobble
160		158	
165			Gravel slightly finer, 65 to 75%
170		168	168' Groundwater Gravel finer than above with occasional oversize, 65 to 75%
175			
180		178	Gravel co to fn, slightly coarser than above 65 to 75%
185		188	
190			Gravel co to fn, some slight staining, 65 to 75% sand mostly med to fn with minor laminae of predominantly sand
195			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 013

Boring Location: N 559000 E 462550

Ground Elevation: 163

Elevation Water Table: -5

Date Drill: [illegible]

Drilling [illegible]

Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
		194	Occasional [illegible] small rock's
200			
			Same as above, gravel up to 20%
205			
		209	
210			Same as above
215			
		218	Water orange color 218' to 219'
220			Gravel up to [illegible], appears slightly stained, water [illegible]
225			
		228	228' Water [illegible] brown
230			229' Lost [illegible] losing very hard, 230' water returned ranging red to dk brown
235			Gravel [illegible] trace coal [illegible] manganese.
		238	
240			Bottom [illegible] 238'

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 032

Boring Location: N 655000 E 467000

Ground Elevation: 214

Elevation Water Table: 214-17-197
Caved in at 8.5' 2-23-89

Date Drill: Dec 2, 1988
Began 2 P.M.

Sampled by:

Depth	Strata	Sample Interval	Description/Drilling Notes
5		1	Topsoil - organic silty sandy gravel loose, moist to 1' Sandy gravel, gravel 60 to mostly fg, subround to round, Thin silt coatings, 50 to 60%; sand md; loose moist, no odor, brown; below 8' occasional small cobble
10		12	12' Sandy gravel, gravel mostly fg, round, silt coated, increasing from 60 to 70% to 70 to 80%, below 16'; sand md; loose, moist to very moist, md brown,
15		2	
20		22	Below 17' gravel wet - [illegible] Effluent at 22'
25		3	22 Sandy gravel, gravel mostly fg, round, occ. cobble 70 to 80%, sand md, loose, saturated, brown Few oversize (broken)
30		28	
35		4	Below 30' strong sandy - gravel mostly fg, 65 to 75%; sand md to fg, 5 to 10% silt, brown, intervals silty sand, sand 70 to 80, silt 10% occ. cobble gravel.
40		38	Below 38' very sandy, 10 to 20% cobbles being washed out of formation. Sample - Sandy gravel gravel [illegible] mostly fg, sand fg to md, silt 5% [illegible]
45		5	
50		48	Gravel mostly fg, fine, 65 to 75%
55		6	Below 55' [illegible] gray
60		58	Below 55' effluent, light chocolate brown (bentonite), gravel mostly fg (heavy pea gravel), 70 to 80%; occasional oversize [illegible] being washed out. clasts stained and oxidized - with depth (below 62)
65	Soil Sym 40 142	62 7	214 62 152

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.NW 033 | Boring Location: N 656500 E 467500

Ground Elevation: 218 | Elevation Water Table: _____

Date Drill: Dec 2, 1992 | Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
		66	66' Gravelly sand, sand mdm to fn, 60 to 75%; gravel fine gravel, sand + increasing below 69' mostly
70		70	70' Sandy gravel, gravel co to fn, 60 to 70%, sand m-c, occasional oversize, sand interbeds – some clasts oxidized, stained
75			
		78	
80			80' Sand, co to fn, 10% fn gravel; gravelly interbeds with gravel mostly <1", yellow brown
85			
		88	87' Sandy gravel, gravel mostly fn (<5/8"), 65 to 75%; sand co to fn.
90			
95			Below 94' effluent becoming reddish chocolate brown
100		100	100' Gravelly sand, sand co to fn, gravel fn, 20 to 30%; loose, saturated, yellowish to reddish brown
105			
110		110	110' Sand, md to fn, gray brown
115			
120		118	118' Sandy gravel, gravel mostly fn (<5/8"), 50 to 60%; sand c to fn; loose, saturated, gray brown. Below 120' effluent yellowish brown
125			125' Gravelly sand, sand co to fn, 50 to 60%; gravel fn gravel in lower beds
		128	
130			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.N.W. 035 — Boring Location: N 656500 E 467500

Ground Elevation: _____ — Elevation Water Table: _____

Date Drill: _____ — Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
			Continuation of above
135			
		138	Strong water flow from cyclone
138			Bit Hammer Hole 138'
			Bottom called as practical mining depth

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.WY 034

Boring Location: N 656000 E 467500

Ground Elevation: 218

Elevation Water Table: 218-28 = 190

Date Drill:

Sampled by: C.W. - 22' (1961) - caudina 42' 2-23-84

Began drilling 12:50

Depth	Strata	Sample Interval	Description/Drilling Notes
5			Organic top soil - gravel in ~50% sand matrix
			1' Sandy gravel, gravel 50 to 60% fine, subrounded to rounded, fine silty sand, 60 to 70%, sand medium, loose, moist, brown
		8	
10			Below 8' gravel finer, 65 to 75%, lighter brown
			Below 12' gravel 60 to 70%
15			
		18	
20			Below 18' gravel v. moist to wet, 60 to 70%, coarse sand with occasional cobble
25			
		28	
30			Slightly more oversize, gravel 65 to 75%
35			Below 35' moisture increasing
		38	effluent at 38', zones seepage
40			Gravel same fine, 70 to 80%; some oversize
45			
		48	
50			Same as above, appears grayish
55			
		58	
60			Gravel same with interlens of med pea gravel
			65 to 75%, sand coarse to fine
65			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.WY 034 Boring Location: N 154000 E 41750

Ground Elevation: 218 Elevation Water Table: _____

Date Drill: _____ Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
		68	Gravel co to fn 60 to 70%; 3 to 5% oversize
75		78	77' Gravelly sand, sand md to fn, 50 to 60%; gravel co to fn, interbedded very gravelly to sandy gravel, loose, saturated, brown with yellowish cast.
			Gravel content increasing below 87'
		87	88' Sandy gravel; gravel mostly fn, 60 to 70%.
			91' - Some light gray silt interbeds
		93	92' [illegible] gravel mostly fn 60 to 70%; yellowish-brown to grey brown
		98	Few 2½" gravel, 98' to 100'
		107	107' Sand, m-c to fn, 10% fn gravel, few [illegible]
		118	Bottom hole 118'

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.WY 035

Boring Location: N 656000 E 467000

Ground Elevation: 215

Elevation Water Table: Caved in at 14' - 2.23.89

Date Drill: Dec 4, 1988
Drilling completed 10:45AM

Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
		68	Few sand lenses, sand md to fn, 1-2" thick
70			GR - gravel co to fn with much < 1/2", 60 to 70%,
			sand md.
			72' few cobbles
75			74 Sand interbed, sand md 80 to 90%, gravel fn.
	Vs. 8.16.89		77' Sand.
		78	78' Gravel co to fn, 70 to 80%, gray brown.
80			
	~~Soil Gvr~~		Below 84', Reddish-brown - butterscotch, cemented. Gravel
85	131 Du Pont		reddish brown cast. Some gravel stained, oxidized.
		87.5	Sample 87 to 88 contained some silt balls - contact sediments?
	127		87.5' Silt, yellowish brown,
90		91.	
			Bottom Hole 91'
95			
100			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.'WY 036

Boring Location: N 655500 E 1166500

Ground Elevation: 214'

Elevation Water Table: 58' Covered at 12' 2-23-89

Date Drill: Dec. 4, 1988
Drilling started 12:00 PM

Sampled by:

* Point in bottom of final riser - reamed to 214' elev. to place sand pack at original surface.

Depth	Strata	Sample Interval	Description/Drilling Notes
5		6	Sandy gravel, gravel co to fn, subrounded to rounded, slightly silt coated, 50 to 60%, sand md to fn, loose, moist, dark brown; occas. coal large cobble below 2' md brown,
10		12	6' Sandy gravel, gravel mostly fn, 50 to 60%; sand md fn; loose, damp, md light brown; below 10' gravel coarser, 60-70%; few broken cobbles; below 12' gravel co to fn, 65 to 75% with some broken cobbles
15		16	16' Sand, md fn, 80 to 90%; gravel co to fn; slightly silty
20		22	Below 18' gravel content increasing - grading to - 22' Sandy gravel, gravel co to fn, silt coated, 60 to 70%; sand md; loose, moist, brown; 5 to 10% +2" gravel
25		28	26 to 28' gravel mostly ±1", 65 to 75%; very moist. silt coated. Effluent at 28'
30			Below 28' gravel co to fn. 60 to 70%, sand co, few oversize.
35		38	
40			38 to 40' Soupy sand, sand md to fn
45			Below 40' gravel co to fn, 65 to 75%; sand md to fn, silty. few broken cobbles, material semi soupy
50		48	
55			Below 48' gravel finer 60 to 70%; sand md to co.
60		58	Below 54' gravel coarser, 70 to 80%, silt coated; semi soupy
65			Gravel becoming finer, 60 to 70%; interval gray-brown, soupy due to high silty sands

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 036

Boring Location: N 655500 E 466500

Ground Elevation: 214

Elevation Water Table: 188'

Date Drill:

Sampled by:

Dr...

214 GW 142

Depth	Strata	Sample Interval	Description/Drilling Notes
		68	Below 68' sand, silt increasing
70	VD, ~~Sat Sat~~ 147 DuPont	72	72' Silty, sandy gravel, gravel co to fn, round, 60 to 70%; sand med to fn, silt coating gravel, mixed with sand (to fn salt silty sand balls) ±10%, loose, saturated, brown; interbeds may be silty fine sand <1' thick
75			
		78	Little or no water return to 78'; below 78' heavy return,
80			gravel mostly fn, 65 to 75%, sand co to fn,
85			brown with slightly reddish cast, gravel generally clean ... little silt
		88	87' effluent light chocolate brown
90			
		92	92' Brown silt, slightly sandy interbeds ≤1' thick
95			Gravel fine, sand co to fn below 93'; slightly silty
		98	97.5' Silty sand, sand v. fn (+ 110 mesh), 50 to 60%; silt
100			interspersed ... thin silt beds <6" thick and
			silt balls, occasional small gravel, yellowish brown,
			very salt (soupy)
			Below ... gravel fn 60 to 70% ...
		108	sand co fn ...
			Bottom Hole 108'

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 037 Boring Location: N 655500 E 467000

Ground Elevation: 215 Elevation Water Table: 187' 197

Date Drill: Dec 5, 1988 Sampled by:

began 5 pm

Depth	Strata	Sample Interval	Description/Drilling Notes
5			Sandy gravel, gravel co to fn, subrounded to rounded, 55 to 65%; sand md to fn, organic, loose, moist, dk brown
		8	± 2' Sandy gravel, gravel co to fn, 70 to 80%; sand md-fn, loose, damp, brown,
10			Below 12' few small cobbles (broken), gravel coarser, co to 70%.
15		16	16' Sandy gravel, gravel co to fn, silt coated, 70 to 80%; sand co to md, loose, very moist, brown;
20			Occasional cobble below 18', heavy silt coating
25			
		28	Groundwater 27.5', gravel effluent at 28'
30			Gravel co to fn, co to 70%; sand mostly co.
			28' to 32' soupy; below 32' saturated; very little effluent
35			do 38'
40		41	
			41' Gravelly sand, sand md to fn, 70 to 80%;
45			gravel mostly fn, (soupy) soft, saturated, brown
		47	
			47' Sandy gravel, gravel co to fn, 65 to 75%, sand co to mostly fn; loose, saturated, brown,
50			Below 50' few broken cobbles
55			Gravel content increasing 70 to 80%; intervals soupy from fine sand and silt (5 to 10%), gray brown
		54	
60			1st good water return below 60', gravel co to fn (finer than above) with coarse intervals, 60 to 65';
65			sand co to fn, brown gray

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: SWY 037

Boring Location: N 655500 E 467000
Caved in at 41' - 2-23-89

Ground Elevation: 215

Elevation Water Table: _____

Date Drill: _____

Sampled by: _____

Finished drilling 10:25

Depth	Strata	Sample Interval	Description/Drilling Notes
215			
70	DuPont fill	67	67' Sandy gravel, gravel fn with coarse gravel and cobbles below 70'; 70 to 80%, sand mostly fn, silty with silt stringers; loose to semi soupy, saturated, light brown
75		76	76' Sandy gravel, gravel fn (mostly <1/2"), 50 to 60%; sand co.; loose, wet, md rust brown; below 77 some coarse gravel, darker (soupy) brown (md dk chocolate) Effluent md-dk brown below 77' - slightly silty (±5%), color due to organic?
80	134	80	80' Sandy gravel, gravel mostly fn 50 to 60%, sand co to m, gray brown, reddish cast
85		81	85' Thin silt bed (<2" thick)
90		89	86' Gravel mostly <3/4", 70 to 80%, few large gravels/cobbles (broken) Effluent yellow brown
95			89' Gravelly sand, sand co to md, 50 to 60%, gravel fn to coarse; with depth - md dense, saturated gray brown
100		98	98' contact gradational Sandy gravel, gravel co to fn (avg <5/8"), co to 70%; sand co to md; md dense, yellow brown, gravel content increase to ±80% 96' to 98'
105		101	Below 98' gravel very silty, some silt balls, lost effluent; drilled hard.
110		104	Bottom Hole 104'
			Bottom 15' section of drill pipe filled with fine silty brown sand followed by 2.5' dense, gray, fine sandy silt
			Lost 1 hour reaming pipe

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 038

Boring Location: N 655000 E 466500

Ground Elevation: 215

Elevation Water Table: 200
Water 11.5, caved, wet 12.5' 2-23-89

Date Drill: Dec. 5, 1988

Sampled by:

Drilling water 12:25 PM

El 215

Depth	Strata	Sample Interval	Description/Drilling Notes
5			Sandy gravel, gravel mostly fn, round, 50 to 60%; sand md to fn; slightly silty (3-5%), organic, loose, very moist, dark brown
		8	~2' Sandy gravel, gravel mostly fn, subround to round, thin silt coating, 50 to 60%; sand co to md; few small cobbles; loose, moist, brown; below 9' few more broken cobbles. Moisture increasing below 13', gravel generally finer. Water return at 15', silt content increasing.
10			
15			
		18	
20			Below 18' gravel co to mostly fn, 50 to 60%; sand co to md; slightly silty (~5%) wet, sticky, becoming gray brown
25			20' gray brown, md sand, water bed
		28	21' gravel coarser
30			28' Gravel co to fn, 50 to 60%, some gravel broken, angular most round; sand mostly v fn (soupy), some silt; few small cobbles.
35			
		38	38' gravelly sand, sand fn, 80 to 90%; gravel mostly fn; loose, soupy, saturated, brown
40			
		43	43' Sandy gravel gravel mostly fn, 60 to 70%; sand co to fn; silty; occasional small cobble; gravel coarsing with depth
45			
		48	
50			Gravel mostly fn 65 to 75%; sand co to md; few oversize; sand becoming finer (md to fn) below 50'
55			
		58	
60			Gravel mostly fn (<3/4"), 10% 2 1/2", gravel 60 to 70%; sand mostly md to fn with few thin ~~fn~~ interbeds, predominantly co sand (50 to 60) with fn gravel
65			

(HTW-4 is screened 27' - 32')

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 038 Boring Location: N 655000 E 466500

Ground Elevation: 215 Elevation Water Table: _____

Date Drill: _____ Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
215 70 145			
70	NS Vo	70	70' Gravelly sand, sand m dp to fn, 60 to 70% gravel co to mostly fn; loose, saturated brown. Few interbeds high gravel concentrations; sand coarsing below 75' materials becoming more stained and oxidized -
75			
	~~silt~~ Sa 137	78	77 - hard water.
80			Pipe plugged off at 78' - drilled to 83' worked for ± 2 hrs trying to unplug - recovered coarse, fn gravel
		83'	At 83' bits of brick. After pulling pipe recovered co gravel packed out to silty sand.
85			Bottom Hole 83' - Bit penetration to 88' with no recovery
90			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 045

Boring Location: N 657500 E 464000

Ground Elevation: 168

Elevation Water Table: ~~± 9 ft~~ 120 Cased in at 6' 2-24-89

Date Drill: Dec. 12, 1988

Sampled by:

Drilling began ±10 AM
Drilling completed 11:30 AM

weather - overcast, foggy, poor light

168
-120
48

Depth	Strata	Sample Interval	Description/Drilling Notes
5		8	Sandy gravel, gravel co (max 2"), f to m, silt coated, subrounded to round, 60 to 70%, sand m d, loose, moist; organic dark brown to 2', below 2, slightly organic, m d grayish brown
10			Below 8' gravel co to fn, coarser than above, 60 to 70% sand co to md.
15			(Note (3-18-89) S&C fresher looking w/ less oxidized/stained clasts than #12)
20		18	Below 21' gravel slightly finer, slightly lighter grayish brown
25			
30		28	Few small cobbles; gravel less silt coatings and sand finer below 35'
35	Gillespie		
40		38	Gravel co to fn, slightly coarser than above, 60 to 70% 42 to 46, gravel mostly 3/4 to 1/2", 80 to 90%, occasional large gravel sand co to md; few oversize 38 to 42
45			
50	VT	48	48 Sandy gravel, gravel co mostly, heavily silt coated (sticky) 65 to 75%, sand co to md, loose, wet gray brown, 49' gravel much finer, yellow brown (stained oxidized) (transition zone.)
55	Kitsap 114	54	54' Silt, brown organic 54 to 54, occasion gravel, slightly sandy
60			56' Silt greenish to purplish gray
65		68	64' Groundwater - low volume - Very little return thru cyclone 68' Bottom Hole. Enviroplug added 3 bags

168
-54
114

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 047

Boring Location: N 657000 E 464500

Ground Elevation: 212

Elevation Water Table: 212 - 40 = 172 (Coulson at 13.9' 2-26-89)

Date Drill: Dec 13, 1988 (Began drilling 9:10 AM.)

Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
5			Sandy gravel, gravel co (<2") to fn, subround to round, silt coated, 60 to 70%; sand co to md, loose, v moist to moist, top 1' organic dk brown, below 1' md brown.
		8	
10			
			occasional oversize (+2½)
15			
		18	
20			Gravel <2", co to fn, 60 to 70%; below 21' wet. (perched water?)
25			
		28	
30			29 - Gravel coarser with some oversize, silt coated, wet
35			Below 35 gravel becoming finer.
	Vs'		No return at 38' water
		38'	Groundwater 40' (return when stopped 2 min. at this depth)
40			Below 38' gravel co (<1½") to fn, silty, 60 to 70%, sand coarse to md., wet; below 40 saturated, gravel 70 to 80%,
	V2'		1 cobble, below 44 gravel co to fn, sticky, 60 to 75%,
45			45 to 46 Sand with 1 cobble, sand md to fn.
		48	47' Gravel co to fn, sticky, 65 to 75%, heavy lt brown return.
50			Few stained, oxidized clasts -
			50' Sandy gravel, gravel co to fn, subround to round, may be concentrated in interbed units w/ broken cobbles,
55			60 to 70%, sand mostly md, may occurs as sand
		58	interbed at 60 to 80%; md dense, saturated, gray brown
60			
			Below 60' yellowish-gray brown, gravel co to fn mostly
65			50 to 60%, sand co to fn.

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 047

Boring Location: N 657000 E 664500

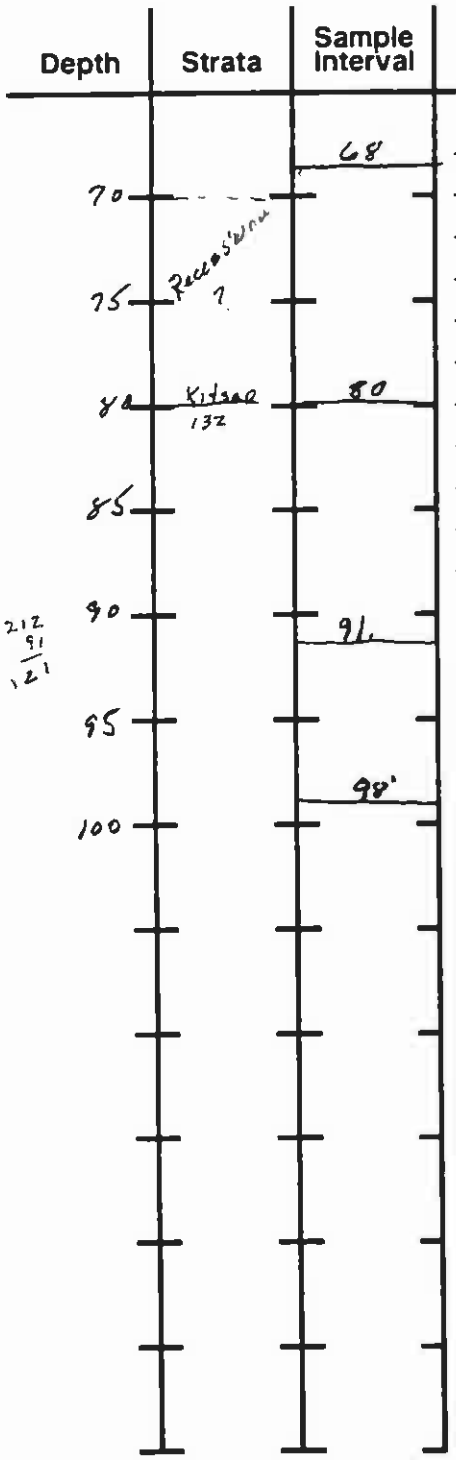
Ground Elevation: 212

Elevation Water Table: _____

Date Drill: _____

Sampled by: _____

Finished drilling 10:35



Gravel fn with coarse zones; 60 to 70%, sand co to fn. yellowish brown effluent, material gray brown. Amount of stained, oxidized clasts increasing with depth.

76 Gravelly sand, sand co to fn, 60 to 70%, gravel fn with sand co:, brown

80 Gravelly sand, sand md, 60 to 70%, gravel mostly fn with intervals co to fn and in heavy concentrations. md. dense, saturated, blue-gray ~ Kitsap.

Silt, blue-green with organic fragments 91 to 92' damp. md dense

Below 96 purplish cast. Ibey ENVIRONMENTAL

Bottom hole

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 050

Boring Location: N 656500 E 465500

Ground Elevation: 214

Elevation Water Table: [illegible] - 18½' (188)
Cavedinal 14.9' dup -2 20-89

Date Drill: Dec. 14, 1988
Began drilling ± 8:30

Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
5			Sandy gravel, gravel mostly fn (avg <3/4"), subround to round, 60 to 70%; sand co to md, silt coatings; loose, very moist organic, dark brown to 1', below 1' moisture decreasing, md. brown
		8'	recovery fair
10			8' Gravelly sand, sand md to fn, 60 to 70%; gravel mostly fn (<5/8"), occasional very coarse gravel, loose, moist brown
		13'	gravel content increasing
15			13' Sandy gravel; gravel co to mostly fn, silt coated, 60 to 70%
		18'	occasional oversize or small broken cobble; sand md;
20			loose, moist, brown
			Below 18 sand finer.
25			Below 25 moisture increasing
		28'	Groundwater - 28
30			Gravel co to mostly fn, 65 to 75%, occasional oversize or small cobble, top 3', very sandy, soupy
35			
		38'	37 to 38 very sandy, soupy
40			Below 38 gravel co to fn, 65 to 75%, few interval high sand content, sand co to md, brown,
45	V. VR		Below 45 material gray brown, effluent yellow brown.
		48'	
50			Gravel coarser with more oversize & small cobbles than above
55			Below 42' gravel finer with interbeds of coarse gravel and fn gravelly co sand.
		58'	
60			Below 58 gravel co to fn, 60 to 70%, few oversize and small cobbles; sand co to fn. gray brown mod. dense
65			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 050

Boring Location: N 256500 E 465500

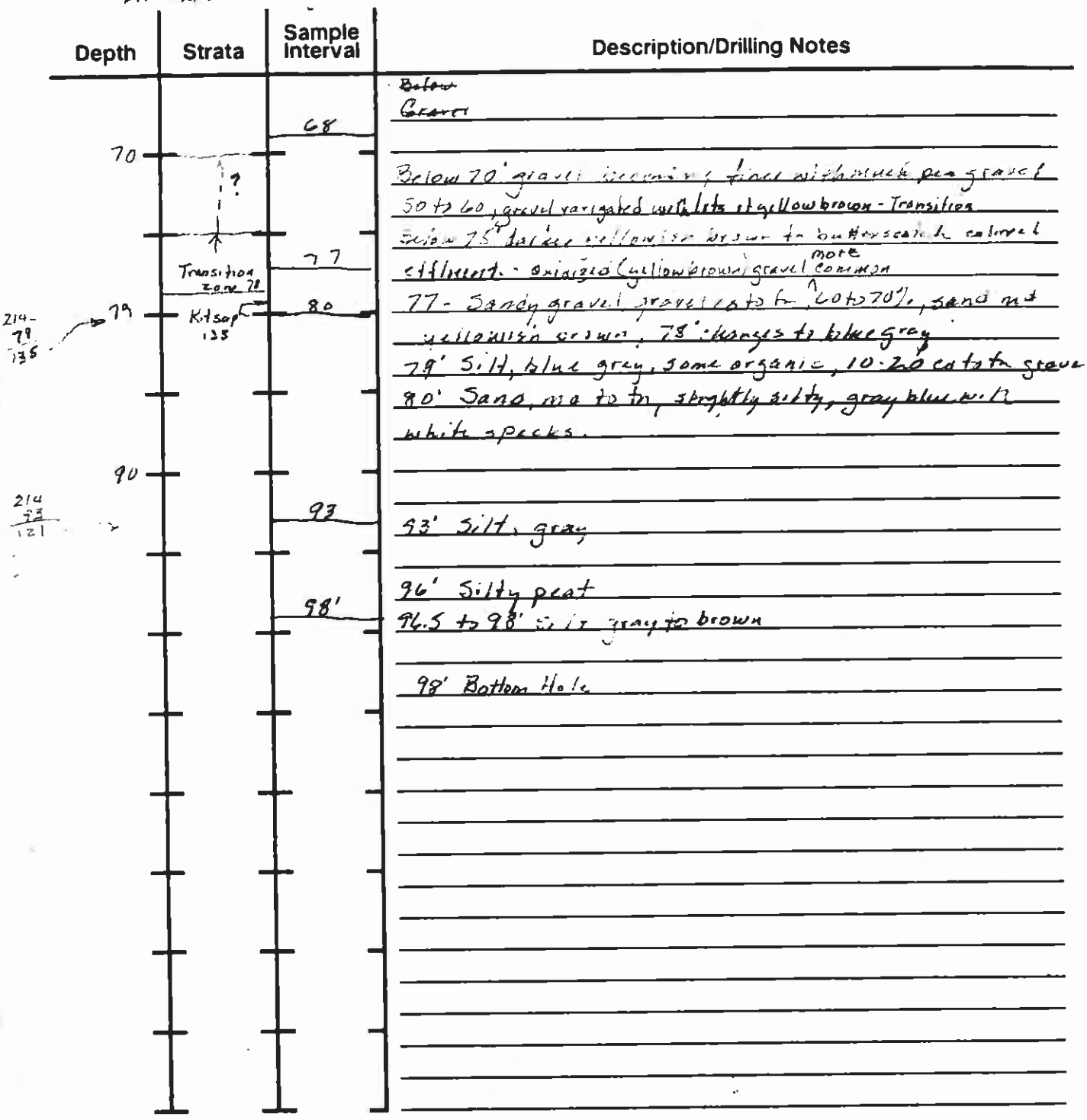
Ground Elevation: 214

Elevation Water Table: 186

Date Drill: Dec. 4, 1992

Sampled by:

10:15AM



Below Gravel

Below 70' gravel increasing, fines with much pea gravel

50 to 60, gravel variegated with lots of yellow brown - Transition

Below 75' darker yellowish brown to buttery oatmeal colored

effluent - oxidized (yellow brown) gravel more common

77 - Sandy gravel, gravel est to 1", 60 to 70%, sand mod yellowish brown, 78' changes to blue gray

79' Silt, blue gray, some organic, 10-20 est to 1/4" gravel - Kitsap

80' Sand, m-c to fn, slightly silty, gray blue w/ white specks.

93' Silt, gray

96' Silty peat

96.5 to 98' silt gray to brown

98' Bottom Hole

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 075

Boring Location: N 658000 E 463500

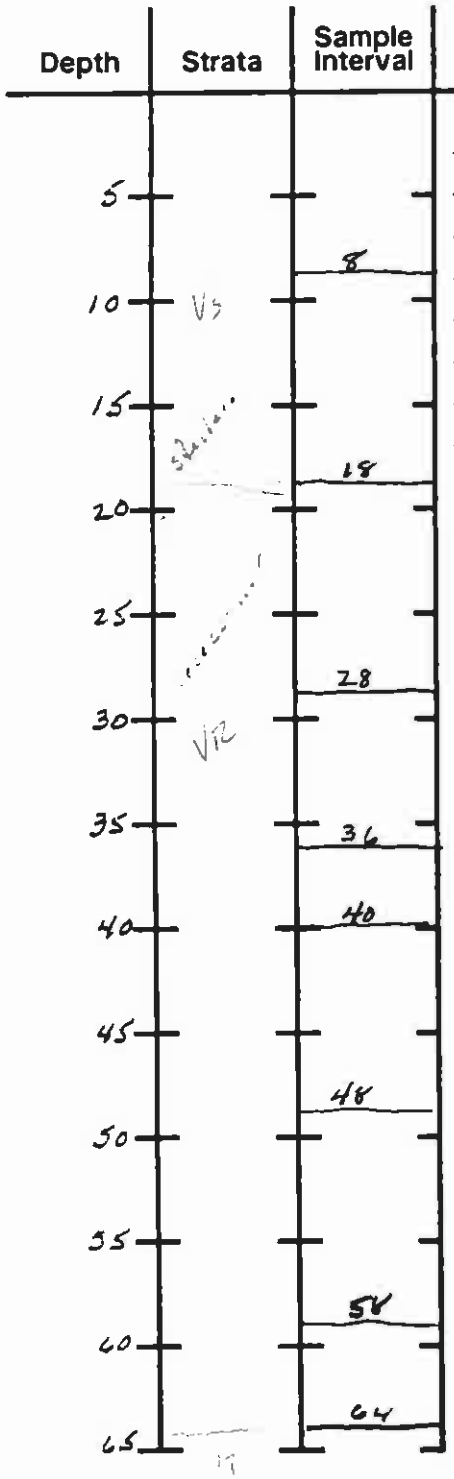
Ground Elevation: 212

Elevation Water Table: N/W
caved 42.3'-N/W-2-22-89

Date Drill: _____

Sampled by: _____

Started drilling 9:20 AM



Description/Drilling Notes

Sandy gravel, gravel mainly fn, silt coated, 70 to 80% sand co to md, loose, very moist, grayish brown

5' Sandy gravel, gravel fn, silt coated, 60 to 70%, sand mostly md, one small cobble

Below 8' sand md 40 to 50%

Below 10' gravel co to fn, silt coated, 60 to 70%, sand md, loose, moist, grayish brown

18 Sand, md to fn, 80 to 90%, gravel co to fn occurring as isolated clasts or in thin interbeds 5 to 10%, silt occurring with sand, increasing with depth content loose, moist, yellow brown - gravel increasing below 25'

28 Sandy gravel, gravel co to fn, silt coated (slightly sticky) 50 to 60%, sand fn to md, loose, moist, yellowish-brown

Below 30' moisture increasing, few small silt coated cobbles

34' to 36' very moist with silt more common

36 Gravelly Sand, sand mostly md, 50 to 60%, gravel co to ~~mostly~~ fn, silt coated, loose, moist, yellowish-brown

intervals very gravelly to predominant, silt interspersed; sand becoming finer, silty below 38'

40' Sandy gravel, gravel co to fn, silt coated, 60 to 70%; sand md to fn, loose, moist, yellowish brown

Same as above

Below 54 gravel becoming finer, 50 to 60%, sand co to fn few small cobbles, slightly silty

62 to 64 Sand md, sharp, 50 to 60%, grey mostly fn, loose damp, gray brown

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 075 Boring Location: N 658000 E 463500

Ground Elevation: 212 Elevation Water Table: _____

Date Drill: _____ Sampled by: _____

Finished drilling ± 10:15

Depth	Strata	Sample Interval	Description/Drilling Notes
70		71	Sand, gravel, gravel cobbles, silt coated, 60 to 70% sand mostly fn, ~~slightly~~ silty, few oversize, md dense, damp, yellowish brown
75			Below 71 gravel cobbles, more cleaved clasts, 65 to 75%, clasts stained; yellowish brown with orange tint east 71' to 72', bright yellowish brown below 72'; some stained, oxidized clasts
80	~~Kitsap~~ ?	78	
85	Kitsap 128	84	Staining, oxidizing increasing 84' Silt, gray, dry; becoming lighter gray to yellowish brown below 86
90		88	88' Bottom Hole
95			
100			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L S W.Y 099

Boring Location: N 665500 E 465000

Ground Elevation: 217

Elevation Water Table: 217 -16 = 201

Date Drill: Jan 24, 1989
Drilling started 9:20

Sampled by:

Depth	Strata	Sample Interval	Description/Drilling Notes
5			Sandy gravel, gravel co to mostly fn, silt coated, subround to round, 60 to 70%, sand md to mostly fn, loose, moist, top 2' organic, dk brown, below 2' brown
		8	
10			Gravel becoming coarser, sand coarser
15			Few small cobbles below 14'
		18	16' material wet, water return at 18.
20			Gravel co to fn, sticky silt coatings, 65 to 75%, sand mostly co.
25			
		29	
30			29 Sand, md to fn, 80 to 90%, slightly silty (5 to 10%) gravel co to fn, as interbeds, 5 to 10%, loose, saturated gray brown
35	1/2		
		38	38' Sandy gravel, gravel fn and coarsing, 50 to 60%, sand md to co, md dense, saturated, lt brown surface coatings
40	1'		40 Sandy Gravel, gravel co to fn, sticky silt coatings, 70 to 80% sand co, md dense, saturated, lt brown surface coatings
45	1/2		45 to 45 - Sandy sandy with silt
		48	48 Gravelly sand, sand md to fn, 50 to 60%, gravel co to fn, clean
50			51 Sandy gravel, gravel co to fn, clean to silt coated, 20 to 50%, some broken oversize and small cobbles (± 5%), sand co to fine, slightly silty, md dense, saturated, gray brown with lt brown coating
55			Below 44 Sandy
		54	Below 58 gravel 60 to 70%, few oversize
60			
65			(No strong water return)

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 099

Boring Location: N 655500 E 465000

Ground Elevation: _____

Elevation Water Table: _____

Date Drill: Jan. 24, 1989
Drilling complete 10:55

Sampled by: _____

217 − 82 = 135

Depth	Strata	Sample Interval	Description/Drilling Notes
		68	Gravel co fo fn, clean to slightly silt coated, 65 to 75% sand mostly md to f. dk brown
70			
	Vashon Drift		Same as above, few intervals with +2½" clasts.
75			Below 75 sand co to md
			Below 78 gravel co to fn 65 to 75%, sand co to fn, silt 10-15% as coatings - increasing with depth
80	Vashon Kitsap		81 Sand and silt content increasing.
217 − 82 = 135	135	82	82' Silt, gray; some wood fragments - poor recovery.
85			
		88	
90			88 Bottom Hole

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.N.W. 101

Boring Location: N 656500 E 465000

Ground Elevation: 212

Elevation Water Table: 212 - 28 = 184
Measured at 16' - 2-24-89

Date Drill:

Sampled by:

Drilling began ± 3:10

Depth	Strata	Sample Interval	Description/Drilling Notes
5			Sandy gravel, gravel co to fn, some silt coatings, subround to round, 60 to 70%, sand mostly fn, slightly silty, Top 2' loose, organic very moist, dk brown; below 2' loose, moist grayish brown
		8	
10		10	8 Sand md fn 80 to 90%, gravel co to fn, loose, moist yellowbrown
			10 Sandy gravel, gravel mostly fn, silt coated, 60 to 70%,
15			sand md to fn, loose, moist, brown.
		18	Occasional oversize
20			
25			Moisture increasing, grayish brown below 25
		28	28 some water return - gravel co to fn, 50 to 60%, sand
30			co to md
			Below 32' gravel coarser, co to fn (40:60), slight sticky silt
35			coating, 70 to 80%, sand co to fn
		38	Below 38' gravel co to fn 65 to 75%; sand co to fn.
40			silt 10-25% interval semi liquid
45			
		48	
50			Sand md with 20 to 30% gravel interbedded with
			sandy gravel, gravel mostly co, 70 to 80%, relatively
55			clean, md dense, saturated, gray brown
			56 to 60 Sand md to fn
		58	Below 60 gravel mostly fn 55 to 65%, sand md to fn, slightly silty
60			
65			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 101

Boring Location: N 656500 E 465000

Ground Elevation: 212

Elevation Water Table: _____

Date Drill: Jan. 24, 1989

Sampled by: _____

Drilling complete 4:20

Depth	Strata	Sample Interval	Description/Drilling Notes
	VR?	69	cg yellowish brown to butterscotch return — material coated with thin yellow brown soupy silt
70			gravel co fo to, subangular to round, 65 to 75%,
	VR? VD		sand co fo to, md dense, saturated (low return
75	Recovery		flow), carbonaceous (some charts stained, oxidized)
		78	Below 78 gravel mostly fn, some clay layers, stained 50 to 60%
80			sand md vi fn, clean, md dense, saturated, brown - Transitional?
		83	83 - Same gravel content co to fn, increase in silt/sand interbeds
85			20 to 25%, sand co to fn, few oversize, some interbeds, - Transition or recovery?
212 87 125	Kitsap 125	87	87 Sand, mostly fn, few gravel, slightly silty, loose
90	122	90	saturated, trace clay.
		92	89. Few silt layers in sand
			90' Silt grayish brown with organics common — several
95			large wood chips.
		98	92 Sand, md to fn, dry. purple with red specks, few wood chips.
101			98 Bottom Hole
			2-17-89
			Note: Gravel content mostly fn sandy, sl silty, brown, gray
			clay, yellow brown weight VR

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.4.106

Boring Location: N 655000 E 465500

Ground Elevation: 218

Elevation Water Table: 218 - 25 = 193
Caved in at 19 2-20-89

Date Drill: Jan. 26, 1989
Drilling started ± 10:30

Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
5			Sandy gravel, gravel co to fn, slightly silt coated, subround to round, 60 to 70%; sand md to fn; slightly silty, ± 10% oversize, small cobbles, loose, moist, top 1' organic dk brown; to 2½' brown - poor recovery
		8'	
10			Below 8' gravel co to fn, silt coated, 65 to 75%; sand md to fn; few oversize and small (broken) cobbles (5 to 10%); loose, moist, grayish brown.
15			Below 16' moisture increasing
		18'	Below 18' gravel finer, coated with sticky silt, 65 to 75%; sand mostly md; very moist, grayish brown.
20			
		25'	Below 25' wet, clasts coated in heavy sticky silt. light brown
25			
		28'	
30			Gravel finer with occasional oversize. less sticky silt coating, gravel mostly fn, 60 to 70%; sand md to fn, some breakage due to drilling; material md dense, saturated
35			
		38'	
40			41' - silty interbed, sticky
			Water return increasing - (very slight return)
45			44' Gravelly sand, sand md to fn, 70 to 80%; gravel co to fn; silt 10 - 20% (coating) loose, saturated, light brown
		49'	46' Sandy gravel - same as 38' to 41'
50			
			Below 52 - Sand to silty sand with gravel - same as 44' to 46'
55			
		58'	Below 56' gravel content increasing
			Below 58' water return increasing - gravel co to fn, some broken, clean, interval slightly concentrated, 60 to 70%; sand co to fn; intervals finer, few broken oversize, silt increasing slightly as coating below 65', md dense, saturated, gray brown
60			
65			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 106 Boring Location: N 655000 E 465500

Ground Elevation: 218 Elevation Water Table: _____

Date Drill: Jan 26, 1989 Sampled by: _____

2:20 - Pipe plugging
3:30 Pipe unplugged assumed at this time

Depth	Strata	Sample Interval	Description/Drilling Notes
		68	Continuation of above - see last page for description
70	Vs		Below 66' gravel mostly <1 1/4" with coarser intervals.
	144	72	65 to 75%; sand co to md, thin wet sticky silt coating
	Transitional		clasts. Below 72' soupy silty fn sand with gravel and oversize
75	Sat Spec? 141	77	76' gravel content increasing
			77 Gravel coarse, heavily coated with silt, dense, yellow brown
80	Vo	82	gravel co to fn 65 to 75%, sand co to fn, silt 10 to 15%. (DuPont)
			82' Sandy gravel, gravel co to fn, 60 to 70%, sand co to fn;
85			clean, md dense, saturated, yellowish brown, gravel
		88	stained, slightly oxidized
90			90' to 91' gravel coarse
			91' Gravelly sand, sand mostly md to fn, clean, 85 to 90%; gravel
95			mostly fn, md dense saturated, lt md brown with white specks -
		98	- Sand result of segregation from dragged pipe
100			Interval continuation of sandy gravel from 82' - Butterscotch colored return
		102	Gravel co to mostly fn 60 to 70%; clean, sand mostly md to fn,
105			saturated, brown
			102' Sand, mostly fn, 90 to 95%; occasional gravel; dispersed silt
		108	and sandy silt balls, occasional thin gravel interbed
110			loose to md dense, saturated, yellowish brown - some sample drag-ging
		111	Below 108' sandy gravel - see description @ 102'
			Below 111' silt content increasing - few silt balls - water return
115			thicker, dark butterscotch (low volume), material dense -
		117	gravel co to mostly fn, clean, 60 to 70%; sand co to fn
			Below 115' gravel co to fn, few oversize, clasts, fractured, angular
120			to round, 60 to 70%; sand co to fn, dense, saturated, brown
		122	122' Silty gravelly sand, silt content increasing, dark brown & water return
			gravel angular to round, co to fn, 60 to 70%; sand co to fn
125	Projection V92 Kitsap	126	122' Gravelly sand, sand md to fn 60 to 70%, gravel co to fn, saturated, brown
			126' Gravelly sand, sand mostly md to fn 70 to 80%, gravel mostly fn
130			loose, saturated, bluish-green

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 106

Boring Location: N 655000 E 465500

Ground Elevation: 218

Elevation Water Table: _____

Date Drill: Jan 26-27, 1989

Sampled by: _____

Drilling complete 8:35AM 1-27-89

Depth	Strata	Sample Interval	Description/Drilling Notes
218			
135	83	134	134' S/H. brown with gray interbed some organics and volcanic ashy, hard, very moist to moist
	79	137	137 Sand, md to fn, 5 to 10% fn gravel, some mud laymonds, small silt balls and interspersed silt (5 to 10%), purplish gray with red speckles
140			
145			
		148	
150			148' Bottom Hole

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 107

Boring Location: N 655500 E 466000

Ground Elevation: 212

Elevation Water Table: 212 - 12 = 200
Carlin 12.5 - water on top. 2-20-89

Date Drill: Jan 27, 1989
Drilling began = 10:30

Sampled by:

Depth	Strata	Sample Interval	Description/Drilling Notes
			2' Topsoil showing in ditch beside boring
			Sandy gravel, gravel mostly (1"½", slightly silt coated, subround to round, 55 to 65%, sand md to fn, slightly silty, loose, to 2' organic, w/ dk brown, below 2', moist, grayish brown to 6, brown below 6
5			
		8	Below 8' gravel co to fn, silt coated, 60 to 70%, sand mostly fn
10			
			Below 12 moisture increasing
15		15	15 water return, gravel co to fn, clean, 65 to 75%, sand fn.
20		20	Gravel co to fn, sticky silt coatings, increasing in concentration with depth, 70 to 80%; sand co to fn, few oversize (±5%) loose, saturated, gray brown with brown coating
25			
		24	Below 30 gravel co to fn, clean, 60 to 70%, few oversize (broken)
30			sand md to fn, silt <5%, gray brown with slight reddish cast
		34	
35			Same as above with some sticky, silt coating
			slightly soupy.
		38	
40			
45			Below 45 material with less silt, cleaner, soupy interval 40' to 42'
		47	
			47 - Gravelly sand, sand md to fn, 60 to 70%, gravel co to fn,
50		50	loose, saturated, brown
			50 Sandy gravel, gravel co to fn, some co. interbeds, clean, 60 to 70%;
55	Sl. Lacustrine		sand mostly md to fn with coarser intervals, few oversize, some
		58	oxidized & stained clasts, md dense, saturated, gray brown
60	Sat Sprg	61	strong water return
	151		61' Sandy gravel, gravel mostly fn with coarser interbeds
	DuPont		stained, oxidized, 50 to 60%; sand mostly md to fn; slightly silty
65			yellowish brown paste (reduced), md dense, saturated, brown, yellow coat
			61' to 65' heavy silt; yellow is reddish brown

212
61
151

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 107 Boring Location: N 655500 E 466000

Ground Elevation: 212 Elevation Water Table: _____

Date Drill: Jan 27, 1984 Sampled by: _____

Drilling began ±10:30

Depth	Strata	Sample Interval	Description/Drilling Notes
70		68	Gravel mostly fn, clean 50 to 60%, sand mostly md to fn slightly silty, md dense, saturated yellowish brown
75			few coarse gravel intervals
80		78	Below 78' sand intervals 50 to 60%. few small cobbles - gravel then interval mostly fn 50 to 60%
85			
90		88	(1 x ½") Gravel mostly fn 50 to 60%, sand md to fn.
95		93	93 Gravelly sand, sand mostly fn, 70 to 80%, silty 10 to 15% hard silt intervals, few gravel (5 to 10%), loose, saturated yellowish brown
100		100	100 Sandy gravel, gravel co to fn, max ±2", 55 to 65%; sand md to fn, slightly silty, 5 to 10%, md dense, saturated, yellowish gray brown
105			Water return good, yellowish brown (butterscotch) Below 106 gravel mostly fn, 50 to 60%, sand md to fn.
110		108	
115		114	112 Decomposed granite cobble or boulder 114 Gravelly sand, sand md to fn, 70 to 80%, gravel co to fn, clean, md dense, saturated, brown
120	Advance		117 Sandy gravel, gravel co to mostly fn, 50 to 60%, sand md to fn; clean, md dense, saturated, brown white specked.
125			
130	Riprap	127	127 Sand, md to fn 30 to 70%, gravel co to fn; clean md dense, saturated - gray blue

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L S W.Y. 107

Boring Location: N 655500 E 466000

Ground Elevation: 212

Elevation Water Table: _____

Date Drill: Jan 27, 1989
Drilling completed 1:55 1/27/89

Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
212		134	
134	78		134 - Silt, gray (about 'h' thick)
135			135 - Silty sand, sand fn, 80 to 90%, gray, saturated
			Below 137 v. fn sand and silt mixed
140			
		142	142 Silt, brown, last return
145			
		146	146 Sand fn. green, silty
212		148	
149	69		
150			Bottom Hole 148

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 119

Boring Location: N 656000 E 466000

Ground Elevation: 218

Elevation Water Table: 218 - 30 = 188
Corrected at 4.6' 2-24-89

Date Drill: Feb. 7
Drilling started 12:20 P.M

Sampled by:

Depth	Strata	Sample Interval	Description/Drilling Notes
5			Sandy gravel, gravel mostly fn, clean. 65 to 75%; sand co to fn, loose, moist; top 3' organics, dk brown, below 3' brown - poor recovery -
		8	
10			Below 8 gravel coarser, some silt coatings, some crushing (10 to 20%), 70 to 80%, some oversize and broken cobbles (±10%); sand most md to fn, loose, moist, brown
15			Below 15 silt coating increasing, oversize broken to round ±10%;
		18	moisture increasing.
20			
25			
30		30	30 Gravelly sand, sand md to fn, 50 to 60%, gravel co to fn loose, wet to saturated, brown, slightly silty.
35			few oversize and small cobbles
			Strong water return below 36'
40		40	40 Sandy gravel, gravel co to fn, subangular (some breakage) to round, slight wet sticky silt coatings 70 to 80%, sand co to md, md dense, saturated gray brown to brown
45			
50		48	Below 40 seeps, slightly more silt, few oversize, sand fines
55			
		58	
60			
65			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 119

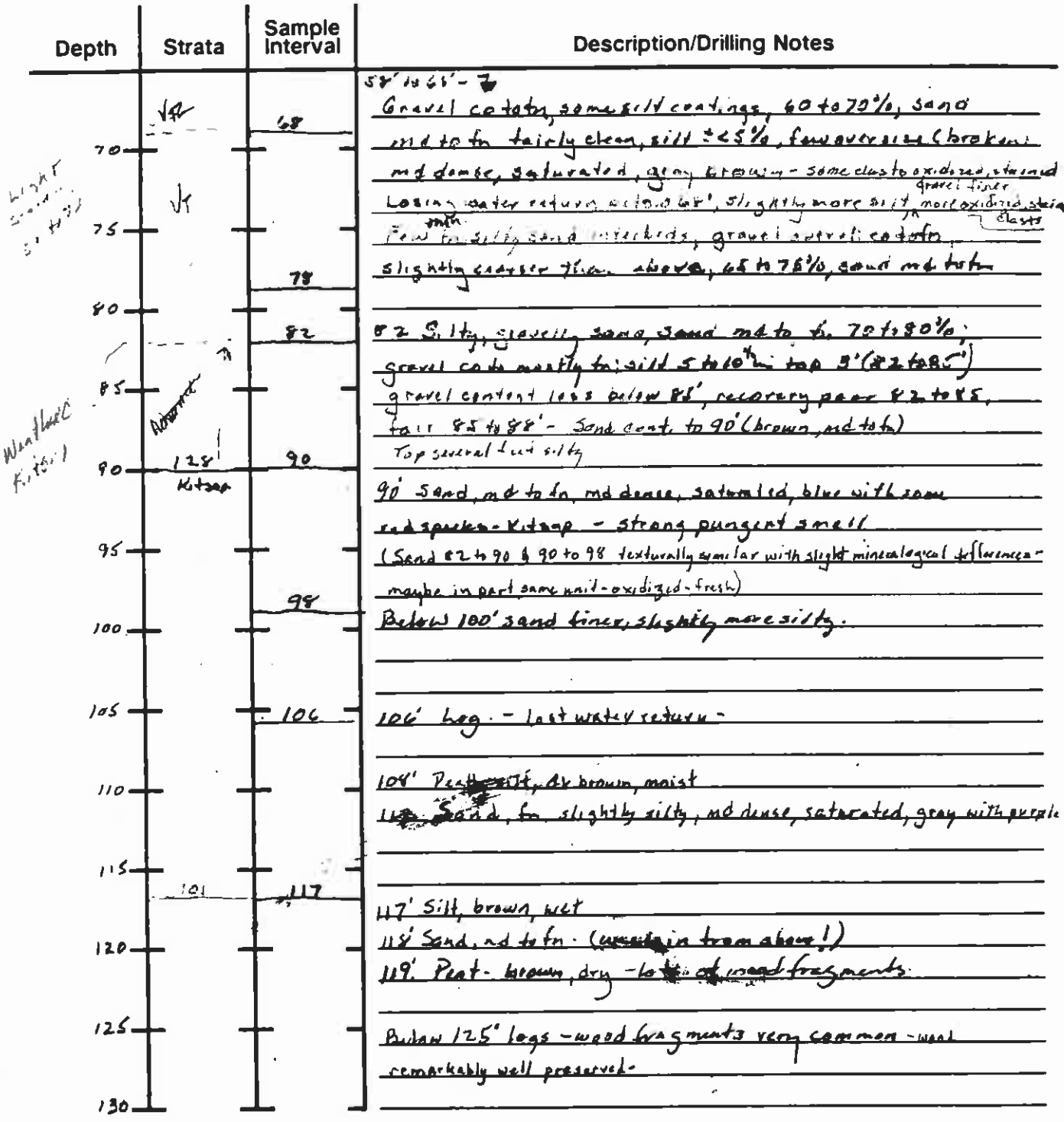
Boring Location: N 656000 E 466000

Ground Elevation: 218

Elevation Water Table: 188
Caved at 4.6' 2-24-89

Date Drill: Feb. 7

Sampled by:



LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 119

Boring Location: N 656000 E 460000

Ground Elevation: 218

Elevation Water Table: _____

Date Drill: Feb 7, 1985

Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
		131	131. Organic sandy gravel, gravel mostly fine, 50 to 60%, sand coarse to fine, dense, wet, dk brown - water returning
135		136	132 material gray, silt 10 to 20%, gravel angular to round
			Bit plugged 2' off bottom 129 to 131' deep. - cobbles & boulders.
140			Intervals very silty, gray with wood fragment, dense
			("Till-like - mudflow?)
			136 Bottom hole - 2 hrs spent trying to penetrate
			131' to 136'-

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 120

Boring Location: N 655000 E 466000

Ground Elevation: 214

Elevation Water Table: 214 - 16 = 198 ✓ 2-20-89 = 20.89
Water 12.5' 2-20-89 - Sand w at 13.5

Date Drill: Feb. 8, 1989

Sampled by:

Depth	Strata	Sample Interval	Description/Drilling Notes
			Location approx 3' below original ground level. Area cut out for completed building, roadway N.W. of boring site
5			Sandy gravel, gravel co to fn, slightly silt coated, subrounded rounded, 65 to 75%, sand mostly fn, slightly silty (±5%), loose, moist, brown - Top slightly organic - Occasional cobble
		8	
10			Below 9' small cobbles 8 to 10%, gravel slightly coarser
15		16	Below 16 slightly heavier silt coating, less oversize gravel co to fn (finer than above) very moist to wet
20			sand co to fn
25		26	Below 26 few small cobbles
			Below 28 gravel becoming finer.
30		32	Below 32' soupy with silty fn sand common, gravel co to fn, 50 to 60%, sand md to mostly fn 30 to 40%, silt 10 to 20%
35			
40		40	Below 40 gravel co to fn 65 to 75%, sand co to fn, some sticky silt coatings, few oversize, md dense, saturated, brown
45			
		48	
50			Gravel co to fn with some fn gravel intervals. Sand md to fn mostly slightly soupy in sand intervals, few subrounded cobbles, md dense, saturated, brown to gray brown.
55			
		58	
60			Below 58 gravel co to fn, clean to silt coated, 65 to 75%; sand co to fn, md dense, saturated, gray brown
65			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 120

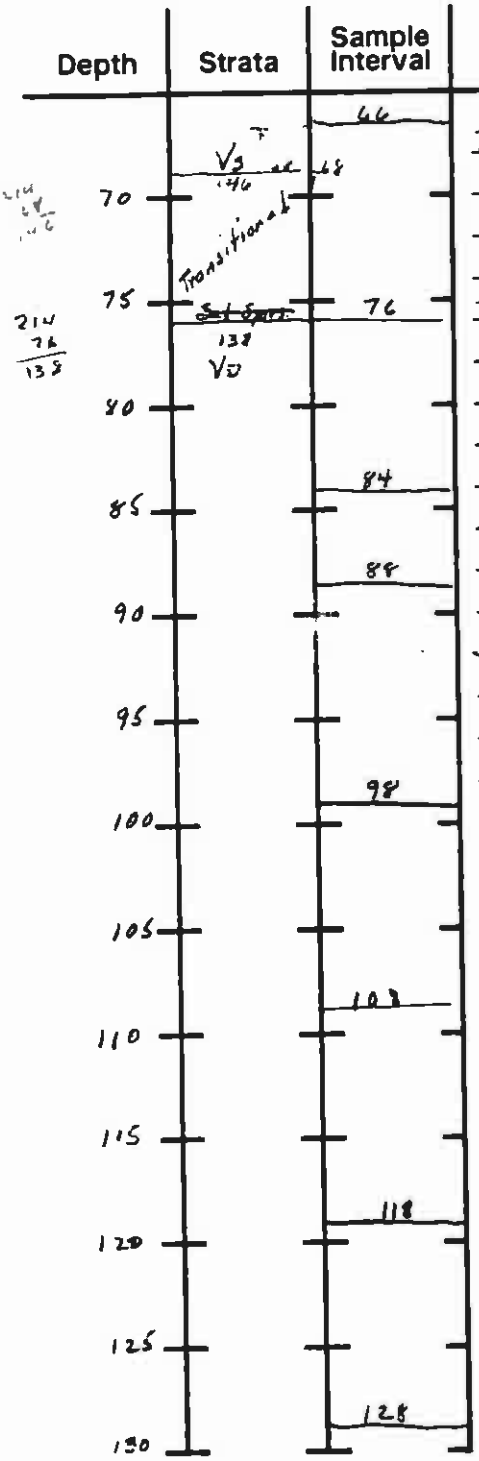
Boring Location: N 655000 E 466000

Ground Elevation: 214

Elevation Water Table: _____

Date Drill: _____

Sampled by: _____



Below 66' silt increasing

Below 68' gravel co to fn, 60 to 70%, sand co to fn, silt heavily coating clasts, 10 to 15%, md dense, saturated, brown

Transitional (Field exam. 3-16-89 - phreatic contact at 76')

76 Sandy gravel, gravel co to mostly fn, most < 2", few + 2", some staining, oxidized, many yellowbrown, 60 to 70%; sand co to fn; md dense, saturated (darker yellow brown effluent), brown with yellowish cast - Few cobbles below 82'

84' Gravelly sand, sand md to fn, 60 to 70%, gravel co to fn, occasional oversize, loose, saturated, brown - materials slightly oxidized

88 Sandy gravel, gravel co to mostly fn, few 2", 60 to 70%; sand mostly md to fn, loose to md dense, saturated, brown

82 to 85 predominantly sand md, 70 to 80%, gravel mostly fn.

Below 85' gravel mostly fn, stained, 50 to 60%, occasional oversize, sand mostly md to fn, yellow to red hue

sand content increasing - grading to

102 gravelly sand, sand md to fn, bids coarser, 60 to 70%; gravel mostly fn, concentrations as interbeds; loose to md dense, saturated, yellowish brown

1

Same as above - sand md to fn, 50 to 60%, gravel mostly fn, with some reddish brown below 112'

Below 114' greyish brown.

Same as above, few fn gravel interbeds

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 120 Boring Location: N 655000 E 466000

Ground Elevation: 214 Elevation Water Table: _____

Date Drill: Feb. 8, 1989 Sampled by: _____

Drilling completed ± 2

Depth	Strata	Sample Interval	Description/Drilling Notes
135			Below 130' becoming gray, silty, losing water return.
			Some coarse gravel - grading to
			132 Sand, fn, silty, saturated, gray.
214 139 75	75 Rotary Kitsap	139	139 Silt, brown
140			
			Recovery poor - drilled tight
145		145	
			145' Bottom Hole
150			
			214
			− 139
			75

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 122

Boring Location: N 656500 E 466500

Ground Elevation: 212

Elevation Water Table: 212 - 18 = 194'
Caved in at 18.1' 2-23-89

Date Drill: Feb 9
Drilling began 11:30 AM

Sampled by: _____

Depth	Strata	Sample Interval	Description/Drilling Notes
			Top Soil 1'-2'
			2' Sandy gravel, gravel co to mostly fn, slight silt coating, subround to round, 60 to 70%; sand md to fn, few oversize; loose, moist, brown
5		8	Below 8 gravel coarser
10			
15			16 to 18 coarse gravel common.
		18	
20			Below 18 wet, gravel finer, few broken cobbles, sand coarser. 18' water return - gravel co to mostly fn 60 to 70%, sand md, few sandy intervals, material clean loose, saturated, gray brown
25			
		28	
30			Below 28 clasts coated in silt, gravel co to fn, 65 to 75%, sand co to fn, oversize 5 to 10%; loose, sticky, gray brown
35			Below 35 material finer
		38	
40			Below 38 gravel finer, gravel co to fn, 60 to 70%, sand mostly md, (co to fn), 5 to 8% oversize, generally clean, gray brown
45			
		48	
50			Same as above
			Below 52 less oversize
55			
		58	
60			Gravel co to fn, 55 to 65%, sand mostly md to fn; clean
65			

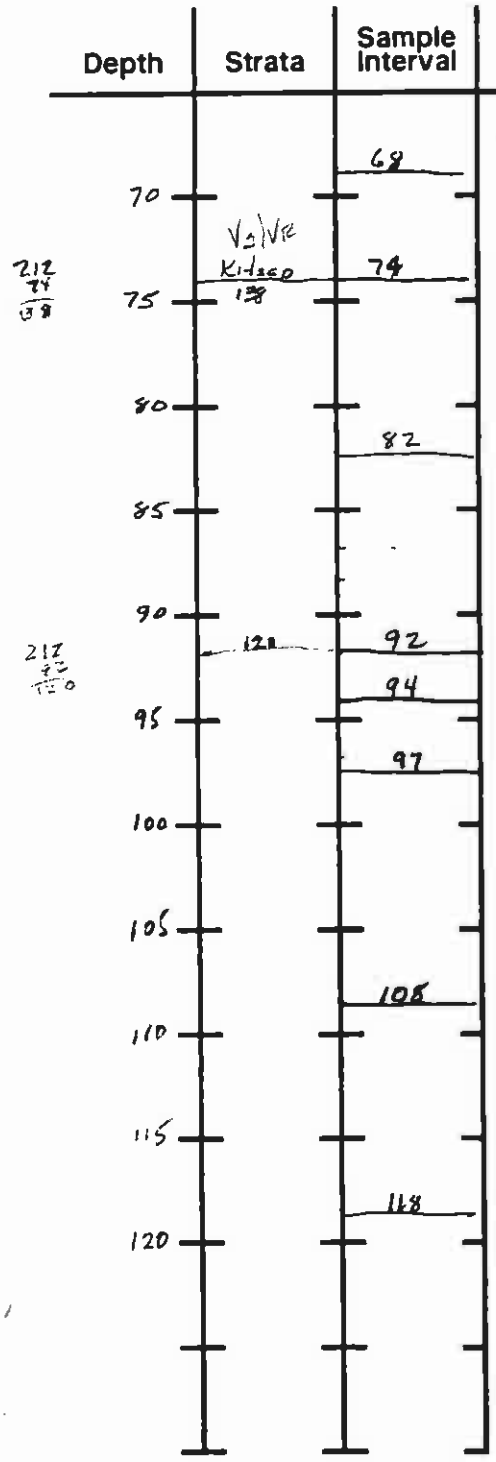
LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 122 — Boring Location: N 656500 E 466500

Ground Elevation: 212 — Elevation Water Table: _____

Date Drill: Feb. 9, 1989 — Sampled by: _____

Drilling completed 1:40



212 74 138

217 92 TD

Below 65 few oversize. -

Gravel content increase, more volcanic materials, some stained oxidized

74 Effluent slightly darker brown - changing to olive below 76'

74' Sandy gravel, gravel co to fn, subround to round, few oxidized, 60 to 70%, sand co to fn, moist, clasts volcanic origin, md dense saturated bluish green

Below 78 bluish green with purple hue, gravel co to mostly fn 55 to 65%; sand co to fn, sharp to round, oversize 5 to 10%; md dense, saturated. -

82' Sand, md to fn, few gravel, cobbles (10 - 20% total) md dense, saturated greenish-blue white speckled (quartz)

Few gravel interbeds, wood 88 to 90'

92' (915) Peat. - Lost return at 92'

94' Silt, gray, organic; moist to damp - recovery poor

97' Sand, fn, few silt balls (<1"), purple; damp

Below 100' interval coarser, contains occasional fn pebble (hard) or silt ball (soft), becoming more bluish

Water return (chocolate brown when began at 108

113 Silt layers and interspersed with fine sand, saturated, brown

Below 116 sand coarsing

118' Bottom Hole.

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y. 124

Boring Location: N 658250 E 463250

Ground Elevation: 207

Elevation Water Table: Wet zone 124' to 127' depth
Cored in at 40' 2-22-89

Date Drill: Feb. 10
Drilling began ± 10:45

Sampled by:

Located between two kettles

Depth	Strata	Sample Interval	Description/Drilling Notes
5		6	Sandy gravel, gravel co to tn, 60 to 70%, sand md, loose, moist, yellowish brown - sand content increasing with depth
			6' Gravelly sand, sand md to mostly fn, 85 to 95%, gravel fn, loose, damp, brown
10		10	10' Sandy gravel, gravel co to fn, slightly silt coated, subrounded to rounded, 65 to 75%; sand mostly fn, loose, damp, brown
15			Below 15 some oversize
		18	
20			Below 22' occasional cobbles, damp.
25			
		28	28' Gravelly sand; sand md to fn, 50 to 60%, gravel co to fn, occasional cobble, clean, loose, moist, brown
30			
35			Few very gravelly interbeds
		38	38' Sandy gravel, gravel co to mostly fn, slightly silt coated, 50 to 60%; sand mostly fn, loose, damp, brown
40			
45			Below 45' gravel fn, 60 to 70%
		48	Below 48' gravel co to fn, 60 to 70%, occasional oversize or small cobble - becoming grayish brown
50			
55			
		58	58' to 60' co gravel, small cobbles
60			Below 60' gravel co to fn, relatively clean, 65 to 75%, sand md to fn, sharp, loose, dry, light brown; occasional oversize
65			

LONE STAR NORTHWEST
DUPONT PROJECT

Boring: L.S.W.Y 124

Boring Location: N 658250 E 463250

Ground Elevation: 207

Elevation Water Table: _____

Date Drill: Feb. 10, 1989
Finished drilling 12:40

Sampled by: _____

207 - 118 / 89

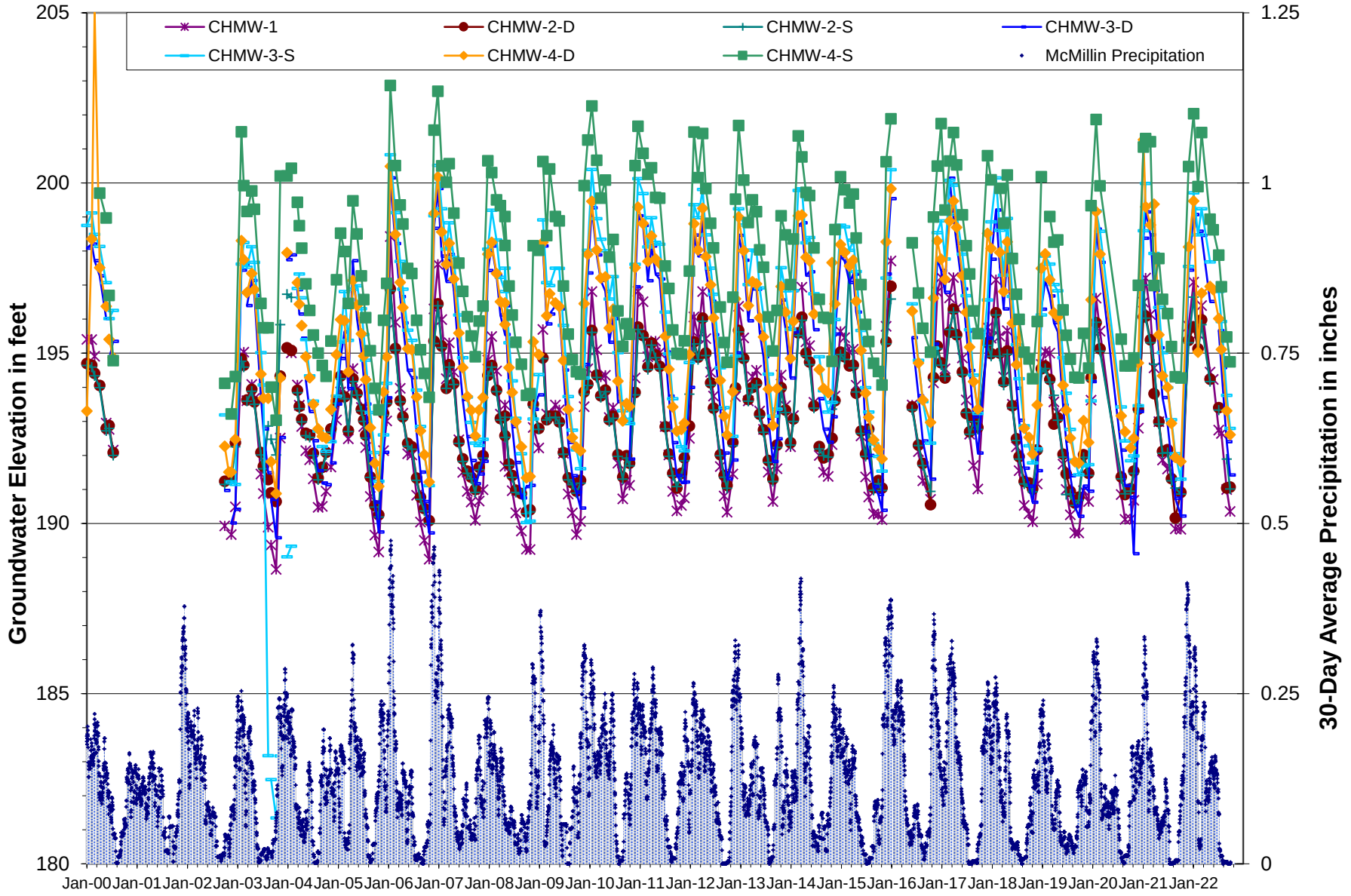
Depth	Strata	Sample Interval	Description/Drilling Notes
70		68	Below 70 gravel mostly fn, 60 to 65%, sand fn, occasional oversize damp, grey brown
75			
80		78	Below 78 gravel covering with more oversize
85			
90		88	88 Gravelly sand, sand mostly fn, 85 to 95%, gravel co to fn, mostly isolated; loose, damp brown
95			
100		97	97 Sandy gravel, gravel mostly fn, silt coated, 55 to 65%, sand fn becoming med to fn, loose, dry to damp, brown
105		104	104 Sand same as 88 to 97, slightly more moist slightly silty with few small silt balls
110		110	Below 110 gravel co to fn 30 to 40%, silty (10 to 20%)
115			
120	Kitsap 89	118	118 Sand, md to fn, occasional small gravel or wood fragment loose, moist, purple with red specks - Kitsap.
125	88 / 31		124 Water return 126 ~~Silt~~ Peat mixed with sand wet
130		127	127 Silt gray, very moist to wet becoming moist to damp below 132
		138	138' Bottom Hole

207 / 118 / 89

207 / 124 / 89

APPENDIX B

Hydographs of Groundwater and Surface Water Monitoring Data



Aspect Consulting, LLC
10/28/2022
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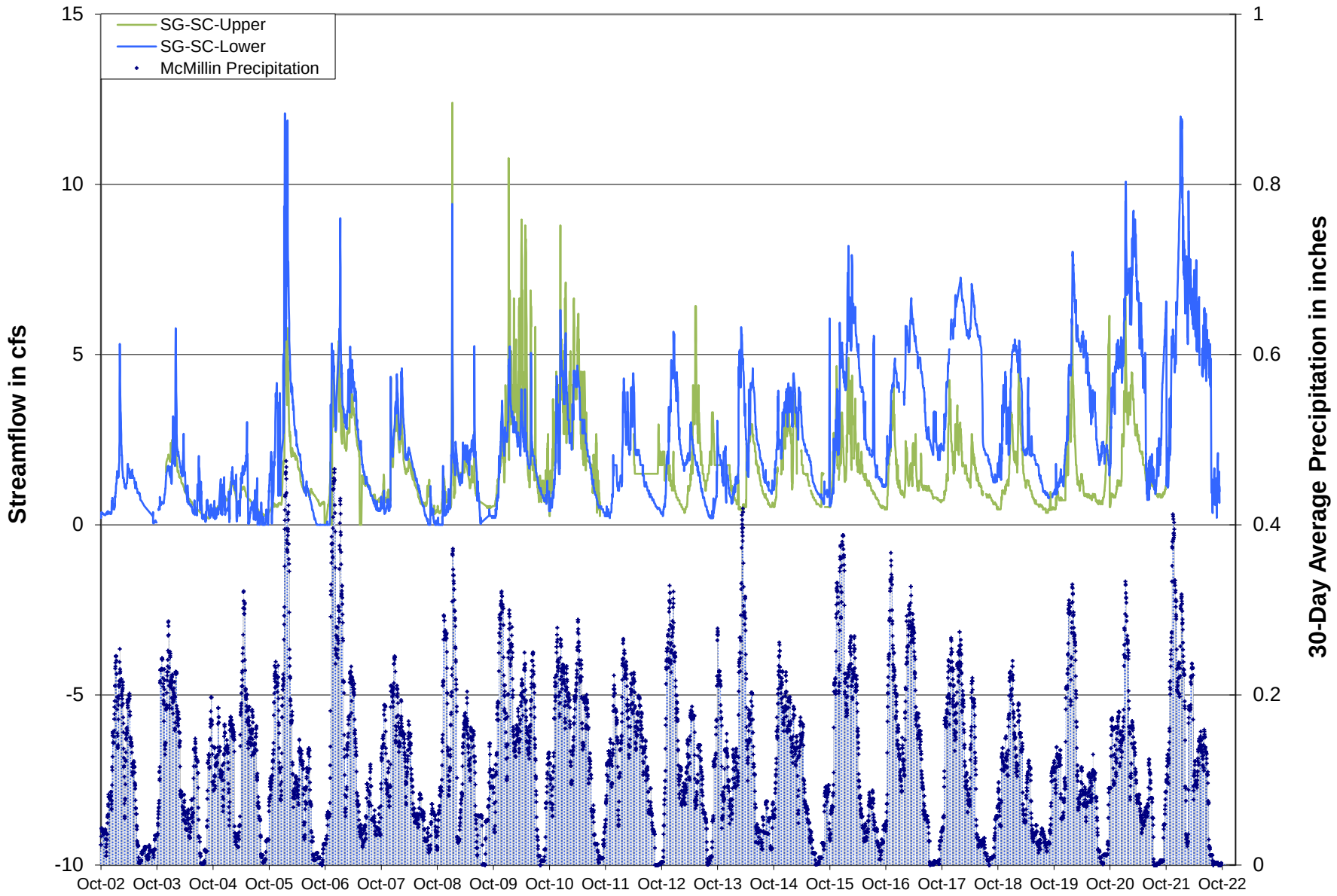
B-1 Vashon Aquifer Water Levels

Pioneer Aggregates South Parcel Project
DuPont, WA



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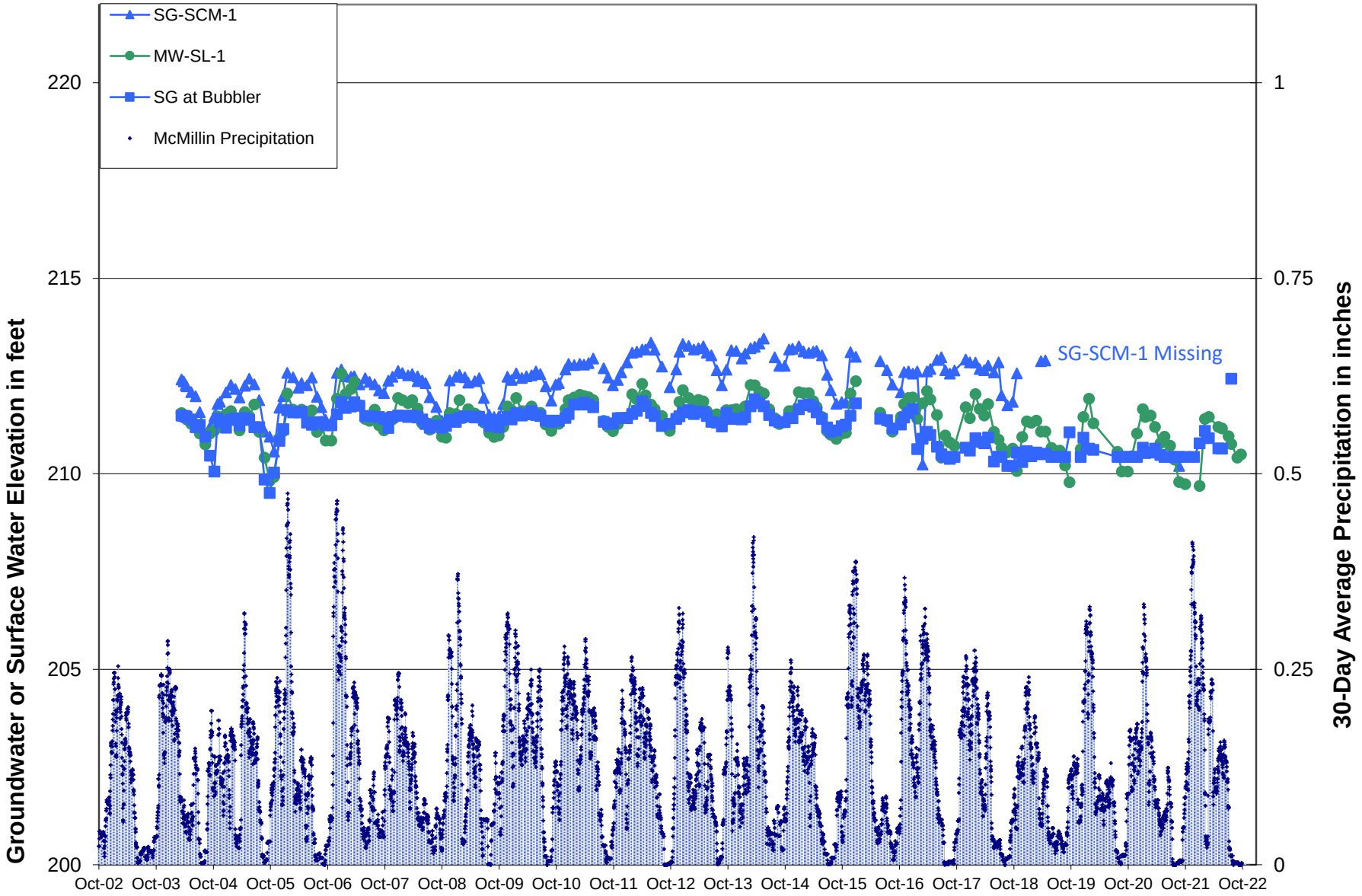
B-2 Sequalitchew Creek Hydrographs

Pioneer Aggregates South Parcel Project
DuPont, WA



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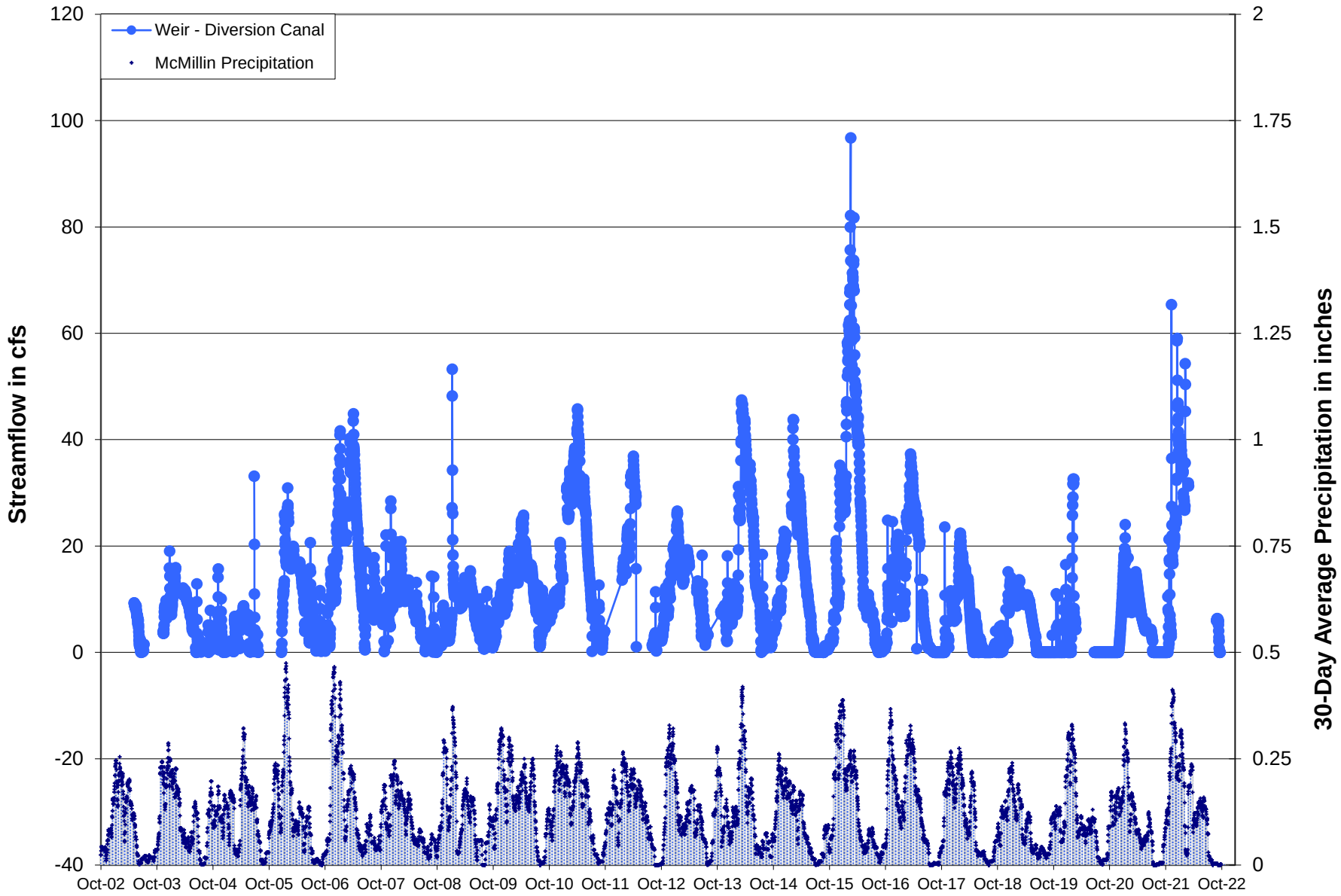
B-3 Sequalitchew Lake Area Water Levels

Pioneer Aggregates South Parcel Project
DuPont, WA



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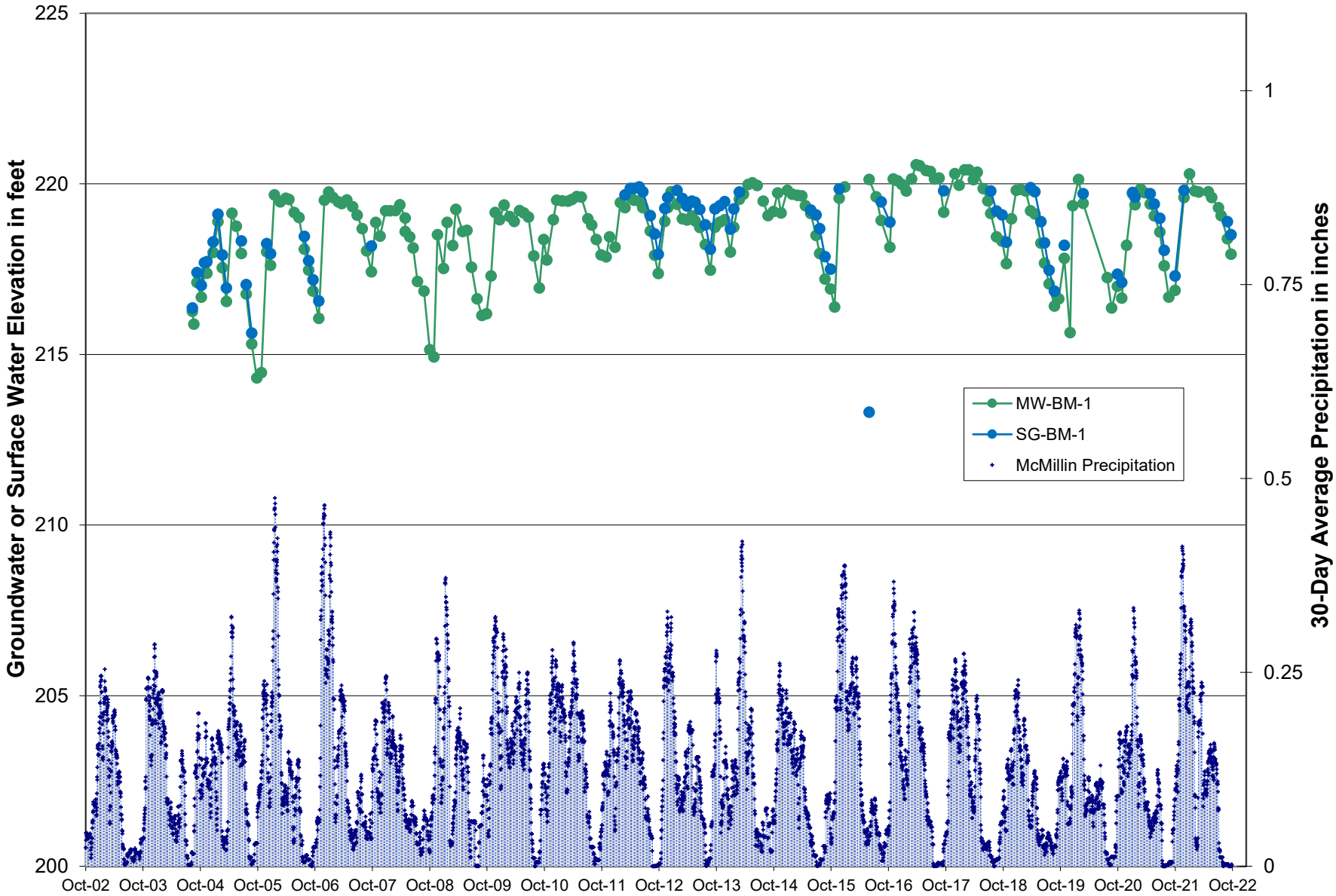
B-4 Diversion Weir Hydrograph

Pioneer Aggregates South Parcel Project
DuPont, WA



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10/28/2022
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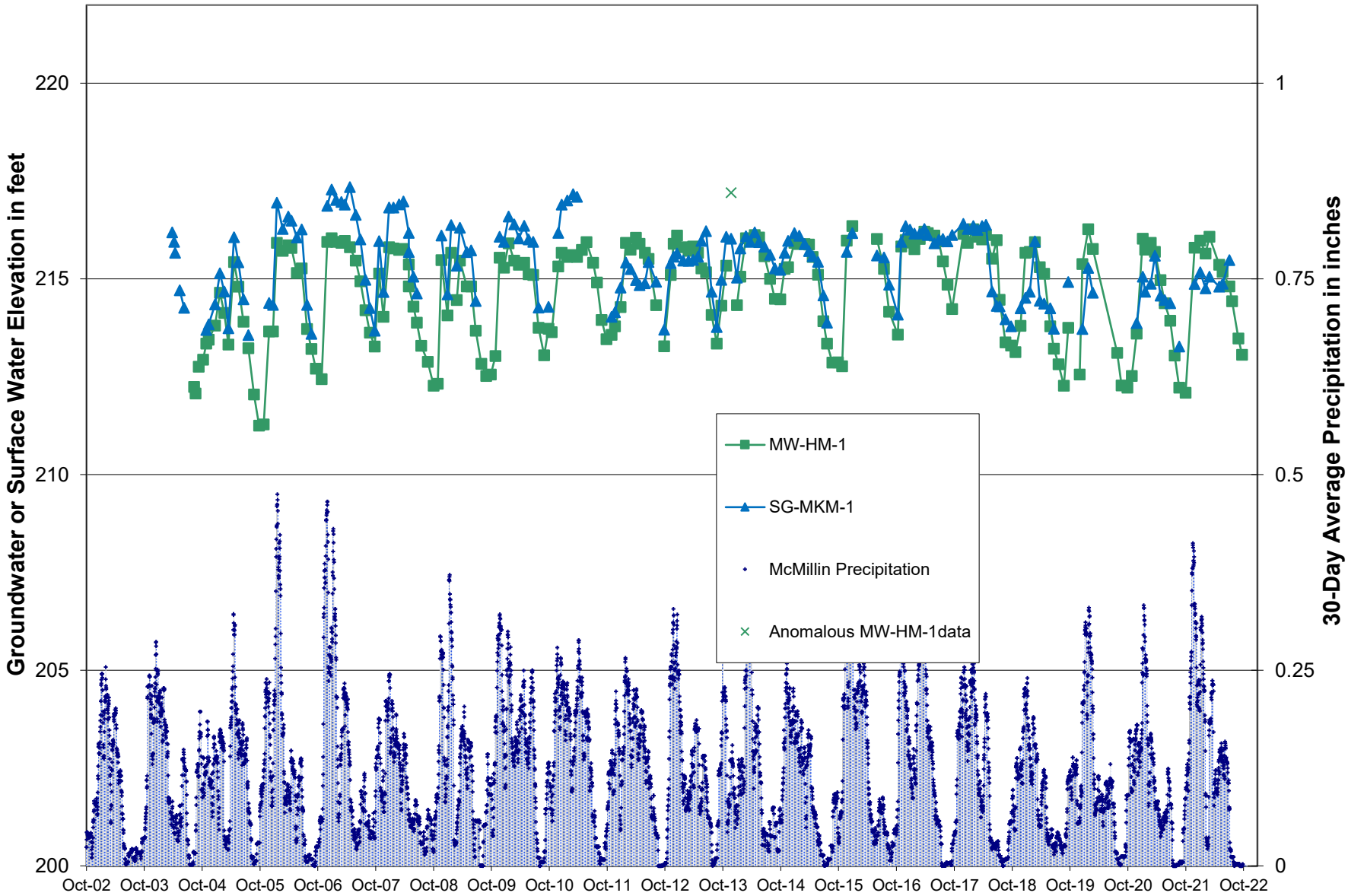
B-5a Bell Marsh Water Levels

Pioneer Aggregates South Parcel Project
DuPont, WA



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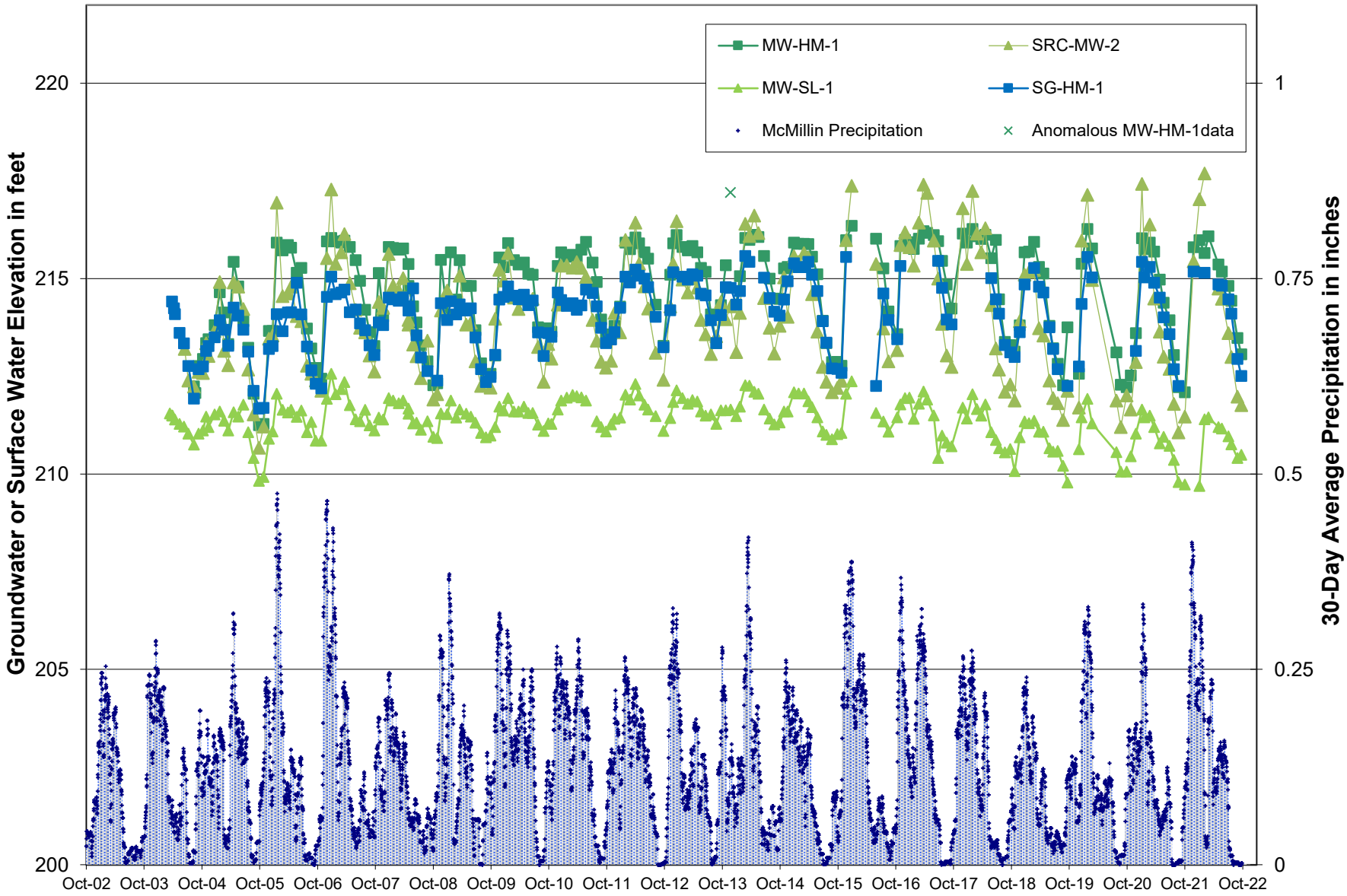
B-5b McKay Marsh Water Levels

Pioneer Aggregates South Parcel Project
DuPont, WA



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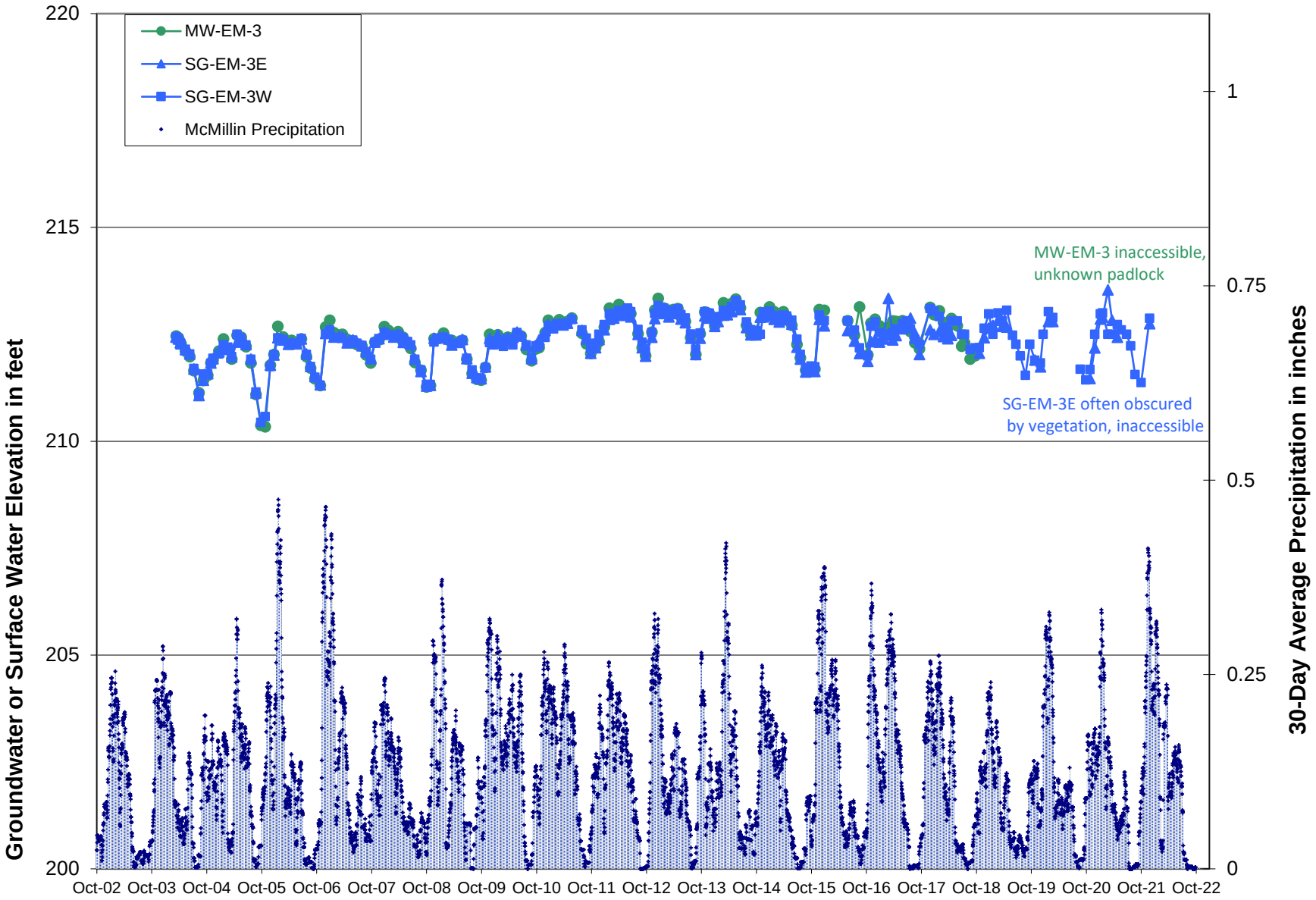
B-5c Hamer Marsh Water Levels

Pioneer Aggregates South Parcel Project
DuPont, WA



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10/28/2022
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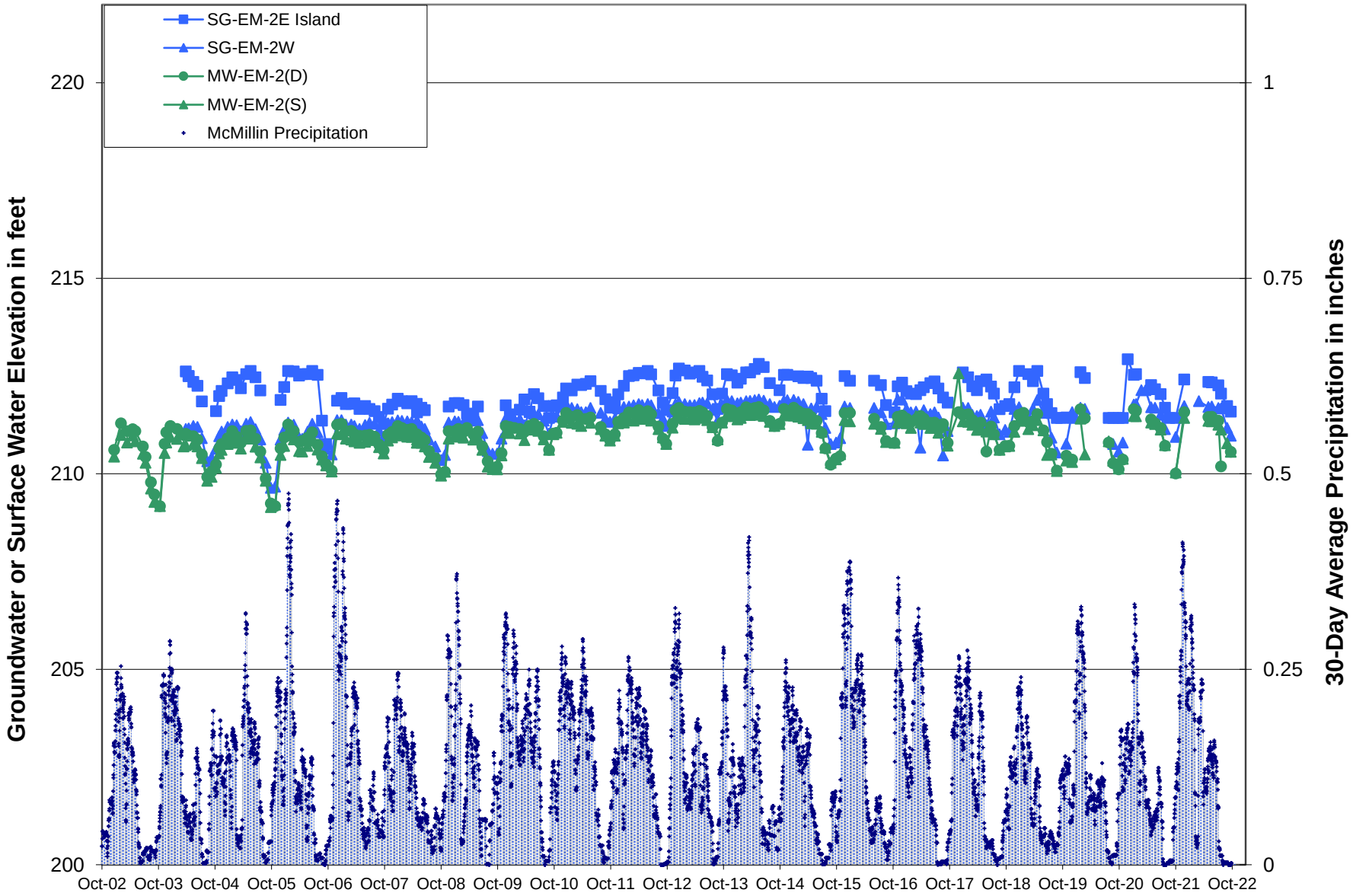
B-6 East Edmond Marsh Water Levels

Pioneer Aggregates South Parcel Project
DuPont, WA



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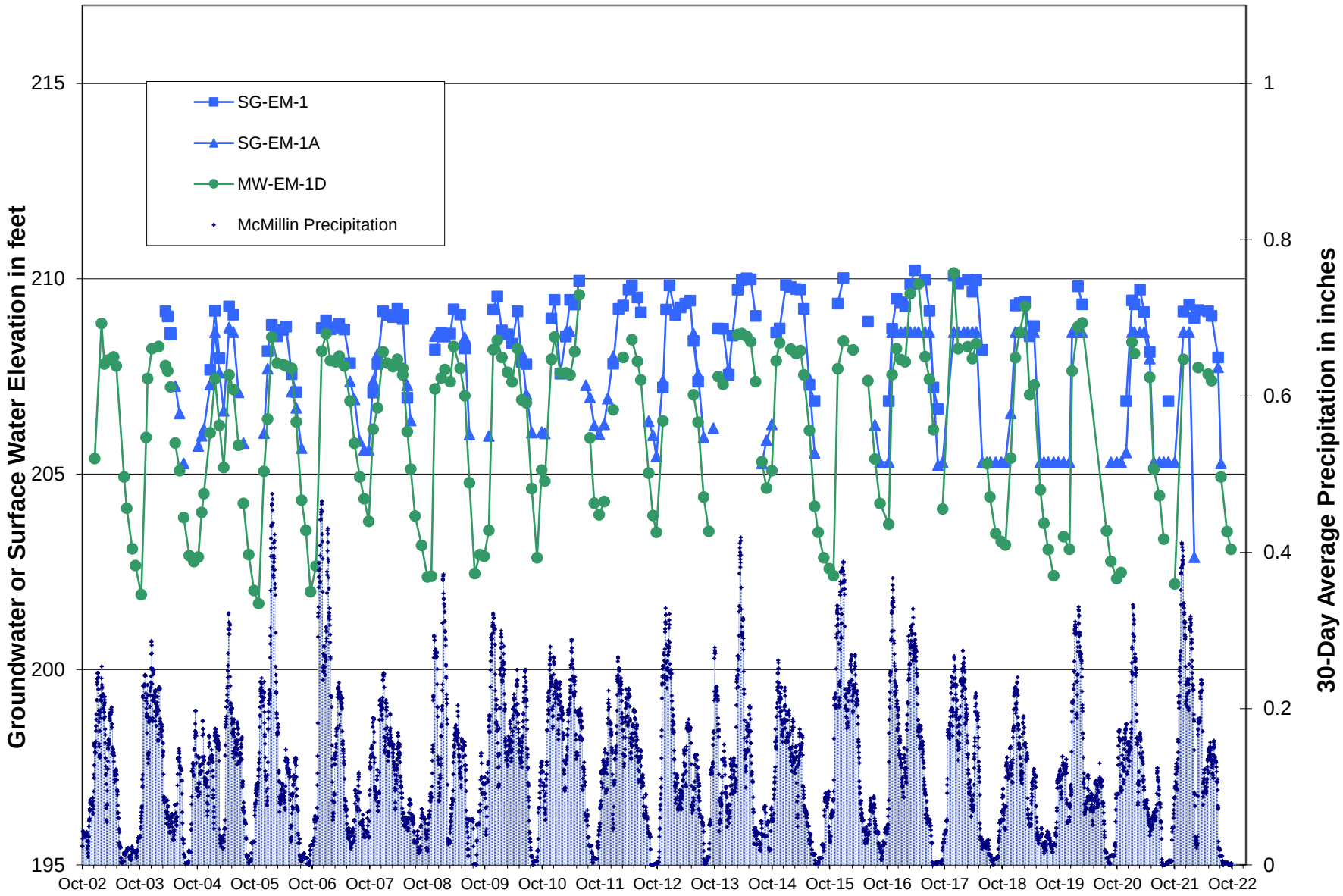
B-7 East Edmond Marsh Water Levels

Pioneer Aggregates South Parcel Project
DuPont, WA



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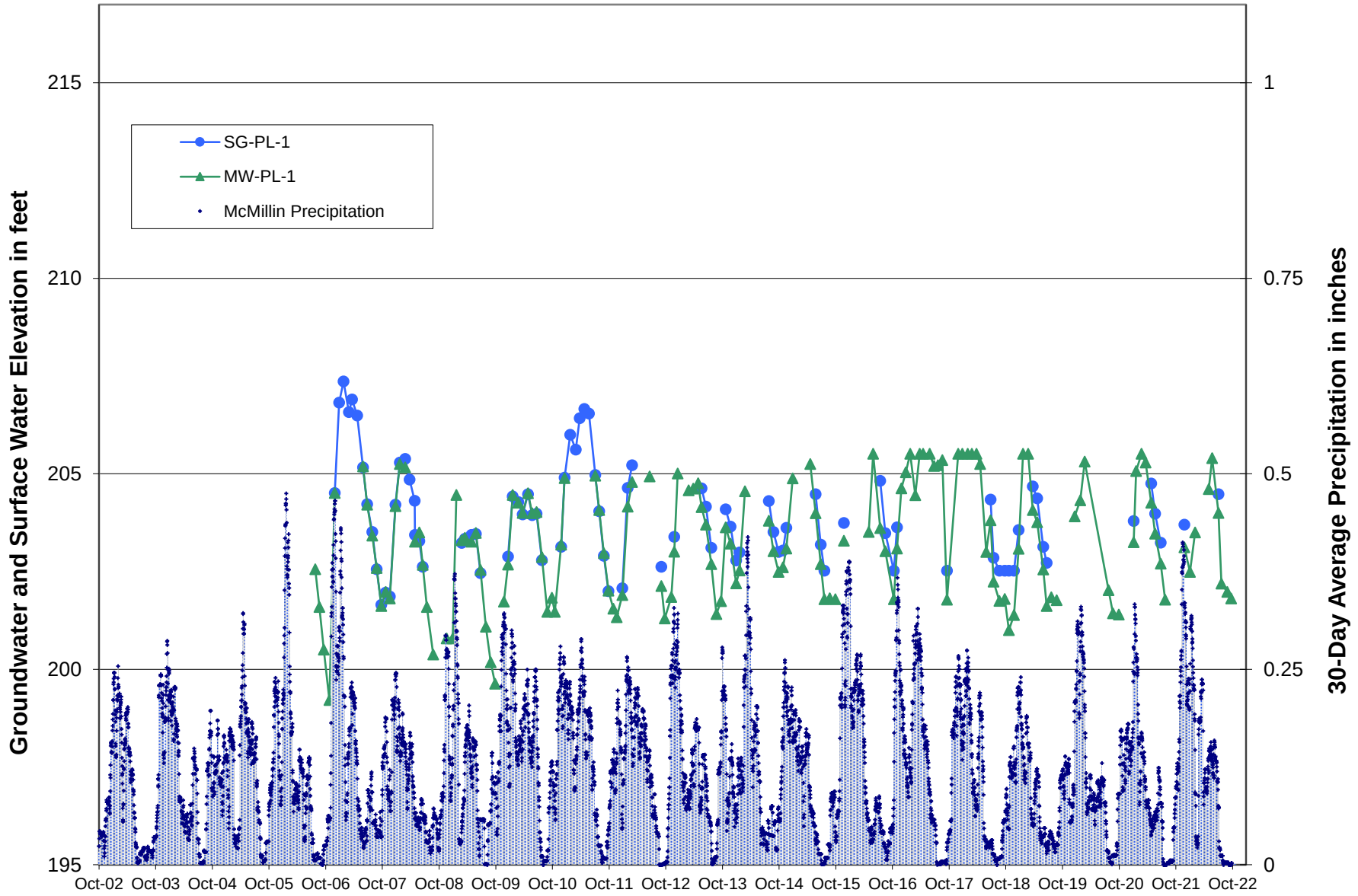
B-8 West Edmond Marsh Water Levels

Pioneer Aggregates South Parcel Project
DuPont, WA



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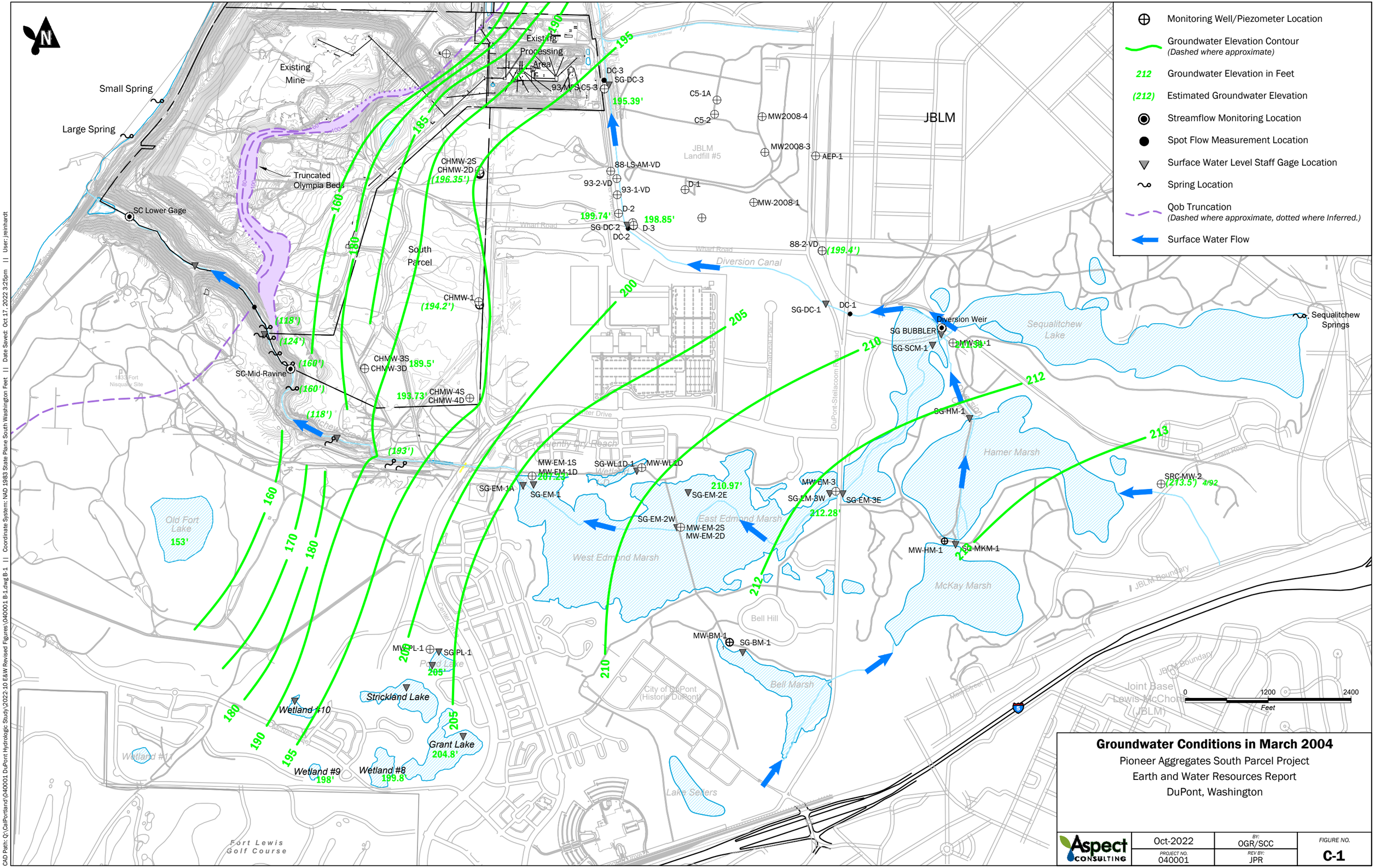
B-9 Pond Lake Water Levels

Pioneer Aggregates South Parcel Project
DuPont, WA

APPENDIX C

Groundwater Elevation Contour Maps



Groundwater Conditions in March 2004

Pioneer Aggregates South Parcel Project

Earth and Water Resources Report

DuPont, Washington

Aspect Consulting	Oct-2022	BY: OGR/SCC	FIGURE NO. C-1
	PROJECT NO. 040001	REV BY: JPR	

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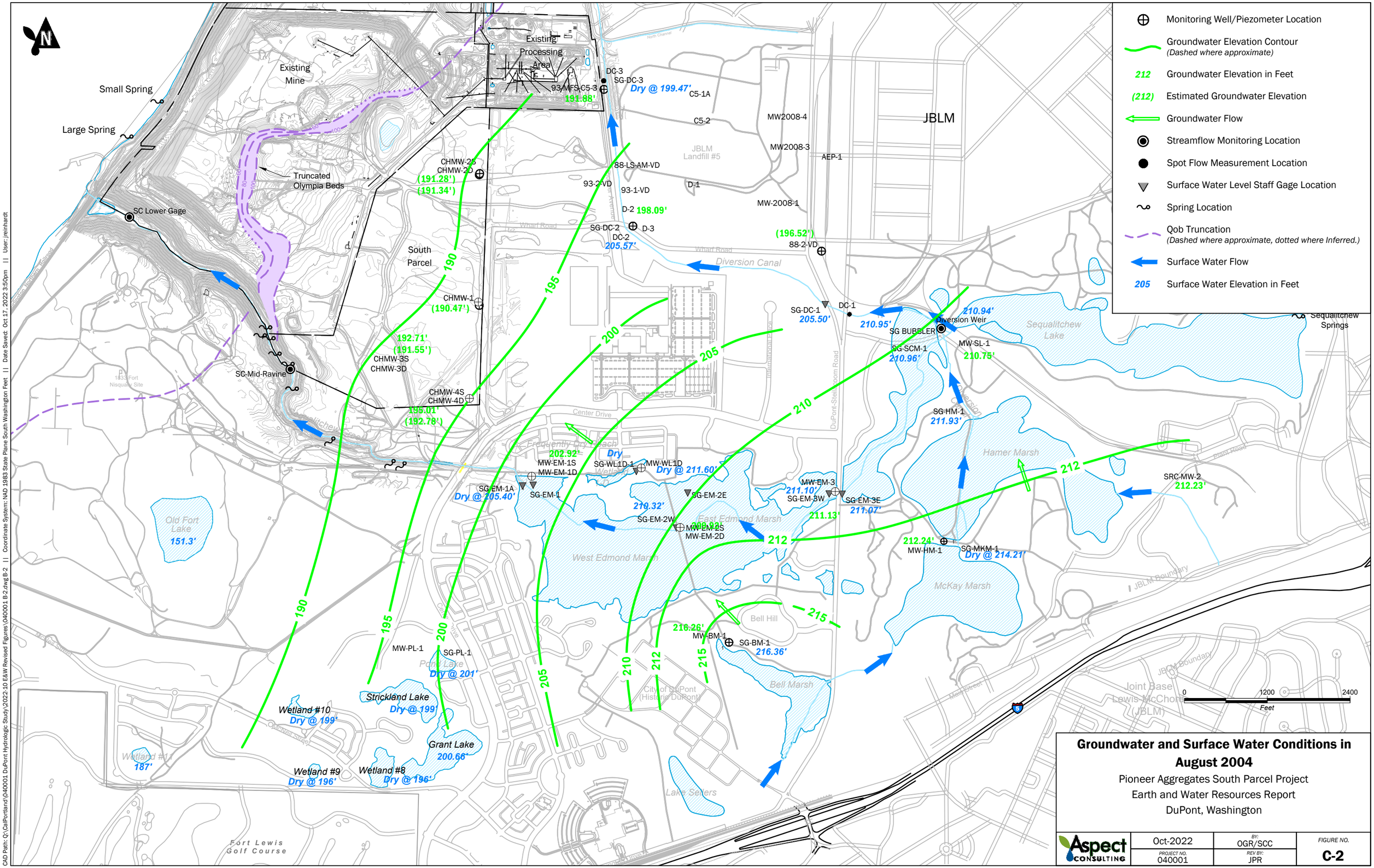

Groundwater and Surface Water Conditions in August 2004

Pioneer Aggregates South Parcel Project
Earth and Water Resources Report
DuPont, Washington

Aspect Consulting	Oct-2022	BY: OGR/SCC	FIGURE NO. C-2
	PROJECT NO. 040001	REV BY: JPR	

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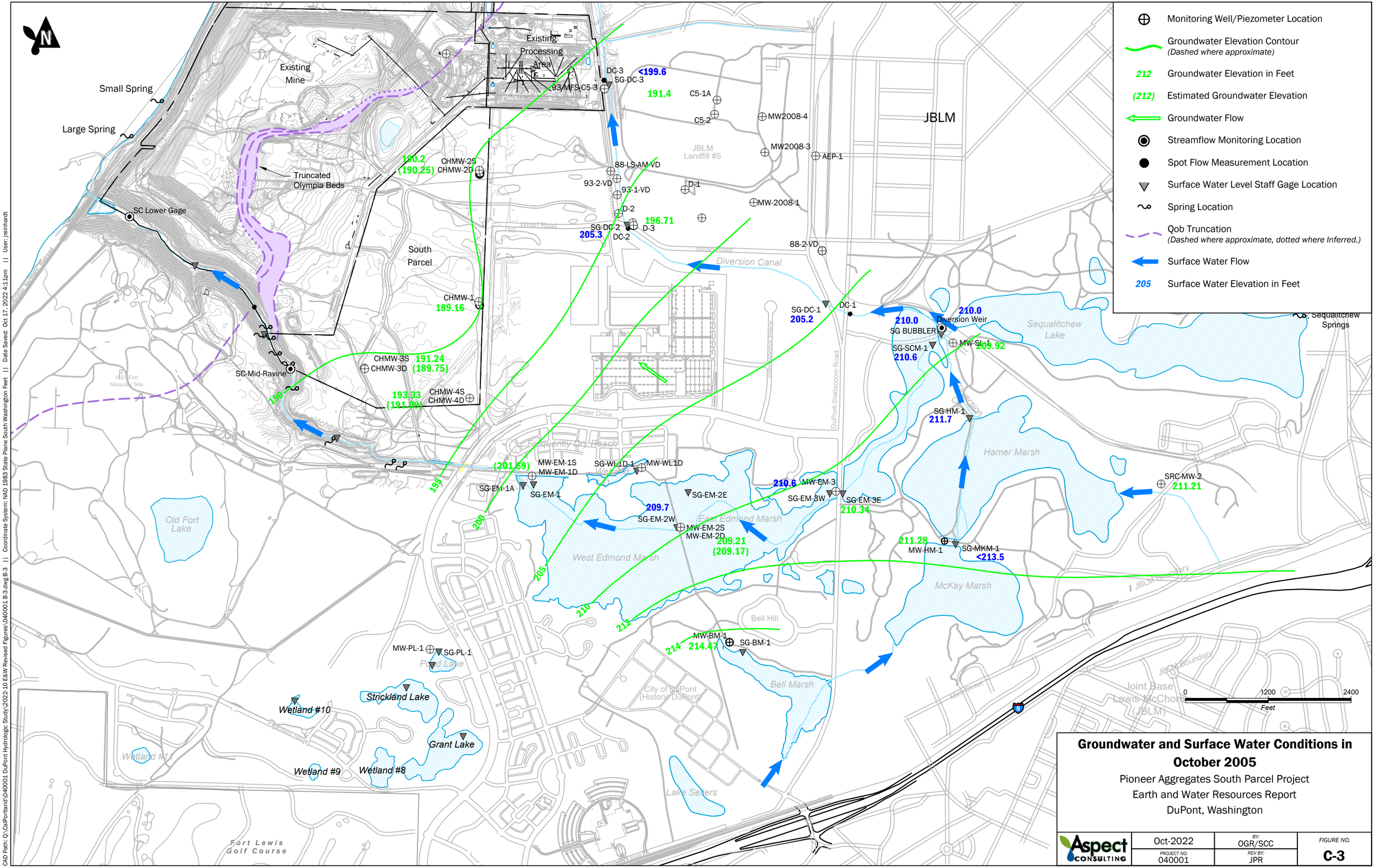

Groundwater and Surface Water Conditions in October 2005

Pioneer Aggregates South Parcel Project
Earth and Water Resources Report
DuPont, Washington

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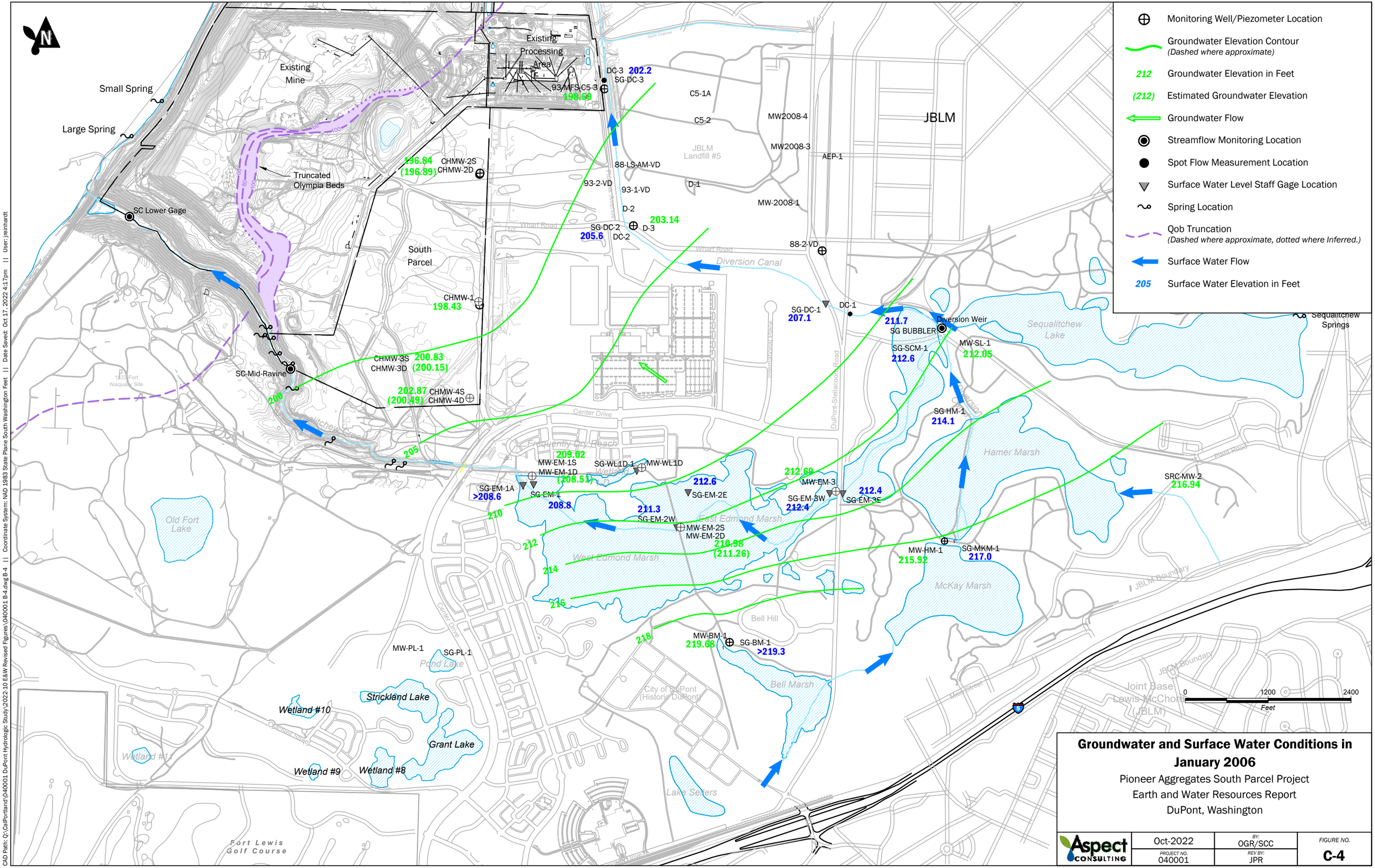

Groundwater and Surface Water Conditions in January 2006

Pioneer Aggregates South Parcel Project
Earth and Water Resources Report
DuPont, Washington

Aspect Consulting	Oct-2022	BY: OGR/SCC	FIGURE NO. C-4
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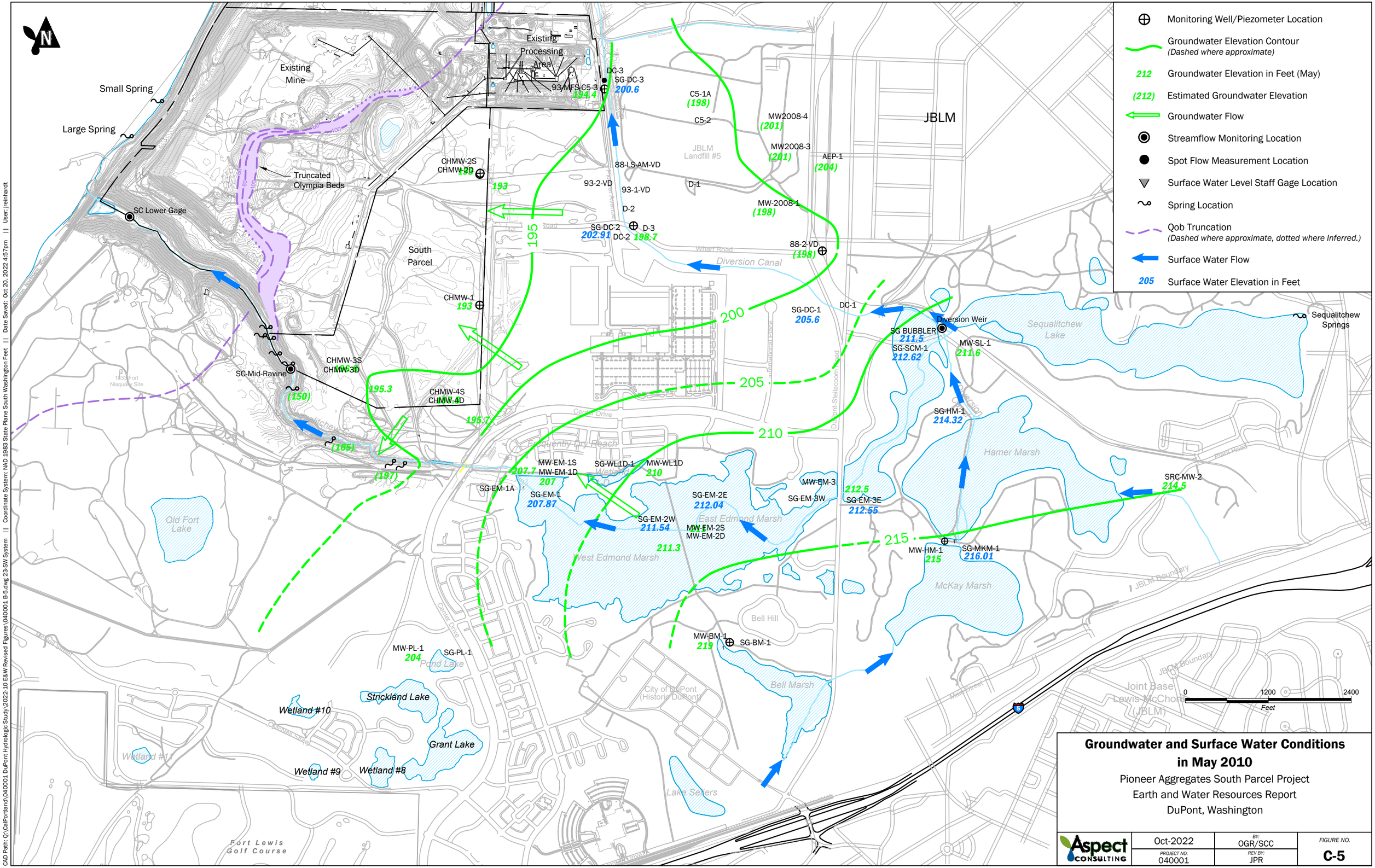

Groundwater and Surface Water Conditions in May 2010

Pioneer Aggregates South Parcel Project
Earth and Water Resources Report
DuPont, Washington

Aspect Consulting	Oct-2022	BY: OGR/SCC	FIGURE NO. C-5
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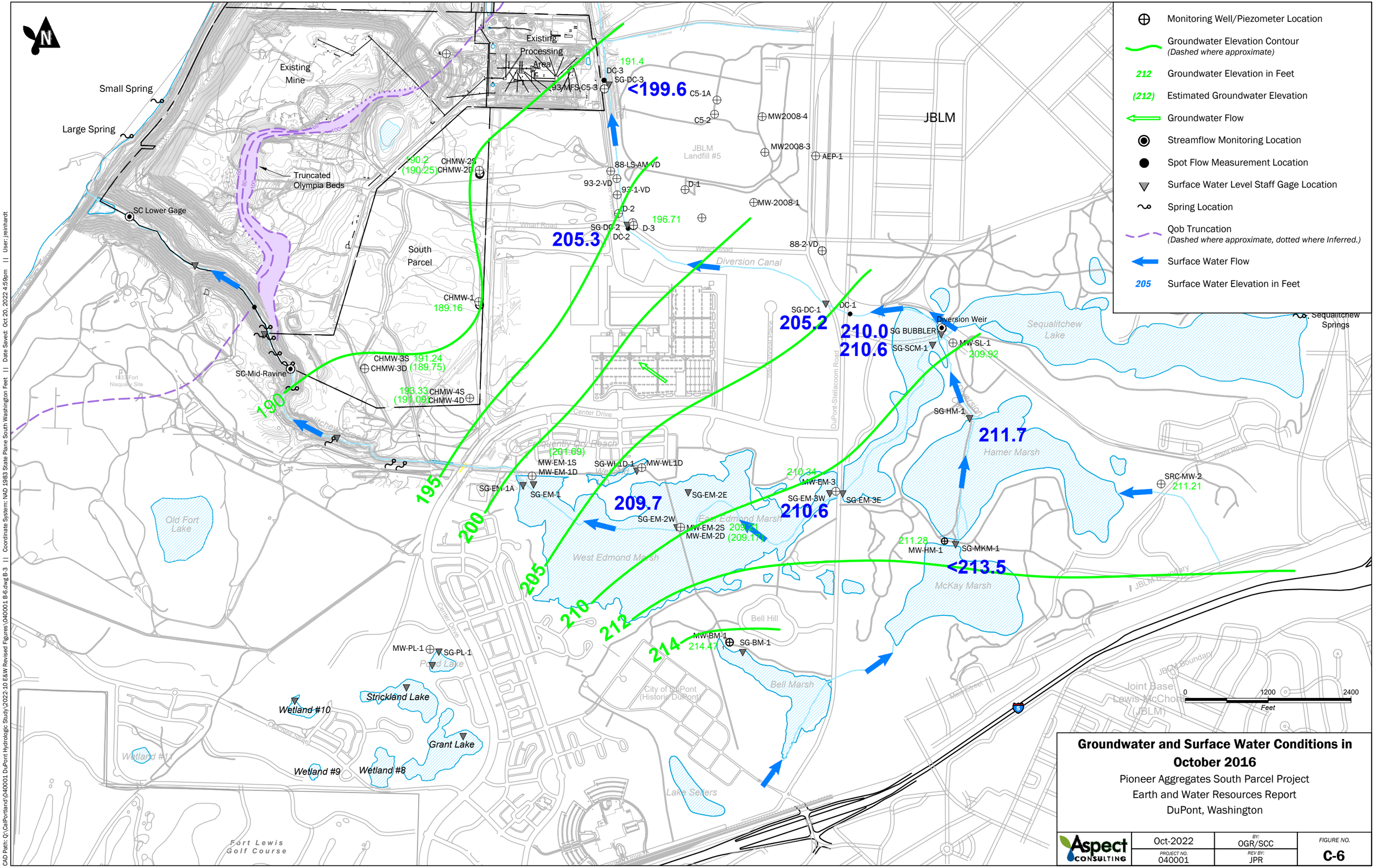

Groundwater and Surface Water Conditions in October 2016

Pioneer Aggregates South Parcel Project
Earth and Water Resources Report
DuPont, Washington

Aspect Consulting	Oct-2022	BY: OGR/SCC	FIGURE NO. C-6
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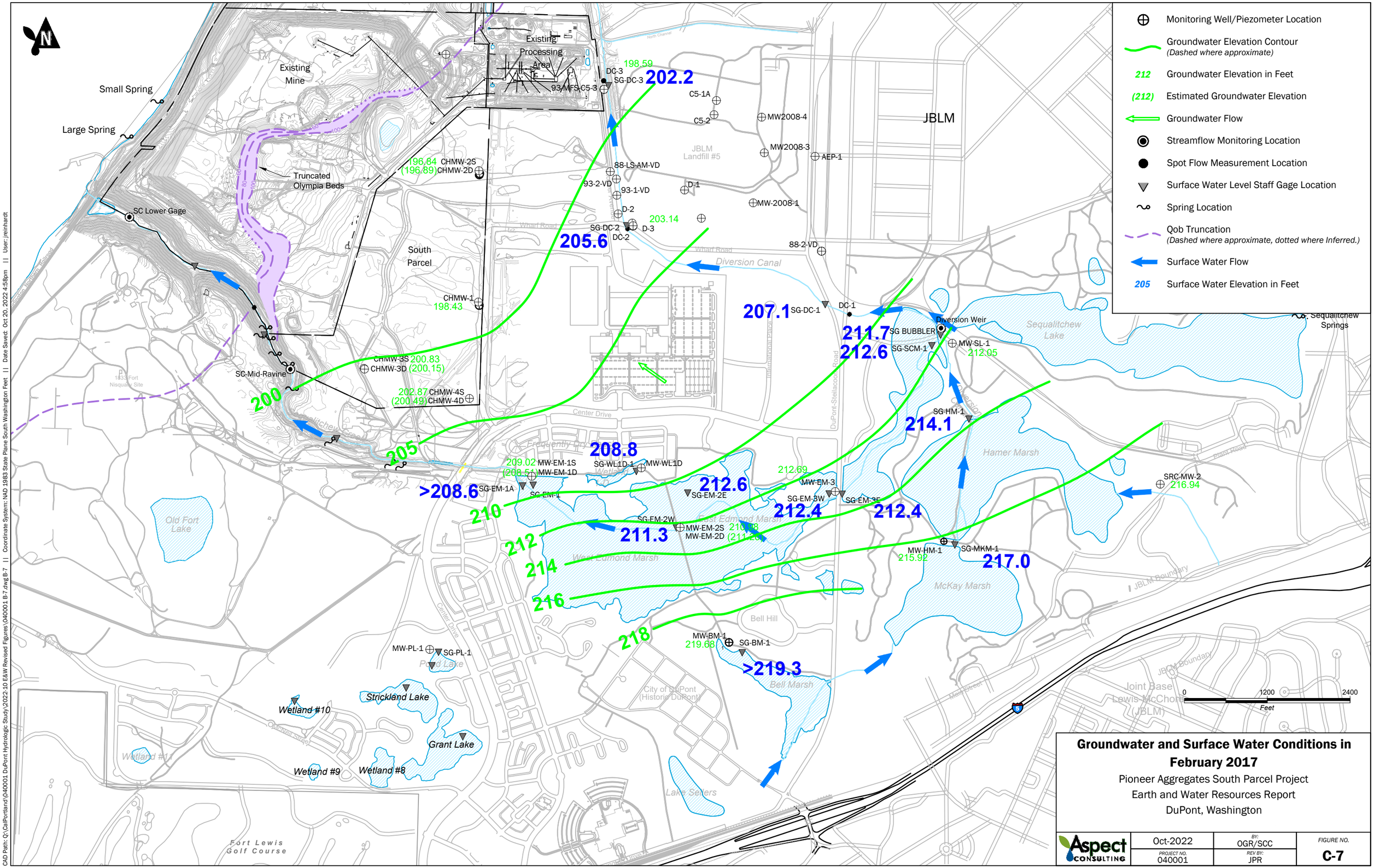

Groundwater and Surface Water Conditions in February 2017

Pioneer Aggregates South Parcel Project
Earth and Water Resources Report
DuPont, Washington

Aspect Consulting	Oct-2022	BY: OGR/SCC	FIGURE NO. C-7
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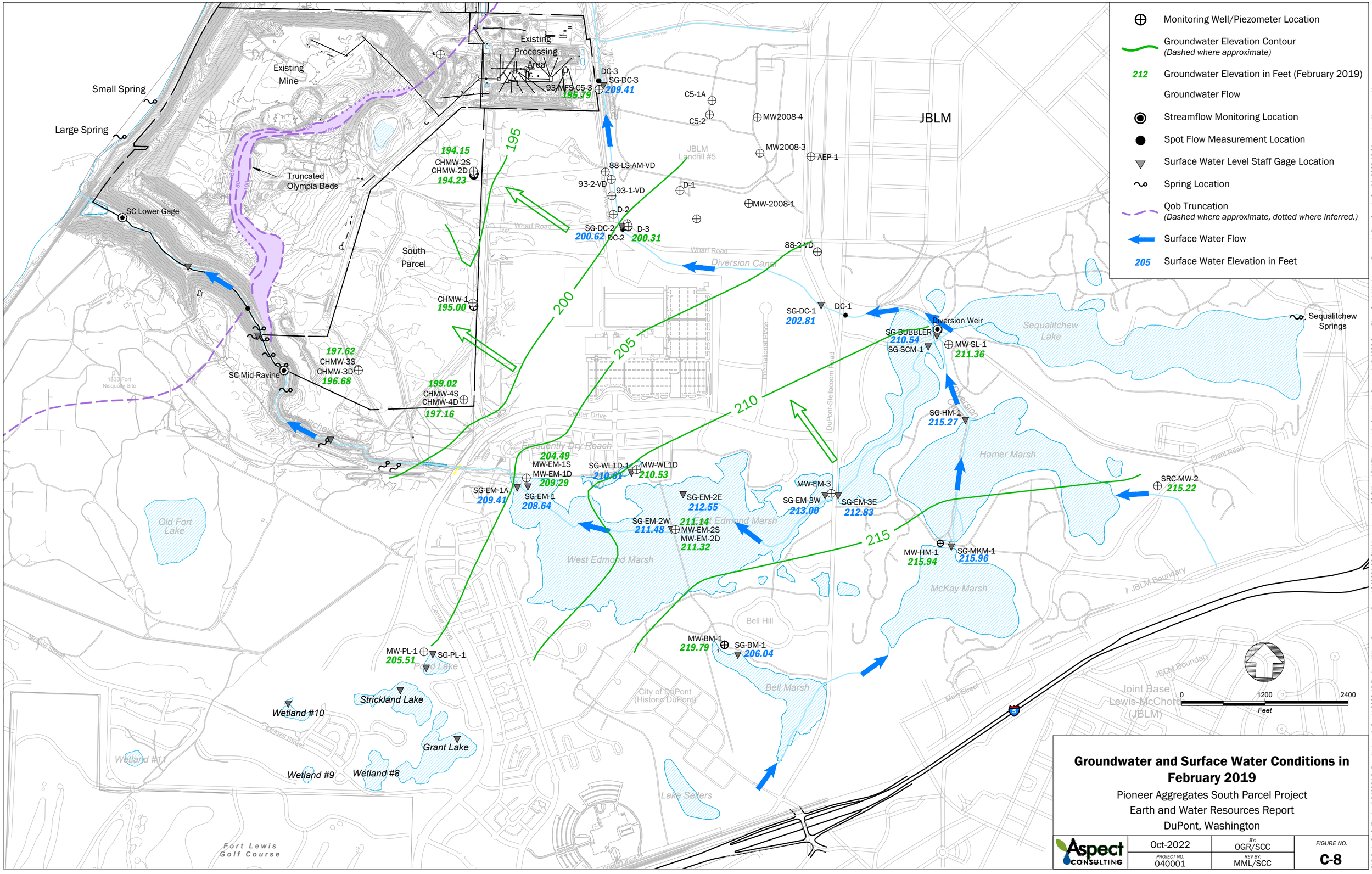

Groundwater and Surface Water Conditions in February 2019

Pioneer Aggregates South Parcel Project
Earth and Water Resources Report
DuPont, Washington

Aspect Consulting	Oct-2022	BY: OGR/SCC	FIGURE NO. C-8
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APPENDIX D

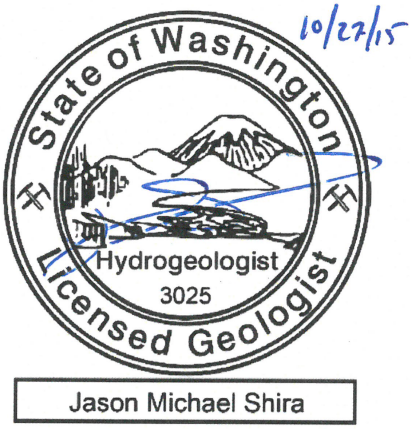
Intertidal Springs Evaluation

MEMORANDUM

Project No.: 040001-014-02

October 27, 2015

To: Pete Stoltz, CalPortland Company



From: Jason Shira, LHG and Owen Reese, P.E.

Re: **Water Sources of the Intertidal Beach Springs—FINAL**

This memorandum presents an evaluation of the water sources to the intertidal beach springs along the Puget Sound shoreline north of Sequalitchew Creek in DuPont, Washington.

An initial analysis was performed in 2004 as a component of the surface water and groundwater evaluations for the proposed mine expansion of CalPortland's DuPont Mine (Aspect, 2004). This update incorporates information about groundwater levels collected since 2004 and the results of a significant update to the three-dimensional groundwater model. This memorandum presents background information about the springs, aquifers, and groundwater conditions, and an analysis of the three contributors of flow in the springs: tidal intrusion, the Vashon Aquifer, and the Sea Level Aquifer.

The relative contribution of these three sources is estimated using standard hydrogeological analytical solutions (as opposed to a numerical model) and site-specific information collected from a variety of studies over the past several decades. This approach provides a rough estimate of the discharge from each of the sources to the intertidal springs collectively. There is insufficient information to evaluate the specific sources at any individual spring; however, much of the information on flow and water quality that informs our approach was collected from the Large Springs.

The 2004 analysis concluded that the Vashon Aquifer contributes 0.5 to 16 percent of flow to the intertidal springs. This updated analysis estimates the Vashon Aquifer contributes 0.2 to 14 percent of the flow to the springs.

Background

Intertidal Beach Springs

Springs are located at multiple points along the shoreline of the Nisqually Reach. Two springs are located along the beach just north of the Sequalitchew Creek estuary and directly west of the area of the proposed South Parcel mine development, Figure 1. The largest of these springs, the Large Spring, was reported to flow between 11 and 18 cubic feet per second (cfs) based on monthly data collected by the U.S. Geological Survey (USGS) in 1942. Spot measurements by CH2M HILL in 1999 and 2000 indicated flows of 9.1 and 14.9 cfs, respectively (CH2M HILL, 2001).

Hydrogeologic Conditions

The Steilacoom Delta was created by a glacial outburst flood that resulted in deposition of glacial outwash sand and gravel, Steilacoom Gravels (Borden and Troost, 2001). The outburst of flood waters eroded away older deposits (Vashon Till and Vashon Outwash) in some areas resulting in a channel of Steilacoom Gravels (Savoca, et al., 2010). In the area of the South Parcel, the Steilacoom Gravels (Qvs) overlie Vashon Till (Qvt) and Vashon Advance Outwash (Qva), which are identified in drilling logs. Beneath these Vashon Drift deposits lies a nonglacial deposit known as the Olympia Beds (Qob).

The Olympia Beds are a low permeable layer that generally consists of lahars, ashes, and fine-grained fluvial sediments. In the vicinity of the South Parcel, the Olympia Beds are best described as mudflows that separate the Vashon Aquifer and Sea Level Aquifer that are of interest in this evaluation. The Olympia Beds are not present in the vicinity of the beach springs. After the Olympia Beds were deposited, advancement of the Puget lobe of the Cordilleran ice sheet, and flow of water beneath the glacier, carved a valley through the Olympia Beds. As the glaciers receded, outburst floods from glacial lakes located northeast of DuPont deposited Steilacoom Gravels over the truncated Vashon Drift deposits and Olympia Beds effectively filling the valley carved by the glacier.

Below the Olympia Beds are glacial drift deposits locally referred to as the Salmon Springs Drift ($Qpog_2$) (Savoca, et al, 2010). These deposits are characterized by intervening nonglacial sediments, the presence of intervening glaciolacustrine sediments, and the presence of a thick, intensely oxidized zone at the top of the recessional outwash (Borden and Troost, 2001). Like the Olympia Beds, the Salmon Springs Drift deposits were truncated by the meltwater and advancement of the Puget lobe of the Cordilleran ice sheet, which was subsequently filled by the outwash of Steilacoom Gravels, Figure 2.

The Steilacoom Gravels host the upper unconfined aquifer. This upper aquifer is separated from a semiconfined aquifer by a 10-foot-thick low permeability unit comprised of Vashon Till. The till layer is not uniformly present. Beneath the till layer is a semiconfined aquifer hosted by the Vashon Advance Outwash. In this memorandum, the unconfined aquifer, upper confining unit, and semiconfined outwash aquifer are referred to collectively as the Vashon Aquifer.

The Salmon Springs Drift hosts the Sea Level Aquifer. The Sea Level Aquifer is regionally considered to be a confined aquifer; however, extending from approximately 6,000 feet upgradient of the truncation of the Olympia Beds, the Sea Level Aquifer is unconfined (Hart Crowser, 1994).

The area between the Olympia Bed truncation and the Puget Sound is comprised of Steilacoom Gravels (Qvs) overlying the Salmon Springs Drift ($Qpog_2$). Locally referred to as the Sequalitchew Delta Aquifer. Due to the thickness and high hydraulic conductivity of the Steilacoom Gravels, the hydraulic gradient of the Sequalitchew Delta Aquifer is fairly shallow. This is one reason springs are not observed higher on the bluffs overlooking Puget Sound.

Downgradient of the truncation of the Olympia Beds, the Vashon Aquifer and the Sea Level Aquifer flow into the Sequalitchew Delta Aquifer, which then discharges to the springs and sea floor of the Puget Sound. Intrusion of salt water into the Sequalitchew Delta Aquifer also occurs near the shoreline and as tidal elevations fluctuate. We evaluated the water sources to the intertidal springs based on the relative contributions to the Sequalitchew Delta Aquifer of saltwater, freshwater from the Vashon Aquifer, and freshwater from the Sea Level Aquifer.

Physical Properties (Hydraulic Conductivity and Gradient)

Hydraulic conductivities (K) within glacial deposits can vary by orders of magnitude because of the heterogenous deposition of gravels, sands, silts, and clay. The unconfined aquifer in the Steilacoom Gravels exhibits a high hydraulic conductivity (1,100 feet per day [ft/d] on average) due to the size of the grains deposited, sand and gravel, and lack of fine-grained material (silts or clay). The two other hydrogeologic units that make up the Vashon Aquifer exhibit hydraulic conductivities that are orders of magnitude lower (0.33 and 77 ft/d on average, respectively). The hydraulic conductivity of the Sea Level Aquifer in the Salmon Springs Drift is also fairly high (690 ft/d on average). The average hydraulic conductivities presented here are derived from parameter estimation techniques used during calibration of the South Parcel Mine Expansion groundwater model (Aspect, 2015), and are generally consistent with prior studies and pumping test results (Woodward Clyde, 1991; CH2M HILL, 2000; Aspect, 2004).

The hydraulic gradient, or slope, of the water table for the Vashon Aquifer is moderate on a regional scale; however, the hydraulic gradient steepens as the Vashon Aquifer approaches and travels over the Olympia Beds truncation. The Sea Level Aquifer also exhibits a change in hydraulic gradient; however, relative to the Vashon Aquifer, it has a comparatively shallow gradient near the Olympia Beds truncation (Figure 2 and Table 1).

Table 1—Hydraulic Gradients

Unit and Location Description	Hydraulic Gradient	Reference
Vashon near landfill	0.0006	Woodward Clyde, 1991,p.3-34
Vashon South Parcel (Dec 2014, high)	0.0009	Unpublished, based on recent monitoring data.
Vashon South Parcel (Oct 2014, low)	0.001	Unpublished, based on recent monitoring data.
Vashon west of landfill	0.005	Woodward Clyde, 1991, p.3-34
Vashon south of Sequalitchew Ck.	0.02	Hart Crowser, 1994, p.3.1-13
Vashon north of Sequalitchew Ck.	0.05	Hart Crowser, 1994, p.3.1-13
Vashon near Qob cutoff	0.33	Woodward Clyde, 1991,p.3-34
Sea Level Aq. near landfill	0.0001	Woodward Clyde, 1991, p.3-35
Sea Level Aq. (Bell Hill No. 1 to MW-18)	0.007	Hart Crowser, 1994, p.3.1-14
Sea Level Aq. west of landfill	0.01	WCC, 1992, p.3-35
Sea Level Aq. (MW-18 to PS)	0.03	Hart Crowser, 1994, p.3.1-14
Sea Level Aq. near Qob cutoff	0.05	Woodward Clyde,1991, p.3-35
Sequalitchew Delta Aquifer	0.002	Woodward Clyde,1991, p.3-35
SLA/Sequalitchew Delta Aquifer (MW-3 to PS)	0.005	Hart Crowser, 1994, p.3.1-14
SLA/ Sequalitchew Delta Aquifer (MW-6 to PS)	0.02	Hart Crowser, 1994, p.3.1-14

Seawater Intrusion

In coastal aquifer systems, the interaction of saltwater with freshwater aquifers is an important component for understanding the physical and chemical behavior of the groundwater system. The Ghyben-Herzberg Relation (Freeze and Cherry, 1979) states that the depth of the freshwater below sea level (Z) is 40 times the height of the water table above sea level (h). It is important to note that the Ghyben-Herzberg Relation is a simplified solution. In reality, the exact position of the saltwater/freshwater interface is governed by hydrostatic pressure, which varies with tide stage, mixing of freshwater and saltwater, combined with geologic heterogeneities, to create a diffuse zone instead of a sharp boundary.

The elevation of the Sequalitchew Delta Aquifer water table is less than 5-feet above mean sea level at the Puget Sound bluffs (Hart Crowser, 1994). This allows for seawater to potentially intrude the Sequalitchew Delta Aquifer. With seawater intrusion, the fresh water floats on top of the denser seawater. The lower the water table elevation (pressure), the more readily seawater displaces the freshwater. Tidal action and diffusion results in a mixing zone between the seawater and freshwater.

Freshwater within the Sequalitchew Delta Aquifer may be up to 100 feet thick in the area below the existing mine, and a few feet thick at the location where the springs discharge to the Puget Sound, Figure 2.

Analysis

Our approach for estimating the relative contribution of the three sources to the intertidal springs was to first estimate the portion of saltwater in the spring discharge using water quality measurements (electrical conductivity) to distinguish saltwater from freshwater. We then used analytical techniques to calculate the flow per unit width in each of the freshwater aquifers based on

their hydrogeologic characteristics. These results were compared with the output from a three-dimensional numerical groundwater model.

Evaluation of Saltwater Discharge from Large Springs

The portion of the discharge in the large springs coming from saltwater that intrudes into the aquifer at high tide, then drains through the springs at lower tidal elevations, was evaluated based on water quality measurements taken from the springs.

Electrical conductivity (EC) is an indicator of the quantity of dissolved solids in a water, and provides a useful measure for identifying salt waters (which have a high EC values) and freshwaters, which have much lower EC values. Monitoring data from the Large Spring (Aspect, 2004) indicate that EC of the spring discharge ranges from 15,400 to 43,200 micromhos per centimeter (μm/cm), and change diurnally with the tidal cycle. Spring discharge measuring EC at this range is indicative of seawater intrusion of the Sequalitchew Delta Aquifer. Groundwater is typically 150 to 200 μm/cm in the Vashon and Sea Level Aquifers (Woodward Clyde, 1991), and marine water in the Nisqually Reach area is 43,236 μm/cm (Thut, et al., 1978). These data indicate that marine water constitutes between 36 and 99 percent of the spring discharge, depending on diurnal tide stage.

Estimate of Vashon and Sea Level Aquifer Contributions

Based on the observed water quality at the Large Spring, the two freshwater aquifers are estimated to contribute from 1 to 64 percent of the flow to the spring. The contributions of each of the aquifers were evaluated using two approaches for calculating groundwater flux: an analytical approach, and the results of a calibrated three-dimensional groundwater model.

An analytical solution, the Dupuit Equation, was used to evaluate the unconfined aquifer conditions, and Darcy's Law for the confined aquifer conditions (Fetter, 2001).

Dupuit Equation

$$q' = K\frac{(h_1^2 - h_2^2)}{2L}$$

Darcy's Law

$$q' = Kb\frac{(h_1 - h_2)}{L}$$

Where,

q' = flow per unit width (square feet per day [ft^2/d]);
K = hydraulic conductivity (feet per day [ft/d]);
h_1 = water level elevation at origin (feet [ft]);
h_2 = water level elevation at L (ft);
L = the distance from origin at point h_2 (ft); and
b = aquifer thickness (ft).

The unconfined portions of the Vashon and Sea Level Aquifers have been characterized in a variety of studies conducted over the past several decades. South of Sequalitchew Creek, the aquifers were characterized as part of remedial efforts for the Former DuPont Works Site. Monitoring wells completed in the Vashon and Sea Level Aquifers indicate the hydraulic gradients vary seasonally and spatially (Hart Crowser, 1994). Similar work was performed for the Army Corp of Engineers on the north side of Sequalitchew Creek. Here, great variations occurred in the Vashon Aquifer and Sequalitchew Delta Aquifer (likely due to tidal influence) with little measurable change in the Sea Level Aquifer (Woodward Clyde, 1991). Recent monitoring data and model simulations of the groundwater response to dewatering confirmed seasonal variations in the Vashon Aquifer system (Aspect, 2015). The range of hydraulic gradients for each hydrogeologic unit are listed in Table 1. In this analysis, the median hydraulic gradient from previous investigations in the area was used for each aquifer and are shown in Table 2. The hydraulic conductivities listed in Table 2 were determined during calibration of the South Parcel Mine Expansion groundwater model (Aspect, 2015).

Table 2—Aquifer Parameters and Flow

Aquifer	Hydrogeologic Unit	Hydraulic Conductivity (K), ft/d	Hydraulic Gradient (dh/dl), ft/ft	Unit Thickness (b), ft	Flow per Unit Width (q'), ft^2/d
Vashon Aquifer	Vashon Steilacoom Gravels (Qvs)	1100	0.005	70	151
	Vashon Advance Outwash (Qva)	77	0.005	40	2
Sea Level Aquifer	Salmon Springs (Qpog2)	690	0.010	150	518
Percentage of Total Flow from Vashon Aquifer					23%

Using the DuPuit equation and the aquifer characteristics shown in Table 2, the total flow per unit width is estimated at 153 ft^2/d for the Vashon Aquifer and 518 ft^2/d for the Sea Level Aquifer. Flow in the Sequalitchew Delta Aquifer is the sum of the flows in these two aquifers, or 671 ft^2/d. As a result, the Vashon Aquifer contributes 23 percent of the freshwater flow to the Sequalitchew Delta Aquifer.

This analysis makes idealized assumptions about the occurrence and movement of groundwater through a complex geological and geographical setting. The analytical solutions presented represent one-dimensional steady-state conditions in an area that is better characterized by transient (tidally and seasonally changing hydraulic gradients and groundwater flow directions) and spatially variable conditions. The location of the intertidal springs and the amount of water discharged is controlled not only by the regional geology, but also by the fine-scale spatial variability of physical conditions that lead to preferential flow paths.

Comparison with Groundwater Model Results

A groundwater model has been previously developed (Aspect, 2004 and 2009) and recently updated (Aspect, 2015) to simulate effects on groundwater behavior in response to CalPortland's proposed dewatering, mining, and cessation of dewatering in the South Parcel. The model is centered between the South Parcel and East Edmonds Marsh, and extends beyond the Olympia Beds truncation to the west and Sequalitchew Lake to the east. The Sea Level Aquifer was treated as underflow in the vicinity of the South Parcel to the Puget Sound. The Vashon Aquifer was simulated as groundwater outflow to the Puget Sound. Although the primary purpose of the model is not predicting the relative discharge amounts from the two aquifers, it is capable of doing so. However, the model does not simulate saltwater intrusion from Puget Sound.

Model results indicate that, on average over the six-year period simulated by the model, the Vashon Aquifer contributes 15 percent of the total freshwater groundwater discharge to Puget Sound. This result is generally consistent with, but slightly lower than, the 23 percent predicted by the simpler analytical approach described above.

Summary of Sources of Water to the Intertidal Springs

By combining the estimates of the marine portion of the springs discharge with the relative flow in the two freshwater aquifers, we arrive at the breakdown of sources shown in Table 3. The makeup of the water (saltwater versus freshwater) discharging from the springs is influenced by tidal stage and season, and the contribution of the Vashon Aquifer from less than 1 percent up to 14 percent. This result is remarkably consistent with the 2004 estimate of 0.5 to 16 percent.

The ratio of sources at a specific intertidal spring may vary depending on its elevation (and thus potential for saltwater intrusion) and preferential flow paths for freshwater from one aquifer or the other.

Table 3—Percentage Contribution to Large Spring

Source	Estimated Percentage of Intertidal Spring Flow
Vashon Aquifer	0.2 - 14
Sea Level Aquifer	0.8 - 49
Puget Sound	36 - 99

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Limitations

Work for this project was performed for the CalPortland Company (Client), and this memorandum was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This memorandum does not represent a legal opinion. No other warranty, expressed or implied, is made.

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Attachments

Figure 1—Sequalitchew Creek Basin Map
Figure 2—Aquifer Systems Near DuPont

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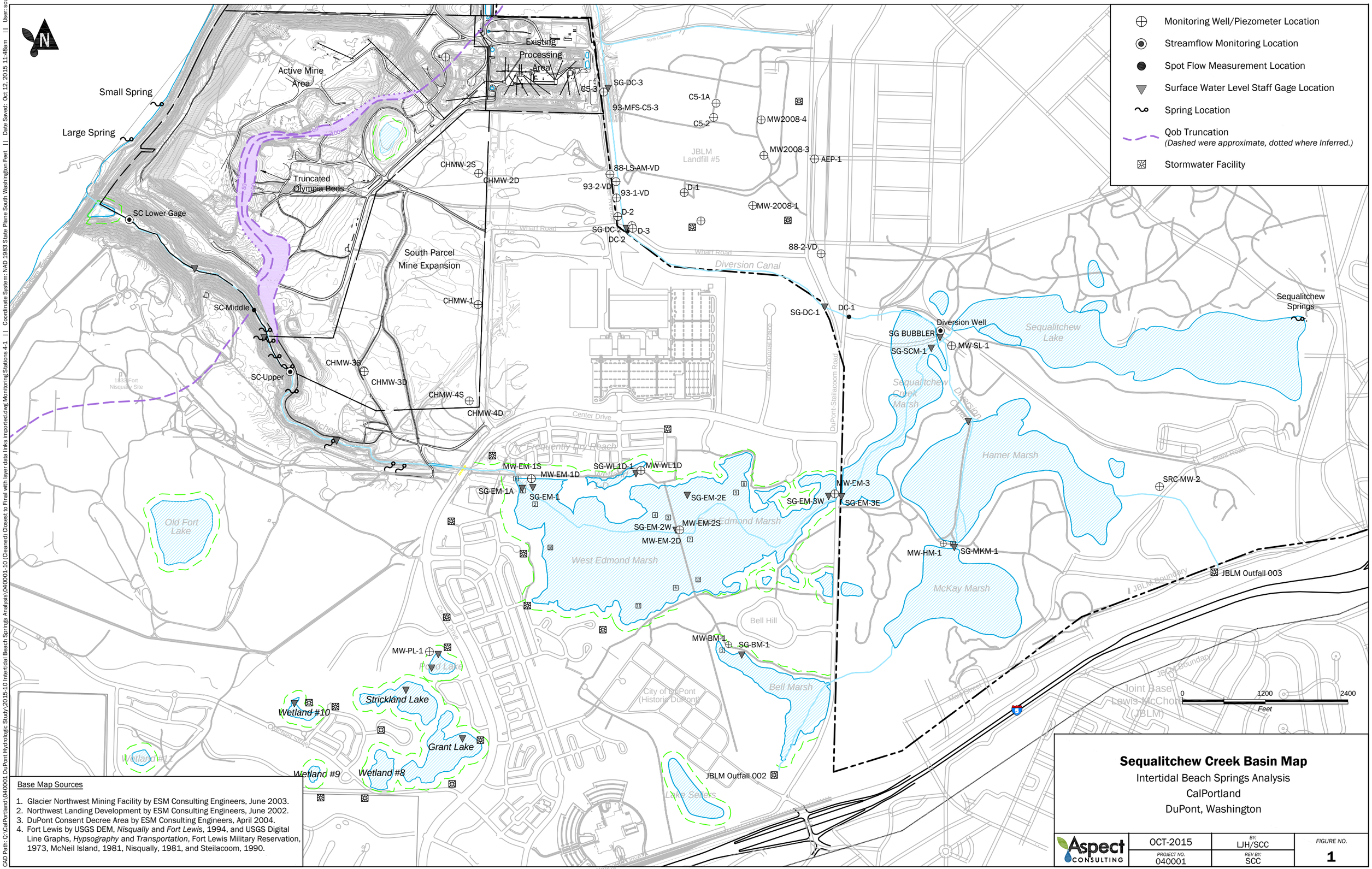
FIGURES



Base Map Sources

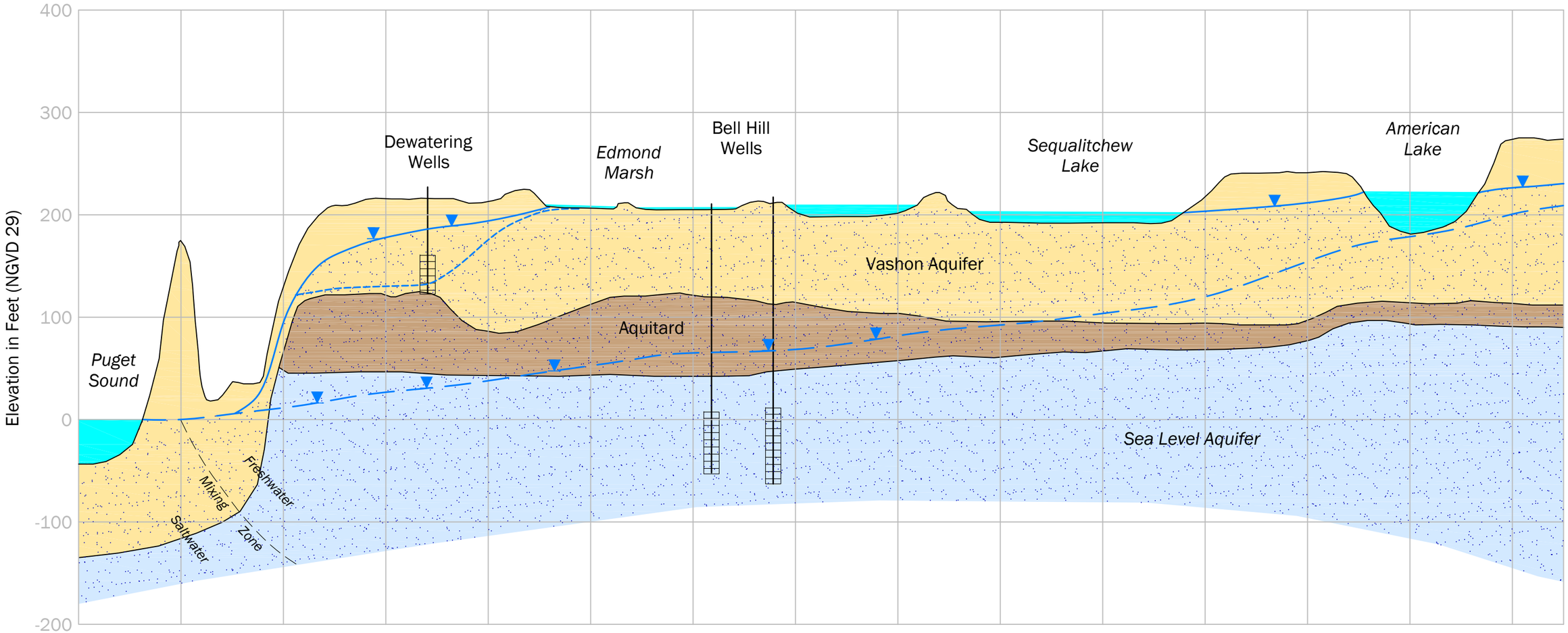
1. Glacier Northwest Mining Facility by ESM Consulting Engineers, June 2003.
2. Northwest Landing Development by ESM Consulting Engineers, June 2002.
3. DuPont Consent Decree Area by ESM Consulting Engineers, April 2004.
4. Fort Lewis by USGS DEM, *Nisqually* and *Fort Lewis*, 1994, and USGS Digital Line Graphs, *Hypsography* and *Transportation*, Fort Lewis Military Reservation, 1973, McNeil Island, 1981, Nisqually, 1981, and Steilacoom, 1990.

Sequalitchew Creek Basin Map

Intertidal Beach Springs Analysis
CalPortland
DuPont, Washington

Aspect Consulting	OCT-2015	BY: LJH/SCC	FIGURE NO. 1
	PROJECT NO. 040001	REV BY: SCC	

C:\CAD Path: Q:\CalPortland\040001 DuPont Hydrologic Study\2015-10 Intertidal Beach Springs Analysis\040001-10 (Cleaned) Closest to Final with layer data links imported.dwg Monitoring Stations 4-1 || Coordinate System: NAD 1983 State Plane South Washington Feet || Date Saved: Oct 12, 2015 11:48am || User: scud



— — — Ghyben-Herzberg Interface

Current Water Level in Vashon Aquifer

Predicted Water Level with Mining

Water Level in the Sea Level Aquifer (City of DuPont Water Supply Aquifer)

Aquifer Systems Near DuPont

Intertidal Beach Springs Analysis

CalPortland

DuPont, Washington

Aspect CONSULTING	OCT-2015	BY: JS/SCC	FIGURE NO. 2
	PROJECT NO. 040001	REV BY: SC	

CAD Path: Q:\CalPortland\040001 DuPont Hydrologic Study\2015-10 Intertidal Beach Springs Analysis\040001-AA-20x.dwg 11x17 Landscape || Coordinate System: NAD 1983 State Plane Washington North FIPS 4601 Feet || Date Saved: Oct 12, 2015 11:48am || User: scudd

APPENDIX E

Site Water Balance Results

Table E-1. Site Water Balance for Existing Conditions

Project No. 040001, DuPont, Washington

	Inflows			Outflows			
Year	Total Precipitation in inches	Total Surface Water Run-On in cfs	Groundwater Inflows in cfs	Evapo-transpiration in inches	Stormwater in cfs	Direct Groundwater Recharge in cfs	Total Groundwater Outflow in cfs
1901	40.83	0	6.9	21.75	0.14	0.92	7.96
1902	38.26	0	6.9	19.55	0.11	0.93	7.94
1903	35.03	0	6.9	16.33	0.11	0.93	7.94
1904	38.42	0	6.9	17.55	0.13	1.03	8.06
1905	25.71	0	6.9	14.10	0.06	0.58	7.54
1906	37.95	0	6.9	21.91	0.12	0.78	7.79
1907	38.20	0	6.9	16.92	0.13	1.05	8.08
1908	38.11	0	6.9	17.89	0.12	1.00	8.02
1909	53.09	0	6.9	25.48	0.18	1.35	8.43
1910	33.20	0	6.9	12.51	0.11	1.04	8.05
1911	48.37	0	6.9	20.55	0.19	1.36	8.44
1912	45.91	0	6.9	16.27	0.18	1.47	8.55
1913	32.51	0	6.9	15.47	0.10	0.85	7.85
1914	36.06	0	6.9	18.48	0.11	0.86	7.88
1915	46.92	0	6.9	21.81	0.16	1.24	8.29
1916	31.16	0	6.9	15.39	0.09	0.79	7.78
1917	50.58	0	6.9	19.90	0.19	1.51	8.60
1918	37.07	0	6.9	16.79	0.12	1.01	8.03
1919	38.67	0	6.9	17.95	0.13	1.02	8.05
1920	45.83	0	6.9	20.26	0.16	1.26	8.32
1921	41.45	0	6.9	18.25	0.14	1.15	8.19
1922	48.12	0	6.9	18.46	0.18	1.47	8.55
1923	34.20	0	6.9	16.99	0.10	0.86	7.86
1924	36.53	0	6.9	18.54	0.11	0.89	7.90
1925	45.82	0	6.9	21.91	0.15	1.18	8.23
1926	37.20	0	6.9	16.90	0.12	1.01	8.03
1927	41.37	0	6.9	19.19	0.14	1.10	8.13
1928	45.78	0	6.9	17.27	0.17	1.41	8.48
1929	51.97	0	6.9	25.28	0.18	1.31	8.38
1930	48.05	0	6.9	18.29	0.17	1.48	8.55
1931	37.66	0	6.9	15.49	0.13	1.10	8.13
1932	48.90	0	6.9	21.31	0.17	1.36	8.43
1933	62.18	0	6.9	22.37	0.26	1.95	9.11
1934	35.86	0	6.9	14.11	0.12	1.09	8.11
1935	52.09	0	6.9	20.01	0.20	1.59	8.68
1936	42.98	0	6.9	19.49	0.15	1.16	8.20
1937	49.63	0	6.9	21.90	0.17	1.37	8.44
1938	26.62	0	6.9	16.09	0.06	0.52	7.48
1939	46.62	0	6.9	23.06	0.15	1.16	8.21
1940	30.97	0	6.9	13.76	0.10	0.86	7.86
1941	43.78	0	6.9	19.73	0.15	1.18	8.24
1942	37.47	0	6.9	17.78	0.12	0.97	7.99
1943	49.82	0	6.9	20.25	0.18	1.46	8.54
1944	50.74	0	6.9	23.68	0.17	1.33	8.40
1945	40.83	0	6.9	16.73	0.14	1.20	8.24
1946	34.17	0	6.9	17.32	0.10	0.84	7.84

Table E-1. Site Water Balance for Existing Conditions

Project No. 040001, DuPont, Washington

	Inflows			Outflows			
Year	Total Precipitation in inches	Total Surface Water Run-On in cfs	Groundwater Inflows in cfs	Evapo-transpiration in inches	Stormwater in cfs	Direct Groundwater Recharge in cfs	Total Groundwater Outflow in cfs
1947	38.87	0	6.9	18.11	0.13	1.02	8.05
1948	43.71	0	6.9	18.59	0.16	1.23	8.29
1949	31.37	0	6.9	16.29	0.09	0.75	7.74
1950	42.12	0	6.9	20.24	0.13	1.08	8.12
1951	46.83	0	6.9	19.36	0.18	1.34	8.43
1952	53.37	0	6.9	20.03	0.22	1.63	8.75
1953	35.77	0	6.9	14.74	0.12	1.05	8.07
1954	39.97	0	6.9	20.58	0.12	0.96	7.98
1955	30.18	0	6.9	15.69	0.08	0.72	7.70
1956	44.18	0	6.9	20.40	0.15	1.17	8.22
1957	58.24	0	6.9	21.68	0.24	1.79	8.93
1958	52.59	0	6.9	19.25	0.21	1.64	8.75
1959	33.13	0	6.9	12.83	0.11	1.01	8.03
1960	55.41	0	6.9	22.14	0.22	1.63	8.75
1961	36.29	0	6.9	15.89	0.13	1.01	8.03
1962	36.22	0	6.9	19.15	0.10	0.85	7.85
1963	33.33	0	6.9	15.82	0.10	0.87	7.87
1964	57.69	0	6.9	23.56	0.24	1.66	8.80
1965	28.52	0	6.9	11.27	0.09	0.87	7.86
1966	38.98	0	6.9	20.63	0.12	0.90	7.92
1967	43.40	0	6.9	18.08	0.15	1.25	8.31
1968	37.92	0	6.9	18.86	0.11	0.94	7.96
1969	45.01	0	6.9	19.71	0.16	1.25	8.30
1970	44.55	0	6.9	17.55	0.17	1.33	8.40
1971	45.61	0	6.9	19.02	0.16	1.31	8.38
1972	51.44	0	6.9	17.60	0.21	1.67	8.78
1973	43.43	0	6.9	17.78	0.15	1.27	8.32
1974	45.51	0	6.9	19.86	0.16	1.26	8.32
1975	46.93	0	6.9	18.39	0.17	1.41	8.49
1976	36.53	0	6.9	16.71	0.11	0.99	8.00
1977	57.46	0	6.9	20.49	0.23	1.82	8.95
1978	35.73	0	6.9	15.88	0.11	0.99	8.00
1979	44.96	0	6.9	19.26	0.16	1.27	8.33
1980	42.56	0	6.9	17.97	0.15	1.22	8.27
1981	38.36	0	6.9	18.84	0.11	0.97	7.98
1982	48.39	0	6.9	19.70	0.18	1.42	8.49
1983	34.00	0	6.9	15.77	0.10	0.91	7.91
1984	38.65	0	6.9	17.77	0.13	1.03	8.06
1985	36.02	0	6.9	16.93	0.11	0.95	7.96
1986	39.21	0	6.9	17.69	0.13	1.06	8.10
1987	35.69	0	6.9	15.79	0.12	0.99	8.01
1988	36.33	0	6.9	17.25	0.12	0.94	7.96
1989	44.58	0	6.9	22.35	0.14	1.09	8.13
1990	47.15	0	6.9	16.93	0.18	1.50	8.58
1991	46.79	0	6.9	17.39	0.18	1.46	8.53
1992	52.29	0	6.9	22.48	0.19	1.47	8.56

Table E-1. Site Water Balance for Existing Conditions

Project No. 040001, DuPont, Washington

	Inflows			Outflows			
Year	Total Precipitation in inches	Total Surface Water Run-On in cfs	Groundwater Inflows in cfs	Evapo-transpiration in inches	Stormwater in cfs	Direct Groundwater Recharge in cfs	Total Groundwater Outflow in cfs
1993	44.54	0	6.9	15.32	0.17	1.46	8.52
1994	33.69	0	6.9	16.27	0.10	0.87	7.87
1995	61.78	0	6.9	20.71	0.26	2.02	9.18
1996	40.75	0	6.9	18.04	0.13	1.13	8.16
1997	43.33	0	6.9	19.88	0.14	1.16	8.20
1998	23.49	0	6.9	13.46	0.05	0.50	7.46
1999	44.25	0	6.9	23.38	0.14	1.02	8.06
2000	31.82	0	6.9	15.14	0.09	0.83	7.83
2001	41.20	0	6.9	18.33	0.14	1.13	8.17
2002	37.41	0	6.9	17.64	0.12	0.98	8.00
2003	46.97	0	6.9	19.04	0.17	1.38	8.45
2004	57.63	0	6.9	24.78	0.21	1.61	8.72
2005	43.60	0	6.9	15.75	0.15	1.39	8.45
2006	35.32	0	6.9	14.01	0.12	1.06	8.08
2007	37.55	0	6.9	17.85	0.12	0.97	7.99
2008	40.60	0	6.9	19.35	0.13	1.05	8.08
2009	35.07	0	6.9	16.35	0.11	0.93	7.94
2010	33.78	0	6.9	16.34	0.10	0.87	7.87
2011	34.09	0	6.9	17.15	0.11	0.83	7.84
2012	38.96	0	6.9	18.93	0.13	0.99	8.01
2013	30.12	0	6.9	14.01	0.09	0.80	7.79
2014	43.52	0	6.9	21.82	0.15	1.06	8.11
2015	25.74	0	6.9	11.70	0.07	0.71	7.68
2016	50.36	0	6.9	23.17	0.18	1.33	8.41
2017	56.54	0	6.9	19.80	0.23	1.81	8.94
2018	58.35	0	6.9	21.81	0.23	1.80	8.93
2019	43.38	0	6.9	17.78	0.15	1.27	8.32
2020	52.71	0	6.9	19.25	0.20	1.65	8.76
2021	37.15	0	6.9	18.10	0.11	0.95	7.96
2022	49.81	0	6.9	19.76	0.19	1.48	8.57
2023	37.80	0	6.9	18.08	0.12	0.97	8.00
2024	39.84	0	6.9	18.68	0.13	1.04	8.08
2025	45.58	0	6.9	20.38	0.15	1.24	8.30
2026	35.92	0	6.9	16.57	0.11	0.96	7.97
2027	31.55	0	6.9	17.24	0.08	0.72	7.69
2028	43.54	0	6.9	18.08	0.16	1.26	8.31
2029	47.68	0	6.9	20.22	0.17	1.35	8.42
2030	34.39	0	6.9	14.94	0.11	0.97	7.98
2031	35.52	0	6.9	18.28	0.10	0.86	7.86
2032	35.66	0	6.9	18.56	0.11	0.84	7.85
2033	43.89	0	6.9	21.58	0.14	1.10	8.14
2034	35.91	0	6.9	15.30	0.12	1.02	8.04
2035	45.85	0	6.9	20.68	0.16	1.24	8.30
2036	27.87	0	6.9	13.20	0.08	0.73	7.71
2037	48.88	0	6.9	20.58	0.19	1.39	8.47
2038	28.10	0	6.9	16.17	0.06	0.60	7.56

Table E-1. Site Water Balance for Existing Conditions

Project No. 040001, DuPont, Washington

	Inflows			Outflows			
Year	Total Precipitation in inches	Total Surface Water Run-On in cfs	Groundwater Inflows in cfs	Evapo-transpiration in inches	Stormwater in cfs	Direct Groundwater Recharge in cfs	Total Groundwater Outflow in cfs
2039	36.26	0	6.9	20.13	0.10	0.79	7.80
2040	33.69	0	6.9	16.62	0.10	0.85	7.85
2041	46.65	0	6.9	23.03	0.16	1.15	8.21
2042	53.77	0	6.9	22.52	0.19	1.54	8.64
2043	51.49	0	6.9	17.48	0.20	1.69	8.79
2044	51.64	0	6.9	21.40	0.19	1.49	8.58
2045	52.33	0	6.9	19.56	0.20	1.62	8.72
2046	36.35	0	6.9	15.18	0.12	1.06	8.08
2047	42.13	0	6.9	20.70	0.13	1.06	8.09
2048	41.81	0	6.9	18.00	0.15	1.18	8.22
2049	36.96	0	6.9	18.50	0.12	0.91	7.93
2050	46.15	0	6.9	19.94	0.16	1.30	8.36
2051	45.24	0	6.9	18.70	0.16	1.31	8.37
2052	48.60	0	6.9	20.18	0.17	1.41	8.48
2053	45.60	0	6.9	18.98	0.17	1.31	8.38
2054	37.71	0	6.9	18.78	0.11	0.94	7.95
2055	33.13	0	6.9	16.22	0.09	0.84	7.84
2056	46.21	0	6.9	21.31	0.16	1.22	8.28
2057	41.86	0	6.9	16.27	0.15	1.27	8.32
2058	67.38	0	6.9	24.61	0.29	2.08	9.27
Average	41.99	0	6.90	18.51	0.14	1.16	8.20
Average in inches	41.99	0	124.26	18.51	2.59	20.89	147.74

Notes:

1) Stormwater is the sum of surface runoff and interflow.

2) Under existing conditions, all stormwater infiltrates within the mine area or on the South Parcel.

3) Total Groundwater outflow is the sum of stormwater + direct groundwater recharge + groundwater inflows.

4) Average flows in cfs are converted to inches by calculating the total volume in cubic feet for the year, then dividing by the project area of 482.4 acres

Table E-2. Site Water Balance for Proposed Action

Project No. 040001, DuPont, Washington

	Inflows			Outflows			
Year	Total Precipitation in inches	Total Surface Water Run-On in cfs	Groundwater Inflows in cfs	Evapo-transpiration in inches	Stormwater in cfs	Direct Groundwater Recharge in cfs	Total Groundwater Outflow in cfs
1901	40.83	0	6.9	19.65	0.62	0.56	8.08
1902	38.26	0	6.9	19.29	0.43	0.62	7.95
1903	35.03	0	6.9	15.81	0.44	0.63	7.97
1904	38.42	0	6.9	16.50	0.56	0.66	8.12
1905	25.71	0	6.9	14.40	0.20	0.42	7.53
1906	37.95	0	6.9	20.60	0.45	0.52	7.86
1907	38.20	0	6.9	16.03	0.53	0.70	8.13
1908	38.11	0	6.9	17.11	0.51	0.65	8.07
1909	53.09	0	6.9	24.23	0.76	0.84	8.50
1910	33.20	0	6.9	11.88	0.49	0.69	8.08
1911	48.37	0	6.9	19.10	0.80	0.83	8.53
1912	45.91	0	6.9	15.18	0.81	0.90	8.61
1913	32.51	0	6.9	15.03	0.39	0.59	7.87
1914	36.06	0	6.9	17.78	0.45	0.57	7.91
1915	46.92	0	6.9	20.70	0.66	0.80	8.36
1916	31.16	0	6.9	15.12	0.32	0.57	7.79
1917	50.58	0	6.9	17.88	0.87	0.94	8.72
1918	37.07	0	6.9	16.10	0.48	0.69	8.06
1919	38.67	0	6.9	16.89	0.53	0.68	8.11
1920	45.83	0	6.9	19.35	0.66	0.81	8.37
1921	41.45	0	6.9	17.43	0.59	0.75	8.23
1922	48.12	0	6.9	17.15	0.81	0.91	8.62
1923	34.20	0	6.9	16.90	0.37	0.59	7.86
1924	36.53	0	6.9	17.69	0.43	0.62	7.95
1925	45.82	0	6.9	20.58	0.63	0.77	8.30
1926	37.20	0	6.9	16.23	0.48	0.68	8.06
1927	41.37	0	6.9	18.21	0.56	0.73	8.19
1928	45.78	0	6.9	15.90	0.78	0.88	8.56
1929	51.97	0	6.9	23.88	0.73	0.83	8.46
1930	48.05	0	6.9	17.46	0.76	0.94	8.60
1931	37.66	0	6.9	15.13	0.54	0.71	8.15
1932	48.90	0	6.9	20.00	0.74	0.87	8.50
1933	62.18	0	6.9	20.65	1.14	1.16	9.21
1934	35.86	0	6.9	13.56	0.52	0.72	8.14
1935	52.09	0	6.9	18.64	0.87	0.98	8.76
1936	42.98	0	6.9	18.66	0.61	0.74	8.25
1937	49.63	0	6.9	21.08	0.71	0.88	8.49
1938	26.62	0	6.9	15.91	0.19	0.41	7.49
1939	46.62	0	6.9	21.51	0.64	0.76	8.29
1940	30.97	0	6.9	13.15	0.40	0.59	7.89
1941	43.78	0	6.9	18.51	0.66	0.74	8.30
1942	37.47	0	6.9	17.09	0.49	0.65	8.03
1943	49.82	0	6.9	18.92	0.82	0.89	8.62
1944	50.74	0	6.9	22.60	0.71	0.85	8.46
1945	40.83	0	6.9	15.79	0.59	0.80	8.29
1946	34.17	0	6.9	17.10	0.36	0.59	7.85

Table E-2. Site Water Balance for Proposed Action

Project No. 040001, DuPont, Washington

	Inflows			Outflows			
Year	Total Precipitation in inches	Total Surface Water Run-On in cfs	Groundwater Inflows in cfs	Evapo-transpiration in inches	Stormwater in cfs	Direct Groundwater Recharge in cfs	Total Groundwater Outflow in cfs
1947	38.87	0	6.9	16.98	0.55	0.67	8.12
1948	43.71	0	6.9	17.19	0.72	0.75	8.37
1949	31.37	0	6.9	16.39	0.32	0.51	7.73
1950	42.12	0	6.9	19.23	0.54	0.73	8.17
1951	46.83	0	6.9	17.77	0.78	0.83	8.51
1952	53.37	0	6.9	18.69	0.96	0.97	8.83
1953	35.77	0	6.9	14.38	0.50	0.69	8.09
1954	39.97	0	6.9	19.95	0.47	0.64	8.01
1955	30.18	0	6.9	15.71	0.28	0.52	7.70
1956	44.18	0	6.9	19.04	0.65	0.75	8.30
1957	58.24	0	6.9	19.94	1.07	1.05	9.03
1958	52.59	0	6.9	17.77	0.97	0.96	8.83
1959	33.13	0	6.9	12.42	0.49	0.66	8.05
1960	55.41	0	6.9	20.71	0.97	0.96	8.83
1961	36.29	0	6.9	15.14	0.53	0.64	8.07
1962	36.22	0	6.9	19.22	0.36	0.58	7.84
1963	33.33	0	6.9	14.98	0.42	0.60	7.92
1964	57.69	0	6.9	21.39	1.06	0.95	8.92
1965	28.52	0	6.9	11.41	0.36	0.59	7.85
1966	38.98	0	6.9	19.52	0.49	0.59	7.98
1967	43.40	0	6.9	17.00	0.65	0.82	8.37
1968	37.92	0	6.9	18.21	0.45	0.65	7.99
1969	45.01	0	6.9	18.12	0.70	0.79	8.39
1970	44.55	0	6.9	16.44	0.74	0.82	8.46
1971	45.61	0	6.9	17.78	0.72	0.83	8.44
1972	51.44	0	6.9	16.26	0.94	1.01	8.85
1973	43.43	0	6.9	17.16	0.65	0.81	8.36
1974	45.51	0	6.9	18.84	0.69	0.79	8.38
1975	46.93	0	6.9	17.37	0.75	0.89	8.54
1976	36.53	0	6.9	16.37	0.43	0.69	8.02
1977	57.46	0	6.9	19.08	1.03	1.10	9.03
1978	35.73	0	6.9	15.40	0.46	0.67	8.03
1979	44.96	0	6.9	18.25	0.66	0.82	8.38
1980	42.56	0	6.9	17.22	0.63	0.78	8.31
1981	38.36	0	6.9	18.37	0.45	0.66	8.01
1982	48.39	0	6.9	18.34	0.79	0.88	8.57
1983	34.00	0	6.9	15.82	0.37	0.64	7.91
1984	38.65	0	6.9	16.62	0.54	0.68	8.12
1985	36.02	0	6.9	16.34	0.45	0.64	7.99
1986	39.21	0	6.9	16.73	0.56	0.69	8.15
1987	35.69	0	6.9	14.90	0.50	0.65	8.05
1988	36.33	0	6.9	16.58	0.46	0.64	8.00
1989	44.58	0	6.9	21.30	0.59	0.71	8.19
1990	47.15	0	6.9	15.40	0.79	0.97	8.66
1991	46.79	0	6.9	16.41	0.78	0.91	8.59
1992	52.29	0	6.9	21.48	0.78	0.93	8.61

Table E-2. Site Water Balance for Proposed Action

Project No. 040001, DuPont, Washington

	Inflows			Outflows			
Year	Total Precipitation in inches	Total Surface Water Run-On in cfs	Groundwater Inflows in cfs	Evapo-transpiration in inches	Stormwater in cfs	Direct Groundwater Recharge in cfs	Total Groundwater Outflow in cfs
1993	44.54	0	6.9	14.26	0.73	0.95	8.58
1994	33.69	0	6.9	16.06	0.38	0.60	7.88
1995	61.78	0	6.9	18.54	1.22	1.18	9.30
1996	40.75	0	6.9	17.66	0.54	0.74	8.18
1997	43.33	0	6.9	18.98	0.59	0.76	8.25
1998	23.49	0	6.9	13.95	0.15	0.38	7.43
1999	44.25	0	6.9	21.64	0.56	0.69	8.16
2000	31.82	0	6.9	14.33	0.37	0.60	7.87
2001	41.20	0	6.9	16.95	0.61	0.74	8.25
2002	37.41	0	6.9	17.01	0.50	0.63	8.03
2003	46.97	0	6.9	17.93	0.76	0.86	8.51
2004	57.63	0	6.9	23.43	0.90	1.00	8.80
2005	43.60	0	6.9	15.06	0.67	0.92	8.48
2006	35.32	0	6.9	13.53	0.50	0.71	8.11
2007	37.55	0	6.9	17.10	0.49	0.64	8.04
2008	40.60	0	6.9	18.40	0.55	0.69	8.13
2009	35.07	0	6.9	16.21	0.44	0.61	7.95
2010	33.78	0	6.9	15.96	0.39	0.60	7.89
2011	34.09	0	6.9	16.25	0.43	0.56	7.89
2012	38.96	0	6.9	17.90	0.52	0.65	8.07
2013	30.12	0	6.9	13.89	0.36	0.54	7.80
2014	43.52	0	6.9	20.23	0.62	0.68	8.19
2015	25.74	0	6.9	12.26	0.24	0.50	7.65
2016	50.36	0	6.9	21.46	0.79	0.81	8.50
2017	56.54	0	6.9	18.34	1.04	1.08	9.02
2018	58.35	0	6.9	20.40	1.05	1.05	9.01
2019	43.38	0	6.9	17.03	0.65	0.82	8.36
2020	52.71	0	6.9	18.40	0.92	0.99	8.81
2021	37.15	0	6.9	17.64	0.44	0.64	7.98
2022	49.81	0	6.9	18.08	0.85	0.91	8.66
2023	37.80	0	6.9	17.69	0.46	0.66	8.02
2024	39.84	0	6.9	17.46	0.55	0.69	8.14
2025	45.58	0	6.9	19.13	0.66	0.81	8.37
2026	35.92	0	6.9	15.90	0.44	0.67	8.01
2027	31.55	0	6.9	17.05	0.27	0.53	7.71
2028	43.54	0	6.9	16.21	0.69	0.83	8.42
2029	47.68	0	6.9	18.88	0.76	0.84	8.50
2030	34.39	0	6.9	14.73	0.41	0.68	7.99
2031	35.52	0	6.9	17.71	0.39	0.60	7.89
2032	35.66	0	6.9	17.56	0.43	0.58	7.91
2033	43.89	0	6.9	19.82	0.61	0.73	8.24
2034	35.91	0	6.9	14.71	0.51	0.67	8.08
2035	45.85	0	6.9	19.52	0.67	0.79	8.36
2036	27.87	0	6.9	13.06	0.32	0.50	7.72
2037	48.88	0	6.9	18.53	0.84	0.85	8.59
2038	28.10	0	6.9	16.42	0.19	0.46	7.55

Table E-2. Site Water Balance for Proposed Action

Project No. 040001, DuPont, Washington

	Inflows			Outflows			
Year	Total Precipitation in inches	Total Surface Water Run-On in cfs	Groundwater Inflows in cfs	Evapo-transpiration in inches	Stormwater in cfs	Direct Groundwater Recharge in cfs	Total Groundwater Outflow in cfs
2039	36.26	0	6.9	19.01	0.40	0.56	7.86
2040	33.69	0	6.9	15.82	0.40	0.59	7.89
2041	46.65	0	6.9	21.34	0.68	0.73	8.31
2042	53.77	0	6.9	21.07	0.87	0.95	8.72
2043	51.49	0	6.9	16.58	0.90	1.04	8.84
2044	51.64	0	6.9	19.94	0.83	0.93	8.66
2045	52.33	0	6.9	18.02	0.91	1.00	8.81
2046	36.35	0	6.9	14.98	0.50	0.69	8.09
2047	42.13	0	6.9	19.91	0.54	0.70	8.13
2048	41.81	0	6.9	17.02	0.62	0.76	8.28
2049	36.96	0	6.9	17.67	0.47	0.60	7.97
2050	46.15	0	6.9	18.99	0.68	0.83	8.41
2051	45.24	0	6.9	16.76	0.74	0.84	8.48
2052	48.60	0	6.9	19.39	0.73	0.89	8.52
2053	45.60	0	6.9	16.45	0.77	0.85	8.52
2054	37.71	0	6.9	18.67	0.41	0.65	7.96
2055	33.13	0	6.9	16.08	0.35	0.60	7.85
2056	46.21	0	6.9	19.74	0.68	0.79	8.37
2057	41.86	0	6.9	15.44	0.65	0.82	8.37
2058	67.38	0	6.9	22.01	1.35	1.17	9.42
Average	41.99	0	6.90	17.57	0.61	0.75	8.26
Average in inches	41.99	0	124.26	17.57	10.95	13.47	148.68

Notes:

1) Stormwater is the sum of surface runoff and interflow.

2) Under existing conditions, all stormwater infiltrates within the mine area or on the South Parcel.

3) Total Groundwater outflow is the sum of stormwater + direct groundwater recharge + groundwater inflows.

4) Average flows in cfs are converted to inches by calculating the total volume in cubic feet for the year, then dividing by the project area of 482.4 acres

Table E-3. Site Water Balance for No Action

Project No. 040001, DuPont, Washington

	Inflows			Outflows			
Year	Total Precipitation in inches	Total Surface Water Run-On in cfs	Groundwater Inflows in cfs	Evapo-transpiration in inches	Stormwater in cfs	Direct Groundwater Recharge in cfs	Total Groundwater Outflow in cfs
1901	40.83	0	6.9	17.80	0.61	0.67	8.18
1902	38.26	0	6.9	15.76	0.53	0.72	8.15
1903	35.03	0	6.9	13.02	0.48	0.74	8.12
1904	38.42	0	6.9	13.94	0.57	0.79	8.26
1905	25.71	0	6.9	11.59	0.32	0.47	7.68
1906	37.95	0	6.9	17.52	0.54	0.60	8.03
1907	38.20	0	6.9	13.57	0.55	0.82	8.27
1908	38.11	0	6.9	14.43	0.54	0.78	8.22
1909	53.09	0	6.9	20.53	0.77	1.04	8.71
1910	33.20	0	6.9	9.95	0.48	0.81	8.19
1911	48.37	0	6.9	16.48	0.74	1.03	8.67
1912	45.91	0	6.9	13.02	0.71	1.12	8.73
1913	32.51	0	6.9	12.67	0.45	0.65	8.00
1914	36.06	0	6.9	15.01	0.50	0.66	8.07
1915	46.92	0	6.9	17.27	0.69	0.95	8.55
1916	31.16	0	6.9	12.31	0.41	0.64	7.95
1917	50.58	0	6.9	15.58	0.79	1.16	8.84
1918	37.07	0	6.9	13.68	0.51	0.79	8.20
1919	38.67	0	6.9	14.68	0.54	0.79	8.23
1920	45.83	0	6.9	16.34	0.67	0.97	8.54
1921	41.45	0	6.9	14.75	0.59	0.89	8.38
1922	48.12	0	6.9	14.65	0.74	1.12	8.76
1923	34.20	0	6.9	13.86	0.46	0.67	8.03
1924	36.53	0	6.9	14.96	0.49	0.71	8.10
1925	45.82	0	6.9	17.56	0.66	0.91	8.47
1926	37.20	0	6.9	13.30	0.53	0.80	8.23
1927	41.37	0	6.9	15.24	0.60	0.85	8.35
1928	45.78	0	6.9	13.70	0.70	1.08	8.68
1929	51.97	0	6.9	20.14	0.77	1.00	8.67
1930	48.05	0	6.9	14.46	0.72	1.14	8.77
1931	37.66	0	6.9	12.52	0.54	0.85	8.30
1932	48.90	0	6.9	17.12	0.72	1.04	8.66
1933	62.18	0	6.9	17.58	0.98	1.49	9.38
1934	35.86	0	6.9	11.17	0.51	0.86	8.27
1935	52.09	0	6.9	16.05	0.80	1.21	8.90
1936	42.98	0	6.9	15.67	0.63	0.88	8.42
1937	49.63	0	6.9	17.60	0.72	1.06	8.68
1938	26.62	0	6.9	12.74	0.33	0.44	7.67
1939	46.62	0	6.9	18.46	0.66	0.91	8.46
1940	30.97	0	6.9	10.99	0.43	0.68	8.01
1941	43.78	0	6.9	15.70	0.65	0.91	8.46
1942	37.47	0	6.9	14.23	0.53	0.76	8.19
1943	49.82	0	6.9	16.31	0.75	1.11	8.76
1944	50.74	0	6.9	18.81	0.74	1.03	8.67
1945	40.83	0	6.9	13.28	0.59	0.94	8.43
1946	34.17	0	6.9	13.91	0.46	0.67	8.02

Table E-3. Site Water Balance for No Action

Project No. 040001, DuPont, Washington

	Inflows			Outflows			
Year	Total Precipitation in inches	Total Surface Water Run-On in cfs	Groundwater Inflows in cfs	Evapo-transpiration in inches	Stormwater in cfs	Direct Groundwater Recharge in cfs	Total Groundwater Outflow in cfs
1947	38.87	0	6.9	14.59	0.55	0.80	8.25
1948	43.71	0	6.9	14.87	0.66	0.94	8.50
1949	31.37	0	6.9	13.16	0.42	0.59	7.91
1950	42.12	0	6.9	16.19	0.60	0.84	8.34
1951	46.83	0	6.9	15.39	0.72	1.03	8.65
1952	53.37	0	6.9	15.86	0.85	1.23	8.98
1953	35.77	0	6.9	11.59	0.53	0.81	8.24
1954	39.97	0	6.9	16.73	0.54	0.75	8.19
1955	30.18	0	6.9	12.57	0.40	0.58	7.88
1956	44.18	0	6.9	16.18	0.66	0.90	8.45
1957	58.24	0	6.9	17.02	0.92	1.37	9.19
1958	52.59	0	6.9	15.27	0.81	1.26	8.97
1959	33.13	0	6.9	10.33	0.48	0.79	8.17
1960	55.41	0	6.9	17.86	0.86	1.23	8.99
1961	36.29	0	6.9	12.51	0.54	0.78	8.22
1962	36.22	0	6.9	15.53	0.49	0.66	8.05
1963	33.33	0	6.9	12.61	0.46	0.69	8.05
1964	57.69	0	6.9	18.56	0.92	1.25	9.07
1965	28.52	0	6.9	9.03	0.40	0.68	7.98
1966	38.98	0	6.9	16.62	0.55	0.69	8.14
1967	43.40	0	6.9	14.50	0.64	0.96	8.51
1968	37.92	0	6.9	15.10	0.53	0.74	8.17
1969	45.01	0	6.9	15.97	0.66	0.95	8.51
1970	44.55	0	6.9	14.03	0.68	1.02	8.59
1971	45.61	0	6.9	15.45	0.68	1.00	8.57
1972	51.44	0	6.9	14.04	0.82	1.26	8.98
1973	43.43	0	6.9	14.57	0.64	0.97	8.50
1974	45.51	0	6.9	15.92	0.69	0.95	8.54
1975	46.93	0	6.9	14.59	0.71	1.09	8.70
1976	36.53	0	6.9	13.24	0.52	0.77	8.19
1977	57.46	0	6.9	16.26	0.91	1.38	9.19
1978	35.73	0	6.9	12.85	0.51	0.76	8.17
1979	44.96	0	6.9	15.51	0.67	0.97	8.54
1980	42.56	0	6.9	14.51	0.63	0.93	8.46
1981	38.36	0	6.9	15.42	0.52	0.75	8.17
1982	48.39	0	6.9	16.01	0.72	1.07	8.70
1983	34.00	0	6.9	12.86	0.46	0.71	8.07
1984	38.65	0	6.9	14.19	0.57	0.79	8.26
1985	36.02	0	6.9	14.00	0.49	0.73	8.12
1986	39.21	0	6.9	14.05	0.58	0.81	8.30
1987	35.69	0	6.9	12.69	0.52	0.75	8.18
1988	36.33	0	6.9	13.88	0.52	0.72	8.15
1989	44.58	0	6.9	18.11	0.64	0.83	8.37
1990	47.15	0	6.9	13.12	0.72	1.17	8.79
1991	46.79	0	6.9	13.71	0.73	1.11	8.74
1992	52.29	0	6.9	17.95	0.79	1.11	8.81

Table E-3. Site Water Balance for No Action

Project No. 040001, DuPont, Washington

	Inflows			Outflows			
Year	Total Precipitation in inches	Total Surface Water Run-On in cfs	Groundwater Inflows in cfs	Evapo-transpiration in inches	Stormwater in cfs	Direct Groundwater Recharge in cfs	Total Groundwater Outflow in cfs
1993	44.54	0	6.9	12.23	0.68	1.12	8.69
1994	33.69	0	6.9	13.11	0.47	0.68	8.04
1995	61.78	0	6.9	16.24	1.01	1.52	9.43
1996	40.75	0	6.9	14.58	0.59	0.86	8.35
1997	43.33	0	6.9	16.08	0.62	0.89	8.41
1998	23.49	0	6.9	10.68	0.29	0.42	7.61
1999	44.25	0	6.9	18.54	0.63	0.80	8.33
2000	31.82	0	6.9	11.87	0.43	0.67	8.01
2001	41.20	0	6.9	14.60	0.60	0.87	8.38
2002	37.41	0	6.9	14.08	0.54	0.76	8.20
2003	46.97	0	6.9	15.14	0.72	1.05	8.67
2004	57.63	0	6.9	19.74	0.88	1.23	9.00
2005	43.60	0	6.9	12.37	0.65	1.08	8.63
2006	35.32	0	6.9	11.04	0.52	0.82	8.25
2007	37.55	0	6.9	14.31	0.54	0.75	8.19
2008	40.60	0	6.9	15.46	0.59	0.81	8.30
2009	35.07	0	6.9	13.14	0.50	0.71	8.12
2010	33.78	0	6.9	13.18	0.48	0.67	8.04
2011	34.09	0	6.9	13.76	0.48	0.65	8.03
2012	38.96	0	6.9	15.06	0.56	0.76	8.23
2013	30.12	0	6.9	11.39	0.42	0.62	7.94
2014	43.52	0	6.9	17.71	0.63	0.81	8.33
2015	25.74	0	6.9	9.40	0.35	0.56	7.81
2016	50.36	0	6.9	18.58	0.76	1.01	8.66
2017	56.54	0	6.9	15.78	0.89	1.38	9.16
2018	58.35	0	6.9	17.23	0.92	1.37	9.18
2019	43.38	0	6.9	14.12	0.64	0.99	8.52
2020	52.71	0	6.9	15.67	0.81	1.24	8.96
2021	37.15	0	6.9	14.75	0.51	0.73	8.14
2022	49.81	0	6.9	15.58	0.77	1.13	8.80
2023	37.80	0	6.9	14.65	0.52	0.76	8.19
2024	39.84	0	6.9	14.75	0.58	0.82	8.29
2025	45.58	0	6.9	16.51	0.65	0.97	8.51
2026	35.92	0	6.9	12.97	0.51	0.76	8.17
2027	31.55	0	6.9	14.07	0.40	0.57	7.87
2028	43.54	0	6.9	14.17	0.65	0.98	8.53
2029	47.68	0	6.9	16.24	0.72	1.03	8.65
2030	34.39	0	6.9	11.78	0.49	0.77	8.16
2031	35.52	0	6.9	14.83	0.48	0.67	8.05
2032	35.66	0	6.9	14.83	0.50	0.66	8.06
2033	43.89	0	6.9	17.36	0.62	0.85	8.37
2034	35.91	0	6.9	11.96	0.53	0.80	8.23
2035	45.85	0	6.9	16.49	0.68	0.95	8.53
2036	27.87	0	6.9	10.47	0.40	0.57	7.87
2037	48.88	0	6.9	16.44	0.75	1.05	8.70
2038	28.10	0	6.9	12.94	0.35	0.49	7.74

Table E-3. Site Water Balance for No Action

Project No. 040001, DuPont, Washington

	Inflows			Outflows			
Year	Total Precipitation in inches	Total Surface Water Run-On in cfs	Groundwater Inflows in cfs	Evapo-transpiration in inches	Stormwater in cfs	Direct Groundwater Recharge in cfs	Total Groundwater Outflow in cfs
2039	36.26	0	6.9	16.09	0.49	0.63	8.02
2040	33.69	0	6.9	13.50	0.45	0.68	8.02
2041	46.65	0	6.9	18.18	0.68	0.90	8.48
2042	53.77	0	6.9	17.80	0.80	1.20	8.90
2043	51.49	0	6.9	13.78	0.80	1.30	8.99
2044	51.64	0	6.9	17.17	0.77	1.14	8.81
2045	52.33	0	6.9	15.36	0.81	1.25	8.95
2046	36.35	0	6.9	12.28	0.52	0.82	8.24
2047	42.13	0	6.9	16.60	0.60	0.82	8.32
2048	41.81	0	6.9	14.25	0.62	0.91	8.43
2049	36.96	0	6.9	14.79	0.52	0.71	8.13
2050	46.15	0	6.9	15.87	0.68	1.00	8.58
2051	45.24	0	6.9	14.87	0.67	1.01	8.59
2052	48.60	0	6.9	16.45	0.71	1.08	8.69
2053	45.60	0	6.9	14.17	0.72	1.03	8.65
2054	37.71	0	6.9	15.06	0.51	0.75	8.16
2055	33.13	0	6.9	12.90	0.45	0.67	8.02
2056	46.21	0	6.9	16.88	0.68	0.95	8.53
2057	41.86	0	6.9	12.85	0.63	0.98	8.51
2058	67.38	0	6.9	19.34	1.10	1.57	9.57
Average	41.99	0	6.90	14.80	0.61	0.90	8.41
Average in inches	41.99	0	124.26	14.80	11.07	16.12	151.44

Notes:

1) Stormwater is the sum of surface runoff and interflow.

2) Under existing conditions, all stormwater infiltrates within the mine area or on the South Parcel.

3) Total Groundwater outflow is the sum of stormwater + direct groundwater recharge + groundwater inflows.

4) Average flows in cfs are converted to inches by calculating the total volume in cubic feet for the year, then dividing by the project area of 482.4 acres

APPENDIX F

Wetland Water Balance Calculations

MARSH WATER BALANCE FIGURES

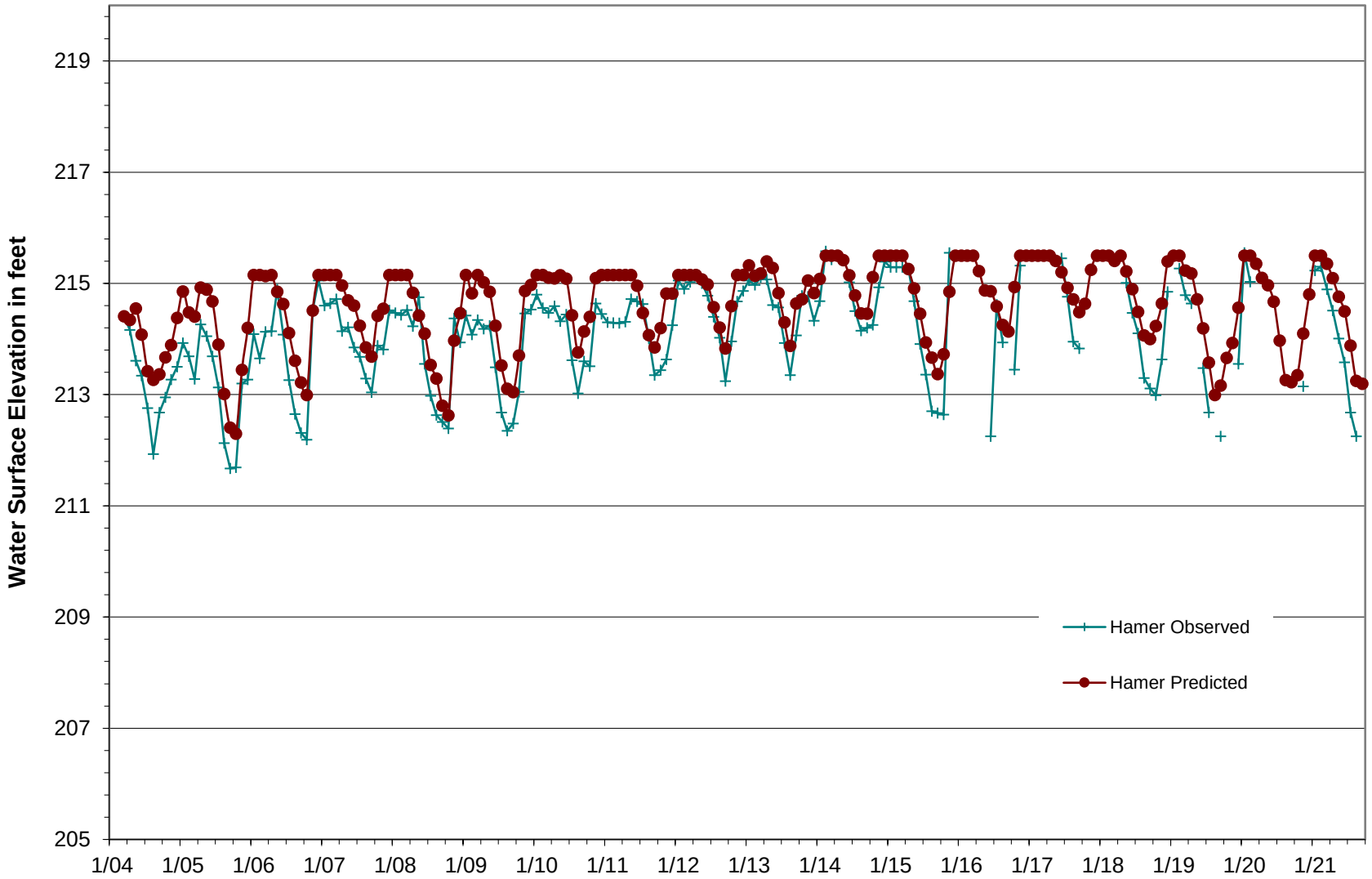


Figure F-1

Predicted Water Levels for Hamer Marsh under Existing Conditions

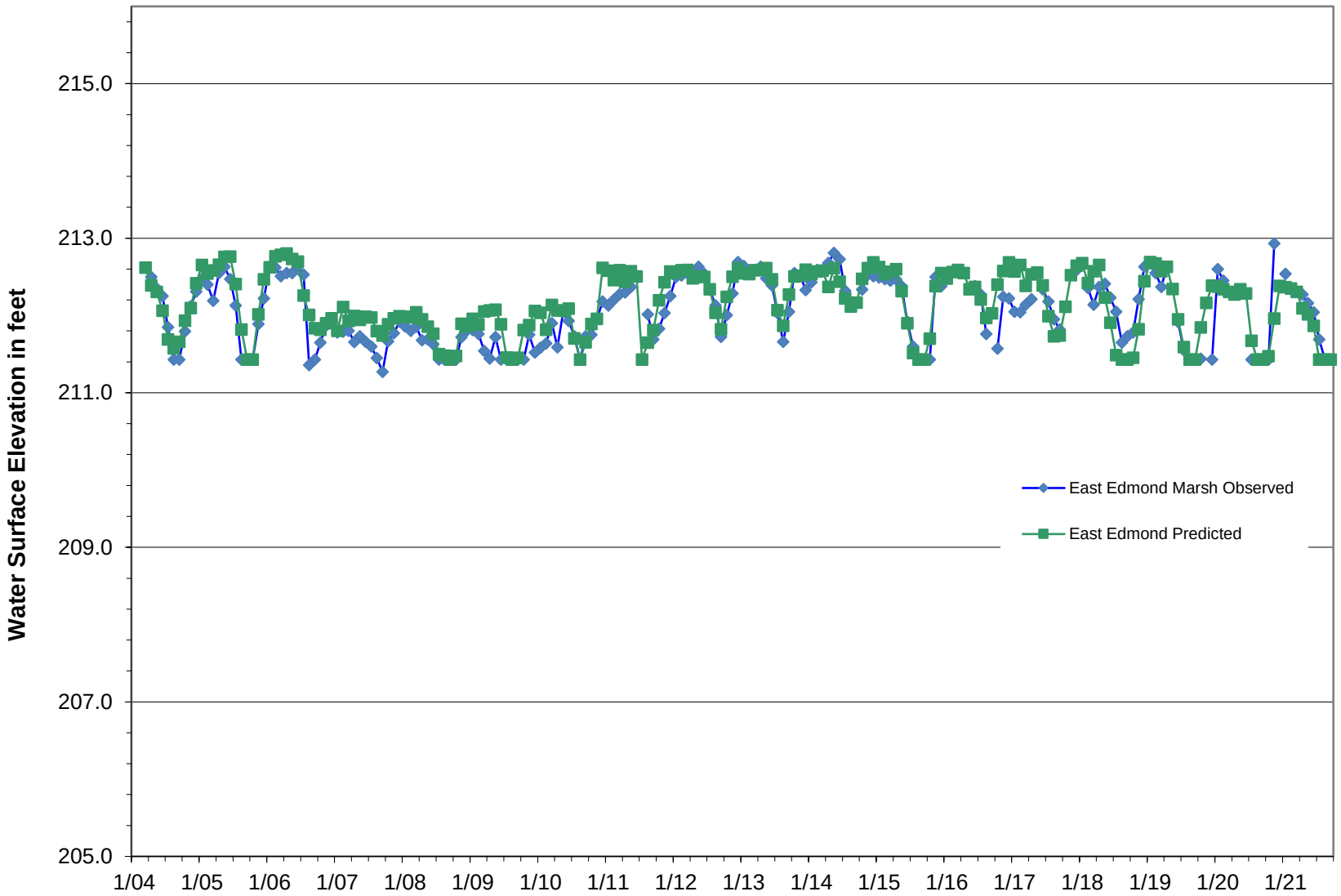


Figure F-2

Predicted Water Levels for East Edmond Marsh under Existing Conditions

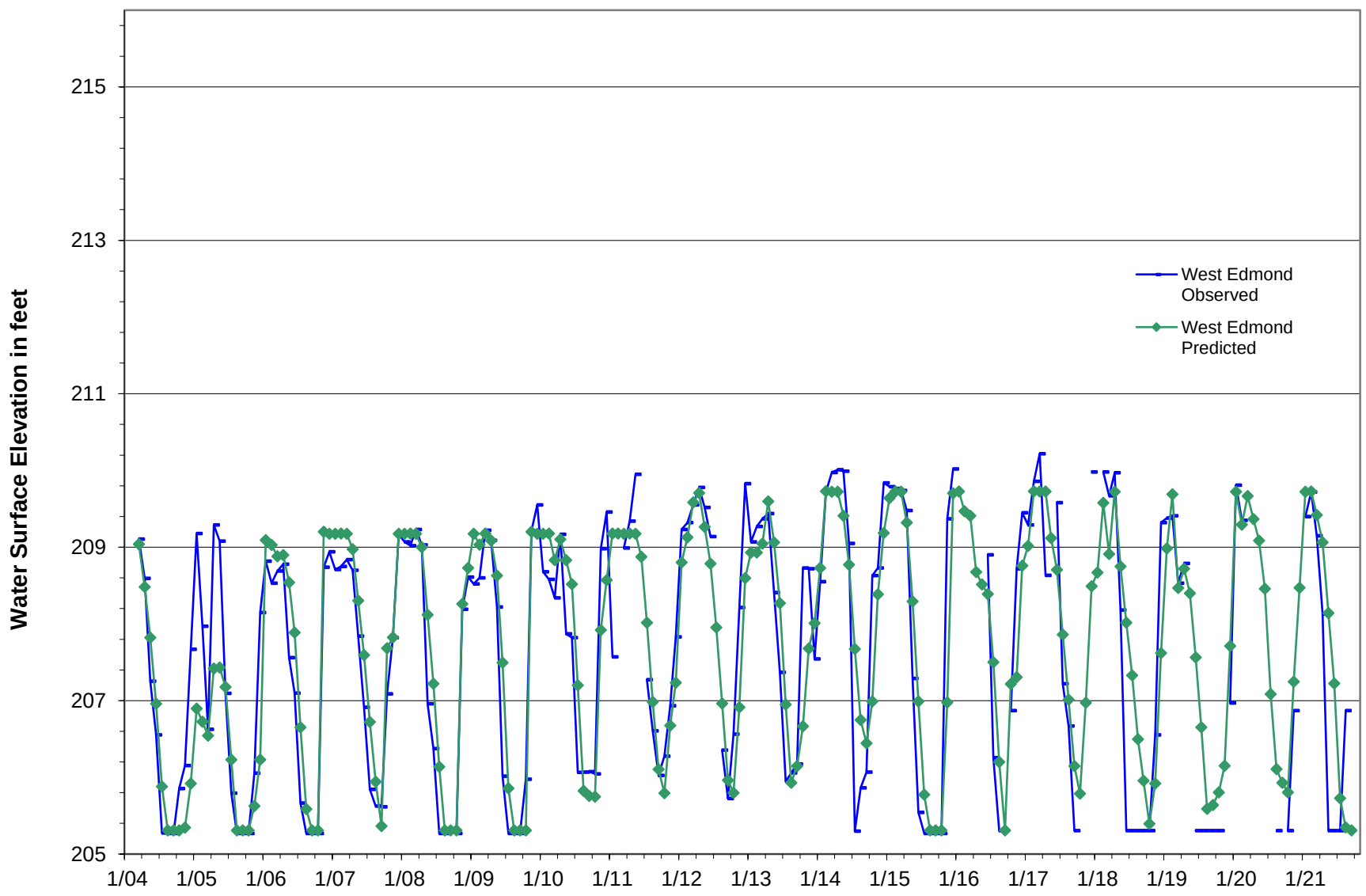


Figure F-3

Predicted Water Levels for West Edmond Marsh under Existing Conditions

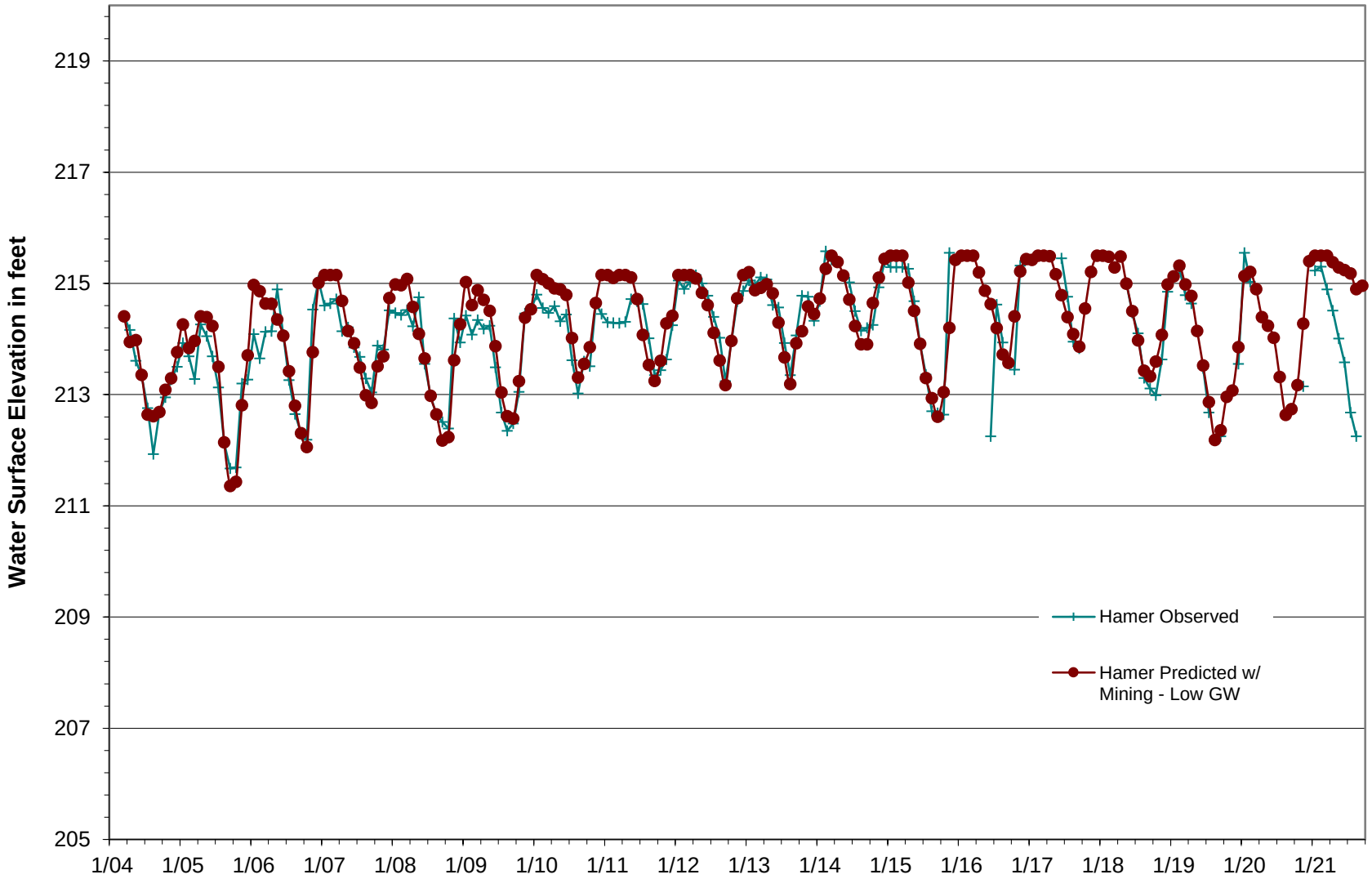


Figure F-4

Predicted Water Levels for Hamer Marsh with Mining - Low Groundwater

Earth and Water Resources Report

DuPont, WA

Aspect Consulting

10/28/2022

S:\CalPortland\DuPont\South Parcel\Water Balance Analyses\Water Balance -2022 - Mining.xlsm

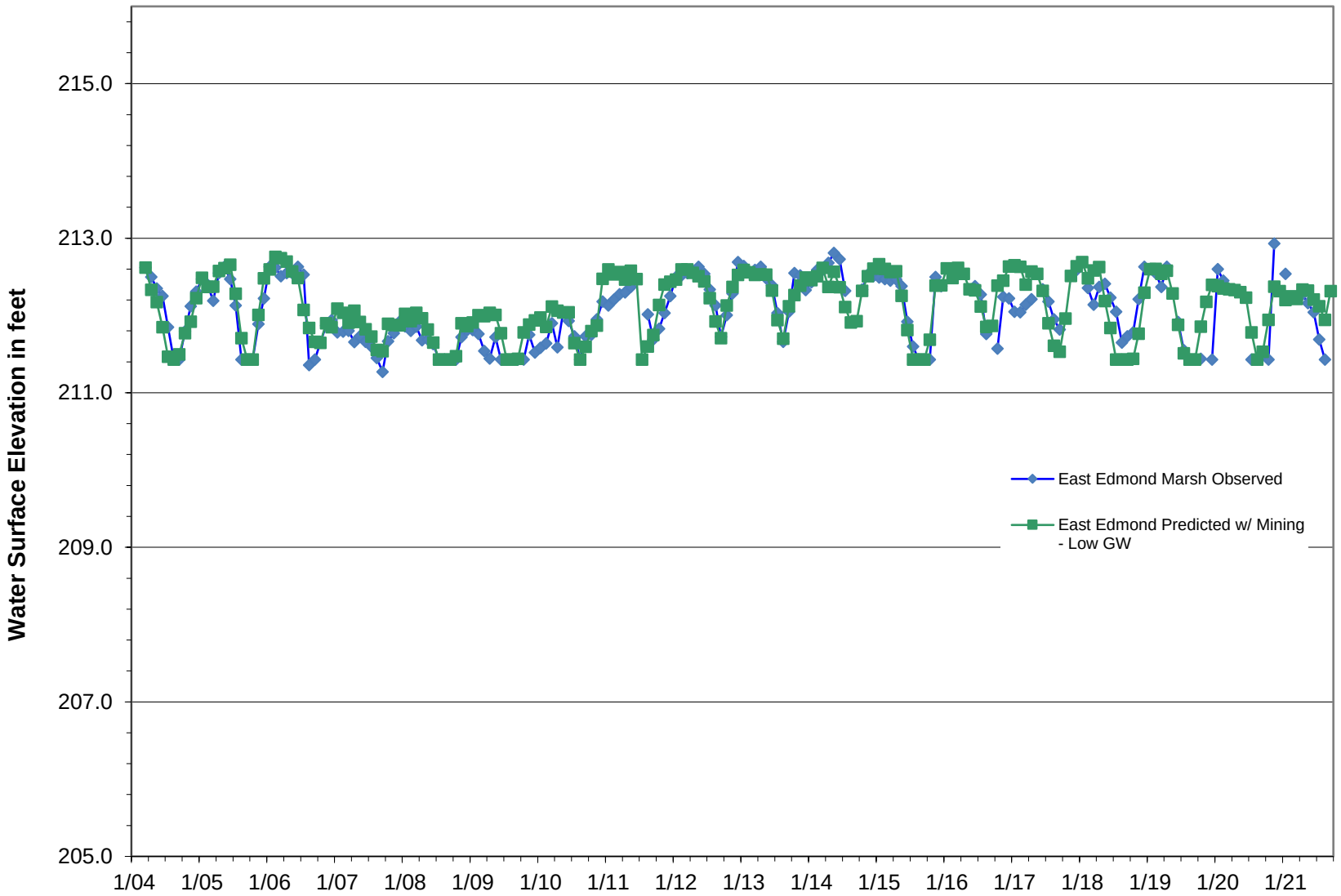


Figure F-5

Predicted Water Levels for East Edmond Marsh with Mining - Low Groundwater

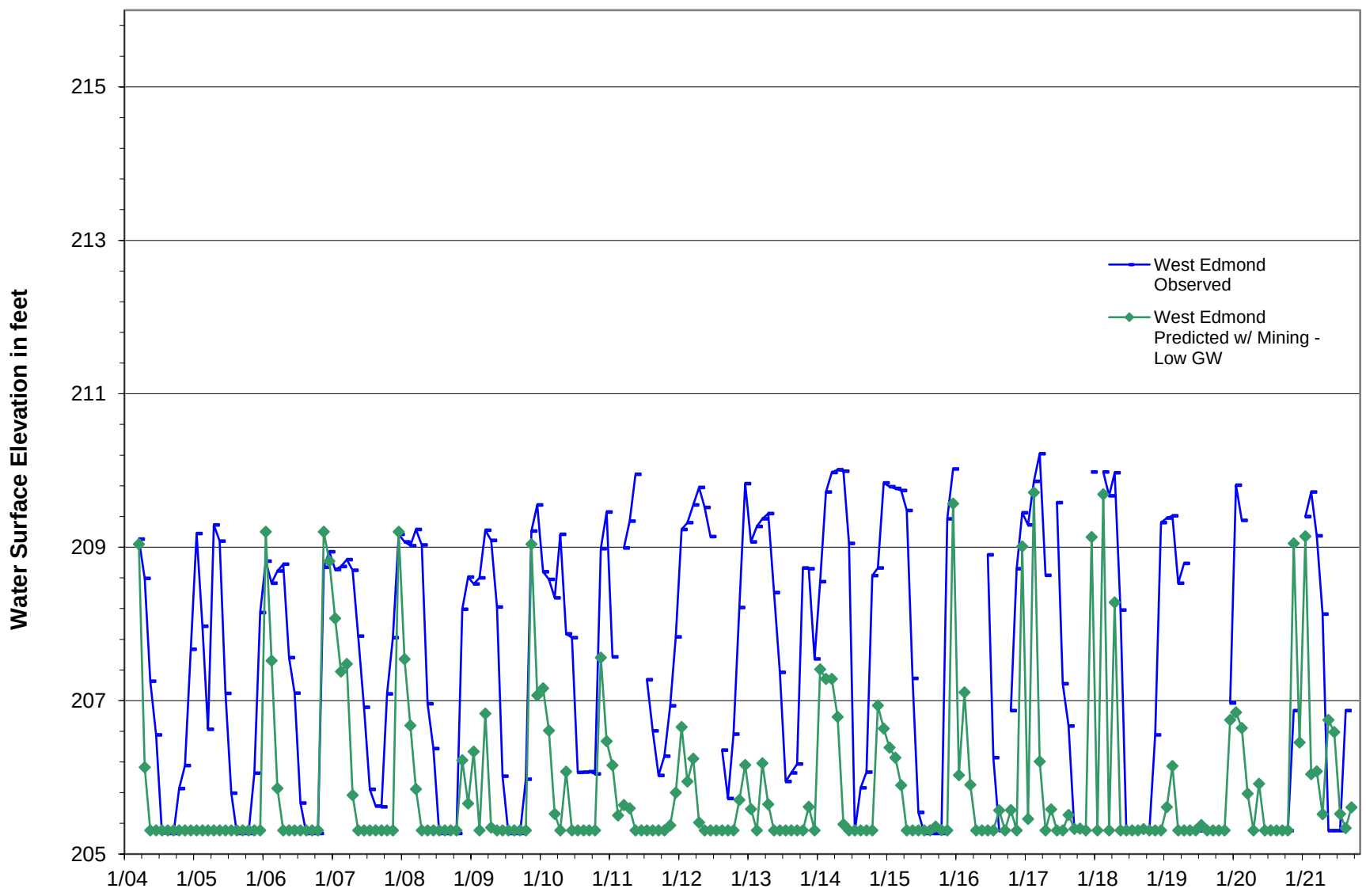


Figure F-6

Predicted Water Levels for West Edmond Marsh with Mining - Low GW

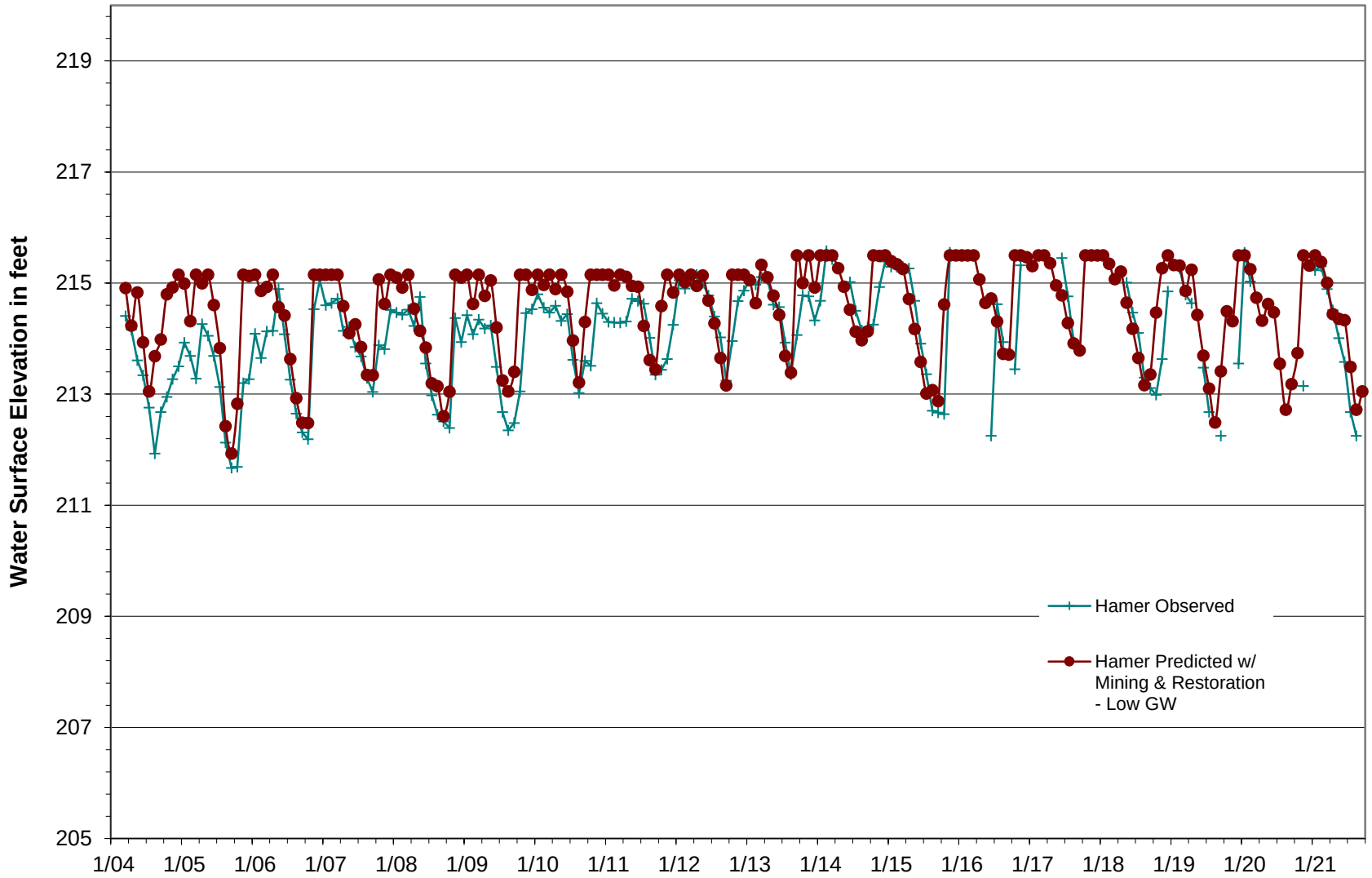


Figure F-7

Predicted Water Levels for Hamer Marsh with Mining + Restoration - Low Groundwater

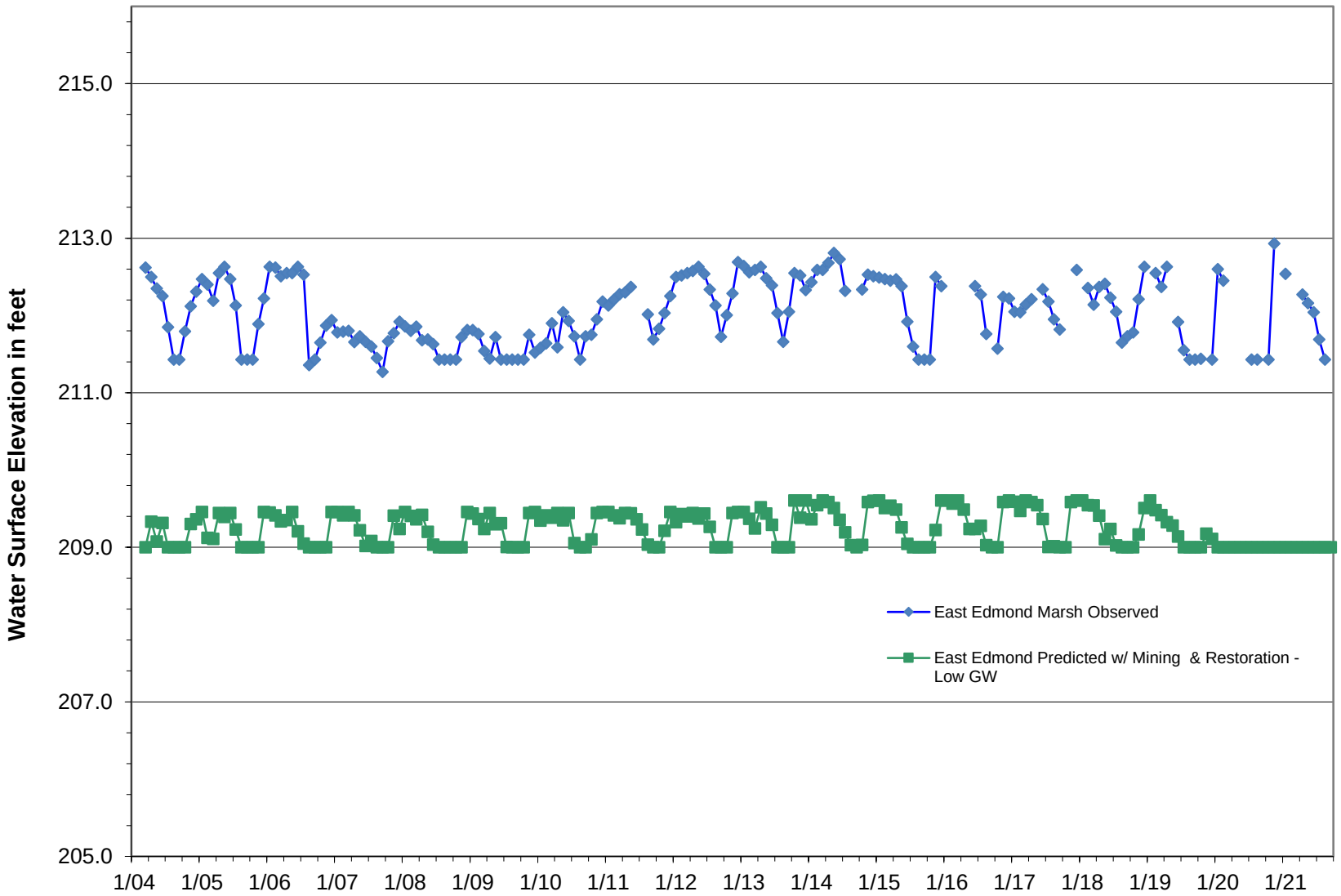


Figure F-8
Predicted Water Levels for East Edmond Marsh with Mining + Restoration - Low Groundwater

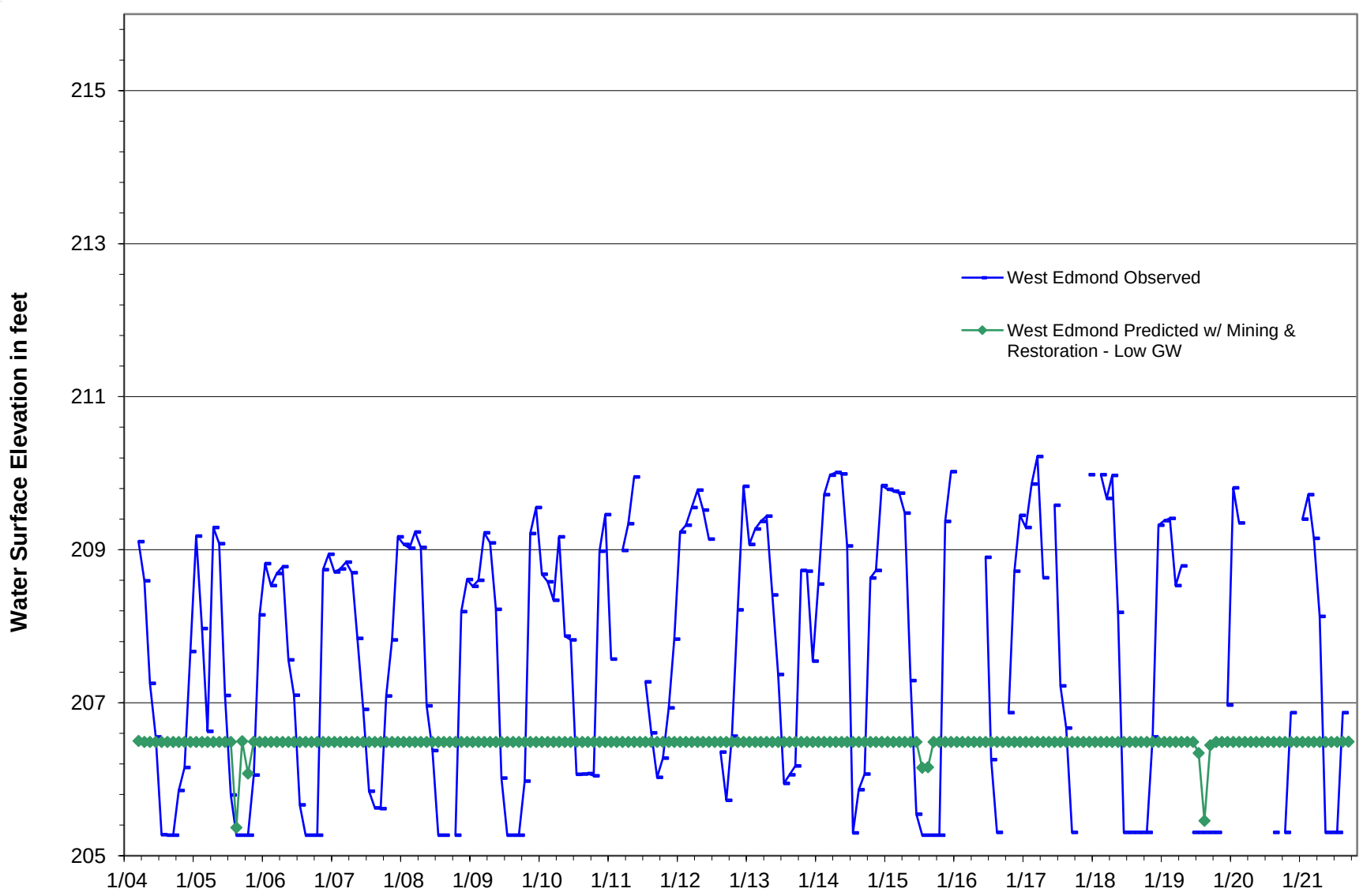


Figure F-9

Predicted Water Levels for West Edmond Marsh with Mining + Restoration - Low GW

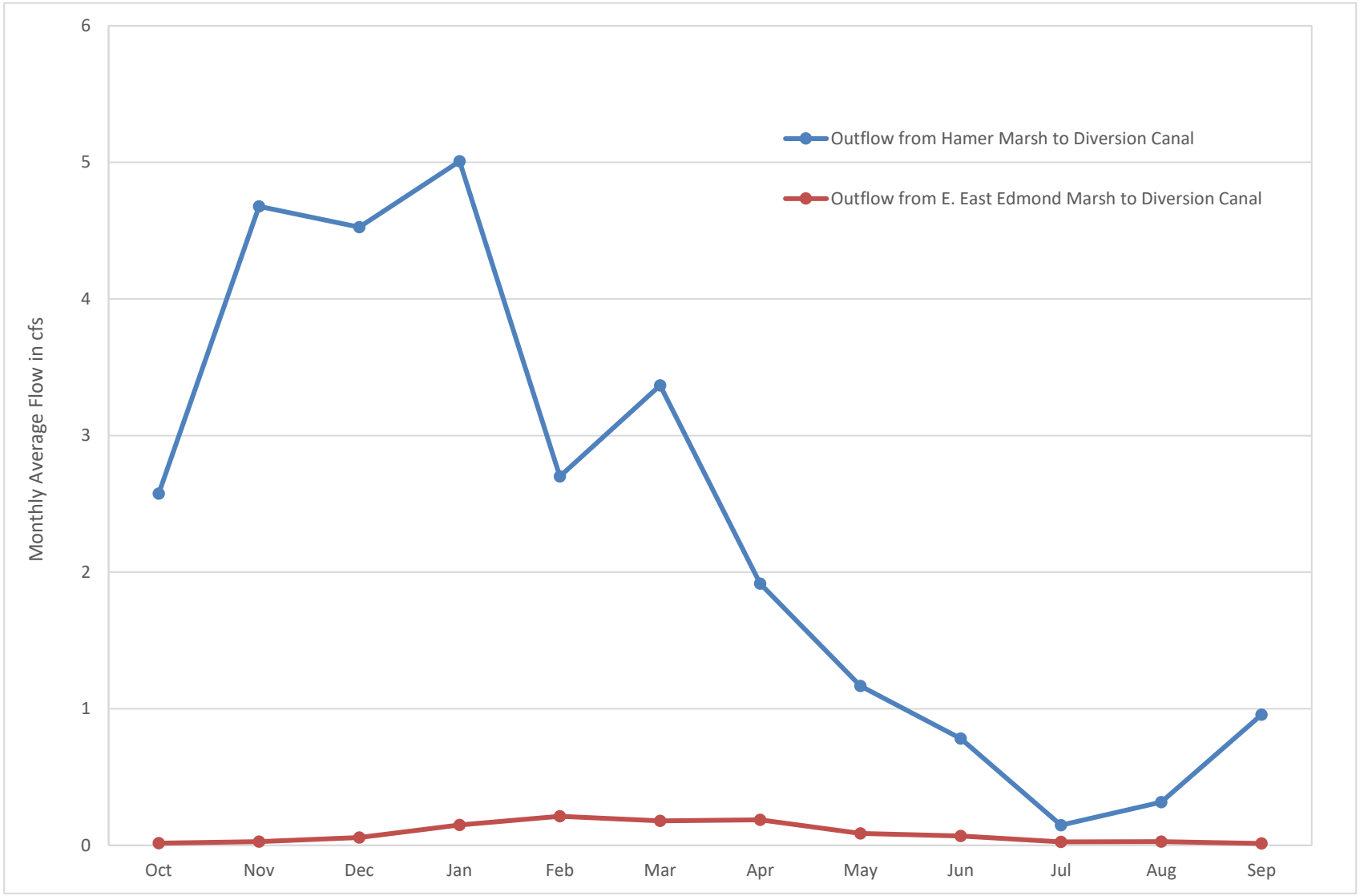


Figure F-10
Marsh Outflow to Diversion Canal under Existing Conditions

MARSH WATER BALANCE MONTHLY AVERAGE TABLES

Table F-1. Annual Average Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

CalPortland DuPont - 040001

Flow

	Monthly Average in cfs												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average in cfs
Precipitation	0.6	0.9	0.9	1.0	0.7	0.8	0.6	0.4	0.3	0.1	0.1	0.3	0.6
Surface Water Inflows	3.2	5.4	4.8	5.2	2.8	3.5	2.2	1.5	1.0	0.2	0.4	1.2	2.6
Runoff from Ft. Lewis - Outfall 002	1.9	3.3	3.0	3.2	1.7	2.2	1.3	0.9	0.6	0.1	0.2	0.7	1.6
Runoff from Ft. Lewis - Outfall 003	1.2	2.1	1.9	2.0	1.1	1.4	0.9	0.6	0.4	0.1	0.2	0.5	1.0
Evapotranspiration	-0.1	-0.1	0.0	0.0	-0.1	-0.2	-0.3	-0.5	-0.6	-0.7	-0.6	-0.3	-0.3
Recharge (-) Discharge (+)	-0.3	0.1	0.0	0.1	0.1	0.0	0.2	0.1	0.1	0.0	-0.1	-0.1	0.0
Surface Water Outflows	-2.6	-4.8	-4.8	-5.4	-3.2	-3.9	-2.4	-1.6	-1.1	-0.3	-0.4	-1.0	-2.6
To Diversion Canal	-2.6	-4.7	-4.5	-5.0	-2.7	-3.4	-1.9	-1.2	-0.8	-0.1	-0.3	-1.0	-2.3
To E. East Edmond. Marsh (surface)	-0.04	-0.13	-0.30	-0.44	-0.55	-0.53	-0.49	-0.41	-0.35	-0.11	-0.04	-0.03	-0.28
Subsurface Outflows	-0.2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	-0.3
Change in Storage	0.5	1.2	0.6	0.5	-0.1	-0.1	-0.1	-0.3	-0.5	-1.0	-0.8	-0.2	0.0

Water Volume

	Average Monthly Volume in AF												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg. Annual Volume in AF
Precipitation	38	53	55	59	40	46	34	25	20	6	8	18	401
Surface Water Inflows	196	319	297	319	157	218	131	92	62	11	24	71	1898
Runoff from Ft. Lewis - Outfall 002	120	194	181	195	96	133	80	56	37	6	14	43	1156
Runoff from Ft. Lewis - Outfall 003	76	125	116	125	61	85	51	36	24	5	9	28	741
Evapotranspiration	-9	-4	0	0	-6	-12	-19	-31	-35	-42	-35	-20	-214
Recharge (-) Discharge (+)	-16	6	1	8	4	0	10	8	7	0	-6	-6	15
Surface Water Outflows	-161	-286	-297	-335	-181	-239	-143	-97	-67	-16	-22	-59	-1903
To Diversion Canal	-158	-278	-278	-308	-150	-207	-114	-72	-47	-9	-19	-57	-1698
To E. East Edmond. Marsh (surface)	-3	-8	-19	-27	-31	-32	-29	-25	-21	-7	-2	-2	-205
Subsurface Outflows	-15	-18	-18	-20	-18	-19	-19	-19	-18	-17	-15	-14	-210
Change in Storage	33	69	37	31	-3	-6	-7	-21	-32	-59	-47	-10	-13

Table F-2. Annual Average Water Balance for East Edmond Marsh - Existing Conditions

CalPortland DuPont - 040001

Flow

	Monthly Average in cfs												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average in cfs
Precipitation	0.6	0.9	0.9	1.0	0.7	0.7	0.6	0.4	0.3	0.1	0.1	0.3	0.5
Surface Water Inflows	0.1	0.2	0.3	0.5	0.6	0.5	0.5	0.4	0.4	0.1	0.0	0.0	0.3
From Sequalitchew Lake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
From Center Drive	0.03	0.04	0.04	0.04	0.02	0.03	0.02	0.01	0.01	0.00	0.00	0.01	0.02
From Hamer (surface)	0.04	0.13	0.30	0.44	0.55	0.53	0.49	0.41	0.35	0.11	0.04	0.03	0.28
Subsurface Inflows	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.3
Evapotranspiration	-0.1	-0.1	0.0	0.0	-0.1	-0.2	-0.3	-0.5	-0.6	-0.7	-0.6	-0.3	-0.3
Recharge (-) Discharge (+)	-0.3	-0.3	-0.4	-0.5	-0.6	-0.6	-0.6	-0.6	-0.5	-0.6	-0.3	-0.3	-0.5
Surface Water Outflows	-0.1	-0.6	-0.7	-1.2	-1.0	-0.9	-0.7	-0.2	-0.2	-0.1	-0.1	0.0	-0.5
To Diversion Canal	-0.1	-0.3	-0.4	-0.8	-0.7	-0.6	-0.5	-0.2	-0.1	0.0	0.0	0.0	-0.3
To West Edmond Marsh	-0.03	-0.24	-0.28	-0.48	-0.36	-0.31	-0.22	-0.06	-0.05	-0.01	-0.01	-0.01	-0.17
Change in Storage	0.4	0.5	0.4	0.0	-0.1	-0.1	-0.2	-0.2	-0.3	-0.8	-0.5	-0.1	-0.1

Water Volume

	Average Monthly Volume in AF												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg. Annual Volume
Precipitation	37	53	54	59	39	46	33	25	20	6	8	18	398
Surface Water Inflows	4	10	21	29	32	34	30	26	21	7	3	2	220
From Sequalitchew Lake	0	0	0	0	0	0	0	0	0	0	0	0	0
From Center Drive	2	2	2	2	1	2	1	1	1	0	0	1	16
From Hamer (surface)	3	8	19	27	31	32	29	25	21	7	2	2	205
Subsurface Inflows	15	18	18	20	18	19	19	19	18	17	15	14	210
Evapotranspiration	-8	-4	0	0	-6	-12	-19	-31	-35	-41	-34	-19	-210
Recharge (-) Discharge (+)	-20	-17	-27	-33	-33	-39	-34	-37	-31	-37	-16	-17	-341
Surface Water Outflows	-6	-33	-42	-76	-58	-53	-42	-13	-10	-3	-4	-2	-342
To Diversion Canal	-4	-19	-25	-46	-38	-34	-28	-10	-8	-3	-3	-1	-218
To West Edmond Marsh	-2	-14	-17	-29	-20	-19	-13	-3	-3	-1	-1	0	-124
Change in Storage	21.9	28.1	24.4	-0.9	-8.1	-6.0	-11.7	-10.5	-18.3	-51.5	-28.0	-3.1	-64.0

Table F-3. Annual Average Water Balance for West Edmond Marsh - Existing Conditions

CalPortland DuPont - 040001

Flow

	Monthly Average in cfs												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average in cfs
Precipitation	0.07	0.10	0.19	0.27	0.23	0.25	0.18	0.14	0.10	0.03	0.02	0.04	0.14
Surface Water Inflows	0.03	0.24	0.28	0.48	0.36	0.31	0.22	0.06	0.05	0.01	0.01	0.01	0.17
From East Edmond	0.03	0.24	0.28	0.48	0.36	0.31	0.22	0.06	0.05	0.01	0.01	0.01	0.17
Evapotranspiration	-0.02	-0.01	0.00	0.00	-0.03	-0.07	-0.11	-0.16	-0.19	-0.18	-0.12	-0.05	-0.08
Recharge (-) Discharge (+)	-0.08	-0.04	-0.11	-0.23	-0.28	-0.30	-0.26	-0.36	-0.42	-0.43	-0.27	-0.12	-0.24
Surface Water Outflows	0.00	-0.06	-0.13	-0.17	-0.12	-0.19	-0.07	-0.03	-0.01	-0.01	-0.01	0.00	-0.07
To Center Drive	0.00	-0.06	-0.13	-0.17	-0.12	-0.19	-0.07	-0.03	-0.01	-0.01	-0.01	0.00	-0.07
Change in Storage	0.00	0.23	0.23	0.35	0.16	0.00	-0.03	-0.36	-0.48	-0.58	-0.36	-0.12	-0.1

Water Volume

	Average Monthly Volume in AF												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg. Annual Volume
Precipitation	4	6	12	17	13	15	11	8	6	2	1	2	98
Surface Water Inflows	2	14	17	29	20	19	13	3	3	1	1	0	124
From East Edmond	2	14	17	29	20	19	13	3	3	1	1	0	124
Evapotranspiration	-1	-1	0	0	-2	-4	-6	-10	-11	-11	-7	-3	-56
Recharge (-) Discharge (+)	-5	-2	-7	-14	-16	-18	-15	-22	-25	-27	-17	-7	-175
Surface Water Outflows	0	-3	-8	-11	-7	-12	-4	-2	-1	-1	0	0	-49
To Center Drive	0	-3	-8	-11	-7	-12	-4	-2	-1	-1	0	0	-49
Change in Storage	0.1	13.8	14.4	21.8	9.2	0.0	-1.9	-22.0	-28.3	-35.9	-22.3	-7.3	-58.6

Table F-4. Annual Average Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Flow

	Monthly Average in cfs												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average in cfs
Precipitation	0.6	0.8	0.9	1.0	0.7	0.8	0.6	0.4	0.3	0.1	0.1	0.3	0.5
Surface Water Inflows	3.2	5.4	4.8	5.2	2.8	3.5	2.2	1.5	1.0	0.2	0.4	1.2	2.6
Runoff from Ft. Lewis - Outfall 002	1.9	3.3	3.0	3.2	1.7	2.2	1.3	0.9	0.6	0.1	0.2	0.7	1.6
Runoff from Ft. Lewis - Outfall 003	1.2	2.1	1.9	2.0	1.1	1.4	0.9	0.6	0.4	0.1	0.2	0.5	1.0
Evapotranspiration	-0.1	-0.1	0.0	0.0	-0.1	-0.2	-0.3	-0.5	-0.6	-0.7	-0.6	-0.3	-0.3
Recharge (-) Discharge (+)	-0.2	0.0	0.0	-0.1	-0.3	-0.2	-0.3	-0.2	-0.2	-0.2	-0.3	-0.2	-0.2
Surface Water Outflows	-2.6	-4.7	-4.4	-5.2	-3.0	-3.7	-2.2	-1.5	-1.0	-0.2	-0.3	-1.0	-2.5
To Diversion Canal	-2.6	-4.6	-4.2	-4.8	-2.5	-3.2	-1.7	-1.2	-0.8	-0.2	-0.3	-1.0	-2.3
To Seq. Ck. Marsh (surface)	0.0	0.0	-0.2	-0.4	-0.5	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.0	-0.2
Subsurface Outflows	-0.2	-0.2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Change in Storage	0.7	1.3	1.0	0.6	-0.1	-0.1	-0.3	-0.5	-0.7	-1.0	-0.9	-0.2	0.0

Water Volume

	Average Monthly Volume in AF												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg. Annual Volume
Precipitation	35	51	53	59	41	47	34	25	20	6	8	17	395
Surface Water Inflows	196	319	297	319	157	218	131	92	62	11	24	71	1897
Runoff from Ft. Lewis - Outfall 002	120	194	181	195	96	133	80	56	37	6	14	43	1156
Runoff from Ft. Lewis - Outfall 003	76	125	116	125	61	85	51	36	24	5	9	28	741
Evapotranspiration	-8	-4	0	0	-6	-13	-20	-31	-36	-41	-34	-19	-210
Recharge (-) Discharge (+)	-12	3	-2	-4	-15	-11	-19	-12	-12	-12	-19	-11	-126
Surface Water Outflows	-158	-279	-268	-317	-165	-228	-130	-91	-62	-14	-20	-58	-1791
To Diversion Canal	-158	-276	-258	-295	-137	-199	-104	-71	-48	-10	-20	-57	-1633
To Seq. Ck. Marsh (surface)	0	-2	-10	-22	-28	-29	-26	-20	-14	-4	-1	-1	-158
Subsurface Outflows	-11	-15	-17	-18	-15	-17	-15	-15	-13	-13	-11	-10	-170
Change in Storage	41	75	64	40	-4	-4	-19	-31	-42	-63	-53	-10	-6

Table F-5. Annual Average Water Balance for East Edmond Marsh with Mining - Low Groundwater

Flow

	Monthly Average in cfs												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average in cfs
Precipitation	0.6	0.9	0.9	0.9	0.7	0.7	0.6	0.4	0.3	0.1	0.1	0.3	0.5
Surface Water Inflows	0.0	0.1	0.2	0.4	0.5	0.5	0.5	0.3	0.3	0.1	0.0	0.0	0.2
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Hamer (surface)	0.0	0.0	0.2	0.4	0.5	0.5	0.4	0.3	0.2	0.1	0.0	0.0	0.2
Subsurface Inflows	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Evapotranspiration	-0.1	-0.1	0.0	0.0	-0.1	-0.2	-0.3	-0.5	-0.6	-0.7	-0.6	-0.3	-0.3
Recharge (-) Discharge (+)	-0.2	-0.1	-0.3	-0.4	-0.5	-0.6	-0.5	-0.5	-0.4	-0.4	-0.2	-0.2	-0.4
Surface Water Outflows	0.0	-0.2	-0.4	-0.5	-0.6	-0.5	-0.3	-0.1	-0.1	0.0	0.0	0.0	-0.2
To Diversion Canal	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.1	-0.1	0.0	0.0	0.0	-0.1
To West Edmond Marsh	-0.01	-0.22	-0.32	-0.41	-0.37	-0.28	-0.18	-0.07	-0.06	-0.01	-0.01	-0.01	-0.16
Change in Storage	0.4	0.8	0.7	0.7	0.3	0.3	0.1	-0.1	-0.3	-0.8	-0.4	0.0	0.1

Water Volume

	Average Monthly Volume in AF												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg. Annual Volume
Precipitation	36	53	53	58	39	46	33	25	20	6	8	18	395
Surface Water Inflows	2	5	13	24	29	30	27	21	15	4	1	2	173
From Sequalitchew Lake	0	0	0	0	0	0	0	0	0	0	0	0	0
From Center Drive	2	2	2	2	1	2	1	1	1	0	0	1	16
From Hamer (surface)	0.0	2.5	10.2	22.1	27.9	29.0	26.1	20.2	14.4	3.7	0.5	1.3	158
Subsurface Inflows	11	15	17	18	15	17	15	15	13	13	11	10	170
Evapotranspiration	-8	-4	0	0	-6	-12	-19	-31	-35	-41	-34	-19	-209
Recharge (-) Discharge (+)	-13	-8	-16	-27	-29	-35	-30	-31	-23	-27	-9	-10	-259
Surface Water Outflows	-1	-15	-23	-33	-32	-29	-20	-9	-8	-3	-2	-1	-175
To Diversion Canal	-1	-1	-3	-8	-11	-11	-10	-5	-4	-2	-1	-1	-59
To West Edmond Marsh	-1	-13	-20	-25	-20	-17	-11	-4	-3	-1	-1	0	-116
Change in Storage	26.4	45.2	43.8	40.3	17.7	17.2	5.6	-9.1	-18.2	-48.4	-26.0	0.2	94.9

Table F-6. Annual Average Water Balance for West Edmond Marsh with Mining - Low Groundwater

Flow

	Monthly Average in cfs												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average in cfs
Precipitation	0.03	0.05	0.12	0.18	0.13	0.13	0.08	0.04	0.03	0.00	0.01	0.02	0.07
Surface Water Inflows	0.01	0.22	0.32	0.41	0.37	0.28	0.18	0.07	0.06	0.01	0.01	0.01	0.16
From East Edmond	0.01	0.22	0.32	0.41	0.37	0.28	0.18	0.07	0.06	0.01	0.01	0.01	0.16
Evapotranspiration	-0.01	0.00	0.00	0.00	-0.02	-0.04	-0.05	-0.05	-0.04	-0.04	-0.03	-0.02	-0.02
Recharge (-) Discharge (+)	-0.03	-0.20	-0.51	-0.65	-0.64	-0.64	-0.51	-0.13	-0.06	0.02	0.01	0.00	-0.28
Surface Water Outflows	0.00	-0.02	-0.05	-0.02	-0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
To Center Drive	0.00	-0.02	-0.05	-0.02	-0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Change in Storage	0.00	0.05	-0.11	-0.08	-0.19	-0.26	-0.31	-0.07	-0.01	0.00	0.00	0.00	-0.1

Water Volume

	Average Monthly Volume in AF												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg. Annual Volume
Precipitation	2	3	7	11	7	8	4	2	2	0	0	1	49
Surface Water Inflows	1	13	20	25	20	17	11	4	3	1	1	0	116
From East Edmond	1	13	20	25	20	17	11	4	3	1	1	0	116
Evapotranspiration	0	0	0	0	-1	-2	-3	-3	-2	-2	-2	-1	-17
Recharge (-) Discharge (+)	-2	-12	-31	-40	-36	-39	-30	-8	-3	1	1	0	-201
Surface Water Outflows	0	-1	-3	-1	-2	0	0	0	0	0	0	0	-8
To Center Drive	0	-1	-3	-1	-2	0	0	0	0	0	0	0	-8
Change in Storage	-0.1	2.9	-6.7	-5.0	-10.5	-16.3	-18.6	-4.6	-0.8	-0.1	-0.1	-0.1	-60.0

Table F-7. Annual Average Water Balance for Bell, McKay, and Hamer Marshes with Mining + Restoration - Low Groundwater

Flow

	Monthly Average in cfs												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average in cfs
Precipitation	0.6	0.9	0.9	1.0	0.7	0.7	0.6	0.4	0.3	0.1	0.1	0.3	0.6
Surface Water Inflows	3.2	5.4	4.8	5.2	2.8	3.5	2.2	1.5	1.0	0.2	0.4	1.2	2.6
Runoff from Ft. Lewis - Outfall 002	1.9	3.3	3.0	3.2	1.7	2.2	1.3	0.9	0.6	0.1	0.2	0.7	1.6
Runoff from Ft. Lewis - Outfall 003	1.2	2.1	1.9	2.0	1.1	1.4	0.9	0.6	0.4	0.1	0.2	0.5	1.0
Evapotranspiration	-0.1	-0.1	0.0	0.0	-0.1	-0.2	-0.3	-0.5	-0.6	-0.7	-0.5	-0.3	-0.3
Recharge (-) Discharge (+)	-0.5	-0.3	-0.1	0.0	-0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2
Surface Water Outflows	-0.7	-4.0	-4.7	-5.3	-2.9	-3.1	-2.0	-0.9	-0.6	-0.1	0.0	-0.1	-2.0
To Diversion Canal	-0.6	-3.7	-4.2	-4.7	-2.3	-2.7	-1.5	-0.6	-0.3	0.0	0.0	-0.1	-1.7
To E. East Edmond. Marsh (surface)	-0.05	-0.33	-0.53	-0.55	-0.54	-0.47	-0.49	-0.34	-0.29	-0.09	-0.01	0.00	-0.3
Subsurface Outflows	-0.8	-0.9	-0.9	-0.9	-0.9	-0.9	-0.8	-0.8	-0.7	-0.6	-0.5	-0.5	-0.8
Change in Storage	1.7	1.0	0.1	0.1	-0.4	0.0	-0.5	-0.4	-0.6	-1.2	-0.8	0.3	0.0

Water Volume

	Average Monthly Volume in AF												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg. Annual Volume
Precipitation	36	56	57	60	40	45	33	25	19	6	8	17	401
Surface Water Inflows	196	319	297	319	157	218	131	92	62	11	24	71	1898
Runoff from Ft. Lewis - Outfall 002	120	194	181	195	96	133	80	56	37	6	14	43	1156
Runoff from Ft. Lewis - Outfall 003	76	125	116	125	61	85	51	36	24	5	9	28	741
Evapotranspiration	-8	-4	0	0	-6	-12	-19	-30	-34	-40	-33	-18	-206
Recharge (-) Discharge (+)	-33	-16	-6	3	-4	-2	-8	-3	-6	-5	-13	-15	-109
Surface Water Outflows	-41	-241	-291	-323	-160	-193	-121	-58	-37	-5	0	-4	-1473
To Diversion Canal	-38	-221	-259	-289	-130	-164	-91	-37	-19	0	0	-4	-1252
To E. East Edmond. Marsh (surface)	-3	-20	-32	-34	-30	-29	-29	-21	-17	-5	0	0	-221
Subsurface Outflows	-46	-52	-54	-56	-48	-55	-47	-48	-42	-37	-31	-32	-548
Change in Storage	104	62	4	4	-20	2	-30	-22	-38	-71	-47	18	-36

Table F-8. Annual Average Water Balance for East Edmond Marsh with Mining + Restoration - Low Groundwater

Flow

	Monthly Average in cfs												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average in cfs
Precipitation	0.4	0.6	0.5	0.6	0.4	0.4	0.3	0.2	0.2	0.1	0.1	0.2	0.3
Surface Water Inflows	3.8	7.5	11.6	16.4	20.4	22.1	20.9	13.7	8.0	3.5	2.5	2.2	10.98
From Sequalitchew Lake	3.7	7.1	11.0	15.8	19.8	21.6	20.4	13.4	7.7	3.4	2.5	2.2	10.66
From Center Drive	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02
From Hamer (surface)	0.0	0.3	0.5	0.5	0.5	0.5	0.5	0.3	0.3	0.1	0.0	0.0	0.31
Subsurface Inflows	0.8	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.7	0.6	0.5	0.5	0.8
Evapotranspiration	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.3	-0.4	-0.4	-0.4	-0.2	-0.2
Recharge (-) Discharge (+)	1.1	1.3	1.3	1.4	1.3	1.4	1.3	1.3	1.2	1.0	1.1	1.0	1.2
Surface Water Outflows	-5.6	-9.5	-13.7	-18.9	-22.6	-24.2	-22.7	-15.4	-9.4	-4.6	-3.5	-3.4	-12.7
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-5.6	-9.5	-13.7	-18.9	-22.6	-24.2	-22.7	-15.4	-9.4	-4.6	-3.5	-3.4	-12.7
Change in Storage	0.4	0.7	0.6	0.4	0.4	0.5	0.5	0.3	0.4	0.2	0.2	0.3	0.4

Water Volume

	Average Monthly Volume in AF												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg. Annual Volume
Precipitation	25	35	34	35	23	27	19	15	12	4	5	12	246
Surface Water Inflows	232	444	710	1008	1142	1356	1243	845	477	216	152	129	7956
From Sequalitchew Lake	227	422	676	972	1111	1326	1212	823	459	211	151	129	7719
From Center Drive	2	2	2	2	1	2	1	1	1	0	0	1	16
From Hamer (surface)	3.0	19.9	32.3	33.5	30.5	28.9	29.1	20.7	17.4	5.5	0.4	0.0	221
Subsurface Inflows	46	52	54	56	48	55	47	48	42	37	31	32	548
Evapotranspiration	-6	-3	0	0	-3	-7	-11	-18	-21	-26	-23	-13	-131
Recharge (-) Discharge (+)	70	76	80	84	75	85	78	78	73	62	66	62	889
Surface Water Outflows	-342	-565	-843	-1161	-1265	-1487	-1348	-950	-561	-283	-217	-202	-9224
To Diversion Canal	0	0	0	0	0	0	0	0	0	0	0	0	0
To West Edmond Marsh	-342	-565	-843	-1161	-1265	-1487	-1348	-950	-561	-283	-217	-202	-9224
Change in Storage	26.0	40.2	34.3	22.4	20.7	28.1	27.6	17.8	21.5	9.7	15.1	20.5	283.8

Table F-9. Annual Average Water Balance for West Edmond Marsh with Mining + Restoration - Low Groundwater

Flow

	Monthly Average in cfs												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average in cfs
Precipitation	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1
Surface Water Inflows	5.6	9.5	13.7	18.9	22.6	24.2	22.7	15.4	9.4	4.6	3.5	3.4	12.7
From East Edmond	5.6	9.5	13.7	18.9	22.6	24.2	22.7	15.4	9.4	4.6	3.5	3.4	12.7
Evapotranspiration	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Recharge (-) Discharge (+)	-1.0	-0.8	-0.7	-0.6	-0.7	-0.7	-0.8	-0.8	-0.9	-1.0	-1.1	-1.0	-0.8
Surface Water Outflows	-4.7	-8.8	-13.2	-18.5	-22.0	-23.6	-21.9	-14.6	-8.5	-3.5	-2.4	-2.4	-11.9
To Center Drive	-4.7	-8.8	-13.2	-18.5	-22.0	-23.6	-21.9	-14.6	-8.5	-3.5	-2.4	-2.4	-11.9
Change in Storage	-0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.03	0.01	0.0

Water Volume

	Average Monthly Volume in AF												
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg. Annual Volume
Precipitation	8	11	10	11	7	8	6	5	4	1	2	3	75
Surface Water Inflows	342	565	843	1161	1265	1487	1348	950	561	283	217	202	9224
From East Edmond	342	565	843	1161	1265	1487	1348	950	561	283	217	202	9224
Evapotranspiration	-2	-1	0	0	-1	-2	-3	-6	-6	-8	-7	-4	-40
Recharge (-) Discharge (+)	-63	-49	-44	-36	-37	-44	-46	-51	-54	-64	-67	-60	-614
Surface Water Outflows	-286	-525	-809	-1136	-1234	-1450	-1305	-898	-504	-213	-147	-142	-8648
To Center Drive	-286	-525	-809	-1136	-1234	-1450	-1305	-898	-504	-213	-147	-142	-8648
Change in Storage	-0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	-2.1	0.7	-2.0

MARSH WATER BALANCE MONTHLY RESULTS

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water	WY2004					WY2005							
Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	2.0	1.0	3.8	0.9	0.1	3.6	2.9	4.0	3.2	4.3	4.3	0.6	4.5
Surface Water Inflows	6.3	1.5	16.1	1.4	0.0	16.4	11.7	18.7	13.0	21.1	19.1	0.3	20.3
Runoff from Ft. Lewis - Outfall 002	3.8	0.8	9.9	0.7	0.0	10.0	7.2	11.5	8.0	12.9	11.7	0.0	12.5
Runoff from Ft. Lewis - Outfall 003	2.5	0.7	6.2	0.7	0.0	6.3	4.5	7.2	5.0	8.1	7.3	0.3	7.8
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	-6.0	2.8	0.8	-0.3	-2.1	-4.1	-0.9	-2.1	-1.6	-1.3	0.1	-2.7	-6.0
Surface Water Outflows	-5.9	-2.4	-13.2	-2.4	-0.1	-12.5	-8.8	-14.4	-9.8	-16.4	-15.8	-0.9	-17.1
To Diversion Canal	-4.8	-1.5	-12.3	-1.3	0.0	-12.5	-8.8	-14.4	-9.8	-16.4	-14.8	-0.3	-15.9
To Seq. Ck. Marsh (surface)	-1.1	-0.9	-0.9	-1.1	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	-0.6	-1.3
Subsurface Outflows	-1.3	-1.6	-1.9	-1.6	-1.4	-1.3	-1.5	-1.5	-1.5	-1.8	-2.0	-1.3	-1.3
Change in Storage	-6.2	-0.8	2.5	-5.6	-7.9	-1.8	1.1	3.7	2.7	5.8	5.7	-4.5	-0.9
Predicted WSE in feet													
Bell	218.34	218.27	218.48	218.01	217.35	217.20	217.29	217.60	217.82	218.31	218.79	218.41	218.33
McKay	216.19	216.12	216.33	215.86	215.20	215.05	215.14	215.45	215.67	216.16	216.64	216.26	216.18
Hamer	214.41	214.34	214.55	214.08	213.42	213.27	213.36	213.67	213.89	214.38	214.86	214.48	214.40
Observed WSE ('04) in feet													
Bell						216.36	217.40	217.36	217.72	218.30	219.11	217.92	216.95
McKay	216.19	215.81	214.71	214.26				213.70	213.84	214.35	215.15	214.68	213.74
Hamer	214.41	214.17	213.61	213.34	212.76	211.93	212.68	212.95	213.27	213.50	213.93	213.69	213.28

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water — WY2006

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	5.4	3.9	3.8	1.4	0.2	1.6	3.3	6.7	6.5	12.2	3.2	2.6	3.9
Surface Water Inflows	25.8	16.4	15.5	3.2	0.0	5.1	17.0	46.3	38.2	94.8	10.6	8.7	15.6
Runoff from Ft. Lewis - Outfall 002	15.8	10.1	9.5	1.9	0.0	3.0	10.4	28.3	23.4	57.1	6.5	5.3	9.6
Runoff from Ft. Lewis - Outfall 003	10.0	6.3	6.0	1.4	0.0	2.1	6.6	18.0	14.8	37.6	4.1	3.4	6.0
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	0.8	-0.4	-2.3	-3.6	-5.7	-6.8	-6.7	2.2	-2.0	2.0	1.1	1.6	1.4
Surface Water Outflows	-21.9	-15.2	-14.3	-4.6	-0.2	-4.1	-12.9	-38.8	-31.8	-95.3	-12.5	-9.8	-16.7
To Diversion Canal	-20.8	-12.6	-11.9	-2.8	-0.2	-4.1	-12.9	-38.8	-31.8	-94.9	-9.6	-6.6	-13.6
To Seq. Ck. Marsh (surface)	-1.0	-2.7	-2.5	-1.8	0.0	0.0	0.0	0.0	0.0	-0.5	-2.9	-3.2	-3.1
Subsurface Outflows	-2.0	-1.9	-1.5	-1.2	-1.0	-0.8	-0.9	-2.1	-1.8	-2.2	-1.8	-2.1	-2.0
Change in Storage	6.3	-0.4	-2.6	-9.3	-10.7	-7.3	-1.3	13.8	9.1	11.4	0.0	-0.2	0.2
Predicted WSE in feet													
Bell	218.86	218.82	218.60	217.83	216.94	216.33	216.23	217.37	218.13	219.08	219.08	219.06	219.08
McKay	216.71	216.67	216.45	215.68	214.79	214.18	214.08	215.22	215.98	216.93	216.93	216.91	216.93
Hamer	214.93	214.89	214.67	213.90	213.01	212.40	212.30	213.44	214.20	215.15	215.15	215.13	215.15
Observed WSE ('04) in feet													
Bell			218.33	217.05	215.63			218.25	217.95				
McKay	216.07	215.43	214.48	213.57				214.39	214.34	216.95	216.28	216.60	216.49
Hamer	214.26	214.05	213.69	213.13	212.13	211.67	211.69	213.20	213.27	214.09	213.65	214.13	214.14

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water	WY2007												
Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	2.1	2.2	0.4	0.0	0.8	1.6	14.4	8.6	6.5	4.5	5.7	1.7	1.1
Surface Water Inflows	6.5	6.8	0.0	0.0	1.0	5.2	152.0	52.5	33.2	17.8	27.6	4.5	2.2
Runoff from Ft. Lewis - Outfall 002	3.9	4.1	0.0	0.0	0.4	3.1	91.2	31.9	20.3	10.9	16.9	2.7	1.2
Runoff from Ft. Lewis - Outfall 003	2.5	2.7	0.0	0.0	0.5	2.1	60.8	20.6	12.9	6.9	10.7	1.8	1.0
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	1.1	1.4	-0.1	-0.5	-1.2	-3.2	4.0	2.2	1.6	1.1	1.1	1.9	2.2
Surface Water Outflows	-8.2	-7.5	-0.4	0.0	-1.5	-4.2	-149.1	-53.4	-39.0	-21.0	-31.1	-6.2	-3.3
To Diversion Canal	-4.9	-5.2	-0.1	0.0	-1.5	-4.2	-149.1	-52.0	-35.8	-18.0	-27.8	-3.3	-1.4
To Seq. Ck. Marsh (surface)	-3.2	-2.4	-0.3	0.0	0.0	0.0	0.0	-1.4	-3.2	-2.9	-3.2	-2.9	-1.8
Subsurface Outflows	-1.9	-1.8	-1.7	-1.5	-1.3	-1.1	-2.6	-2.2	-2.3	-1.9	-2.1	-2.2	-2.3
Change in Storage	-3.6	-2.7	-6.3	-6.0	-4.7	-2.7	18.2	7.7	0.0	0.0	0.0	-2.3	-3.2
Predicted WSE in feet													
Bell	218.78	218.56	218.03	217.54	217.15	216.92	218.44	219.08	219.08	219.08	219.08	218.89	218.63
McKay	216.63	216.41	215.88	215.39	215.00	214.77	216.29	216.93	216.93	216.93	216.93	216.74	216.48
Hamer	214.85	214.63	214.10	213.61	213.22	212.99	214.51	215.15	215.15	215.15	215.15	214.96	214.70
Observed WSE ('04) in feet													
Bell			218.46	217.75	217.19	216.57							
McKay	216.06	216.27	214.34	213.60			216.87	217.29	217.02	216.97	216.90	217.35	216.64
Hamer	214.89	214.08	213.26	212.65	212.31	212.19	214.53	215.05	214.60	214.64	214.72	214.14	214.21

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water						WY2008							
Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.7	1.5	1.0	1.7	5.0	2.8	7.7	4.2	3.6	4.9	1.8	1.3	1.7
Surface Water Inflows	9.1	4.0	1.9	5.2	26.2	9.9	44.6	17.9	13.5	22.1	4.7	2.8	4.4
Runoff from Ft. Lewis - Outfall 002	5.6	2.4	1.0	3.1	16.1	6.1	27.2	11.0	8.3	13.6	2.8	1.6	2.6
Runoff from Ft. Lewis - Outfall 003	3.5	1.7	0.9	2.1	10.1	3.9	17.4	6.9	5.2	8.5	1.9	1.2	1.8
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	1.6	1.5	0.6	-0.9	1.8	-0.3	0.4	0.4	0.4	1.0	0.0	0.1	0.1
Surface Water Outflows	-8.7	-5.0	-2.6	-4.1	-20.8	-8.5	-43.3	-20.5	-15.0	-24.6	-6.5	-4.0	-4.6
To Diversion Canal	-6.9	-3.3	-2.0	-4.1	-20.8	-7.5	-41.8	-17.3	-11.9	-21.4	-3.5	-2.1	-3.5
To Seq. Ck. Marsh (surface)	-1.9	-1.7	-0.6	0.0	0.0	-1.1	-1.5	-3.2	-3.0	-3.2	-3.0	-1.9	-1.1
Subsurface Outflows	-2.1	-1.9	-1.7	-1.6	-2.3	-1.9	-2.1	-2.1	-2.0	-2.1	-1.9	-1.9	-1.7
Change in Storage	-1.2	-4.3	-4.7	-2.0	8.8	1.6	7.3	0.0	0.0	0.0	-3.8	-4.9	-3.9
Predicted WSE in feet													
Bell	218.53	218.17	217.78	217.61	218.35	218.48	219.08	219.08	219.08	219.08	218.76	218.35	218.03
McKay	216.38	216.02	215.63	215.46	216.20	216.33	216.93	216.93	216.93	216.93	216.61	216.20	215.88
Hamer	214.60	214.24	213.85	213.68	214.42	214.55	215.15	215.15	215.15	215.15	214.83	214.42	214.10
Observed WSE ('04) in feet													
Bell				218.18									
McKay	216.01	214.98	214.26	213.68	215.97	214.67	216.83	216.83	216.91	216.98	215.93	215.06	214.63
Hamer	213.85	213.68	213.29	213.04	213.88	213.81	214.52	214.47	214.43	214.52	214.23	214.75	213.55

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water WY2009

Hydrologic Process	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Precipitation	0.9	2.1	0.5	2.6	8.3	5.2	7.3	1.6	5.3	3.5	3.4	1.3	0.0
Surface Water Inflows	1.4	7.4	0.2	11.8	64.3	27.5	41.4	3.6	25.4	13.0	13.2	3.0	0.0
Runoff from Ft. Lewis - Outfall 002	0.7	4.5	0.0	7.2	39.1	16.9	25.3	2.2	15.6	8.0	8.1	1.7	0.0
Runoff from Ft. Lewis - Outfall 003	0.7	2.9	0.2	4.6	25.2	10.6	16.1	1.5	9.8	5.0	5.1	1.3	0.0
Evapotranspiration	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5
Recharge (-) Discharge (+)	-1.3	-1.4	-2.6	-5.7	2.4	-3.1	-0.7	-1.7	0.5	-1.2	-0.6	-2.1	-2.9
Surface Water Outflows	-1.9	-5.6	-0.7	-8.9	-56.3	-22.0	-37.8	-5.2	-23.6	-13.0	-13.0	-4.3	0.0
To Diversion Canal	-1.8	-5.6	-0.7	-8.9	-56.3	-22.0	-36.6	-2.6	-21.3	-9.9	-10.0	-2.3	0.0
To Seq. Ck. Marsh (surface)	-0.1	0.0	0.0	0.0	0.0	0.0	-1.2	-2.6	-2.3	-3.1	-3.0	-2.0	0.0
Subsurface Outflows	-1.5	-1.4	-0.9	-0.8	-2.1	-1.7	-2.0	-1.7	-2.2	-1.8	-1.9	-1.4	-1.2
Change in Storage	-6.8	-2.9	-5.9	-2.1	16.1	5.9	8.2	-4.0	4.0	-1.5	-2.1	-7.3	-8.6
Predicted WSE in feet													
Bell	217.46	217.22	216.73	216.56	217.90	218.39	219.08	218.75	219.08	218.95	218.78	218.17	217.45
McKay	215.31	215.07	214.58	214.41	215.75	216.24	216.93	216.60	216.93	216.80	216.63	216.02	215.30
Hamer	213.53	213.29	212.80	212.63	213.97	214.46	215.15	214.82	215.15	215.02	214.85	214.24	213.52
Observed WSE ('04) in feet													
Bell													
McKay					216.11	214.61	216.38	215.34	216.31	215.69	215.73	214.44	
Hamer	212.98	212.63	212.51	212.39	214.37	213.94	214.42	214.08	214.34	214.18	214.24	213.49	212.68

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water			WY2010										
Hydrologic Process	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Precipitation	1.9	2.8	5.6	8.9	3.0	8.0	3.3	3.3	3.3	4.6	4.3	0.4	0.2
Surface Water Inflows	6.3	11.4	32.9	60.0	11.0	47.2	11.4	12.5	12.3	20.2	17.6	0.0	0.0
Runoff from Ft. Lewis - Outfall 002	3.8	7.0	20.2	36.5	6.7	28.8	7.0	7.7	7.5	12.4	10.8	0.0	0.0
Runoff from Ft. Lewis - Outfall 003	2.5	4.4	12.7	23.6	4.3	18.5	4.4	4.8	4.8	7.8	6.8	0.0	0.0
Evapotranspiration	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0
Recharge (-) Discharge (+)	-3.2	-2.8	-1.4	1.2	0.1	1.0	-0.2	-0.5	0.5	0.1	-0.1	-1.7	-2.6
Surface Water Outflows	-4.9	-8.6	-26.7	-53.4	-10.8	-52.0	-11.9	-12.7	-12.3	-18.9	-16.8	-0.4	-0.2
To Diversion Canal	-4.9	-8.6	-26.7	-53.4	-8.3	-49.2	-9.0	-9.5	-9.3	-15.8	-13.7	-0.1	0.0
To Seq. Ck. Marsh (surface)	0.0	0.0	0.0	0.0	-2.5	-2.8	-2.9	-3.2	-3.0	-3.1	-3.1	-0.3	-0.1
Subsurface Outflows	-1.1	-1.1	-1.6	-2.3	-2.0	-2.1	-2.1	-2.0	-2.0	-2.1	-2.0	-1.7	-1.4
Change in Storage	-5.0	-0.7	7.9	14.0	1.3	2.1	0.0	-0.6	-0.1	0.7	-0.7	-7.9	-8.0
Predicted WSE in feet													
Bell	217.03	216.98	217.63	218.79	218.90	219.08	219.08	219.03	219.02	219.08	219.02	218.36	217.69
McKay	214.88	214.83	215.48	216.64	216.75	216.93	216.93	216.88	216.87	216.93	216.87	216.21	215.54
Hamer	213.10	213.05	213.70	214.86	214.97	215.15	215.15	215.10	215.09	215.15	215.09	214.43	213.76
Observed WSE ('04) in feet													
Bell													
McKay				216.08	215.95	216.60	216.40	216.04	216.36	216.01	215.95	214.27	214.28
Hamer	212.35	212.48	213.05	214.46	214.53	214.80	214.56	214.47	214.59	214.32	214.44	213.62	213.02

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water	WY2011												
Hydrologic Process	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precipitation	4.0	4.2	6.6	7.2	6.1	3.1	7.2	5.7	4.8	2.8	0.8	0.3	1.3
Surface Water Inflows	18.2	18.9	34.4	38.5	30.5	10.3	39.3	26.9	21.2	9.3	0.9	0.0	3.0
Runoff from Ft. Lewis - Outfall 002	11.2	11.6	21.0	23.5	18.7	6.3	24.0	16.5	13.0	5.7	0.4	0.0	1.7
Runoff from Ft. Lewis - Outfall 003	7.0	7.3	13.4	15.0	11.8	4.0	15.3	10.4	8.2	3.6	0.5	0.0	1.3
Evapotranspiration	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	0.7	-2.2	-0.3	1.3	1.2	1.1	1.3	1.6	1.7	1.2	1.9	1.7	0.2
Surface Water Outflows	-14.0	-14.9	-29.8	-44.5	-36.2	-12.3	-44.8	-30.4	-22.6	-10.1	-1.7	-0.3	-2.7
To Diversion Canal	-14.0	-14.6	-28.8	-41.4	-32.9	-9.4	-41.6	-27.3	-19.4	-7.0	-0.6	-0.1	-2.7
To Seq. Ck. Marsh (surface)	0.0	-0.2	-1.0	-3.1	-3.2	-2.9	-3.2	-3.1	-3.2	-3.1	-1.1	-0.2	0.0
Subsurface Outflows	-2.0	-1.8	-2.1	-1.8	-1.7	-1.7	-1.7	-1.8	-1.9	-1.7	-3.3	-2.6	-2.1
Change in Storage	4.5	3.2	8.3	0.7	0.0	0.0	0.0	0.0	0.0	-2.3	-5.9	-4.8	-2.6
Predicted WSE in feet													
Bell	218.06	218.33	219.02	219.08	219.08	219.08	219.08	219.08	219.08	218.89	218.40	218.00	217.78
McKay	215.91	216.18	216.87	216.93	216.93	216.93	216.93	216.93	216.93	216.74	216.25	215.85	215.63
Hamer	214.13	214.40	215.09	215.15	215.15	215.15	215.15	215.15	215.15	214.96	214.47	214.07	213.85
Observed WSE ('04) in feet													
Bell													
McKay	214.29	215.23	216.18	216.90	217.01	217.07	217.13						
Hamer	213.60	213.51	214.64	214.45	214.30	214.29	214.28	214.31	214.72	214.68	214.63	214.01	213.35

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water	WY2012												WY2013
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Precipitation	4.1	6.1	3.2	7.2	3.9	6.8	4.3	3.1	3.3	1.6	0.0	0.1	6.5
Surface Water Inflows	19.3	32.1	12.6	40.0	14.7	35.5	17.5	11.1	11.9	4.3	0.0	0.0	38.6
Runoff from Ft. Lewis - Outfall 002	11.9	19.7	7.7	24.4	9.0	21.7	10.7	6.8	7.3	2.5	0.0	0.0	23.6
Runoff from Ft. Lewis - Outfall 003	7.4	12.5	4.9	15.6	5.7	13.8	6.7	4.3	4.6	1.7	0.0	0.0	15.0
Evapotranspiration	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0
Recharge (-) Discharge (+)	-1.2	-1.3	-2.2	1.2	0.6	1.1	1.5	1.5	1.1	1.4	1.4	-0.6	-0.7
Surface Water Outflows	-14.9	-26.9	-11.9	-42.4	-17.0	-40.5	-19.5	-11.6	-11.9	-5.9	0.0	-0.1	-32.2
To Diversion Canal	-14.9	-26.5	-9.5	-40.0	-14.0	-37.2	-16.4	-8.4	-9.0	-3.2	0.0	0.0	-32.2
To Seq. Ck. Marsh (surface)	0.0	-0.4	-2.3	-2.3	-3.0	-3.2	-3.1	-3.2	-2.9	-2.6	0.0	-0.1	0.0
Subsurface Outflows	-2.1	-2.1	-1.8	-2.0	-1.7	-1.7	-1.8	-1.9	-1.8	-1.8	-1.8	-1.5	-2.1
Change in Storage	4.2	7.4	0.0	4.0	0.0	0.0	0.0	-1.0	-1.1	-4.9	-4.4	-4.5	9.2
Predicted WSE in feet													
Bell	218.13	218.75	218.75	219.08	219.08	219.08	219.08	219.00	218.91	218.50	218.13	217.76	218.52
McKay	215.98	216.60	216.60	216.93	216.93	216.93	216.93	216.85	216.76	216.35	215.98	215.61	216.37
Hamer	214.20	214.82	214.82	215.15	215.15	215.15	215.15	215.07	214.98	214.57	214.20	213.83	214.59
Observed WSE ('04) in feet													
Bell					219.68	219.77	219.87	219.91	219.77	219.42	219.07	218.23	218.84
McKay	214.03	214.15	214.78	215.42	215.25	215.08	214.91	214.89	215.43	215.18	214.93	213.70	214.59
Hamer	213.44	213.63	214.25	215.05	214.90	215.03	215.15	215.00	214.78	214.40	214.02	213.24	213.96

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water — WY2014

Hydrologic Process	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Precipitation	6.5	7.6	3.5	1.7	3.7	5.5	4.4	1.9	0.0	1.6	6.9	2.6	4.1
Surface Water Inflows	33.5	42.4	13.5	4.0	14.6	25.0	17.7	5.0	0.0	4.3	40.5	8.9	17.3
Runoff from Ft. Lewis - Outfall 002	20.5	25.8	8.3	2.4	9.0	15.3	10.9	3.0	0.0	2.6	24.7	5.5	10.6
Runoff from Ft. Lewis - Outfall 003	13.0	16.5	5.2	1.6	5.6	9.7	6.8	2.0	0.0	1.8	15.8	3.5	6.7
Evapotranspiration	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5
Recharge (-) Discharge (+)	0.0	2.2	0.4	-0.2	-0.5	-0.8	-1.1	-0.2	-0.2	-1.3	0.3	0.8	0.3
Surface Water Outflows	-30.8	-50.4	-13.5	-5.7	-14.4	-23.4	-17.6	-6.9	0.0	-4.2	-34.1	-8.5	-15.3
To Diversion Canal	-29.2	-47.1	-10.2	-2.8	-11.2	-20.1	-13.8	-3.7	0.0	-3.5	-34.1	-6.7	-13.4
To Seq. Ck. Marsh (surface)	-1.6	-3.2	-3.2	-2.9	-3.2	-3.2	-3.8	-3.2	0.0	-0.7	0.0	-1.8	-1.9
Subsurface Outflows	-2.0	-1.8	-1.8	-1.5	-1.7	-1.7	-1.7	-1.5	-1.6	-1.4	-2.0	-1.9	-1.9
Change in Storage	6.7	0.0	2.1	-2.3	0.5	2.6	-1.4	-5.4	-6.3	-5.1	9.2	0.9	4.1
Predicted WSE in feet													
Bell	219.08	219.08	219.25	219.07	219.11	219.32	219.21	218.76	218.23	217.81	218.57	218.64	218.98
McKay	216.93	216.93	217.10	216.92	216.96	217.17	217.06	216.61	216.08	215.66	216.42	216.49	216.83
Hamer	215.15	215.15	215.32	215.14	215.18	215.39	215.28	214.83	214.30	213.88	214.64	214.71	215.05
Observed WSE ('04) in feet													
Bell	219.44	219.62	219.81	219.57	219.35	219.49	219.46	219.25	218.80	218.09	219.27	219.36	219.48
McKay	215.49	215.65	215.47	215.46	215.49	215.57	215.97	216.22	214.67	213.77	214.98	216.08	216.03
Hamer	214.68	214.86	215.05	214.97	215.11	215.07	214.61	214.57	213.93	213.35	214.07	214.78	214.76

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water — WY2015

Hydrologic Process	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation	2.4	4.2	6.9	9.8	4.5	3.3	1.3	1.2	1.6	1.8	5.9	6.1	4.8
Surface Water Inflows	7.7	18.1	33.2	59.2	18.2	12.0	2.5	2.4	4.2	5.2	30.0	29.3	20.6
Runoff from Ft. Lewis - Outfall 002	4.7	11.1	20.3	35.9	11.2	7.3	1.4	1.3	2.5	3.1	18.4	17.9	12.7
Runoff from Ft. Lewis - Outfall 003	3.0	7.0	12.9	23.3	7.0	4.6	1.1	1.0	1.7	2.1	11.6	11.4	8.0
Evapotranspiration	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0
Recharge (-) Discharge (+)	-2.5	-1.0	0.3	0.8	1.6	2.0	2.5	2.2	2.0	2.6	1.1	-1.0	1.1
Surface Water Outflows	-8.7	-16.4	-33.1	-66.8	-20.3	-13.1	-3.8	-3.6	-5.7	-5.3	-25.8	-27.2	-24.6
To Diversion Canal	-5.8	-14.0	-30.4	-62.7	-16.3	-9.1	-1.4	-1.5	-3.4	-4.1	-24.5	-24.2	-20.6
To Seq. Ck. Marsh (surface)	-2.9	-2.4	-2.7	-4.1	-3.9	-4.1	-2.3	-2.1	-2.2	-1.2	-1.2	-3.0	-4.1
Subsurface Outflows	-1.5	-1.8	-1.7	-1.7	-2.1	-2.0	-2.0	-2.1	-2.0	-2.0	-2.3	-2.0	-1.9
Change in Storage	-2.7	3.1	5.0	0.0	0.0	-1.0	-3.2	-4.4	-3.9	0.0	7.9	4.6	0.0
Predicted WSE in feet													
Bell	218.76	219.01	219.43	219.43	219.43	219.35	219.08	218.71	218.39	218.39	219.04	219.43	219.43
McKay	216.61	216.86	217.28	217.28	217.28	217.20	216.93	216.56	216.24	216.24	216.89	217.28	217.28
Hamer	214.83	215.08	215.50	215.50	215.50	215.42	215.15	214.78	214.46	214.46	215.11	215.50	215.50
Observed WSE ('04) in feet													
Bell	218.67	219.27	219.76										
McKay	215.03	215.78	216.09	215.95	216.19	215.94	215.82	215.62	215.27	215.36	215.45	215.97	216.17
Hamer	214.33	214.68	215.58	215.43			215.02	214.50	214.15	214.20	214.25	214.93	215.39

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water — WY2016

Hydrologic Process	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Precipitation	4.1	4.7	4.4	2.1	0.8	0.4	0.2	2.2	1.3	5.0	7.1	12.0	6.9
Surface Water Inflows	16.3	17.9	17.9	5.9	1.0	0.0	0.0	7.7	3.2	26.3	42.8	88.5	34.5
Runoff from Ft. Lewis - Outfall 002	10.0	11.0	11.0	3.6	0.4	0.0	0.0	4.7	1.8	16.2	26.1	53.4	21.1
Runoff from Ft. Lewis - Outfall 003	6.3	6.9	6.9	2.3	0.5	0.0	0.0	3.0	1.3	10.2	16.7	35.1	13.4
Evapotranspiration	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0
Recharge (-) Discharge (+)	0.7	0.6	0.6	0.9	0.7	0.0	0.0	-1.6	-1.4	-3.6	2.7	1.6	-0.5
Surface Water Outflows	-19.4	-21.0	-19.7	-8.0	-1.8	-0.4	-0.2	-5.9	-2.8	-21.0	-36.3	-92.3	-39.1
To Diversion Canal	-15.3	-17.3	-15.6	-4.3	-0.5	-0.1	-0.1	-5.9	-2.8	-21.0	-36.3	-89.8	-35.1
To Seq. Ck. Marsh (surface)	-4.1	-3.7	-4.1	-3.7	-1.3	-0.3	-0.2	0.0	0.0	0.0	0.0	-2.4	-4.1
Subsurface Outflows	-1.8	-1.7	-1.9	-1.8	-1.8	-1.8	-1.7	-1.7	-1.4	-1.4	-2.3	-2.1	-1.8
Change in Storage	0.0	0.0	0.0	-2.9	-4.2	-5.5	-6.2	-3.3	-3.6	4.3	13.5	7.8	0.0
Predicted WSE in feet													
Bell	219.43	219.43	219.43	219.19	218.84	218.38	217.87	217.59	217.30	217.66	218.78	219.43	219.43
McKay	217.28	217.28	217.28	217.04	216.69	216.23	215.72	215.44	215.15	215.51	216.63	217.28	217.28
Hamer	215.50	215.50	215.50	215.26	214.91	214.45	213.94	213.66	213.37	213.73	214.85	215.50	215.50
Observed WSE ('04) in feet													
Bell					219.23	219.09	218.69	217.87	217.69	217.50	219.85		
McKay	216.10	215.99	215.89	215.65	215.44	214.58	213.88				215.69	216.17	
Hamer	215.29	215.29	215.29	215.26	214.68	213.91	213.36	212.70	212.67	212.64	215.55		

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water — WY2017

Hydrologic Process	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Precipitation	5.8	5.9	1.8	1.0	2.3	1.3	0.2	1.5	9.3	6.9	3.9	3.4	8.6
Surface Water Inflows	25.0	27.6	4.5	1.6	7.3	2.9	0.0	3.7	62.0	36.3	15.4	12.6	43.5
Runoff from Ft. Lewis - Outfall 002	15.3	16.9	2.7	0.9	4.4	1.7	0.0	2.2	37.6	22.2	9.4	7.8	26.5
Runoff from Ft. Lewis - Outfall 003	9.7	10.7	1.8	0.8	2.9	1.2	0.0	1.5	24.4	14.1	5.9	4.9	17.1
Evapotranspiration	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6
Recharge (-) Discharge (+)	-1.1	-1.8	0.4	0.8	4.2	3.5	2.1	1.2	-2.9	2.1	1.8	1.0	1.9
Surface Water Outflows	-27.5	-28.7	-6.2	-2.6	-7.9	-4.2	-0.2	-3.7	-55.8	-35.5	-19.0	-14.9	-51.6
To Diversion Canal	-23.7	-24.7	-3.0	-0.9	-5.5	-2.2	0.0	-3.1	-55.5	-32.9	-15.0	-10.8	-48.0
To Seq. Ck. Marsh (surface)	-3.8	-4.1	-3.3	-1.7	-2.4	-2.0	-0.2	-0.6	-0.2	-2.6	-4.1	-4.1	-3.7
Subsurface Outflows	-1.6	-1.7	-1.8	-1.8	-2.3	-2.3	-2.1	-1.8	-2.0	-2.4	-2.1	-2.2	-1.8
Change in Storage	0.0	0.0	-3.3	-4.2	-0.2	-3.3	-4.0	-1.5	9.6	6.8	0.0	0.0	0.0
Predicted WSE in feet													
Bell	219.43	219.43	219.15	218.80	218.79	218.51	218.18	218.06	218.87	219.43	219.43	219.43	219.43
McKay	217.28	217.28	217.00	216.65	216.64	216.36	216.03	215.91	216.72	217.28	217.28	217.28	217.28
Hamer	215.50	215.50	215.22	214.87	214.86	214.58	214.25	214.13	214.94	215.50	215.50	215.50	215.50
Observed WSE ('04) in feet													
Bell							219.47		218.88				
McKay					215.60	215.55	214.85		214.09	215.95	216.30	216.16	216.16
Hamer					212.25	214.62	213.94		213.45	215.32			

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water — WY2018

Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	8.7	4.6	2.8	1.8	0.0	0.1	1.0	5.2	7.2	5.8	7.2	3.3	2.3
Surface Water Inflows	49.3	18.7	9.4	4.6	0.0	0.0	1.8	25.2	38.8	27.0	37.3	10.8	7.1
Runoff from Ft. Lewis - Outfall 002	30.0	11.5	5.8	2.8	0.0	0.0	0.9	15.5	23.7	16.6	22.8	6.6	4.3
Runoff from Ft. Lewis - Outfall 003	19.3	7.2	3.7	1.8	0.0	0.0	0.8	9.7	15.1	10.5	14.6	4.2	2.8
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	3.4	3.2	3.4	3.6	3.9	4.6	2.1	-4.4	-1.4	2.0	2.5	2.7	2.3
Surface Water Outflows	-57.8	-22.3	-11.2	-6.4	0.0	-0.1	-2.8	-21.5	-34.6	-29.5	-45.1	-14.0	-9.4
To Diversion Canal	-53.7	-18.4	-7.1	-3.2	0.0	0.0	-1.4	-20.2	-32.9	-26.2	-41.0	-10.3	-5.4
To Seq. Ck. Marsh (surface)	-4.1	-3.9	-4.1	-3.2	0.0	-0.1	-1.4	-1.3	-1.7	-3.4	-4.1	-3.7	-4.1
Subsurface Outflows	-2.3	-2.3	-2.4	-2.4	-2.8	-3.1	-2.5	-1.8	-2.1	-2.2	-2.0	-2.2	-2.2
Change in Storage	0.0	0.0	-1.1	-2.5	-3.4	-2.4	-2.8	1.8	7.3	3.1	0.0	0.0	-1.1
Predicted WSE in feet													
Bell	219.43	219.43	219.34	219.13	218.85	218.65	218.41	218.56	219.17	219.43	219.43	219.43	219.34
McKay	217.28	217.28	217.19	216.98	216.70	216.50	216.26	216.41	217.02	217.28	217.28	217.28	217.19
Hamer	215.50	215.50	215.41	215.20	214.92	214.72	214.48	214.63	215.24	215.50	215.50	215.50	215.41
Observed WSE ('04) in feet													
Bell							219.80						
McKay	216.28	216.12		215.96	216.02	215.96	216.12			216.35		216.30	216.35
Hamer				215.45	214.76	213.95	213.83						

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water — WY2019

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	6.1	0.7	0.9	0.2	0.3	1.8	4.0	3.8	6.4	3.4	4.8	1.6	3.6
Surface Water Inflows	27.7	0.3	1.3	0.0	0.0	5.2	18.6	15.2	33.7	12.3	18.5	3.8	12.9
Runoff from Ft. Lewis - Outfall 002	17.0	0.0	0.6	0.0	0.0	3.1	11.4	9.3	20.6	7.5	11.4	2.2	7.9
Runoff from Ft. Lewis - Outfall 003	10.8	0.3	0.6	0.0	0.0	2.1	7.2	5.9	13.1	4.7	7.2	1.5	5.0
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	2.6	2.0	2.1	2.1	1.1	0.9	-2.1	0.9	1.4	1.1	0.9	0.0	-0.1
Surface Water Outflows	-31.2	-1.0	-2.2	-0.2	-0.3	-4.1	-14.3	-12.2	-29.7	-13.2	-21.8	-5.3	-13.1
To Diversion Canal	-27.5	-0.2	-0.7	0.0	-0.1	-4.1	-14.3	-11.6	-27.9	-9.4	-18.1	-2.3	-9.8
To Seq. Ck. Marsh (surface)	-3.7	-0.8	-1.5	-0.2	-0.2	0.0	0.0	-0.5	-1.8	-3.8	-3.7	-3.0	-3.2
Subsurface Outflows	-2.1	-2.2	-2.3	-2.5	-2.2	-2.2	-2.3	-2.3	-2.7	-2.3	-1.9	-2.0	-1.9
Change in Storage	1.1	-3.4	-3.9	-4.9	-5.1	-0.8	2.8	4.8	9.1	1.3	0.0	-3.3	-0.6
Predicted WSE in feet													
Bell	219.43	219.15	218.83	218.42	218.00	217.93	218.16	218.57	219.33	219.43	219.43	219.16	219.11
McKay	217.28	217.00	216.68	216.27	215.85	215.78	216.01	216.42	217.18	217.28	217.28	217.01	216.96
Hamer	215.50	215.22	214.90	214.49	214.07	214.00	214.23	214.64	215.40	215.50	215.50	215.23	215.18
Observed WSE ('04) in feet													
Bell				219.79	219.20	219.09	218.29					219.89	219.77
McKay	216.38	214.68	214.31	214.30	213.97	213.79		214.25	214.52	214.67	215.96	214.44	214.37
Hamer		215.01	214.47	214.10	213.30	213.11	212.99	213.63	214.85		215.27	214.79	214.64

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water	WY2020												
Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	1.1	0.7	1.0	0.8	3.5	3.9	1.7	6.5	9.6	4.2	3.5	1.5	3.1
Surface Water Inflows	2.1	0.4	1.9	1.2	18.1	19.3	5.1	38.7	62.1	15.8	13.1	3.6	11.6
Runoff from Ft. Lewis - Outfall 002	1.1	0.1	1.0	0.6	11.1	11.9	3.0	23.7	37.7	9.7	8.0	2.1	7.1
Runoff from Ft. Lewis - Outfall 003	0.9	0.3	0.9	0.6	7.0	7.4	2.0	15.0	24.4	6.1	5.0	1.5	4.5
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	-0.6	-0.8	-1.8	-2.0	-1.6	0.6	3.0	-3.5	2.2	-0.1	-1.3	0.8	0.6
Surface Water Outflows	-3.2	-1.0	-2.5	-1.7	-13.7	-14.8	-4.0	-32.3	-60.1	-17.4	-14.0	-5.1	-11.8
To Diversion Canal	-1.2	-0.4	-2.0	-1.7	-13.7	-14.8	-4.0	-32.3	-58.5	-13.6	-9.9	-2.3	-8.8
To Seq. Ck. Marsh (surface)	-1.9	-0.7	-0.4	0.0	0.0	0.0	0.0	0.0	-1.5	-3.8	-4.1	-2.8	-3.1
Subsurface Outflows	-1.9	-1.7	-1.6	-1.4	-1.9	-2.0	-2.0	-1.9	-2.6	-2.0	-1.8	-1.9	-1.9
Change in Storage	-5.6	-6.2	-7.4	-7.0	2.0	6.0	3.2	7.6	11.3	0.0	-1.8	-3.1	-1.6
Predicted WSE in feet													
Bell	218.64	218.12	217.51	216.92	217.09	217.59	217.86	218.49	219.43	219.43	219.28	219.03	218.90
McKay	216.49	215.97	215.36	214.77	214.94	215.44	215.71	216.34	217.28	217.28	217.13	216.88	216.75
Hamer	214.71	214.19	213.58	212.99	213.16	213.66	213.93	214.56	215.50	215.50	215.35	215.10	214.97
Observed WSE ('04) in feet													
Bell		218.58	217.47	216.86		218.20				219.71			
McKay		213.99			214.92			213.72	215.28	214.65			
Hamer		213.47	212.68		212.25			213.55	215.55	215.03			

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water					WY2021								
Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.5	0.3	0.4	2.8	3.0	5.6	5.2	7.3	4.7	2.5	1.2	2.0	2.4
Surface Water Inflows	8.1	0.0	0.0	10.8	12.3	29.6	26.5	41.2	18.1	8.0	2.2	6.1	8.1
Runoff from Ft. Lewis - Outfall 002	4.9	0.0	0.0	6.6	7.6	18.1	16.2	25.2	11.1	4.9	1.2	3.7	4.9
Runoff from Ft. Lewis - Outfall 003	3.2	0.0	0.0	4.2	4.8	11.5	10.2	16.1	7.0	3.1	0.9	2.4	3.1
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	0.2	-2.4	-3.1	-2.1	-1.9	0.3	0.3	0.3	1.1	1.3	0.9	0.8	0.2
Surface Water Outflows	-8.8	-0.3	-0.4	-8.1	-9.3	-23.9	-21.3	-38.0	-21.3	-10.1	-3.3	-7.8	-8.2
To Diversion Canal	-6.1	0.0	-0.4	-8.1	-9.3	-23.9	-21.2	-35.7	-17.7	-6.0	-1.2	-4.7	-6.1
To Seq. Ck. Marsh (surface)	-2.7	-0.2	0.0	0.0	0.0	0.0	-0.1	-2.3	-3.7	-4.1	-2.1	-3.1	-2.1
Subsurface Outflows	-1.8	-1.5	-1.4	-1.5	-1.6	-2.0	-2.3	-2.5	-2.0	-2.2	-2.1	-2.1	-2.0
Change in Storage	-3.5	-8.4	-8.5	-0.5	1.5	9.0	8.4	8.4	0.0	-1.8	-3.1	-4.0	-3.2
Predicted WSE in feet													
Bell	218.60	217.90	217.19	217.15	217.28	218.03	218.73	219.43	219.43	219.28	219.02	218.69	218.43
McKay	216.45	215.75	215.04	215.00	215.13	215.88	216.58	217.28	217.28	217.13	216.87	216.54	216.28
Hamer	214.67	213.97	213.26	213.22	213.35	214.10	214.80	215.50	215.50	215.35	215.09	214.76	214.50
Observed WSE ('04) in feet													
Bell					217.23			219.68			219.71	219.41	218.99
McKay						213.87		214.86	214.88	215.59	214.57	214.46	214.38
Hamer						213.15		215.23	215.30	214.89	214.51	214.01	213.58

Table F-10. Water Balance for Bell, McKay, and Hamer Marshes - Existing Conditions

Monthly Average in Inches of Water	WY2021		
Hydrologic Process	Jul	Aug	Sep
Precipitation	0.0	0.3	2.6
Surface Water Inflows	0.0	0.0	9.7
Runoff from Ft. Lewis - Outfall 002	0.0	0.0	5.9
Runoff from Ft. Lewis - Outfall 003	0.0	0.0	3.8
Evapotranspiration	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	-1.1	-2.0	-1.5
Surface Water Outflows	0.0	-0.3	-7.3
To Diversion Canal	0.0	-0.3	-7.3
To Seq. Ck. Marsh (surface)	0.0	0.0	0.0
Subsurface Outflows	-1.8	-1.7	-1.7
Change in Storage	-7.4	-7.7	-0.6
Predicted WSE in feet			
Bell	217.81	217.17	217.13
McKay	215.66	215.02	214.98
Hamer	213.88	213.24	213.20
Observed WSE ('04) in feet			
Bell	218.05		
McKay		213.27	
Hamer	212.68	212.25	

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water	WY2004						WY2005						
Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	2.0	1.0	3.8	0.9	0.1	3.6	2.9	4.0	3.2	4.3	4.3	0.6	4.5
Surface Water Inflows	0.3	0.9	1.0	1.1	0.0	0.2	0.1	0.2	0.1	0.2	1.2	0.6	1.4
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.1	0.0	0.1	0.0	0.0	0.2	0.1	0.2	0.1	0.2	0.2	0.0	0.2
From Hamer (surface)	1.0	0.9	0.9	1.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.6	1.3
Subsurface Inflows	1.2	1.6	1.8	1.6	1.3	1.3	1.5	1.5	1.5	1.7	2.0	1.3	1.2
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	*-5.2*	*-4.2*	*-4.0*	*-2.4*	*-1.1*	*-2.4*	*-1.2*	*-1.3*	*-2.2*	*-2.1*	*-2.9*	*-3.3*	*-5.0*
Surface Water Outflows	-1.8	0.0	-0.4	-0.3	-0.2	0.0	0.0	0.0	-0.1	-0.1	-0.9	0.0	-0.3
To Diversion Canal	-1.5	0.0	-0.7	-0.6	-0.4	-0.1	0.0	0.0	-0.2	-0.3	-1.1	0.0	-0.5
To West Edmond Marsh	-2.0	0.0	-0.3	-0.2	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.9	0.0	-0.2
Change in Storage	-4.8	-2.8	-0.8	-2.8	-4.4	-1.4	1.0	3.3	2.0	3.9	3.7	-1.4	0.6
Predicted WSE in ft													
EM-2S	212.62	212.32	212.19	211.87	211.51	211.39	211.48	211.75	211.92	212.25	212.48	212.31	212.26
East Edmond	212.62	212.39	212.31	212.06	211.69	211.57	211.66	211.93	212.10	212.42	212.65	212.54	212.58
Eastern East Edmond Marsh	212.36	212.13	211.89	211.53	211.07	210.94	211.03	211.29	211.41	211.66	211.90	211.79	211.71
Observed WSE in ft													
EM-2S	210.72	210.74	210.76	210.70	210.40	209.82	209.92	210.33	210.61	210.76	210.86	210.79	210.64
East Edmond (EM-2E)	212.62	212.50	212.35	212.25	211.85	211.43	211.43	211.80	212.12	212.31	212.47	212.40	212.19
East Edmond (EM-2W)	211.15	211.15	211.22	211.20	210.91	210.32	210.41	210.80	211.08	211.20	211.26	211.24	211.09
East Edmond (EM-3E)	212.42	212.29	212.14	212.04	211.69	211.07	211.43	211.70	211.93	212.09	212.15	212.17	211.97
East Edmond (EM-3W)	212.42	212.29	212.15	212.04	211.70	211.10	211.57	211.70	211.94	212.04	212.26	212.20	211.98
Eastern East Edmond (SCM-1)	212.39	212.26	212.09	211.98	211.58	210.96	211.20	211.63	211.84	212.08	212.27	212.17	211.95

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2006

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	5.4	3.9	3.8	1.4	0.2	1.6	3.3	6.7	6.5	12.2	3.2	2.6	3.9
Surface Water Inflows	1.2	2.8	2.5	1.8	0.0	0.1	0.2	0.3	0.3	1.0	3.0	3.2	3.2
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.2	0.1	0.1	0.0	0.0	0.1	0.2	0.3	0.3	0.6	0.1	0.1	0.1
From Hamer (surface)	1.0	2.6	2.4	1.8	0.0	0.0	0.0	0.0	0.0	0.5	2.9	3.1	3.0
Subsurface Inflows	2.0	1.9	1.5	1.2	0.9	0.8	0.9	2.0	1.8	2.2	1.7	2.0	1.9
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	*-2.8*	*-3.7*	*-2.4*	*-3.7*	*-4.2*	*-5.3*	*-4.6*	*-1.5*	*-3.1*	*-2.0*	*-4.1*	*-4.6*	*-4.3*
Surface Water Outflows	-1.6	-0.3	-0.9	-0.3	0.0	0.0	0.0	0.0	0.0	-5.8	-0.9	-1.0	-1.4
To Diversion Canal	-1.8	-0.6	-1.2	-0.6	0.0	0.0	0.0	0.0	0.0	-5.9	-1.4	-1.5	-1.7
To West Edmond Marsh	-1.5	-0.2	-0.9	-0.2	0.0	0.0	0.0	0.0	0.0	-5.8	-0.7	-0.8	-1.3
Change in Storage	2.4	1.4	0.8	-4.1	-7.1	-5.2	-1.3	7.0	5.4	7.6	2.3	0.9	1.4
Predicted WSE in ft													
EM-2S	212.38	212.29	212.16	211.68	211.09	210.66	210.55	211.14	211.59	212.19	212.15	211.98	211.85
East Edmond	212.66	212.76	212.76	212.41	211.82	211.43	211.43	212.01	212.47	212.62	212.77	212.78	212.80
Eastern East Edmond Marsh	211.90	211.87	211.86	211.38	210.79	210.36	210.25	210.84	211.29	212.35	212.34	212.20	212.23
Observed WSE in ft													
EM-2S	210.94	210.90	210.69	210.42	209.82	209.15	209.21	210.48	210.71	210.98	210.88	210.58	210.57
East Edmond (EM-2E)	212.55	212.63	212.47	212.13	211.43	211.43	211.43	211.89	212.22	212.63	212.62	212.51	212.55
East Edmond (EM-2W)	211.28	211.32	211.14	210.88	210.28	209.64	209.67	210.87	211.12	211.31	211.25	210.92	210.89
East Edmond (EM-3E)	212.32	212.40	212.26	211.92	211.13			211.78	212.02	212.42	212.37	212.27	212.30
East Edmond (EM-3W)	212.50	212.41	212.25	211.92	211.15	210.44	210.58	211.75	212.02	212.42	212.38	212.26	212.29
Eastern East Edmond (SCM-1)	212.25	212.43	212.29	211.88	211.08	210.95	210.57	211.69	211.99	212.58	212.47	212.20	212.32

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2007

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	2.1	2.2	0.4	0.0	0.8	1.6	14.4	8.6	6.5	4.5	5.7	1.7	1.1
Surface Water Inflows	3.2	2.4	0.3	0.0	0.0	0.1	0.7	1.8	3.6	3.2	3.5	3.1	1.9
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.1	0.1	0.0	0.0	0.0	0.1	0.7	0.4	0.3	0.2	0.2	0.1	0.0
From Hamer (surface)	3.2	2.3	0.3	0.0	0.0	0.0	0.0	1.4	3.3	3.1	3.3	3.0	1.9
Subsurface Inflows	1.8	1.8	1.7	1.5	1.3	1.1	2.2	2.3	2.3	2.0	2.2	2.3	2.4
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	*-4.3*	*-2.5*	*-3.1*	*-0.4*	*-1.8*	*-2.0*	*-0.4*	*0.8*	*-0.9*	*-1.2*	*-0.1*	*-1.3*	*-2.2*
Surface Water Outflows	-0.4	-0.3	0.0	-0.1	0.0	0.0	-7.7	-6.5	-7.5	-2.5	-6.6	-2.1	-0.4
To Diversion Canal	-0.8	-0.6	0.0	-0.3	0.0	0.0	-7.7	-6.9	-10.1	-3.8	-8.3	-3.9	-0.8
To West Edmond Marsh	-0.3	-0.2	0.0	-0.1	0.0	0.0	-7.7	-6.4	-6.7	-2.1	-6.1	-1.6	-0.3
Change in Storage	-0.7	-0.2	-5.3	-2.9	-2.1	-0.2	8.8	7.0	3.9	5.4	3.4	1.8	-0.4
Predicted WSE in ft													
EM-2S	211.54	211.34	210.88	210.63	210.46	210.44	211.17	211.65	211.77	212.00	212.05	211.99	211.81
East Edmond	212.73	212.70	212.26	212.01	211.83	211.82	211.90	211.96	211.80	212.11	211.93	211.99	211.94
Eastern East Edmond Marsh	211.99	211.82	211.38	211.06	210.88	210.86	212.23	212.75	212.54	212.60	212.63	212.10	211.91
Observed WSE in ft													
EM-2S	210.71	210.85	210.62	210.36	210.21	210.06	211.03	211.01	210.90	210.87	210.83	210.79	210.82
East Edmond (EM-2E)	212.55	212.63	212.53	211.36	211.43	211.65	211.87	211.94	211.78	211.79	211.80	211.65	211.73
East Edmond (EM-2W)	211.08	211.28	211.06	210.74	210.64	210.49	211.37	211.37	211.26	211.26	211.22	211.15	211.24
East Edmond (EM-3E)	212.28	212.39	212.04	211.75	211.51	211.32	212.52	212.61	212.44	212.46	212.43	212.30	212.37
East Edmond (EM-3W)	212.27	212.40	212.03	211.75	211.50	211.31	212.51	212.60	212.42	212.42	212.42	212.29	212.36
Eastern East Edmond (SCM-1)	212.26	212.46	211.97	211.70	211.38	211.33	212.58	212.67	212.49	212.48	212.49	212.29	212.44

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2008

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.7	1.5	1.0	1.7	5.0	2.8	7.7	4.2	3.6	4.9	1.8	1.3	1.7
Surface Water Inflows	2.1	1.8	0.6	0.1	0.2	1.2	1.9	3.6	3.3	3.6	3.1	2.1	1.2
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.1	0.0	0.0	0.1	0.2	0.1	0.3	0.2	0.1	0.2	0.1	0.0	0.1
From Hamer (surface)	2.0	1.8	0.6	0.0	0.0	1.1	1.6	3.4	3.2	3.4	3.0	2.0	1.1
Subsurface Inflows	2.2	2.0	1.8	1.6	2.3	2.0	2.3	2.2	2.1	2.2	2.0	1.9	1.7
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	*-2.3*	*-0.5*	*-1.2*	*-1.4*	*-1.1*	*-2.0*	*-1.7*	*-2.1*	*-2.0*	*-2.3*	*-2.0*	*-2.6*	*-1.5*
Surface Water Outflows	-0.3	-0.3	-0.3	-0.1	-1.9	-1.4	-5.0	-4.4	-3.7	-3.5	-2.4	-0.4	-0.3
To Diversion Canal	-0.6	-0.6	-0.5	-0.3	-2.0	-1.6	-5.3	-5.8	-5.0	-4.5	-3.8	-0.8	-0.6
To West Edmond Marsh	-0.2	-0.2	-0.2	-0.1	-1.9	-1.3	-4.9	-4.0	-3.2	-3.2	-2.0	-0.3	-0.2
Change in Storage	0.6	0.0	-2.0	-0.6	3.6	2.2	5.2	3.5	2.7	3.7	0.5	-0.9	-1.0
Predicted WSE in ft													
EM-2S	211.70	211.56	211.35	211.31	211.61	211.70	212.01	212.05	212.05	212.10	211.92	211.68	211.51
East Edmond	211.98	211.97	211.80	211.74	211.89	211.96	211.99	211.98	211.98	212.04	211.95	211.86	211.76
Eastern East Edmond Marsh	211.82	211.70	211.41	211.29	211.68	211.84	212.54	212.54	212.45	212.55	212.12	211.88	211.67
Observed WSE in ft													
EM-2S	210.87	210.86	210.68	210.52	210.85	210.93	211.00	210.98	210.95	210.94	210.83	210.79	210.70
East Edmond (EM-2E)	211.66	211.60	211.45	211.27	211.66	211.77	211.92	211.86	211.80	211.86	211.68	211.69	211.63
East Edmond (EM-2W)	211.30	211.28	211.11	210.95	211.29	211.32	211.37	211.35	211.34	211.32	211.28	211.21	211.15
East Edmond (EM-3E)	212.31	212.23	212.09	211.93	212.32	212.40	212.56	212.50	212.44	212.50	212.37	212.33	212.27
East Edmond (EM-3W)	212.29	212.24	212.09	211.91	212.31	212.40	212.54	212.49	212.43	212.49	212.35	212.33	212.25
Eastern East Edmond (SCM-1)	212.35	212.29	212.13	212.06	212.38	212.48	212.63	212.58	212.52	212.55	212.43	212.39	212.32

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water WY2009

Hydrologic Process	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Precipitation	0.9	2.1	0.5	2.6	8.3	5.2	7.3	1.6	5.3	3.5	3.4	1.3	0.0
Surface Water Inflows	0.2	0.1	0.0	0.1	0.4	0.2	1.6	2.7	2.7	3.4	3.1	2.1	0.0
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.0	0.1	0.0	0.1	0.4	0.2	0.3	0.0	0.2	0.1	0.1	0.0	0.0
From Hamer (surface)	0.1	0.0	0.0	0.0	0.0	0.0	1.3	2.7	2.4	3.2	3.0	2.1	0.0
Subsurface Inflows	1.5	1.4	1.0	0.7	1.8	1.6	2.1	1.7	2.3	1.9	1.9	1.5	1.3
Evapotranspiration	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5
Recharge (-) Discharge (+)	*-0.8*	*0.3*	*-0.3*	*-1.8*	*-1.0*	*-2.0*	*-2.4*	*-2.3*	*-3.1*	*-3.3*	*-3.3*	*-2.8*	*-2.0*
Surface Water Outflows	-0.2	-0.1	-0.1	0.0	-2.0	-2.8	-3.8	-2.5	-2.0	-1.9	-1.0	-0.4	0.0
To Diversion Canal	-0.5	-0.2	-0.2	-0.1	-2.1	-3.1	-4.2	-4.2	-2.4	-2.6	-1.5	-0.8	0.0
To West Edmond Marsh	-0.2	-0.1	-0.1	0.0	-2.0	-2.7	-3.7	-2.0	-1.9	-1.7	-0.9	-0.3	0.0
Change in Storage	-3.0	-0.2	-1.2	0.6	7.0	2.2	4.8	0.6	3.8	1.6	0.8	-2.1	-5.2
Predicted WSE in ft													
EM-2S	211.26	211.24	211.15	211.19	211.78	211.97	212.27	212.14	212.27	212.15	211.98	211.65	211.22
East Edmond	211.50	211.48	211.43	211.48	211.89	211.86	211.96	211.88	212.05	212.06	212.08	211.89	211.46
Eastern East Edmond Marsh	211.30	211.23	211.08	211.11	211.84	212.10	212.62	212.09	212.39	212.31	212.21	211.87	211.44
Observed WSE in ft													
EM-2S	210.43	210.28	210.14	210.00	210.90	210.97	210.95	210.92	210.89	210.87	210.93	210.61	210.18
East Edmond (EM-2E)	211.43	211.43	211.43	211.43	211.72	211.81	211.81	211.76	211.54	211.44	211.72	211.43	211.43
East Edmond (EM-2W)	210.88	210.70	210.56	210.41	211.31	211.34	211.33	211.30	211.36	211.36	211.37	211.04	210.58
East Edmond (EM-3E)	211.92	211.63	211.47	211.30	212.41	212.42	212.44	212.39	212.25	212.31	212.38	211.93	211.59
East Edmond (EM-3W)	211.92	211.67	211.50	211.33	212.32	212.40	212.43	212.37	212.25	212.29	212.36	211.94	211.67
Eastern East Edmond (SCM-1)	211.96	211.71	211.54	211.38	212.39	212.48	212.53	212.47	212.33	212.37	212.44	211.94	211.51

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water WY2010

Hydrologic Process	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Precipitation	1.9	2.8	5.6	8.9	3.0	8.0	3.3	3.3	3.3	4.6	4.3	0.4	0.2
Surface Water Inflows	0.1	0.1	0.3	0.4	2.7	3.1	3.1	3.6	3.2	3.4	3.4	0.3	0.1
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.1	0.1	0.3	0.4	0.1	0.3	0.1	0.1	0.1	0.2	0.2	0.0	0.0
From Hamer (surface)	0.0	0.0	0.0	0.0	2.6	2.8	2.9	3.5	3.1	3.2	3.2	0.3	0.1
Subsurface Inflows	1.2	1.1	1.6	2.3	2.1	2.1	2.1	2.1	2.1	2.2	2.1	1.7	1.5
Evapotranspiration	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0
Recharge (-) Discharge (+)	*-1.5*	*-1.3*	*-2.0*	*-1.3*	*-3.1*	*-2.8*	*-1.8*	*-3.4*	*-2.6*	*-3.1*	*-3.0*	*-2.6*	*-1.3*
Surface Water Outflows	-0.1	-0.1	-0.1	-4.6	-1.3	-5.5	-5.1	-0.4	-2.7	-2.2	-1.5	0.0	-0.3
To Diversion Canal	-0.3	-0.1	-0.1	-4.7	-1.7	-6.2	-7.4	-0.8	-3.3	-2.9	-2.1	0.0	-0.6
To West Edmond Marsh	-0.1	0.0	0.0	-4.5	-1.2	-5.3	-4.4	-0.3	-2.5	-2.0	-1.3	0.0	-0.2
Change in Storage	-2.5	0.3	4.3	5.3	3.3	4.9	1.0	4.0	1.4	1.7	1.5	-4.6	-3.8
Predicted WSE in ft													
EM-2S	211.01	211.04	211.40	211.84	211.91	212.10	212.00	212.05	211.93	211.83	211.70	211.28	210.96
East Edmond	211.43	211.45	211.81	211.88	212.06	212.04	211.82	212.14	212.07	212.06	212.09	211.70	211.43
Eastern East Edmond Marsh	211.14	211.14	211.47	212.19	212.37	212.75	212.20	212.36	212.38	212.34	212.30	211.92	211.46
Observed WSE in ft													
EM-2S	210.12	210.11	210.47	211.06	211.04	211.03	211.03	210.86	211.15	211.13	211.10	210.88	210.61
East Edmond (EM-2E)	211.43	211.43	211.43	211.75	211.52	211.58	211.64	211.90	211.59	212.04	211.93	211.73	211.43
East Edmond (EM-2W)	210.51	210.52	210.90	211.41	211.41	211.39	211.40	211.24	211.58	211.54	211.52	211.36	211.03
East Edmond (EM-3E)	211.49	211.46	211.74	212.41	212.33	212.49	212.38	212.42	212.43	212.55	212.48	212.25	211.93
East Edmond (EM-3W)	211.48	211.46	211.72	212.31	212.25	212.27	212.22	212.39	212.25	212.54	212.44	212.25	211.96
Eastern East Edmond (SCM-1)	211.45	211.46	211.78	212.48	212.40	212.57	212.45	212.49	212.52	212.62	212.55	212.24	211.87

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water WY2011

Hydrologic Process	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precipitation	4.0	4.2	6.6	7.2	6.1	3.1	7.2	5.7	4.8	2.8	0.8	0.3	1.3
Surface Water Inflows	0.2	0.4	1.4	3.6	3.3	2.9	3.5	3.2	3.4	3.1	1.1	0.2	0.1
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.2	0.2	0.3	0.3	0.2	0.1	0.3	0.2	0.2	0.1	0.0	0.0	0.0
From Hamer (surface)	0.0	0.3	1.1	3.3	3.1	2.8	3.2	3.0	3.2	3.0	1.1	0.2	0.0
Subsurface Inflows	2.1	1.9	2.3	1.9	1.6	1.6	1.6	1.7	1.8	1.7	3.2	3.1	2.3
Evapotranspiration	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	*-1.0*	*-2.2*	*-2.0*	*-4.1*	*-4.8*	*-3.1*	*-4.6*	*-3.4*	*-3.9*	*-3.8*	*-26.1*	*3.0*	*0.6*
Surface Water Outflows	-0.1	-0.2	-3.6	-0.5	-3.5	-3.1	-2.7	-4.0	-0.8	-0.6	0.0	0.0	0.0
To Diversion Canal	-0.3	-0.5	-3.8	-0.9	-4.1	-4.3	-3.2	-5.4	-1.5	-1.1	0.0	0.0	0.0
To West Edmond Marsh	-0.1	-0.2	-3.5	-0.4	-3.4	-2.7	-2.5	-3.5	-0.6	-0.4	0.0	0.0	0.0
Change in Storage	2.7	3.0	4.2	8.2	2.7	0.8	3.9	1.2	2.1	-0.5	-25.6	2.6	1.9
Predicted WSE in ft													
EM-2S	211.19	211.43	211.69	212.11	212.09	211.96	212.03	211.93	211.85	211.57	209.35	209.55	209.70
East Edmond	211.65	211.89	211.96	212.62	212.58	212.46	212.58	212.43	212.57	212.50	211.43	211.65	211.81
Eastern East Edmond Marsh	211.60	211.74	212.25	212.75	213.02	212.78	213.06	212.82	212.75	212.49	210.36	210.58	210.74
Observed WSE in ft													
EM-2S	211.01	211.05	211.33	211.43	211.30	211.27	211.25	211.27	211.30	211.22	206.59	211.06	210.85
East Edmond (EM-2E)	211.73	211.75	211.95	212.18	212.13	212.20	212.27	212.30	212.37			212.01	211.69
East Edmond (EM-2W)	211.46	211.48	211.73	211.78	211.68	211.65	211.61	211.58	211.68			211.48	211.33
East Edmond (EM-3E)	212.23	212.37	212.59	212.73	212.73	212.73	212.73	212.76	212.88			212.49	212.06
East Edmond (EM-3W)	212.23	212.25	212.43	212.70	212.63	212.69	212.75	212.77	212.85			212.50	212.18
Eastern East Edmond (SCM-1)	212.28	212.32	212.67	212.81	212.78	212.79	212.80	212.83	212.95			212.58	212.26

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water	WY2012												WY2013
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Precipitation	4.1	6.1	3.2	7.2	3.9	6.8	4.3	3.1	3.3	1.6	0.0	0.1	6.5
Surface Water Inflows	0.2	0.7	2.5	2.6	3.1	3.4	3.2	3.3	2.9	2.6	0.0	0.1	0.3
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.2	0.3	0.1	0.3	0.1	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.3
From Hamer (surface)	0.0	0.4	2.4	2.3	2.9	3.1	3.0	3.2	2.8	2.6	0.0	0.1	0.0
Subsurface Inflows	2.1	2.2	1.8	2.0	1.6	1.6	1.7	1.8	1.7	1.7	1.8	1.5	2.0
Evapotranspiration	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0
Recharge (-) Discharge (+)	*-0.7*	*-2.2*	*-3.0*	*-2.0*	*-3.3*	*-3.9*	*-2.2*	*-3.6*	*-3.5*	*-2.6*	*-0.9*	*-1.9*	*-2.5*
Surface Water Outflows	0.0	-1.8	-1.5	-5.0	-2.3	-3.4	-3.5	-0.8	-0.5	-0.5	-0.4	0.0	-0.2
To Diversion Canal	0.0	-1.8	-1.7	-5.3	-2.7	-4.0	-4.7	-1.4	-1.0	-1.0	-0.8	0.0	-0.3
To West Edmond Marsh	0.0	-1.7	-1.4	-5.0	-2.2	-3.3	-3.1	-0.6	-0.4	-0.4	-0.3	0.0	-0.1
Change in Storage	4.6	4.6	3.1	4.7	2.4	3.2	1.4	0.7	0.2	-1.7	-3.5	-2.6	5.1
Predicted WSE in ft													
EM-2S	210.09	210.43	210.49	210.70	210.67	210.68	210.58	210.39	210.18	209.84	209.56	209.34	209.77
East Edmond	212.20	212.43	212.57	212.55	212.59	212.59	212.48	212.51	212.50	212.34	212.03	211.82	212.24
Eastern East Edmond Marsh	211.13	211.63	211.88	212.52	212.70	212.99	212.83	212.63	212.45	212.12	211.66	211.45	211.79
Observed WSE in ft													
EM-2S	210.97	211.29	211.31	211.37	211.36	211.38	211.40	211.41	211.36	211.25	211.14	210.84	211.08
East Edmond (EM-2E)	211.83	212.03	212.25	212.50	212.52	212.55	212.57	212.63	212.54	212.34	212.13	211.72	212.01
East Edmond (EM-2W)	211.40	211.67	211.71	211.72	211.75	211.76	211.77	211.78	211.75	211.65	211.55	211.31	211.50
East Edmond (EM-3E)	212.19	212.38	212.61	212.85	212.88	212.92	212.95	213.00	212.91	212.70	212.50	212.09	212.37
East Edmond (EM-3W)	212.29	212.50	212.73	212.98	212.99	213.02	213.05	213.11	213.03	212.82	212.61	212.20	212.48
Eastern East Edmond (SCM-1)	212.40	212.59	212.85	213.10	213.12	213.15	213.18	213.35	213.17	212.95	212.74	212.21	212.55

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water | WY2014

Hydrologic Process	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Precipitation	6.5	7.6	3.5	1.7	3.7	5.5	4.4	1.9	0.0	1.6	6.9	2.6	4.1
Surface Water Inflows	1.9	3.5	3.2	2.9	3.2	3.3	4.0	3.3	0.0	0.8	0.3	1.9	2.0
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.3	0.3	0.1	0.0	0.1	0.2	0.2	0.1	0.0	0.0	0.3	0.1	0.2
From Hamer (surface)	1.6	3.2	3.1	2.9	3.1	3.1	3.8	3.2	0.0	0.8	0.0	1.8	1.9
Subsurface Inflows	2.1	1.8	1.8	1.5	1.6	1.7	1.7	1.6	1.6	1.4	2.0	1.9	1.8
Evapotranspiration	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5
Recharge (-) Discharge (+)	*-3.0*	*-2.7*	*-3.8*	*-3.4*	*-3.6*	*-4.1*	*-5.0*	*-4.0*	*-1.9*	*-1.8*	*-1.6*	*-2.0*	*-2.7*
Surface Water Outflows	-2.0	-4.6	-3.0	-1.3	-1.7	-2.3	-1.0	-0.5	0.0	-0.3	-0.2	-0.3	-2.4
To Diversion Canal	-2.3	-5.0	-3.8	-2.1	-2.2	-2.9	-1.8	-1.0	0.0	-0.6	-0.4	-0.6	-2.7
To West Edmond Marsh	-1.9	-4.5	-2.8	-1.1	-1.5	-2.2	-0.8	-0.4	0.0	-0.2	-0.2	-0.3	-2.3
Change in Storage	5.0	5.7	1.7	0.8	2.0	2.1	0.8	-1.5	-4.8	-2.3	5.0	3.0	2.4
Predicted WSE in ft													
EM-2S	210.06	210.28	210.18	210.02	209.94	209.86	209.63	209.25	209.00	209.00	209.42	209.52	209.57
East Edmond	212.50	212.61	212.54	212.54	212.59	212.59	212.61	212.47	212.07	211.87	212.27	212.50	212.51
Eastern East Edmond Marsh	212.23	212.88	212.88	212.70	212.75	212.86	212.66	212.34	211.93	211.60	211.91	212.02	212.24
Observed WSE in ft													
EM-2S	211.31	211.47	211.40	211.40	211.39	211.44	211.43	211.37	211.19	210.88	211.31	211.51	211.47
East Edmond (EM-2E)	212.29	212.69	212.64	212.56	212.59	212.63	212.48	212.39	212.03	211.66	212.05	212.55	212.52
East Edmond (EM-2W)	211.69	211.83	211.78	211.75	211.76	211.81	211.82	211.80	211.64	211.36	211.76	211.89	211.86
East Edmond (EM-3E)	212.65	213.05	212.99	212.91	213.01	212.99	212.86	212.77	212.41	212.03	212.41	212.93	212.88
East Edmond (EM-3W)	212.76	213.17	213.11	213.04	213.06	213.10	212.96	212.88	212.51	212.15	212.53	213.03	212.99
Eastern East Edmond (SCM-1)	212.90	213.32	213.27	213.18	213.21	213.26	213.10	213.03	212.65	212.26	212.66	213.16	213.14

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2015

Hydrologic Process	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation	2.4	4.2	6.9	9.8	4.5	3.3	1.3	1.2	1.6	1.8	5.9	6.1	4.8
Surface Water Inflows	3.0	2.4	3.0	4.5	4.0	4.4	2.4	2.1	2.3	1.3	1.5	3.3	4.4
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.1	0.2	0.3	0.4	0.2	0.1	0.0	0.0	0.0	0.1	0.3	0.2	0.2
From Hamer (surface)	2.9	2.3	2.7	4.1	3.9	4.3	2.4	2.1	2.3	1.2	1.3	3.1	4.2
Subsurface Inflows	1.5	1.7	1.7	1.8	2.1	2.1	2.0	2.1	2.0	2.1	2.4	2.1	2.0
Evapotranspiration	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0
Recharge (-) Discharge (+)	*-4.2*	*-3.4*	*-2.1*	*-3.6*	*-1.8*	*-2.8*	*-3.1*	*-2.8*	*-2.7*	*-1.8*	*-3.2*	*-4.0*	*-3.3*
Surface Water Outflows	-1.0	-2.9	-4.4	-5.9	-5.5	-0.6	-0.7	-0.5	-0.4	-0.3	-1.0	-2.8	-3.6
To Diversion Canal	-1.4	-3.3	-4.8	-7.0	-7.9	-1.1	-1.2	-0.9	-0.7	-0.5	-1.3	-3.1	-4.1
To West Edmond Marsh	-0.9	-2.8	-4.2	-5.5	-4.7	-0.4	-0.5	-0.4	-0.3	-0.2	-1.0	-2.7	-3.5
Change in Storage	1.7	2.0	4.5	5.3	1.4	3.2	-1.8	-2.3	-1.1	0.7	4.6	4.3	4.3
Predicted WSE in ft													
EM-2S	209.48	209.46	209.62	209.76	209.61	209.54	209.21	209.00	209.00	209.00	209.28	209.38	209.40
East Edmond	212.59	212.54	212.57	212.58	212.37	212.61	212.44	212.22	212.12	212.17	212.47	212.61	212.69
Eastern East Edmond Marsh	212.25	212.44	212.97	213.25	212.75	212.80	212.43	212.04	211.80	211.74	212.06	212.46	212.88
Observed WSE in ft													
EM-2S	211.39	211.43	211.51	211.50	211.51	211.54	211.48	211.33	211.22	211.30	211.38	211.49	211.49
East Edmond (EM-2E)	212.33	212.43	212.59	212.59	212.68	212.81	212.73	212.32			212.34	212.53	212.51
East Edmond (EM-2W)	211.80	211.82	211.86	211.87	211.88	211.90	211.87	211.78	211.71	211.76	211.81	211.88	211.89
East Edmond (EM-3E)	212.69	212.80	212.95	212.96	213.04	213.19	213.08	212.66	212.49	212.59	212.69	212.91	212.94
East Edmond (EM-3W)	212.80	212.91	213.06	213.06	213.15	213.29	213.19	212.79	212.61	212.57	212.54	213.02	213.04
Eastern East Edmond (SCM-1)	212.95	213.07	213.21	213.25	213.33	213.46	213.22	212.98	212.76	212.86	212.97	213.20	213.26

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2016

Hydrologic Process	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Precipitation	4.1	4.7	4.4	2.1	0.8	0.4	0.2	2.2	1.3	5.0	7.1	12.0	6.9
Surface Water Inflows	4.3	3.8	4.3	3.8	1.3	0.3	0.2	0.1	0.0	0.2	0.3	2.9	4.3
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.2	0.2	0.2	0.1	0.0	0.0	0.0	0.1	0.0	0.2	0.3	0.5	0.3
From Hamer (surface)	4.1	3.7	4.1	3.8	1.3	0.3	0.2	0.0	0.0	0.0	0.0	2.4	4.0
Subsurface Inflows	1.9	1.7	1.9	1.8	1.8	1.7	1.8	1.7	1.5	1.5	2.3	2.0	1.8
Evapotranspiration	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0
Recharge (-) Discharge (+)	*-3.9*	*-3.3*	*-3.4*	*-3.9*	*-4.2*	*-3.8*	*-2.4*	*-2.0*	*-1.1*	*-2.4*	*0.1*	*-2.6*	*-4.6*
Surface Water Outflows	-3.8	-4.0	-3.1	-1.0	0.0	0.0	0.0	-0.2	-0.1	-0.1	-0.7	-6.3	-5.1
To Diversion Canal	-4.6	-5.2	-4.4	-1.8	0.0	0.0	0.0	-0.4	-0.2	-0.1	-0.8	-6.6	-6.9
To West Edmond Marsh	-3.5	-3.7	-2.8	-0.7	0.0	0.0	0.0	-0.2	-0.1	0.0	-0.6	-6.2	-4.6
Change in Storage	2.5	2.2	2.8	0.9	-3.4	-5.0	-4.6	-2.3	-0.8	3.3	8.7	8.1	3.2
Predicted WSE in ft													
EM-2S	209.29	209.20	209.12	209.00	209.00	209.00	209.00	209.00	209.00	209.28	210.01	210.49	210.46
East Edmond	212.63	212.54	212.57	212.60	212.32	211.90	211.52	211.43	211.43	211.70	212.38	212.55	212.48
Eastern East Edmond Marsh	213.01	212.99	212.89	212.66	212.37	211.96	211.57	211.28	211.17	211.41	212.10	213.11	212.99
Observed WSE in ft													
EM-2S	211.46	211.44	211.42	211.33	211.28	211.07	210.67	210.28	210.36	210.44	211.37	211.34	
East Edmond (EM-2E)	212.49	212.47	212.45	212.47	212.38	211.92	211.60	211.43	211.43	211.43	212.50	212.38	
East Edmond (EM-2W)	211.84	211.81	211.78	211.21	211.71	211.53	211.17	210.76	210.81	210.86	211.72	211.68	
East Edmond (EM-3E)	212.85	212.82	212.79	212.83	212.74	212.20	211.92	211.62	211.64	211.65	212.85	212.70	
East Edmond (EM-3W)	212.94	212.92	212.91	212.94	212.83	212.39	212.03	211.71	211.73	211.75	212.95	212.82	
Eastern East Edmond (SCM-1)	213.13	213.11	213.09	213.13	213.03	212.53	212.14	211.79	211.81	211.83	213.11	212.99	

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2017

Hydrologic Process	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Precipitation	5.8	5.9	1.8	1.0	2.3	1.3	0.2	1.5	9.3	6.9	3.9	3.4	8.6
Surface Water Inflows	4.1	4.3	3.4	1.8	2.5	2.0	0.2	0.7	0.7	2.9	4.4	4.2	4.1
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.2	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.4	0.3	0.1	0.1	0.3
From Hamer (surface)	3.9	4.1	3.3	1.7	2.4	2.0	0.2	0.6	0.2	2.6	4.2	4.1	3.8
Subsurface Inflows	1.7	1.7	1.8	1.9	2.3	2.2	2.2	2.0	2.0	2.4	2.1	2.2	1.8
Evapotranspiration	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6
Recharge (-) Discharge (+)	*-4.9*	*-5.1*	*-4.0*	*-3.2*	*-2.4*	*-2.4*	*-1.1*	*-0.9*	*-3.6*	*-3.3*	*-4.0*	*-5.7*	*-5.1*
Surface Water Outflows	-2.9	-2.9	-1.0	-0.5	-0.4	-0.4	-0.3	-0.1	-1.5	-3.2	-2.7	-3.1	-4.0
To Diversion Canal	-4.1	-4.0	-1.9	-1.0	-0.8	-0.7	-0.5	-0.3	-1.6	-3.5	-3.1	-4.4	-4.4
To West Edmond Marsh	-2.6	-2.6	-0.7	-0.4	-0.3	-0.3	-0.2	-0.1	-1.4	-3.1	-2.5	-2.8	-3.9
Change in Storage	3.2	2.6	0.0	-2.2	0.5	-1.7	-2.8	0.8	5.9	5.2	3.8	1.0	4.8
Predicted WSE in ft													
EM-2S	210.43	210.34	210.08	209.76	209.61	209.31	209.07	209.08	209.56	209.78	209.75	209.52	209.61
East Edmond	212.56	212.59	212.55	212.34	212.37	212.21	211.97	212.03	212.40	212.58	212.69	212.57	212.65
Eastern East Edmond Marsh	212.95	212.90	212.57	212.19	212.07	211.77	211.42	211.40	211.93	212.45	212.75	212.52	213.00
Observed WSE in ft													
EM-2S					211.28	211.15	210.81		210.79	211.31	211.32	211.17	211.47
East Edmond (EM-2E)					212.38	212.27	211.76		211.57	212.24	212.22	212.05	212.04
East Edmond (EM-2W)					211.68	211.57	211.27		211.29	211.90	211.78	211.57	211.59
East Edmond (EM-3E)					212.59	212.34	212.05		211.87	212.33	212.35	212.39	213.34
East Edmond (EM-3W)					212.81	212.60	212.19		212.00	212.69	212.66	212.50	212.46
Eastern East Edmond (SCM-1)					212.88	212.65	212.28		212.08	212.60	212.59	212.62	210.24

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY 2018

Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	8.7	4.6	2.8	1.8	0.0	0.1	1.0	5.2	7.2	5.8	7.2	3.3	2.3
Surface Water Inflows	4.4	4.2	4.3	3.4	0.0	0.1	1.6	1.7	2.1	3.7	4.4	3.8	4.3
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.2	0.3	0.2	0.3	0.1	0.1
From Hamer (surface)	4.0	4.1	4.2	3.3	0.0	0.1	1.6	1.5	1.8	3.5	4.2	3.7	4.2
Subsurface Inflows	2.3	2.3	2.4	2.5	2.8	3.3	2.8	2.0	2.2	2.3	2.1	2.2	2.3
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	*-2.7*	*-3.2*	*-4.8*	*-5.3*	*-3.2*	*-2.3*	*-2.8*	*-3.3*	*-3.3*	*-4.5*	*-5.6*	*-2.5*	*-5.1*
Surface Water Outflows	-8.1	-2.6	-0.8	-0.4	0.0	-0.2	-0.1	-0.1	-1.4	-3.0	-4.0	-5.3	-0.5
To Diversion Canal	-10.6	-4.1	-1.5	-0.9	0.0	-0.5	-0.2	-0.2	-1.6	-3.4	-4.5	-7.3	-1.0
To West Edmond Marsh	-7.3	-2.1	-0.6	-0.3	0.0	-0.2	-0.1	-0.1	-1.4	-3.0	-3.8	-4.7	-0.4
Change in Storage	3.3	3.4	0.7	-1.8	-4.8	-3.0	0.2	4.5	6.2	4.3	4.1	1.0	2.1
Predicted WSE in ft													
EM-2S	209.62	209.61	209.33	209.00	209.00	209.00	209.00	209.26	209.63	209.71	209.72	209.54	209.37
East Edmond	212.38	212.53	212.56	212.39	211.99	211.73	211.74	212.11	212.52	212.64	212.68	212.42	212.57
Eastern East Edmond Marsh	212.82	212.62	212.39	212.06	211.66	211.29	211.25	211.58	212.11	212.53	212.96	212.50	212.49
Observed WSE in ft													
EM-2S	211.31	211.27		211.18	211.05	211.24	210.72			211.95		211.29	211.12
East Edmond (EM-2E)	212.14	212.21		212.34	212.18	211.95	211.82			212.59		212.35	212.14
East Edmond (EM-2W)	210.67	211.63		211.55	211.44	210.47	211.09			211.69		211.60	211.48
East Edmond (EM-3E)	212.37	212.47		212.67	212.88	212.52	212.03			212.56		212.51	212.40
East Edmond (EM-3W)	212.54	212.62		212.78	212.62	212.37	212.27			213.07		212.79	212.58
Eastern East Edmond (SCM-1)	212.62	212.68		212.95	212.65	212.56	212.64			212.89		212.76	212.65

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2019

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	6.1	0.7	0.9	0.2	0.3	1.8	4.0	3.8	6.4	3.4	4.8	1.6	3.6
Surface Water Inflows	4.0	0.8	1.5	0.2	0.2	0.1	0.2	0.8	2.2	4.2	4.0	3.2	3.5
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.2	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.1	0.2	0.0	0.1
From Hamer (surface)	3.8	0.8	1.5	0.2	0.2	0.0	0.0	0.6	1.9	4.1	3.9	3.1	3.4
Subsurface Inflows	2.2	2.3	2.3	2.6	2.4	2.4	2.4	2.7	2.9	2.5	2.0	2.1	2.0
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	*-4.5*	*-5.6*	*-5.0*	*-3.5*	*-3.1*	*-2.2*	*-5.2*	*-2.3*	*-3.7*	*-5.3*	*-5.3*	*-6.0*	*-5.6*
Surface Water Outflows	-2.5	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.2	-1.0	-2.7	-0.5	-0.5
To Diversion Canal	-3.0	0.0	0.0	0.0	0.0	-0.2	-0.1	-0.1	-0.4	-1.3	-3.1	-1.0	-0.8
To West Edmond Marsh	-2.4	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.9	-2.6	-0.4	-0.4
Change in Storage	3.3	-5.1	-3.9	-5.0	-4.1	-0.4	0.3	4.5	7.6	3.8	2.3	-1.0	1.0
Predicted WSE in ft													
EM-2S	209.34	209.00	209.00	209.00	209.00	209.00	209.03	209.35	209.82	209.80	209.68	209.35	209.16
East Edmond	212.66	212.23	211.91	211.49	211.43	211.43	211.45	211.82	212.44	212.69	212.67	212.57	212.63
Eastern East Edmond Marsh	212.74	212.32	211.99	211.57	211.23	211.15	211.15	211.49	212.03	212.24	212.46	212.19	212.11
Observed WSE in ft													
EM-2S	211.17	211.08	211.17	211.01	210.61	210.70	210.71	211.07	211.35	211.39	211.14	211.24	211.37
East Edmond (EM-2E)	212.37	212.41	212.23	212.05	211.65	211.73	211.78	212.21	212.63		212.55	212.37	212.63
East Edmond (EM-2W)	211.51	211.24	211.59	211.44	211.01	211.12	211.07	211.66	211.70		211.48	211.66	211.89
East Edmond (EM-3E)	212.48						212.06	212.42	212.65	212.71	212.83	212.69	212.67
East Edmond (EM-3W)	212.81	212.81	212.50	212.50	212.14	212.19	212.19	212.64	212.98	212.50	213.00	212.81	213.06
Eastern East Edmond (SCM-1)	212.77	212.59	212.85	212.01	211.75	211.84	212.57					212.88	212.90

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2020

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	1.1	0.7	1.0	0.8	3.5	3.9	1.7	6.5	9.6	4.2	3.5	1.5	3.1
Surface Water Inflows	2.0	0.7	0.5	0.0	0.2	0.2	0.1	0.3	2.0	4.2	4.4	2.9	3.2
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.3	0.4	0.2	0.1	0.0	0.1
From Hamer (surface)	2.0	0.7	0.5	0.0	0.0	0.0	0.0	0.0	1.6	4.0	4.3	2.9	3.1
Subsurface Inflows	1.9	1.7	1.7	1.5	1.7	2.1	2.0	1.8	2.6	2.1	1.9	2.0	1.9
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	*-5.2*	*-4.0*	*-2.8*	*-2.7*	*-4.3*	*-0.2*	*0.5*	*-3.7*	*-2.3*	*-5.7*	*-3.6*	*-2.6*	*-3.6*
Surface Water Outflows	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-1.1	-6.1	-2.4	-2.9	-1.4	-0.5
To Diversion Canal	0.0	0.0	-0.3	0.0	0.0	0.0	0.0	-1.2	-6.3	-2.9	-3.6	-2.3	-0.9
To West Edmond Marsh	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-1.1	-6.0	-2.3	-2.7	-1.1	-0.4
Change in Storage	-3.5	-4.7	-4.2	-4.4	-1.3	5.0	3.8	3.8	5.8	1.8	2.1	0.5	1.1
Predicted WSE in ft													
EM-2S	209.00	209.00	209.00	209.00	209.00	209.41	209.73	210.05	210.41	210.23	210.06	209.88	209.72
East Edmond	212.34	211.95	211.59	211.43	211.43	211.84	212.16	212.39	212.37	212.34	212.30	212.27	212.34
Eastern East Edmond Marsh	211.82	211.43	210.99	210.63	210.52	210.94	211.26	211.61	212.47	212.60	212.68	212.38	212.29
Observed WSE in ft													
EM-2S		210.80	210.49	210.07	210.20	210.34		210.30	211.41	210.49			
East Edmond (EM-2E)		211.91	211.55	211.43	211.43	211.44		211.43	212.60	212.45			
East Edmond (EM-2W)		211.58	210.92	210.54		210.77		211.58	211.69	211.66			
East Edmond (EM-3E)						211.90		211.74	212.80	212.80			
East Edmond (EM-3W)		212.37	212.00	211.54	212.27	211.89		212.16	213.03	212.89			
Eastern East Edmond (SCM-1)													

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY 2021

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.5	0.3	0.4	2.8	3.0	5.6	5.2	7.3	4.7	2.5	1.2	2.0	2.4
Surface Water Inflows	2.7	0.2	0.0	0.1	0.1	0.3	0.4	2.6	4.1	4.3	2.3	3.3	2.2
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.1	0.0	0.0	0.1	0.1	0.3	0.2	0.3	0.2	0.1	0.0	0.1	0.1
From Hamer (surface)	2.6	0.2	0.0	0.0	0.0	0.0	0.1	2.3	3.9	4.3	2.2	3.2	2.1
Subsurface Inflows	1.7	1.5	1.4	1.6	1.7	2.1	2.3	2.5	2.1	2.3	2.2	2.2	2.0
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	*-3.2*	*-4.9*	*-4.5*	*-3.5*	*-3.3*	*-1.6*	*-2.6*	*-3.5*	*-4.5*	*-5.8*	*-6.2*	*-4.6*	*-4.3*
Surface Water Outflows	-0.4	0.0	0.0	0.0	0.0	0.0	-0.1	-4.6	-3.1	-1.5	0.0	-0.4	-0.3
To Diversion Canal	-0.8	0.0	0.0	0.0	0.0	0.0	-0.3	-4.9	-3.5	-2.2	0.0	-0.8	-0.7
To West Edmond Marsh	-0.3	0.0	0.0	0.0	0.0	0.0	-0.1	-4.6	-3.0	-1.3	0.0	-0.3	-0.3
Change in Storage	-0.4	-7.4	-6.7	-1.4	0.5	5.9	5.2	4.3	2.7	0.6	-2.6	-0.7	-1.6
Predicted WSE in ft													
EM-2S	209.48	209.00	209.00	209.00	209.04	209.53	209.95	210.12	210.03	209.75	209.35	209.03	209.00
East Edmond	212.29	211.67	211.43	211.43	211.47	211.96	212.38	212.37	212.35	212.30	212.09	212.02	211.86
Eastern East Edmond Marsh	212.09	211.47	210.92	210.80	210.84	211.33	211.70	212.31	212.60	212.44	212.23	212.00	211.71
Observed WSE in ft													
EM-2S		210.83	210.33		210.25			211.47			211.31	211.27	211.13
East Edmond (EM-2E)		211.43	211.43		211.43	212.93		212.54			212.27	212.16	212.04
East Edmond (EM-2W)			210.76		210.69			211.77	212.14	212.14	211.70	211.69	211.51
East Edmond (EM-3E)					211.47	212.18		212.88	213.54	212.83	212.43		
East Edmond (EM-3W)			211.69		211.56	212.50		212.99	212.50	212.50	212.73	212.60	212.50
Eastern East Edmond (SCM-1)													

Table F-11. Water Balance for East Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water WY 2021

Hydrologic Process	Jul	Aug	Sep
Precipitation	0.0	0.3	2.6
Surface Water Inflows	0.0	0.0	0.1
From Sequalitchew Lake	0.0	0.0	0.0
From Center Drive	0.0	0.0	0.1
From Hamer (surface)	0.0	0.0	0.0
Subsurface Inflows	2.0	1.7	1.8
Evapotranspiration	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	*-4.1*	*-4.6*	*-4.1*
Surface Water Outflows	0.0	0.0	0.0
To Diversion Canal	0.0	0.0	0.0
To West Edmond Marsh	0.0	0.0	0.0
Change in Storage	-6.6	-6.6	-1.9
Predicted WSE in ft			
EM-2S	209.00	209.00	209.00
East Edmond	211.43	211.43	211.43
Eastern East Edmond Marsh	211.16	210.61	210.45
Observed WSE in ft			
EM-2S	210.73		
East Edmond (EM-2E)	211.69	211.43	
East Edmond (EM-2W)	211.14		
East Edmond (EM-3E)			
East Edmond (EM-3W)	212.23	211.56	
Eastern East Edmond (SCM-1)		210.20	

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water	WY2004						WY2005						
Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	2.0	1.0	3.8	0.9	0.1	3.6	2.9	4.0	3.2	4.3	4.3	0.6	4.5
Surface Water Inflows	8.8	0.0	0.7	0.8	0.6	0.1	0.0	0.1	1.4	2.0	5.1	0.0	0.9
From East Edmond	8.8	0.0	0.7	0.8	0.6	0.1	0.0	0.1	1.4	2.0	5.1	0.0	0.9
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	-5.9	-5.4	-9.0	-8.1	-8.9	-6.6	-0.6	-3.1	-3.6	0.6	2.4	-1.9	-6.1
Surface Water Outflows	0.0	-0.3	-0.3	-0.3	-0.2	-0.1	0.0	0.0	0.0	0.0	-0.1	-0.2	-0.2
To Center Drive	0.0	-0.3	-0.3	-0.3	-0.2	-0.1	0.0	0.0	0.0	0.0	-0.1	-0.2	-0.2
Change in Storage	3.6	-6.7	-7.9	-10.3	-13.0	-6.9	0.0	0.0	0.4	6.9	11.8	-2.1	-2.2
Predicted WSE in ft	209.04	208.48	207.82	206.96	205.88	205.31	205.31	205.31	205.34	205.92	206.90	206.73	206.54
Observed WSE EM-1/EM-1A	209.10	208.59	207.26	206.55	205.27	205.27	205.27	205.86	206.15	207.67	209.18	207.97	206.63

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2006

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	5.4	3.9	3.8	1.4	0.2	1.6	3.3	6.7	6.5	12.2	3.2	2.6	3.9
Surface Water Inflows	6.7	0.8	3.3	0.8	0.0	0.0	0.0	0.0	0.0	24.9	1.7	1.9	3.4
From East Edmond	6.7	0.8	3.3	0.8	0.0	0.0	0.0	0.0	0.0	24.9	1.7	1.9	3.4
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	0.5	-1.2	-6.2	-8.8	-7.2	0.7	-2.3	-2.4	0.8	-2.6	-4.8	-4.8	-4.9
Surface Water Outflows	-0.2	-0.2	-0.2	-0.2	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.3	-0.3
To Center Drive	-0.2	-0.2	-0.2	-0.2	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.3	-0.3
Change in Storage	10.5	0.1	-3.0	-11.4	-11.2	0.0	0.0	3.8	7.2	34.4	-0.8	-1.8	0.2
Predicted WSE in ft	207.42	207.43	207.18	206.23	205.31	205.31	205.31	205.63	206.23	209.09	209.03	208.88	208.90
Observed WSE EM-1/EM-1A	209.29	209.08	207.09	205.79	205.27	205.27	205.27	206.05	208.15	208.82	208.53	208.69	208.78

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water WY2007

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	2.1	2.2	0.4	0.0	0.8	1.6	14.4	8.6	6.5	4.5	5.7	1.7	1.1
Surface Water Inflows	0.8	0.6	0.0	0.4	0.1	0.0	131.8	13.3	14.0	4.4	13.2	3.3	0.7
From East Edmond	0.8	0.6	0.0	0.4	0.1	0.0	131.8	13.3	14.0	4.4	13.2	3.3	0.7
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	-3.7	-6.7	-10.4	-9.1	-1.9	-0.6	-4.5	-2.6	-5.7	-5.2	-5.2	-5.2	-6.4
Surface Water Outflows	-0.3	-0.3	-0.3	-0.2	-0.1	0.0	-94.6	-19.6	-14.9	-3.1	-12.5	-0.3	-0.3
To Center Drive	-0.3	-0.3	-0.3	-0.2	-0.1	0.0	-94.6	-19.6	-14.9	-3.1	-12.5	-0.3	-0.3
Change in Storage	-4.3	-7.9	-14.8	-12.8	-3.4	0.0	46.7	-0.3	0.0	0.0	0.0	-2.4	-8.0
Predicted WSE in ft	208.54	207.89	206.65	205.59	205.31	205.31	209.20	209.18	209.18	209.18	209.18	208.97	208.30
Observed WSE EM-1/EM-1A	207.56	207.10	205.67	205.27	205.27	205.27	208.74	208.94	208.71	208.75	208.84	208.70	207.84

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2008

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.7	1.5	1.0	1.7	5.0	2.8	7.7	4.2	3.6	4.9	1.8	1.3	1.7
Surface Water Inflows	0.6	0.8	0.8	0.6	30.7	4.5	16.8	8.4	6.8	6.7	4.3	0.7	0.6
From East Edmond	0.6	0.8	0.8	0.6	30.7	4.5	16.8	8.4	6.8	6.7	4.3	0.7	0.6
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	-7.8	-8.0	-7.0	-6.8	-6.8	-4.9	-4.7	-6.0	-6.0	-5.5	-5.9	-9.1	-9.0
Surface Water Outflows	-0.2	-0.3	-0.2	-0.1	0.0	-0.3	-3.6	-6.6	-3.9	-4.8	-0.3	-0.3	-0.2
To Center Drive	-0.2	-0.3	-0.2	-0.1	0.0	-0.3	-3.6	-6.6	-3.9	-4.8	-0.3	-0.3	-0.2
Change in Storage	-8.5	-10.4	-9.4	-6.9	27.8	1.7	16.2	0.0	0.0	0.0	-2.1	-10.6	-10.8
Predicted WSE in ft	207.59	206.72	205.94	205.37	207.68	207.83	209.18	209.18	209.18	209.18	209.00	208.12	207.22
Observed WSE EM-1/EM-1A	206.92	205.84	205.63	205.62	207.09	207.82	209.17	209.07	209.02	209.23	209.03	206.96	206.38

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water WY2009

Hydrologic Process	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Precipitation	0.9	2.1	0.5	2.6	8.3	5.2	7.3	1.6	5.3	3.5	3.4	1.3	0.0
Surface Water Inflows	0.6	0.3	1.0	0.4	32.2	6.4	8.8	4.2	4.0	3.6	1.9	0.8	0.0
From East Edmond	0.6	0.3	1.0	0.4	32.2	6.4	8.8	4.2	4.0	3.6	1.9	0.8	0.0
Evapotranspiration	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5
Recharge (-) Discharge (+)	-9.9	-8.4	0.8	-1.9	-4.7	-5.7	-6.7	-6.7	-4.1	-5.9	-7.2	-11.7	-15.2
Surface Water Outflows	-0.2	-0.1	0.0	0.0	0.0	-0.2	-4.1	-0.3	-2.2	-0.3	-0.3	-0.3	0.0
To Center Drive	-0.2	-0.1	0.0	0.0	0.0	-0.2	-4.1	-0.3	-2.2	-0.3	-0.3	-0.3	0.0
Change in Storage	-13.0	-10.0	0.0	0.0	35.4	5.6	5.4	-1.7	1.7	-1.1	-5.5	-13.6	-19.7
Predicted WSE in ft	206.14	205.31	205.31	205.31	208.26	208.73	209.18	209.03	209.18	209.08	208.63	207.50	205.86
Observed WSE EM-1/EM-1A	205.27	205.27		205.27	208.19	208.61	208.52	208.60	209.22	209.09	208.22	206.01	205.27

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water WY2010

Hydrologic Process	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Precipitation	1.9	2.8	5.6	8.9	3.0	8.0	3.3	3.3	3.3	4.6	4.3	0.4	0.2
Surface Water Inflows	0.6	0.7	0.7	77.1	2.5	11.5	9.4	0.6	6.0	4.2	3.3	0.0	0.7
From East Edmond	0.6	0.7	0.7	77.1	2.5	11.5	9.4	0.6	6.0	4.2	3.3	0.0	0.7
Evapotranspiration	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0
Recharge (-) Discharge (+)	-5.1	-1.1	-5.2	-4.4	-3.3	-5.3	-6.3	-6.6	-3.9	-8.6	-7.3	-11.5	-13.2
Surface Water Outflows	-0.1	0.0	0.0	-34.5	-2.4	-14.2	-5.8	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2
To Center Drive	-0.1	0.0	0.0	-34.5	-2.4	-14.2	-5.8	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2
Change in Storage	-6.7	0.0	0.0	46.7	-0.3	0.0	0.0	-4.2	3.3	-3.3	-3.7	-15.8	-16.5
Predicted WSE in ft	205.31	205.31	205.31	209.20	209.18	209.18	209.18	208.83	209.10	208.83	208.52	207.20	205.82
Observed WSE EM-1/EM-1A	205.27	205.27	205.98	209.21	209.55	208.68	208.58	208.34	209.17	207.87	207.82	206.07	206.07

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water WY2011

Hydrologic Process	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precipitation	4.0	4.2	6.6	7.2	6.1	3.1	7.2	5.7	4.8	2.8	0.8	0.3	1.3
Surface Water Inflows	0.5	1.0	20.0	1.2	8.8	6.1	5.5	8.1	1.3	1.0	0.0	0.0	0.0
From East Edmond	0.5	1.0	20.0	1.2	8.8	6.1	5.5	8.1	1.3	1.0	0.0	0.0	0.0
Evapotranspiration	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	-2.8	-4.1	0.1	-0.3	-7.1	-6.5	-7.2	-4.5	1.8	-3.4	-6.3	-8.4	-9.3
Surface Water Outflows	-0.1	-0.1	-0.1	-0.3	-0.5	-2.2	-4.3	-7.4	-4.7	-0.3	-0.3	-0.2	-0.2
To Center Drive	-0.1	-0.1	-0.1	-0.3	-0.5	-2.2	-4.3	-7.4	-4.7	-0.3	-0.3	-0.2	-0.2
Change in Storage	-0.8	-0.1	26.1	7.8	7.3	0.0	0.0	0.0	0.0	-3.6	-10.3	-12.4	-10.5
Predicted WSE in ft	205.76	205.75	207.92	208.57	209.18	209.18	209.18	209.18	209.18	208.88	208.01	206.98	206.11
Observed WSE EM-1/EM-1A	206.07	206.05	208.98	209.46	207.57		208.99	209.34	209.95		207.28	206.60	206.03

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water	WY2012												WY2013
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Precipitation	4.1	6.1	3.2	7.2	3.9	6.8	4.3	3.1	3.3	1.6	0.0	0.1	6.5
Surface Water Inflows	0.0	10.2	6.2	18.5	5.6	7.5	7.2	1.2	0.9	0.9	1.1	0.0	0.7
From East Edmond	0.0	10.2	6.2	18.5	5.6	7.5	7.2	1.2	0.9	0.9	1.1	0.0	0.7
Evapotranspiration	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0
Recharge (-) Discharge (+)	-6.7	-5.2	-2.6	-6.6	-4.7	-7.3	-7.7	-6.1	-5.9	-7.7	-8.6	-9.7	-8.0
Surface Water Outflows	-0.1	-0.1	-0.2	-0.2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.1	-0.1
To Center Drive	-0.1	-0.1	-0.2	-0.2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.1	-0.1
Change in Storage	-3.8	10.6	6.7	18.8	3.9	5.5	1.5	-5.3	-5.7	-10.0	-11.9	-12.0	-2.0
Predicted WSE in ft	205.79	206.68	207.23	208.80	209.13	209.59	209.71	209.26	208.79	207.95	206.96	205.96	205.80
Observed WSE EM-1/EM-1A	206.28	206.94	207.83	209.23	209.32	209.55	209.78	209.52	209.14		206.36	205.73	206.56

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water : WY2014

Hydrologic Process	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Precipitation	6.5	7.6	3.5	1.7	3.7	5.5	4.4	1.9	0.0	1.6	6.9	2.6	4.1
Surface Water Inflows	11.4	19.9	7.2	2.9	3.9	5.0	1.8	0.9	0.0	1.0	0.9	1.1	10.3
From East Edmond	11.4	19.9	7.2	2.9	3.9	5.0	1.8	0.9	0.0	1.0	0.9	1.1	10.3
Evapotranspiration	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5
Recharge (-) Discharge (+)	-4.0	-7.1	-6.4	-3.8	-4.7	-1.6	-9.1	-8.4	-11.3	-10.7	-2.7	3.7	-1.6
Surface Water Outflows	-0.1	-0.2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	0.0	-0.2	-0.1	-0.1	-0.2
To Center Drive	-0.1	-0.2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	0.0	-0.2	-0.1	-0.1	-0.2
Change in Storage	13.4	20.2	4.0	0.0	1.4	6.6	-6.4	-9.5	-15.8	-12.3	2.6	6.2	12.1
Predicted WSE in ft	206.91	208.60	208.93	208.93	209.05	209.60	209.06	208.27	206.95	205.93	206.15	206.67	207.68
Observed WSE EM-1/EM-1A	208.21	209.83	209.07	209.27	209.37	209.44	208.41	207.37	205.95	206.06	206.17	208.73	208.72

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2015

Hydrologic Process	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation	2.4	4.2	6.9	9.8	4.5	3.3	1.3	1.2	1.6	1.8	5.9	6.1	4.8
Surface Water Inflows	3.2	7.3	11.0	12.7	10.7	1.0	1.1	0.9	1.0	0.9	4.0	11.5	9.1
From East Edmond	3.2	7.3	11.0	12.7	10.7	1.0	1.1	0.9	1.0	0.9	4.0	11.5	9.1
Evapotranspiration	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0
Recharge (-) Discharge (+)	-1.3	-2.6	-4.7	-5.0	-5.2	-4.6	-6.1	-10.5	-9.4	-3.8	-2.2	-0.1	-4.0
Surface Water Outflows	-0.3	-0.2	-0.7	-16.3	-8.1	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.3
To Center Drive	-0.3	-0.2	-0.7	-16.3	-8.1	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.3
Change in Storage	4.0	8.6	12.0	-0.1	0.0	-3.8	-7.7	-13.2	-11.1	-3.6	6.5	16.8	9.6
Predicted WSE in ft	208.01	208.73	209.73	209.72	209.72	209.41	208.77	207.67	206.75	206.45	206.99	208.39	209.19
Observed WSE EM-1/EM-1A	207.55	208.55	209.72	209.98	210.01	209.99	209.05	205.30	205.87	206.07	208.63	208.73	209.84

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2016

Hydrologic Process	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Precipitation	4.1	4.7	4.4	2.1	0.8	0.4	0.2	2.2	1.3	5.0	7.1	12.0	6.9
Surface Water Inflows	8.0	8.4	6.4	1.7	0.0	0.0	0.0	0.9	1.3	0.8	10.2	26.7	10.5
From East Edmond	8.0	8.4	6.4	1.7	0.0	0.0	0.0	0.9	1.3	0.8	10.2	26.7	10.5
Evapotranspiration	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0
Recharge (-) Discharge (+)	-6.4	-6.4	-7.3	-6.4	-9.7	-12.1	-10.1	-4.6	-0.2	-4.8	3.1	-5.8	-8.0
Surface Water Outflows	-0.3	-5.2	-2.2	-0.3	-0.3	-0.2	-0.2	-0.1	0.0	0.0	0.0	-26.8	-2.8
To Center Drive	-0.3	-5.2	-2.2	-0.3	-0.3	-0.2	-0.2	-0.1	0.0	0.0	0.0	-26.8	-2.8
Change in Storage	5.4	1.0	0.0	-4.8	-12.3	-15.6	-14.6	-5.7	0.0	0.0	20.0	6.1	6.6
Predicted WSE in ft	209.64	209.73	209.72	209.32	208.29	206.99	205.77	205.31	205.31	205.31	206.98	209.70	209.73
Observed WSE EM-1/EM-1A	209.79	209.76	209.74	209.48	207.29	205.54	205.27	205.27	205.27	205.27	209.37	210.02	

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2017

Hydrologic Process	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Precipitation	5.8	5.9	1.8	1.0	2.3	1.3	0.2	1.5	9.3	6.9	3.9	3.4	8.6
Surface Water Inflows	5.7	6.0	1.7	1.0	0.7	0.7	0.7	0.4	25.2	11.3	9.5	7.2	8.9
From East Edmond	5.7	6.0	1.7	1.0	0.7	0.7	0.7	0.4	25.2	11.3	9.5	7.2	8.9
Evapotranspiration	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6
Recharge (-) Discharge (+)	-7.2	-7.5	-3.1	-5.6	-4.3	-9.4	-8.7	-5.7	-15.6	1.1	-3.1	-5.1	-0.4
Surface Water Outflows	-0.3	-0.3	-0.2	-0.3	-0.3	-0.3	-0.2	-0.1	-0.3	0.0	-0.3	-0.3	-9.9
To Center Drive	-0.3	-0.3	-0.2	-0.3	-0.3	-0.3	-0.2	-0.1	-0.3	0.0	-0.3	-0.3	-9.9
Change in Storage	3.5	2.8	-1.9	-7.1	-5.3	-12.2	-12.0	-6.2	17.5	18.7	10.1	5.3	6.6
Predicted WSE in ft	209.47	209.41	208.68	208.51	208.39	207.50	206.20	205.31	207.22	207.31	208.76	209.02	209.73
Observed WSE EM-1/EM-1A					208.90	206.26	205.31		206.87	208.72	209.45	209.29	209.86

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2018

Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	8.7	4.6	2.8	1.8	0.0	0.1	1.0	5.2	7.2	5.8	7.2	3.3	2.3
Surface Water Inflows	16.8	4.7	1.4	0.8	0.0	0.6	0.3	0.3	8.1	13.1	10.0	12.2	0.8
From East Edmond	16.8	4.7	1.4	0.8	0.0	0.6	0.3	0.3	8.1	13.1	10.0	12.2	0.8
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	0.1	0.6	-1.4	-4.3	-7.7	-8.4	-8.8	-8.2	-0.5	3.1	0.2	-5.3	-4.2
Surface Water Outflows	-17.8	-1.4	-0.3	-0.3	0.0	-0.3	-0.2	-0.1	-0.1	-0.2	-0.2	-0.3	-0.3
To Center Drive	-17.8	-1.4	-0.3	-0.3	0.0	-0.3	-0.2	-0.1	-0.1	-0.2	-0.2	-0.3	-0.3
Change in Storage	6.6	6.6	-0.7	-5.7	-12.2	-12.0	-10.0	-3.8	14.2	21.8	17.3	9.3	-2.6
Predicted WSE in ft	209.73	209.73	209.12	208.70	207.86	207.01	206.15	205.79	206.97	208.49	208.67	209.58	208.91
Observed WSE EM-1/EM-1A	210.22	208.64		209.58	207.22	206.67	205.31			209.98		209.98	209.67

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2019

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	6.1	0.7	0.9	0.2	0.3	1.8	4.0	3.8	6.4	3.4	4.8	1.6	3.6
Surface Water Inflows	6.3	0.0	0.0	0.0	0.0	0.3	0.2	0.7	0.8	3.2	6.8	0.8	1.0
From East Edmond	6.3	0.0	0.0	0.0	0.0	0.3	0.2	0.7	0.8	3.2	6.8	0.8	1.0
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	-6.0	-8.7	-11.9	-13.0	-13.5	-11.6	-9.8	-2.2	1.6	-1.6	-1.6	-6.4	-6.2
Surface Water Outflows	-2.8	-0.3	-0.3	-0.2	-0.3	-0.2	-0.1	-0.3	-0.3	-0.4	-0.3	-0.3	-0.3
To Center Drive	-2.8	-0.3	-0.3	-0.2	-0.3	-0.2	-0.1	-0.3	-0.3	-0.4	-0.3	-0.3	-0.3
Change in Storage	1.6	-11.5	-15.0	-17.5	-17.5	-12.1	-6.8	1.5	8.5	4.6	9.1	-5.5	-3.9
Predicted WSE in ft	209.72	208.75	208.02	207.33	206.50	205.96	205.40	205.92	207.62	208.98	209.69	208.47	208.72
Observed WSE EM-1/EM-1A	209.97	208.18	205.31	205.31	205.31	205.31	205.31	206.55	209.32	209.38	209.41	208.53	208.79

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2020

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	1.1	0.7	1.0	0.8	3.5	3.9	1.7	6.5	9.6	4.2	3.5	1.5	3.1
Surface Water Inflows	0.0	0.0	0.4	0.0	0.0	0.0	0.0	4.7	21.8	5.1	6.0	2.5	0.8
From East Edmond	0.0	0.0	0.4	0.0	0.0	0.0	0.0	4.7	21.8	5.1	6.0	2.5	0.8
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	-11.9	-14.7	-16.0	-13.0	-4.5	-6.8	-7.1	-10.5	-4.3	-1.8	-8.7	-6.1	-8.2
Surface Water Outflows	-0.4	-0.3	-0.3	-0.2	-0.1	-0.2	-0.3	-0.3	-6.6	-0.2	-0.3	-0.3	-0.3
To Center Drive	-0.4	-0.3	-0.3	-0.2	-0.1	-0.2	-0.3	-0.3	-6.6	-0.2	-0.3	-0.3	-0.3
Change in Storage	-14.4	-18.0	-19.4	-16.3	-3.5	-4.1	-6.2	0.4	20.5	6.8	-0.8	-4.3	-7.7
Predicted WSE in ft	208.40	207.56	206.65	205.59	205.64	205.80	206.15	207.71	209.72	209.29	209.67	209.37	209.08
Observed WSE EM-1/EM-1A		205.31	205.31	205.31	205.31	205.31		206.97	209.81	209.35			

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water — WY2021

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.5	0.3	0.4	2.8	3.0	5.6	5.2	7.3	4.7	2.5	1.2	2.0	2.4
Surface Water Inflows	0.7	0.0	0.0	0.0	0.0	0.0	0.4	11.6	6.7	2.9	0.0	0.7	0.6
From East Edmond	0.7	0.0	0.0	0.0	0.0	0.0	0.4	11.6	6.7	2.9	0.0	0.7	0.6
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	-10.6	-15.8	-14.9	-10.0	-9.4	-1.6	-4.3	-6.6	-8.0	-7.6	-6.8	-13.4	-12.0
Surface Water Outflows	-0.3	-0.3	-0.3	-0.2	-0.2	-0.3	-0.4	-5.8	-1.9	-0.3	-0.3	-0.3	-0.2
To Center Drive	-0.3	-0.3	-0.3	-0.2	-0.2	-0.3	-0.4	-5.8	-1.9	-0.3	-0.3	-0.3	-0.2
Change in Storage	-11.4	-20.3	-18.8	-9.8	-7.7	3.1	1.0	6.4	1.0	-3.7	-7.9	-14.2	-12.8
Predicted WSE in ft	208.46	207.08	206.11	205.93	205.81	207.25	208.47	209.72	209.73	209.42	209.06	208.14	207.22
Observed WSE EM-1/EM-1A			205.31		205.31	206.87		209.40	209.72	209.15	208.13	205.31	205.31

Table F-12. Water Balance for West Edmond Marsh - Existing Conditions

Monthly Average in Inches of Water WY2021

Hydrologic Process	Jul	Aug	Sep
Precipitation	0.0	0.3	2.6
Surface Water Inflows	0.0	0.0	0.0
From East Edmond	0.0	0.0	0.0
Evapotranspiration	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	-10.7	-1.3	-0.7
Surface Water Outflows	0.0	-0.1	0.0
To Center Drive	0.0	-0.1	0.0
Change in Storage	-15.1	-5.1	-0.5
Predicted WSE in ft	205.73	205.35	205.31
Observed WSE EM-1/EM-1A	205.31	206.87	

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water	WY2004					WY2005							
Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	2.0	1.0	3.8	0.9	0.1	3.6	2.9	4.0	3.2	4.3	4.3	0.6	4.5
Surface Water Inflows	6.3	1.5	17.8	1.6	0.0	19.4	13.9	22.2	13.7	21.1	21.1	0.3	22.5
Runoff from Ft. Lewis - Outfall 002	3.8	0.8	10.9	0.8	0.0	11.9	8.5	13.6	8.4	12.9	13.0	0.0	13.8
Runoff from Ft. Lewis - Outfall 003	2.5	0.7	6.9	0.8	0.0	7.5	5.4	8.6	5.3	8.1	8.1	0.3	8.7
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	-2.5	-2.6	-3.1	-3.4	-3.2	-3.5	-2.0	-2.0	-2.4	-2.1	-1.4	-3.6	-5.4
Surface Water Outflows	-5.9	-2.4	-13.7	-1.9	-0.1	-14.8	-10.5	-17.1	-10.3	-16.4	-16.4	-0.9	-17.6
To Diversion Canal	-4.8	-1.5	-13.7	-1.9	-0.1	-14.8	-10.5	-17.1	-10.3	-16.4	-16.4	-0.6	-17.6
To Seq. Ck. Marsh (surface)	-1.1	-0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	0.0
Subsurface Outflows	-1.3	-1.0	-1.3	-1.0	-0.8	-1.1	-1.1	-1.3	-1.1	-1.3	-1.6	-0.9	-1.2
Change in Storage	-2.7	-5.5	0.4	-7.5	-8.6	-0.3	0.9	4.8	2.5	5.6	6.0	-5.1	1.5
Predicted WSE in feet													
Bell	218.34	217.88	217.91	217.28	216.57	216.54	216.62	217.02	217.22	217.69	218.19	217.77	217.89
McKay	216.19	215.73	215.76	215.13	214.42	214.39	214.47	214.87	215.07	215.54	216.04	215.62	215.74
Hamer	214.41	213.95	213.98	213.35	212.64	212.61	212.69	213.09	213.29	213.76	214.26	213.84	213.96
Observed WSE ('04) in feet													
Bell						216.36	217.40	217.36	217.72	218.30	219.11	217.92	216.95
McKay	216.19	215.81	214.71	214.26				213.70	213.84	214.35	215.15	214.68	213.74
Hamer	214.41	214.17	213.61	213.34	212.76	211.93	212.68	212.95	213.27	213.50	213.93	213.69	213.28

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2006

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	5.4	3.9	3.8	1.4	0.2	1.6	3.3	6.7	6.5	12.2	3.2	2.6	3.9
Surface Water Inflows	28.7	16.4	15.5	3.2	0.0	6.0	25.4	69.0	42.9	100.4	10.5	8.7	16.1
Runoff from Ft. Lewis - Outfall 002	17.6	10.1	9.5	1.9	0.0	3.6	15.6	42.2	26.2	60.5	6.5	5.3	9.9
Runoff from Ft. Lewis - Outfall 003	11.1	6.3	6.0	1.4	0.0	2.4	9.8	26.8	16.7	39.9	4.1	3.4	6.2
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	-2.1	-2.1	-3.3	-4.5	-12.0	-9.6	-6.7	1.3	-1.1	0.0	-2.8	-2.3	-2.6
Surface Water Outflows	-23.1	-13.6	-12.9	-3.4	-0.2	-4.9	-19.2	-57.8	-35.7	-95.2	-10.4	-8.9	-14.1
To Diversion Canal	-23.1	-12.6	-11.9	-2.8	-0.2	-4.9	-19.2	-57.8	-35.7	-95.2	-7.9	-6.5	-12.4
To Seq. Ck. Marsh (surface)	0.0	-1.1	-1.0	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	-2.4	-2.4	-1.7
Subsurface Outflows	-1.6	-1.5	-1.3	-1.0	-0.4	-0.3	-0.8	-2.3	-1.7	-2.2	-1.3	-1.4	-1.4
Change in Storage	5.3	-0.2	-1.9	-8.8	-16.3	-9.5	1.0	16.5	10.8	15.2	-1.4	-2.6	-0.1
Predicted WSE in feet													
Bell	218.34	218.32	218.17	217.43	216.07	215.28	215.36	216.74	217.64	218.90	218.79	218.57	218.56
McKay	216.19	216.17	216.02	215.28	213.92	213.57	213.65	215.02	215.92	217.19	217.07	216.85	216.85
Hamer	214.41	214.39	214.24	213.50	212.14	211.35	211.43	212.81	213.71	214.97	214.86	214.64	214.63
Observed WSE ('04) in feet													
Bell			218.33	217.05	215.63			218.25	217.95				
McKay	216.07	215.43	214.48	213.57				214.39	214.34	216.95	216.28	216.60	216.49
Hamer	214.26	214.05	213.69	213.13	212.13	211.67	211.69	213.20	213.27	214.09	213.65	214.13	214.14

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water	WY2007												
Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	2.1	2.2	0.4	0.0	0.8	1.6	14.4	8.6	6.5	4.5	5.7	1.7	1.1
Surface Water Inflows	6.7	6.8	0.0	0.0	1.1	5.9	153.8	58.3	33.0	16.8	26.1	4.3	2.2
Runoff from Ft. Lewis - Outfall 002	4.1	4.1	0.0	0.0	0.5	3.5	92.3	35.4	20.2	10.3	16.0	2.6	1.2
Runoff from Ft. Lewis - Outfall 003	2.6	2.7	0.0	0.0	0.6	2.4	61.5	22.8	12.8	6.5	10.1	1.7	1.0
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	-0.5	-1.4	-1.9	-2.5	-2.9	-4.1	5.9	1.8	-0.5	-1.2	-0.6	-2.1	-1.8
Surface Water Outflows	-6.9	-6.0	-0.4	0.0	-1.7	-4.8	-150.9	-51.3	-35.3	-17.9	-28.0	-6.0	-3.3
To Diversion Canal	-5.1	-5.2	-0.4	0.0	-1.7	-4.8	-150.9	-51.3	-32.5	-15.2	-24.9	-3.2	-1.7
To Seq. Ck. Marsh (surface)	-1.8	-0.9	0.0	0.0	0.0	0.0	0.0	0.0	-2.8	-2.8	-3.1	-2.8	-1.5
Subsurface Outflows	-1.6	-1.3	-1.2	-1.0	-0.8	-0.7	-2.2	-2.4	-2.0	-1.6	-1.9	-1.5	-1.5
Change in Storage	-3.4	-3.5	-7.6	-7.5	-5.9	-3.0	20.5	14.9	1.7	0.0	0.0	-5.6	-6.5
Predicted WSE in feet													
Bell	218.28	217.99	217.35	216.73	216.24	215.99	217.70	218.94	219.08	219.08	219.08	218.62	218.08
McKay	216.57	216.27	215.64	215.02	214.52	214.27	215.98	217.22	217.37	217.37	217.37	216.90	216.36
Hamer	214.35	214.06	213.42	212.80	212.31	212.06	213.77	215.01	215.15	215.15	215.15	214.69	214.15
Observed WSE ('04) in feet													
Bell			218.46	217.75	217.19	216.57							
McKay	216.06	216.27	214.34	213.60			216.87	217.29	217.02	216.97	216.90	217.35	216.64
Hamer	214.89	214.08	213.26	212.65	212.31	212.19	214.53	215.05	214.60	214.64	214.72	214.14	214.21

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2008

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.7	1.5	1.0	1.7	5.0	2.8	7.7	4.2	3.6	4.9	1.8	1.3	1.7
Surface Water Inflows	9.1	4.3	2.1	5.8	29.4	11.0	49.4	18.6	12.9	22.0	4.5	2.8	4.4
Runoff from Ft. Lewis - Outfall 002	5.6	2.5	1.1	3.5	18.0	6.7	30.1	11.4	7.9	13.5	2.7	1.6	2.6
Runoff from Ft. Lewis - Outfall 003	3.5	1.7	1.0	2.3	11.4	4.3	19.3	7.2	5.0	8.5	1.8	1.2	1.8
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	-2.3	-1.7	-1.8	-1.0	-0.5	-1.5	0.2	-1.6	-2.3	-2.4	-2.6	-1.1	-2.8
Surface Water Outflows	-7.1	-3.5	-2.2	-4.6	-23.4	-8.3	-42.6	-16.5	-12.3	-20.1	-6.3	-4.0	-3.6
To Diversion Canal	-6.9	-3.5	-2.2	-4.6	-23.4	-8.3	-42.6	-14.4	-9.8	-17.4	-3.5	-2.5	-3.5
To Seq. Ck. Marsh (surface)	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	-2.1	-2.4	-2.7	-2.8	-1.6	-0.1
Subsurface Outflows	-1.4	-1.3	-1.1	-1.2	-1.5	-1.4	-2.2	-1.8	-1.6	-1.8	-1.4	-1.6	-1.2
Change in Storage	-2.7	-5.2	-6.0	-1.7	7.9	2.2	12.5	2.9	-0.2	1.4	-6.1	-5.8	-5.3
Predicted WSE in feet													
Bell	217.85	217.42	216.92	216.78	217.44	217.62	218.67	218.91	218.90	219.01	218.51	218.02	217.58
McKay	216.14	215.70	215.20	215.06	215.73	215.91	216.95	217.19	217.18	217.30	216.79	216.31	215.86
Hamer	213.92	213.49	212.99	212.85	213.51	213.69	214.74	214.98	214.97	215.08	214.58	214.09	213.65
Observed WSE ('04) in feet													
Bell				218.18									
McKay	216.01	214.98	214.26	213.68	215.97	214.67	216.83	216.83	216.91	216.98	215.93	215.06	214.63
Hamer	213.85	213.68	213.29	213.04	213.88	213.81	214.52	214.47	214.43	214.52	214.23	214.75	213.55

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water WY2009

Hydrologic Process	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Precipitation	0.9	2.1	0.5	2.6	8.3	5.2	7.3	1.6	5.3	3.5	3.4	1.3	0.0
Surface Water Inflows	1.5	8.3	0.2	11.8	64.3	27.5	41.4	3.6	25.4	12.9	13.2	3.0	0.0
Runoff from Ft. Lewis - Outfall 002	0.8	5.0	0.0	7.2	39.1	16.9	25.3	2.1	15.6	7.9	8.1	1.7	0.0
Runoff from Ft. Lewis - Outfall 003	0.8	3.3	0.2	4.6	25.2	10.6	16.1	1.5	9.8	5.0	5.1	1.3	0.0
Evapotranspiration	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5
Recharge (-) Discharge (+)	-3.0	-3.1	-2.5	-3.0	2.6	-1.2	-1.7	-3.0	-2.3	-2.9	-2.2	-3.0	-4.6
Surface Water Outflows	-1.9	-6.3	-0.7	-8.9	-56.3	-22.0	-36.0	-5.2	-22.0	-12.1	-12.0	-4.0	0.0
To Diversion Canal	-1.9	-6.3	-0.7	-8.9	-56.3	-22.0	-35.3	-2.8	-20.3	-9.8	-10.0	-2.7	0.0
To Seq. Ck. Marsh (surface)	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	-2.4	-1.7	-2.3	-2.0	-1.3	0.0
Subsurface Outflows	-1.1	-1.0	-0.8	-0.8	-1.8	-1.7	-1.9	-1.4	-1.8	-1.5	-1.6	-1.2	-0.9
Change in Storage	-8.1	-4.0	-5.6	0.7	16.6	7.8	9.1	-5.0	3.2	-2.1	-2.4	-7.6	-10.0
Predicted WSE in feet													
Bell	216.91	216.57	216.11	216.16	217.55	218.20	218.95	218.54	218.81	218.63	218.44	217.80	216.97
McKay	215.19	214.86	214.39	214.45	215.83	216.48	217.24	216.83	217.09	216.92	216.72	216.09	215.25
Hamer	212.98	212.64	212.18	212.23	213.62	214.27	215.02	214.61	214.88	214.70	214.51	213.87	213.04
Observed WSE ('04) in feet													
Bell													
McKay					216.11	214.61	216.38	215.34	216.31	215.69	215.73	214.44	
Hamer	212.98	212.63	212.51	212.39	214.37	213.94	214.42	214.08	214.34	214.18	214.24	213.49	212.68

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water WY2010

Hydrologic Process	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Precipitation	1.9	2.8	5.6	8.9	3.0	8.0	3.3	3.3	3.3	4.6	4.3	0.4	0.2
Surface Water Inflows	6.3	12.9	36.8	60.0	11.0	47.2	10.7	12.0	12.2	20.0	17.5	0.0	0.0
Runoff from Ft. Lewis - Outfall 002	3.8	7.9	22.6	36.5	6.7	28.8	6.6	7.4	7.5	12.3	10.7	0.0	0.0
Runoff from Ft. Lewis - Outfall 003	2.5	5.0	14.2	23.6	4.3	18.5	4.1	4.6	4.7	7.7	6.7	0.0	0.0
Evapotranspiration	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0
Recharge (-) Discharge (+)	-3.6	-3.1	-2.1	0.5	-1.2	-0.1	-1.7	-1.2	-1.0	-1.7	-1.6	-3.5	-3.5
Surface Water Outflows	-4.9	-9.7	-29.8	-53.4	-9.3	-45.7	-10.9	-12.0	-11.9	-18.2	-15.9	-0.4	-0.2
To Diversion Canal	-4.9	-9.7	-29.8	-53.4	-8.3	-44.2	-8.1	-9.1	-9.3	-15.7	-13.6	-0.1	-0.2
To Seq. Ck. Marsh (surface)	0.0	0.0	0.0	0.0	-1.0	-1.5	-2.8	-2.9	-2.7	-2.5	-2.4	-0.3	0.0
Subsurface Outflows	-0.9	-1.0	-1.4	-1.9	-1.7	-2.1	-1.8	-1.8	-1.8	-1.8	-1.7	-1.3	-1.1
Change in Storage	-5.1	-0.5	8.0	13.7	1.8	7.4	-0.9	-0.9	-1.1	-0.2	-1.2	-9.3	-8.5
Predicted WSE in feet													
Bell	216.54	216.50	217.17	218.31	218.46	219.08	219.01	218.93	218.84	218.82	218.73	217.95	217.24
McKay	214.83	214.79	215.46	216.60	216.75	217.37	217.29	217.21	217.12	217.11	217.01	216.23	215.52
Hamer	212.61	212.57	213.24	214.38	214.53	215.15	215.08	215.00	214.91	214.89	214.80	214.02	213.31
Observed WSE ('04) in feet													
Bell													
McKay				216.08	215.95	216.60	216.40	216.04	216.36	216.01	215.95	214.27	214.28
Hamer	212.35	212.48	213.05	214.46	214.53	214.80	214.56	214.47	214.59	214.32	214.44	213.62	213.02

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water	WY2011												
Hydrologic Process	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precipitation	4.0	4.2	6.6	7.2	6.1	3.1	7.2	5.7	4.8	2.8	0.8	0.3	1.3
Surface Water Inflows	18.2	20.0	36.4	40.0	28.8	9.7	37.6	25.4	20.0	8.9	0.9	0.0	3.2
Runoff from Ft. Lewis - Outfall 002	11.2	12.3	22.2	24.4	17.6	6.0	23.0	15.5	12.3	5.4	0.4	0.0	1.8
Runoff from Ft. Lewis - Outfall 003	7.0	7.7	14.1	15.6	11.2	3.8	14.7	9.8	7.7	3.5	0.5	0.0	1.3
Evapotranspiration	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	-1.5	-2.6	-0.6	-1.4	-0.9	-1.5	-0.6	-2.5	-1.8	-1.8	-0.5	-0.5	-1.1
Surface Water Outflows	-14.0	-15.5	-30.4	-37.9	-32.5	-10.1	-40.9	-25.2	-18.8	-9.6	-1.7	-0.3	-2.8
To Diversion Canal	-14.0	-15.5	-30.4	-36.1	-29.4	-7.3	-37.9	-22.3	-15.8	-6.7	-0.7	-0.2	-2.8
To Seq. Ck. Marsh (surface)	0.0	0.0	0.0	-1.8	-3.1	-2.8	-2.9	-3.0	-3.1	-2.9	-1.0	0.0	0.0
Subsurface Outflows	-1.4	-1.5	-1.9	-1.8	-1.5	-1.3	-1.5	-1.4	-1.5	-1.3	-2.7	-2.0	-1.6
Change in Storage	2.9	3.6	9.5	6.0	0.0	-0.6	0.6	0.0	-0.5	-4.7	-7.7	-6.5	-3.5
Predicted WSE in feet													
Bell	217.48	217.78	218.58	219.08	219.08	219.03	219.08	219.08	219.04	218.65	218.00	217.47	217.18
McKay	215.77	216.07	216.86	217.37	217.37	217.31	217.37	217.37	217.33	216.93	216.29	215.75	215.46
Hamer	213.55	213.85	214.65	215.15	215.15	215.10	215.15	215.15	215.11	214.72	214.07	213.54	213.25
Observed WSE ('04) in feet													
Bell													
McKay	214.29	215.23	216.18	216.90	217.01	217.07	217.13						
Hamer	213.60	213.51	214.64	214.45	214.30	214.29	214.28	214.31	214.72	214.68	214.63	214.01	213.35

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water	WY2012												WY2013
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Precipitation	4.1	6.1	3.2	7.2	3.9	6.8	4.3	3.1	3.3	1.6	0.0	0.1	6.5
Surface Water Inflows	19.3	34.1	12.6	40.0	13.4	33.5	16.5	10.7	11.8	4.3	0.0	0.0	38.6
Runoff from Ft. Lewis - Outfall 002	11.9	20.8	7.7	24.4	8.2	20.5	10.1	6.5	7.3	2.5	0.0	0.0	23.6
Runoff from Ft. Lewis - Outfall 003	7.4	13.2	4.9	15.6	5.2	13.0	6.4	4.1	4.6	1.7	0.0	0.0	15.0
Evapotranspiration	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0
Recharge (-) Discharge (+)	-1.5	-1.8	-2.4	-1.0	-2.1	-0.7	-2.4	-1.3	-1.5	-0.8	-0.7	-1.8	-0.9
Surface Water Outflows	-14.9	-28.1	-10.2	-35.3	-13.2	-36.8	-15.8	-11.0	-11.2	-5.2	0.0	-0.1	-32.2
To Diversion Canal	-14.9	-28.1	-9.5	-34.2	-10.4	-33.7	-12.8	-8.0	-9.0	-3.5	0.0	-0.1	-32.2
To Seq. Ck. Marsh (surface)	0.0	0.0	-0.7	-1.1	-2.8	-3.1	-3.0	-2.9	-2.2	-1.7	0.0	0.0	0.0
Subsurface Outflows	-1.6	-1.8	-1.6	-2.0	-1.4	-1.5	-1.3	-1.4	-1.4	-1.4	-1.3	-1.1	-1.6
Change in Storage	4.3	8.1	1.7	8.8	0.0	0.0	-0.7	-3.1	-2.6	-6.0	-6.0	-5.3	9.5
Predicted WSE in feet													
Bell	217.54	218.21	218.35	219.08	219.08	219.08	219.02	218.76	218.54	218.04	217.54	217.10	217.89
McKay	215.82	216.50	216.63	217.37	217.37	217.37	217.31	217.04	216.83	216.33	215.83	215.39	216.18
Hamer	213.61	214.28	214.42	215.15	215.15	215.15	215.09	214.83	214.61	214.11	213.61	213.17	213.96
Observed WSE ('04) in feet													
Bell					219.68	219.77	219.87	219.91	219.77	219.42	219.07	218.23	218.84
McKay	214.03	214.15	214.78	215.42	215.25	215.08	214.91	214.89	215.43	215.18	214.93	213.70	214.59
Hamer	213.44	213.63	214.25	215.05	214.90	215.03	215.15	215.00	214.78	214.40	214.02	213.24	213.96

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2014

Hydrologic Process	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Precipitation	6.5	7.6	3.5	1.7	3.7	5.5	4.4	1.9	0.0	1.6	6.9	2.6	4.1
Surface Water Inflows	35.4	44.0	12.7	3.9	14.5	24.8	18.5	5.2	0.0	4.8	40.5	9.5	17.3
Runoff from Ft. Lewis - Outfall 002	21.6	26.8	7.8	2.4	8.9	15.2	11.4	3.1	0.0	2.8	24.7	5.8	10.6
Runoff from Ft. Lewis - Outfall 003	13.7	17.2	4.9	1.6	5.6	9.6	7.1	2.1	0.0	1.9	15.8	3.7	6.7
Evapotranspiration	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5
Recharge (-) Discharge (+)	-0.8	0.7	-1.3	-2.2	-1.5	-3.8	-3.2	-2.3	-1.9	-3.2	-0.7	0.4	-0.3
Surface Water Outflows	-29.5	-45.4	-12.7	-5.7	-13.5	-22.5	-17.1	-6.2	0.0	-3.9	-34.1	-7.1	-13.6
To Diversion Canal	-29.5	-43.3	-9.7	-3.0	-11.1	-20.0	-14.4	-4.1	0.0	-3.9	-34.1	-7.1	-13.4
To Seq. Ck. Marsh (surface)	0.0	-2.1	-3.1	-2.7	-2.4	-2.4	-2.7	-2.2	0.0	0.0	0.0	0.0	-0.2
Subsurface Outflows	-1.9	-1.9	-1.6	-1.2	-1.5	-1.3	-1.3	-1.2	-1.2	-1.0	-1.5	-1.6	-1.6
Change in Storage	9.2	5.0	0.6	-3.9	0.5	0.8	-2.0	-6.3	-7.5	-5.8	8.8	2.6	5.3
Predicted WSE in feet													
Bell	218.66	219.08	219.13	218.81	218.85	218.91	218.75	218.23	217.60	217.12	217.85	218.07	218.52
McKay	216.95	217.37	217.42	217.09	217.13	217.20	217.04	216.51	215.89	215.41	216.14	216.36	216.80
Hamer	214.73	215.15	215.20	214.88	214.92	214.98	214.82	214.30	213.67	213.19	213.92	214.14	214.59
Observed WSE ('04) in feet													
Bell	219.44	219.62	219.81	219.57	219.35	219.49	219.46	219.25	218.80	218.09	219.27	219.36	219.48
McKay	215.49	215.65	215.47	215.46	215.49	215.57	215.97	216.22	214.67	213.77	214.98	216.08	216.03
Hamer	214.68	214.86	215.05	214.97	215.11	215.07	214.61	214.57	213.93	213.35	214.07	214.78	214.76

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2015

Hydrologic Process	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation	2.4	4.2	6.9	9.8	4.5	3.3	1.3	1.2	1.6	1.8	5.9	6.1	4.8
Surface Water Inflows	8.0	18.1	34.5	58.6	17.9	11.8	2.5	2.5	4.2	5.5	31.7	30.4	20.8
Runoff from Ft. Lewis - Outfall 002	4.9	11.1	21.0	35.5	11.0	7.2	1.4	1.4	2.5	3.3	19.4	18.6	12.7
Runoff from Ft. Lewis - Outfall 003	3.1	7.0	13.4	23.1	6.9	4.5	1.1	1.1	1.7	2.2	12.3	11.8	8.0
Evapotranspiration	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0
Recharge (-) Discharge (+)	-2.9	-2.1	-1.9	-1.0	-2.2	-0.7	0.0	0.4	-0.3	1.1	0.3	-1.9	-0.2
Surface Water Outflows	-7.6	-15.2	-30.9	-61.7	-17.9	-12.6	-3.7	-3.7	-4.0	-4.3	-25.9	-26.8	-19.4
To Diversion Canal	-6.0	-14.0	-29.1	-58.3	-14.0	-8.9	-1.6	-2.0	-3.4	-4.3	-25.9	-25.0	-16.4
To Seq. Ck. Marsh (surface)	-1.6	-1.2	-1.9	-3.4	-3.9	-3.7	-2.1	-1.7	-0.5	0.0	0.0	-1.7	-3.0
Subsurface Outflows	-1.4	-1.6	-1.6	-1.6	-1.7	-1.6	-1.5	-1.7	-1.5	-1.7	-2.1	-1.9	-2.0
Change in Storage	-1.6	3.3	6.4	2.8	-1.4	-2.9	-5.2	-5.7	-4.0	0.0	8.9	5.5	4.1
Predicted WSE in feet													
Bell	218.38	218.66	219.19	219.43	219.32	219.07	218.64	218.16	217.83	217.84	218.58	219.03	219.37
McKay	216.67	216.94	217.48	217.72	217.60	217.36	216.93	216.45	216.12	216.12	216.86	217.32	217.66
Hamer	214.45	214.73	215.26	215.50	215.39	215.14	214.71	214.23	213.90	213.91	214.65	215.10	215.44
Observed WSE ('04) in feet													
Bell	218.67	219.27	219.76										
McKay	215.03	215.78	216.09	215.95	216.19	215.94	215.82	215.62	215.27	215.36	215.45	215.97	216.17
Hamer	214.33	214.68	215.58	215.43			215.02	214.50	214.15	214.20	214.25	214.93	215.39

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2016

Hydrologic Process	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Precipitation	4.1	4.7	4.4	2.1	0.8	0.4	0.2	2.2	1.3	5.0	7.1	12.0	6.9
Surface Water Inflows	16.1	17.6	17.6	5.8	1.0	0.0	0.0	7.7	3.5	31.3	43.2	88.5	34.0
Runoff from Ft. Lewis - Outfall 002	9.9	10.8	10.8	3.5	0.5	0.0	0.0	4.7	2.0	19.2	26.4	53.4	20.8
Runoff from Ft. Lewis - Outfall 003	6.2	6.8	6.8	2.3	0.5	0.0	0.0	3.0	1.5	12.1	16.8	35.1	13.2
Evapotranspiration	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0
Recharge (-) Discharge (+)	-1.4	-2.1	-1.2	-2.5	-1.5	-2.1	-1.6	-3.3	-2.3	-4.0	2.5	0.3	-0.9
Surface Water Outflows	-16.4	-18.2	-17.7	-7.9	-1.8	-0.4	-0.2	-5.9	-3.2	-24.9	-36.7	-84.1	-37.4
To Diversion Canal	-12.5	-14.6	-13.7	-4.2	-0.6	-0.2	-0.2	-5.9	-3.2	-24.9	-36.7	-83.7	-33.6
To Seq. Ck. Marsh (surface)	-3.8	-3.6	-4.0	-3.7	-1.2	-0.3	0.0	0.0	0.0	0.0	0.0	-0.4	-3.8
Subsurface Outflows	-1.7	-1.4	-1.8	-1.3	-1.4	-1.3	-1.3	-1.1	-1.0	-1.2	-1.8	-2.1	-1.7
Change in Storage	0.7	0.0	0.0	-5.8	-6.1	-7.1	-7.4	-4.3	-4.0	5.3	13.9	14.6	0.9
Predicted WSE in feet													
Bell	219.43	219.43	219.43	218.94	218.43	217.84	217.23	216.87	216.53	216.97	218.13	219.35	219.43
McKay	217.72	217.72	217.72	217.23	216.72	216.13	215.51	215.15	214.82	215.26	216.42	217.64	217.72
Hamer	215.50	215.50	215.50	215.01	214.50	213.91	213.30	212.94	212.60	213.04	214.20	215.42	215.50
Observed WSE ('04) in feet													
Bell					219.23	219.09	218.69	217.87	217.69	217.50	219.85		
McKay	216.10	215.99	215.89	215.65	215.44	214.58	213.88				215.69	216.17	
Hamer	215.29	215.29	215.29	215.26	214.68	213.91	213.36	212.70	212.67	212.64	215.55		

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2017

Hydrologic Process	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Precipitation	5.8	5.9	1.8	1.0	2.3	1.3	0.2	1.5	9.3	6.9	3.9	3.4	8.6
Surface Water Inflows	24.6	27.1	4.4	1.6	7.0	2.9	0.0	4.1	65.7	36.3	15.2	12.4	42.9
Runoff from Ft. Lewis - Outfall 002	15.1	16.6	2.6	0.9	4.2	1.7	0.0	2.4	39.9	22.2	9.4	7.6	26.1
Runoff from Ft. Lewis - Outfall 003	9.5	10.5	1.8	0.7	2.7	1.2	0.0	1.7	25.8	14.1	5.9	4.8	16.8
Evapotranspiration	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6
Recharge (-) Discharge (+)	-0.8	-0.9	0.1	1.1	0.9	1.0	-0.2	0.0	-3.4	0.8	0.5	-0.9	-0.9
Surface Water Outflows	-27.3	-29.1	-6.2	-2.6	-7.6	-4.2	-0.2	-3.4	-58.8	-31.6	-14.9	-13.3	-47.5
To Diversion Canal	-23.6	-25.1	-2.9	-0.9	-5.3	-2.5	-0.1	-3.4	-58.8	-30.5	-11.7	-9.4	-44.0
To Seq. Ck. Marsh (surface)	-3.7	-4.0	-3.2	-1.7	-2.3	-1.7	-0.1	0.0	0.0	-1.0	-3.2	-3.8	-3.4
Subsurface Outflows	-1.7	-1.7	-1.7	-1.9	-1.8	-1.8	-1.6	-1.6	-1.7	-2.2	-2.0	-1.9	-1.6
Change in Storage	0.0	0.0	-3.6	-4.0	-2.9	-5.2	-5.7	-1.8	10.0	9.7	2.7	-0.2	0.9
Predicted WSE in feet													
Bell	219.43	219.43	219.13	218.80	218.56	218.12	217.65	217.50	218.34	219.15	219.37	219.35	219.43
McKay	217.72	217.72	217.41	217.08	216.85	216.41	215.94	215.79	216.63	217.43	217.65	217.64	217.72
Hamer	215.50	215.50	215.20	214.87	214.63	214.19	213.72	213.57	214.41	215.22	215.44	215.42	215.50
Observed WSE ('04) in feet													
Bell							219.47		218.88				
McKay					215.60	215.55	214.85		214.09	215.95	216.30	216.16	216.16
Hamer					212.25	214.62	213.94		213.45	215.32			

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2018

Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	8.7	4.6	2.8	1.8	0.0	0.1	1.0	5.2	7.2	5.8	7.2	3.3	2.3
Surface Water Inflows	48.5	18.4	9.3	4.6	0.0	0.0	1.8	26.6	38.8	26.6	36.8	10.6	7.0
Runoff from Ft. Lewis - Outfall 002	29.5	11.3	5.7	2.7	0.0	0.0	0.9	16.3	23.7	16.3	22.4	6.5	4.3
Runoff from Ft. Lewis - Outfall 003	19.0	7.1	3.6	1.8	0.0	0.0	0.8	10.3	15.1	10.3	14.3	4.1	2.7
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	1.5	-1.0	0.0	1.1	1.9	2.6	0.8	1.2	-1.0	0.6	0.2	-0.1	0.9
Surface Water Outflows	-55.3	-18.4	-11.0	-6.3	0.0	-0.1	-2.0	-21.3	-34.4	-27.3	-42.4	-11.6	-9.2
To Diversion Canal	-51.3	-14.5	-7.0	-3.5	0.0	0.0	-1.9	-21.3	-32.9	-24.1	-38.3	-8.0	-5.3
To Seq. Ck. Marsh (surface)	-4.0	-3.9	-4.0	-2.9	0.0	-0.1	-0.1	0.0	-1.5	-3.2	-4.0	-3.6	-3.9
Subsurface Outflows	-2.2	-1.9	-1.9	-1.9	-2.1	-2.3	-2.0	-2.5	-2.2	-2.2	-1.9	-1.9	-2.0
Change in Storage	0.0	-0.1	-3.9	-4.5	-4.7	-3.7	-2.7	8.2	7.9	3.5	0.0	-0.3	-2.3
Predicted WSE in feet													
Bell	219.43	219.42	219.09	218.72	218.33	218.02	217.79	218.48	219.14	219.43	219.43	219.41	219.22
McKay	217.72	217.71	217.38	217.00	216.61	216.30	216.08	216.77	217.42	217.72	217.72	217.69	217.50
Hamer	215.50	215.49	215.16	214.79	214.40	214.09	213.86	214.55	215.21	215.50	215.50	215.48	215.29
Observed WSE ('04) in feet													
Bell							219.80						
McKay	216.28	216.12		215.96	216.02	215.96	216.12			216.35		216.30	216.35
Hamer				215.45	214.76	213.95	213.83						

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2019

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	6.1	0.7	0.9	0.2	0.3	1.8	4.0	3.8	6.4	3.4	4.8	1.6	3.6
Surface Water Inflows	27.5	0.3	1.3	0.0	0.0	5.5	18.6	16.9	33.7	12.8	18.6	3.7	13.4
Runoff from Ft. Lewis - Outfall 002	16.8	0.0	0.6	0.0	0.0	3.3	11.4	10.4	20.6	7.8	11.4	2.2	8.2
Runoff from Ft. Lewis - Outfall 003	10.7	0.3	0.6	0.0	0.0	2.2	7.2	6.5	13.1	4.9	7.2	1.5	5.2
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	-1.5	-0.8	-0.5	0.0	-0.9	-0.2	-2.2	0.6	1.3	0.2	-1.3	-1.0	-3.1
Surface Water Outflows	-25.9	-1.0	-2.2	-0.2	-0.3	-4.3	-14.3	-12.9	-28.0	-12.4	-17.5	-5.3	-12.8
To Diversion Canal	-22.6	-0.2	-0.8	0.0	-0.3	-4.3	-14.3	-12.9	-27.9	-9.7	-14.7	-2.4	-10.2
To Seq. Ck. Marsh (surface)	-3.3	-0.8	-1.4	-0.2	0.0	0.0	0.0	0.0	0.0	-2.7	-2.7	-2.8	-2.6
Subsurface Outflows	-1.8	-1.8	-1.8	-1.9	-1.6	-1.7	-1.8	-2.1	-2.5	-2.2	-1.8	-1.8	-1.6
Change in Storage	2.4	-5.9	-5.9	-6.3	-6.5	-1.3	3.2	5.7	10.9	1.8	2.3	-4.1	-2.5
Predicted WSE in feet													
Bell	219.42	218.93	218.43	217.90	217.36	217.26	217.53	218.00	218.91	219.06	219.25	218.91	218.70
McKay	217.70	217.21	216.72	216.19	215.65	215.54	215.81	216.29	217.20	217.34	217.54	217.20	216.99
Hamer	215.49	215.00	214.50	213.97	213.43	213.33	213.60	214.07	214.98	215.13	215.32	214.98	214.77
Observed WSE ('04) in feet													
Bell				219.79	219.20	219.09	218.29					219.89	219.77
McKay	216.38	214.68	214.31	214.30	213.97	213.79		214.25	214.52	214.67	215.96	214.44	214.37
Hamer		215.01	214.47	214.10	213.30	213.11	212.99	213.63	214.85		215.27	214.79	214.64

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water	WY2020												
Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	1.1	0.7	1.0	0.8	3.5	3.9	1.7	6.5	9.6	4.2	3.5	1.5	3.1
Surface Water Inflows	2.1	0.4	2.0	1.4	18.1	21.8	5.7	38.7	65.6	15.9	12.9	3.7	12.1
Runoff from Ft. Lewis - Outfall 002	1.2	0.1	1.1	0.6	11.1	13.4	3.4	23.7	39.8	9.8	7.9	2.2	7.4
Runoff from Ft. Lewis - Outfall 003	1.0	0.3	0.9	0.7	7.0	8.4	2.3	15.0	25.8	6.1	5.0	1.5	4.7
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	-2.9	-2.5	-3.1	-3.5	-2.2	0.9	0.3	-2.2	1.7	-1.8	-4.6	-2.9	-2.5
Surface Water Outflows	-3.2	-1.0	-2.2	-1.9	-13.7	-16.8	-4.5	-32.3	-59.2	-15.2	-13.0	-5.2	-10.1
To Diversion Canal	-1.6	-0.8	-2.2	-1.9	-13.7	-16.8	-4.5	-32.3	-59.2	-12.3	-9.8	-2.9	-9.1
To Seq. Ck. Marsh (surface)	-1.6	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.8	-3.2	-2.3	-1.0
Subsurface Outflows	-1.4	-1.2	-1.2	-0.9	-1.2	-1.7	-1.3	-1.4	-2.4	-1.7	-1.3	-1.1	-1.2
Change in Storage	-7.5	-7.5	-7.9	-8.2	2.1	7.2	1.4	9.4	15.3	0.9	-3.7	-6.0	-1.9
Predicted WSE in feet													
Bell	218.08	217.45	216.79	216.11	216.29	216.89	217.00	217.78	219.06	219.14	218.83	218.33	218.17
McKay	216.36	215.74	215.08	214.40	214.57	215.17	215.29	216.07	217.35	217.42	217.11	216.61	216.46
Hamer	214.15	213.52	212.86	212.18	212.36	212.96	213.07	213.85	215.13	215.21	214.90	214.40	214.24
Observed WSE ('04) in feet													
Bell		218.58	217.47	216.86		218.20				219.71			
McKay		213.99			214.92			213.72	215.28	214.65			
Hamer		213.47	212.68		212.25			213.55	215.55	215.03			

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water WY2021

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.5	0.3	0.4	2.8	3.0	5.6	5.2	7.3	4.7	2.5	1.2	2.0	2.4
Surface Water Inflows	8.1	0.0	0.0	12.9	14.7	29.6	25.3	37.3	17.8	7.9	2.1	5.7	7.3
Runoff from Ft. Lewis - Outfall 002	4.9	0.0	0.0	7.9	9.0	18.1	15.5	22.8	10.9	4.8	1.2	3.5	4.5
Runoff from Ft. Lewis - Outfall 003	3.2	0.0	0.0	5.0	5.7	11.5	9.8	14.5	6.9	3.1	0.9	2.3	2.9
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	-1.7	-3.0	-3.5	-1.5	0.4	3.5	5.4	4.8	3.0	4.2	2.2	3.8	3.7
Surface Water Outflows	-6.7	-0.3	-0.4	-9.7	-11.0	-23.9	-20.9	-46.4	-23.3	-11.2	-3.3	-7.8	-8.9
To Diversion Canal	-6.1	-0.3	-0.4	-9.7	-11.0	-23.9	-20.3	-42.7	-19.7	-7.2	-1.1	-4.3	-5.5
To Seq. Ck. Marsh (surface)	-0.5	0.0	0.0	0.0	0.0	0.0	-0.7	-3.7	-3.6	-4.0	-2.2	-3.5	-3.3
Subsurface Outflows	-1.2	-0.9	-0.7	-0.9	-0.9	-1.0	-1.5	-1.8	-1.7	-2.1	-1.7	-1.7	-1.5
Change in Storage	-2.6	-8.5	-8.2	1.3	5.2	13.3	13.5	1.2	0.0	0.0	-1.4	-1.1	-0.6
Predicted WSE in feet													
Bell	217.95	217.25	216.56	216.67	217.10	218.21	219.33	219.43	219.43	219.43	219.31	219.22	219.17
McKay	216.24	215.53	214.85	214.96	215.39	216.49	217.61	217.72	217.72	217.72	217.59	217.50	217.45
Hamer	214.02	213.32	212.63	212.74	213.17	214.28	215.40	215.50	215.50	215.50	215.38	215.29	215.24
Observed WSE ('04) in feet													
Bell					217.23			219.68			219.71	219.41	218.99
McKay						213.87		214.86	214.88	215.59	214.57	214.46	214.38
Hamer						213.15		215.23	215.30	214.89	214.51	214.01	213.58

Table F-13. Water Balance for Bell, McKay, and Hamer Marshes with Mining - Low Groundwater

Monthly Average in Inches of Water	WY2021		
Hydrologic Process	Jul	Aug	Sep
Precipitation	0.0	0.3	2.6
Surface Water Inflows	0.0	0.0	8.3
Runoff from Ft. Lewis - Outfall 002	0.0	0.0	5.1
Runoff from Ft. Lewis - Outfall 003	0.0	0.0	3.2
Evapotranspiration	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	5.3	2.1	2.5
Surface Water Outflows	0.0	-0.3	-8.7
To Diversion Canal	0.0	0.0	-6.3
To Seq. Ck. Marsh (surface)	0.0	-0.2	-2.4
Subsurface Outflows	-1.5	-1.5	-1.7
Change in Storage	-0.7	-3.4	0.7
Predicted WSE in feet			
Bell	219.11	218.83	218.89
McKay	217.40	217.11	217.17
Hamer	215.18	214.90	214.96
Observed WSE ('04) in feet			
Bell	218.05		
McKay		213.27	
Hamer	212.68	212.25	

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water	WY2004						WY2005						
Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	2.0	1.0	3.8	0.9	0.1	3.6	2.9	4.0	3.2	4.3	4.3	0.6	4.5
Surface Water Inflows	0.3	0.9	0.1	0.0	0.0	0.2	0.1	0.2	0.1	0.2	0.2	0.3	0.2
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.1	0.0	0.1	0.0	0.0	0.2	0.1	0.2	0.1	0.2	0.2	0.0	0.2
From Hamer (surface)	1.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Subsurface Inflows	1.2	0.9	1.2	0.9	0.8	0.9	1.0	1.1	1.0	1.3	1.5	0.9	1.1
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	*-5.7*	*-4.2*	*-3.4*	*-2.1*	*-1.0*	*-2.2*	*-0.9*	*-1.0*	*-1.9*	*-1.9*	*-2.5*	*-2.7*	*-4.1*
Surface Water Outflows	1.1	0.0	-0.6	0.0	0.0	0.0	0.0	0.0	-0.2	-0.3	-0.4	0.0	-0.4
To Diversion Canal	-1.5	0.0	-0.4	0.0	0.0	0.0	0.0	0.0	-0.1	-0.2	-0.3	0.0	-0.3
To West Edmond Marsh	2.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.2	0.0	-0.2
Change in Storage	-1.5	-3.4	-1.7	-3.9	-4.6	-1.5	0.8	3.3	1.8	3.8	3.3	-1.4	0.2
Predicted WSE in ft													
EM-2S	212.62	212.26	212.12	211.80	211.41	211.29	211.35	211.63	211.78	212.10	212.37	212.23	212.25
East Edmond	212.62	212.33	212.17	211.85	211.47	211.43	211.50	211.77	211.92	212.22	212.49	212.37	212.37
Eastern East Edmond Marsh	212.36	212.07	211.77	211.44	211.06	210.92	210.99	211.26	211.36	211.61	211.78	211.66	211.55
Observed WSE in ft													
EM-2S	210.72	210.74	210.76	210.70	210.40	209.82	209.92	210.33	210.61	210.76	210.86	210.79	210.64
East Edmond (EM-2E)	212.62	212.50	212.35	212.25	211.85	211.43	211.43	211.80	212.12	212.31	212.47	212.40	212.19
East Edmond (EM-2W)	211.15	211.15	211.22	211.20	210.91	210.32	210.41	210.80	211.08	211.20	211.26	211.24	211.09
East Edmond (EM-3E)	212.42	212.29	212.14	212.04	211.69	211.07	211.43	211.70	211.93	212.09	212.15	212.17	211.97
East Edmond (EM-3W)	212.42	212.29	212.15	212.04	211.70	211.10	211.57	211.70	211.94	212.04	212.26	212.20	211.98
Eastern East Edmond (SCM-1)	212.39	212.26	212.09	211.98	211.58	210.96	211.20	211.63	211.84	212.08	212.27	212.17	211.95

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2006

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	5.4	3.9	3.8	1.4	0.2	1.6	3.3	6.7	6.5	12.2	3.2	2.6	3.9
Surface Water Inflows	0.2	1.2	1.1	0.6	0.0	0.1	0.2	0.3	0.3	0.6	2.5	2.4	1.8
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.2	0.2	0.1	0.0	0.0	0.1	0.2	0.3	0.3	0.6	0.1	0.1	0.1
From Hamer (surface)	0.0	1.1	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	2.4	2.3	1.7
Subsurface Inflows	1.5	1.5	1.3	1.0	0.3	0.3	0.5	1.4	1.5	2.0	1.3	1.4	1.4
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	*-2.1*	*-2.6*	*-1.4*	*-2.6*	*-3.4*	*-4.8*	*-3.9*	*-1.0*	*-2.7*	*-1.6*	*-3.9*	*-4.3*	*-3.5*
Surface Water Outflows	-0.5	-0.4	-0.5	-0.4	0.0	0.0	0.0	0.0	0.0	-5.0	-0.7	-0.9	-1.3
To Diversion Canal	-0.2	-0.3	-0.3	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-0.5	-0.4
To West Edmond Marsh	-0.3	-0.2	-0.3	-0.2	0.0	0.0	0.0	0.0	0.0	-5.9	-0.3	-0.5	-1.1
Change in Storage	2.8	0.6	0.8	-4.3	-6.9	-5.1	-1.0	7.0	5.7	7.3	2.3	0.3	0.5
Predicted WSE in ft													
EM-2S	212.47	212.44	212.43	212.02	211.44	211.02	210.93	211.51	211.98	212.59	212.57	212.40	212.31
East Edmond	212.58	212.61	212.66	212.28	211.71	211.43	211.43	212.01	212.48	212.60	212.76	212.74	212.70
Eastern East Edmond Marsh	211.70	211.63	211.60	211.13	210.55	210.12	210.04	210.62	211.09	212.16	212.20	212.06	212.01
Observed WSE in ft													
EM-2S	210.94	210.90	210.69	210.42	209.82	209.15	209.21	210.48	210.71	210.98	210.88	210.58	210.57
East Edmond (EM-2E)	212.55	212.63	212.47	212.13	211.43	211.43	211.43	211.89	212.22	212.63	212.62	212.51	212.55
East Edmond (EM-2W)	211.28	211.32	211.14	210.88	210.28	209.64	209.67	210.87	211.12	211.31	211.25	210.92	210.89
East Edmond (EM-3E)	212.32	212.40	212.26	211.92	211.13			211.78	212.02	212.42	212.37	212.27	212.30
East Edmond (EM-3W)	212.50	212.41	212.25	211.92	211.15	210.44	210.58	211.75	212.02	212.42	212.38	212.26	212.29
Eastern East Edmond (SCM-1)	212.25	212.43	212.29	211.88	211.08	210.95	210.57	211.69	211.99	212.58	212.47	212.20	212.32

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2007

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	2.1	2.2	0.4	0.0	0.8	1.6	14.4	8.6	6.5	4.5	5.7	1.7	1.1
Surface Water Inflows	1.8	0.9	0.0	0.0	0.0	0.1	0.7	0.4	3.2	3.2	3.5	3.1	1.6
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.1	0.1	0.0	0.0	0.0	0.1	0.7	0.4	0.3	0.2	0.2	0.1	0.0
From Hamer (surface)	1.7	0.9	0.0	0.0	0.0	0.0	0.0	0.0	2.9	3.0	3.3	3.1	1.6
Subsurface Inflows	1.5	1.3	1.2	1.0	0.7	0.6	2.0	2.2	2.1	1.8	2.1	1.7	1.5
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	*-3.3*	*-1.3*	*-2.1*	*0.3*	*-1.4*	*-1.5*	*-0.1*	*0.6*	*-1.6*	*-1.5*	*-0.1*	*-1.9*	*-2.2*
Surface Water Outflows	-0.6	-0.5	0.0	-0.1	0.0	0.0	-5.8	-5.4	-6.2	-4.2	-6.9	-2.2	-0.7
To Diversion Canal	-0.4	-0.3	0.0	-0.1	0.0	0.0	0.0	-0.5	-3.4	-1.1	-2.5	-1.9	-0.5
To West Edmond Marsh	-0.3	-0.2	0.0	0.0	0.0	0.0	-6.7	-6.2	-3.7	-4.0	-5.7	-0.4	-0.3
Change in Storage	-1.3	-0.8	-5.0	-2.8	-2.1	-0.2	9.8	5.6	6.5	3.4	4.2	2.3	-1.4
Predicted WSE in ft													
EM-2S	212.06	211.92	211.51	211.28	211.10	211.09	211.90	212.37	212.67	212.70	212.78	212.71	212.46
East Edmond	212.57	212.49	212.07	211.84	211.66	211.65	211.90	211.85	212.09	212.03	211.91	212.06	211.92
Eastern East Edmond Marsh	211.75	211.56	211.15	210.89	210.71	210.69	212.07	212.75	212.43	212.64	212.56	212.10	211.82
Observed WSE in ft													
EM-2S	210.71	210.85	210.62	210.36	210.21	210.06	211.03	211.01	210.90	210.87	210.83	210.79	210.82
East Edmond (EM-2E)	212.55	212.63	212.53	211.36	211.43	211.65	211.87	211.94	211.78	211.79	211.80	211.65	211.73
East Edmond (EM-2W)	211.08	211.28	211.06	210.74	210.64	210.49	211.37	211.37	211.26	211.26	211.22	211.15	211.24
East Edmond (EM-3E)	212.28	212.39	212.04	211.75	211.51	211.32	212.52	212.61	212.44	212.46	212.43	212.30	212.37
East Edmond (EM-3W)	212.27	212.40	212.03	211.75	211.50	211.31	212.51	212.60	212.42	212.42	212.42	212.29	212.36
Eastern East Edmond (SCM-1)	212.26	212.46	211.97	211.70	211.38	211.33	212.58	212.67	212.49	212.48	212.49	212.29	212.44

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY2008

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.7	1.5	1.0	1.7	5.0	2.8	7.7	4.2	3.6	4.9	1.8	1.3	1.7
Surface Water Inflows	0.4	0.0	0.0	0.1	0.2	0.1	0.4	2.3	2.6	3.1	3.0	1.6	0.2
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.1	0.0	0.0	0.1	0.2	0.1	0.4	0.2	0.1	0.2	0.1	0.0	0.1
From Hamer (surface)	0.3	0.0	0.0	0.0	0.0	0.0	0.0	2.1	2.5	2.9	2.9	1.6	0.1
Subsurface Inflows	1.4	1.3	1.1	1.1	1.4	1.3	2.1	1.9	1.6	1.9	1.5	1.6	1.3
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	*-1.5*	*0.8*	*-0.1*	*-0.7*	*-0.8*	*-1.2*	*-0.7*	*-2.5*	*-2.0*	*-2.5*	*-2.3*	*-2.5*	*-1.0*
Surface Water Outflows	-0.5	-0.4	-0.3	-0.1	-0.3	-1.4	-4.1	-2.2	-4.2	-2.8	-2.7	-0.7	-0.5
To Diversion Canal	-0.4	-0.3	-0.2	-0.1	-0.1	-0.2	-0.3	-0.6	-1.7	-1.0	-1.6	-0.5	-0.3
To West Edmond Marsh	-0.2	-0.2	-0.1	0.0	-0.3	-1.4	-4.7	-2.0	-3.3	-2.4	-1.4	-0.3	-0.2
Change in Storage	-0.9	-1.0	-2.0	-0.2	4.6	1.2	4.7	3.8	2.1	3.7	0.6	-1.4	-1.8
Predicted WSE in ft													
EM-2S	212.36	212.28	212.12	212.10	212.48	212.58	212.97	213.11	213.08	213.15	212.95	212.70	212.54
East Edmond	211.82	211.73	211.56	211.54	211.89	211.88	211.87	212.02	211.93	212.04	211.96	211.82	211.65
Eastern East Edmond Marsh	211.61	211.42	211.17	211.12	211.50	211.60	212.26	212.54	212.39	212.52	212.09	211.80	211.52
Observed WSE in ft													
EM-2S	210.87	210.86	210.68	210.52	210.85	210.93	211.00	210.98	210.95	210.94	210.83	210.79	210.70
East Edmond (EM-2E)	211.66	211.60	211.45	211.27	211.66	211.77	211.92	211.86	211.80	211.86	211.68	211.69	211.63
East Edmond (EM-2W)	211.30	211.28	211.11	210.95	211.29	211.32	211.37	211.35	211.34	211.32	211.28	211.21	211.15
East Edmond (EM-3E)	212.31	212.23	212.09	211.93	212.32	212.40	212.56	212.50	212.44	212.50	212.37	212.33	212.27
East Edmond (EM-3W)	212.29	212.24	212.09	211.91	212.31	212.40	212.54	212.49	212.43	212.49	212.35	212.33	212.25
Eastern East Edmond (SCM-1)	212.35	212.29	212.13	212.06	212.38	212.48	212.63	212.58	212.52	212.55	212.43	212.39	212.32

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY2009

Hydrologic Process	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Precipitation	0.9	2.1	0.5	2.6	8.3	5.2	7.3	1.6	5.3	3.5	3.4	1.3	0.0
Surface Water Inflows	0.0	0.1	0.0	0.1	0.4	0.2	1.0	2.6	1.9	2.6	2.1	1.4	0.0
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.0	0.1	0.0	0.1	0.4	0.2	0.3	0.0	0.2	0.1	0.1	0.0	0.0
From Hamer (surface)	0.0	0.0	0.0	0.0	0.0	0.0	0.7	2.5	1.7	2.5	2.0	1.3	0.0
Subsurface Inflows	1.1	0.9	0.7	0.7	1.6	1.7	2.0	1.4	1.8	1.6	1.6	1.2	0.9
Evapotranspiration	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5
Recharge (-) Discharge (+)	*-0.5*	*0.5*	*-0.1*	*-1.8*	*-1.0*	*-2.0*	*-2.2*	*-3.0*	*-3.1*	*-3.4*	*-3.1*	*-2.5*	*-1.8*
Surface Water Outflows	-0.4	-0.1	-0.1	0.0	-1.6	-2.6	-3.4	-1.8	-2.4	-1.4	-0.9	-0.7	0.0
To Diversion Canal	-0.2	-0.1	0.0	0.0	0.0	-0.3	-0.4	-1.5	-0.5	-0.7	-0.5	-0.5	0.0
To West Edmond Marsh	-0.1	0.0	0.0	0.0	-1.9	-2.8	-3.8	-0.4	-2.4	-0.9	-0.5	-0.3	0.0
Change in Storage	-3.2	-0.4	-1.2	0.5	7.0	2.3	4.3	1.6	2.2	1.4	0.2	-2.5	-5.3
Predicted WSE in ft													
EM-2S	212.27	212.24	212.13	212.18	212.76	212.95	213.25	213.17	213.22	213.13	212.98	212.66	212.21
East Edmond	211.43	211.43	211.43	211.47	211.90	211.86	211.91	212.00	211.99	212.03	212.01	211.77	211.43
Eastern East Edmond Marsh	211.17	211.09	210.97	211.01	211.75	212.02	212.51	212.14	212.32	212.25	212.11	211.74	211.29
Observed WSE in ft													
EM-2S	210.43	210.28	210.14	210.00	210.90	210.97	210.95	210.92	210.89	210.87	210.93	210.61	210.18
East Edmond (EM-2E)	211.43	211.43	211.43	211.43	211.72	211.81	211.81	211.76	211.54	211.44	211.72	211.43	211.43
East Edmond (EM-2W)	210.88	210.70	210.56	210.41	211.31	211.34	211.33	211.30	211.36	211.36	211.37	211.04	210.58
East Edmond (EM-3E)	211.92	211.63	211.47	211.30	212.41	212.42	212.44	212.39	212.25	212.31	212.38	211.93	211.59
East Edmond (EM-3W)	211.92	211.67	211.50	211.33	212.32	212.40	212.43	212.37	212.25	212.29	212.36	211.94	211.67
Eastern East Edmond (SCM-1)	211.96	211.71	211.54	211.38	212.39	212.48	212.53	212.47	212.33	212.37	212.44	211.94	211.51

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY2010

Hydrologic Process	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Precipitation	1.9	2.8	5.6	8.9	3.0	8.0	3.3	3.3	3.3	4.6	4.3	0.4	0.2
Surface Water Inflows	0.1	0.1	0.3	0.4	1.1	1.9	3.2	3.4	2.9	2.8	2.6	0.3	0.0
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.1	0.1	0.3	0.4	0.1	0.4	0.1	0.1	0.1	0.2	0.2	0.0	0.0
From Hamer (surface)	0.0	0.0	0.0	0.0	1.0	1.5	3.1	3.2	2.8	2.6	2.5	0.3	0.0
Subsurface Inflows	0.9	0.9	1.2	1.9	1.8	2.1	2.0	2.0	1.9	1.9	1.8	1.4	1.1
Evapotranspiration	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0
Recharge (-) Discharge (+)	*-1.5*	*-1.3*	*-2.0*	*-1.3*	*-2.5*	*-3.0*	*-2.2*	*-3.4*	*-2.9*	*-3.1*	*-3.0*	*-2.4*	*-1.7*
Surface Water Outflows	-0.2	0.0	0.0	-3.5	-1.5	-3.9	-5.5	-0.9	-2.2	-2.0	-1.3	0.0	0.0
To Diversion Canal	-0.1	0.0	0.0	-0.2	-0.5	-0.5	-2.8	-0.5	-0.6	-0.8	-0.6	0.0	0.0
To West Edmond Marsh	-0.1	0.0	0.0	-4.1	-1.3	-4.3	-3.6	-0.4	-2.0	-1.6	-1.0	0.0	0.0
Change in Storage	-2.7	0.1	4.1	5.3	2.0	4.7	2.1	3.6	1.3	1.3	1.0	-4.8	-4.4
Predicted WSE in ft													
EM-2S	211.98	211.99	212.34	212.78	212.86	213.13	213.05	213.08	212.96	212.85	212.73	212.30	211.93
East Edmond	211.43	211.44	211.78	211.88	211.94	211.97	211.85	212.12	212.06	212.04	212.04	211.64	211.43
Eastern East Edmond Marsh	211.01	211.02	211.35	212.06	212.15	212.71	212.18	212.31	212.34	212.29	212.23	211.83	211.46
Observed WSE in ft													
EM-2S	210.12	210.11	210.47	211.06	211.04	211.03	211.03	210.86	211.15	211.13	211.10	210.88	210.61
East Edmond (EM-2E)	211.43	211.43	211.43	211.75	211.52	211.58	211.64	211.90	211.59	212.04	211.93	211.73	211.43
East Edmond (EM-2W)	210.51	210.52	210.90	211.41	211.41	211.39	211.40	211.24	211.58	211.54	211.52	211.36	211.03
East Edmond (EM-3E)	211.49	211.46	211.74	212.41	212.33	212.49	212.38	212.42	212.43	212.55	212.48	212.25	211.93
East Edmond (EM-3W)	211.48	211.46	211.72	212.31	212.25	212.27	212.22	212.39	212.25	212.54	212.44	212.25	211.96
Eastern East Edmond (SCM-1)	211.45	211.46	211.78	212.48	212.40	212.57	212.45	212.49	212.52	212.62	212.55	212.24	211.87

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY2011

Hydrologic Process	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precipitation	4.0	4.2	6.6	7.2	6.1	3.1	7.2	5.7	4.8	2.8	0.8	0.3	1.3
Surface Water Inflows	0.2	0.2	0.3	2.2	3.5	2.9	3.2	3.2	3.4	3.0	1.0	0.0	0.0
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.2	0.2	0.3	0.3	0.2	0.1	0.3	0.2	0.2	0.1	0.0	0.0	0.0
From Hamer (surface)	0.0	0.0	0.0	1.9	3.2	2.8	3.0	3.0	3.2	2.9	1.0	0.0	0.0
Subsurface Inflows	1.4	1.4	2.0	1.9	1.6	1.3	1.5	1.4	1.5	1.3	2.7	2.4	1.7
Evapotranspiration	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	*-1.0*	*-2.0*	*-1.6*	*-3.4*	*-4.7*	*-3.6*	*-4.7*	*-3.8*	*-4.1*	*-3.8*	*-26.0*	*3.3*	*1.0*
Surface Water Outflows	-0.3	-0.4	-2.7	-0.7	-2.6	-2.4	-3.0	-3.8	-1.2	-1.0	0.0	0.0	0.0
To Diversion Canal	-0.2	-0.3	-0.3	-0.5	-0.6	-0.9	-0.8	-1.7	-0.8	-0.7	0.0	0.0	0.0
To West Edmond Marsh	-0.1	-0.2	-3.0	-0.3	-2.5	-2.0	-2.8	-2.9	-0.5	-0.4	0.0	0.0	0.0
Change in Storage	2.1	2.6	3.8	7.5	4.0	1.2	3.2	1.7	1.9	-0.9	-26.1	2.0	1.8
Predicted WSE in ft													
EM-2S	212.11	212.32	212.64	213.11	213.18	213.04	213.06	212.96	212.85	212.53	210.28	210.44	210.59
East Edmond	211.60	211.80	211.87	212.47	212.60	212.53	212.56	212.46	212.58	212.47	211.43	211.60	211.75
Eastern East Edmond Marsh	211.55	211.66	212.10	212.56	212.87	212.80	213.02	212.80	212.71	212.42	210.25	210.42	210.57
Observed WSE in ft													
EM-2S	211.01	211.05	211.33	211.43	211.30	211.27	211.25	211.27	211.30	211.22	206.59	211.06	210.85
East Edmond (EM-2E)	211.73	211.75	211.95	212.18	212.13	212.20	212.27	212.30	212.37			212.01	211.69
East Edmond (EM-2W)	211.46	211.48	211.73	211.78	211.68	211.65	211.61	211.58	211.68			211.48	211.33
East Edmond (EM-3E)	212.23	212.37	212.59	212.73	212.73	212.73	212.73	212.76	212.88			212.49	212.06
East Edmond (EM-3W)	212.23	212.25	212.43	212.70	212.63	212.69	212.75	212.77	212.85			212.50	212.18
Eastern East Edmond (SCM-1)	212.28	212.32	212.67	212.81	212.78	212.79	212.80	212.83	212.95			212.58	212.26

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water	WY2012												WY2013
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Precipitation	4.1	6.1	3.2	7.2	3.9	6.8	4.3	3.1	3.3	1.6	0.0	0.1	6.5
Surface Water Inflows	0.2	0.3	0.8	1.4	3.1	3.4	3.2	3.0	2.3	1.7	0.0	0.0	0.3
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.2	0.3	0.1	0.3	0.1	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.3
From Hamer (surface)	0.0	0.0	0.7	1.1	3.0	3.1	3.0	2.9	2.1	1.7	0.0	0.0	0.0
Subsurface Inflows	1.7	1.8	1.7	2.0	1.5	1.6	1.3	1.4	1.3	1.3	1.3	1.1	1.6
Evapotranspiration	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0
Recharge (-) Discharge (+)	*-0.3*	*-1.8*	*-2.2*	*-1.3*	*-2.9*	*-3.7*	*-2.8*	*-3.6*	*-3.2*	*-2.1*	*-0.5*	*-1.4*	*-2.1*
Surface Water Outflows	0.0	-1.2	-1.5	-4.0	-1.8	-3.2	-2.7	-1.4	-0.9	-0.8	-0.6	0.0	-0.2
To Diversion Canal	0.0	0.0	-0.2	-0.3	-0.5	-0.6	-0.9	-0.9	-0.6	-0.5	-0.4	0.0	-0.1
To West Edmond Marsh	0.0	-1.3	-1.5	-4.5	-1.7	-3.4	-2.2	-0.6	-0.4	-0.3	-0.2	0.0	-0.1
Change in Storage	4.7	4.5	2.0	4.8	3.3	3.4	1.7	0.1	-0.5	-2.3	-3.4	-2.6	5.2
Predicted WSE in ft													
EM-2S	210.98	211.36	211.47	211.77	211.80	211.82	211.71	211.48	211.26	210.93	210.65	210.44	210.87
East Edmond	212.14	212.40	212.44	212.47	212.60	212.60	212.55	212.51	212.44	212.22	211.92	211.71	212.13
Eastern East Edmond Marsh	210.96	211.45	211.64	212.29	212.52	212.85	212.84	212.56	212.33	211.95	211.51	211.30	211.67
Observed WSE in ft													
EM-2S	210.97	211.29	211.31	211.37	211.36	211.38	211.40	211.41	211.36	211.25	211.14	210.84	211.08
East Edmond (EM-2E)	211.83	212.03	212.25	212.50	212.52	212.55	212.57	212.63	212.54	212.34	212.13	211.72	212.01
East Edmond (EM-2W)	211.40	211.67	211.71	211.72	211.75	211.76	211.77	211.78	211.75	211.65	211.55	211.31	211.50
East Edmond (EM-3E)	212.19	212.38	212.61	212.85	212.88	212.92	212.95	213.00	212.91	212.70	212.50	212.09	212.37
East Edmond (EM-3W)	212.29	212.50	212.73	212.98	212.99	213.02	213.05	213.11	213.03	212.82	212.61	212.20	212.48
Eastern East Edmond (SCM-1)	212.40	212.59	212.85	213.10	213.12	213.15	213.18	213.35	213.17	212.95	212.74	212.21	212.55

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water | WY2014

Hydrologic Process	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Precipitation	6.5	7.6	3.5	1.7	3.7	5.5	4.4	1.9	0.0	1.6	6.9	2.6	4.1
Surface Water Inflows	0.3	2.4	3.3	2.8	2.5	2.6	2.8	2.2	0.0	0.1	0.3	0.1	0.4
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.3	0.3	0.1	0.0	0.1	0.2	0.2	0.1	0.0	0.1	0.3	0.1	0.2
From Hamer (surface)	0.0	2.1	3.1	2.8	2.4	2.4	2.7	2.1	0.0	0.0	0.0	0.0	0.2
Subsurface Inflows	1.8	1.9	1.6	1.2	1.4	1.2	1.3	1.2	1.1	1.0	1.5	1.6	1.7
Evapotranspiration	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5
Recharge (-) Discharge (+)	*-2.3*	*-2.0*	*-3.9*	*-3.7*	*-3.5*	*-3.8*	*-4.5*	*-3.2*	*-1.3*	*-1.1*	*-1.1*	*-1.0*	*-1.9*
Surface Water Outflows	-1.5	-3.6	-2.1	-1.4	-1.9	-2.0	-1.0	-0.9	0.0	-0.5	-0.3	-0.5	-1.3
To Diversion Canal	-0.3	-0.4	-0.7	-0.7	-0.7	-0.6	-0.7	-0.6	0.0	-0.3	-0.2	-0.3	-0.3
To West Edmond Marsh	-1.5	-4.0	-1.8	-0.9	-1.6	-1.7	-0.4	-0.4	0.0	-0.2	-0.1	-0.2	-1.2
Change in Storage	4.4	5.9	2.6	0.5	1.3	1.8	0.4	-2.1	-4.6	-2.7	5.1	2.0	2.6
Predicted WSE in ft													
EM-2S	211.23	211.55	211.50	211.32	211.23	211.18	210.99	210.64	210.25	210.03	210.46	210.62	210.82
East Edmond	212.37	212.53	212.59	212.56	212.53	212.53	212.53	212.32	211.94	211.70	212.12	212.27	212.39
Eastern East Edmond Marsh	212.03	212.67	212.78	212.66	212.65	212.70	212.51	212.14	211.76	211.41	211.76	211.80	211.98
Observed WSE in ft													
EM-2S	211.31	211.47	211.40	211.40	211.39	211.44	211.43	211.37	211.19	210.88	211.31	211.51	211.47
East Edmond (EM-2E)	212.29	212.69	212.64	212.56	212.59	212.63	212.48	212.39	212.03	211.66	212.05	212.55	212.52
East Edmond (EM-2W)	211.69	211.83	211.78	211.75	211.76	211.81	211.82	211.80	211.64	211.36	211.76	211.89	211.86
East Edmond (EM-3E)	212.65	213.05	212.99	212.91	213.01	212.99	212.86	212.77	212.41	212.03	212.41	212.93	212.88
East Edmond (EM-3W)	212.76	213.17	213.11	213.04	213.06	213.10	212.96	212.88	212.51	212.15	212.53	213.03	212.99
Eastern East Edmond (SCM-1)	212.90	213.32	213.27	213.18	213.21	213.26	213.10	213.03	212.65	212.26	212.66	213.16	213.14

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2015

Hydrologic Process	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation	2.4	4.2	6.9	9.8	4.5	3.3	1.3	1.2	1.6	1.8	5.9	6.1	4.8
Surface Water Inflows	1.7	1.4	2.1	3.9	4.0	4.0	2.2	1.7	0.6	0.1	0.3	2.0	3.3
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.1	0.2	0.3	0.4	0.2	0.1	0.0	0.0	0.0	0.1	0.3	0.2	0.2
From Hamer (surface)	1.6	1.2	1.8	3.5	3.9	3.9	2.2	1.6	0.6	0.0	0.0	1.8	3.1
Subsurface Inflows	1.4	1.6	1.6	1.6	1.7	1.7	1.6	1.6	1.6	1.8	2.1	1.9	2.1
Evapotranspiration	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0
Recharge (-) Discharge (+)	*-3.4*	*-2.6*	*-1.5*	*-4.0*	*-2.0*	*-2.6*	*-2.9*	*-2.4*	*-1.7*	*-0.8*	*-2.3*	*-3.1*	*-2.5*
Surface Water Outflows	-0.8	-2.4	-3.6	-4.1	-6.6	-1.0	-1.0	-0.8	-0.6	-0.4	-0.3	-2.0	-3.1
To Diversion Canal	-0.4	-0.4	-0.4	-0.7	-3.2	-0.7	-0.7	-0.5	-0.4	-0.3	-0.2	-0.3	-0.5
To West Edmond Marsh	-0.4	-2.5	-4.0	-4.4	-4.6	-0.4	-0.4	-0.3	-0.2	-0.2	-0.1	-2.0	-3.2
Change in Storage	1.7	2.1	4.6	5.7	1.6	2.8	-2.0	-2.8	-2.2	0.4	4.8	4.3	4.4
Predicted WSE in ft													
EM-2S	210.83	210.90	211.13	211.31	211.12	211.03	210.68	210.32	210.09	210.12	210.53	210.74	210.85
East Edmond	212.49	212.46	212.51	212.62	212.37	212.57	212.37	212.11	211.91	211.93	212.32	212.51	212.61
Eastern East Edmond Marsh	211.97	212.16	212.70	213.25	212.70	212.71	212.33	211.91	211.58	211.51	211.82	212.20	212.63
Observed WSE in ft													
EM-2S	211.39	211.43	211.51	211.50	211.51	211.54	211.48	211.33	211.22	211.30	211.38	211.49	211.49
East Edmond (EM-2E)	212.33	212.43	212.59	212.59	212.68	212.81	212.73	212.32			212.34	212.53	212.51
East Edmond (EM-2W)	211.80	211.82	211.86	211.87	211.88	211.90	211.87	211.78	211.71	211.76	211.81	211.88	211.89
East Edmond (EM-3E)	212.69	212.80	212.95	212.96	213.04	213.19	213.08	212.66	212.49	212.59	212.69	212.91	212.94
East Edmond (EM-3W)	212.80	212.91	213.06	213.06	213.15	213.29	213.19	212.79	212.61	212.57	212.54	213.02	213.04
Eastern East Edmond (SCM-1)	212.95	213.07	213.21	213.25	213.33	213.46	213.22	212.98	212.76	212.86	212.97	213.20	213.26

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2016

Hydrologic Process	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Precipitation	4.1	4.7	4.4	2.1	0.8	0.4	0.2	2.2	1.3	5.0	7.1	12.0	6.9
Surface Water Inflows	4.1	3.9	4.3	3.8	1.2	0.3	0.0	0.1	0.0	0.2	0.3	1.0	4.2
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.2	0.2	0.2	0.1	0.0	0.0	0.0	0.1	0.0	0.2	0.3	0.5	0.3
From Hamer (surface)	4.0	3.7	4.1	3.8	1.2	0.3	0.0	0.0	0.0	0.0	0.0	0.4	4.0
Subsurface Inflows	1.8	1.5	1.8	1.4	1.4	1.2	1.3	1.1	1.0	1.0	1.8	2.1	1.7
Evapotranspiration	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0
Recharge (-) Discharge (+)	*-4.0*	*-3.8*	*-3.6*	*-4.0*	*-4.0*	*-3.5*	*-2.0*	*-1.9*	*-1.0*	*-2.2*	*0.2*	*-1.8*	*-5.4*
Surface Water Outflows	-2.7	-3.4	-4.0	-1.4	0.0	0.0	0.0	-0.3	-0.1	0.0	-0.4	-5.8	-3.0
To Diversion Canal	-0.6	-1.0	-1.6	-0.9	0.0	0.0	0.0	-0.2	-0.1	0.0	-0.1	-0.4	-1.1
To West Edmond Marsh	-2.7	-3.2	-3.0	-0.6	0.0	0.0	0.0	-0.1	0.0	0.0	-0.3	-6.6	-2.4
Change in Storage	3.4	2.5	2.6	0.7	-3.8	-5.3	-5.0	-2.6	-1.1	3.1	8.7	6.7	5.0
Predicted WSE in ft													
EM-2S	210.80	210.69	210.56	210.31	209.89	209.42	209.01	209.00	209.00	209.26	209.98	210.50	210.59
East Edmond	212.66	212.60	212.56	212.57	212.25	211.81	211.43	211.43	211.43	211.69	212.39	212.39	212.61
Eastern East Edmond Marsh	212.88	213.00	212.86	212.62	212.30	211.86	211.44	211.14	211.02	211.27	211.96	212.89	213.10
Observed WSE in ft													
EM-2S	211.46	211.44	211.42	211.33	211.28	211.07	210.67	210.28	210.36	210.44	211.37	211.34	
East Edmond (EM-2E)	212.49	212.47	212.45	212.47	212.38	211.92	211.60	211.43	211.43	211.43	212.50	212.38	
East Edmond (EM-2W)	211.84	211.81	211.78	211.21	211.71	211.53	211.17	210.76	210.81	210.86	211.72	211.68	
East Edmond (EM-3E)	212.85	212.82	212.79	212.83	212.74	212.20	211.92	211.62	211.64	211.65	212.85	212.70	
East Edmond (EM-3W)	212.94	212.92	212.91	212.94	212.83	212.39	212.03	211.71	211.73	211.75	212.95	212.82	
Eastern East Edmond (SCM-1)	213.13	213.11	213.09	213.13	213.03	212.53	212.14	211.79	211.81	211.83	213.11	212.99	

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2017

Hydrologic Process	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Precipitation	5.8	5.9	1.8	1.0	2.3	1.3	0.2	1.5	9.3	6.9	3.9	3.4	8.6
Surface Water Inflows	4.0	4.4	3.4	1.8	2.5	1.7	0.1	0.0	0.4	1.3	3.6	4.1	3.9
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.2	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.4	0.3	0.2	0.1	0.3
From Hamer (surface)	3.8	4.2	3.3	1.7	2.4	1.7	0.1	0.0	0.0	1.0	3.5	4.0	3.6
Subsurface Inflows	1.7	1.8	1.8	1.9	1.8	1.8	1.6	1.5	1.6	2.2	2.2	2.0	1.6
Evapotranspiration	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6
Recharge (-) Discharge (+)	*-4.4*	*-5.3*	*-3.9*	*-3.1*	*-2.5*	*-2.2*	*-0.8*	*-0.4*	*-3.4*	*-2.6*	*-3.5*	*-6.4*	*-5.3*
Surface Water Outflows	-5.1	-2.8	-2.0	-0.9	-0.7	-0.6	-0.4	-0.2	-0.4	-3.0	-2.1	-1.9	-3.9
To Diversion Canal	-2.0	-1.3	-1.3	-0.6	-0.5	-0.4	-0.3	-0.1	-0.1	-0.3	-0.5	-0.7	-0.6
To West Edmond Marsh	-4.0	-2.0	-1.0	-0.4	-0.3	-0.3	-0.2	-0.1	-0.3	-3.2	-2.0	-1.5	-4.2
Change in Storage	2.5	3.6	0.1	-2.0	0.1	-2.2	-3.0	0.3	6.6	4.0	4.2	1.7	3.9
Predicted WSE in ft													
EM-2S	210.48	210.43	210.16	209.85	209.66	209.33	209.07	209.09	209.64	209.89	209.95	209.76	209.79
East Edmond	212.49	212.62	212.54	212.34	212.32	212.12	211.85	211.87	212.39	212.45	212.63	212.65	212.63
Eastern East Edmond Marsh	212.92	212.93	212.56	212.19	212.02	211.68	211.31	211.27	211.79	212.25	212.56	212.54	212.99
Observed WSE in ft													
EM-2S					211.28	211.15	210.81		210.79	211.31	211.32	211.17	211.47
East Edmond (EM-2E)					212.38	212.27	211.76		211.57	212.24	212.22	212.05	212.04
East Edmond (EM-2W)					211.68	211.57	211.27		211.29	211.90	211.78	211.57	211.59
East Edmond (EM-3E)					212.59	212.34	212.05		211.87	212.33	212.35	212.39	213.34
East Edmond (EM-3W)					212.81	212.60	212.19		212.00	212.69	212.66	212.50	212.46
Eastern East Edmond (SCM-1)					212.88	212.65	212.28		212.08	212.60	212.59	212.62	210.24

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY 2018

Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	8.7	4.6	2.8	1.8	0.0	0.1	1.0	5.2	7.2	5.8	7.2	3.3	2.3
Surface Water Inflows	4.4	4.2	4.2	3.1	0.0	0.1	0.1	0.2	1.9	3.6	4.5	3.8	4.3
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.2	0.3	0.2	0.3	0.1	0.1
From Hamer (surface)	4.1	4.1	4.1	3.0	0.0	0.1	0.1	0.0	1.6	3.4	4.2	3.7	4.2
Subsurface Inflows	2.2	2.0	1.9	2.0	2.3	2.5	2.2	2.7	2.4	2.3	2.0	1.9	2.1
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	*-2.8*	*-3.7*	*-4.9*	*-5.1*	*-2.8*	*-1.9*	*-1.9*	*-1.9*	*-3.2*	*-4.5*	*-5.7*	*-3.1*	*-5.3*
Surface Water Outflows	-8.6	-2.8	-1.4	-0.8	0.0	-0.4	-0.1	0.0	-0.7	-2.7	-3.5	-5.2	-1.0
To Diversion Canal	-3.2	-1.6	-0.9	-0.5	0.0	-0.2	-0.1	0.0	-0.2	-0.4	-0.6	-2.1	-0.7
To West Edmond Marsh	-7.0	-1.6	-0.6	-0.3	0.0	-0.1	0.0	0.0	-0.6	-2.8	-3.7	-3.9	-0.4
Change in Storage	4.2	3.6	0.3	-2.3	-5.0	-3.3	-0.9	5.2	7.2	4.3	4.3	1.4	1.6
Predicted WSE in ft													
EM-2S	209.80	209.76	209.44	209.00	209.00	209.00	209.00	209.43	209.90	209.98	209.98	209.80	209.58
East Edmond	212.40	212.57	212.54	212.32	211.90	211.61	211.53	211.96	212.51	212.64	212.69	212.48	212.58
Eastern East Edmond Marsh	212.76	212.61	212.33	211.96	211.54	211.16	211.05	211.47	212.02	212.44	212.87	212.55	212.46
Observed WSE in ft													
EM-2S	211.31	211.27		211.18	211.05	211.24	210.72			211.95		211.29	211.12
East Edmond (EM-2E)	212.14	212.21		212.34	212.18	211.95	211.82			212.59		212.35	212.14
East Edmond (EM-2W)	210.67	211.63		211.55	211.44	210.47	211.09			211.69		211.60	211.48
East Edmond (EM-3E)	212.37	212.47		212.67	212.88	212.52	212.03			212.56		212.51	212.40
East Edmond (EM-3W)	212.54	212.62		212.78	212.62	212.37	212.27			213.07		212.79	212.58
Eastern East Edmond (SCM-1)	212.62	212.68		212.95	212.65	212.56	212.64			212.89		212.76	212.65

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2019

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	6.1	0.7	0.9	0.2	0.3	1.8	4.0	3.8	6.4	3.4	4.8	1.6	3.6
Surface Water Inflows	3.7	0.8	1.5	0.2	0.0	0.1	0.2	0.2	0.3	3.0	3.1	3.0	2.8
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.2	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.1	0.2	0.0	0.1
From Hamer (surface)	3.5	0.8	1.4	0.2	0.0	0.0	0.0	0.0	0.0	2.8	2.9	3.0	2.7
Subsurface Inflows	1.9	1.9	1.9	2.0	1.8	1.7	1.9	2.3	2.7	2.3	1.9	1.9	1.6
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	*-4.5*	*-5.5*	*-4.7*	*-3.2*	*-2.8*	*-1.9*	*-4.9*	*-1.8*	*-2.8*	*-4.5*	*-4.6*	*-5.4*	*-5.0*
Surface Water Outflows	-2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.5	-2.2	-0.7	-0.6
To Diversion Canal	-0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.3	-0.4	-0.5	-0.4
To West Edmond Marsh	-2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.2	-2.3	-0.3	-0.2
Change in Storage	2.9	-5.3	-4.2	-5.3	-4.7	-0.7	0.1	3.9	6.5	3.9	2.3	-0.5	0.7
Predicted WSE in ft													
EM-2S	209.53	209.03	209.00	209.00	209.00	209.00	209.01	209.33	209.87	209.96	209.91	209.62	209.46
East Edmond	212.63	212.19	211.84	211.43	211.43	211.43	211.44	211.76	212.29	212.60	212.60	212.54	212.58
Eastern East Edmond Marsh	212.66	212.22	211.87	211.43	211.04	210.97	210.98	211.31	211.79	211.98	212.20	211.98	211.88
Observed WSE in ft													
EM-2S	211.17	211.08	211.17	211.01	210.61	210.70	210.71	211.07	211.35	211.39	211.14	211.24	211.37
East Edmond (EM-2E)	212.37	212.41	212.23	212.05	211.65	211.73	211.78	212.21	212.63		212.55	212.37	212.63
East Edmond (EM-2W)	211.51	211.24	211.59	211.44	211.01	211.12	211.07	211.66	211.70		211.48	211.66	211.89
East Edmond (EM-3E)	212.48						212.06	212.42	212.65	212.71	212.83	212.69	212.67
East Edmond (EM-3W)	212.81	212.81	212.50	212.50	212.14	212.19	212.19	212.64	212.98	212.50	213.00	212.81	213.06
Eastern East Edmond (SCM-1)	212.77	212.59	212.85	212.01	211.75	211.84	212.57					212.88	212.90

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2020

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	1.1	0.7	1.0	0.8	3.5	3.9	1.7	6.5	9.6	4.2	3.5	1.5	3.1
Surface Water Inflows	1.6	0.2	0.0	0.0	0.2	0.2	0.1	0.3	0.4	3.1	3.6	2.3	1.1
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.3	0.4	0.1	0.1	0.0	0.1
From Hamer (surface)	1.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	3.4	2.3	1.0
Subsurface Inflows	1.4	1.2	1.1	0.9	1.1	1.6	1.2	1.3	2.3	1.8	1.3	1.1	1.2
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	*-4.5*	*-3.3*	*-2.0*	*-2.2*	*-3.8*	*0.5*	*1.4*	*-3.1*	*-1.5*	*-4.6*	*-2.8*	*-2.2*	*-1.9*
Surface Water Outflows	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-1.0	-4.8	-2.2	-2.3	-1.0	-0.8
To Diversion Canal	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	-0.2	-0.5	-0.6	-0.7	-0.6
To West Edmond Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.2	-5.5	-2.2	-2.2	-0.5	-0.4
Change in Storage	-3.5	-4.9	-4.4	-4.5	-1.3	5.1	3.9	3.9	5.3	1.8	2.1	0.4	0.0
Predicted WSE in ft													
EM-2S	209.03	209.00	209.00	209.00	209.00	209.43	209.75	210.07	210.51	210.41	210.30	210.14	210.06
East Edmond	212.28	211.88	211.51	211.43	211.43	211.86	212.18	212.40	212.38	212.35	212.34	212.33	212.30
Eastern East Edmond Marsh	211.59	211.18	210.78	210.41	210.30	210.72	211.05	211.46	212.26	212.41	212.54	212.36	212.17
Observed WSE in ft													
EM-2S		210.80	210.49	210.07	210.20	210.34		210.30	211.41	210.49			
East Edmond (EM-2E)		211.91	211.55	211.43	211.43	211.44		211.43	212.60	212.45			
East Edmond (EM-2W)		211.58	210.92	210.54		210.77		211.58	211.69	211.66			
East Edmond (EM-3E)						211.90		211.74	212.80	212.80			
East Edmond (EM-3W)		212.37	212.00	211.54	212.27	211.89		212.16	213.03	212.89			
Eastern East Edmond (SCM-1)													

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY 2021

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.5	0.3	0.4	2.8	3.0	5.6	5.2	7.3	4.7	2.5	1.2	2.0	2.4
Surface Water Inflows	0.6	0.0	0.0	0.1	0.1	0.2	0.9	4.1	4.0	4.4	2.4	3.8	3.5
From Sequalitchew Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
From Center Drive	0.1	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.2	0.1	0.0	0.1	0.1
From Hamer (surface)	0.5	0.0	0.0	0.0	0.0	0.0	0.6	3.9	3.8	4.3	2.4	3.8	3.5
Subsurface Inflows	1.2	0.9	0.7	0.8	0.7	0.9	1.4	1.8	1.8	2.3	1.9	1.8	1.6
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	*-0.8*	*-2.1*	*-1.9*	*-0.1*	*2.3*	*7.1*	*8.4*	*5.0*	*2.2*	*0.1*	*0.0*	*1.7*	*1.9*
Surface Water Outflows	-0.7	0.0	0.0	-0.1	-0.1	-3.6	-7.2	-10.8	-7.4	-6.6	-1.4	-3.2	-4.6
To Diversion Canal	-0.5	0.0	0.0	0.0	-0.1	-0.2	-0.7	-3.3	-3.1	-3.3	-0.6	-0.7	-1.8
To West Edmond Marsh	-0.3	0.0	0.0	0.0	-0.1	-4.1	-8.3	-9.8	-5.8	-4.2	-1.0	-3.2	-3.6
Change in Storage	-0.5	-5.4	-4.8	1.2	5.0	9.2	7.6	8.5	6.4	3.8	2.5	3.0	2.2
Predicted WSE in ft													
EM-2S	209.97	209.51	209.12	209.22	209.64	210.41	210.99	211.37	211.58	211.54	211.55	211.49	211.38
East Edmond	212.23	211.78	211.43	211.53	211.94	212.37	212.32	212.20	212.25	212.21	212.34	212.32	212.21
Eastern East Edmond Marsh	211.95	211.50	211.10	211.18	211.56	212.56	213.00	213.00	212.99	212.49	212.55	212.80	212.62
Observed WSE in ft													
EM-2S		210.83	210.33		210.25			211.47			211.31	211.27	211.13
East Edmond (EM-2E)		211.43	211.43		211.43	212.93		212.54			212.27	212.16	212.04
East Edmond (EM-2W)			210.76		210.69			211.77	212.14	212.14	211.70	211.69	211.51
East Edmond (EM-3E)					211.47	212.18		212.88	213.54	212.83	212.43		
East Edmond (EM-3W)			211.69		211.56	212.50		212.99	212.50	212.50	212.73	212.60	212.50
Eastern East Edmond (SCM-1)													

Table F-14. Water Balance for East Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY 2021

Hydrologic Process	Jul	Aug	Sep
Precipitation	0.0	0.3	2.6
Surface Water Inflows	0.0	0.3	2.7
From Sequalitchew Lake	0.0	0.0	0.0
From Center Drive	0.0	0.0	0.1
From Hamer (surface)	0.0	0.3	2.6
Subsurface Inflows	1.7	1.7	1.8
Evapotranspiration	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	*3.0*	*0.4*	*0.1*
Surface Water Outflows	-1.4	-0.8	-0.6
To Diversion Canal	-1.0	-0.5	-0.4
To West Edmond Marsh	-0.6	-0.3	-0.2
Change in Storage	-0.4	-1.7	4.7
Predicted WSE in ft			
EM-2S	211.34	211.18	211.35
East Edmond	212.12	211.94	212.32
Eastern East Edmond Marsh	212.27	211.95	212.19
Observed WSE in ft			
EM-2S	210.73		
East Edmond (EM-2E)	211.69	211.43	
East Edmond (EM-2W)	211.14		
East Edmond (EM-3E)			
East Edmond (EM-3W)	212.23	211.56	
Eastern East Edmond (SCM-1)		210.20	

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water	WY2004						WY2005						
Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	2.0	1.0	3.8	0.9	0.1	3.6	2.9	4.0	3.2	4.3	4.3	0.6	4.5
Surface Water Inflows	-8.8	0.0	1.0	0.0	0.0	0.3	0.0	0.0	1.3	1.7	3.0	0.0	3.1
From East Edmond	-8.8	0.0	1.0	0.0	0.0	0.3	0.0	0.0	1.3	1.7	3.0	0.0	3.1
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	-44.6	-33.6	-11.5	2.8	4.4	0.1	-0.6	-2.9	-3.9	-6.0	-7.3	-0.1	-6.3
Surface Water Outflows	0.0	-0.3	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To Center Drive	0.0	-0.3	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change in Storage	-52.6	-34.9	-10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	209.04	206.13	205.31	205.31	205.31	205.31	205.31	205.31	205.31	205.31	205.31	205.31	205.31
Observed WSE EM-1/EM-1A	209.10	208.59	207.26	206.55	205.27	205.27	205.27	205.86	206.15	207.67	209.18	207.97	206.63

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2006

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	5.4	3.9	3.8	1.4	0.2	1.6	3.3	6.7	6.5	12.2	3.2	2.6	3.9
Surface Water Inflows	5.3	3.4	6.1	2.8	0.0	0.0	0.0	0.0	0.0	106.7	0.7	1.9	6.8
From East Edmond	5.3	3.4	6.1	2.8	0.0	0.0	0.0	0.0	0.0	106.7	0.7	1.9	6.8
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	-8.8	-4.1	-6.2	0.3	3.8	0.7	-2.3	-6.2	-6.5	-26.0	-23.2	-23.0	-15.3
Surface Water Outflows	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-46.1	-0.3	-0.3	-0.1
To Center Drive	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-46.1	-0.3	-0.3	-0.1
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.7	-20.2	-20.0	-6.7
Predicted WSE in ft	205.31	205.31	205.31	205.31	205.31	205.31	205.31	205.31	205.31	209.20	207.52	205.86	205.31
Observed WSE EM-1/EM-1A	209.29	209.08	207.09	205.79	205.27	205.27	205.27	206.05	208.15	208.82	208.53	208.69	208.78

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2007

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	2.1	2.2	0.4	0.0	0.8	1.6	14.4	8.6	6.5	4.5	5.7	1.7	1.1
Surface Water Inflows	4.8	3.4	0.0	0.7	0.0	0.0	111.0	13.0	8.7	9.9	20.2	1.5	1.8
From East Edmond	4.8	3.4	0.0	0.7	0.0	0.0	111.0	13.0	8.7	9.9	20.2	1.5	1.8
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	-3.7	-1.9	4.1	3.3	1.5	-0.6	-28.1	-25.8	-23.8	-21.9	-23.2	-21.5	-5.2
Surface Water Outflows	0.0	0.0	0.0	0.0	0.0	0.0	-50.1	-0.3	-0.3	-0.2	-0.2	-0.2	-0.1
To Center Drive	0.0	0.0	0.0	0.0	0.0	0.0	-50.1	-0.3	-0.3	-0.2	-0.2	-0.2	-0.1
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	46.7	-4.6	-9.0	-8.3	1.2	-20.5	-5.6
Predicted WSE in ft	205.31	205.31	205.31	205.31	205.31	205.31	209.20	208.82	208.07	207.38	207.48	205.77	205.31
Observed WSE EM-1/EM-1A	207.56	207.10	205.67	205.27	205.27	205.27	208.74	208.94	208.71	208.75	208.84	208.70	207.84

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY2008

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.7	1.5	1.0	1.7	5.0	2.8	7.7	4.2	3.6	4.9	1.8	1.3	1.7
Surface Water Inflows	3.6	2.9	1.9	0.8	4.7	23.5	80.7	4.3	11.5	9.6	8.4	5.0	3.7
From East Edmond	3.6	2.9	1.9	0.8	4.7	23.5	80.7	4.3	11.5	9.6	8.4	5.0	3.7
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	-2.6	0.1	1.0	-0.2	-8.7	-25.8	-34.8	-28.2	-24.7	-23.0	-14.6	-3.1	-1.6
Surface Water Outflows	0.0	0.0	0.0	0.0	0.0	0.0	-6.9	-0.3	-0.2	-0.2	-0.1	0.0	0.0
To Center Drive	0.0	0.0	0.0	0.0	0.0	0.0	-6.9	-0.3	-0.2	-0.2	-0.1	0.0	0.0
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	46.7	-19.9	-10.4	-10.0	-6.5	0.0	0.0
Predicted WSE in ft	205.31	205.31	205.31	205.31	205.31	205.31	209.20	207.54	206.68	205.85	205.31	205.31	205.31
Observed WSE EM-1/EM-1A	206.92	205.84	205.63	205.62	207.09	207.82	209.17	209.07	209.02	209.23	209.03	206.96	206.38

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY2009

Hydrologic Process	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Precipitation	0.9	2.1	0.5	2.6	8.3	5.2	7.3	1.6	5.3	3.5	3.4	1.3	0.0
Surface Water Inflows	2.4	0.8	0.4	0.0	29.7	11.2	21.4	1.7	41.9	3.6	9.5	5.1	0.0
From East Edmond	2.4	0.8	0.4	0.0	29.7	11.2	21.4	1.7	41.9	3.6	9.5	5.1	0.0
Evapotranspiration	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5
Recharge (-) Discharge (+)	1.2	1.1	1.4	-1.5	-26.5	-23.0	-20.5	-15.0	-27.6	-22.8	-10.0	-2.7	4.5
Surface Water Outflows	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	-0.2	0.0	0.0	0.0
To Center Drive	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	-0.2	0.0	0.0	0.0
Change in Storage	0.0	0.0	0.0	0.0	11.0	-6.8	8.1	-12.4	18.3	-17.8	-0.4	0.0	0.0
Predicted WSE in ft	205.31	205.31	205.31	205.31	206.22	205.66	206.34	205.31	206.83	205.35	205.31	205.31	205.31
Observed WSE EM-1/EM-1A	205.27	205.27		205.27	208.19	208.61	208.52	208.60	209.22	209.09	208.22	206.01	205.27

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY2010

Hydrologic Process	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Precipitation	1.9	2.8	5.6	8.9	3.0	8.0	3.3	3.3	3.3	4.6	4.3	0.4	0.2
Surface Water Inflows	1.3	0.0	0.1	69.6	2.8	14.7	12.1	1.8	11.5	28.6	4.0	0.0	0.0
From East Edmond	1.3	0.0	0.1	69.6	2.8	14.7	12.1	1.8	11.5	28.6	4.0	0.0	0.0
Evapotranspiration	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0
Recharge (-) Discharge (+)	0.8	-0.5	-4.7	-33.3	-29.2	-21.3	-21.3	-16.7	-15.5	-20.8	-13.8	4.1	3.8
Surface Water Outflows	0.0	0.0	0.0	0.0	-0.3	-0.2	-0.2	-0.2	0.0	0.0	-0.1	0.0	0.0
To Center Drive	0.0	0.0	0.0	0.0	-0.3	-0.2	-0.2	-0.2	0.0	0.0	-0.1	0.0	0.0
Change in Storage	0.0	0.0	0.0	44.8	-23.7	1.1	-6.6	-13.0	-2.6	9.2	-9.3	0.0	0.0
Predicted WSE in ft	205.31	205.31	205.31	209.04	207.07	207.16	206.61	205.53	205.31	206.08	205.31	205.31	205.31
Observed WSE EM-1/EM-1A	205.27	205.27	205.98	209.21	209.55	208.68	208.58	208.34	209.17	207.87	207.82	206.07	206.07

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY2011

Hydrologic Process	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precipitation	4.0	4.2	6.6	7.2	6.1	3.1	7.2	5.7	4.8	2.8	0.8	0.3	1.3
Surface Water Inflows	1.6	2.7	50.6	1.0	10.9	8.8	17.6	17.8	3.1	8.1	0.0	0.0	0.0
From East Edmond	1.6	2.7	50.6	1.0	10.9	8.8	17.6	17.8	3.1	8.1	0.0	0.0	0.0
Evapotranspiration	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	-3.2	-5.8	-29.7	-21.0	-20.5	-19.0	-21.9	-22.0	-8.1	-7.1	3.7	3.7	1.0
Surface Water Outflows	0.0	0.0	0.0	-0.3	-0.2	-0.1	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0
To Center Drive	0.0	0.0	0.0	-0.3	-0.2	-0.1	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0
Change in Storage	0.0	0.0	27.0	-13.1	-3.7	-7.9	1.6	-0.5	-3.5	0.0	0.0	0.0	0.0
Predicted WSE in ft	205.31	205.31	207.56	206.47	206.16	205.50	205.64	205.60	205.31	205.31	205.31	205.31	205.31
Observed WSE EM-1/EM-1A	206.07	206.05	208.98	209.46	207.57		208.99	209.34	209.95		207.28	206.60	206.03

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water	WY2012												WY2013
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Precipitation	4.1	6.1	3.2	7.2	3.9	6.8	4.3	3.1	3.3	1.6	0.0	0.1	6.5
Surface Water Inflows	0.0	23.6	28.1	27.2	7.5	21.1	10.0	11.1	7.1	6.1	4.3	0.0	1.4
From East Edmond	0.0	23.6	28.1	27.2	7.5	21.1	10.0	11.1	7.1	6.1	4.3	0.0	1.4
Evapotranspiration	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0
Recharge (-) Discharge (+)	-3.0	-28.5	-26.2	-24.0	-19.1	-22.9	-22.1	-12.2	-6.7	-3.2	-0.4	2.2	-6.9
Surface Water Outflows	0.0	0.0	0.0	-0.1	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0
To Center Drive	0.0	0.0	0.0	-0.1	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0
Change in Storage	0.0	0.8	5.1	10.3	-8.5	3.6	-10.0	-1.3	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	205.31	205.38	205.80	206.66	205.95	206.24	205.41	205.31	205.31	205.31	205.31	205.31	205.31
Observed WSE EM-1/EM-1A	206.28	206.94	207.83	209.23	209.32	209.55	209.78	209.52	209.14		206.36	205.73	206.56

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY2014

Hydrologic Process	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Precipitation	6.5	7.6	3.5	1.7	3.7	5.5	4.4	1.9	0.0	1.6	6.9	2.6	4.1
Surface Water Inflows	26.3	24.2	8.1	5.7	30.5	7.8	2.7	6.9	0.0	3.4	1.8	3.8	21.7
From East Edmond	26.3	24.2	8.1	5.7	30.5	7.8	2.7	6.9	0.0	3.4	1.8	3.8	21.7
Evapotranspiration	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5
Recharge (-) Discharge (+)	-27.6	-26.2	-18.4	-10.2	-22.4	-17.5	-7.9	-5.1	4.5	-1.0	-6.4	-5.4	-21.6
Surface Water Outflows	0.0	-0.1	-0.1	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
To Center Drive	0.0	-0.1	-0.1	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
Change in Storage	4.7	5.5	-6.9	-3.4	10.5	-6.4	-4.1	0.0	0.0	0.0	0.0	0.0	3.7
Predicted WSE in ft	205.70	206.16	205.59	205.31	206.18	205.65	205.31	205.31	205.31	205.31	205.31	205.31	205.62
Observed WSE EM-1/EM-1A	208.21	209.83	209.07	209.27	209.37	209.44	208.41	207.37	205.95	206.06	206.17	208.73	208.72

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2015

Hydrologic Process	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation	2.4	4.2	6.9	9.8	4.5	3.3	1.3	1.2	1.6	1.8	5.9	6.1	4.8
Surface Water Inflows	2.6	44.7	14.5	16.3	17.2	1.9	8.0	6.1	4.2	2.6	2.4	36.7	14.4
From East Edmond	2.6	44.7	14.5	16.3	17.2	1.9	8.0	6.1	4.2	2.6	2.4	36.7	14.4
Evapotranspiration	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0
Recharge (-) Discharge (+)	-8.6	-23.6	-22.2	-24.7	-25.4	-18.6	-6.5	-2.8	-1.8	-2.1	-7.3	-22.8	-22.6
Surface Water Outflows	-0.1	0.0	-0.2	-0.2	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
To Center Drive	-0.1	0.0	-0.2	-0.2	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
Change in Storage	-3.8	25.2	-1.5	0.0	-5.9	-16.8	-1.0	0.0	0.0	0.0	0.0	19.5	-3.6
Predicted WSE in ft	205.31	207.41	207.28	207.28	206.79	205.39	205.31	205.31	205.31	205.31	205.31	206.94	206.64
Observed WSE EM-1/EM-1A	207.55	208.55	209.72	209.98	210.01	209.99	209.05	205.30	205.87	206.07	208.63	208.73	209.84

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2016

Hydrologic Process	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Precipitation	4.1	4.7	4.4	2.1	0.8	0.4	0.2	2.2	1.3	5.0	7.1	12.0	6.9
Surface Water Inflows	11.9	14.2	13.5	3.8	0.0	0.0	0.0	1.6	0.6	0.1	4.7	120.1	5.4
From East Edmond	11.9	14.2	13.5	3.8	0.0	0.0	0.0	1.6	0.6	0.1	4.7	120.1	5.4
Evapotranspiration	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0
Recharge (-) Discharge (+)	-18.8	-19.8	-20.8	-11.0	2.3	3.3	4.2	0.2	1.0	-4.1	-33.8	-27.9	-24.6
Surface Water Outflows	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-97.8	-0.1
To Center Drive	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-97.8	-0.1
Change in Storage	-3.0	-1.6	-4.3	-7.2	0.0	0.0	0.0	0.0	0.6	0.0	-22.5	6.3	-12.5
Predicted WSE in ft	206.39	206.26	205.90	205.31	205.31	205.31	205.31	205.31	205.36	205.31	205.31	209.57	206.03
Observed WSE EM-1/EM-1A	209.79	209.76	209.74	209.48	207.29	205.54	205.27	205.27	205.27	205.27	209.37	210.02	

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2017

Hydrologic Process	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Precipitation	5.8	5.9	1.8	1.0	2.3	1.3	0.2	1.5	9.3	6.9	3.9	3.4	8.6
Surface Water Inflows	17.6	7.4	6.3	7.4	5.3	4.8	3.1	0.5	5.8	19.6	36.2	3.4	78.2
From East Edmond	17.6	7.4	6.3	7.4	5.3	4.8	3.1	0.5	5.8	19.6	36.2	3.4	78.2
Evapotranspiration	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6
Recharge (-) Discharge (+)	-23.2	-20.3	-24.1	-17.4	-15.6	-5.5	3.8	-0.7	-10.9	-29.2	-21.4	-18.9	-14.2
Surface Water Outflows	-0.2	-0.2	0.0	0.0	-0.4	0.0	0.0	0.0	0.0	0.0	-1.3	-0.1	-29.3
To Center Drive	-0.2	-0.2	0.0	0.0	-0.4	0.0	0.0	0.0	0.0	0.0	-1.3	-0.1	-29.3
Change in Storage	-0.6	-8.5	-18.1	-12.2	-12.1	-3.9	3.1	-1.1	3.1	-3.2	17.4	-12.2	42.6
Predicted WSE in ft	207.11	205.90	205.31	205.31	205.31	205.31	205.57	205.31	205.57	205.31	209.01	205.46	209.71
Observed WSE EM-1/EM-1A					208.90	206.26	205.31		206.87	208.72	209.45	209.29	209.86

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2018

Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	8.7	4.6	2.8	1.8	0.0	0.1	1.0	5.2	7.2	5.8	7.2	3.3	2.3
Surface Water Inflows	16.1	6.8	11.2	2.0	0.0	2.4	0.2	0.3	10.1	52.9	8.4	73.8	1.0
From East Edmond	16.1	6.8	11.2	2.0	0.0	2.4	0.2	0.3	10.1	52.9	8.4	73.8	1.0
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	-15.1	-16.2	-10.9	-6.2	4.5	3.9	1.3	-4.2	-23.5	-13.5	-21.8	-18.2	-21.7
Surface Water Outflows	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-21.9	0.0
To Center Drive	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-21.9	0.0
Change in Storage	8.4	-6.7	-0.2	-6.0	0.0	2.4	0.2	0.3	-6.7	45.1	-6.2	36.4	-19.7
Predicted WSE in ft	206.21	205.31	205.58	205.31	205.31	205.51	205.33	205.33	205.31	209.13	205.31	209.69	205.31
Observed WSE EM-1/EM-1A	210.22	208.64		209.58	207.22	206.67	205.31			209.98		209.98	209.67

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water — WY2019

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	6.1	0.7	0.9	0.2	0.3	1.8	4.0	3.8	6.4	3.4	4.8	1.6	3.6
Surface Water Inflows	43.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	1.6	4.2	14.3	1.4	4.5
From East Edmond	43.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	1.6	4.2	14.3	1.4	4.5
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	-22.3	-7.9	-4.4	-1.8	-0.7	0.6	-4.3	-28.8	-35.7	-13.6	-11.8	-25.0	-18.2
Surface Water Outflows	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.5	0.0	0.0	-0.5
To Center Drive	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.5	0.0	0.0	-0.5
Change in Storage	24.4	-10.5	-7.1	-6.1	-4.3	0.2	-1.4	-25.5	-28.0	-6.6	6.7	-23.4	-12.7
Predicted WSE in ft	208.28	205.31	205.31	205.31	205.31	205.32	205.31	205.31	205.31	205.61	206.15	205.31	205.31
Observed WSE EM-1/EM-1A	209.97	208.18	205.31	205.31	205.31	205.31	205.31	206.55	209.32	209.38	209.41	208.53	208.79

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY2020

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	1.1	0.7	1.0	0.8	3.5	3.9	1.7	6.5	9.6	4.2	3.5	1.5	3.1
Surface Water Inflows	0.0	0.0	0.8	0.0	0.0	0.0	0.0	21.4	23.9	9.3	9.7	2.8	6.4
From East Edmond	0.0	0.0	0.8	0.0	0.0	0.0	0.0	21.4	23.9	9.3	9.7	2.8	6.4
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	-5.1	-3.9	3.5	-0.2	-3.0	-6.7	-22.9	-14.2	-15.0	-21.9	-29.6	-29.2	-16.0
Surface Water Outflows	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	-0.3	-0.3	-0.4	-0.9
To Center Drive	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	-0.3	-0.3	-0.4	-0.9
Change in Storage	-7.4	-6.9	0.8	-3.4	-1.8	-3.8	-21.7	13.6	18.5	-9.2	-17.9	-27.2	-10.5
Predicted WSE in ft	205.31	205.31	205.38	205.31	205.31	205.31	205.31	206.75	206.85	206.64	205.79	205.31	205.92
Observed WSE EM-1/EM-1A		205.31	205.31	205.31	205.31	205.31		206.97	209.81	209.35			

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY2021

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.5	0.3	0.4	2.8	3.0	5.6	5.2	7.3	4.7	2.5	1.2	2.0	2.4
Surface Water Inflows	1.8	0.0	0.0	0.4	0.9	69.3	18.5	42.5	12.5	17.7	4.3	19.2	15.4
From East Edmond	1.8	0.0	0.0	0.4	0.9	69.3	18.5	42.5	12.5	17.7	4.3	19.2	15.4
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	-4.8	-1.9	-0.6	-3.0	-4.3	-29.4	-29.4	-19.6	-20.8	-21.0	-8.0	-0.8	1.3
Surface Water Outflows	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.2	-0.1	-0.1	-0.1	0.0	0.0
To Center Drive	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.2	-0.1	-0.1	-0.1	0.0	0.0
Change in Storage	-4.3	-6.1	-4.2	-2.1	-1.5	44.9	-5.8	30.1	-4.2	-2.1	-4.5	17.3	15.4
Predicted WSE in ft	205.31	205.31	205.31	205.31	205.31	209.05	206.46	209.14	206.04	206.08	205.52	206.75	206.59
Observed WSE EM-1/EM-1A			205.31		205.31	206.87		209.40	209.72	209.15	208.13	205.31	205.31

Table F-15. Water Balance for West Edmond Marsh with Mining - Low Groundwater

Monthly Average in Inches of Water WY2021

Hydrologic Process	Jul	Aug	Sep
Precipitation	0.0	0.3	2.6
Surface Water Inflows	2.5	2.0	4.2
From East Edmond	2.5	2.0	4.2
Evapotranspiration	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	4.5	2.1	-0.9
Surface Water Outflows	0.0	0.0	0.0
To Center Drive	0.0	0.0	0.0
Change in Storage	2.5	0.4	3.6
Predicted WSE in ft	205.52	205.34	205.61
Observed WSE EM-1/EM-1A	205.31	206.87	

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water	WY2004					WY2005							
Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	2.0	1.0	3.8	0.9	0.1	3.6	2.9	4.0	3.2	4.3	4.3	0.6	4.5
Surface Water Inflows	6.3	1.5	17.0	1.4	0.0	17.4	12.3	18.7	11.7	19.0	18.4	0.3	21.4
Runoff from Ft. Lewis - Outfall 002	3.8	0.8	10.4	0.7	0.0	10.7	7.5	11.5	7.2	11.7	11.3	0.0	13.2
Runoff from Ft. Lewis - Outfall 003	2.5	0.7	6.5	0.7	0.0	6.7	4.8	7.2	4.5	7.3	7.1	0.3	8.3
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	-2.6	-2.0	-4.3	-3.7	-3.0	-5.3	-4.8	-6.2	-6.1	-5.1	-2.2	-3.6	-7.6
Surface Water Outflows	-7.4	-2.4	-0.6	-2.3	0.0	0.0	0.0	0.0	-2.2	-10.3	-17.5	-0.9	-1.4
To Diversion Canal	-4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-7.6	-14.3	0.0	-0.6
To E. East Edmond (surface)	-2.6	-2.4	-0.6	-2.3	0.0	0.0	0.0	0.0	-2.2	-2.7	-3.2	-0.9	-0.8
Subsurface Outflows	-6.2	-4.2	-5.6	-3.5	-3.2	-4.1	-4.5	-5.7	-4.6	-5.2	-4.9	-3.9	-5.6
Change in Storage	-9.2	-8.1	7.2	-10.8	-10.6	7.6	3.6	9.8	1.5	2.7	-1.9	-8.1	10.0
Predicted WSE in feet													
Bell	218.34	217.66	218.26	217.36	216.48	217.11	217.41	218.23	218.35	218.58	218.42	217.74	218.58
McKay	216.19	215.51	216.11	215.21	214.33	214.96	215.26	216.08	216.20	216.43	216.27	215.59	216.43
Hamer	214.91	214.23	214.83	213.93	213.05	213.68	213.98	214.80	214.92	215.15	214.99	214.31	215.15
Observed WSE ('04) in feet													
Bell						216.36	217.40	217.36	217.72	218.30	219.11	217.92	216.95
McKay	216.19	215.81	214.71	214.26				213.70	213.84	214.35	215.15	214.68	213.74
Hamer	214.41	214.17	213.61	213.34	212.76	211.93	212.68	212.95	213.27	213.50	213.93	213.69	213.28

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2006

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	5.4	3.9	3.8	1.4	0.2	1.6	3.3	6.7	6.5	12.2	3.2	2.6	3.9
Surface Water Inflows	24.9	16.4	14.9	3.4	0.0	6.1	21.6	46.3	33.2	87.3	10.6	9.0	16.1
Runoff from Ft. Lewis - Outfall 002	15.3	10.1	9.2	2.0	0.0	3.6	13.2	28.3	20.3	52.6	6.5	5.5	9.9
Runoff from Ft. Lewis - Outfall 003	9.6	6.3	5.8	1.4	0.0	2.5	8.3	18.0	12.9	34.7	4.1	3.5	6.2
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	-2.3	-3.0	-2.9	-4.2	-11.3	-9.5	-9.4	-5.9	-4.1	0.9	-1.4	-1.8	-2.8
Surface Water Outflows	-23.2	-6.8	-14.6	-1.8	0.0	0.0	0.0	-11.3	-30.9	-94.5	-10.9	-2.5	-7.4
To Diversion Canal	-20.1	-3.9	-11.4	0.0	0.0	0.0	0.0	-11.3	-27.6	-91.3	-8.0	0.0	-4.8
To E. East Edmond (surface)	-3.1	-2.9	-3.1	-1.8	0.0	0.0	0.0	0.0	-3.2	-3.2	-2.9	-2.5	-2.6
Subsurface Outflows	-4.7	-5.3	-4.1	-3.6	-1.8	-1.8	-3.7	-7.4	-4.9	-5.6	-4.4	-5.3	-5.3
Change in Storage	-1.9	1.9	-6.5	-9.3	-16.9	-5.9	10.8	27.9	-0.3	0.3	-3.5	0.9	2.6
Predicted WSE in feet													
Bell	218.42	218.58	218.04	217.26	215.85	215.36	216.26	218.58	218.56	218.58	218.29	218.36	218.58
McKay	216.27	216.43	215.89	215.11	213.70	213.57	214.47	216.79	216.77	216.79	216.50	216.57	216.79
Hamer	214.99	215.15	214.61	213.83	212.42	211.93	212.83	215.15	215.13	215.15	214.86	214.93	215.15
Observed WSE ('04) in feet													
Bell			218.33	217.05	215.63			218.25	217.95				
McKay	216.07	215.43	214.48	213.57				214.39	214.34	216.95	216.28	216.60	216.49
Hamer	214.26	214.05	213.69	213.13	212.13	211.67	211.69	213.20	213.27	214.09	213.65	214.13	214.14

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2007

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	2.1	2.2	0.4	0.0	0.8	1.6	14.4	8.6	6.5	4.5	5.7	1.7	1.1
Surface Water Inflows	6.5	6.9	0.0	0.0	1.1	6.0	153.8	50.6	33.2	17.8	27.6	4.5	2.2
Runoff from Ft. Lewis - Outfall 002	3.9	4.2	0.0	0.0	0.5	3.6	92.3	30.8	20.3	10.9	16.9	2.7	1.2
Runoff from Ft. Lewis - Outfall 003	2.5	2.7	0.0	0.0	0.6	2.4	61.5	19.8	12.9	6.9	10.7	1.8	1.0
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	0.3	-1.0	-1.1	-1.3	-1.9	-3.7	2.7	2.7	1.1	0.2	0.9	-0.4	0.0
Surface Water Outflows	-8.2	-1.5	-0.4	0.0	0.0	0.0	-129.6	-56.2	-35.2	-16.9	-27.4	-6.2	-1.6
To Diversion Canal	-4.9	0.0	0.0	0.0	0.0	0.0	-129.6	-52.9	-32.0	-14.0	-24.2	-3.3	0.0
To E. East Edmond (surface)	-3.2	-1.5	-0.4	0.0	0.0	0.0	0.0	-3.2	-3.2	-2.9	-3.2	-2.9	-1.6
Subsurface Outflows	-4.6	-4.6	-3.8	-3.2	-3.0	-2.9	-8.8	-5.8	-5.6	-5.0	-5.6	-4.4	-4.3
Change in Storage	-7.0	-1.8	-9.4	-8.5	-5.3	0.0	32.0	0.0	0.0	0.0	0.0	-6.8	-5.9
Predicted WSE in feet													
Bell	218.00	217.85	217.06	216.36	215.91	215.91	218.58	218.58	218.58	218.58	218.58	218.02	217.53
McKay	216.20	216.06	215.27	214.57	214.12	214.12	216.79	216.79	216.79	216.79	216.79	216.23	215.74
Hamer	214.57	214.42	213.63	212.93	212.48	212.48	215.15	215.15	215.15	215.15	215.15	214.59	214.10
Observed WSE ('04) in feet													
Bell			218.46	217.75	217.19	216.57							
McKay	216.06	216.27	214.34	213.60			216.87	217.29	217.02	216.97	216.90	217.35	216.64
Hamer	214.89	214.08	213.26	212.65	212.31	212.19	214.53	215.05	214.60	214.64	214.72	214.14	214.21

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2008

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.7	1.5	1.0	1.7	5.0	2.8	7.7	4.2	3.6	4.9	1.8	1.3	1.7
Surface Water Inflows	9.6	4.3	2.1	5.5	27.8	9.6	44.6	17.9	13.5	22.9	4.7	2.8	4.6
Runoff from Ft. Lewis - Outfall 002	5.9	2.5	1.1	3.3	17.1	5.9	27.2	11.0	8.3	14.1	2.8	1.6	2.8
Runoff from Ft. Lewis - Outfall 003	3.7	1.7	1.0	2.2	10.8	3.7	17.4	6.9	5.2	8.9	1.9	1.2	1.9
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	-1.8	-1.3	-1.4	-1.0	-4.3	-2.9	0.4	-0.4	-0.8	-1.1	-1.1	0.3	-1.9
Surface Water Outflows	-0.1	-0.6	0.0	0.0	0.0	-10.1	-40.3	-17.1	-13.1	-17.1	-6.5	-1.5	-0.3
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	-7.2	-38.5	-13.9	-10.3	-14.4	-3.5	0.0	0.0
To E. East Edmond (surface)	-0.1	-0.6	0.0	0.0	0.0	-2.9	-1.7	-3.2	-2.9	-2.7	-3.0	-1.5	-0.3
Subsurface Outflows	-4.8	-4.2	-3.8	-4.0	-6.8	-4.2	-6.1	-5.3	-4.8	-5.7	-4.3	-4.5	-4.1
Change in Storage	1.9	-4.9	-6.0	-0.1	20.7	-5.3	6.3	-0.6	-2.1	2.7	-7.3	-4.8	-3.6
Predicted WSE in feet													
Bell	217.69	217.28	216.77	216.77	218.50	218.05	218.58	218.53	218.35	218.58	217.97	217.57	217.27
McKay	215.89	215.49	214.98	214.98	216.70	216.26	216.79	216.74	216.56	216.79	216.18	215.78	215.48
Hamer	214.26	213.85	213.34	213.34	215.07	214.62	215.15	215.10	214.92	215.15	214.54	214.14	213.84
Observed WSE ('04) in feet													
Bell				218.18									
McKay	216.01	214.98	214.26	213.68	215.97	214.67	216.83	216.83	216.91	216.98	215.93	215.06	214.63
Hamer	213.85	213.68	213.29	213.04	213.88	213.81	214.52	214.47	214.43	214.52	214.23	214.75	213.55

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2009

Hydrologic Process	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Precipitation	0.9	2.1	0.5	2.6	8.3	5.2	7.3	1.6	5.3	3.5	3.4	1.3	0.0
Surface Water Inflows	1.5	7.8	0.2	11.8	57.5	23.9	39.9	3.6	25.4	13.0	13.2	3.0	0.0
Runoff from Ft. Lewis - Outfall 002	0.8	4.7	0.0	7.2	35.0	14.7	24.4	2.2	15.6	8.0	8.1	1.7	0.0
Runoff from Ft. Lewis - Outfall 003	0.8	3.1	0.2	4.6	22.5	9.2	15.6	1.5	9.8	5.0	5.1	1.3	0.0
Evapotranspiration	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5
Recharge (-) Discharge (+)	-2.1	-3.0	-2.1	-4.3	-1.2	-2.3	-0.5	-1.7	-1.7	-1.6	-2.4	-2.6	-3.7
Surface Water Outflows	0.0	0.0	0.0	0.0	-31.7	-22.3	-40.6	-5.2	-15.5	-13.0	-2.2	-4.3	0.0
To Diversion Canal	0.0	0.0	0.0	0.0	-31.7	-19.1	-37.6	-2.6	-13.8	-9.9	0.0	-2.1	0.0
To E. East Edmond (surface)	0.0	0.0	0.0	0.0	0.0	-3.2	-3.1	-2.6	-1.7	-3.1	-2.2	-2.3	0.0
Subsurface Outflows	-3.5	-3.6	-2.8	-3.7	-7.2	-5.1	-5.4	-4.1	-5.8	-4.5	-5.4	-3.9	-3.3
Change in Storage	-7.7	-0.6	-6.5	5.3	25.3	-0.6	0.6	-6.3	6.3	-4.6	3.3	-10.2	-11.4
Predicted WSE in feet													
Bell	216.63	216.58	216.03	216.48	218.58	218.53	218.58	218.05	218.58	218.20	218.48	217.63	216.68
McKay	214.83	214.78	214.24	214.68	216.79	216.74	216.79	216.26	216.79	216.41	216.69	215.84	214.88
Hamer	213.20	213.15	212.60	213.05	215.15	215.10	215.15	214.62	215.15	214.77	215.05	214.20	213.25
Observed WSE ('04) in feet													
Bell													
McKay					216.11	214.61	216.38	215.34	216.31	215.69	215.73	214.44	
Hamer	212.98	212.63	212.51	212.39	214.37	213.94	214.42	214.08	214.34	214.18	214.24	213.49	212.68

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2010

Hydrologic Process	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Precipitation	1.9	2.8	5.6	8.9	3.0	8.0	3.3	3.3	3.3	4.6	4.3	0.4	0.2
Surface Water Inflows	6.7	11.5	31.3	52.2	10.6	47.2	11.4	13.0	12.3	20.9	17.6	0.0	0.0
Runoff from Ft. Lewis - Outfall 002	4.0	7.1	19.2	31.7	6.5	28.8	7.0	8.0	7.5	12.9	10.8	0.0	0.0
Runoff from Ft. Lewis - Outfall 003	2.6	4.5	12.1	20.5	4.1	18.5	4.4	5.0	4.8	8.1	6.8	0.0	0.0
Evapotranspiration	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0
Recharge (-) Discharge (+)	-3.6	-4.0	-6.7	-0.5	-0.7	1.5	-0.1	-0.2	0.6	-1.0	-0.2	-1.9	-1.8
Surface Water Outflows	0.0	0.0	-1.8	-54.9	-11.2	-47.4	-11.5	-7.0	-12.4	-12.6	-16.8	-0.4	0.0
To Diversion Canal	0.0	0.0	-1.8	-51.8	-8.0	-44.9	-8.6	-4.2	-9.3	-10.0	-13.7	0.0	0.0
To E. East Edmond (surface)	0.0	0.0	0.0	-3.1	-3.2	-2.5	-2.9	-2.8	-3.1	-2.6	-3.1	-0.4	0.0
Subsurface Outflows	-3.4	-3.7	-6.4	-5.2	-4.9	-6.0	-4.7	-5.8	-5.0	-5.7	-4.8	-4.2	-3.6
Change in Storage	-2.4	4.2	21.0	0.0	-3.3	3.3	-2.2	2.2	-3.1	3.1	-3.6	-10.5	-9.1
Predicted WSE in feet													
Bell	216.48	216.83	218.58	218.58	218.31	218.58	218.40	218.58	218.32	218.58	218.28	217.40	216.64
McKay	214.69	215.04	216.79	216.79	216.52	216.79	216.61	216.79	216.53	216.79	216.49	215.61	214.84
Hamer	213.05	213.40	215.15	215.15	214.88	215.15	214.97	215.15	214.89	215.15	214.85	213.97	213.21
Observed WSE ('04) in feet													
Bell													
McKay				216.08	215.95	216.60	216.40	216.04	216.36	216.01	215.95	214.27	214.28
Hamer	212.35	212.48	213.05	214.46	214.53	214.80	214.56	214.47	214.59	214.32	214.44	213.62	213.02

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2011

Hydrologic Process	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precipitation	4.0	4.2	6.6	7.2	6.1	3.1	7.2	5.7	4.8	2.8	0.8	0.3	1.3
Surface Water Inflows	19.3	19.1	33.2	38.5	30.5	10.3	40.7	26.9	21.2	9.6	0.9	0.0	3.2
Runoff from Ft. Lewis - Outfall 002	11.9	11.7	20.3	23.5	18.7	6.3	24.9	16.5	13.0	5.9	0.4	0.0	1.8
Runoff from Ft. Lewis - Outfall 003	7.4	7.4	12.9	15.0	11.8	4.0	15.9	10.4	8.2	3.7	0.5	0.0	1.3
Evapotranspiration	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	-2.4	-5.3	-0.7	0.2	0.6	0.3	1.0	-1.0	0.3	-1.0	0.6	0.8	-0.2
Surface Water Outflows	0.0	-0.8	-33.4	-40.4	-31.7	-10.7	-39.5	-25.0	-19.8	-2.6	-1.7	-0.3	0.0
To Diversion Canal	0.0	0.0	-30.3	-37.2	-28.5	-7.8	-36.7	-21.9	-16.7	0.0	0.0	0.0	0.0
To E. East Edmond (surface)	0.0	-0.8	-3.1	-3.2	-3.2	-2.9	-2.8	-3.1	-3.1	-2.6	-1.7	-0.3	0.0
Subsurface Outflows	-5.4	-6.0	-5.2	-5.5	-5.5	-4.7	-5.9	-5.1	-5.2	-5.1	-4.6	-4.2	-4.0
Change in Storage	13.1	10.2	0.0	0.0	0.0	-2.3	2.3	-0.5	-2.0	-0.1	-8.5	-7.4	-2.0
Predicted WSE in feet													
Bell	217.73	218.58	218.58	218.58	218.58	218.39	218.58	218.54	218.38	218.37	217.66	217.04	216.87
McKay	215.94	216.79	216.79	216.79	216.79	216.60	216.79	216.75	216.59	216.57	215.87	215.25	215.08
Hamer	214.30	215.15	215.15	215.15	215.15	214.96	215.15	215.11	214.95	214.94	214.23	213.61	213.44
Observed WSE ('04) in feet													
Bell													
McKay	214.29	215.23	216.18	216.90	217.01	217.07	217.13						
Hamer	213.60	213.51	214.64	214.45	214.30	214.29	214.28	214.31	214.72	214.68	214.63	214.01	213.35

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water	WY2012												WY2013
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Precipitation	4.1	6.1	3.2	7.2	3.9	6.8	4.3	3.1	3.3	1.6	0.0	0.1	6.5
Surface Water Inflows	19.5	30.7	12.2	40.0	14.7	36.8	17.5	11.6	11.9	4.3	0.0	0.0	41.1
Runoff from Ft. Lewis - Outfall 002	12.0	18.8	7.5	24.4	9.0	22.5	10.7	7.1	7.3	2.5	0.0	0.0	25.1
Runoff from Ft. Lewis - Outfall 003	7.5	11.9	4.7	15.6	5.7	14.3	6.7	4.5	4.6	1.7	0.0	0.0	16.0
Evapotranspiration	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0
Recharge (-) Discharge (+)	-3.1	-3.0	-2.1	0.6	-0.4	0.9	-0.6	-0.8	-0.2	0.2	0.8	-0.1	-3.3
Surface Water Outflows	0.0	-21.0	-12.4	-38.0	-14.3	-35.7	-16.7	-2.7	-12.1	-1.9	0.0	0.0	-12.2
To Diversion Canal	0.0	-19.4	-9.2	-35.6	-11.3	-32.8	-13.6	0.0	-9.0	0.0	0.0	0.0	-12.2
To E. East Edmond (surface)	0.0	-1.6	-3.2	-2.4	-3.0	-2.9	-3.1	-2.7	-3.1	-1.9	0.0	0.0	0.0
Subsurface Outflows	-5.7	-5.5	-4.7	-5.9	-4.9	-5.8	-4.9	-5.7	-4.5	-4.6	-4.3	-3.6	-7.2
Change in Storage	13.7	6.8	-3.8	3.8	-1.6	1.6	-2.4	2.2	-5.4	-4.9	-7.5	-5.9	23.9
Predicted WSE in feet													
Bell	218.01	218.58	218.26	218.58	218.44	218.58	218.38	218.56	218.12	217.71	217.08	216.59	218.58
McKay	216.22	216.79	216.47	216.79	216.65	216.79	216.59	216.77	216.32	215.91	215.29	214.79	216.79
Hamer	214.58	215.15	214.83	215.15	215.01	215.15	214.95	215.13	214.69	214.28	213.65	213.16	215.15
Observed WSE ('04) in feet													
Bell					219.68	219.77	219.87	219.91	219.77	219.42	219.07	218.23	218.84
McKay	214.03	214.15	214.78	215.42	215.25	215.08	214.91	214.89	215.43	215.18	214.93	213.70	214.59
Hamer	213.44	213.63	214.25	215.05	214.90	215.03	215.15	215.00	214.78	214.40	214.02	213.24	213.96

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2014

Hydrologic Process	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Precipitation	6.5	7.6	3.5	1.7	3.7	5.5	4.4	1.9	0.0	1.6	6.9	2.6	4.1
Surface Water Inflows	32.3	42.4	13.5	4.2	15.2	25.0	18.6	5.5	0.0	4.8	40.9	8.3	17.3
Runoff from Ft. Lewis - Outfall 002	19.7	25.8	8.3	2.5	9.3	15.3	11.4	3.3	0.0	2.8	25.0	5.0	10.6
Runoff from Ft. Lewis - Outfall 003	12.5	16.5	5.2	1.7	5.9	9.7	7.2	2.2	0.0	1.9	15.9	3.2	6.7
Evapotranspiration	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5
Recharge (-) Discharge (+)	-0.6	2.3	0.7	-0.2	-1.3	-2.6	-1.5	-1.2	-0.3	-2.3	-4.2	-0.9	-1.7
Surface Water Outflows	-32.5	-46.5	-13.5	-5.9	-1.8	-23.8	-17.6	-2.1	0.0	0.0	-8.7	-10.3	-7.2
To Diversion Canal	-29.4	-43.3	-10.2	-3.3	0.0	-20.1	-14.5	0.0	0.0	0.0	-8.7	-6.2	-4.4
To E. East Edmond (surface)	-3.1	-3.2	-3.2	-2.6	-1.8	-3.6	-3.1	-2.1	0.0	0.0	0.0	-4.1	-2.8
Subsurface Outflows	-5.2	-5.7	-5.4	-4.3	-6.2	-4.8	-4.7	-4.4	-4.1	-3.8	-7.1	-4.6	-5.9
Change in Storage	0.0	0.0	-1.2	-5.0	8.3	-2.8	-3.9	-4.1	-8.9	-3.6	25.4	-6.0	6.0
Predicted WSE in feet													
Bell	218.58	218.58	218.48	218.07	218.76	218.53	218.20	217.86	217.12	216.82	218.93	218.43	218.93
McKay	216.79	216.79	216.69	216.27	216.97	216.74	216.41	216.07	215.33	215.02	217.14	216.64	217.14
Hamer	215.15	215.15	215.05	214.64	215.33	215.10	214.77	214.43	213.69	213.39	215.50	215.00	215.50
Observed WSE ('04) in feet													
Bell	219.44	219.62	219.81	219.57	219.35	219.49	219.46	219.25	218.80	218.09	219.27	219.36	219.48
McKay	215.49	215.65	215.47	215.46	215.49	215.57	215.97	216.22	214.67	213.77	214.98	216.08	216.03
Hamer	214.68	214.86	215.05	214.97	215.11	215.07	214.61	214.57	213.93	213.35	214.07	214.78	214.76

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2015

Hydrologic Process	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation	2.4	4.2	6.9	9.8	4.5	3.3	1.3	1.2	1.6	1.8	5.9	6.1	4.8
Surface Water Inflows	7.4	18.1	31.8	59.6	18.3	12.5	2.7	2.5	4.5	5.8	31.7	28.1	20.8
Runoff from Ft. Lewis - Outfall 002	4.5	11.1	19.5	36.1	11.2	7.7	1.6	1.4	2.6	3.5	19.4	17.2	12.7
Runoff from Ft. Lewis - Outfall 003	2.9	7.0	12.4	23.5	7.1	4.8	1.2	1.1	1.8	2.3	12.3	10.9	8.0
Evapotranspiration	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0
Recharge (-) Discharge (+)	-2.7	-3.1	-1.1	0.5	-0.4	1.6	2.3	2.3	1.1	2.0	-0.9	-1.5	1.1
Surface Water Outflows	-9.7	-6.2	-32.2	-62.9	-18.3	-13.1	-2.6	-1.4	-0.2	0.0	-11.9	-27.1	-20.9
To Diversion Canal	-5.6	-3.5	-28.5	-58.8	-14.3	-9.5	0.0	0.0	0.0	0.0	-11.6	-23.1	-16.8
To E. East Edmond (surface)	-4.1	-2.6	-3.7	-4.1	-4.0	-3.6	-2.6	-1.4	-0.2	0.0	-0.2	-4.0	-4.1
Subsurface Outflows	-4.3	-6.1	-5.0	-5.6	-5.0	-5.2	-4.9	-4.8	-4.8	-5.3	-7.4	-5.2	-5.7
Change in Storage	-7.0	7.0	0.0	0.0	-2.8	-4.0	-5.0	-4.7	-1.9	1.9	16.4	-0.1	0.1
Predicted WSE in feet													
Bell	218.35	218.93	218.93	218.93	218.70	218.36	217.95	217.56	217.40	217.56	218.93	218.92	218.93
McKay	216.56	217.14	217.14	217.14	216.90	216.57	216.16	215.76	215.61	215.77	217.14	217.13	217.14
Hamer	214.92	215.50	215.50	215.50	215.27	214.93	214.52	214.13	213.97	214.13	215.50	215.49	215.50
Observed WSE ('04) in feet													
Bell	218.67	219.27	219.76										
McKay	215.03	215.78	216.09	215.95	216.19	215.94	215.82	215.62	215.27	215.36	215.45	215.97	216.17
Hamer	214.33	214.68	215.58	215.43			215.02	214.50	214.15	214.20	214.25	214.93	215.39

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2016

Hydrologic Process	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Precipitation	4.1	4.7	4.4	2.1	0.8	0.4	0.2	2.2	1.3	5.0	7.1	12.0	6.9
Surface Water Inflows	16.4	18.0	18.7	6.2	1.0	0.0	0.0	8.2	3.4	31.3	38.6	81.8	34.7
Runoff from Ft. Lewis - Outfall 002	10.1	11.1	11.5	3.8	0.5	0.0	0.0	5.0	1.9	19.2	23.6	49.3	21.2
Runoff from Ft. Lewis - Outfall 003	6.3	7.0	7.2	2.4	0.6	0.0	0.0	3.2	1.4	12.1	15.0	32.5	13.5
Evapotranspiration	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0
Recharge (-) Discharge (+)	0.4	-0.3	1.2	-0.1	1.2	0.5	1.0	-2.1	-1.5	-8.2	-0.2	1.5	0.6
Surface Water Outflows	-16.8	-17.6	-18.4	-8.2	-1.9	-0.4	0.0	0.0	0.0	0.0	-28.0	-89.6	-36.6
To Diversion Canal	-12.7	-14.2	-14.6	-4.7	0.0	0.0	0.0	0.0	0.0	0.0	-26.3	-85.5	-32.5
To E. East Edmond (surface)	-4.1	-3.4	-3.8	-3.4	-1.9	-0.4	0.0	0.0	0.0	0.0	-1.6	-4.1	-4.1
Subsurface Outflows	-5.4	-4.9	-5.6	-4.5	-4.5	-4.0	-3.6	-3.6	-3.2	-6.2	-6.4	-5.7	-5.6
Change in Storage	-1.2	-0.7	-1.0	-6.5	-6.5	-7.1	-6.8	0.8	-2.4	20.9	10.6	0.0	0.0
Predicted WSE in feet													
Bell	218.83	218.77	218.69	218.15	217.60	217.01	216.44	216.50	216.30	218.04	218.93	218.93	218.93
McKay	217.03	216.98	216.89	216.35	215.81	215.22	214.65	214.71	214.51	216.25	217.14	217.14	217.14
Hamer	215.40	215.34	215.26	214.72	214.17	213.58	213.01	213.07	212.87	214.61	215.50	215.50	215.50
Observed WSE ('04) in feet													
Bell					219.23	219.09	218.69	217.87	217.69	217.50	219.85		
McKay	216.10	215.99	215.89	215.65	215.44	214.58	213.88				215.69	216.17	
Hamer	215.29	215.29	215.29	215.26	214.68	213.91	213.36	212.70	212.67	212.64	215.55		

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2017

Hydrologic Process	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Precipitation	5.8	5.9	1.8	1.0	2.3	1.3	0.2	1.5	9.3	6.9	3.9	3.4	8.6
Surface Water Inflows	25.2	27.7	4.5	1.7	7.3	2.9	0.0	4.1	65.7	33.5	15.5	12.7	45.7
Runoff from Ft. Lewis - Outfall 002	15.4	17.0	2.7	0.9	4.4	1.7	0.0	2.4	39.9	20.5	9.5	7.8	27.8
Runoff from Ft. Lewis - Outfall 003	9.7	10.7	1.8	0.8	2.9	1.2	0.0	1.7	25.8	13.0	6.0	4.9	17.9
Evapotranspiration	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6
Recharge (-) Discharge (+)	0.6	0.6	1.9	3.5	2.3	2.3	1.4	1.1	-5.6	1.3	1.9	1.0	0.5
Surface Water Outflows	-25.6	-27.3	-6.3	-2.7	-1.7	-2.0	-0.2	0.0	-39.7	-35.6	-16.0	-13.6	-46.3
To Diversion Canal	-21.8	-23.2	-3.0	-1.0	0.0	0.0	0.0	0.0	-39.7	-31.7	-11.9	-9.7	-43.0
To E. East Edmond (surface)	-3.8	-4.1	-3.3	-1.7	-1.7	-2.0	-0.2	0.0	0.0	-4.0	-4.1	-4.0	-3.3
Subsurface Outflows	-5.3	-5.6	-5.1	-5.4	-5.4	-4.9	-4.5	-4.5	-7.2	-5.6	-5.7	-5.4	-5.5
Change in Storage	0.0	0.0	-5.2	-5.1	1.0	-4.9	-7.0	-0.2	21.5	0.0	-0.4	-1.9	2.4
Predicted WSE in feet													
Bell	218.93	218.93	218.50	218.07	218.15	217.74	217.15	217.14	218.93	218.93	218.89	218.73	218.93
McKay	217.14	217.14	216.71	216.28	216.36	215.95	215.36	215.35	217.14	217.14	217.10	216.94	217.14
Hamer	215.50	215.50	215.07	214.64	214.72	214.31	213.72	213.71	215.50	215.50	215.46	215.30	215.50
Observed WSE ('04) in feet													
Bell							219.47		218.88				
McKay					215.60	215.55	214.85		214.09	215.95	216.30	216.16	216.16
Hamer					212.25	214.62	213.94		213.45	215.32			

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2018

Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	8.7	4.6	2.8	1.8	0.0	0.1	1.0	5.2	7.2	5.8	7.2	3.3	2.3
Surface Water Inflows	49.6	18.8	9.9	5.0	0.0	0.0	1.9	28.0	35.8	27.0	37.6	10.8	7.4
Runoff from Ft. Lewis - Outfall 002	30.1	11.6	6.1	3.0	0.0	0.0	1.0	17.2	21.9	16.6	22.9	6.6	4.5
Runoff from Ft. Lewis - Outfall 003	19.4	7.3	3.8	2.0	0.0	0.0	0.9	10.8	14.0	10.5	14.6	4.2	2.9
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	3.0	0.9	2.2	2.8	4.0	4.8	2.8	-0.4	-0.4	2.1	1.7	1.6	3.2
Surface Water Outflows	-54.0	-18.8	-11.3	-2.7	0.0	-0.1	0.0	-3.4	-36.7	-29.1	-40.7	-11.9	-9.5
To Diversion Canal	-49.9	-14.8	-7.4	0.0	0.0	0.0	0.0	-3.4	-32.8	-25.0	-36.6	-8.2	-5.6
To E. East Edmond (surface)	-4.1	-4.0	-3.8	-2.7	0.0	-0.1	0.0	0.0	-4.0	-4.1	-4.1	-3.7	-3.8
Subsurface Outflows	-6.0	-5.3	-5.3	-5.4	-5.5	-5.3	-4.9	-7.9	-5.4	-5.8	-5.8	-5.1	-5.6
Change in Storage	0.0	-1.7	-4.8	-2.1	-6.0	-4.4	-1.5	20.5	0.0	0.0	0.0	-1.8	-3.4
Predicted WSE in feet													
Bell	218.93	218.79	218.39	218.21	217.71	217.34	217.22	218.93	218.93	218.93	218.93	218.78	218.50
McKay	217.14	217.00	216.60	216.42	215.92	215.55	215.43	217.14	217.14	217.14	217.14	216.99	216.71
Hamer	215.50	215.36	214.96	214.78	214.28	213.91	213.79	215.50	215.50	215.50	215.50	215.35	215.07
Observed WSE ('04) in feet													
Bell							219.80						
McKay	216.28	216.12		215.96	216.02	215.96	216.12			216.35		216.30	216.35
Hamer				215.45	214.76	213.95	213.83						

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2019

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	6.1	0.7	0.9	0.2	0.3	1.8	4.0	3.8	6.4	3.4	4.8	1.6	3.6
Surface Water Inflows	29.1	0.3	1.3	0.0	0.0	5.8	19.8	15.3	32.5	12.3	19.4	3.9	14.0
Runoff from Ft. Lewis - Outfall 002	17.8	0.0	0.7	0.0	0.0	3.5	12.2	9.4	19.9	7.6	11.9	2.3	8.6
Runoff from Ft. Lewis - Outfall 003	11.3	0.3	0.7	0.0	0.0	2.3	7.6	5.9	12.6	4.8	7.5	1.6	5.4
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	0.8	1.9	2.1	2.7	1.7	1.3	-3.6	-1.8	1.1	1.0	0.1	0.9	-3.2
Surface Water Outflows	-26.8	-1.0	-1.7	-0.2	0.0	0.0	0.0	-1.2	-31.0	-13.4	-18.7	-5.5	-2.4
To Diversion Canal	-23.9	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	-27.5	-9.4	-15.4	-2.6	0.0
To E. East Edmond (surface)	-2.9	-0.7	-1.7	-0.2	0.0	0.0	0.0	-1.2	-3.6	-4.1	-3.4	-2.9	-2.4
Subsurface Outflows	-5.6	-5.4	-4.5	-4.6	-3.9	-4.3	-5.8	-6.0	-6.1	-5.4	-5.1	-5.2	-5.5
Change in Storage	1.7	-6.7	-5.6	-6.3	-5.9	2.3	13.4	9.6	2.8	-2.1	-0.1	-5.5	4.6
Predicted WSE in feet													
Bell	218.64	218.08	217.61	217.08	216.59	216.78	217.90	218.70	218.93	218.75	218.74	218.29	218.67
McKay	216.85	216.28	215.82	215.29	214.80	214.99	216.11	216.91	217.14	216.96	216.95	216.50	216.88
Hamer	215.21	214.65	214.18	213.65	213.16	213.35	214.47	215.27	215.50	215.32	215.31	214.86	215.24
Observed WSE ('04) in feet													
Bell				219.79	219.20	219.09	218.29					219.89	219.77
McKay	216.38	214.68	214.31	214.30	213.97	213.79		214.25	214.52	214.67	215.96	214.44	214.37
Hamer		215.01	214.47	214.10	213.30	213.11	212.99	213.63	214.85		215.27	214.79	214.64

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2020

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	1.1	0.7	1.0	0.8	3.5	3.9	1.7	6.5	9.6	4.2	3.5	1.5	3.1
Surface Water Inflows	2.1	0.4	2.0	1.3	18.3	18.5	4.6	36.9	57.4	15.9	13.7	3.9	12.7
Runoff from Ft. Lewis - Outfall 002	1.1	0.1	1.1	0.6	11.2	11.4	2.7	22.6	34.8	9.8	8.4	2.3	7.8
Runoff from Ft. Lewis - Outfall 003	0.9	0.3	0.9	0.7	7.1	7.2	1.9	14.3	22.6	6.1	5.3	1.6	4.9
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	-2.2	-1.5	-2.3	-2.8	-4.2	-2.9	-2.3	-6.4	1.5	-0.8	-3.0	-1.7	-2.7
Surface Water Outflows	-3.2	-1.0	0.0	0.0	0.0	0.0	-1.3	-16.3	-61.6	-16.2	-13.9	-2.0	-0.9
To Diversion Canal	-1.2	0.0	0.0	0.0	0.0	0.0	0.0	-15.5	-57.5	-12.3	-10.4	0.0	0.0
To E. East Edmond (surface)	-2.0	-1.0	0.0	0.0	0.0	0.0	-1.3	-0.8	-4.1	-3.8	-3.5	-2.0	-0.9
Subsurface Outflows	-4.3	-3.6	-3.4	-2.7	-4.2	-5.6	-4.4	-6.5	-6.8	-5.7	-5.2	-4.7	-5.5
Change in Storage	-9.7	-8.8	-7.1	-7.3	11.0	13.0	-2.1	14.2	0.0	-3.0	-6.2	-4.9	3.6
Predicted WSE in feet													
Bell	217.86	217.12	216.53	215.92	216.84	217.92	217.75	218.93	218.93	218.68	218.16	217.75	218.05
McKay	216.07	215.33	214.74	214.13	215.05	216.13	215.95	217.14	217.14	216.89	216.37	215.96	216.26
Hamer	214.43	213.69	213.10	212.49	213.41	214.49	214.32	215.50	215.50	215.25	214.73	214.32	214.62
Observed WSE ('04) in feet													
Bell		218.58	217.47	216.86		218.20				219.71			
McKay		213.99			214.92			213.72	215.28	214.65			
Hamer		213.47	212.68		212.25			213.55	215.55	215.03			

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2021

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.5	0.3	0.4	2.8	3.0	5.6	5.2	7.3	4.7	2.5	1.2	2.0	2.4
Surface Water Inflows	8.1	0.0	0.0	12.9	13.1	29.6	23.4	39.7	18.2	8.0	2.4	6.4	8.5
Runoff from Ft. Lewis - Outfall 002	4.9	0.0	0.0	7.9	8.0	18.1	14.3	24.3	11.2	4.9	1.3	3.9	5.2
Runoff from Ft. Lewis - Outfall 003	3.2	0.0	0.0	5.0	5.1	11.5	9.0	15.5	7.0	3.1	1.0	2.5	3.3
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	-2.2	-3.0	-3.6	-3.9	-3.9	-5.1	-2.0	-0.3	0.0	2.0	0.3	0.1	-1.6
Surface Water Outflows	-1.7	-0.3	0.0	0.0	0.0	-1.4	-22.8	-37.7	-18.0	-9.8	-3.5	-1.2	-0.9
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	-1.4	-18.7	-34.0	-14.3	-6.0	-1.6	0.0	0.0
To E. East Edmond (surface)	-1.7	-0.3	0.0	0.0	0.0	0.0	-4.1	-3.7	-3.7	-3.8	-2.0	-1.2	-0.9
Subsurface Outflows	-4.9	-3.6	-2.7	-3.8	-4.4	-7.0	-6.0	-6.8	-5.8	-6.0	-5.1	-5.2	-5.0
Change in Storage	-1.8	-11.1	-10.0	5.6	6.7	21.1	-2.2	2.2	-1.4	-4.5	-6.8	-1.0	-0.3
Predicted WSE in feet													
Bell	217.90	216.98	216.15	216.61	217.17	218.93	218.75	218.93	218.81	218.44	217.87	217.79	217.76
McKay	216.11	215.19	214.36	214.82	215.38	217.14	216.95	217.14	217.02	216.64	216.08	216.00	215.97
Hamer	214.47	213.55	212.72	213.18	213.74	215.50	215.32	215.50	215.38	215.01	214.44	214.36	214.33
Observed WSE ('04) in feet													
Bell					217.23			219.68			219.71	219.41	218.99
McKay						213.87		214.86	214.88	215.59	214.57	214.46	214.38
Hamer						213.15		215.23	215.30	214.89	214.51	214.01	213.58

Table F-16. Water Balance for Bell, McKay, and Hamer Marshes with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water	WY2021		
Hydrologic Process	Jul	Aug	Sep
Precipitation	0.0	0.3	2.6
Surface Water Inflows	0.0	0.0	11.5
Runoff from Ft. Lewis - Outfall 002	0.0	0.0	7.0
Runoff from Ft. Lewis - Outfall 003	0.0	0.0	4.5
Evapotranspiration	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	-1.8	-2.7	-4.2
Surface Water Outflows	0.0	0.0	0.0
To Diversion Canal	0.0	0.0	0.0
To E. East Edmond (surface)	0.0	0.0	0.0
Subsurface Outflows	-3.8	-2.8	-3.6
Change in Storage	-10.1	-9.2	3.9
Predicted WSE in feet			
Bell	216.92	216.15	216.48
McKay	215.13	214.36	214.69
Hamer	213.49	212.72	213.05
Observed WSE ('04) in feet			
Bell	218.05		
McKay		213.27	
Hamer	212.68	212.25	

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water	WY2004						WY2005						
Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	2.0	1.0	3.8	0.9	0.1	3.6	2.9	4.0	3.2	4.3	4.3	0.6	4.5
Surface Water Inflows	122.8	107.4	68.2	30.6	7.8	4.7	17.0	28.7	62.7	10.4	16.9	21.3	30.4
From Sequalitchew Lake	118.6	103.4	67.1	26.8	7.8	4.4	16.8	28.4	58.9	5.7	11.1	19.9	28.8
From Center Drive	0.1	0.0	0.2	0.0	0.0	0.2	0.2	0.3	0.2	0.3	0.3	0.0	0.3
From Hamer (surface)	4.1	4.0	0.9	3.8	0.0	0.0	0.0	0.0	3.6	4.4	5.5	1.5	1.3
Subsurface Inflows	9.7	6.8	8.7	5.7	4.7	5.7	6.3	8.4	7.6	8.5	8.3	6.4	8.8
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	*16.4*	*12.9*	*13.9*	*11.2*	*12.1*	*10.2*	*11.5*	*13.6*	*11.1*	*12.8*	*12.9*	*12.4*	*12.3*
Surface Water Outflows	-106.4	-99.8	-75.7	-31.1	-17.6	-14.9	-26.0	-40.8	-64.2	-25.9	-30.9	-32.9	-42.0
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-129.8	-116.3	-88.3	-36.3	-20.5	-17.4	-30.4	-47.5	-74.9	-30.2	-36.0	-38.4	-49.0
Change in Storage	19.9	9.8	3.2	8.5	-0.4	2.9	5.0	6.1	9.2	5.8	6.4	1.8	5.7
Predicted WSE in ft													
EM-2S	209.00	209.49	209.68	210.07	210.04	210.28	210.70	211.21	211.67	211.78	211.86	211.89	212.26
East Edmond	209.00	209.33	209.07	209.31	209.00	209.00	209.00	209.00	209.30	209.36	209.46	209.12	209.11
Eastern East Edmond Marsh	209.00	209.33	209.20	209.44	209.20	209.20	209.20	209.20	209.50	209.56	209.66	209.32	209.31
Observed WSE in ft													
EM-2S	210.72	210.74	210.76	210.70	210.40	209.82	209.92	210.33	210.61	210.76	210.86	210.79	210.64
East Edmond (EM-2E)	212.62	212.50	212.35	212.25	211.85	211.43	211.43	211.80	212.12	212.31	212.47	212.40	212.19
East Edmond (EM-2W)	211.15	211.15	211.22	211.20	210.91	210.32	210.41	210.80	211.08	211.20	211.26	211.24	211.09
East Edmond (EM-3E)	212.42	212.29	212.14	212.04	211.69	211.07	211.43	211.70	211.93	212.09	212.15	212.17	211.97
East Edmond (EM-3W)	212.42	212.29	212.15	212.04	211.70	211.10	211.57	211.70	211.94	212.04	212.26	212.20	211.98
Eastern East Edmond (SCM-1)	212.39	212.26	212.09	211.98	211.58	210.96	211.20	211.63	211.84	212.08	212.27	212.17	211.95

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2006

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	5.4	3.9	3.8	1.4	0.2	1.6	3.3	6.7	6.5	12.2	3.2	2.6	3.9
Surface Water Inflows	80.4	57.0	55.6	9.9	0.0	0.1	0.2	0.4	24.4	198.6	213.5	191.7	168.6
From Sequalitchew Lake	74.7	52.0	50.1	7.1	0.0	0.0	0.0	0.0	18.5	192.3	208.4	187.5	164.1
From Center Drive	0.4	0.3	0.2	0.1	0.0	0.1	0.2	0.4	0.4	0.9	0.2	0.2	0.2
From Hamer (surface)	5.3	4.7	5.3	2.8	0.0	0.0	0.0	0.0	5.5	5.4	5.0	4.0	4.3
Subsurface Inflows	8.0	8.8	7.0	5.7	2.6	2.1	3.6	9.3	8.4	9.5	7.5	8.6	8.7
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	*12.8*	*12.9*	*13.4*	*11.2*	*8.3*	*4.4*	*5.2*	*11.3*	*10.1*	*15.6*	*12.3*	*13.6*	*13.4*
Surface Water Outflows	-81.8	-64.0	-60.2	-19.3	-7.2	-4.3	-8.3	-20.0	-33.2	-197.9	-198.1	-180.7	-160.4
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-95.3	-74.6	-70.2	-22.5	-8.4	-5.0	-9.7	-23.3	-38.7	-230.6	-231.0	-210.7	-187.0
Change in Storage	9.3	4.8	5.9	1.2	-1.4	0.8	1.6	3.9	10.8	5.2	4.9	4.5	5.7
Predicted WSE in ft													
EM-2S	212.59	212.60	212.65	212.51	212.40	212.47	212.60	212.92	213.36	213.35	213.34	213.38	213.50
East Edmond	209.44	209.39	209.44	209.23	209.00	209.00	209.00	209.00	209.46	209.45	209.41	209.34	209.35
Eastern East Edmond Marsh	209.64	209.59	209.64	209.43	209.20	209.20	209.20	209.20	209.66	209.65	209.61	209.54	209.55
Observed WSE in ft													
EM-2S	210.94	210.90	210.69	210.42	209.82	209.15	209.21	210.48	210.71	210.98	210.88	210.58	210.57
East Edmond (EM-2E)	212.55	212.63	212.47	212.13	211.43	211.43	211.43	211.89	212.22	212.63	212.62	212.51	212.55
East Edmond (EM-2W)	211.28	211.32	211.14	210.88	210.28	209.64	209.67	210.87	211.12	211.31	211.25	210.92	210.89
East Edmond (EM-3E)	212.32	212.40	212.26	211.92	211.13			211.78	212.02	212.42	212.37	212.27	212.30
East Edmond (EM-3W)	212.50	212.41	212.25	211.92	211.15	210.44	210.58	211.75	212.02	212.42	212.38	212.26	212.29
Eastern East Edmond (SCM-1)	212.25	212.43	212.29	211.88	211.08	210.95	210.57	211.69	211.99	212.58	212.47	212.20	212.32

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2007

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	2.1	2.2	0.4	0.0	0.8	1.6	14.4	8.6	6.5	4.5	5.7	1.7	1.1
Surface Water Inflows	120.0	110.7	76.7	42.2	14.1	16.7	127.0	203.1	297.3	232.0	365.1	345.6	177.5
From Sequalitchew Lake	114.4	108.1	76.1	42.2	14.1	16.6	126.0	197.0	291.4	226.8	359.2	340.5	174.8
From Center Drive	0.1	0.1	0.0	0.0	0.0	0.1	1.0	0.6	0.4	0.3	0.4	0.1	0.0
From Hamer (surface)	5.5	2.5	0.6	0.0	0.0	0.0	0.0	5.5	5.5	5.0	5.5	4.9	2.7
Subsurface Inflows	7.8	7.5	6.2	4.8	3.8	3.6	10.8	9.9	9.5	8.5	9.5	7.5	7.1
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	*12.3*	*14.3*	*12.5*	*13.6*	*10.5*	*10.6*	*17.2*	*18.2*	*15.3*	*14.6*	*16.8*	*13.5*	*13.5*
Surface Water Outflows	-113.6	-110.1	-74.9	-43.9	-19.7	-23.2	-139.8	-196.4	-277.4	-218.2	-334.6	-310.2	-165.3
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-132.5	-128.3	-87.3	-51.1	-23.0	-27.1	-162.9	-228.9	-323.3	-254.3	-390.1	-361.6	-192.6
Change in Storage	6.5	2.7	4.1	5.5	3.8	4.5	6.1	10.8	5.3	4.8	5.8	4.8	3.4
Predicted WSE in ft													
EM-2S	213.59	213.60	213.90	214.35	214.67	215.04	215.55	215.99	215.97	215.95	215.98	215.97	216.03
East Edmond	209.46	209.21	209.05	209.00	209.00	209.00	209.00	209.46	209.46	209.41	209.46	209.41	209.22
Eastern East Edmond Marsh	209.66	209.41	209.25	209.20	209.20	209.20	209.20	209.66	209.66	209.61	209.66	209.61	209.42
Observed WSE in ft													
EM-2S	210.71	210.85	210.62	210.36	210.21	210.06	211.03	211.01	210.90	210.87	210.83	210.79	210.82
East Edmond (EM-2E)	212.55	212.63	212.53	211.36	211.43	211.65	211.87	211.94	211.78	211.79	211.80	211.65	211.73
East Edmond (EM-2W)	211.08	211.28	211.06	210.74	210.64	210.49	211.37	211.37	211.26	211.26	211.22	211.15	211.24
East Edmond (EM-3E)	212.28	212.39	212.04	211.75	211.51	211.32	212.52	212.61	212.44	212.46	212.43	212.30	212.37
East Edmond (EM-3W)	212.27	212.40	212.03	211.75	211.50	211.31	212.51	212.60	212.42	212.42	212.42	212.29	212.36
Eastern East Edmond (SCM-1)	212.26	212.46	211.97	211.70	211.38	211.33	212.58	212.67	212.49	212.48	212.49	212.29	212.44

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2008

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.7	1.5	1.0	1.7	5.0	2.8	7.7	4.2	3.6	4.9	1.8	1.3	1.7
Surface Water Inflows	79.0	7.6	110.7	90.8	63.2	81.4	139.0	150.2	137.5	124.1	127.7	86.7	52.3
From Sequalitchew Lake	78.6	6.5	110.6	90.8	62.9	76.3	135.6	144.4	132.4	119.4	122.6	84.2	51.8
From Center Drive	0.2	0.1	0.0	0.1	0.3	0.2	0.5	0.3	0.2	0.3	0.1	0.1	0.1
From Hamer (surface)	0.2	1.0	0.0	0.0	0.0	4.9	2.9	5.5	4.9	4.3	5.0	2.4	0.4
Subsurface Inflows	7.4	6.6	5.6	5.5	9.5	7.1	10.0	9.0	8.1	9.3	7.2	7.3	6.4
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	*13.9*	*15.3*	*13.6*	*12.4*	*15.0*	*11.9*	*16.4*	*14.6*	*13.2*	*15.2*	*12.7*	*13.0*	*13.6*
Surface Water Outflows	-82.1	-18.9	-104.6	-87.5	-73.5	-79.3	-145.3	-146.0	-134.7	-126.3	-121.3	-87.5	-56.8
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-95.7	-22.1	-121.9	-102.0	-85.6	-92.5	-169.4	-170.1	-157.0	-147.3	-141.5	-102.0	-66.2
Change in Storage	3.6	4.5	5.1	6.1	6.1	10.3	3.6	7.9	4.8	4.9	6.0	3.1	4.0
Predicted WSE in ft													
EM-2S	216.31	216.60	217.02	217.52	218.03	218.47	218.53	218.74	218.72	218.77	218.85	218.91	219.21
East Edmond	209.02	209.08	209.00	209.00	209.00	209.41	209.24	209.46	209.41	209.36	209.42	209.20	209.03
Eastern East Edmond Marsh	209.22	209.28	209.20	209.20	209.20	209.61	209.44	209.66	209.61	209.56	209.62	209.40	209.23
Observed WSE in ft													
EM-2S	210.87	210.86	210.68	210.52	210.85	210.93	211.00	210.98	210.95	210.94	210.83	210.79	210.70
East Edmond (EM-2E)	211.66	211.60	211.45	211.27	211.66	211.77	211.92	211.86	211.80	211.86	211.68	211.69	211.63
East Edmond (EM-2W)	211.30	211.28	211.11	210.95	211.29	211.32	211.37	211.35	211.34	211.32	211.28	211.21	211.15
East Edmond (EM-3E)	212.31	212.23	212.09	211.93	212.32	212.40	212.56	212.50	212.44	212.50	212.37	212.33	212.27
East Edmond (EM-3W)	212.29	212.24	212.09	211.91	212.31	212.40	212.54	212.49	212.43	212.49	212.35	212.33	212.25
Eastern East Edmond (SCM-1)	212.35	212.29	212.13	212.06	212.38	212.48	212.63	212.58	212.52	212.55	212.43	212.39	212.32

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2009

Hydrologic Process	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Precipitation	0.9	2.1	0.5	2.6	8.3	5.2	7.3	1.6	5.3	3.5	3.4	1.3	0.0
Surface Water Inflows	14.1	31.9	17.2	5.3	56.4	39.0	193.9	90.2	117.1	118.6	106.8	71.7	43.2
From Sequalitchew Lake	14.1	31.7	17.2	5.1	55.8	33.2	188.2	85.8	113.9	113.1	103.0	67.9	43.1
From Center Drive	0.0	0.1	0.0	0.2	0.6	0.3	0.5	0.1	0.4	0.2	0.2	0.1	0.0
From Hamer (surface)	0.0	0.0	0.0	0.0	0.0	5.5	5.2	4.4	2.8	5.3	3.6	3.8	0.0
Subsurface Inflows	5.2	5.0	3.9	4.6	10.0	8.7	9.2	7.0	9.5	7.7	8.9	6.4	5.1
Evapotranspiration	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5
Recharge (-) Discharge (+)	*12.9*	*13.6*	*12.1*	*11.1*	*15.1*	*12.8*	*14.7*	*11.6*	*14.5*	*12.3*	*13.4*	*11.5*	*12.0*
Surface Water Outflows	-21.3	-36.4	-23.1	-16.6	-71.4	-47.1	-188.8	-90.2	-120.9	-113.5	-107.6	-69.9	-45.9
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-24.8	-42.5	-26.9	-19.3	-83.3	-54.9	-220.1	-105.2	-141.0	-132.3	-125.5	-81.5	-53.5
Change in Storage	3.7	6.1	4.5	3.2	6.1	10.8	5.0	4.6	4.1	7.8	3.8	5.7	2.3
Predicted WSE in ft													
EM-2S	219.52	220.02	220.39	220.66	221.16	221.60	221.59	221.60	221.71	221.91	221.93	222.09	222.28
East Edmond	209.00	209.00	209.00	209.00	209.00	209.46	209.44	209.37	209.24	209.44	209.30	209.31	209.00
Eastern East Edmond Marsh	209.20	209.20	209.20	209.20	209.20	209.66	209.64	209.57	209.44	209.64	209.50	209.51	209.20
Observed WSE in ft													
EM-2S	210.43	210.28	210.14	210.00	210.90	210.97	210.95	210.92	210.89	210.87	210.93	210.61	210.18
East Edmond (EM-2E)	211.43	211.43	211.43	211.43	211.72	211.81	211.81	211.76	211.54	211.44	211.72	211.43	211.43
East Edmond (EM-2W)	210.88	210.70	210.56	210.41	211.31	211.34	211.33	211.30	211.36	211.36	211.37	211.04	210.58
East Edmond (EM-3E)	211.92	211.63	211.47	211.30	212.41	212.42	212.44	212.39	212.25	212.31	212.38	211.93	211.59
East Edmond (EM-3W)	211.92	211.67	211.50	211.33	212.32	212.40	212.43	212.37	212.25	212.29	212.36	211.94	211.67
Eastern East Edmond (SCM-1)	211.96	211.71	211.54	211.38	212.39	212.48	212.53	212.47	212.33	212.37	212.44	211.94	211.51

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2010

Hydrologic Process	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Precipitation	1.9	2.8	5.6	8.9	3.0	8.0	3.3	3.3	3.3	4.6	4.3	0.4	0.2
Surface Water Inflows	33.8	27.4	42.2	103.9	96.9	161.8	140.9	173.0	242.7	176.3	150.9	88.3	50.7
From Sequalitchew Lake	33.7	27.3	41.8	98.0	91.3	157.1	135.7	168.2	237.2	171.8	145.3	87.7	50.7
From Center Drive	0.1	0.2	0.4	0.6	0.2	0.6	0.2	0.2	0.2	0.3	0.3	0.0	0.0
From Hamer (surface)	0.0	0.0	0.0	5.3	5.5	4.1	5.0	4.6	5.3	4.2	5.3	0.6	0.0
Subsurface Inflows	4.7	5.2	9.3	8.9	8.4	9.9	8.0	9.5	8.4	9.4	8.1	6.9	5.3
Evapotranspiration	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0
Recharge (-) Discharge (+)	*11.3*	*11.1*	*13.0*	*13.3*	*13.0*	*15.4*	*11.9*	*13.6*	*13.2*	*13.8*	*12.7*	*13.7*	*12.8*
Surface Water Outflows	-35.7	-32.6	-54.1	-106.3	-99.3	-163.9	-135.0	-165.7	-222.8	-168.6	-142.3	-88.8	-51.0
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-41.6	-38.1	-63.0	-123.9	-115.8	-191.0	-157.4	-193.1	-259.7	-196.6	-165.9	-103.5	-59.5
Change in Storage	6.0	6.1	6.1	10.6	5.5	4.1	6.2	5.0	6.0	4.3	6.4	1.3	5.4
Predicted WSE in ft													
EM-2S	222.79	223.29	223.79	224.24	224.23	224.23	224.33	224.37	224.43	224.44	224.53	224.58	225.03
East Edmond	209.00	209.00	209.00	209.44	209.46	209.34	209.41	209.38	209.44	209.35	209.44	209.05	209.00
Eastern East Edmond Marsh	209.20	209.20	209.20	209.64	209.66	209.54	209.61	209.58	209.64	209.55	209.64	209.25	209.20
Observed WSE in ft													
EM-2S	210.12	210.11	210.47	211.06	211.04	211.03	211.03	210.86	211.15	211.13	211.10	210.88	210.61
East Edmond (EM-2E)	211.43	211.43	211.43	211.75	211.52	211.58	211.64	211.90	211.59	212.04	211.93	211.73	211.43
East Edmond (EM-2W)	210.51	210.52	210.90	211.41	211.41	211.39	211.40	211.24	211.58	211.54	211.52	211.36	211.03
East Edmond (EM-3E)	211.49	211.46	211.74	212.41	212.33	212.49	212.38	212.42	212.43	212.55	212.48	212.25	211.93
East Edmond (EM-3W)	211.48	211.46	211.72	212.31	212.25	212.27	212.22	212.39	212.25	212.54	212.44	212.25	211.96
Eastern East Edmond (SCM-1)	211.45	211.46	211.78	212.48	212.40	212.57	212.45	212.49	212.52	212.62	212.55	212.24	211.87

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2011

Hydrologic Process	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precipitation	4.0	4.2	6.6	7.2	6.1	3.1	7.2	5.7	4.8	2.8	0.8	0.3	1.3
Surface Water Inflows	67.0	80.3	116.7	149.7	324.2	289.4	378.5	398.4	313.8	183.8	89.8	42.2	26.7
From Sequalitchew Lake	66.8	78.8	110.9	143.7	318.2	284.3	373.5	392.7	308.2	179.3	87.1	41.8	26.7
From Center Drive	0.2	0.3	0.4	0.5	0.4	0.2	0.5	0.4	0.3	0.2	0.0	0.0	0.1
From Hamer (surface)	0.0	1.2	5.3	5.5	5.5	5.0	4.5	5.3	5.3	4.3	2.8	0.4	0.0
Subsurface Inflows	7.5	9.3	8.9	9.3	9.4	8.1	9.7	8.7	8.8	8.4	7.5	6.5	5.9
Evapotranspiration	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	*13.7*	*13.5*	*13.1*	*15.0*	*15.1*	*14.1*	*16.1*	*14.9*	*15.2*	*14.0*	*-17.5*	*14.1*	*12.5*
Surface Water Outflows	-71.9	-85.0	-116.1	-150.7	-303.2	-268.7	-351.0	-363.3	-289.9	-175.5	-65.1	-50.8	-36.3
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-83.8	-99.1	-135.4	-175.6	-353.4	-313.2	-409.1	-423.5	-337.9	-204.6	-75.9	-59.3	-42.3
Change in Storage	6.1	7.1	9.4	5.5	1.4	1.0	1.1	2.3	1.4	0.6	0.2	-0.2	1.8
Predicted WSE in ft													
EM-2S	225.54	226.03	226.37	226.36	226.02	225.69	225.41	225.15	224.83	224.52	224.31	224.26	224.41
East Edmond	209.00	209.10	209.44	209.46	209.46	209.41	209.38	209.44	209.44	209.36	209.23	209.03	209.00
Eastern East Edmond Marsh	209.20	209.30	209.64	209.66	209.66	209.61	209.58	209.64	209.64	209.56	209.43	209.23	209.20
Observed WSE in ft													
EM-2S	211.01	211.05	211.33	211.43	211.30	211.27	211.25	211.27	211.30	211.22	206.59	211.06	210.85
East Edmond (EM-2E)	211.73	211.75	211.95	212.18	212.13	212.20	212.27	212.30	212.37			212.01	211.69
East Edmond (EM-2W)	211.46	211.48	211.73	211.78	211.68	211.65	211.61	211.58	211.68			211.48	211.33
East Edmond (EM-3E)	212.23	212.37	212.59	212.73	212.73	212.73	212.73	212.76	212.88			212.49	212.06
East Edmond (EM-3W)	212.23	212.25	212.43	212.70	212.63	212.69	212.75	212.77	212.85			212.50	212.18
Eastern East Edmond (SCM-1)	212.28	212.32	212.67	212.81	212.78	212.79	212.80	212.83	212.95			212.58	212.26

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water	WY2012												WY2013
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Precipitation	4.1	6.1	3.2	7.2	3.9	6.8	4.3	3.1	3.3	1.6	0.0	0.1	6.5
Surface Water Inflows	88.0	93.1	97.8	135.3	183.3	253.6	325.7	303.6	150.3	94.5	25.2	2.5	42.1
From Sequalitchew Lake	87.8	90.1	92.1	130.9	177.9	248.3	320.1	299.0	144.9	91.3	25.2	2.5	41.6
From Center Drive	0.3	0.4	0.2	0.5	0.2	0.5	0.3	0.2	0.2	0.1	0.0	0.0	0.5
From Hamer (surface)	0.0	2.6	5.5	3.9	5.1	4.8	5.3	4.5	5.3	3.2	0.0	0.0	0.0
Subsurface Inflows	8.4	9.1	8.0	9.8	8.4	9.6	8.3	9.3	7.7	7.5	6.7	5.3	10.0
Evapotranspiration	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0
Recharge (-) Discharge (+)	*14.0*	*13.2*	*12.6*	*16.8*	*14.1*	*16.3*	*16.2*	*15.3*	*13.7*	*14.6*	*15.4*	*12.6*	*14.8*
Surface Water Outflows	-95.4	-100.0	-100.6	-144.9	-177.0	-243.5	-300.8	-280.8	-145.1	-97.8	-38.0	-13.6	-60.2
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-111.3	-116.5	-117.3	-169.0	-206.3	-283.8	-350.6	-327.4	-169.1	-114.0	-44.3	-15.9	-70.2
Change in Storage	2.2	4.4	4.4	0.1	2.7	1.2	2.0	0.7	2.2	-0.3	-0.9	2.2	2.2
Predicted WSE in ft													
EM-2S	224.60	224.75	224.66	224.34	224.14	223.84	223.56	223.24	222.99	222.70	222.62	222.81	222.99
East Edmond	209.00	209.21	209.46	209.33	209.43	209.40	209.44	209.37	209.44	209.26	209.00	209.00	209.00
Eastern East Edmond Marsh	209.20	209.41	209.66	209.53	209.63	209.60	209.64	209.57	209.64	209.46	209.20	209.20	209.20
Observed WSE in ft													
EM-2S	210.97	211.29	211.31	211.37	211.36	211.38	211.40	211.41	211.36	211.25	211.14	210.84	211.08
East Edmond (EM-2E)	211.83	212.03	212.25	212.50	212.52	212.55	212.57	212.63	212.54	212.34	212.13	211.72	212.01
East Edmond (EM-2W)	211.40	211.67	211.71	211.72	211.75	211.76	211.77	211.78	211.75	211.65	211.55	211.31	211.50
East Edmond (EM-3E)	212.19	212.38	212.61	212.85	212.88	212.92	212.95	213.00	212.91	212.70	212.50	212.09	212.37
East Edmond (EM-3W)	212.29	212.50	212.73	212.98	212.99	213.02	213.05	213.11	213.03	212.82	212.61	212.20	212.48
Eastern East Edmond (SCM-1)	212.40	212.59	212.85	213.10	213.12	213.15	213.18	213.35	213.17	212.95	212.74	212.21	212.55

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2014

Hydrologic Process	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Precipitation	6.5	7.6	3.5	1.7	3.7	5.5	4.4	1.9	0.0	1.6	6.9	2.6	4.1
Surface Water Inflows	102.5	188.3	229.0	150.9	185.0	180.6	142.3	95.8	43.0	35.1	26.6	88.0	81.6
From Sequalitchew Lake	96.7	182.3	223.3	146.3	181.9	174.0	136.7	92.3	43.0	35.1	26.2	80.6	76.8
From Center Drive	0.4	0.5	0.2	0.1	0.2	0.4	0.3	0.1	0.0	0.1	0.5	0.2	0.3
From Hamer (surface)	5.3	5.5	5.5	4.5	2.9	6.2	5.3	3.5	0.0	0.0	0.0	7.3	4.6
Subsurface Inflows	8.9	9.7	9.1	7.3	10.1	8.1	8.0	7.3	6.6	5.6	10.5	8.2	9.7
Evapotranspiration	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5
Recharge (-) Discharge (+)	*13.4*	*16.8*	*15.6*	*13.9*	*16.7*	*14.3*	*13.9*	*13.6*	*15.6*	*13.8*	*15.7*	*13.1*	*14.0*
Surface Water Outflows	-106.3	-189.5	-219.4	-148.1	-183.6	-173.1	-141.4	-98.6	-53.2	-42.9	-47.3	-87.9	-94.5
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-123.9	-220.9	-255.7	-172.7	-214.0	-201.8	-164.8	-115.0	-62.0	-50.0	-55.1	-102.5	-110.1
Change in Storage	6.8	1.6	1.4	0.5	0.3	4.6	0.5	0.0	-1.3	2.2	2.2	8.5	-1.1
Predicted WSE in ft													
EM-2S	223.11	222.79	222.45	222.13	221.90	221.77	221.38	221.08	220.98	221.16	221.34	221.44	220.97
East Edmond	209.44	209.46	209.46	209.37	209.24	209.52	209.44	209.29	209.00	209.00	209.00	209.61	209.38
Eastern East Edmond Marsh	209.64	209.66	209.66	209.57	209.44	209.72	209.64	209.49	209.20	209.20	209.20	209.81	209.58
Observed WSE in ft													
EM-2S	211.31	211.47	211.40	211.40	211.39	211.44	211.43	211.37	211.19	210.88	211.31	211.51	211.47
East Edmond (EM-2E)	212.29	212.69	212.64	212.56	212.59	212.63	212.48	212.39	212.03	211.66	212.05	212.55	212.52
East Edmond (EM-2W)	211.69	211.83	211.78	211.75	211.76	211.81	211.82	211.80	211.64	211.36	211.76	211.89	211.86
East Edmond (EM-3E)	212.65	213.05	212.99	212.91	213.01	212.99	212.86	212.77	212.41	212.03	212.41	212.93	212.88
East Edmond (EM-3W)	212.76	213.17	213.11	213.04	213.06	213.10	212.96	212.88	212.51	212.15	212.53	213.03	212.99
Eastern East Edmond (SCM-1)	212.90	213.32	213.27	213.18	213.21	213.26	213.10	213.03	212.65	212.26	212.66	213.16	213.14

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2015

Hydrologic Process	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation	2.4	4.2	6.9	9.8	4.5	3.3	1.3	1.2	1.6	1.8	5.9	6.1	4.8
Surface Water Inflows	81.5	99.7	160.3	443.9	378.8	308.7	142.5	71.6	37.0	22.2	57.5	117.2	218.4
From Sequalitchew Lake	74.1	95.1	153.3	436.0	371.5	302.4	138.2	69.2	36.6	22.1	56.8	109.7	210.9
From Center Drive	0.1	0.3	0.4	0.7	0.3	0.2	0.1	0.0	0.1	0.1	0.4	0.4	0.3
From Hamer (surface)	7.3	4.3	6.6	7.3	7.0	6.1	4.3	2.3	0.3	0.0	0.4	7.0	7.2
Subsurface Inflows	7.7	9.9	8.8	10.0	8.9	8.9	8.0	7.8	7.5	7.9	11.5	9.2	10.1
Evapotranspiration	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0
Recharge (-) Discharge (+)	*11.9*	*14.8*	*15.2*	*16.4*	*15.2*	*16.2*	*14.4*	*14.2*	*14.2*	*14.6*	*15.6*	*12.6*	*15.5*
Surface Water Outflows	-85.5	-111.5	-160.6	-409.1	-346.9	-286.1	-139.6	-77.5	-48.1	-36.3	-74.5	-117.3	-212.3
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-99.6	-129.9	-187.2	-476.9	-404.4	-333.5	-162.7	-90.3	-56.1	-42.3	-86.9	-136.7	-247.5
Change in Storage	3.9	-1.3	3.5	1.9	1.0	0.4	-0.2	-0.1	0.2	1.9	2.5	7.9	1.4
Predicted WSE in ft													
EM-2S	220.68	220.21	219.96	219.51	219.00	218.53	218.16	217.96	217.95	218.10	218.28	218.36	217.87
East Edmond	209.61	209.36	209.55	209.61	209.59	209.51	209.36	209.19	209.03	209.00	209.03	209.59	209.60
Eastern East Edmond Marsh	209.81	209.56	209.75	209.81	209.79	209.71	209.56	209.39	209.23	209.20	209.23	209.79	209.80
Observed WSE in ft													
EM-2S	211.39	211.43	211.51	211.50	211.51	211.54	211.48	211.33	211.22	211.30	211.38	211.49	211.49
East Edmond (EM-2E)	212.33	212.43	212.59	212.59	212.68	212.81	212.73	212.32			212.34	212.53	212.51
East Edmond (EM-2W)	211.80	211.82	211.86	211.87	211.88	211.90	211.87	211.78	211.71	211.76	211.81	211.88	211.89
East Edmond (EM-3E)	212.69	212.80	212.95	212.96	213.04	213.19	213.08	212.66	212.49	212.59	212.69	212.91	212.94
East Edmond (EM-3W)	212.80	212.91	213.06	213.06	213.15	213.29	213.19	212.79	212.61	212.57	212.54	213.02	213.04
Eastern East Edmond (SCM-1)	212.95	213.07	213.21	213.25	213.33	213.46	213.22	212.98	212.76	212.86	212.97	213.20	213.26

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2016

Hydrologic Process	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Precipitation	4.1	4.7	4.4	2.1	0.8	0.4	0.2	2.2	1.3	5.0	7.1	12.0	6.9
Surface Water Inflows	301.6	330.3	310.8	213.3	116.4	31.9	0.2	0.7	8.7	23.5	117.1	282.6	387.3
From Sequalitchew Lake	294.1	324.0	304.1	207.4	113.3	31.4	0.2	0.6	8.6	23.2	113.9	274.4	379.5
From Center Drive	0.3	0.3	0.3	0.1	0.0	0.0	0.0	0.1	0.1	0.3	0.5	0.9	0.5
From Hamer (surface)	7.3	6.1	6.5	5.8	3.1	0.5	0.0	0.0	0.0	0.0	2.7	7.3	7.3
Subsurface Inflows	9.7	8.7	9.6	7.7	7.4	6.2	5.4	5.0	4.5	7.8	10.6	10.2	10.0
Evapotranspiration	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0
Recharge (-) Discharge (+)	*15.1*	*14.3*	*15.6*	*14.0*	*14.0*	*12.6*	*12.4*	*11.4*	*11.4*	*12.2*	*17.0*	*16.7*	*14.4*
Surface Water Outflows	-282.5	-306.5	-289.4	-201.1	-117.1	-41.0	-10.5	-11.2	-18.3	-38.8	-125.9	-270.8	-358.0
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-329.3	-357.2	-337.4	-234.4	-136.5	-47.8	-12.2	-13.1	-21.3	-45.3	-146.7	-315.7	-417.3
Change in Storage	1.2	0.2	1.7	0.8	-1.0	-0.4	1.5	2.2	2.2	2.2	4.5	5.7	1.2
Predicted WSE in ft													
EM-2S	217.37	216.87	216.47	216.05	215.71	215.63	215.76	215.94	216.12	216.31	216.46	216.33	215.83
East Edmond	209.61	209.51	209.54	209.49	209.26	209.05	209.00	209.00	209.00	209.00	209.23	209.61	209.61
Eastern East Edmond Marsh	209.81	209.71	209.74	209.69	209.46	209.25	209.20	209.20	209.20	209.20	209.43	209.81	209.81
Observed WSE in ft													
EM-2S	211.46	211.44	211.42	211.33	211.28	211.07	210.67	210.28	210.36	210.44	211.37	211.34	
East Edmond (EM-2E)	212.49	212.47	212.45	212.47	212.38	211.92	211.60	211.43	211.43	211.43	212.50	212.38	
East Edmond (EM-2W)	211.84	211.81	211.78	211.21	211.71	211.53	211.17	210.76	210.81	210.86	211.72	211.68	
East Edmond (EM-3E)	212.85	212.82	212.79	212.83	212.74	212.20	211.92	211.62	211.64	211.65	212.85	212.70	
East Edmond (EM-3W)	212.94	212.92	212.91	212.94	212.83	212.39	212.03	211.71	211.73	211.75	212.95	212.82	
Eastern East Edmond (SCM-1)	213.13	213.11	213.09	213.13	213.03	212.53	212.14	211.79	211.81	211.83	213.11	212.99	

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2017

Hydrologic Process	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Precipitation	5.8	5.9	1.8	1.0	2.3	1.3	0.2	1.5	9.3	6.9	3.9	3.4	8.6
Surface Water Inflows	650.4	646.3	372.9	137.3	92.9	64.0	8.4	12.4	71.2	134.5	212.6	110.5	176.8
From Sequalitchew Lake	643.2	638.6	367.0	134.4	90.0	60.6	8.1	12.3	70.6	127.0	205.1	103.2	170.6
From Center Drive	0.4	0.4	0.1	0.0	0.1	0.1	0.0	0.1	0.7	0.5	0.3	0.2	0.5
From Hamer (surface)	6.8	7.3	5.9	2.9	2.8	3.3	0.3	0.0	0.0	7.0	7.3	7.1	5.7
Subsurface Inflows	9.4	10.0	9.1	9.2	8.9	8.0	7.0	6.7	10.6	9.9	10.2	9.6	9.4
Evapotranspiration	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6
Recharge (-) Discharge (+)	*12.8*	*13.9*	*13.8*	*14.9*	*14.3*	*13.0*	*14.0*	*14.0*	*14.7*	*13.2*	*14.3*	*11.5*	*13.0*
Surface Water Outflows	-580.8	-577.5	-339.4	-137.6	-96.8	-68.2	-22.7	-26.0	-88.0	-133.6	-201.9	-111.3	-174.0
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-677.0	-673.2	-395.7	-160.4	-112.9	-79.6	-26.5	-30.3	-102.6	-155.7	-235.3	-129.7	-202.9
Change in Storage	0.8	1.7	0.0	-1.2	1.8	2.2	-0.9	1.9	2.2	8.3	5.7	5.3	4.3
Predicted WSE in ft													
EM-2S	215.32	214.86	214.37	214.03	213.94	213.85	213.75	213.91	214.10	214.20	214.06	213.92	213.80
East Edmond	209.57	209.61	209.49	209.24	209.24	209.28	209.03	209.00	209.00	209.59	209.61	209.59	209.47
Eastern East Edmond Marsh	209.77	209.81	209.69	209.44	209.44	209.48	209.23	209.20	209.20	209.79	209.81	209.79	209.67
Observed WSE in ft													
EM-2S					211.28	211.15	210.81		210.79	211.31	211.32	211.17	211.47
East Edmond (EM-2E)					212.38	212.27	211.76		211.57	212.24	212.22	212.05	212.04
East Edmond (EM-2W)					211.68	211.57	211.27		211.29	211.90	211.78	211.57	211.59
East Edmond (EM-3E)					212.59	212.34	212.05		211.87	212.33	212.35	212.39	213.34
East Edmond (EM-3W)					212.81	212.60	212.19		212.00	212.69	212.66	212.50	212.46
Eastern East Edmond (SCM-1)					212.88	212.65	212.28		212.08	212.60	212.59	212.62	210.24

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY 2018

Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	8.7	4.6	2.8	1.8	0.0	0.1	1.0	5.2	7.2	5.8	7.2	3.3	2.3
Surface Water Inflows	340.8	280.4	199.7	63.0	7.9	0.2	8.0	16.8	20.9	94.9	156.4	215.9	175.7
From Sequalitchew Lake	332.9	273.1	193.0	58.6	7.9	0.0	7.9	16.4	13.4	87.2	148.7	209.1	169.1
From Center Drive	0.6	0.3	0.2	0.1	0.0	0.0	0.0	0.4	0.5	0.4	0.5	0.2	0.1
From Hamer (surface)	7.3	7.0	6.6	4.4	0.0	0.2	0.0	0.0	7.0	7.3	7.3	6.6	6.5
Subsurface Inflows	10.6	9.4	9.0	8.8	9.0	8.2	7.2	11.7	9.5	10.4	10.3	9.1	9.5
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	*15.2*	*13.7*	*12.2*	*10.6*	*13.1*	*11.8*	*10.9*	*13.9*	*11.9*	*12.8*	*13.4*	*13.0*	*12.3*
Surface Water Outflows	-314.8	-258.2	-184.8	-66.0	-22.0	-11.9	-18.3	-34.4	-31.4	-101.4	-156.1	-202.3	-165.7
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-366.9	-301.0	-215.5	-76.9	-25.6	-13.9	-21.4	-40.1	-36.6	-118.2	-181.9	-235.8	-193.2
Change in Storage	7.0	5.2	5.1	3.7	-0.1	2.4	3.4	6.5	12.5	5.7	5.4	4.8	5.5
Predicted WSE in ft													
EM-2S	213.78	213.63	213.51	213.45	213.44	213.63	213.91	214.45	214.90	214.77	214.62	214.48	214.39
East Edmond	209.61	209.59	209.55	209.37	209.00	209.01	209.00	209.00	209.59	209.61	209.61	209.55	209.54
Eastern East Edmond Marsh	209.81	209.79	209.75	209.57	209.20	209.21	209.20	209.20	209.79	209.81	209.81	209.75	209.74
Observed WSE in ft													
EM-2S	211.31	211.27		211.18	211.05	211.24	210.72			211.95		211.29	211.12
East Edmond (EM-2E)	212.14	212.21		212.34	212.18	211.95	211.82			212.59		212.35	212.14
East Edmond (EM-2W)	210.67	211.63		211.55	211.44	210.47	211.09			211.69		211.60	211.48
East Edmond (EM-3E)	212.37	212.47		212.67	212.88	212.52	212.03			212.56		212.51	212.40
East Edmond (EM-3W)	212.54	212.62		212.78	212.62	212.37	212.27			213.07		212.79	212.58
Eastern East Edmond (SCM-1)	212.62	212.68		212.95	212.65	212.56	212.64			212.89		212.76	212.65

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2019

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	6.1	0.7	0.9	0.2	0.3	1.8	4.0	3.8	6.4	3.4	4.8	1.6	3.6
Surface Water Inflows	110.3	49.0	24.9	3.7	3.1	21.0	22.0	25.2	114.7	87.3	139.5	17.2	126.8
From Sequalitchew Lake	104.9	47.7	22.0	3.4	3.1	20.9	21.7	22.9	108.2	79.8	133.4	12.1	122.7
From Center Drive	0.4	0.0	0.0	0.0	0.0	0.1	0.3	0.2	0.4	0.2	0.3	0.1	0.2
From Hamer (surface)	4.9	1.3	2.9	0.3	0.0	0.0	0.0	2.0	6.1	7.3	5.8	5.0	3.9
Subsurface Inflows	9.5	9.3	7.4	7.1	5.8	6.0	8.0	9.8	10.4	9.6	8.8	8.8	9.0
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	*14.3*	*13.1*	*10.3*	*11.1*	*10.1*	*10.3*	*7.8*	*11.4*	*11.8*	*11.1*	*10.9*	*11.1*	*11.3*
Surface Water Outflows	-114.9	-56.8	-28.1	-14.8	-11.5	-27.1	-30.0	-35.6	-114.6	-89.8	-136.6	-28.1	-123.4
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-133.9	-66.2	-32.8	-17.3	-13.4	-31.5	-35.0	-41.5	-133.6	-104.7	-159.2	-32.7	-143.9
Change in Storage	4.2	2.6	7.0	0.3	1.9	5.2	5.8	8.2	9.7	6.6	4.2	4.7	4.8
Predicted WSE in ft													
EM-2S	214.33	214.45	214.79	214.79	214.95	215.39	215.87	216.39	216.69	216.64	216.50	216.47	216.55
East Edmond	209.41	209.11	209.24	209.02	209.00	209.00	209.00	209.17	209.51	209.61	209.48	209.42	209.32
Eastern East Edmond Marsh	209.61	209.31	209.44	209.22	209.20	209.20	209.20	209.37	209.71	209.81	209.68	209.62	209.52
Observed WSE in ft													
EM-2S	211.17	211.08	211.17	211.01	210.61	210.70	210.71	211.07	211.35	211.39	211.14	211.24	211.37
East Edmond (EM-2E)	212.37	212.41	212.23	212.05	211.65	211.73	211.78	212.21	212.63		212.55	212.37	212.63
East Edmond (EM-2W)	211.51	211.24	211.59	211.44	211.01	211.12	211.07	211.66	211.70		211.48	211.66	211.89
East Edmond (EM-3E)	212.48						212.06	212.42	212.65	212.71	212.83	212.69	212.67
East Edmond (EM-3W)	212.81	212.81	212.50	212.50	212.14	212.19	212.19	212.64	212.98	212.50	213.00	212.81	213.06
Eastern East Edmond (SCM-1)	212.77	212.59	212.85	212.01	211.75	211.84	212.57					212.88	212.90

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2020

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	1.1	0.7	1.0	0.8	3.5	3.9	1.7	6.5	9.6	4.2	3.5	1.5	3.1
Surface Water Inflows	77.2	21.9	2.7	2.2	2.0	7.6	12.5	43.8	12.9	155.9	243.6	221.4	150.0
From Sequalitchew Lake	73.8	20.2	2.6	2.2	1.8	7.4	10.3	42.1	5.0	148.8	237.4	218.1	148.5
From Center Drive	0.0	0.0	0.0	0.0	0.2	0.3	0.1	0.5	0.7	0.3	0.2	0.1	0.2
From Hamer (surface)	3.4	1.7	0.0	0.0	0.0	0.0	2.1	1.3	7.3	6.8	6.0	3.3	1.3
Subsurface Inflows	7.4	5.9	5.0	3.7	5.1	8.2	7.1	10.1	12.1	10.0	8.8	7.7	8.6
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	*10.8*	*9.9*	*10.0*	*8.2*	*5.9*	*13.0*	*14.2*	*12.7*	*17.9*	*13.2*	*17.2*	*16.3*	*15.9*
Surface Water Outflows	-75.4	-26.7	-11.7	-8.2	-10.5	-23.3	-24.2	-58.0	-40.6	-151.2	-227.6	-204.6	-144.1
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-87.8	-31.1	-13.6	-9.5	-12.2	-27.1	-28.2	-67.6	-47.3	-176.3	-265.4	-238.5	-168.0
Change in Storage	5.5	3.5	0.6	1.6	2.0	4.5	6.8	5.5	5.2	6.5	6.5	6.5	6.5
Predicted WSE in ft													
EM-2S	216.73	216.87	216.92	217.05	217.22	217.60	217.99	218.33	218.16	218.13	218.17	218.44	218.87
East Edmond	209.28	209.14	209.00	209.00	209.00	209.00	209.18	209.11	209.00	209.00	209.00	209.00	209.00
Eastern East Edmond Marsh	209.48	209.34	209.20	209.20	209.20	209.20	209.38	209.31	209.20	209.20	209.20	209.20	209.20
Observed WSE in ft													
EM-2S		210.80	210.49	210.07	210.20	210.34		210.30	211.41	210.49			
East Edmond (EM-2E)		211.91	211.55	211.43	211.43	211.44		211.43	212.60	212.45			
East Edmond (EM-2W)		211.58	210.92	210.54		210.77		211.58	211.69	211.66			
East Edmond (EM-3E)						211.90		211.74	212.80	212.80			
East Edmond (EM-3W)		212.37	212.00	211.54	212.27	211.89		212.16	213.03	212.89			
Eastern East Edmond (SCM-1)													

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY 2021

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.5	0.3	0.4	2.8	3.0	5.6	5.2	7.3	4.7	2.5	1.2	2.0	2.4
Surface Water Inflows	84.5	38.4	26.6	22.8	40.2	74.5	126.4	151.6	127.1	168.1	134.1	82.9	68.9
From Sequalitchew Lake	81.6	38.0	26.6	22.6	40.0	74.2	118.8	144.7	120.2	161.3	130.8	80.9	67.3
From Center Drive	0.1	0.0	0.0	0.2	0.2	0.4	0.4	0.5	0.3	0.1	0.0	0.1	0.1
From Hamer (surface)	2.8	0.4	0.0	0.0	0.0	0.0	7.3	6.3	6.6	6.7	3.2	1.9	1.5
Subsurface Inflows	8.0	5.8	4.0	4.8	6.1	10.3	10.7	11.6	10.3	10.7	8.4	8.4	7.7
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	*14.8*	*9.9*	*7.6*	*7.7*	*8.6*	*12.8*	*14.7*	*16.1*	*14.2*	*14.3*	*11.8*	*13.1*	*11.3*
Surface Water Outflows	-85.4	-37.3	-25.5	-26.3	-43.2	-82.6	-129.2	-154.5	-128.0	-161.2	-126.1	-83.0	-68.8
To Diversion Canal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
To West Edmond Marsh	-99.5	-43.4	-29.7	-30.6	-50.4	-96.3	-150.6	-180.1	-149.2	-187.9	-147.0	-96.8	-80.2
Change in Storage	6.5	6.5	4.9	5.1	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Predicted WSE in ft													
EM-2S	219.18	219.68	220.09	220.52	221.06	221.60	221.53	221.54	221.54	221.52	221.79	222.17	222.59
East Edmond	209.00	209.00	209.00	209.00	209.00	209.00	209.00	209.00	209.00	209.00	209.00	209.00	209.00
Eastern East Edmond Marsh	209.20	209.20	209.20	209.20	209.20	209.20	209.20	209.20	209.20	209.20	209.20	209.20	209.20
Observed WSE in ft													
EM-2S		210.83	210.33		210.25			211.47			211.31	211.27	211.13
East Edmond (EM-2E)		211.43	211.43		211.43	212.93		212.54			212.27	212.16	212.04
East Edmond (EM-2W)			210.76		210.69			211.77	212.14	212.14	211.70	211.69	211.51
East Edmond (EM-3E)					211.47	212.18		212.88	213.54	212.83	212.43		
East Edmond (EM-3W)			211.69		211.56	212.50		212.99	212.50	212.50	212.73	212.60	212.50
Eastern East Edmond (SCM-1)													

Table F-17. Water Balance for East Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY 2021

Hydrologic Process	Jul	Aug	Sep
Precipitation	0.0	0.3	2.6
Surface Water Inflows	21.7	26.6	22.8
From Sequalitchew Lake	21.7	26.6	22.6
From Center Drive	0.0	0.0	0.1
From Hamer (surface)	0.0	0.0	0.0
Subsurface Inflows	5.9	4.2	4.5
Evapotranspiration	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	*8.9*	*6.3*	*5.9*
Surface Water Outflows	-23.6	-24.6	-24.6
To Diversion Canal	0.0	0.0	0.0
To West Edmond Marsh	-27.5	-28.6	-28.6
Change in Storage	4.5	4.7	4.7
Predicted WSE in ft			
EM-2S	222.97	223.36	223.76
East Edmond	209.00	209.00	209.00
Eastern East Edmond Marsh	209.20	209.20	209.20
Observed WSE in ft			
EM-2S	210.73		
East Edmond (EM-2E)	211.69	211.43	
East Edmond (EM-2W)	211.14		
East Edmond (EM-3E)			
East Edmond (EM-3W)	212.23	211.56	
Eastern East Edmond (SCM-1)		210.20	

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water	WY2004						WY2005						
Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	2.0	1.0	3.8	0.9	0.1	3.6	2.9	4.0	3.2	4.3	4.3	0.6	4.5
Surface Water Inflows	441.8	378.0	286.8	117.9	66.7	56.4	98.7	154.5	243.4	98.3	117.0	124.8	159.2
From East Edmond	441.8	378.0	286.8	117.9	66.7	56.4	98.7	154.5	243.4	98.3	117.0	124.8	159.2
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	-33.3	-35.2	-35.4	-37.7	-43.3	-39.9	-37.5	-36.3	-34.9	-33.2	-30.2	-32.6	-32.4
Surface Water Outflows	-409.3	-342.0	-252.1	-77.4	-19.0	-16.2	-61.7	-121.1	-211.1	-69.4	-91.1	-92.3	-130.1
To Center Drive	-409.3	-342.0	-252.1	-77.4	-19.0	-16.2	-61.7	-121.1	-211.1	-69.4	-91.1	-92.3	-130.1
Change in Storage	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.50	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	209.10	208.59	207.26	206.55	205.27	205.27	205.27	205.86	206.15	207.67	209.18	207.97	206.63

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2006

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	5.4	3.9	3.8	1.4	0.2	1.6	3.3	6.7	6.5	12.2	3.2	2.6	3.9
Surface Water Inflows	309.8	242.5	228.1	73.2	27.4	68.4	31.5	75.8	125.6	749.5	750.5	684.7	607.6
From East Edmond	309.8	242.5	228.1	73.2	27.4	68.4	31.5	75.8	125.6	749.5	750.5	684.7	607.6
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	-29.2	-29.7	-31.7	-36.5	-36.9	-42.8	-38.6	-32.4	-27.3	-13.9	-19.1	-25.8	-27.5
Surface Water Outflows	-284.1	-213.5	-196.6	-33.5	-0.2	-11.3	-0.2	-44.6	-104.8	-747.7	-734.0	-660.2	-582.1
To Center Drive	-284.1	-213.5	-196.6	-33.5	-0.2	-11.3	-0.2	-44.6	-104.8	-747.7	-734.0	-660.2	-582.1
Change in Storage	0.0	0.0	0.0	0.0	-13.4	13.6	-5.1	5.0	-0.1	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	205.37	206.50	206.07	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	209.29	209.08	207.09	205.79	205.27	205.27	205.27	206.05	208.15	208.82	208.53	208.69	208.78

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2007

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	2.1	2.2	0.4	0.0	0.8	1.6	14.4	8.6	6.5	4.5	5.7	1.7	1.1
Surface Water Inflows	430.5	417.0	283.6	166.1	74.6	87.9	529.4	743.9	1050.7	826.4	1267.5	1175.0	626.0
From East Edmond	430.5	417.0	283.6	166.1	74.6	87.9	529.4	743.9	1050.7	826.4	1267.5	1175.0	626.0
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	-31.2	-32.1	-38.4	-42.3	-43.4	-45.3	-16.4	-15.4	-16.8	-18.3	-18.8	-24.6	-31.6
Surface Water Outflows	-398.2	-383.4	-241.1	-119.8	-29.6	-43.3	-527.0	-737.0	-1040.4	-812.1	-1253.2	-1150.1	-592.3
To Center Drive	-398.2	-383.4	-241.1	-119.8	-29.6	-43.3	-527.0	-737.0	-1040.4	-812.1	-1253.2	-1150.1	-592.3
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	207.56	207.10	205.67	205.27	205.27	205.27	208.74	208.94	208.71	208.75	208.84	208.70	207.84

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2008

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.7	1.5	1.0	1.7	5.0	2.8	7.7	4.2	3.6	4.9	1.8	1.3	1.7
Surface Water Inflows	311.0	71.7	396.2	331.6	278.3	300.5	550.5	552.9	510.3	478.6	459.7	331.6	215.0
From East Edmond	311.0	71.7	396.2	331.6	278.3	300.5	550.5	552.9	510.3	478.6	459.7	331.6	215.0
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	-33.0	-36.2	-39.2	-38.1	-34.7	-33.7	-22.7	-23.5	-23.9	-25.9	-29.2	-34.7	-36.0
Surface Water Outflows	-277.0	-32.6	-354.1	-292.8	-247.5	-269.1	-535.5	-533.7	-489.5	-456.4	-430.3	-295.0	-177.0
To Center Drive	-277.0	-32.6	-354.1	-292.8	-247.5	-269.1	-535.5	-533.7	-489.5	-456.4	-430.3	-295.0	-177.0
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	206.92	205.84	205.63	205.62	207.09	207.82	209.17	209.07	209.02	209.23	209.03	206.96	206.38

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2009

Hydrologic Process	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Precipitation	0.9	2.1	0.5	2.6	8.3	5.2	7.3	1.6	5.3	3.5	3.4	1.3	0.0
Surface Water Inflows	80.7	138.0	87.4	62.8	270.6	178.3	715.1	341.9	458.2	429.9	407.7	264.9	173.7
From East Edmond	80.7	138.0	87.4	62.8	270.6	178.3	715.1	341.9	458.2	429.9	407.7	264.9	173.7
Evapotranspiration	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5
Recharge (-) Discharge (+)	-40.6	-40.7	-42.7	-42.8	-27.7	-26.7	-21.2	-26.4	-26.0	-27.7	-29.2	-32.6	-40.6
Surface Water Outflows	-36.6	-95.4	-42.9	-21.5	-250.8	-156.8	-701.3	-316.5	-436.1	-403.7	-378.7	-229.9	-128.6
To Center Drive	-36.6	-95.4	-42.9	-21.5	-250.8	-156.8	-701.3	-316.5	-436.1	-403.7	-378.7	-229.9	-128.6
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	205.27	205.27		205.27	208.19	208.61	208.52	208.60	209.22	209.09	208.22	206.01	205.27

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2010

Hydrologic Process	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Precipitation	1.9	2.8	5.6	8.9	3.0	8.0	3.3	3.3	3.3	4.6	4.3	0.4	0.2
Surface Water Inflows	135.2	123.7	204.8	402.7	376.2	620.7	511.4	627.5	843.9	638.8	539.0	336.3	193.2
From East Edmond	135.2	123.7	204.8	402.7	376.2	620.7	511.4	627.5	843.9	638.8	539.0	336.3	193.2
Evapotranspiration	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0
Recharge (-) Discharge (+)	-40.4	-38.3	-33.6	-22.3	-26.6	-18.3	-20.8	-21.0	-20.8	-22.6	-23.8	-33.2	-38.1
Surface Water Outflows	-92.7	-85.8	-175.8	-388.9	-352.6	-610.4	-493.3	-608.6	-824.5	-617.6	-515.8	-299.0	-151.3
To Center Drive	-92.7	-85.8	-175.8	-388.9	-352.6	-610.4	-493.3	-608.6	-824.5	-617.6	-515.8	-299.0	-151.3
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	205.27	205.27	205.98	209.21	209.55	208.68	208.58	208.34	209.17	207.87	207.82	206.07	206.07

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2011

Hydrologic Process	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precipitation	4.0	4.2	6.6	7.2	6.1	3.1	7.2	5.7	4.8	2.8	0.8	0.3	1.3
Surface Water Inflows	272.3	321.9	440.0	570.8	1148.3	1017.8	1329.5	1376.1	1098.1	664.9	246.6	192.6	137.4
From East Edmond	272.3	321.9	440.0	570.8	1148.3	1017.8	1329.5	1376.1	1098.1	664.9	246.6	192.6	137.4
Evapotranspiration	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	-33.1	-33.1	-25.0	-21.1	-22.0	-23.0	-25.7	-25.8	-18.1	-21.9	-27.1	-32.1	-35.5
Surface Water Outflows	-240.9	-292.0	-421.1	-556.8	-1132.4	-997.3	-1309.8	-1354.1	-1081.6	-642.0	-215.8	-156.8	-100.9
To Center Drive	-240.9	-292.0	-421.1	-556.8	-1132.4	-997.3	-1309.8	-1354.1	-1081.6	-642.0	-215.8	-156.8	-100.9
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	206.07	206.05	208.98	209.46	207.57		208.99	209.34	209.95		207.28	206.60	206.03

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water	WY2012												WY2013
Hydrologic Process	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Precipitation	4.1	6.1	3.2	7.2	3.9	6.8	4.3	3.1	3.3	1.6	0.0	0.1	6.5
Surface Water Inflows	361.5	378.7	381.1	549.0	670.4	922.3	1139.3	1063.8	549.5	370.5	143.8	51.7	228.0
From East Edmond	361.5	378.7	381.1	549.0	670.4	922.3	1139.3	1063.8	549.5	370.5	143.8	51.7	228.0
Evapotranspiration	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0
Recharge (-) Discharge (+)	-34.6	-33.3	-29.2	-23.2	-21.3	-24.0	-26.7	-25.7	-24.9	-28.8	-32.4	-36.5	-35.9
Surface Water Outflows	-330.0	-351.1	-355.1	-533.0	-652.4	-903.8	-1114.8	-1038.0	-524.2	-338.8	-107.4	-13.0	-197.6
To Center Drive	-330.0	-351.1	-355.1	-533.0	-652.4	-903.8	-1114.8	-1038.0	-524.2	-338.8	-107.4	-13.0	-197.6
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	206.28	206.94	207.83	209.23	209.32	209.55	209.78	209.52	209.14		206.36	205.73	206.56

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water | WY2014

Hydrologic Process	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Precipitation	6.5	7.6	3.5	1.7	3.7	5.5	4.4	1.9	0.0	1.6	6.9	2.6	4.1
Surface Water Inflows	402.7	717.8	831.0	561.1	695.3	655.8	535.6	373.6	201.5	162.4	179.1	333.0	357.8
From East Edmond	402.7	717.8	831.0	561.1	695.3	655.8	535.6	373.6	201.5	162.4	179.1	333.0	357.8
Evapotranspiration	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5
Recharge (-) Discharge (+)	-31.0	-27.6	-22.4	-21.3	-23.8	-21.1	-29.6	-29.6	-36.8	-39.1	-28.7	-20.3	-25.4
Surface Water Outflows	-377.7	-697.8	-812.1	-540.9	-674.0	-638.2	-507.2	-342.2	-160.2	-121.0	-154.9	-314.2	-336.0
To Center Drive	-377.7	-697.8	-812.1	-540.9	-674.0	-638.2	-507.2	-342.2	-160.2	-121.0	-154.9	-314.2	-336.0
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	208.21	209.83	209.07	209.27	209.37	209.44	208.41	207.37	205.95	206.06	206.17	208.73	208.72

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2015

Hydrologic Process	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation	2.4	4.2	6.9	9.8	4.5	3.3	1.3	1.2	1.6	1.8	5.9	6.1	4.8
Surface Water Inflows	323.7	422.2	608.4	1549.7	1314.1	1083.7	528.8	293.5	182.4	137.5	282.3	444.2	804.1
From East Edmond	323.7	422.2	608.4	1549.7	1314.1	1083.7	528.8	293.5	182.4	137.5	282.3	444.2	804.1
Evapotranspiration	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0
Recharge (-) Discharge (+)	-24.4	-19.5	-19.0	-21.1	-24.1	-23.5	-25.1	-32.8	-34.2	-28.5	-24.8	-20.8	-21.9
Surface Water Outflows	-301.6	-406.9	-595.8	-1537.1	-1292.6	-1060.4	-501.2	-257.5	-145.8	-108.5	-262.4	-429.0	-787.0
To Center Drive	-301.6	-406.9	-595.8	-1537.1	-1292.6	-1060.4	-501.2	-257.5	-145.8	-108.5	-262.4	-429.0	-787.0
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	207.55	208.55	209.72	209.98	210.01	209.99	209.05	205.30	205.87	206.07	208.63	208.73	209.84

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2016

Hydrologic Process	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Precipitation	4.1	4.7	4.4	2.1	0.8	0.4	0.2	2.2	1.3	5.0	7.1	12.0	6.9
Surface Water Inflows	1070.1	1160.8	1096.4	761.7	443.5	155.5	39.7	42.6	69.3	147.0	476.9	1025.9	1356.1
From East Edmond	1070.1	1160.8	1096.4	761.7	443.5	155.5	39.7	42.6	69.3	147.0	476.9	1025.9	1356.1
Evapotranspiration	0.0	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0
Recharge (-) Discharge (+)	-19.3	-20.7	-23.4	-27.1	-33.6	-38.8	-39.4	-40.6	-41.0	-42.7	-23.7	-21.4	-23.2
Surface Water Outflows	-1054.9	-1144.2	-1076.2	-734.7	-407.5	-113.3	-0.2	-0.1	-27.2	-108.4	-459.8	-1016.5	-1339.8
To Center Drive	-1054.9	-1144.2	-1076.2	-734.7	-407.5	-113.3	-0.2	-0.1	-27.2	-108.4	-459.8	-1016.5	-1339.8
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	-4.0	0.1	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.15	206.16	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	209.79	209.76	209.74	209.48	207.29	205.54	205.27	205.27	205.27	205.27	209.37	210.02	

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2017

Hydrologic Process	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Precipitation	5.8	5.9	1.8	1.0	2.3	1.3	0.2	1.5	9.3	6.9	3.9	3.4	8.6
Surface Water Inflows	2200.1	2187.6	1285.8	521.3	366.8	258.5	86.0	98.5	333.4	506.0	764.8	421.6	659.3
From East Edmond	2200.1	2187.6	1285.8	521.3	366.8	258.5	86.0	98.5	333.4	506.0	764.8	421.6	659.3
Evapotranspiration	-0.6	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6
Recharge (-) Discharge (+)	-21.7	-25.0	-24.6	-25.4	-25.0	-32.5	-35.9	-35.4	-37.2	-24.3	-22.9	-20.7	-14.8
Surface Water Outflows	-2183.6	-2167.2	-1260.9	-493.7	-340.4	-222.9	-46.3	-62.3	-304.4	-488.0	-745.9	-404.3	-652.5
To Center Drive	-2183.6	-2167.2	-1260.9	-493.7	-340.4	-222.9	-46.3	-62.3	-304.4	-488.0	-745.9	-404.3	-652.5
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A					208.90	206.26	205.31		206.87	208.72	209.45	209.29	209.86

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2018

Hydrologic Process	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Precipitation	8.7	4.6	2.8	1.8	0.0	0.1	1.0	5.2	7.2	5.8	7.2	3.3	2.3
Surface Water Inflows	1192.4	978.0	700.1	249.8	83.3	45.0	69.5	130.2	118.8	384.0	591.2	766.2	627.7
From East Edmond	1192.4	978.0	700.1	249.8	83.3	45.0	69.5	130.2	118.8	384.0	591.2	766.2	627.7
Evapotranspiration	-1.3	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3
Recharge (-) Discharge (+)	-17.6	-18.3	-21.6	-23.6	-29.1	-32.6	-34.8	-27.0	-26.1	-17.9	-20.2	-20.2	-24.0
Surface Water Outflows	-1182.2	-962.3	-678.1	-224.4	-49.7	-8.6	-33.3	-107.5	-99.4	-371.9	-578.2	-748.7	-604.8
To Center Drive	-1182.2	-962.3	-678.1	-224.4	-49.7	-8.6	-33.3	-107.5	-99.4	-371.9	-578.2	-748.7	-604.8
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	210.22	208.64		209.58	207.22	206.67	205.31			209.98		209.98	209.67

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water — WY2019

Hydrologic Process	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Precipitation	6.1	0.7	0.9	0.2	0.3	1.8	4.0	3.8	6.4	3.4	4.8	1.6	3.6
Surface Water Inflows	435.1	215.1	106.6	56.2	43.4	102.5	113.6	134.7	434.1	340.3	517.4	106.4	467.5
From East Edmond	435.1	215.1	106.6	56.2	43.4	102.5	113.6	134.7	434.1	340.3	517.4	106.4	467.5
Evapotranspiration	-2.0	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0
Recharge (-) Discharge (+)	-24.9	-30.5	-34.1	-36.8	-39.3	-38.4	-39.5	-33.6	-23.3	-17.4	-16.1	-28.1	-29.5
Surface Water Outflows	-414.2	-182.1	-69.7	-15.1	-0.4	-63.5	-77.0	-104.4	-417.2	-326.3	-505.5	-78.5	-439.6
To Center Drive	-414.2	-182.1	-69.7	-15.1	-0.4	-63.5	-77.0	-104.4	-417.2	-326.3	-505.5	-78.5	-439.6
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	209.97	208.18	205.31	205.31	205.31	205.31	205.31	206.55	209.32	209.38	209.41	208.53	208.79

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2020

Hydrologic Process	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation	1.1	0.7	1.0	0.8	3.5	3.9	1.7	6.5	9.6	4.2	3.5	1.5	3.1
Surface Water Inflows	285.4	101.2	44.2	30.9	166.5	88.2	91.6	219.6	153.6	572.9	862.3	775.1	545.9
From East Edmond	285.4	101.2	44.2	30.9	166.5	88.2	91.6	219.6	153.6	572.9	862.3	775.1	545.9
Evapotranspiration	-3.2	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2
Recharge (-) Discharge (+)	-35.3	-38.9	-42.3	-40.0	-40.0	-38.6	-35.6	-35.0	-16.7	-18.4	-30.2	-29.2	-30.2
Surface Water Outflows	-248.1	-59.2	-0.2	-0.2	-128.1	-52.5	-57.2	-191.2	-146.4	-558.1	-834.4	-745.4	-515.7
To Center Drive	-248.1	-59.2	-0.2	-0.2	-128.1	-52.5	-57.2	-191.2	-146.4	-558.1	-834.4	-745.4	-515.7
Change in Storage	0.0	0.0	-1.7	-12.3	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.34	205.46	206.44	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A		205.31	205.31	205.31	205.31	205.31		206.97	209.81	209.35			

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2021

Hydrologic Process	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Precipitation	2.5	0.3	0.4	2.8	3.0	5.6	5.2	7.3	4.7	2.5	1.2	2.0	2.4
Surface Water Inflows	323.4	141.2	96.4	99.6	163.8	312.9	489.3	585.3	485.0	610.6	477.7	314.5	260.6
From East Edmond	323.4	141.2	96.4	99.6	163.8	312.9	489.3	585.3	485.0	610.6	477.7	314.5	260.6
Evapotranspiration	-3.7	-4.5	-4.0	-2.3	-1.0	-0.5	0.0	0.0	-0.6	-1.3	-2.0	-3.2	-3.7
Recharge (-) Discharge (+)	-29.2	-40.7	-42.5	-41.4	-43.1	-30.1	-31.1	-19.1	-22.0	-24.4	-28.7	-38.0	-37.7
Surface Water Outflows	-292.9	-96.3	-50.4	-58.6	-122.7	-287.9	-463.5	-573.4	-467.1	-587.5	-448.2	-275.3	-221.6
To Center Drive	-292.9	-96.3	-50.4	-58.6	-122.7	-287.9	-463.5	-573.4	-467.1	-587.5	-448.2	-275.3	-221.6
Change in Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predicted WSE in ft	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49	206.49
Observed WSE EM-1/EM-1A			205.31		205.31	206.87		209.40	209.72	209.15	208.13	205.31	205.31

Table F-18. Water Balance for West Edmond Marsh with Mining Restoration - Low Groundwater

Monthly Average in Inches of Water WY2021

Hydrologic Process	Jul	Aug	Sep
Precipitation	0.0	0.3	2.6
Surface Water Inflows	89.2	93.0	93.0
From East Edmond	89.2	93.0	93.0
Evapotranspiration	-4.5	-4.0	-2.3
Recharge (-) Discharge (+)	-41.6	-41.6	-40.3
Surface Water Outflows	-43.1	-43.6	-49.0
To Center Drive	-43.1	-43.6	-49.0
Change in Storage	0.0	4.1	4.0
Predicted WSE in ft	206.49	206.49	206.49
Observed WSE EM-1/EM-1A	205.31	206.87	

Appendix C
Design Drawings

60% DESIGN

SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION

SOUTH PUGET SOUND SALMON ENHANCEMENT GROUP

LOCATION MAP

SCALE: 1" = 2000'

DRAWING INDEX		
SHT #	DWG #	SHEET DESCRIPTION
1	G01	COVER SHEET
2	G02	GENERAL NOTES, ABBREVIATIONS, AND LEGEND
3	G03	GENERAL NOTES, ABBREVIATIONS, AND LEGEND
4	G04	OVERALL SITE PLAN AND DRAWING INDEX
5	EC01	EXISTING CONDITIONS
6	T01	TEMPORARY ACCESS AND STAGING PLAN
7	T02	TEMPORARY ACCESS AND STAGING PLAN
8	T03	TEMPORARY ACCESS AND STAGING PLAN
9	TC01	DETAILED CARE OF WATER PLAN
10	TC02	BEAVER MANAGEMENT PLAN
11	TC03	FLEXIBLE LEVELER DETAILS
12	TC04	BEAVER MANAGEMENT DETAILS
13	TC05	ROBISON BRIDGE TEMPORARY SEWER PROTECTION MEASURES
14	C01	ROBISON BRIDGE GRADING AND UTILITY PLAN AND PROFILE
15	C02	ROBISON BRIDGE GENERAL STRUCTURAL NOTES AND TYPICAL SECTION
16	C03	ROBISON BRIDGE FOUNDATION PLAN
17	C04	ROBISON BRIDGE ABUTMENT LAYOUT
18	C05	ROBISON BRIDGE ABUTMENT DETAILS
19	C06	ROBISON BRIDGE RAILING DETAILS
20	C07	ROBISON BRIDGE PLAN AND ELEVATION
21	C08	ROBISON BRIDGE PLANTING PLAN AND SCHEDULE

DRAWING INDEX		
SHT #	DWG #	SHEET DESCRIPTION
22	C09	LOSING REACH/CENTER DRIVE CULVERT DEMOLITION PLAN
23	C10	LOSING REACH/CENTER DRIVE CULVERT MATERIALS AND LAYOUT PLAN
24	C11	LOSING REACH/CENTER DRIVE CULVERT MATERIALS AND LAYOUT PLAN
25	C12	LOSING REACH/CENTER DRIVE CULVERT MATERIALS AND LAYOUT PLAN
26	C13	LOSING REACH/CENTER DRIVE CULVERT RESTORATION SECTIONS
27	C14	LOSING REACH/CENTER DRIVE CULVERT LMW TYPICALS
28	C15	LOSING REACH/CENTER DRIVE CULVERT DETAILS
29	C16	LOSING REACH/CENTER DRIVE CULVERT PLANTING PLAN
30	C17	LOSING REACH/CENTER DRIVE CULVERT PLANTING PLAN
31	C18	LOSING REACH/CENTER DRIVE CULVERT PLANTING DETAILS
32	C19	LOSING REACH/CENTER DRIVE CULVERT PLANTING SCHEDULE
33	C20	CITY HALL BRIDGE DEMOLITION PLAN
34	C21	CITY HALL BRIDGE GRADING PLAN
35	C22	CITY HALL BRIDGE GRADING AND DEMOLITION SECTIONS
36	C23	CITY HALL BRIDGE GENERAL NOTES AND TYPICAL SECTION
37	C24	CITY HALL BRIDGE FOUNDATION PLAN
38	C25	CITY HALL BRIDGE ABUTMENT LAYOUT
39	C26	CITY HALL BRIDGE ABUTMENT DETAILS
40	C27	CITY HALL BRIDGE RAILING DETAILS
41	C28	CITY HALL BRIDGE PLAN AND ELEVATION

PROJECT DATA

LOCATION: DUPONT, WA
SECTIONS 25 AND 26, TOWNSHIP 19N, RANGE 01E

PROJECT ENGINEER: GRAHAM HART, PE
ANCHOR QEA, LLC
949 MARKET STREET, SUITE 700
TACOMA, WA 98402

GEOTECHNICAL ENGINEER: JOHN LAPLANTE, PE
ANCHOR QEA, LLC
1201 3RD AVENUE, SUITE 2600
SEATTLE, WA 98101

PROJECT ADMINISTRATOR: COLE BALDINO
SALMON HABITAT RESTORATION PROJECT MANAGER

CONTRACTING AGENCY: SOUTH PUGET SOUND SALMON ENHANCEMENT GROUP
6700 MARTIN WAY EAST, SUITE 112
OLYMPIA, WA 98516

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH ZONE, NAD83, U.S. SURVEY FEET
2. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

DRAFT-NOT FOR CONSTRUCTION

PLAN INTENDED TO BE VIEWED IN COLOR, ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

REVISIONS				
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: G. HART
DRAWN BY: T. GRIGA
CHECKED BY: T. DRURY
APPROVED BY: J. SMALL
SCALE: AS NOTED
DATE: FEBRUARY 2023

SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

COVER SHEET

G01

SHEET NO. 1 OF 41

Feb 20, 2023 7:49pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-G-COVER.dwg G01

GENERAL CONSTRUCTION NOTES:

1. CONTRACT DOCUMENTS REFER TO THESE DRAWINGS, THE PROJECT SPECIFICATIONS, AND THE BIDDING DOCUMENTS, AND THE CONSTRUCTION CONTRACT.
2. EXCEPT AS OTHERWISE NOTED HEREIN, ALL MATERIAL AND WORK SHALL BE ACCOMPLISHED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, THE WSDOT/APWA "STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION" (2021 EDITION), OTHER APPLICABLE STANDARDS, AND ACCORDING TO MANUFACTURER'S RECOMMENDATIONS.
3. THE CONTRACTOR SHALL HAVE COPIES OF THE APPROVED CONTRACT DOCUMENTS AND THE WSDOT/APWA "STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION" (2021 EDITION) ON THE JOBSITE AT ALL TIMES.
4. THE CONTRACTOR SHALL VISIT THE JOB SITE PRIOR TO CONSTRUCTION AND SHALL BE RESPONSIBLE FOR VERIFYING FIELD CONDITIONS AND DIMENSIONS, AND CONFIRMING THAT THE WORK CAN BE ACCOMPLISHED AS SHOWN ON THESE CONTRACT DOCUMENTS. ANY DISCREPANCIES BETWEEN THE EXISTING FIELD CONDITIONS AND DIMENSIONS SHOWN ON THE CONTRACT DOCUMENTS AND THOSE OBSERVED BY THE CONTRACTOR SHALL BE BROUGHT TO THE ATTENTION OF THE OWNER AND THE PROJECT ADMINISTRATOR PRIOR TO PROCEEDING WITH CONSTRUCTION.
5. A PRE-CONSTRUCTION MEETING BETWEEN THE OWNER, THE PROJECT ADMINISTRATOR AND THE ENGINEER SHALL BE REQUIRED PRIOR TO ANY ON-SITE WORK.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING RIGHT-OF-WAY PERMITS FROM THE CITY OF DUPONT PRIOR TO PROCEEDING WITH THE WORK. THE CONTRACTOR SHALL SUBMIT RIGHT-OF-WAY USE PERMIT APPLICATIONS AND PAY ALL APPLICABLE FEES.
7. THE CONTRACTOR SHALL RECEIVE, IN WRITING, AUTHORIZATION TO PROCEED BEFORE STARTING WITH ANY WORK ON ANY ITEM NOT CLEARLY DEFINED OR IDENTIFIED BY THE CONTRACT DOCUMENTS.
8. ALL WORK SHALL BE IN CONFORMANCE WITH EXISTING LABOR LAWS, SAFETY REQUIREMENTS, AND OTHER REGULATIONS, AS REQUIRED BY CITY OF DUPONT, THE STATE OF WASHINGTON, AND THE FEDERAL GOVERNMENT. THE CONTRACTOR SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION, INCLUDING THE SAFETY OF ALL PERSONS AND PROPERTY. THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND IS NOT LIMITED TO NORMAL WORKING HOURS.
9. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL CONSTRUCTION MEANS, METHODS, TECHNIQUES, SEQUENCES, AND PROCEDURES AND FOR COORDINATING ALL PORTIONS OF THE WORK UNDER THIS CONTRACT.
10. ALL MATERIALS SHALL BE NEW AND UNDAMAGED UNLESS OTHERWISE APPROVED BY THE CONTRACTING OFFICER AND HIS ENGINEER. THE SAME MANUFACTURER OF EACH ITEM SHALL BE USED THROUGHOUT THE WORK UNLESS OTHERWISE APPROVED BY THE OWNER'S REPRESENTATIVE.
11. THE CONTRACTOR SHALL MAKE ALL NECESSARY PROVISIONS TO PROTECT EXISTING IMPROVEMENTS, ROADWAYS, DRAINAGE WAYS, CULVERTS, AND VEGETATION UNTIL SUCH ITEMS ARE TO BE DISTURBED OR REMOVED AS INDICATED ON THE CONTRACT DOCUMENTS.
12. THE CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIR OF PROPERTY IN AND AROUND THE PROJECT AREA. UNLESS OTHERWISE NOTED ON THESE DRAWINGS, ITEMS SUCH AS MAILBOXES, CULVERTS, LAWN ORNAMENTS, FENCING, DRIVEWAYS, IRRIGATION BOXES, ETC., THAT ARE AFFECTED BY CONSTRUCTION ACTIVITIES SHALL BE REPAIRED OR REPLACED FOLLOWING CONSTRUCTION.
13. RUBBISH, DEBRIS, AND GARBAGE SHALL BE REMOVED FROM THE JOB SITE PRIOR TO ACCEPTANCE AND DISPOSED OF LEGALLY. SEE THE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
14. THE NOTES, DETAILS AND SPECIFICATIONS ON THE CONTRACT DOCUMENTS SHALL TAKE PRECEDENCE OVER THESE GENERAL NOTES.
15. DIMENSION CALL-OUTS SHALL TAKE PRECEDENCE OVER SCALES SHOWN ON THE DRAWINGS.
16. THE CONTRACTOR SHALL MAINTAIN HAND DRAWN REDLINES, FIELD NOTES AND PHOTOGRAPHS ("FIELD DOCUMENTATION") OF ALL IMPROVEMENTS AS THE WORK PROGRESSES. THE CONTRACTOR'S FIELD DOCUMENTATION SHALL BE MAINTAINED ON-SITE AND SHALL BE AVAILABLE FOR REVIEW BY THE OWNER AND THE ENGINEER AT ALL TIMES. THE CONTRACTOR SHALL PROVIDE FIELD DOCUMENTATION TO THE ENGINEER FOR PREPARATION OF CERTIFIED RECORD DRAWINGS PRIOR TO PROJECT ACCEPTANCE.

LOCATION OF EXISTING UTILITIES:

1. THE LOCATIONS OF EXISTING UTILITIES SHOWN ON THESE DRAWINGS ARE APPROXIMATE. AND HAVE NOT BEEN FIELD VERIFIED. THE CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING ALL EXISTING UTILITIES PRIOR TO CONSTRUCTION. THE CONTRACTOR SHALL CONTACT THE UTILITY LOCATION REQUEST CENTER (ONE-CALL CENTER) AT 811 OR 1-800-424-5555 FOR UTILITY LOCATIONS NOT LESS THAN TWO (2) BUSINESS DAYS BEFORE THE SCHEDULED DATE FOR EARTHWORK OR TRENCHING THAT MAY IMPACT EXISTING UTILITIES.
2. THE SIZE, LOCATION, AND TYPE OF UNDERGROUND UTILITIES EXPOSED OR MODIFIED BY THE CONTRACTOR SHALL BE ACCURATELY NOTED AND PLACED ON THE CONTRACTOR'S AS-BUILT DRAWINGS.

GENERAL NOTES (STREET CONSTRUCTION)

1. A PRE-CONSTRUCTION CONFERENCE SHALL BE HELD PRIOR TO THE START OF CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR SECURING ALL NECESSARY PERMITS PRIOR TO CONSTRUCTION.
2. A COPY OF THE APPROVED ROADWAY DRAWINGS MUST BE ON THE JOB SITE WHENEVER CONSTRUCTION IS IN PROGRESS.
3. ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH CITY OF DUPONT'S PUBLIC WORKS STANDARDS AND STORMWATER MANAGEMENT MANUAL AND THE MOST CURRENT EDITION OF THE STATE OF WASHINGTON STANDARD SPECIFICATIONS FOR ROAD, BRIDGE, AND MUNICIPAL CONSTRUCTION.
4. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROVIDE ADEQUATE TEMPORARY TRAFFIC CONTROL TO ENSURE TRAFFIC SAFETY DURING CONSTRUCTION ACTIVITIES. THEREFORE, THE CONTRACTOR SHALL SUBMIT A TRAFFIC CONTROL PLAN TO THE PUBLIC WORKS DEPARTMENT AT LEAST 48 HOURS PRIOR TO STARTING ANY WORK IN THE RIGHT-OF-WAY. ALL TRAFFIC CONTROL DEVICES SHALL CONFORM TO THE "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES" (MUTCD).
5. ALL CURB AND GUTTER, STREET GRADES, SIDEWALK GRADES, AND ANY OTHER VERTICAL AND/OR HORIZONTAL ALIGNMENT SHALL BE STAKED BY A PROFESSIONAL ENGINEER OR SURVEYING FIRM CAPABLE OF PERFORMING SUCH WORK.
6. ANY ROADWAY SIGNAGE OR STRIPING REMOVED OR TEMPORARILY MOVED BY THE CONTRACTOR SHALL BE RESTORED SO AS TO MEET THE CURRENT MUTCD STANDARDS.
7. WHERE NEW ASPHALT JOINS EXISTING, THE EXISTING ASPHALT SHALL BE CUT TO A NEAT VERTICAL EDGE AND TACKED WITH ASPHALT EMULSION TYPE CSS-1 IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS. THE JOINT SHALL BE SEALED WITH GRADE AR-4000W PAVING ASPHALT.
8. COMPACTION OF SUBGRADE, ROCK, AND ASPHALT SHALL BE IN ACCORDANCE WITH THE WSDOT/APWA STANDARD SPECIFICATIONS. SEE CITY OF DUPONT PUBLIC WORKS STANDARDS TABLE 10.2-1 FOR TESTING AND SAMPLING FREQUENCIES. DENSITY TEST REPORTS WILL BE REQUIRED FOR ALL PUBLIC ROADWAYS.
9. FORM AND SUBGRADE INSPECTION BY THE CITY IS REQUIRED BEFORE PLACING CONCRETE. TWENTY-FOUR HOURS ADVANCE NOTICE IS REQUIRED FOR THE SCHEDULING OF INSPECTION.
10. CALL UNDERGROUND UTILITY LOCATE LINE, 1-800-424-5555, PRIOR TO ANY EXCAVATION.
11. DEAD-END STREETS SHALL BE APPROPRIATELY SIGNED AND BARRICADED.
12. WHERE A SIDEWALK IS TO BE CONSTRUCTED ABOVE A SLOPE OR ADJACENT TO A ROCKERY OR RETAINING WALL, WHERE THE LOWEST FINISHED ELEVATION OF THE SLOPE, ROCKERY, OR RETAINING WALL IS TO BE 30 INCHES OR MORE BELOW THE FINISHED ELEVATION OF THE SIDEWALK, A SAFETY RAILING SHALL BE REQUIRED WHEN:

(a) THE PLANE OF THE WALL FACE IS LESS THAN 4 FEET IN HORIZONTAL DISTANCE FROM THE OUTSIDE EDGE OF THE SIDEWALK.

(b) THE PLANE OF THE WALL FACE IS GREATER THAN 4-FEET HORIZONTAL DISTANCE TO THE OUTSIDE EDGE OF THE SIDEWALK, BUT THE SLOPE DOWN TO THE WALL TOP EXCEEDS THREE TO ONE.

(c) THE SLOPES ADJACENT TO THE SIDEWALK AVERAGE GREATER THAN TWO TO ONE.

GRADING AND EARTHWORK GENERAL NOTES:

1. THE CONTRACTOR SHALL LIMIT DISTURBANCE OF THE EXISTING SURFACE TO THE LIMITS SHOWN ON THE DRAWINGS. THE CONTRACTOR SHALL FLAG OR MARK THE CLEARING AND DISTURBANCE LIMITS PRIOR TO CONSTRUCTION.
2. ALL EXPOSED OR EXCAVATED SLOPES STEEPER THAN 3:1 MUST BE STABILIZED WITH JUTE MAT OR OTHER APPROVED STABILIZATION WITHIN 24 HOURS OF EXPOSURE.
3. EXPOSED SOIL MUST BE COVERED WITHIN 5 DAYS OF EXPOSURE DURING THE DRY SEASON (APRIL 1 THROUGH SEPTEMBER 30), AND WITHIN 48 HOURS OF EXPOSURE DURING THE WET SEASON (OCTOBER 1 THROUGH MARCH 31).
4. FOR ADDITIONAL TESC REQUIREMENTS, SEE THE TESC PLANS, THE SPECIFICATIONS, AND THE APPROVED CONSTRUCTION SWPPP.
5. COMPACTION OF SOILS PLACED FOR THE PROJECT SHALL BE AS SHOWN ON THE DRAWINGS OR AS REQUIRED BY THE SPECIFICATIONS. WHERE NOT SHOWN OR SPECIFIED, EMBANKMENT SOILS AND SOILS SUPPORTING STRUCTURES OR TRAFFIC SHALL BE COMPACTED TO AT LEAST 95% MAXIMUM DRY DENSITY, AS DETERMINED BY A MODIFIED PROCTOR TEST. ALL OTHER SOILS SHALL BE COMPACTED TO AT LEAST 90% OF MAXIMUM DRY DENSITY.
6. WHERE REQUIRED BY THE CONTRACTING ORGANIZATION'S REPRESENTATIVE OR THE GEOTECHNICAL ENGINEER, UNSUITABLE SUBGRADE MATERIAL SHALL BE REMOVED AND REPLACED WITH SUITABLE ON-SITE EMBANKMENT FILL OR OTHER MATERIAL DESIGNATED BY THE CONTRACTING ORGANIZATION'S REPRESENTATIVE PRIOR TO COMPACTION AND FINAL GRADING.
7. THE CONTRACTOR SHALL DEWATER OR OTHERWISE DRAIN ALL EXCAVATIONS TO A MINIMUM OF 1 FOOT BELOW SUBGRADE ELEVATION PRIOR TO PLACING AND COMPACTING BACKFILL. DEWATERING AND DISPOSAL OF WATER SHALL COMPLY WITH STATE AND LOCAL REGULATIONS AND APPLICABLE PERMITS REQUIREMENTS. DWATERING WATER SHALL BE DISPERSED ON SITE.
8. A LICENSED GEOTECHNICAL ENGINEER SHALL SUPERVISE PLACEMENT OF ALL EMBANKMENT AND FILL MATERIAL AND SHALL WITNESS ALL ON-SITE GEOTECHNICAL TESTING.
9. CONSTRUCTION RECORDS OF SOIL ACTIVITIES AND COMPACTION TESTING SHALL BE TRANSMITTED TO THE CONTRACTING AGENCY ON A WEEKLY BASIS. ALL TEST RESULTS SHALL INCLUDE A MAP INDICATING THE TEST LOCATION.
10. FOR ADDITIONAL GRADING AND EARTHWORK REQUIREMENTS, SEE THE SPECIFICATIONS.
11. GRADING SHALL BE DONE UNDER THE SUPERVISION OF A LICENSED GEOTECHNICAL ENGINEER IN CONFORMANCE WITH THE RECOMMENDATIONS OF THE *DRAFT GEOTECHNICAL ENGINEERING DESIGN REPORT, SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT* BY ANCHOR QEA, LLC, DATED NOVEMBER 2022. THIS REPORT IS PART OF THESE PLANS.

TOPOGRAPHIC SURVEY GENERAL NOTES:

1. THIS MAP CORRECTLY REPRESENTS CONDITIONS AND FEATURES EXISTING AT THE TIME OF THIS SURVEY IN MARCH, 2015.
2. CONVENTIONAL AND GPS SURVEY EQUIPMENT WAS USED IN THE PERFORMANCE OF THIS SURVEY. ALL EQUIPMENT IS MAINTAINED IN CONFORMANCE WITH CURRENT STATE STATUTE.
3. THIS SURVEY WAS PREPARED BY FIELD TRAVERSE AS PER WAC 332-130-090, PART C. RELATIVE ACCURACY EXCEEDS 1 FOOT IN TEN THOUSAND.
4. ALL SURFACE FEATURES AND INVERT STRUCTURE ELEVATION SHOWN HEREON WERE FIELD LOCATED AND MEASURED BY PARAMETRIX FOR THIS SURVEY. UNDERGROUND UTILITY LINES ARE BASED UPON A COMBINATION OF SURFACE FEATURE MEASUREMENTS AND ONSITE UNDERGROUND UTILITY MARKINGS PERFORMED BY OTHERS.
5. THE SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. THE SURVEYOR FURTHER DOES NOT WARRANT THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED ALTHOUGH HE DOES CERTIFY THAT THEY ARE LOCATED AS ACCURATELY AS POSSIBLE FROM INFORMATION AVAILABLE.

ABBREVIATIONS:

'	FEET, MINUTES
"	INCHES, SECONDS
°	DEGREES
ADA	AMERICANS WITH DISABILITIES ACT
APWA	AMERICAN PUBLIC WORKS ASSOCIATION
AWWA	AMERICAN WATER WORKS ASSOCIATION
ASSY	ASSEMBLY
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
AVG.	AVERAGE
CFS	CUBIC FEET PER SECOND
CONC	CONCRETE
CMP	CORRUGATED METAL PIPE
CY	CUBIC YARDS
D.I	DUCTILE IRON
DIA	DIAMETER
DWG	DRAWING
E	EAST, EASTING
ELEV	ELEVATION
ETC.	ETCETERA
EX	EXISTING
FG	FINISHED GRADE
FL	FLOW LINE, FLANGE, FLANGED
FPS	FEET PER SECOND
FT	FEET
GALV	GALVANIZED
GPM	GALLONS PER MINUTE
GV	GATE VALVE
HPDE	HIGH-DENSITY POLYETHYLENE
I.D.	INSIDE DIAMETER
IE	INVERT ELEVATION
IN	INCHES
L	LENGTH
LF	LINEAR FEET
LWM	LARGE WOODY MATERIAL
MAX	MAXIMUM
MIN	MINIMUM
MJ	MECHANICAL JOINT
N	NORTH, NORTHING
NAD	NORTH AMERICAN DATUM
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NO., #	NUMBER
NTS	NOT TO SCALE
O.C.	ON CENTERS
O.D.	OUTSIDE DIAMETER
P	POWER
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
P.E.	PROFESSIONAL ENGINEER
R, RAD	RADIUS
REINF	REINFORCED, REINFORCEMENT
ROW	RIGHT OF WAY
S	SLOPE, SANITARY SEWER, SOUTH
SCH	SCHEDULE
STA	STATION
SY	SQUARE YARD
T	TELEPHONE
TYP	TYPICAL
W	WEST, WATER
W/	WITH
WSDOE	WASHINGTON STATE DEPARTMENT OF ECOLOGY
WSDOT	WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
WSEL	WATER SURFACE ELEVATION
WWT	WASHINGTON WATER TRUST

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

REVISIONS

REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: G. HART
DRAWN BY: T. GRIGA
CHECKED BY: T. DRURY
APPROVED BY: J. SMALL
SCALE: AS NOTED
DATE: FEBRUARY 2023

SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

GENERAL NOTES, ABBREVIATIONS, AND LEGEND

G02

SHEET NO. 2 OF 41

Feb 20, 2023 7:49pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-G-COVER.dwg G02

SEWER CONSTRUCTION NOTES:

1. ALL MATERIALS, WORKMANSHIP, AND TESTING SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE LATEST EDITION OF THE PIERCE COUNTY SANITARY SEWER DEVELOPMENT SPECIFICATIONS, THE PIERCE COUNTY SANITARY SEWER STANDARD DETAILS MANUAL AND THE PIERCE COUNTY SEWER CODE.
2. THE CONTRACTOR SHALL NOTIFY THE DESIGN ENGINEER AND THE PIERCE COUNTY DEVELOPMENT ENGINEERING INSPECTOR IN THE EVENT OF DISCOVERY OF POOR SOILS, STANDING GROUND WATER OR DISCREPANCIES FROM THE PLANS IN GRADES, LOCATIONS AND CONSTRUCTION OF UTILITIES, STRUCTURES, AND OTHER EXISTING CONDITIONS.
3. THE CONTRACTOR SHALL FIELD VERIFY LOCATION AND ELEVATION OF THE POINT OF CONNECTION PRIOR TO CONSTRUCTION.
4. TESTING BY AIR OR WATER EXFILTRATION IS REQUIRED ON ALL SEWERS, INCLUDING DRY LINES, AND VACUUM TESTING IS REQUIRED ON ALL MANHOLES. PIERCE COUNTY REQUIRES A MINIMUM 24-HOUR ADVANCED NOTICE FOR SITE INSPECTION.
5. THE CONTRACTOR SHALL BE REGISTERED WITH PIERCE COUNTY PLANNING AND PUBLIC WORKS DEVELOPMENT ENGINEERING SECTION AND HAVE A VALID $5,000.00 STREET OBSTRUCTION BOND.
6. PIERCE COUNTY REQUIRES THAT THE OWNER OR THE OWNER'S REPRESENTATIVE, THE ENGINEER AND THE CONTRACTOR ATTEND A PRE-CONSTRUCTION CONFERENCE WITH THE PIERCE COUNTY DEVELOPMENT ENGINEERING INSPECTOR FOR ALL WORK ON THESE PLANS. THE CONFERENCE SHOULD BE SCHEDULED BY CALLING (253) 798-4050 A MINIMUM OF TWO WEEKS PRIOR TO COMMENCEMENT OF WORK.
7. IT SHALL BE THE RESPONSIBILITY OF THE OWNER/DEVELOPER/CONTRACTOR TO OBTAIN NECESSARY PERMITS, CONSTRUCTION EASEMENTS AND RELEASES.
8. ANY REVISIONS TO THESE PLANS, ONCE APPROVED BY PIERCE COUNTY MUST BE REVIEWED AND REAPPROVED BY PIERCE COUNTY PLANNING AND PUBLIC WORKS DEVELOPMENT ENGINEERING SECTION PRIOR TO IMPLEMENTATION IN THE FIELD.
9. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO HAVE A SET OF THESE APPROVED PLANS ON THE JOB SITE WHENEVER CONSTRUCTION IS IN PROGRESS.
10. SIDE SEWER STUBS SHALL BE INSTALLED AT LEAST 10 FEET FROM PROPERTY LINES, UNLESS OTHERWISE APPROVED BY PIERCE COUNTY PLANNING AND PUBLIC WORKS DEVELOPMENT ENGINEERING SECTION.
11. ALL MANHOLES LOCATED IN LOW POINTS OF VERTICAL CURVES SHALL HAVE WATERTIGHT LIDS.
12. ALL NEW MANHOLES WILL BE PRE-CHANNELED WITH PIERCE COUNTY APPROVED MANHOLE INVERT LINERS AND HAVE LOCKING LIDS, UNLESS OTHERWISE NOTED.
13. SANITARY SEWER LINES AND WATER MAIN CROSSINGS: THE STANDARD MINIMUM VERTICAL SEPARATION FOR WATER LINES IS 1.5 FEET ABOVE THE SANITARY SEWER LINE. SEPARATION SHALL BE MEASURED FROM THE OUTER WALLS OF THE PIPES.
    A. CONTACT DEVELOPMENT ENGINEERING FOR UNUSUAL CIRCUMSTANCES FOR DEVELOPMENT ENGINEERING TO DETERMINE IF A REDUCED MINIMUM VERTICAL SEPARATION WILL BE ALLOWED FOR LESS THAN 1.5 FEET BUT NOT LESS THAN 0.75 FEET. ADDITIONAL PROVISIONS WILL BE REQUIRED.
14. SANITARY SEWER LINES AND UTILITY CROSSING OTHER THAN WATER LINES:
    A. THE STANDARD MINIMUM VERTICAL SEPARATION FOR UTILITIES OTHER THAN WATER LINES IS 1.5 FEET FROM THE SANITARY SEWER. SEPARATION SHALL BE MEASURED FROM THE OUTER WALLS OF THE PIPES.
    B. IF CONCRETE ENCASEMENT OF THE SANITARY SEWER IS PROVIDED, THEN A REDUCED MINIMUM VERTICAL SEPARATION OF 0.75 FEET WILL BE ALLOWED. THE CONCRETE ENCASEMENT SHALL EXTEND 10 FEET ON EACH SIDE OF THE CROSSING.
    C. CLASS 52 DUCTILE IRON PIPE MAY BE USED FOR THE SANITARY SEWER IN LIEU OF CONCRETE ENCASEMENT PROVIDED THAT THERE IS NO TRANSITIONING TO OTHER PIPE MATERIALS BETWEEN MANHOLES.
15. TEES SHALL BE USED FOR ALL SIDE SEWER CONNECTIONS TO SEWER MAINLINES.
16. THE INTERIOR OF ALL DUCTILE IRON PIPE SHALL BE LINED PER PIERCE COUNTY SANITARY SEWER DEVELOPMENT SPECIFICATIONS.
17. THE INTERIOR WALLS OF ALL CONCRETE MANHOLES FOR INTERCEPTOR SEWERS (15"NOMINAL INSIDE DIAMETER AND LARGER) SHALL BE COATED PER PIERCE COUNTY SANITARY SEWER DEVELOPMENT SPECIFICATIONS.
18. THE EXTERIOR OF ALL MANHOLES SHALL BE COATED PER PIERCE COUNTY SANITARY SEWER DEVELOPMENT SPECIFICATIONS.
19. THE MINIMUM LENGTH OF CONCRETE ENCASEMENT SHALL BE 20 LINEAR FEET.
20. CONCRETE MANHOLES THAT ARE TAPPED FOR A FORCE MAIN CONNECTION SHALL HAVE THEIR INTERIORS RECEIVE PROTECTIVE COATINGS PER PIERCE COUNTY SANITARY SEWER DEVELOPMENT SPECIFICATIONS.
21. ALL TRENCH RESTORATION REQUIREMENTS, OTHER THAN PIPE BEDDING, SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF THE MANUAL ON ACCOMMODATING UTILITIES IN PIERCE COUNTY RIGHT-OF-WAY. PEA GRAVEL, AS SPECIFIED IN THE PIERCE COUNTY SANITARY SEWER DEVELOPMENT SPECIFICATIONS, SHALL BE USED FOR ALL SANITARY SEWER PIPE BEDDING MATERIAL.
22. ALL PAVEMENT RESTORATION REQUIREMENTS IN THE PUBLIC RIGHT-OF-WAY SHALL BE DETERMINED BY THE PERMITTING JURISDICTION (I.E. - PIERCE COUNTY TRANSPORTATION SERVICES, CITY OF UNIVERSITY PLACE, CITY OF LAKEWOOD, TOWN OF MILTON, CITY OF TACOMA, CITY OF DUPONT, OR THE STATE OF WASHINGTON, ETC.) UPON APPLICATION AND ISSUANCE OF RIGHT-OF-WAY PERMIT OR EQUAL THEREOF. IN ADDITION, AT THE PERMITTING JURISDICTION'S DISCRETION, ALTERNATIVE CONSTRUCTION METHODS OTHER THAN STANDARD OPEN TRENCH CONSTRUCTION MAY BE REQUIRED FOR SANITARY SEWER CONSTRUCTION SHOWN ON THESE APPROVED CONSTRUCTION PLANS.

EROSION/SEDIMENTATION CONTROL NOTES

THE CONTRACTOR SHALL PROVIDE EROSION CONTROL METHODS ACCORDING TO THE WASHINGTON STATE DEPARTMENT OF ECOLOGY'S (WDOE) "STORMWATER MANAGEMENT MANUAL FOR WESTERN WASHINGTON." THE FOLLOWING NOTES ARE ONLY A FEW OF THE MINIMUM REQUIREMENTS AND SHOULD NOT BE INTERPRETED TO EXCLUDE ANY EROSION CONTROL PRACTICES AS SPECIFIED IN THE WDOE STORMWATER MANUAL.

1. ALL LIMITS OF CLEARING AND AREAS OF VEGETATION PRESERVATION AS PRESCRIBED ON THE PLAN SHALL BE CLEARLY FLAGGED BY THE ENGINEER IN THE FIELD AND OBSERVED DURING CONSTRUCTION.
2. ALL REQUIRED SEDIMENTATION/EROSION CONTROL FACILITIES MUST BE IN OPERATION PRIOR TO LAND CLEARING AND/OR OTHER CONSTRUCTION TO INSURE THAT SEDIMENT LADEN WATER DOES NOT ENTER THE NATURAL DRAINAGE SYSTEM. ALL EROSION AND SEDIMENT FACILITIES SHALL BE MAINTAINED IN A SATISFACTORY CONDITION UNTIL SUCH TIME THAT CLEARING AND/OR CONSTRUCTION IS COMPLETED AND POTENTIAL FOR ON-SITE EROSION HAS PASSED. THE IMPLEMENTATION, MAINTENANCE, REPLACEMENT AND ADDITIONS TO EROSION/SEDIMENTATION CONTROL SYSTEMS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
3. THE EROSION AND SEDIMENTATION CONTROL SYSTEMS DEPICTED ON THIS DRAWING ARE INTENDED TO BE MINIMUM REQUIREMENTS TO MEET ANTICIPATED SITE CONDITIONS. AS CONSTRUCTION PROGRESSES AND AS UNEXPECTED OR SEASONAL CONDITIONS DICTATE, THE CONTRACTOR SHOULD ANTICIPATE THAT MORE EROSION AND SEDIMENTATION CONTROL FACILITIES WILL BE NECESSARY TO INSURE COMPLETE SILTATION CONTROL ON THE PROPOSED SITE. DURING THE COURSE OF CONSTRUCTION, IT SHALL BE THE OBLIGATION AND RESPONSIBILITY OF THE CONTRACTOR TO ADDRESS ANY NEW CONDITIONS THAT MAY BE CREATED BY HIS ACTIVITIES AND TO PROVIDE ADDITIONAL FACILITIES, OVER AND ABOVE MINIMUM REQUIREMENTS, AS MAY BE NEEDED TO PROTECT ADJACENT PROPERTIES AND WATER QUALITY OF THE RECEIVING DRAINAGE SYSTEM.

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

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Feb 20, 2023 7:49pm tgriga

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

REVISIONS				
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: #########
DRAWN BY: T. GRIGA
CHECKED BY: T. DRURY
APPROVED BY: J. SMALL
SCALE: AS NOTED
DATE: FEBRUARY 2023

SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

GENERAL NOTES, ABBREVIATIONS, AND LEGEND

G03

SHEET NO. 3 OF 41

NOTES:

1. AERIAL FROM ESRI.
2. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH ZONE, NAD 83, U.S. FEET

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

OVERALL SITE PLAN AND DRAWING INDEX

G04

SHEET NO. 4 OF 41

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NORTH

0 300 600

SCALE IN FEET

LEGEND:

SEQUALITCHEW CREEK

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

EXISTING CONDITIONS

EC01

SHEET NO. 5 OF 41

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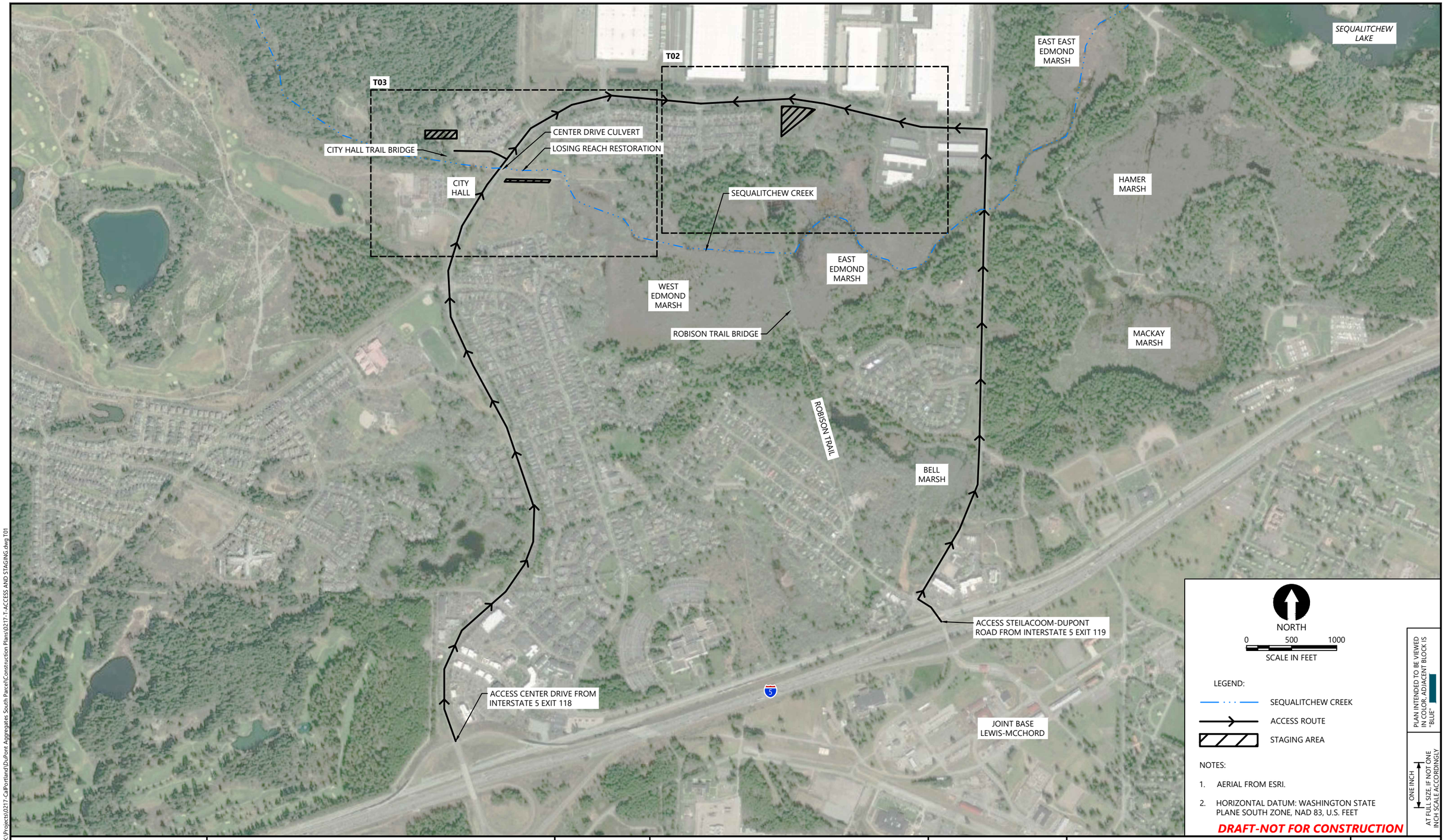

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

TEMPORARY ACCESS AND STAGING PLAN

T01

SHEET NO. 6 OF 41

NORTH

0 100 200

SCALE IN FEET

LEGEND:

- SEQUALITCHEW CREEK
- ACCESS ROUTE
- STAGING AREA

NOTES:

1. AERIAL FROM ESRI.
2. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH ZONE, NAD 83, U.S. FEET

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SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

TEMPORARY ACCESS AND STAGING PLAN

T02

SHEET NO. 7 OF 41

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SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

REVISIONS

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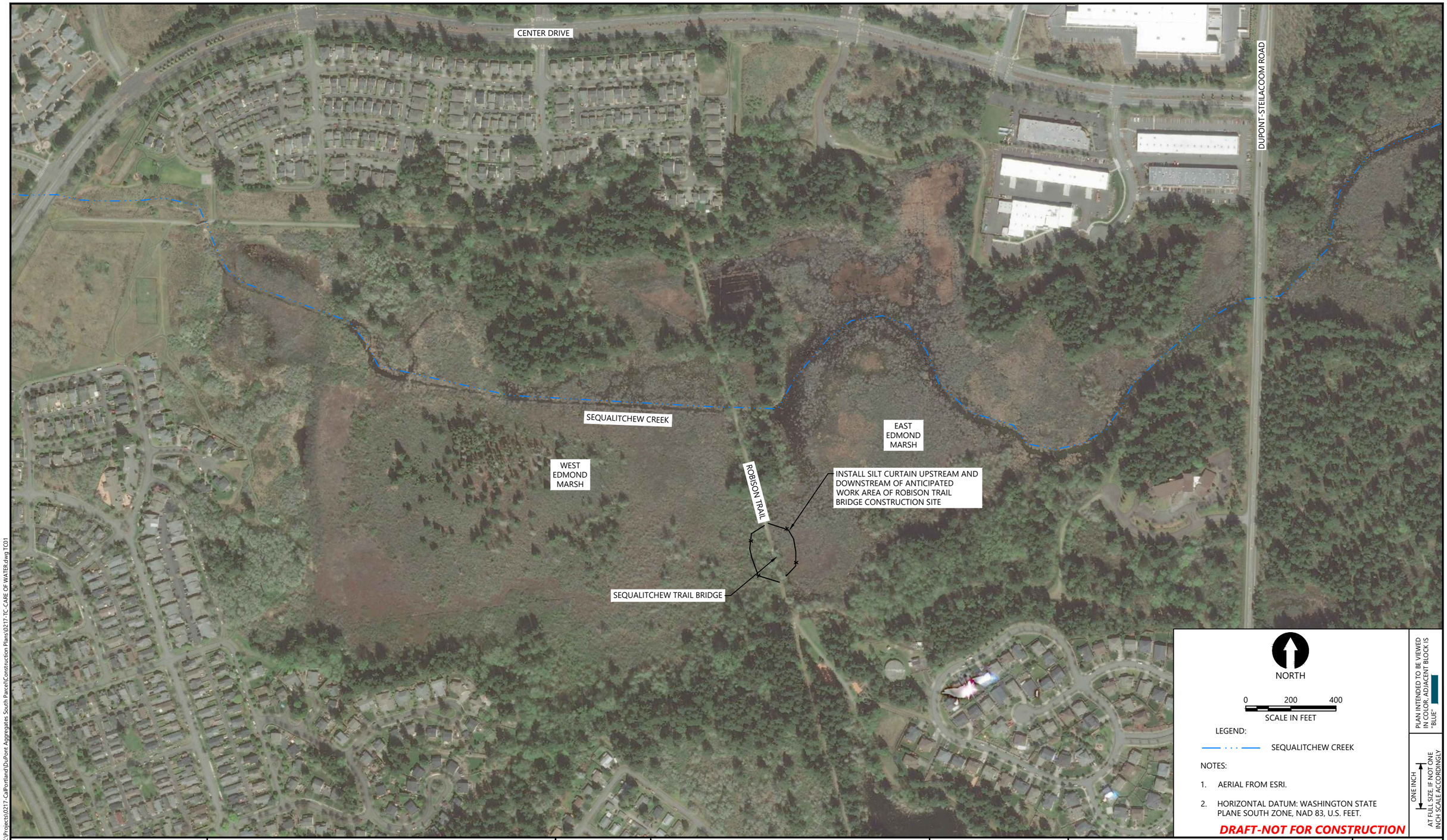
DATE: FEBRUARY 2023

SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

TEMPORARY ACCESS AND STAGING PLAN

T03

SHEET NO. 8 OF 41



NORTH

0 200 400

SCALE IN FEET

LEGEND:

SEQUALITCHEW CREEK

NOTES:

1. AERIAL FROM ESRI.
2. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH ZONE, NAD 83, U.S. FEET.

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

DETAILED CARE OF WATER PLAN

TC01

SHEET NO. 9 OF 41

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Feb 20, 2023 7:50pm tgriga

NORTH

0 200 400

SCALE IN FEET

LEGEND:

WETLAND BOUNDARY

100-FOOT WETLAND BUFFER

SEQUALITCHEW CREEK

NOTES:

1. AERIAL FROM ESRI.
2. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH ZONE, NAD 83, U.S. FEET
3. NOTCH DAM FROM CREST TO TOE WITH A MINIMUM 60 DEGREE CREST ANGLE.

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ANCHOR QEA

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DATE: FEBRUARY 2023

SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

BEAVER MANAGEMENT PLAN

TC02

SHEET NO. 10 OF 41

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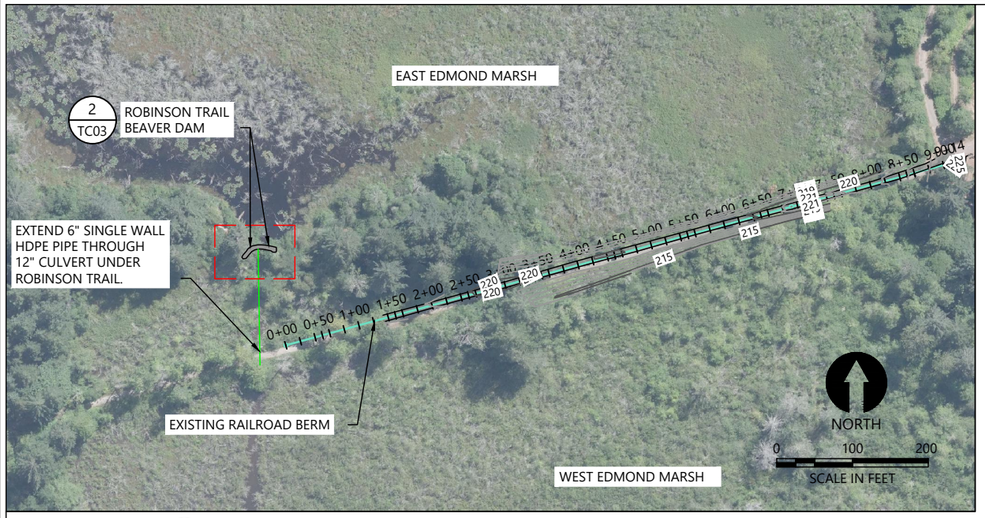


1 TC02 ROBINSON TRAIL BEAVER DAM FLEXIBLE LEVELER INSTALLATION

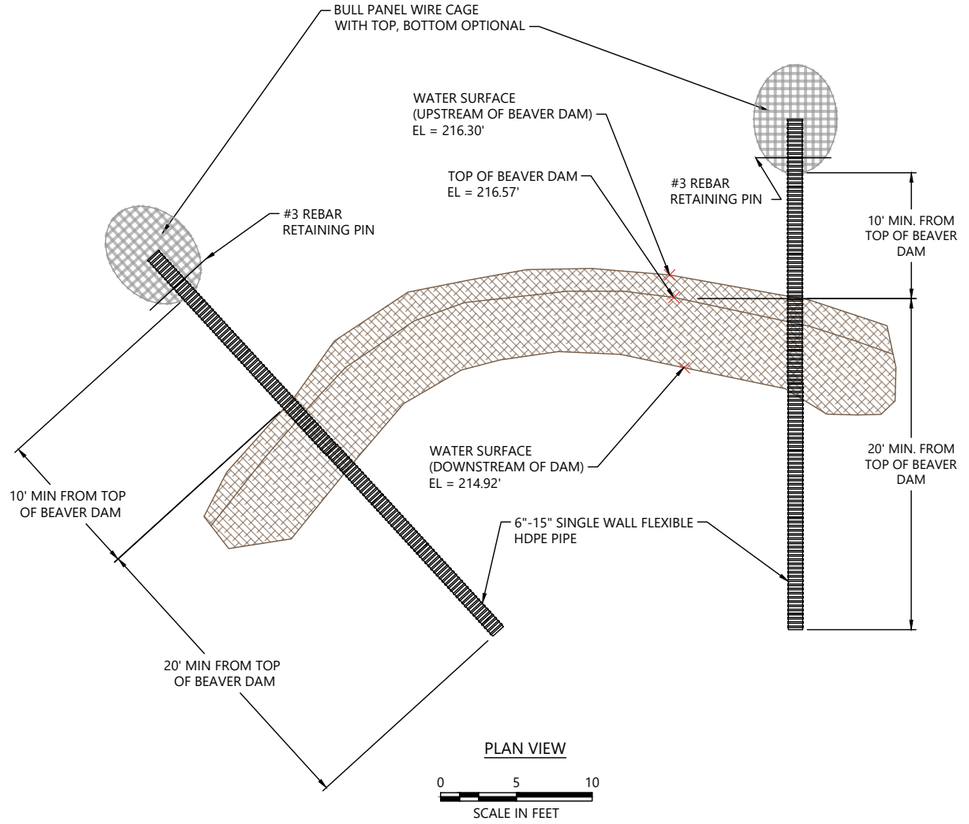
SCALE: NOT TO SCALE

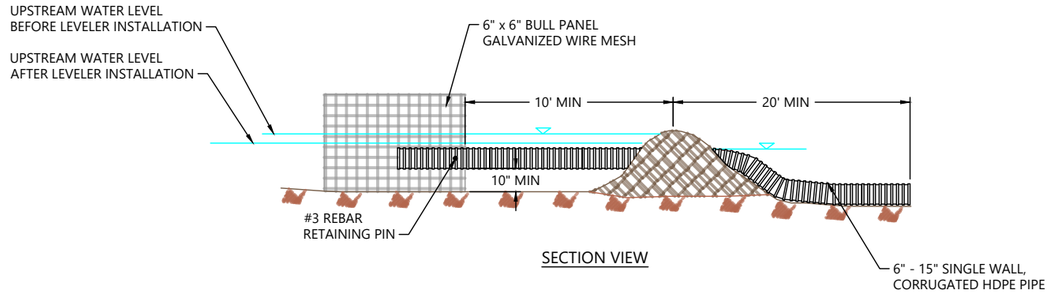
ROBINSON TRAIL BEAVER DAM (FACING NORTH)

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH ZONE, NAD 83/91, U.S. FEET
2. VERTICAL DATUM: NAVD88

NORTH





2 TC02 FLEXIBLE POND LEVELER INSTALLATION

SCALE: NOT TO SCALE

DRAFT-NOT FOR CONSTRUCTION

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SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

FLEXIBLE LEVELER DETAILS

TC03

SHEET NO. 11 OF 41

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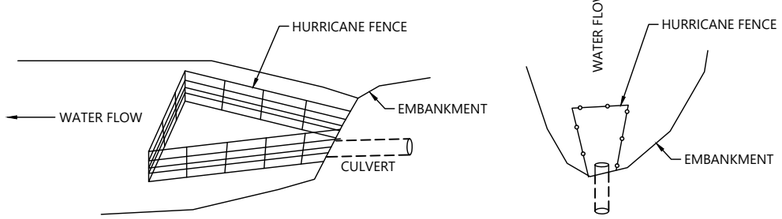
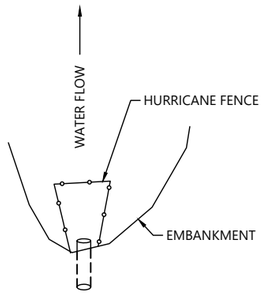


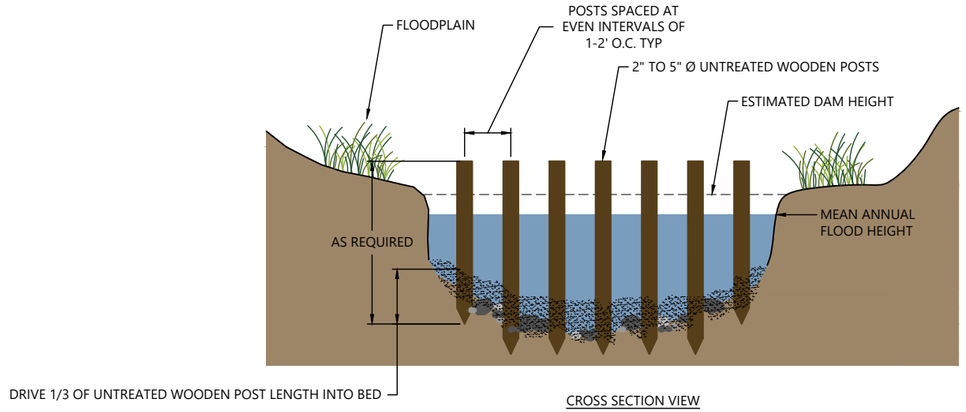
SIDE VIEW



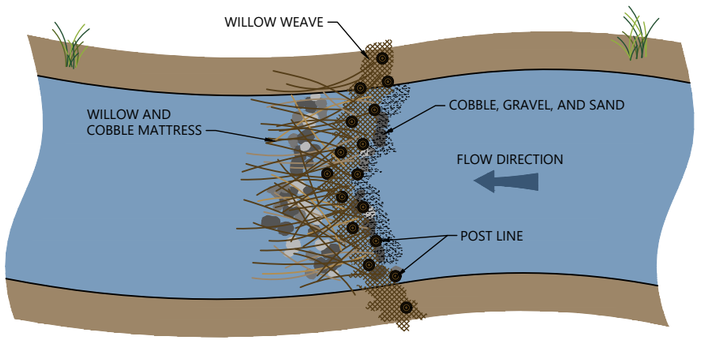
PLAN VIEW

TYPICAL INSTALLATION

3 TC02 BEAVER EXCLUSION DEVICE
SCALE: NOT TO SCALE



CROSS SECTION VIEW



PLAN VIEW (CONVEX PRIMARY DAM)

4 TC02 BEAVER DAM ANALOG
SCALE: NOT TO SCALE

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

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DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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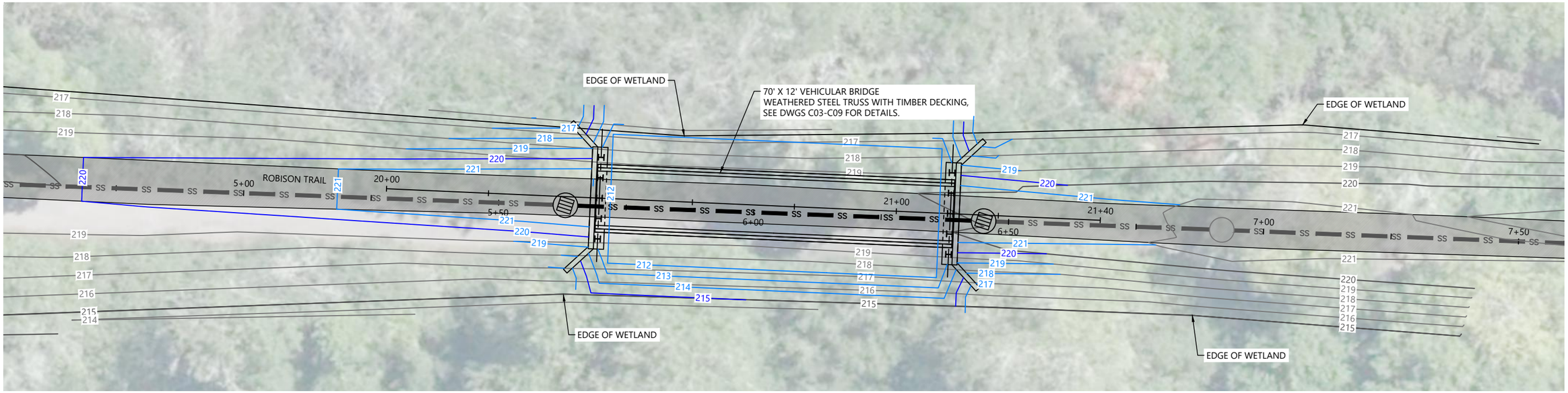
SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

BEAVER MANAGEMENT DETAILS

TC04

SHEET NO. 12 OF 41

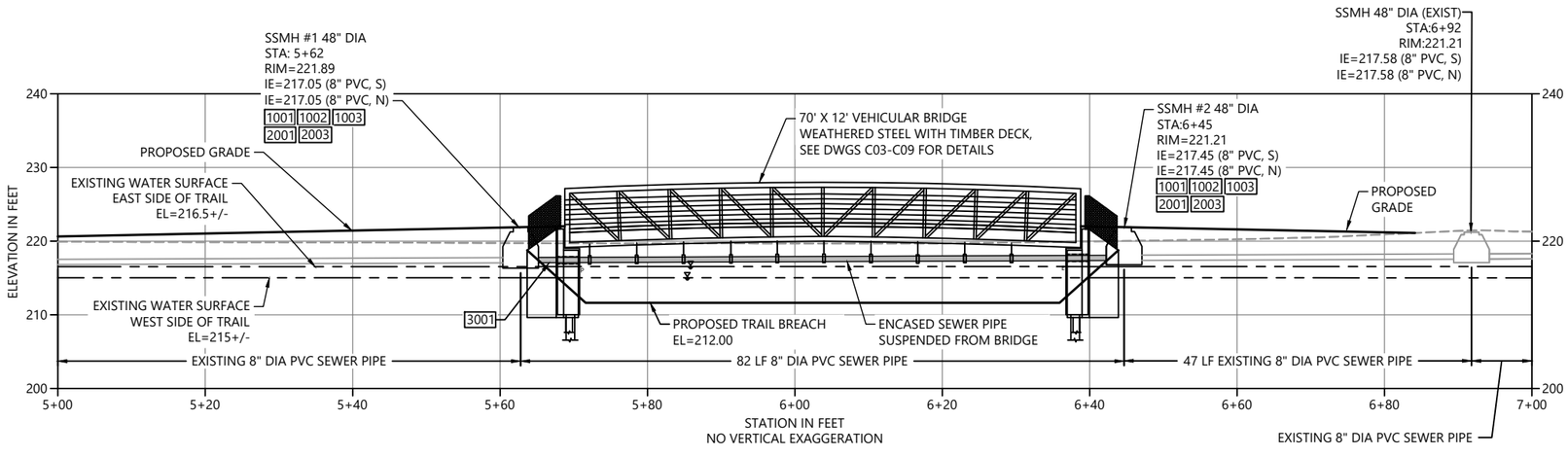
Feb 20, 2023 7:50pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-PL-TC Details.dwg TC04



NORTH

0 10 20

SCALE IN FEET



NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH ZONE, NAD 83/91, U.S. FEET
2. VERTICAL DATUM: NAVD88
3. PHASE NUMBER SHOWN BEFORE PROPOSED ACTIONS.

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

REVISIONS				
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: G. HART
DRAWN BY: T. GRIGA
CHECKED BY: T. DRURY
APPROVED BY: J. SMALL
SCALE: AS NOTED
DATE: FEBRUARY 2023

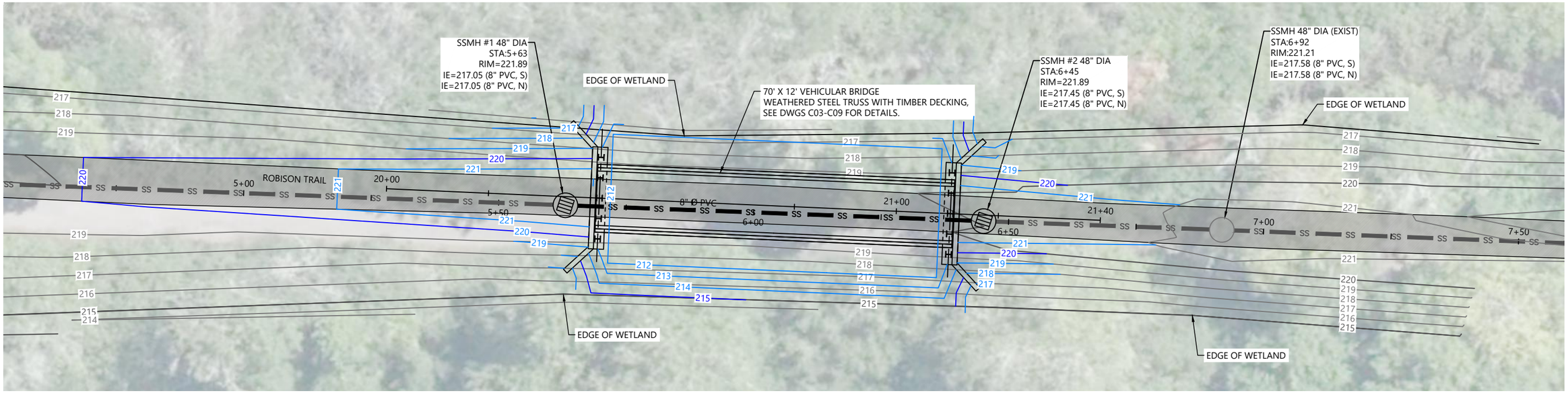
SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

ROBISON BRIDGE TEMPORARY SEWER PROTECTION MEASURES

TC05

SHEET NO. 13 OF 41

Feb 20, 2023 7:50pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-PL-Robison Profile.dwg TC05



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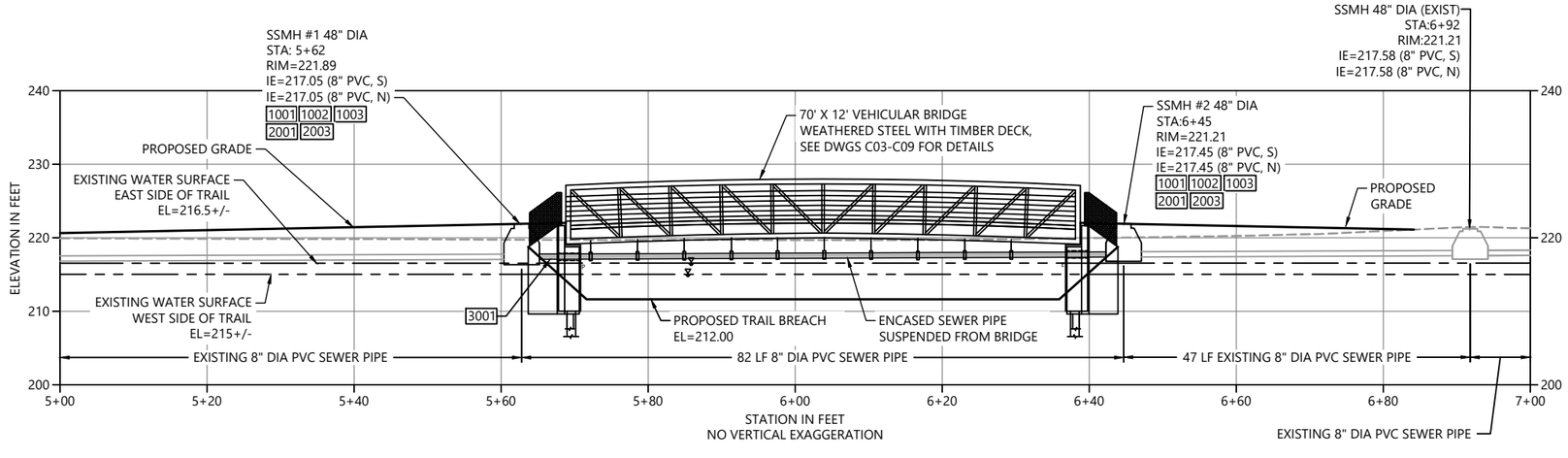
SCALE IN FEET



STANDARD UTILITY LEGEND	
STANDARD DETAIL	DESCRIPTION
1001	CONCRETE MANHOLE STEP
1002	CONCRETE MANHOLE COLLAR IN PAVED AREA
1003	PUBLIC MANHOLE FRAME AND LOCKING LID
2001	CONCRETE MANHOLE
2003	NEW CONCRETE MANHOLE CUT INTO EXISTING MAIN
3001	TYPICAL TRENCH SECTION

NOTES:

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ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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DESIGNED BY: G. HART
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APPROVED BY: J. SMALL
SCALE: AS NOTED
DATE: FEBRUARY 2023

SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

ROBISON BRIDGE GRADING AND UTILITY PLAN AND PROFILE

C01

SHEET NO. 14 OF 41

Feb 20, 2023 7:50pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-PL-Robison Profile.dwg C01

BRIDGE GENERAL NOTES

1. ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION "STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION," DATED 2023, AND PROJECT SPECIAL PROVISIONS.
2. ALL DIMENSIONS ARE HORIZONTAL OR VERTICAL UNLESS OTHERWISE SHOWN.
3. THE CONTRACTOR SHALL PLAN AND CONDUCT THE WORK IN SUCH A MANNER THAT NO OBJECTS OR FOREIGN MATERIALS FALL FROM THE WORK ON THE NEW BRIDGE TO THE CREEK CHANNEL BELOW. THE CONTRACTOR'S PLAN FOR ACCOMPLISHING THIS SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO THE START OF CONSTRUCTION. ALL WORK ASSOCIATED WITH THIS CONTAINMENT SYSTEM SHALL BE CONSIDERED INCIDENTAL TO THE CONTRACT.
4. THE STRUCTURE DESIGN IS IN ACCORDANCE WITH THE REQUIREMENTS OF
   - AASHTO LRFD GUIDE SPECIFICATIONS FOR THE DESIGN OF PEDESTRIAN BRIDGES, 2ND EDITION DATED 2009, AND INTERIM REVSIONS THROUGH 2018.
   - AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, 9TH EDITION, 2020.
   - AASHTO GUIDE SPECIFICATIONS FOR LRFD SEISMIC BRIDGE DESIGN, 2ND EDITION, 2011 WITH INTERIMS THROUGH 2015.
5. FOUNDATION DESIGN BASED ON RECOMMENDATIONS OF ANCHOR QEA IN THE DRAFT GEOTECHNICAL REPORT DATED NOVEMBER, 2022.
6. DESIGN LOADS:

   DEAD LOAD:

CONCRETE, UNLESS NOTED OTHERWISE	155 PCF
STEEL	490 PCF

   LIVE LOAD:

PEDESTRIAN	90 PSF

   BRIDGE SUPERSTRUCTURE REACTIONS:
   THE FOLLOWING STRUCTURE REACTIONS WERE ASSUMED FOR THE DESIGN OF SUBSTRUCTURE ELEMENTS.

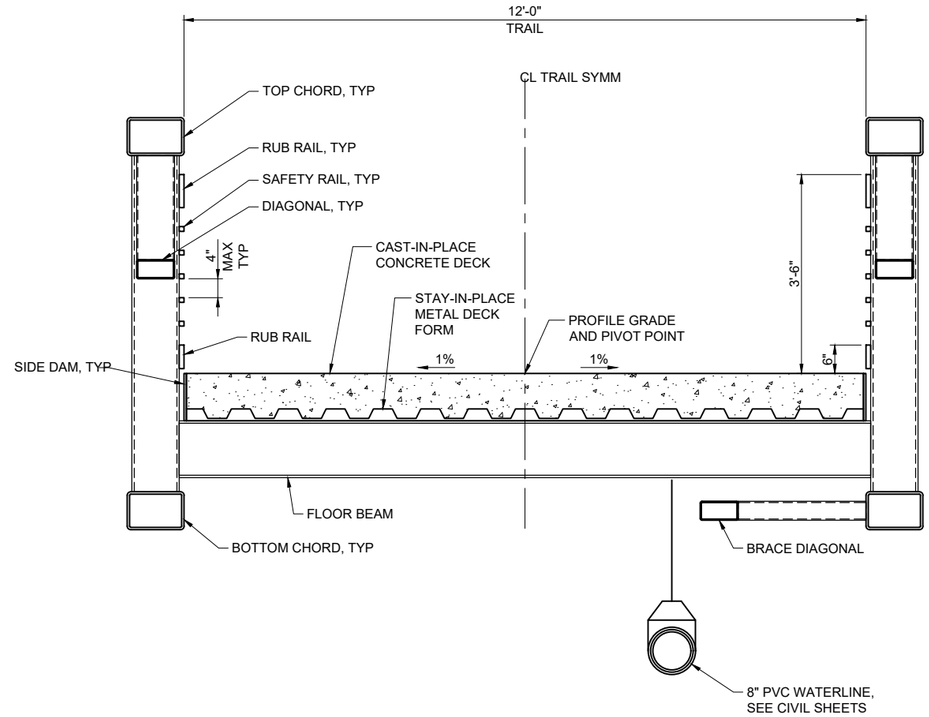
LOAD	P (KIPS)	H (KIPS)
DEAD		-
LIVE		-
WIND	-	

   P = VERTICAL LOAD EACH BASE PLATE (4 EA)
   H = HORIZONTAL LOAD EACH FOOTING (2 EA)

   SEISMIC DESIGN:

PGA	=	0.420g
A_S	=	0.504g
S_{DS}	=	1.067g
S_{D1}	=	0.587g
SITE CLASS	=	D

7. UNLESS OTHERWISE SHOWN IN THE PLANS THE CONCRETE COVER MEASURED FROM THE FACE OF THE CONCRETE TO THE FACE OF ANY REINFORCING STEEL SHALL BE 2 INCHES AT THE TOP OF THE BRIDGE DECK, 3 INCHES AT CONCRETE CAST AGAINST EARTH, AND 1 1/2 INCHES AT ALL OTHER LOCATIONS
8. CONCRETE SHALL BE CLASS 4000 UNLESS NOTED OTHERWISE BELOW.
9. CONCRETE STEEL REINFORCING SHALL BE ASTM A706, GRADE 60, UNLESS NOTED OTHERWISE.
10. ALL EXTERIOR CORNERS AND EDGES SHALL HAVE A 3/4" CHAMFER AND ALL INTERIOR CORNERS SHALL HAVE A 3/4" FILLET UNO.
11. THE STEEL TRUSS SHALL BE CONTRACTOR DESIGNED. STRUCTURAL STEEL SHALL BE WEATHERING STEEL (ASTM A847 Fy = 50 KSI FOR HSS SECTIONS, ASTM A709 GR50W FOR STEEL SHAPES). TRUSS FLOORBEAMS AND BRACE DIAGONALS SHALL BE PAINTED. THE TRUSS SHALL BE MANUFACTURED WITH DEAD LOAD CAMBER SO THAT THE FINAL GEOMETRY OF THE IN-SITU TRUSS DOES NOT HAVE A SAG.



TYPICAL SECTION

SCALE: 3/4" = 1'-0"

PLAN INTENDED TO BE VIEWED IN COLOR, ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

REVISIONS

REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: KPFF
DRAWN BY: KPFF
CHECKED BY: KPFF
APPROVED BY: J. SMALL
SCALE: AS NOTED
DATE: FEBRUARY 2023

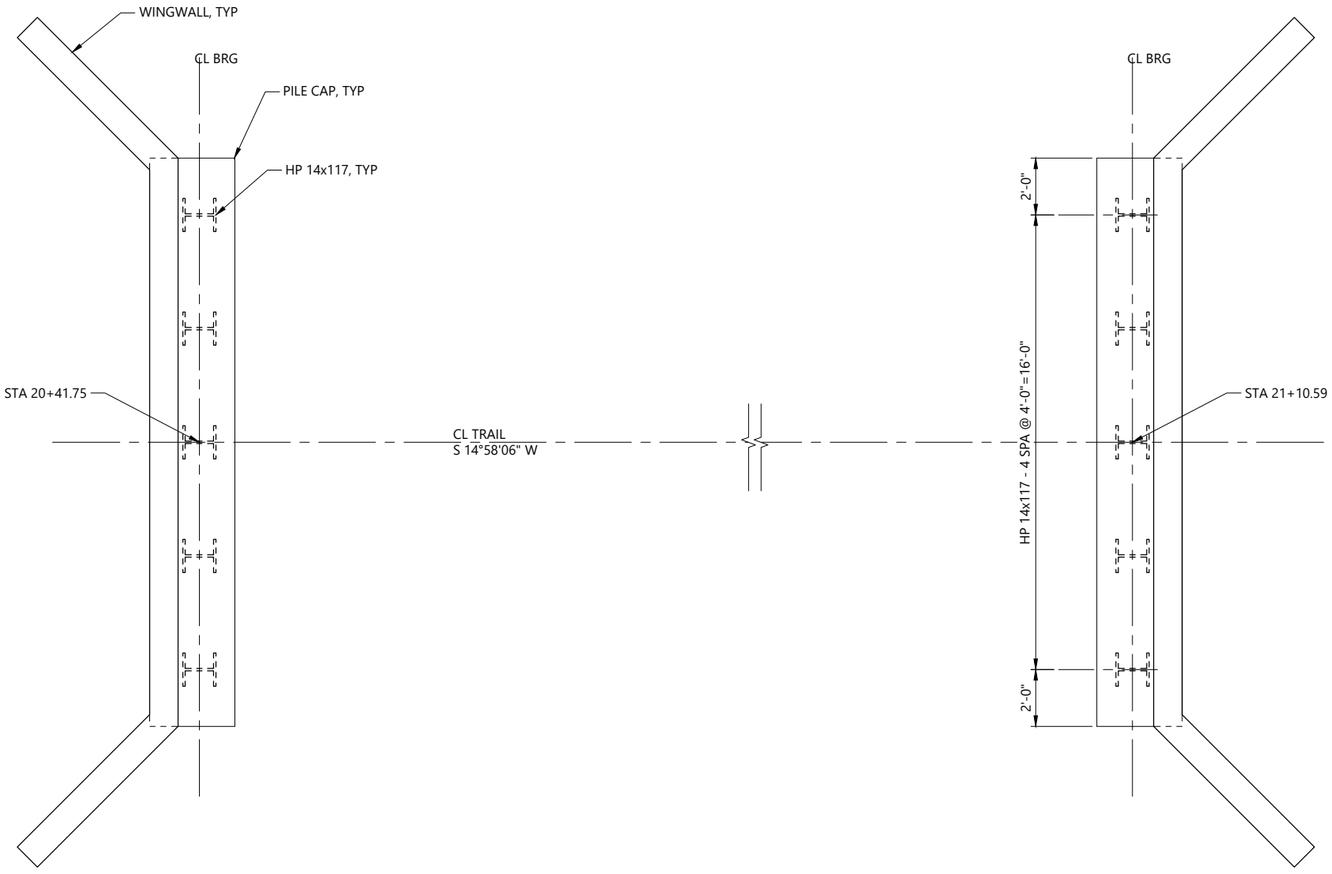
SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

ROBISON BRIDGE GENERAL STRUCTURAL NOTES AND TYPICAL SECTION

C02

SHEET NO. 15 OF 41

Feb 20, 2023 7:50pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\2017-PL-KPFF-RRB-BA02.dwg C02



FOUNDATION PLAN

SCALE: 3/8"=1'-0"

BEARING BOTH ABUTMENTS IS N 75°01'54" E

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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APPROVED BY: J. SMALL
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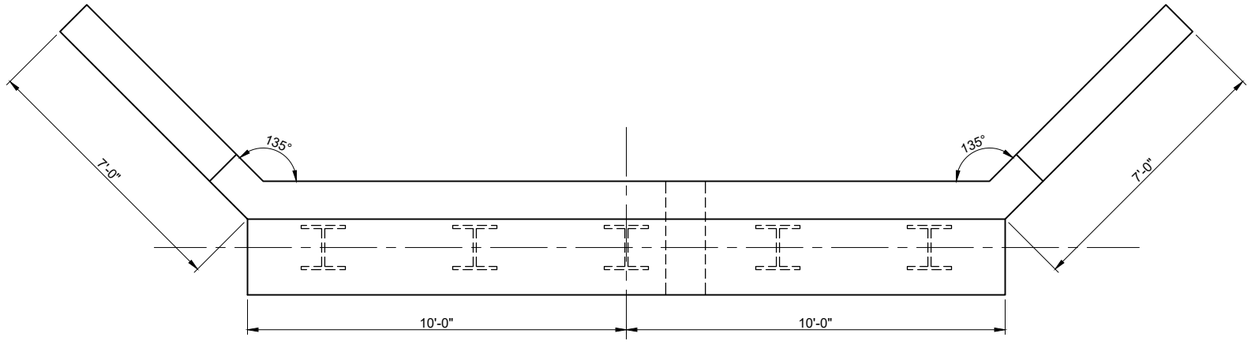
SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

ROBISON BRIDGE FOUNDATION PLAN

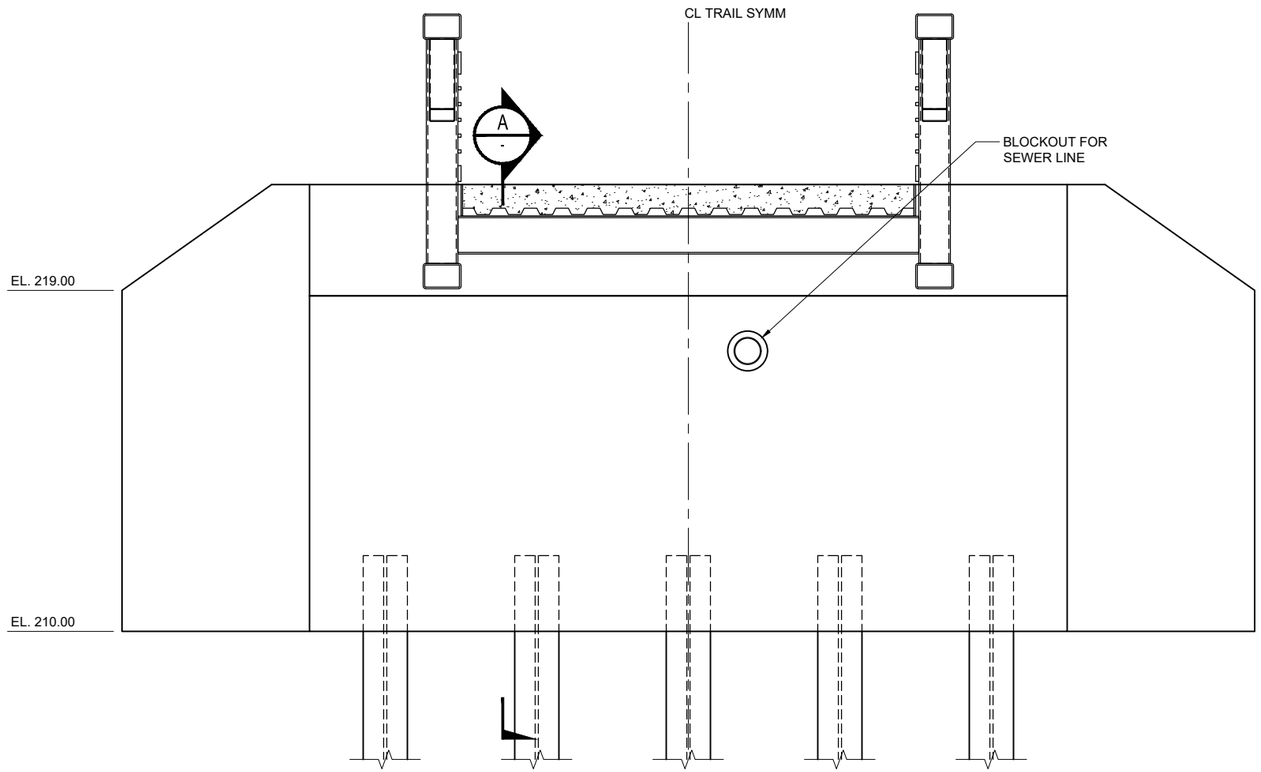
C03

SHEET NO. 16 OF 41

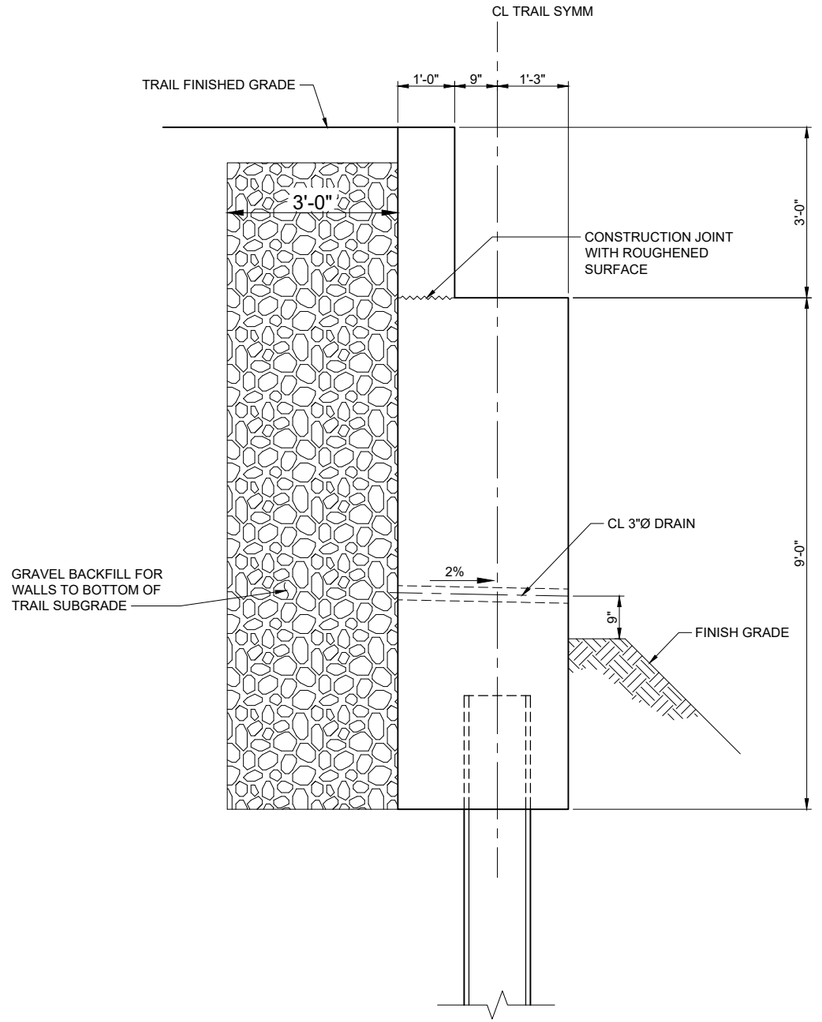
Feb 20, 2023 7:51pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\2017-PL-KPFF-RBB-BA03.dwg C03



ABUTMENT PLAN



ABUTMENT ELEVATION



SECTION A
SCALE: 3/4"=1'-0"

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

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DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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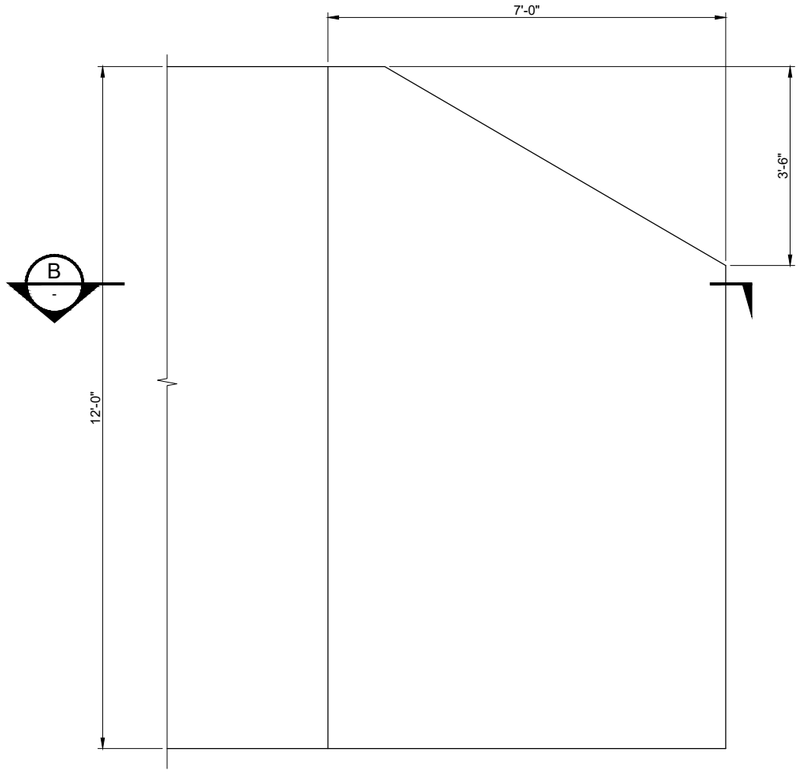
SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

ROBISON BRIDGE ABUTMENT LAYOUT

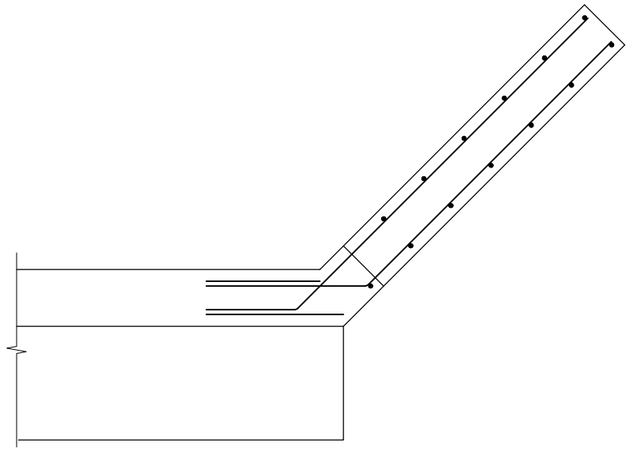
C04

SHEET NO. 17 OF 41

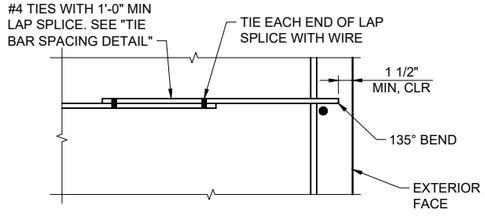
Feb 20, 2023 7:51pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\2017-PL-KPFF-RRB-BA04.dwg C04



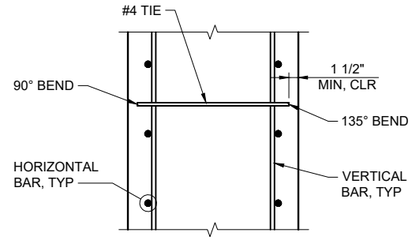
VIEW A
SCALE: 3/4"=1'-0"



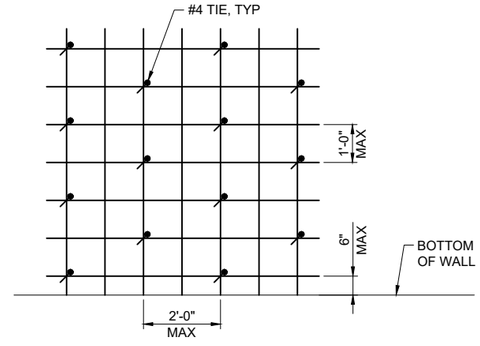
SECTION B
SCALE: 3/4"=1'-0"



ALTERNATE TIE BAR DETAIL
SCALE: 1 1/2"=1'-0"



TIE BAR DETAIL
SCALE: 1"=1'-0"
CONSTANT WIDTH SECTION
ALTERNATE 135° BEND EVERY OTHER TIE



TIE BAR SPACING DETAIL
SCALE: 1"=1'-0"

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

REVISIONS

REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: KPFF
DRAWN BY: KPFF
CHECKED BY: KPFF
APPROVED BY: J. SMALL
SCALE: AS NOTED
DATE: FEBRUARY 2023

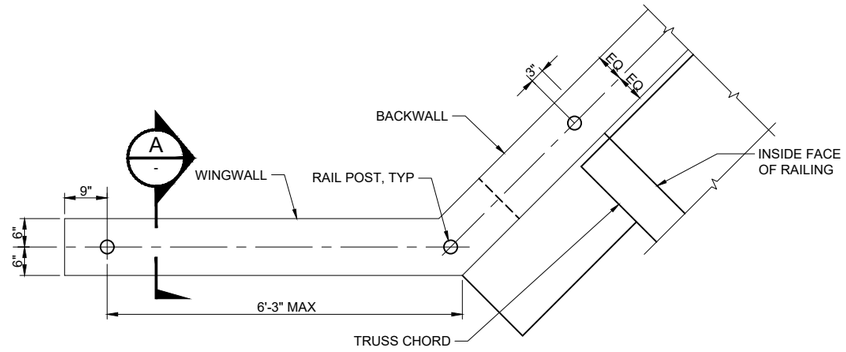
SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

ROBISON BRIDGE ABUTMENT DETAILS

C05

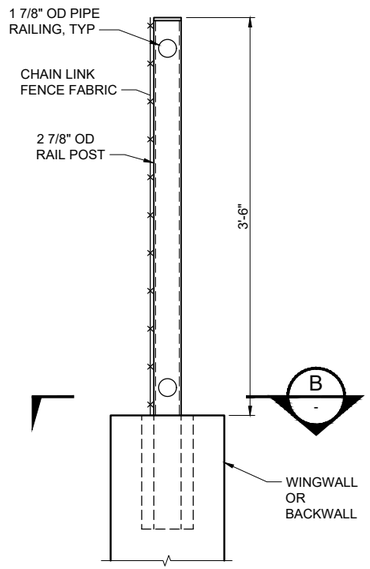
SHEET NO. 18 OF 41

Feb 20, 2023 7:51pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\2017-PL-KPFF-RBB-BA05.dwg C05

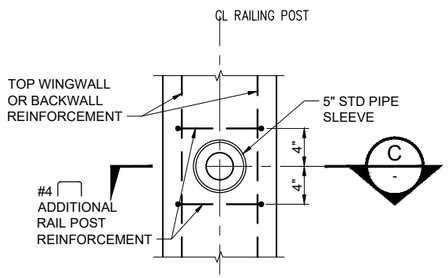


RAIL POST SPACING PLAN DETAIL

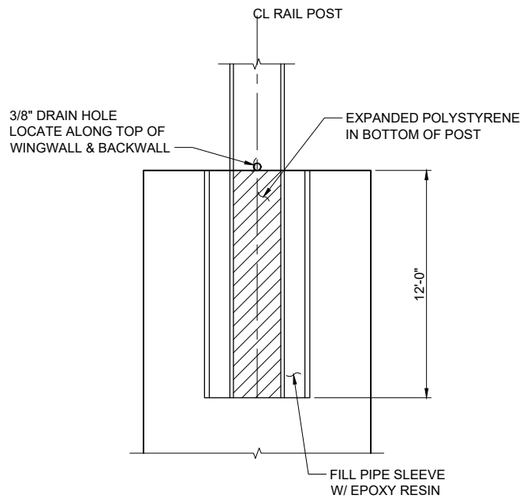
SCALE: 3/4"=1'-0"



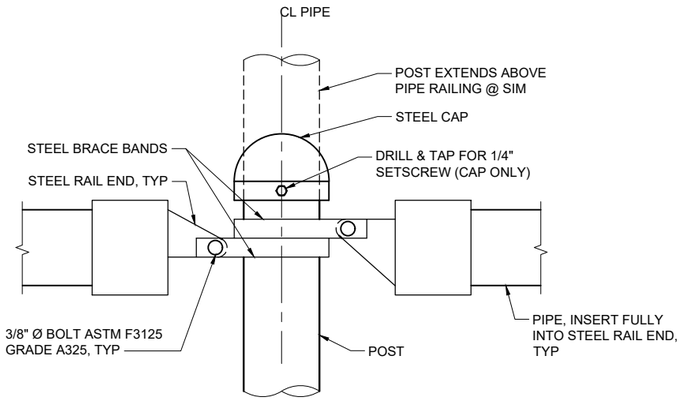
SECTION A - SCALE: 1 1/2"=1'-0"

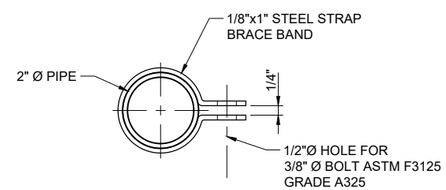


SECTION B - SCALE: 1 1/2"=1'-0"



SECTION C - SCALE: 3"=1'-0"





BRACE BAND

FENCE POST / RAILING CONNECTION DETAIL

SCALE: 6"=1'-0"

PLAN INTENDED TO BE VIEWED IN COLOR, ADJACENT BLOCK IS "BLUE"

ONE INCH — AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

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Feb 20, 2023 7:51pm tgriga

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

REVISIONS

REV	DATE	BY	APP'D	DESCRIPTION

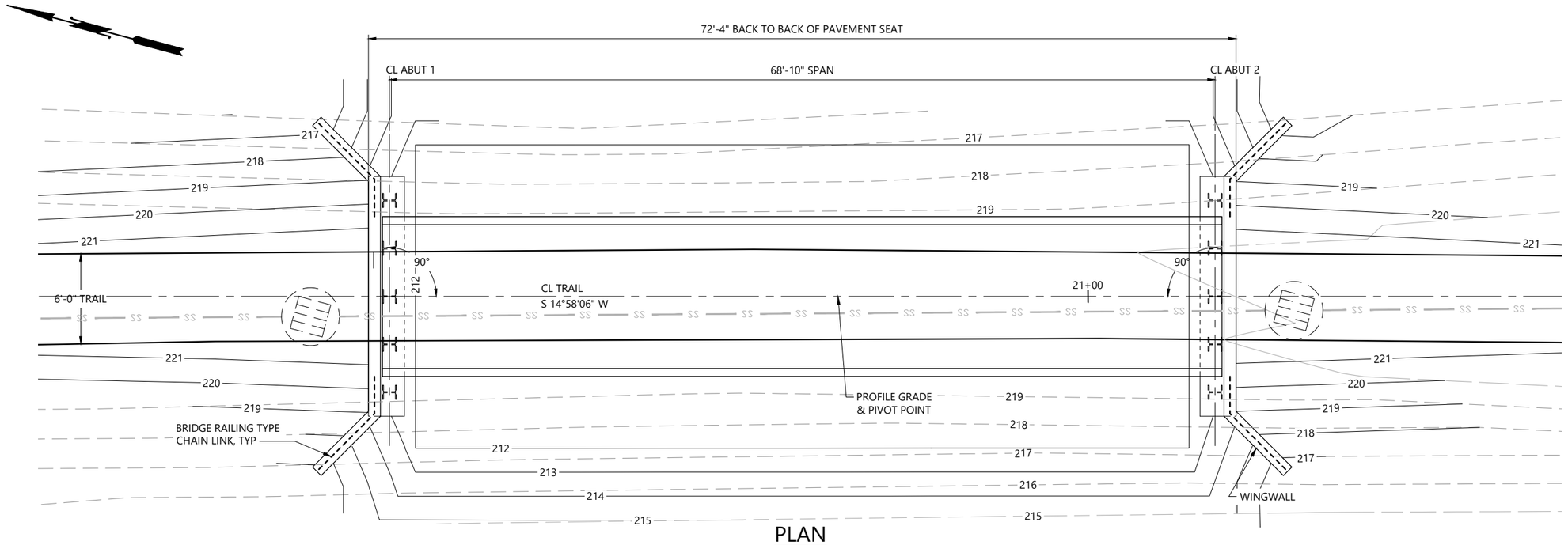
DESIGNED BY:	KPFF
DRAWN BY:	KPFF
CHECKED BY:	KPFF
APPROVED BY:	J. SMALL
SCALE:	AS NOTED
DATE:	FEBRUARY 2023

SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

ROBISON BRIDGE RAILING DETAILS

C06

SHEET NO. 19 OF 41

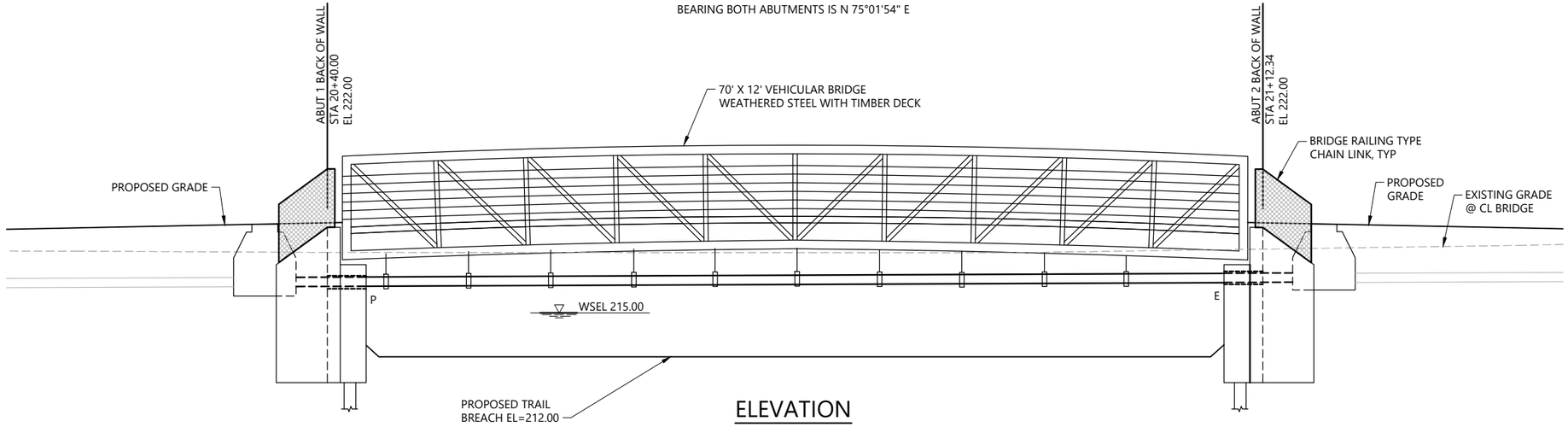


PLAN

0 5 10

SCALE IN FEET

BEARING BOTH ABUTMENTS IS N 75°01'54" E



ELEVATION

0 5 10

SCALE IN FEET

STEEL TRUSS BRIDGE
HS-20 LOADING

DRAFT-NOT FOR CONSTRUCTION

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ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

REVISIONS

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APPROVED BY: J. SMALL
SCALE: AS NOTED
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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

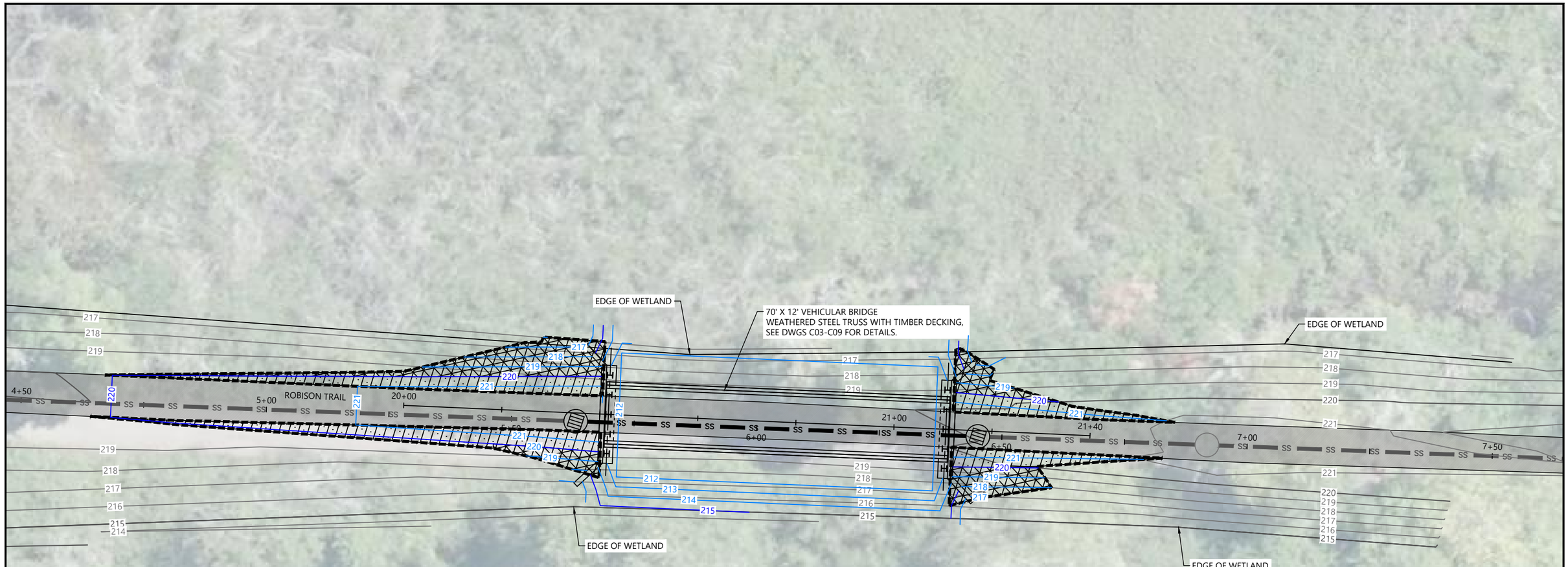
ROBISON BRIDGE PLAN AND ELEVATION

C07

SHEET NO. 20 OF 41

K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-PL-KPFF-RRB-BA01.dwg C07

Feb 20, 2023 7:51pm tgriga



LEGEND

- GEOTEXTILE
- UPLAND PLANTING
- WETLAND AND RIPARIAN PLANTING

PLANTING SCHEDULE				
SHRUBS				
UPLAND				
	OCEANSPRAY	*Holodiscus discolor*	1 GALLON	5' O.C.
	RED FLOWERING CURRANT	*Ribes sanguineum*	1 GALLON	5' O.C.
	NOOTKA ROSE	*Rosa nutkana*	1 GALLON	5' O.C.
	SNOWBERRY	*Symphoricarpos albus*	1 GALLON	5' O.C.
	SASKATOON SERVICEBERRY	*Amelanchier alnifolia*	1 GALLON	5' O.C.
	MOCK ORANGE	*Philadelphus lewisii*	1 GALLON	5' O.C.
	BEAKED HAZELNUT	*Corylus cornuta*	1 GALLON	5' O.C.
	INDIAN PLUM	*Oemleria cerasiformis*	1 GALLON	5' O.C.
WETLAND AND RIPARIAN				
	HOOKER WILLOW	*Salix hookeriana*	LIVESTAKE	2' O.C.
	SCOULER WILLOW	*Salix scouleriana*	LIVESTAKE	2' O.C.
	BLACK TWINBERRY	*Lonicera involucrata*	1 GALLON	5' O.C.
	RED OSIER DOGWOOD	*Cornus sericea*	LIVESTAKE	2' O.C.
	SALMONBERRY	*Rubus spectabilis*	1 GALLON	5' O.C.

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NORTH

0 10 20

SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH ZONE, NAD 83/91, U.S. FEET.
2. VERTICAL DATUM: NAVD88
3. SEE DRAWING C18 FOR PLANTING DETAILS

DRAFT-NOT FOR CONSTRUCTION

PLAN INTENDED TO BE VIEWED IN COLOR, ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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APPROVED BY: J. SMALL
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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

ROBISON BRIDGE PLANTING PLAN AND SCHEDULE

C08

SHEET NO. **21** OF **41**

K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-PL-Robison Profile.dwg C10

Feb 20, 2023 7:52pm tgriga

ROAD RIGHT-OF-WAY

WESTBOUND CENTER DRIVE

EX CONC BOX CULVERT (SKEWED)
3-SIDED, 18' W X 8.5' H, TO REMAIN

EX 30" STEEL PIPE TO REMAIN

EX CONC ABUTMENT
TO REMAIN

3+00

4+00

5+00

6+00

7+00

8+00

9+00

DEMOLISH CONC
SIDEWALK

DEMOLISH CONC SIDEWALK IN BOX
CULVERT, SEE DWG C15 FOR DETAILS

DEMOLISH CONC
SIDEWALK

EX CONC ABUTMENT
TO REMAIN

REMOVE SIDEWALK AT
CONSTRUCTION JOINT
OR SAWCUT

EASTBOUND CENTER DRIVE

REMOVE SIDEWALK AT
CONSTRUCTION JOINT
OR SAWCUT

EX GRAVEL PATH
TO REMAIN

NORTH

0 20 40

SCALE IN FEET

LEGEND:

DEMOLISH FEATURE

OHWM

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH ZONE, NAD 83/91, U.S. FEET
2. VERTICAL DATUM: NAVD88
3. PHASE NUMBER SHOWN BEFORE PROPOSED ACTIONS.

DRAFT-NOT FOR CONSTRUCTION

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE. IF NOT ONE INCH SCALE ACCORDINGLY

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

REVISIONS				
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: G. HART
DRAWN BY: T. GRIGA
CHECKED BY: T. DRURY
APPROVED BY: J. SMALL
SCALE: AS NOTED
DATE: FEBRUARY 2023

SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

LOSING REACH/CENTER DRIVE CULVERT DEMOLITION PLAN

C09

SHEET NO. 22 OF 41

K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-C-Losing Reach Culvert Demo.dwg C11

Feb 20, 2023 7:52pm tgriga

PROPOSED PEDESTRIAN BRIDGE
40' SPAN 6' WIDE

EX DIVERSION DAM
STRUCTURE (TIMBER)

NATIVE RIPARIAN BUFFER
VEGETATION ESTABLISHMENT

NATIVE RIPARIAN BUFFER
VEGETATION ESTABLISHMENT

LEGEND:
- EXISTING CONTOURS (1' & 5' INTERVALS)
- PROPOSED CONTOURS (1' & 5' INTERVALS)
- OHWM

NORTH

0 20 40
SCALE IN FEET

MATCH LINE, SEE C11

2 / C14 SILL LOG AND POOL STRUCTURE, TYP

1 / C14 PLACE TWO ROOTWAD LWM (35)

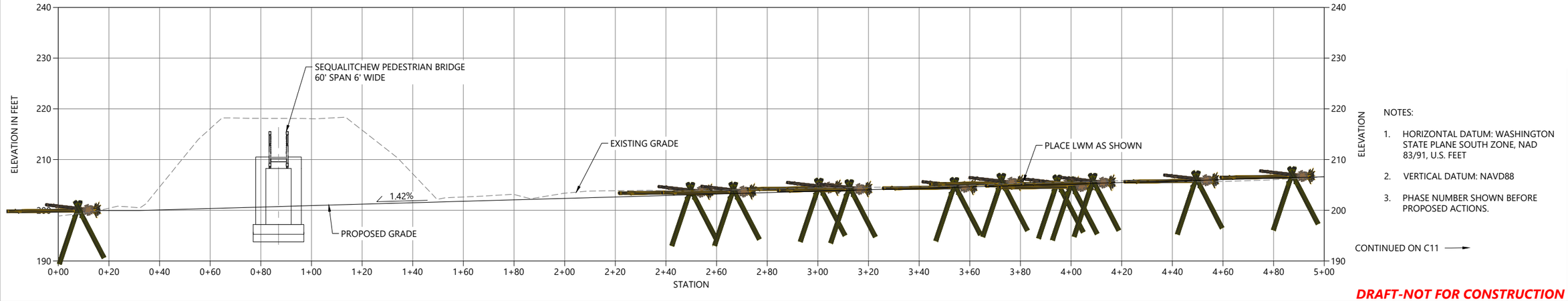
A

A'

B

B'

0+00 1+00 2+00 3+00 4+00 5+00



NOTES:

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CONTINUED ON C11 →

PLAN INTENDED TO BE VIEWED IN "COLOR." ADJACENT BLOCK IS "BLUE"

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SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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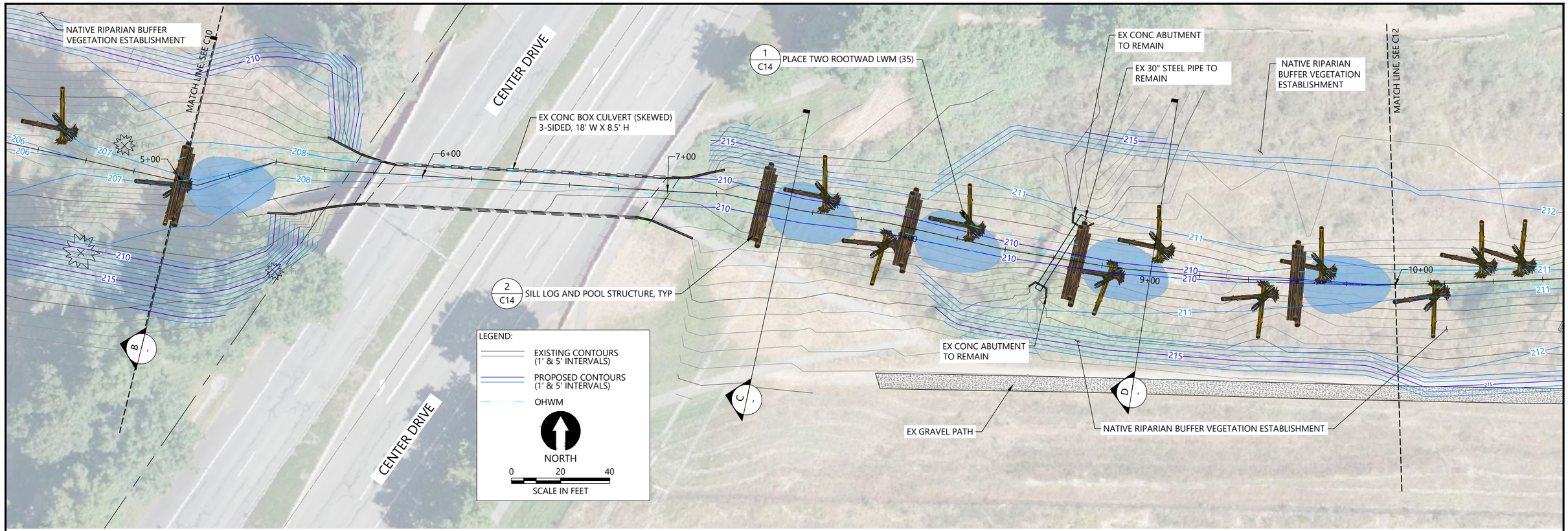
SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

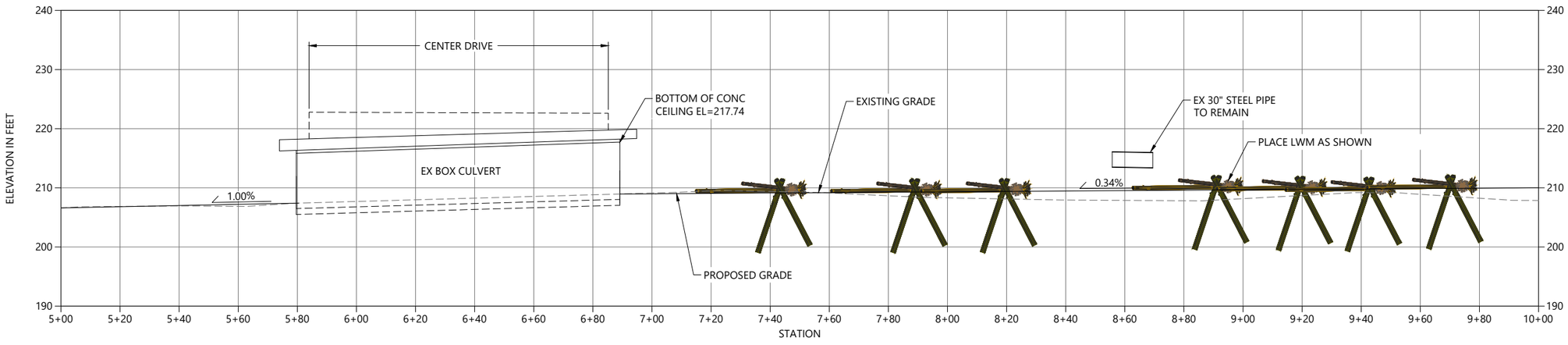
LOSING REACH/CENTER DRIVE CULVERT MATERIALS AND LAYOUT PLAN

C10

SHEET NO. 23 OF 41

K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-PL-Losing Reach Center Drive.dwg C10
Feb 20, 2023 7:53pm tgriga





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CONTINUED ON C12

PLAN INTENDED TO BE VIEWED IN COLOR, ADJACENT BLOCK IS "BLUE"

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DRAFT-NOT FOR CONSTRUCTION

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SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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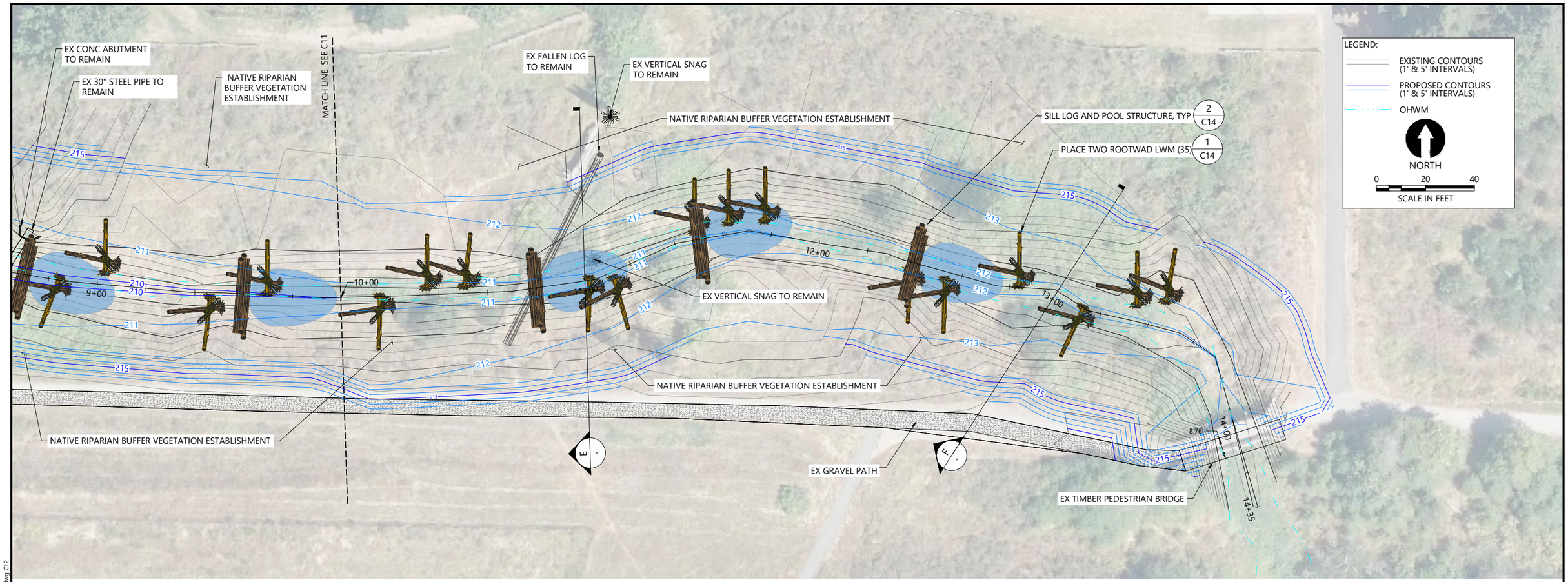
SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

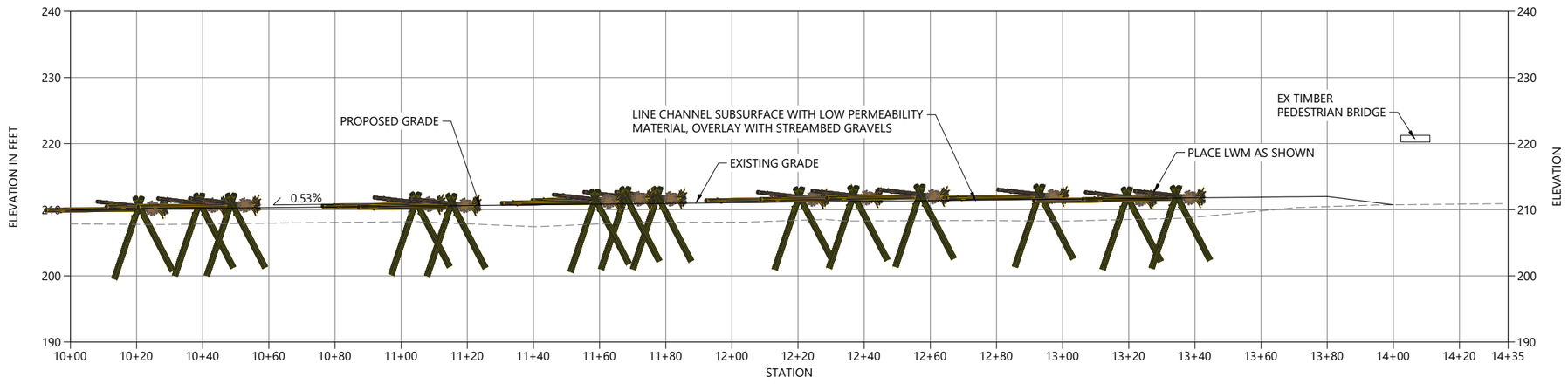
LOSING REACH/CENTER DRIVE CULVERT MATERIALS AND LAYOUT PLAN

C11

SHEET NO. 24 OF 41

K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-PL-Losing Reach Center Drive.dwg C11
Feb 20, 2023 7:53pm tgriga





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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

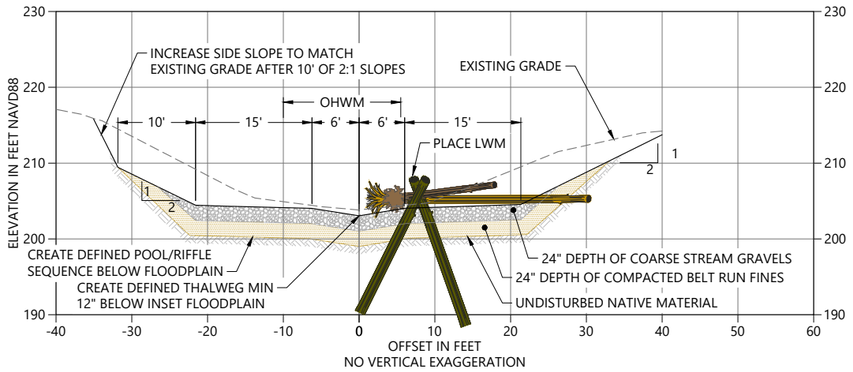
LOSING REACH/CENTER DRIVE CULVERT MATERIALS AND LAYOUT PLAN

C12

SHEET NO. 25 OF 41

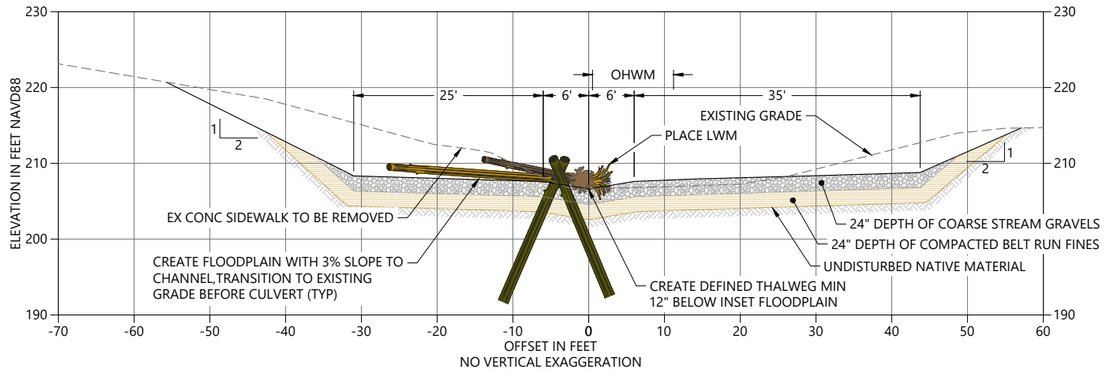
K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-PL-Losing Reach Center Drive.dwg C12

Feb 20, 2023 7:53pm tgriga



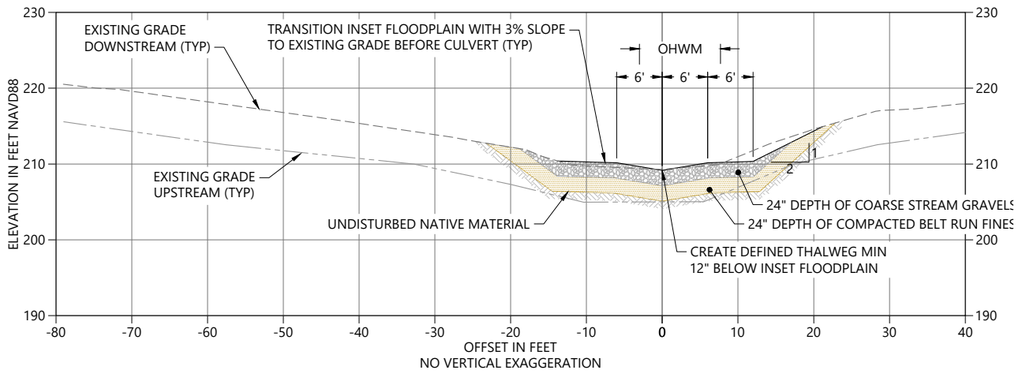
A / C10 STA 2+50 LOSING REACH TYPICAL SECTION

HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'



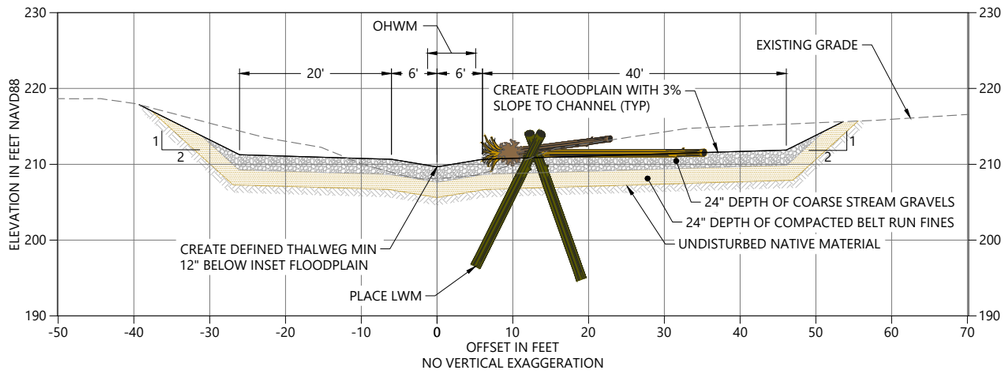
B / C10 STA 5+00 LOSING REACH TYPICAL SECTION

HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'



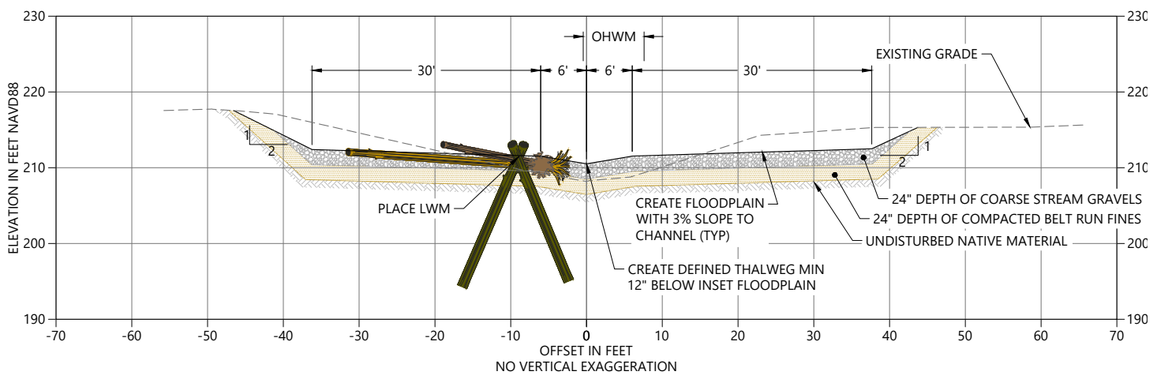
C / C11 STA 7+50 LOSING REACH TYPICAL SECTION

HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'



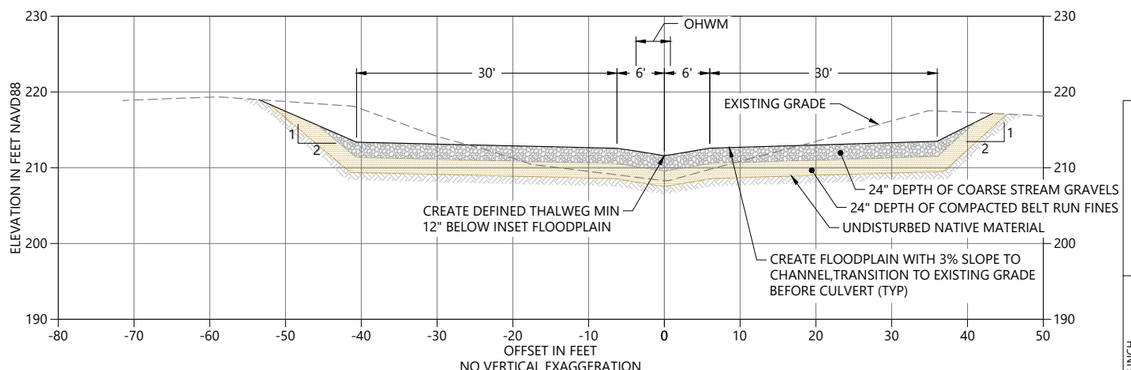
D / C11 STA 9+00 LOSING REACH TYPICAL SECTION

HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'



E / C12 STA 11+00 LOSING REACH TYPICAL SECTION

HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'



F / C12 STA 13+00 LOSING REACH TYPICAL SECTION

HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

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DRAFT-NOT FOR CONSTRUCTION

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Feb 20, 2023 7:53pm tgriga

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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APPROVED BY: J. SMALL
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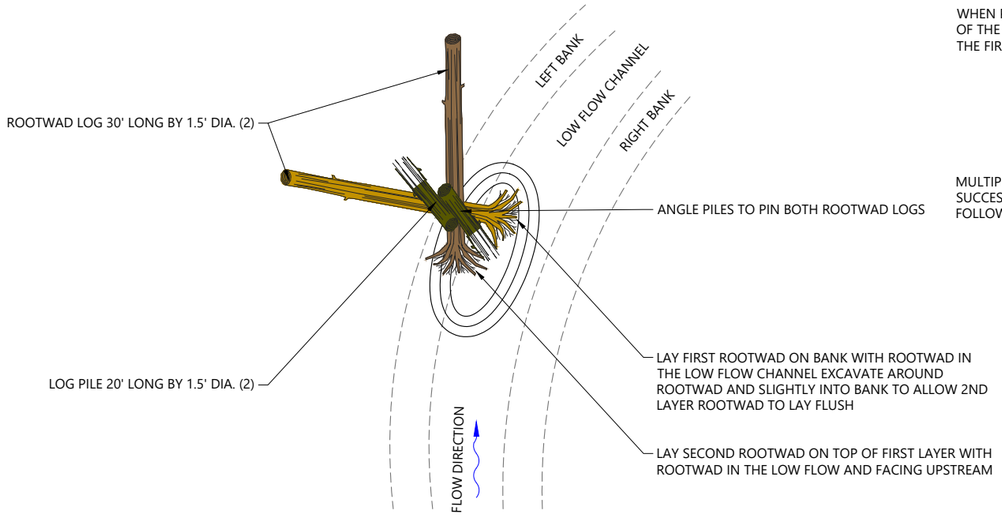
DATE: FEBRUARY 2023

SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

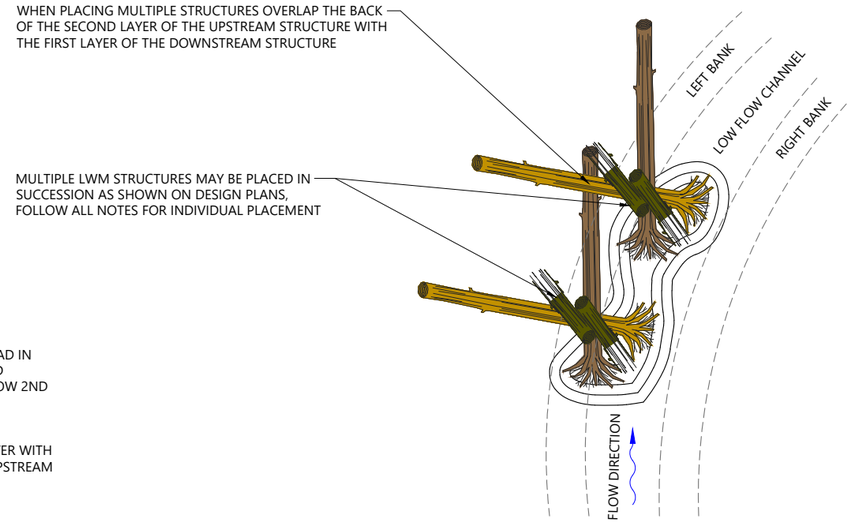
LOSING REACH/CENTER DRIVE CULVERT RESTORATION SECTIONS

C13

SHEET NO. 26 OF 41



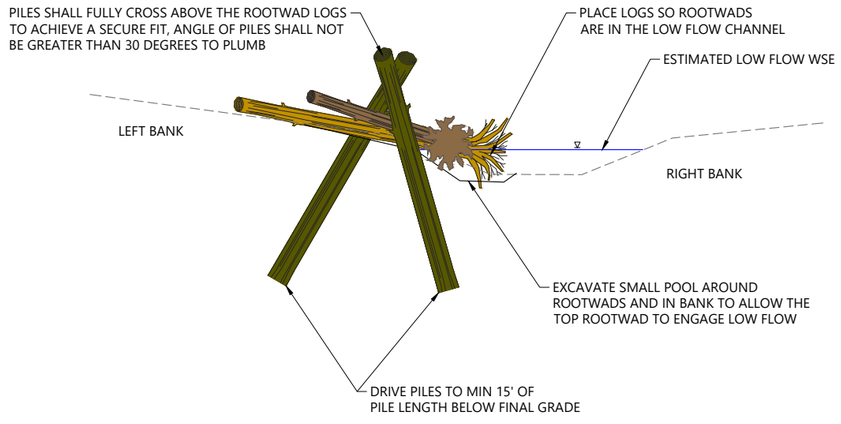
PLAN VIEW



MULTIPLE STRUCTURE PLAN VIEW

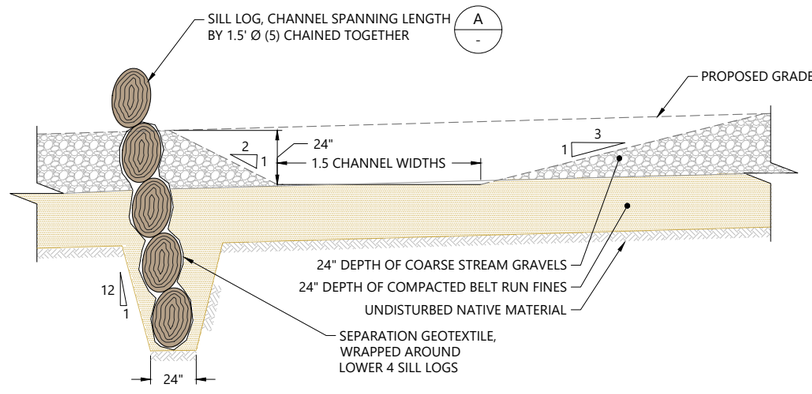
NOTES:

1. LOG DIAMETER TO BE MEASURED 4.5' FROM ROOTWAD COLLAR.
2. LOG PILES AND ROOTWAD LOGS SHALL BE DOUGLAS FIR. OTHER SPECIES MAY BE ALLOWED AT THE DIRECTION OF THE ENGINEER. LENGTHS AND DIAMETERS SHALL BE AS SPECIFIED IN THE TYPICAL.
3. PILES SHALL MEET THE REQUIREMENTS OF ASTM D25 WITH THE EXCEPTION THAT NO PRESSURE TREATMENT OR OTHER CHEMICAL TREATMENT SHALL BE USED.
4. LOW FLOW DEPTH MAY OR MAY NOT BE PRESENT DURING CONSTRUCTION. IF FLOW IS NOT PRESENT LOW FLOW DEPTH SHOULD BE CONSIDERED BELOW THE BANKFULL DEPTH OR AT THE SPECIFICATION OF THE ENGINEER.
5. NO HYDRAULIC MODELING WAS PERFORMED FOR THE DESIGN OF THESE STRUCTURES. STABILITY AND SCOUR REQUIREMENTS ARE ESTIMATED BASED ON ENGINEERS BEST JUDGEMENT AND THE ASSUMPTIONS DETAILED IN THE BASIS OF DESIGN REPORT.



SECTION VIEW

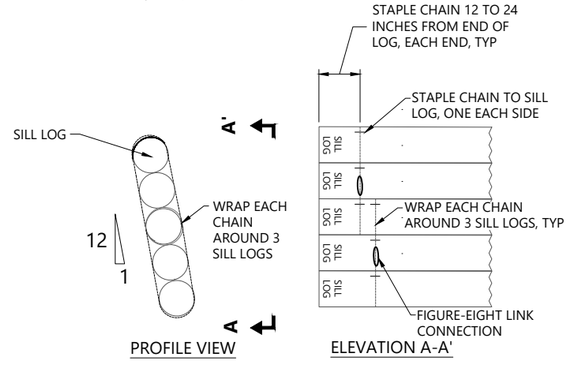
1 / - TYPICAL LWM PLACEMENT
SCALE: NTS



2 / - SILL LOG AND POOL STRUCTURE
SCALE: NTS

NOTES:

1. ALL CONNECTIONS SHALL BE APPROVED BY THE ENGINEER.
2. PRIOR TO FINISHING A CONNECTION REMOVE ALL SLACK FROM THE CONNECTION USING MECHANICAL ADVANTAGE
3. CHAIN MUST MEET THE FOLLOWING SPECIFICATIONS:
   A. 1/2-INCH TRADE SIZE
   B. GRADE 40/43 STEEL
   C. HOT-DIPPED GALVANIZED
   D. WLL NO LESS THAN 9,200 LB
4. CHAIN COUPLING LINKS MUST MEET THE FOLLOWING SPECIFICATIONS:
   A. HAMMERLOCK OR FIGURE EIGHT TWO PIECE - COUPLING TYPE
   B. HOT DIPPED GALVANIZED
   C. GRADE 80 OR 100
   D. FOR TRADE SIZES OF 1/2 INCH
   E. WLL 12,000 LB OR GREATER
7. STAPLES MUST MEET THE FOLLOWING SPECIFICATIONS:
   A. GALVANIZED OR ZINC PLATED STEEL
   B. 1/2" X 6" IN LENGTH



PROFILE VIEW ELEVATION A-A'

A / - SILL LOG CHAIN CONNECTION DETAIL
SCALE: NTS

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE. IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

LOSING REACH/CENTER DRIVE CULVERT LMW TYPICALS

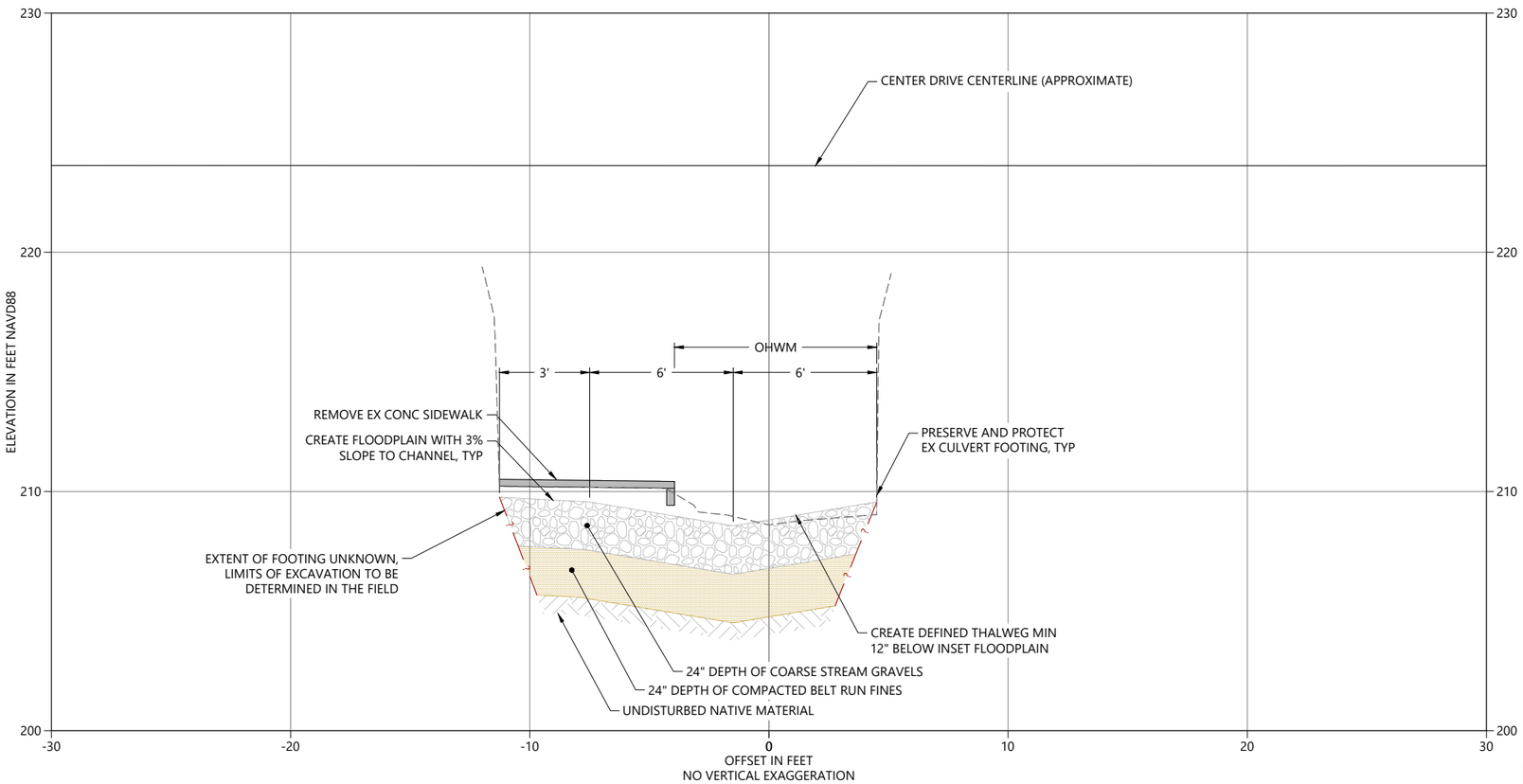
C14

SHEET NO. 27 OF 41

K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-PL-Losing Reach Center Drive.dwg C14

Feb 20, 2023 7:53pm tgriga

1 / C09 CENTER DRIVE CULVERT SIDEWALK DEMOLITION (WEST END OF CULVERT LOOKING EAST)
SCALE: NTS



2 / C09 STA 6+64 LOSING REACH TYPICAL SECTION
HORIZ. SCALE: 1" = 3'
VERT. SCALE: 1" = 3'

NOTES:

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

LOSING REACH/CENTER DRIVE CULVERT DETAILS

C15

SHEET NO. 28 OF 41

Feb 20, 2023 7:53pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-PL-Losing Reach Center Drive.dwg C15

NOTES:

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3. PHASE NUMBER SHOWN BEFORE PROPOSED ACTIONS.
4. SEE PLANTING SCHEDULE, DRAWING C19

DRAFT-NOT FOR CONSTRUCTION

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

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SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

LOSING REACH/CENTER DRIVE CULVERT PLANTING PLAN

C16

SHEET NO. 29 OF 41

K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-C-Losing Reach Culvert Planting.dwg C16

Feb 20, 2023 7:54pm tgriga

NOTES:

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4. SEE PLANTING SCHEDULE, DRAWING C19

DRAFT-NOT FOR CONSTRUCTION

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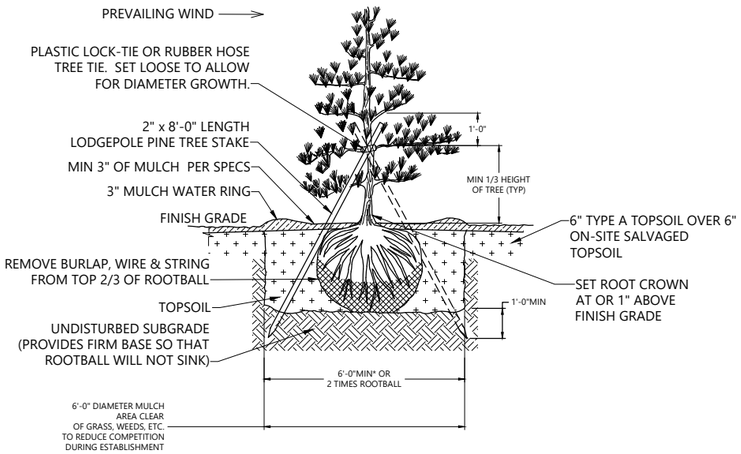
SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

LOSING REACH/CENTER DRIVE CULVERT PLANTING PLAN

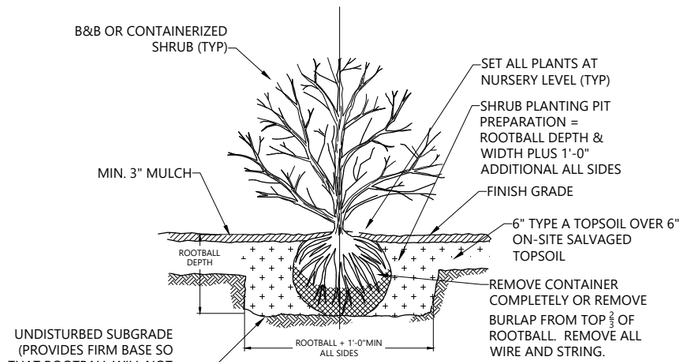
C17

SHEET NO. 30 OF 41

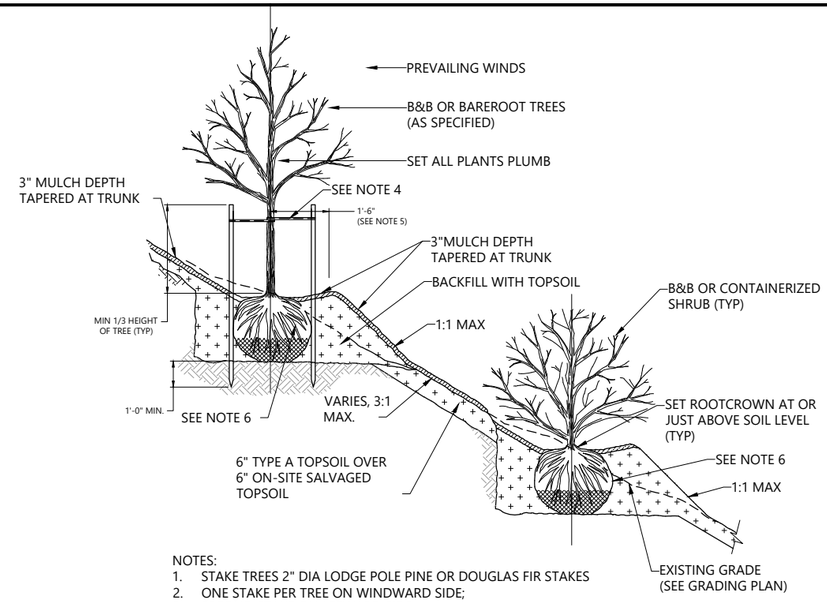
Feb 20, 2023 7:54pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-C-Losing Reach Culvert Planting.dwg C17



1 — CONIFEROUS TREE PLANTING & STAKING
SCALE:NTS



2 — SHRUB PLANTING
SCALE:NTS

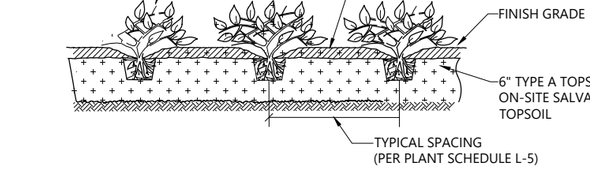


NOTES:
1. STAKE TREES 2" DIA LODGE POLE PINE OR DOUGLAS FIR STAKES
2. ONE STAKE PER TREE ON WINDWARD SIDE;
3. SECOND STAKE ON LEEWARD SIDE

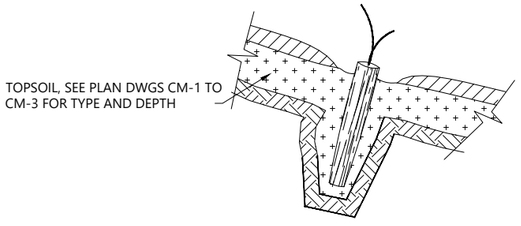
SLOPES STEEPER THAN 3:1 MAY REQUIRE AN APPROVED EMBANKMENT STABILIZATION SYSTEM TO CREATE A LEVEL TREE PIT SUCH AS:
- ROCK FACING
- PRECAST CONCRETE WALL UNITS
- TIMBER WALL
- MANUFACTURED SLOPE RETENTION UNITS

4. CHAINLOCK TREE TIE. LOOP EACH TIE AROUND TREE LOOSELY TO PROVIDE 1" SLACK FOR DIAMETER GROWTH.
5. SHAPE SOIL TO PROVIDE 3' DIAMETER OR ROOTBALL DIAMETER, WHICHEVER IS GREATER, WATERING RING.
6. REMOVE ALL WIRE AND STRING. REMOVE TOP 2/3 OF BURLAP.

3 — PLANTING ON SLOPES
SCALE:NTS



4 — GROUNDCOVER, PERENNIAL, AND ORNAMENTAL GRASS PLANTING
SCALE:NTS

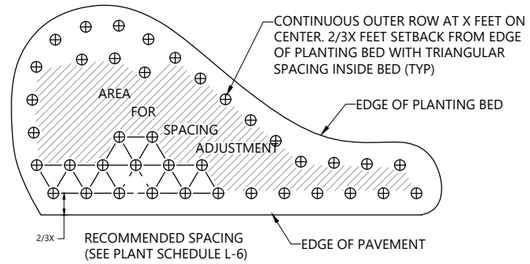


5 — EMERGENT PLANTING
SCALE:NTS

NOTES:

1. 30" MIN. LENGTH LIVE STAKES.
2. HARVEST AND PLANT STAKES DURING THE DORMANT SEASON.
3. MAKE CLEAN CUTS AND DO NOT DAMAGE STAKES OR SPLIT ENDS DURING INSTALLATION, USE A PILOT BAR TO CREATE SHAFT PRIOR TO INSTALLING STAKES.
4. SOAK CUTTINGS CONTINUOUSLY PRIOR TO INSTALLATION.
5. TAMP THE SOIL AROUND THE STAKE.
6. ONLY NURSERY GROWN STOCK SHALL BE USED. HARVESTING OF WILD PLANTS IS NOT ACCEPTABLE.
7. USE EQUAL NUMBER AND EVEN DISTRIBUTION OF EACH WILLOW SPECIES.

6 — LIVESTAKE PLANTING
SCALE:NTS



⊕ ACTUAL PLANT LOCATIONS

NOTES: APPLY PLANTING PATTERN FOR SHRUB, GROUNDCOVER, GRASS, AND PERENNIAL PLANTINGS

7 — PLANTING PATTERN
SCALE:NTS

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE. IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY:	G. HART
DRAWN BY:	T. GRIGA
CHECKED BY:	T. DRURY
APPROVED BY:	J. SMALL
SCALE:	AS NOTED
DATE:	FEBRUARY 2023

SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

LOSING REACH/CENTER DRIVE CULVERT PLANTING DETAILS

C18

SHEET NO. 31 OF 41

Feb 20, 2023 7:54pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-C-Losing Reach Culvert Planting.dwg C18

PLANTING SCHEDULE			
COMMON NAME	SPECIES NAME	SIZE	SPACING
TREES			
CONIFERS			
GRAND FIR	*Abies grandis*	5-6-FT HEIGHT	AS SHOWN
DOUGLAS FIR	*Pseudotsuga menziesii*	5-6-FT HEIGHT	AS SHOWN
WESTERN RED CEDAR	*Thuja plicata*	5-6-FT HEIGHT	AS SHOWN
WESTERN HEMLOCK	*Tsuga heterophylla*	5-6-FT HEIGHT	AS SHOWN
CRYPTOMERIA	*Cryptomeria japonica*	5-6-FT HEIGHT	AS SHOWN
DECIDUOUS			
RED ALDER	*Alnus rubra*	5-6-FT HEIGHT	AS SHOWN
BLACK COTTONWOOD	*Populus trichocarpa*	5-6-FT HEIGHT	AS SHOWN

PLANTING SCHEDULE			
SHRUBS			
UPLAND			
OCEANSPRAY	*Holodiscus discolor*	1 GALLON	5' O.C.
RED FLOWERING CURRANT	*Ribes sanguineum*	1 GALLON	5' O.C.
NOOTKA ROSE	*Rosa nutkana*	1 GALLON	5' O.C.
SNOWBERRY	*Symphoricarpos albus*	1 GALLON	5' O.C.
SASKATOON SERVICEBERRY	*Amelanchier alnifolia*	1 GALLON	5' O.C.
MOCK ORANGE	*Philadelphus lewisii*	1 GALLON	5' O.C.
BEAKED HAZELNUT	*Corylus cornuta*	1 GALLON	5' O.C.
INDIAN PLUM	*Oemleria cerasiformis*	1 GALLON	5' O.C.
WETLAND AND RIPARIAN			
HOOKER WILLOW	*Salix hookeriana*	LIVESTAKE	2' O.C.
SCOULER WILLOW	*Salix scouleriana*	LIVESTAKE	2' O.C.
BLACK TWINBERRY	*Lonicera involucrata*	1 GALLON	5' O.C.
RED OSIER DOGWOOD	*Cornus sericea*	LIVESTAKE	2' O.C.
SALMONBERRY	*Rubus spectabilis*	1 GALLON	5' O.C.

EMERGENT			
RED OSIER DOGWOOD	*Cornus sericea*	LIVESTAKE	2' O.C.
SALMONBERRY	*Rubus spectabilis*	1 GALLON	5' O.C.
COMMON RUSH	*Juncus effusus*	10-CUBIC INCH PLUG	2' O.C.
CREEPING SPIKE-RUSH	*Eleocharis palustris*	10-CUBIC INCH PLUG	2' O.C.
HARDSTEM BULRUSH	*Scirpus acutus*	10-CUBIC INCH PLUG	2' O.C.
SMALL-FRUITED BULRUSH	*Scirpus microcarpus*	10-CUBIC INCH PLUG	2' O.C.
SWITCHGRASS	*Panicum virgatum 'Shenadoah'*	1 GALLON	2' O.C.
SMALL-FRUITED BULRUSH	*Scirpus microcarpus*	10-CUBIC INCH PLUG	2' O.C.
SLOUGH SEDGE	*Carex obnupta*	10-CUBIC INCH PLUG	2' O.C.
STAGING AREA SEEDING			
NORTHWEST MEADOWSCAPES NORTHWEST PRAIRIE MIX OR APPROVED EQUAL, APPLY AS HYDROSEED WITH MULCH, FERTILIZER AND TACKIFIER ACCORDING TO SUPPLIERS RECOMENDATIONS			

PLAN INTENDED TO BE VIEWED IN COLOR, ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

REVISIONS

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

LOSING REACH/CENTER DRIVE CULVERT PLANTING SCHEDULE

C19

SHEET NO. **32** OF **41**

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DEMOLISH EX GATE AND FIXTURE

DEMOLISH EX WIRE FENCE

DEMOLISH EX DIVERSION DAM STRUCTURE (TIMBER)

DEMOLISH EX 56" CMP CULVERT

SEQUALITCHEW CREEK

SEQUALITCHEW CREEK TRAIL

0+00

1+00

2+00

215

210

205

200

205

210

215

220

225

210

205

205

210

215

220

LEGEND:

DEMOLISH LINEAR FEATURE

DEMOLISH FEATURE

NOTES:

1. AERIAL FROM ESRI.
2. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH ZONE, NAD 83, U.S. FEET
2. VERTICAL DATUM: NAVD88

NORTH

0 10 20

SCALE IN FEET

PLAN INTENDED TO BE VIEWED IN COLOR, ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

CITY HALL BRIDGE DEMOLITION PLAN

C20

SHEET NO. **33** OF **41**

PROPOSED 12' WIDE TRAIL

PROPOSED PEDESTRIAN BRIDGE
60' SPAN 6' WIDE

101+00

1+00

100+00

SEQUALITCHEW CREEK

PROPOSED 12' WIDE TRAIL

2 / C14 SILL LOG AND POOL STRUCTURE, TYP

1 / C14 PLACE TWO ROOTWAD LWM (35)

A / C22

B / C26

NORTH

0 10 20

SCALE IN FEET

NOTES:

1. AERIAL FROM ESRI.
2. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH ZONE, NAD 83, U.S. FEET
2. VERTICAL DATUM: NAVD88

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

CITY HALL BRIDGE GRADING PLAN

C21

SHEET NO. 34 OF 41

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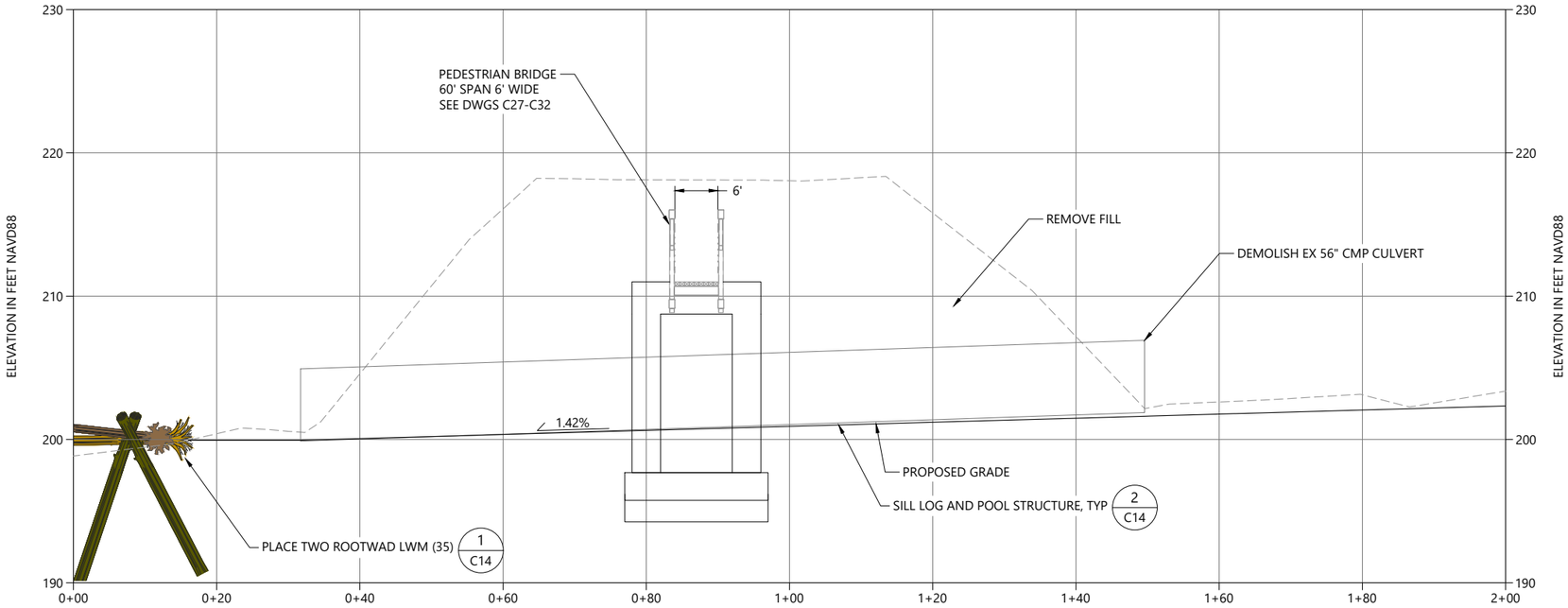
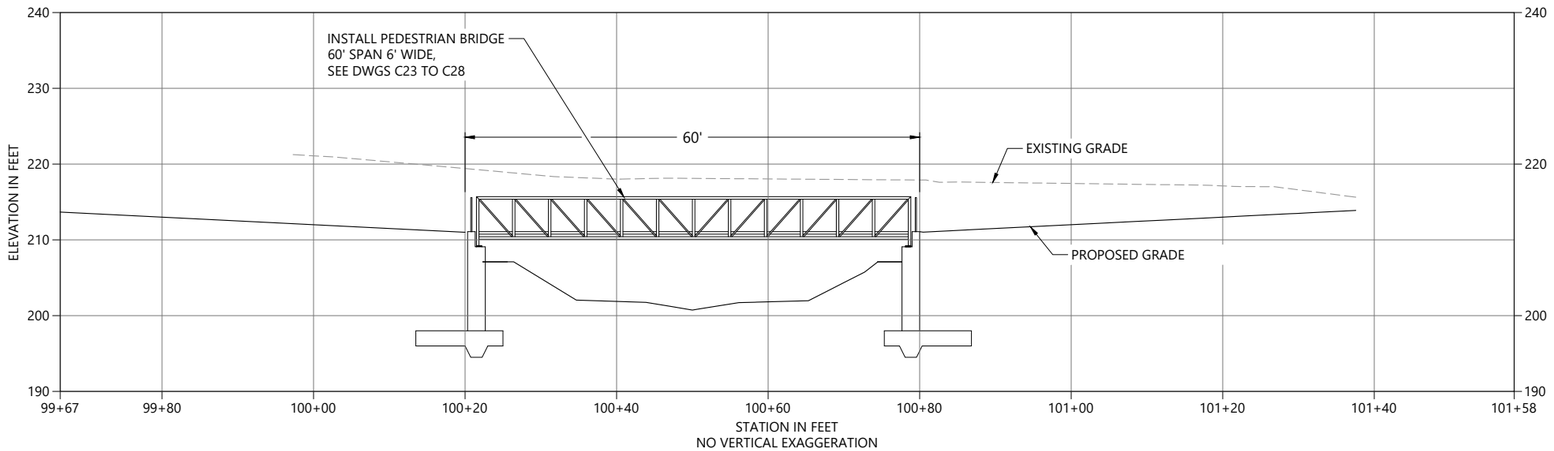


A C20 THALWEG PROFILE
HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 5'



B C20 PEDESTRIAN BRIDGE PROFILE
HORIZ. SCALE: 1" = 10'
VERT. SCALE: 1" = 10'

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH ZONE, NAD 83, U.S. FEET
2. VERTICAL DATUM: NAVD88
3. PHASE NUMBER SHOWN BEFORE PROPOSED ACTIONS.

DRAFT-NOT FOR CONSTRUCTION

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ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

CITY HALL BRIDGE GRADING AND DEMOLITION SECTIONS

C22

SHEET NO. 35 OF 41

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Feb 20, 2023 7:54pm tgriga

BRIDGE GENERAL NOTES

1. ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION "STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION," DATED 2023, AND PROJECT SPECIAL PROVISIONS.
2. ALL DIMENSIONS ARE HORIZONTAL OR VERTICAL UNLESS OTHERWISE SHOWN.
3. THE CONTRACTOR SHALL PLAN AND CONDUCT THE WORK IN SUCH A MANNER THAT NO OBJECTS OR FOREIGN MATERIALS FALL FROM THE WORK ON THE NEW BRIDGE TO THE CREEK CHANNEL BELOW. THE CONTRACTOR'S PLAN FOR ACCOMPLISHING THIS SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO THE START OF CONSTRUCTION. ALL WORK ASSOCIATED WITH THIS CONTAINMENT SYSTEM SHALL BE CONSIDERED INCIDENTAL TO THE CONTRACT.
4. THE STRUCTURE DESIGN IS IN ACCORDANCE WITH THE REQUIREMENTS OF
   - AASHTO LRFD GUIDE SPECIFICATIONS FOR THE DESIGN OF PEDESTRIAN BRIDGES, 2ND EDITION DATED 2009, AND INTERIM REVSIONS THROUGH 2018.
   - AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, 9TH EDITION, 2020.
   - AASHTO GUIDE SPECIFICATIONS FOR LRFD SEISMIC BRIDGE DESIGN, 2ND EDITION, 2011 WITH INTERIMS THROUGH 2015.
5. FOUNDATION DESIGN BASED ON RECOMMENDATIONS OF ANCHOR QEA IN THE DRAFT GEOTECHNICAL REPORT DATED NOVEMBER, 2022.

FOOTING, FACTORED BEARING CAPACITY		
SERVICE	STRENGTH	EXTREME
6.3 KSF	8.6 KSF	17.1 KSF

6. DESIGN LOADS:

   DEAD LOAD:
   CONCRETE, UNLESS NOTED OTHERWISE 155 PCF
   STEEL 490 PCF

   LIVE LOAD:
   PEDESTRIAN 90 PSF

   BRIDGE SUPERSTRUCTURE REACTIONS:
   THE FOLLOWING STRUCTURE REACTIONS WERE ASSUMED FOR THE DESIGN OF SUBSTRUCTURE ELEMENTS.

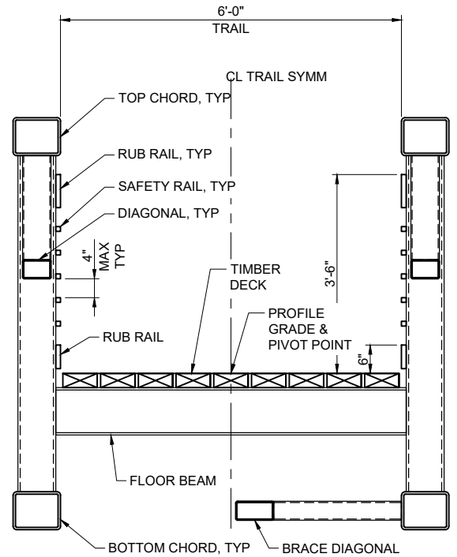
LOAD	P (KIPS)	H (KIPS)
DEAD		-
LIVE		-
WIND	-	

   P = VERTICAL LOAD EACH BASE PLATE (4 EA)
   H = HORIZONTAL LOAD EACH FOOTING (2 EA)

   SEISMIC DESIGN:

PGA	=	0.420g
A_S	=	0.504g
S_{DS}	=	1.164g
S_{D1}	=	0.435g
SITE CLASS	=	C

7. UNLESS OTHERWISE SHOWN IN THE PLANS THE CONCRETE COVER MEASURED FROM THE FACE OF THE CONCRETE TO THE FACE OF ANY REINFORCING STEEL SHALL BE 2 INCHES AT THE TOP OF THE BRIDGE DECK, 3 INCHES AT CONCRETE CAST AGAINST EARTH, AND 1 1/2 INCHES AT ALL OTHER LOCATIONS
8. CONCRETE SHALL BE CLASS 4000 UNLESS NOTED OTHERWISE BELOW.
9. CONCRETE STEEL REINFORCING SHALL BE ASTM A706, GRADE 60, UNLESS NOTED OTHERWISE.
10. ALL EXTERIOR CORNERS AND EDGES SHALL HAVE A 3/4" CHAMFER AND ALL INTERIOR CORNERS SHALL HAVE A 3/4" FILLET UNO.
11. THE STEEL TRUSS SHALL BE CONTRACTOR DESIGNED. STRUCTURAL STEEL SHALL BE WEATHERING STEEL (ASTM A847 Fy = 50 KSI FOR HSS SECTIONS, ASTM A709 GR50W FOR STEEL SHAPES). TRUSS FLOORBEAMS AND BRACE DIAGONALS SHALL BE PAINTED. THE TRUSS SHALL BE MANUFACTURED WITH DEAD LOAD CAMBER SO THAT THE FINAL GEOMETRY OF THE IN-SITU TRUSS DOES NOT HAVE A SAG.



TYPICAL SECTION

SCALE: 3/4" = 1'-0"

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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APPROVED BY: J. SMALL
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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

CITY HALL BRIDGE GENERAL NOTES AND TYPICAL SECTION

C23

SHEET NO. 36 OF 41

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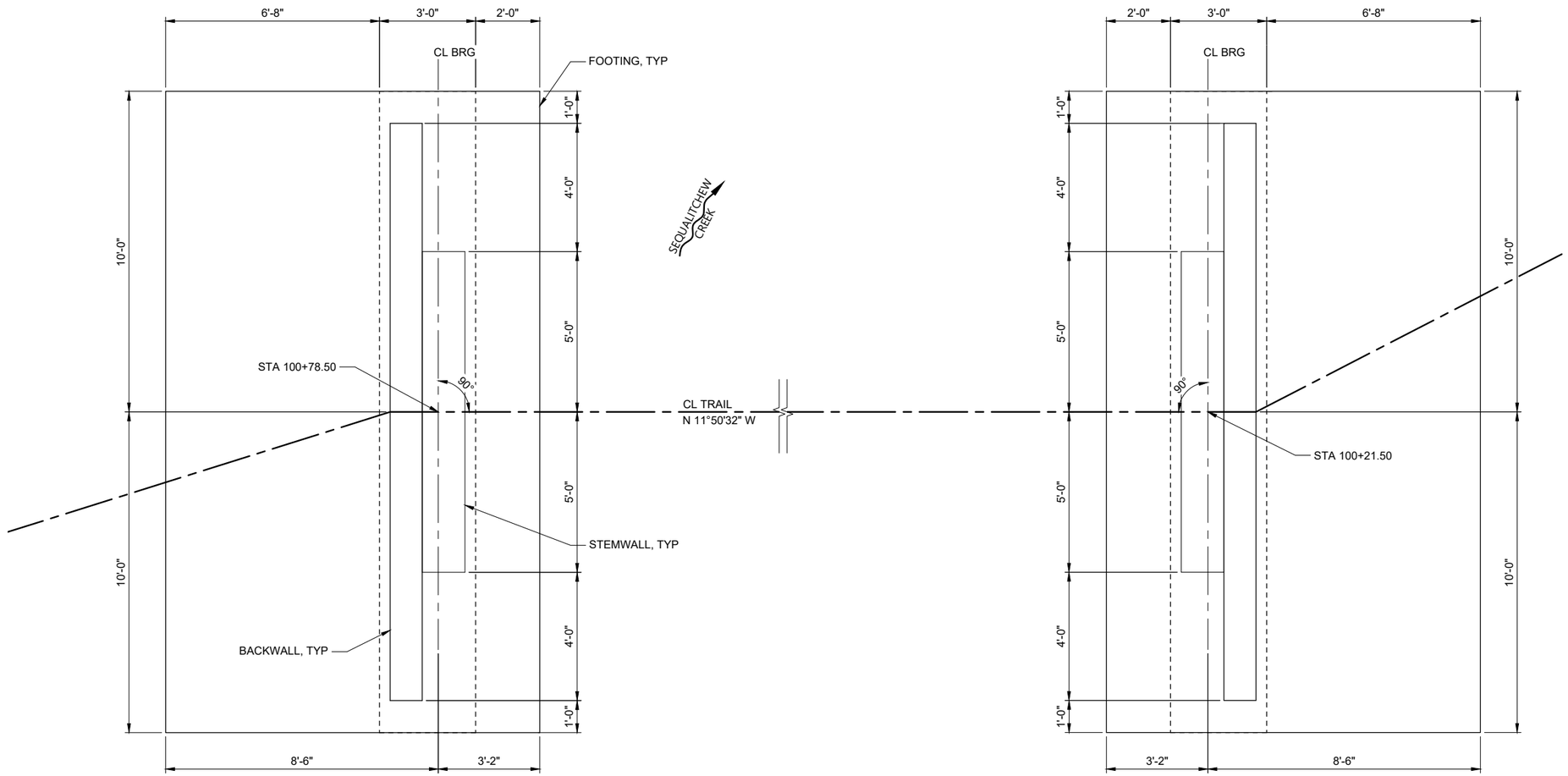

FOUNDATION PLAN

SCALE: 1/2"=1'-0"

BEARING OF BOTH ABUTMENTS IS S 78°09'28" W

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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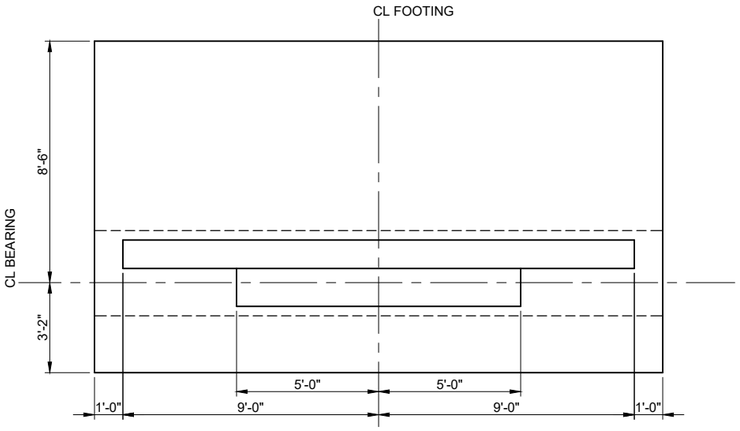
SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

CITY HALL BRIDGE FOUNDATION PLAN

C24

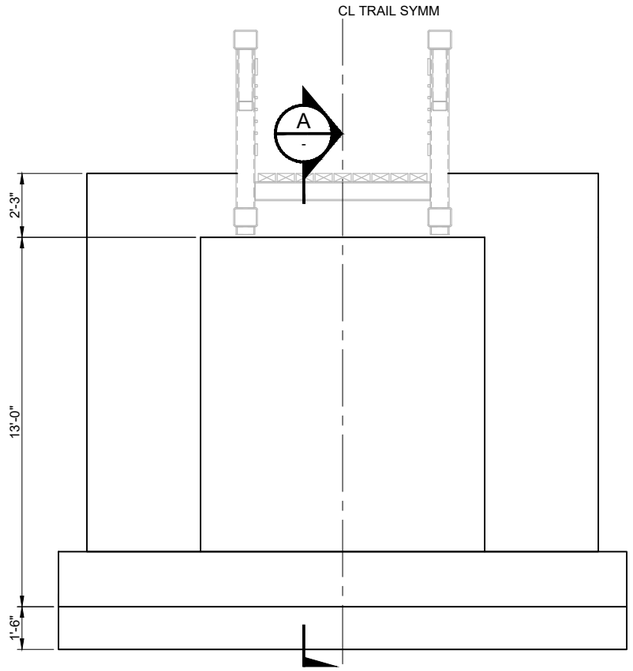
SHEET NO. 37 OF 41

Feb 20, 2023 7:54pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-PL-KPFF-CHB-B803.dwg C28



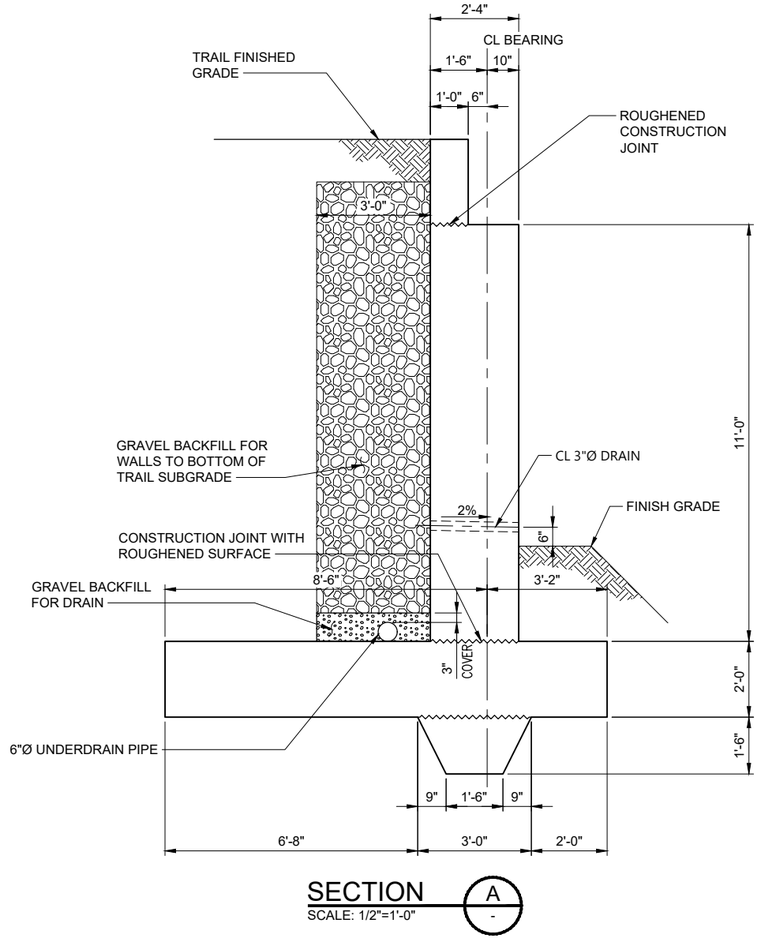
ABUTMENT PLAN

SCALE: 3/4"=1'-0"



ABUTMENT ELEVATION

SCALE: 3/4"=1'-0"



SECTION A

SCALE: 1/2"=1'-0"

PLAN INTENDED TO BE VIEWED IN COLOR, ADJACENT BLOCK IS "BLUE"

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ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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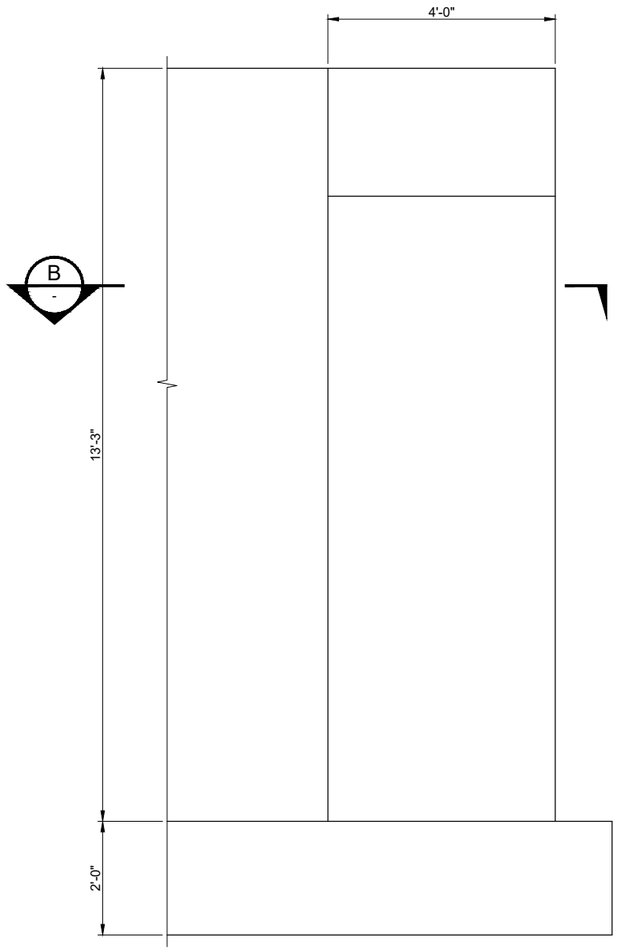
SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

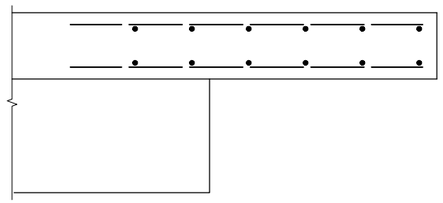
CITY HALL BRIDGE ABUTMENT LAYOUT

C25

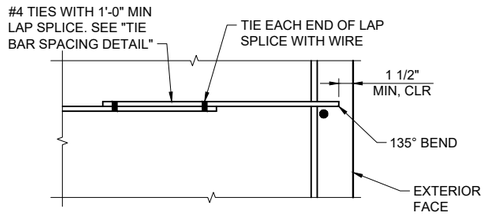
SHEET NO. 38 OF 41



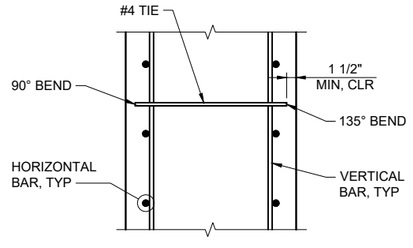
VIEW
SCALE: 3/4"=1'-0"
A
-



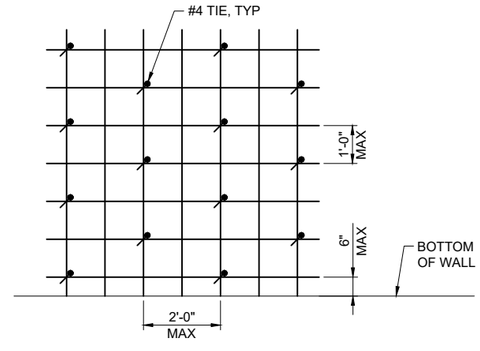
SECTION
SCALE: 3/4"=1'-0"
B
-



ALTERNATE TIE BAR DETAIL
SCALE: 1 1/2"=1'-0"



TIE BAR DETAIL
SCALE: 1"=1'-0"
CONSTANT WIDTH SECTION
ALTERNATE 135° BEND EVERY OTHER TIE



TIE BAR SPACING DETAIL
SCALE: 1"=1'-0"

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DRAFT-NOT FOR CONSTRUCTION

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

CITY HALL BRIDGE ABUTMENT DETAILS

C26

SHEET NO. 39 OF 41

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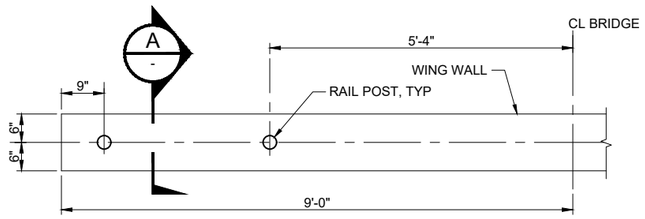
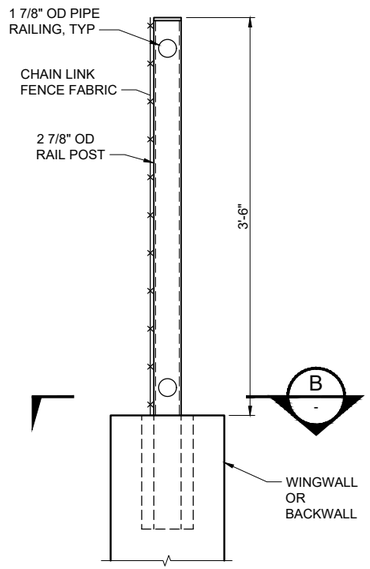


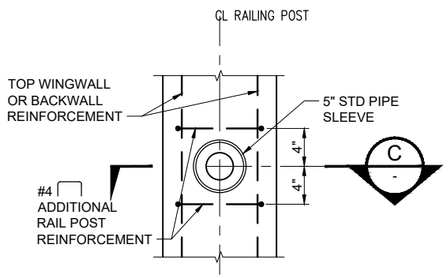
RAIL POST SPACING PLAN DETAIL

SCALE: 3/4"=1'-0"



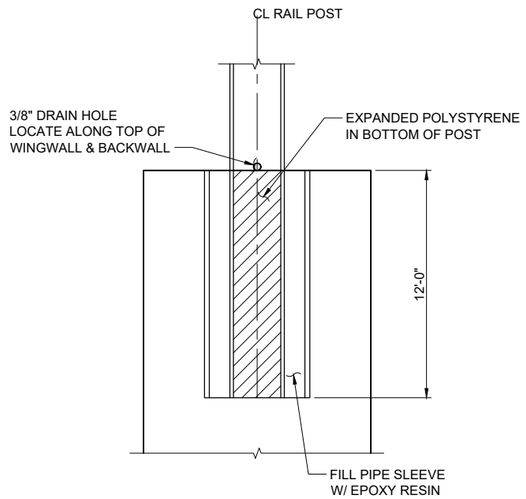
SECTION A -

SCALE: 1 1/2"=1'-0"



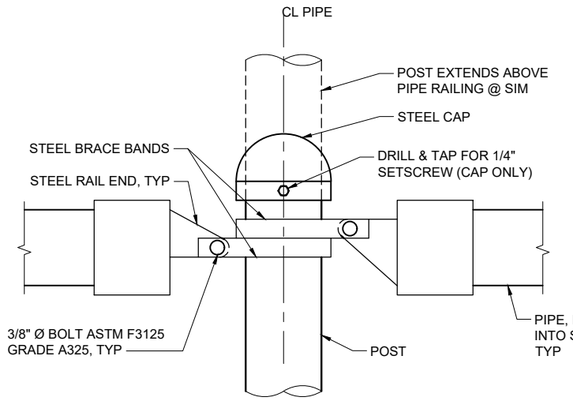
SECTION B -

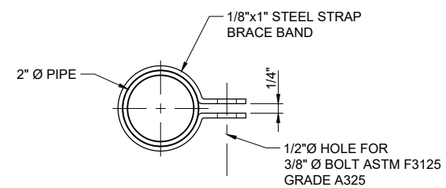
SCALE: 1 1/2"=1'-0"



SECTION C -

SCALE: 3"=1'-0"





BRACE BAND

FENCE POST / RAILING CONNECTION DETAIL

SCALE: 6"=1'-0"

PLAN INTENDED TO BE VIEWED IN COLOR, ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DRAFT-NOT FOR CONSTRUCTION

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ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

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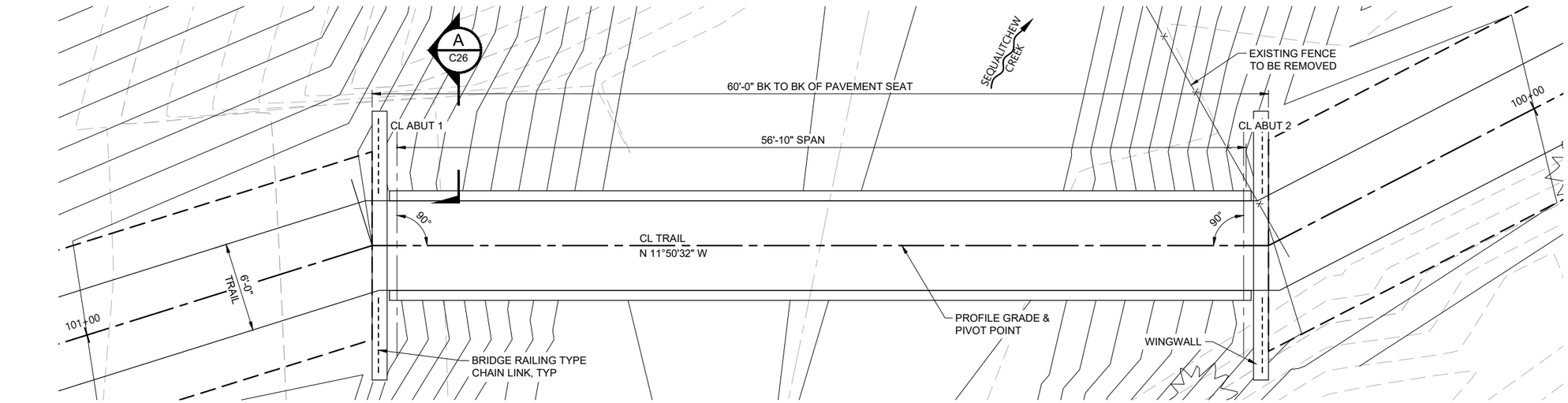
SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

CITY HALL BRIDGE RAILING DETAILS

C27

SHEET NO. **40** OF **41**

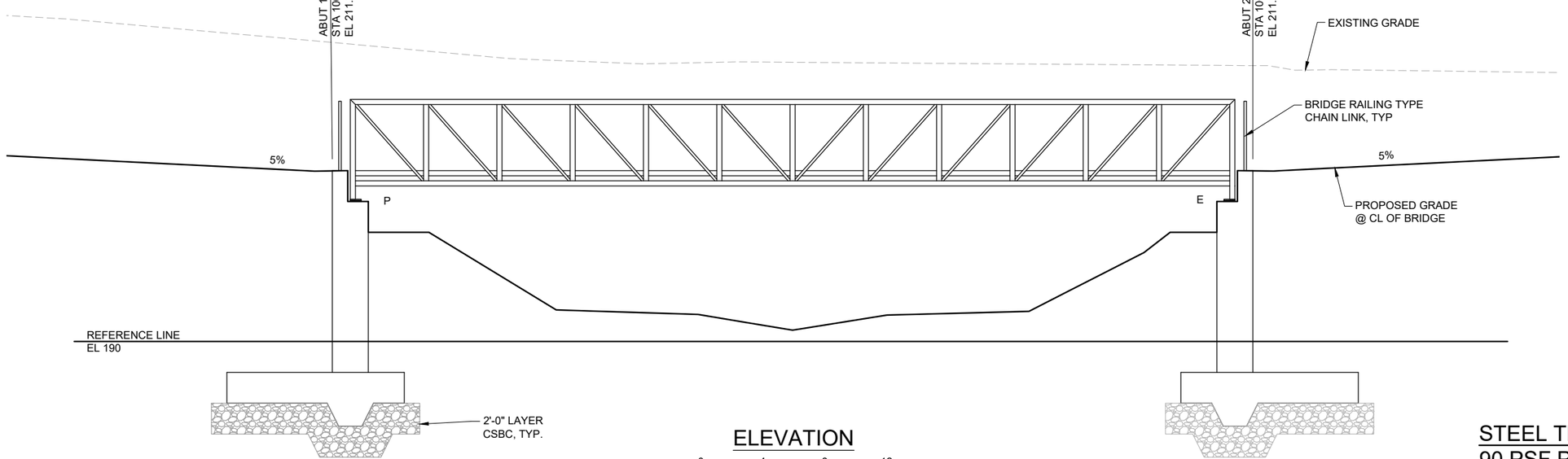


PLAN

0 4 8 12

SCALE IN FEET

BEARING OF BOTH ABUTMENTS IS S 78°09'28" W



ELEVATION

0 4 8 12

SCALE IN FEET

STEEL TRUSS BRIDGE
90 PSF PEDESTRIAN LOADING

DRAFT-NOT FOR CONSTRUCTION

PLAN INTENDED TO BE VIEWED IN COLOR. ADJACENT BLOCK IS "BLUE"

ONE INCH AT FULL SIZE. IF NOT ONE INCH SCALE ACCORDINGLY

ANCHOR QEA

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

REVISIONS				
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: KPFF
DRAWN BY: KPFF
CHECKED BY: KPFF
APPROVED BY: J. SMALL
SCALE: AS NOTED
DATE: FEBRUARY 2023

SEQUALITCHEW CREEK WATERSHED ECOSYSTEM RESTORATION PROJECT

CITY HALL BRIDGE PLAN AND ELEVATION

C28

SHEET NO. **41** OF **41**

Feb 20, 2023 7:55pm tgriga K:\Projects\0217-CalPortland\DuPont Aggregates South Parcel\Construction Plans\0217-PL-KPFF-CHB-BB01.dwg C28

Appendix D
Geotechnical Report

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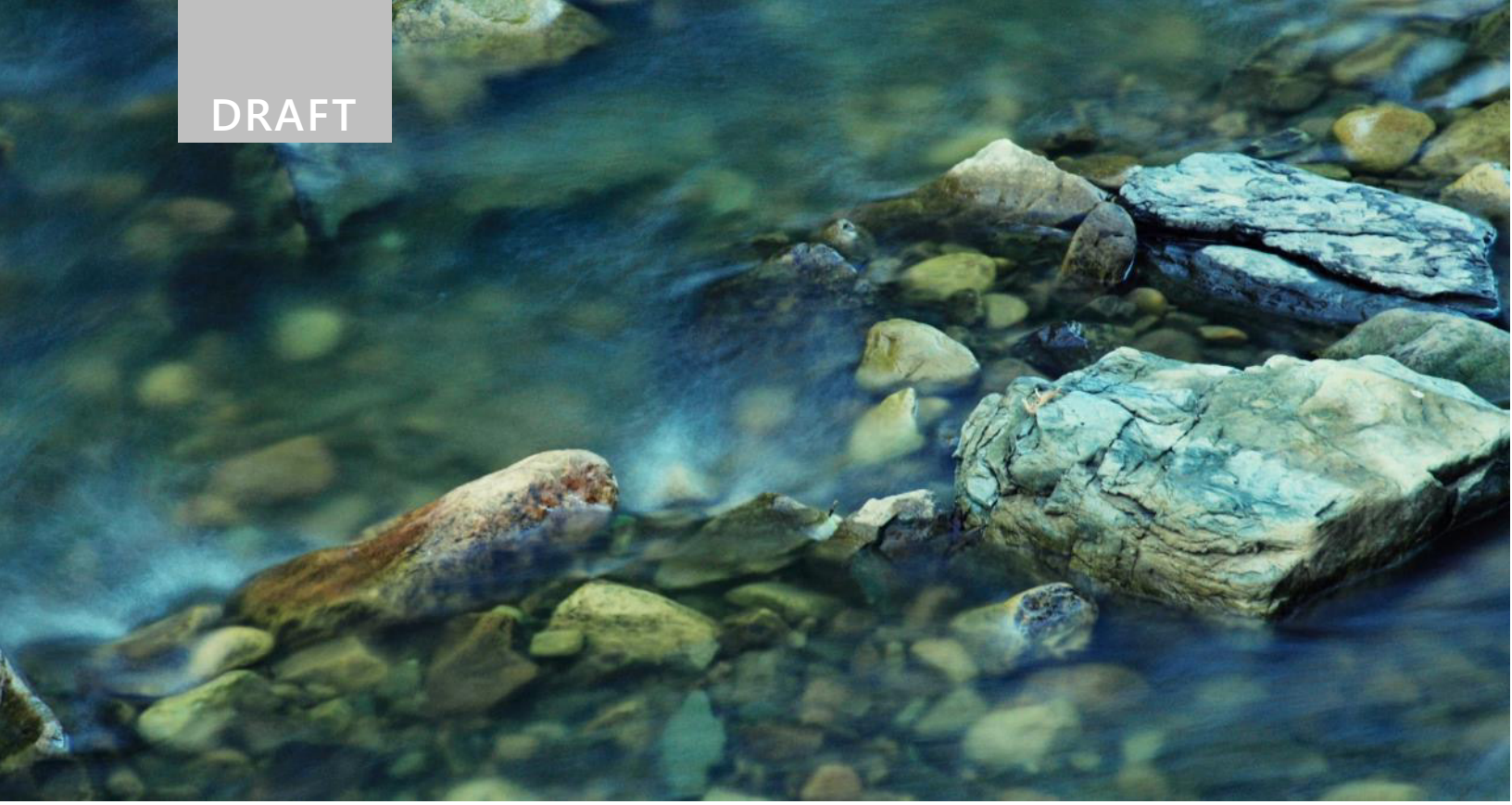

November 2022
Sequalitchew Creek Watershed Ecosystem Restoration Project

ANCHOR QEA

DRAFT Geotechnical Engineering Design Report

Prepared for South Puget Sound Salmon Enhancement Group

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November 2022
Sequalitchew Creek Watershed Ecosystem Restoration Project

DRAFT Geotechnical Engineering Design Report

Prepared for
South Puget Sound Salmon Enhancement Group

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APPENDICES

Appendix A Boring Logs
Appendix B Laboratory Results

ABBREVIATIONS

AASHTO	American Association of State Highway Transportation Officials
ASTM	ASTM International
BGS	below ground surface
CPT	cone penetration test
H:V	horizontal to vertical
NAVD88	North American Vertical Datum of 1988
pcf	pounds per cubic foot
pci	pounds per cubic inch
PGA	peak ground acceleration
Project	Sequalitchew Creek Watershed Ecosystem Restoration Project
psf	pounds per square foot
SPT	standard penetration test
WSDOT	Washington State Department of Transportation

1 Introduction

This report was prepared in support of the Sequalitchew Creek Watershed Ecosystem Restoration Project (Project). The goal of this effort is to restore flows to Sequalitchew Creek. This effort includes a number of individual elements that each address a barrier to flows and/or fish. Two of these Project elements are new bridges in place of existing barriers to flow, including an existing culvert.

- The Robinson Trail Bridge will be a prefabricated steel truss vehicle bridge capable of handling maintenance truck traffic. The bridge will allow the removal of a section of the railroad grade and restore the hydraulic connection between east Edmonds Marsh and west Edmonds Marsh.
- The City Hall Bridge will be a prefabricated steel truss pedestrian bridge that will replace an existing culvert 400 feet downstream of Center Drive. This bridge will not support traffic but will comply with the Americans with Disabilities Act.

Each bridge will be supported on new foundations. This geotechnical study was prepared to describe subsurface conditions at each of the two sites and present geotechnical engineering design recommendations to support the structural foundation design of the two bridges. Depending on the assumptions made in the design of the abutments and spans this report may be sufficient as the geotechnical basis of the final design.

The work described in this report was informed by a site-specific geotechnical subsurface investigation at both proposed bridge locations. During the subsurface investigation, additional subsurface data were collected at two other locations in the area referred to as dry creek, which is not related to the proposed bridge structure foundations. The dry creek subsurface investigations were advanced to support additional ecosystem restoration evaluations. This report also includes the results of the geotechnical investigations and qualitative assessment of the subgrade soils in the area of dry creek.

1.1 Report Organization

This report is organized as follows:

- Section 2 describes subsurface conditions and laboratory results.
- Section 3 presents geotechnical engineering design recommendations for earthwork, pile foundation design, shallow footing design, and lateral earth pressures.
- Section 4 presents seismic design recommendations.
- Section 5 provides construction recommendations and describes recommended additional geotechnical engineering services.

2 Site and Subsurface Conditions

This section describes site and subsurface conditions based on the observations made during the geotechnical investigation described below.

2.1 Investigation and Laboratory Methods

Anchor QEA performed a subsurface geotechnical investigation in April and May 2022, to explore subsurface soil conditions in the vicinity of the two proposed bridges. Cone penetration test (CPT) locations 1 through 5 and boring location BH-01 were advanced near the proposed City Hall Bridge. Boring location BH-04 was advanced near the proposed Robinson Trail Bridge. Two additional borings (BH-02 and BH-03) were advanced in the dry creek area and are discussed in Appendix C.

The exploration and testing program conducted to support the bridge foundation design included the following:

- Advancing two sonic core borings (designated BH-01 and BH-04) to a maximum 71.5 feet below the ground surface (BGS) at selected locations, recording blow counts using the standard penetration test (SPT), and subsampling and conducting visual classification of observed soils for each boring. Boring locations are shown in Figure 2.
- Advancing five CPT soundings into the soil to a refusal depth of 14.5 feet BGS or shallower. These CPTs are located near boring BH-01 and are shown in Figure 2.
- Collecting and submitting representative soil samples for geotechnical laboratory testing at both boring locations. A total of 26 samples were submitted: 11 samples from BH-01 and 15 samples from BH-04.

Borings were advanced using a sonic coring drill rig. SPT tests were conducted, and split spoon samples were collected at 5.0-foot-depth intervals, starting at the ground surface. Boring BH-01 was advanced to a depth of 51.5 BGS, and BH-04 was advanced to the depth of 71.5 feet BGS. Boring logs from these locations are provided in Appendix A.

Soil samples were collected from borings BH-01 and BH-04 and submitted for laboratory testing by GeoTesting Express (results are included in Appendix B). Sample analyses included the following:

- Moisture content per ASTM International (ASTM) D2216 (ASTM 2019): 26 samples
- Specific gravity of soils per ASTM D854 (ASTM 2016): 1 sample
- Particle-size analysis per ASTM D6913 (ASTM 2017b): 5 samples
- Atterberg limits per ASTM D4318 (ASTM 2017a): 1 sample

2.2 Geologic and Hydrologic Setting

The Sequalitchew Creek watershed is located within the Puget Lowlands. This area is a hydraulic zone that contains soils affected by historic glacial processes, including coarse grained sands and gravels

that were deposited during glacial retreat (recessional outwash) overlying glacial till, which is typically an unsorted, very dense mix of soils that were compressed under the weight of the glacial advance. The borings advanced for this study encountered subsurface conditions that are consistent with the reported glacial history in the area, with granular materials in the near surface dominated by gravel.

This watershed area is partially in the Nisqually quadrangle and partially in the Lacey quadrangle, and it is noted that to the south of the Project area this gravel deposit has been observed to be 200 feet thick (DNR 2003). Groundwater was encountered in all subsurface borings at the time of drilling, as summarized in Table 2-1.

Table 2-1
Groundwater Observations During Subsurface Explorations

	AQ-BH-01	AQ-BH-02	AQ-BH-03	AQ-BH-04
N:	47° 06.42 ft	47° 06.40 ft	47° 06.39 ft	47° 06.17 ft
W:	122° 38.80 ft	122° 38.68 ft	122° 38.48 ft	122° 37.86 ft
Boring Top Elevation NAVD88	217.35	209.86	214.27	217.54
Depth BGS (feet)	17.4	5	3	5
Water Level Elevation NAVD88	199.95	204.86	211.27	212.54

2.3 Topography

In the vicinity of the proposed Project, the Sequalitchew Creek watershed is a generally flat area: between borings BH-01 and BH-04 there is a total elevation change of less than 1 foot; however, the elevation change in spots varies up to 7 to 8 feet. The topography of this site, while flat, does tend to drop towards Puget Sound to the west.

2.4 Subsurface Lithology: Robinson Trail Bridge Area

This section describes the generalized subsurface soil profile that was observed in the vicinity of the proposed Robinson Trail Bridge, as informed by boring BH-04. In this area, the following major geologic units were encountered listed in order from the ground surface downward.

Unit #1: Fill. This material, consisting of medium dense sand and gravel, was encountered in boring BH-04 from 217.5 feet North American Vertical Datum of 1988 (NAVD88; ground surface) to 203 feet NAVD88. Considering the relatively non-decomposed organic layer below this section, it is interpreted to be fill material placed on top of the organic layer to support construction of the walking path. The first 5 feet of soil BGS is well-graded sand with silt, which transitions into well-graded gravel with silt and sand from 5 to 15 feet BGS. The water table was encountered at 5 feet BGS, and therefore, the lower half of this unit is liquefiable. This unit had an average moisture content of 10.5%.

Unit #2: Organics. Below the fill unit, a unit of very soft decomposing organic soil was encountered. This unit was roughly 8 feet thick, from elevation 203 to 196 feet. This unit was observed in the field to be primarily (more than 85%) wood chunk debris, with interspersed organic silt. This layer is interpreted to be associated with the surrounding marsh rather than natural depositional processes like alluvial or glacial soils. The average moisture content of this unit was 204%.

Unit #3: Recessional Outwash. The third unit was encountered between elevation 196 and 167.5 feet. This layer was a primarily medium dense to dense gravel, with sand lenses throughout at differing depths. These sand lenses had lower SPT-N value blow counts (blows per foot) at certain elevations as shown on the boring logs; these lower density zones are susceptible to liquefaction as described in Section 4. This unit had an average moisture content of 6.5%.

Unit #4: Advance Outwash. The deepest unit encountered is compositionally similar to Unit #3. This unit is also primarily gravel, with gradations ranging from silt to cobble noted in the samples. This unit is very dense and interpreted to be advance outwash. This unit begins at elevation 167.5 feet and is the target bearing layer for pile design recommendations discussed in Section 3.5. This unit has an average moisture content of 12%.

2.5 Subsurface Lithology: City Hall Bridge Area

This section describes the generalized subsurface soil profile that was observed in the vicinity of the proposed City Hall Bridge, as informed by boring BH-01 and a series of CPTs advanced in the area.

The following provides a description of the lithology observed within the boring and CPTs, from the highest elevation materials down to the lowest elevation materials. The borings' elevations were recorded in NAVD88.

Unit #1: Fill and Recessional Outwash. This material, in boring BH-01, was encountered from 217.3 feet NAVD88 (ground surface) to 197 feet NAVD88. The surface is presumably fill material, although some transition to naturally deposited material is likely, considering this unit is 20 feet thick. Based on density and gradation and in consideration of regional geologic mapping, the lower portion of this unit is interpreted to be recessional outwash. While the exact transition between fill materials and outwash materials is difficult to discern, the upper half is observed to be very dense gravel and below that medium dense to dense sand. This unit had an average moisture content of 6.7%.

Unit #4: Advance Outwash. The deepest unit encountered is compositionally similar to the lower half of Unit #1. This unit is primarily gravel, with gradations ranging from silt to cobble observed in the samples. This composition, combined with the consistently high SPT-N value blow counts (blows per foot), showing the material to be very dense, suggests that the unit is advance outwash. This unit begins at elevation 197 feet and has an average moisture content of 9.6%.

3 Geotechnical Engineering Design Recommendations

This section provides geotechnical engineering recommendations for the design of the proposed bridges. References to local, state, or federal publications and testing standards are with respect to the adopted version at the time of this report.

3.1 Generalized Engineering Soil Properties

Based on Anchor QEA's review of geotechnical laboratory results (Appendix B), published correlations, and experience in similar soil conditions, the parameters in Table 3-1 were used for the geotechnical analyses.

Table 3-1
Soil Model Assumptions for Geotechnical Evaluations

Unit	Material	Total Unit Weight γ (pcf)	Undrained Strength	Drained Strength
			Cohesion (psf)	Internal Friction Angle ϕ (°)
Unit #1	SP-SM	125	-	35
Unit #2	OL	100	130	20
Unit #3	GP-GM	120	-	32
Unit #4	GP-GM	135	-	38

Organic soil only found in boring BH-04, the Robinson Trail Bridge area.

3.2 Earthwork Recommendations

This section describes general earthwork recommendations including site preparation, temporary cut slopes, and backfill. Earthwork activities at the site will include removing a section of the existing trails, creating a new open channel, and constructing a new bridge over the open channel. Temporary excavations will be necessary to construct bridge foundations. Following foundation construction, backfill will be needed to restore grades.

3.2.1 Site Preparation

Initial site preparation should include the removal of any existing soil, pavement, structures, and rock above the proposed subgrade elevation and within the proposed open channel where applicable. All visible organic materials and any deleterious material should be removed from the excavated subgrade. It is recommended that all existing structures and concrete that underly foundation elements or pavement areas should be removed to a depth of at least 2 feet below final subgrade. This is intended to remove any spots that are relatively harder than the surrounding subgrade

material. Such spots could eventually lead to uneven settlement and structural distress and cracking in overlying structural elements. It is also recommended that any existing utility pipelines or culverts that will be abandoned and that underlie the structural footprint or paved areas should either be removed or filled with grout and capped.

When cobbles or boulders are encountered, the contractor should remove the rock and backfill any void space created by removal with structural fill as described in the following section. Although not anticipated at this Project site, if boulders are found that are too large to remove, the contractor should use other means and methods to create a smooth, flat surface to the design elevation of the proposed subgrade, foundation or otherwise.

All exposed subgrades are recommended to be proof rolled with heavy equipment or otherwise evaluated to delineate soft, loose, or yielding soils. Soft or loose material should either be recompacted to a dense and non-yielding condition or removed and replaced with structural fill, as described in the following section, Section 3.2.2.

Shallow foundation elements, pavements, and slabs on grade should be founded on a firm and non-yielding subgrade and prepared using a smooth-edged bucket to the extent practical. In areas of dense, native soil, little subgrade preparation may be necessary. In areas where the subgrade is soft or loose, or contains voids generated by the preparation process (e.g., from removal of oversized materials near the subgrade elevation), a firm and non-yielding condition can be accomplished by moisture conditioning and recompacting the on-site soils, if weather and the nature of the materials permits, or by over-excavating in situ soils and replacing them with structural fill. Use of on-site soils for this purpose may be difficult in wet weather if moisture and silt and clay contents are high.

3.2.2 Temporary Cut Slopes

Temporary cut slopes may be needed to reach subgrade elevations during construction. The contractor should be made responsible for the stability of cut slopes and related safety of the slope.

For cut slope planning purposes, soils above the water table can be classified as Type B or Type C and soils below the water table Type C. We recommend that the contractor follows Washington State safety standards for planning cut slopes using this classification system, which allows for a maximum slope of 1.5 horizontal to 1 vertical (H:V) for Type C soils.

Stability of actual temporary cut slopes should be made the responsibility of the contractor because they are in control of the construction operation and are continuously present at the job site to observe the nature and conditions of the slope. The contractor should be required to perform all excavations in accordance with federal, state, and local safety regulations. The contractor may determine that steeper temporary cut slopes are possible based on observed soil behavior during construction.

Construction equipment should be maintained at least 5 feet back from the top of temporary slopes. The contractor should take precautions to minimize slope erosion from rainfall and from surface water runoff, as well as potential danger from loose, rolling cobbles. Open excavations made in fill soils should be made with great care and attention because zones of loose fill could be particularly susceptible to raveling.

If the footprint of the excavation will be too large for a temporary open cut, shoring of the excavation can be accomplished using sheet piles, soldier piles and lagging, block walls, or geosynthetic walls. Lateral earth pressures used for the design of temporary shoring should follow the recommendations provided in Section 3.6.

3.2.3 Backfill

This section describes recommendations for backfill material specifications and backfill placement.

3.2.3.1 Structural Fill Materials and Compaction

Structural fill should be used as necessary to help accomplish a minimum thickness of 2 feet of firm, non-yielding subgrade beneath mats, shallow foundations, and pavement sections and as wall backfill. Except for areas adjacent to subgrade walls (discussed subsequently), structural fill should be placed in maximum 10-inch-thick lifts and compacted to a minimum density equal to 95% of the modified proctor maximum dry density as determined by ASTM D1557 test procedure (ASTM 2012).

During wet weather or construction in wet subgrades, we recommend using a clean, well-graded sand and gravel mixture with less than 5% by weight passing the No. 200 sieve, based on the minus 3/4-inch fraction. Structural fill that meets Washington State Department of Transportation (WSDOT) specification Section 9-03.14(2), Select Borrow, can be used. During periods of dry weather and construction above the water table, sand, and gravel with as much as 30% fines could be used (WSDOT 2023). However, this material is expected to be moisture sensitive and may require wetting or drying to achieve the required density during compaction. Moisture conditioning of high fines content material is expected to be difficult during wet weather construction.

3.2.3.2 Backfill Adjacent to Subgrade Walls

Where backfill is placed adjacent to subgrade walls or abutments, we recommend the following:

- Use at least 12 inches of free-draining backfill immediately adjacent to the wall to control hydrostatic pressures.
- Perform compaction with small vibratory plate or self-propelled walk-behind equipment within 2 feet of the wall to minimize the potential for over-compaction adjacent to the wall. Over-compaction could result in additional lateral loads on the wall.
- Where small compaction equipment is used, fill loose lift thickness should be limited to 8 inches.

- Compact backfill adjacent to subgrade walls to a minimum of 90% and a maximum of 92% of modified proctor maximum dry density as determined by ASTM D1557 (ASTM 2012).

3.2.3.3 Reuse of Excavated Materials

Most soils excavated for the open channel are expected to be from the surface unit, which consists of silty sand and gravel soils. These materials may be geotechnically suitable to reuse as backfill, provided they are compacted as described in the previous section. However, where the fines content is higher, on-site materials may be moisture sensitive and more difficult to compact, and therefore they may not be suitable as structural fill.

This review of suitability for reuse does not consider any potential soil chemistry considerations associated with non-native fill materials that might be encountered during excavation. Our geotechnical investigation did not encounter materials that are visually suspected to be contaminated; however, it is possible that such materials could unexpectedly be encountered.

3.3 General Foundation Design Considerations

Subsurface soil conditions in the area of the City Hall Bridge are conducive to the use of shallow footings for the direct support of the bridge loads.

Subsurface conditions near to the Robinson Trail Bridge area are not conducive to shallow footings due to the soft organic soils in the near surface and the liquefaction potential of the soils underlying the soft organics.

Direct support of the loads for the Robinson Trail Bridge should be provided by pile foundations. This section provides recommendations for shallow footings at the City Hall Bridge and pile foundations at the Robinson Trail Bridge.

3.4 Shallow Footing Design Recommendations

This section presents recommendations for the design of shallow footings to support the proposed bridge footings and abutments at City Hall Bridge.

3.4.1 Shallow Foundation Bearing Capacity

Shallow foundations may be used to support the proposed City Hall Bridge. For the design of shallow foundations, Anchor QEA recommends the following:

- Construct footings on firm, unyielding subgrade that has been prepared as described in Section 3.2.
- For footings founded on compacted structural fill or properly prepared subgrade, use a maximum allowable bearing pressure from Figure 5 based on footing width.

- Isolated spread and continuous footings should have a minimum width of 24 inches. The base of all footings should be at least 12 inches below the adjacent finished grade in consideration of frost depth. Additional embedment should be considered for footings potentially subject to scour as determined by a hydraulic analysis.
- Allowable bearing capacity can be increased by up to one-third for loads of short duration, such as those caused by wind or seismic forces.
- Use a coefficient of friction of 0.45 to compute the footings' ultimate resistance to sliding. Anchor QEA recommends applying a factor of safety of at least 1.5 for computing allowable sliding resistance.

3.4.2 Shallow Foundation Settlement

Shallow footings designed to allowable loads in accordance with Figure 5 are expected to result in settlement less than 1/4 inch, assuming appropriate subgrade preparation. Settlement is expected to be elastic in nature and to occur as the loads are applied. Long-term, consolidation-type settlement of shallow foundations is expected to be negligible. This and all recommendations regarding shallow footings are predicated on embedment depth being maintained through scour control.

3.4.3 Shallow Foundation Drainage

All footings and slabs should be underlain directly by a layer of free-draining material at least 4 inches thick that serves as a capillary break. This layer could consist of free-draining sand, or sand and gravel, and can be included as part of the 2 feet of non-yielding subgrade or structural fill recommended beneath the footing. Free-draining material contains less than 3% by weight of material finer than the No. 200 sieve (based on the minus 3/4-inch fraction of the material). This layer is intended to reduce the potential buildup of hydrostatic pressures.

3.4.4 Hydrostatic Uplift Forces on Submerged Shallow Footings

Footings founded below the static groundwater elevation should be designed considering the upward pressure of water. This upward force should be applied as the full hydrostatic pressure applied over the entire area of the footing.

3.5 Pile Foundation Design Recommendations

This section provides recommendations for the design of pile foundation support for the proposed Robinson Trail Bridge.

3.5.1 Selection of Pile Foundations

Pile foundation options include timber, steel, precast concrete, helical piles, or concrete cast in place using either continuous flight augers or drilled shafts. To accommodate the loads for a relatively low-use bridge such as this, driven steel or driven precast concrete piles are recommended because

installation is relatively straightforward, materials are typically readily available, and a record of installation can be obtained by recording the energy required to install the piling.

Anchor QEA has assumed that driven steel piles will be used because steel piles are readily adaptable to field changes, and they can be shortened or lengthened relatively easily compared to precast concrete. This section describes recommended capacities for driven steel pipe and H-piles to support the bridge loads.

3.5.2 Driven Pile Vertical Capacity

Pile vertical capacities were evaluated in accordance with the American Association of State Highway and Transportation Officials (AASHTO) 2012 edition of *AASHTO LRFD Bridge Design Specifications* (AASHTO 2012).

Compressive load support relies on a combination of side (skin) friction between the outer surface of the pile and the surrounding soil and end bearing on the soils below the pile. Uplift capacity relies on side friction alone. For open-ended pipe piles, Anchor QEA has assumed that the piles will predominantly behave as friction piles because formation of a pile plug during driving is uncertain. Anchor QEA assumes that KPFF Consulting Engineers will confirm the structural capacity of the pile to support the design loading.

It is possible that piles will achieve the required vertical capacity at a shallower depth than is necessary to embed sufficiently below the zone of potential liquefaction. Because of potential liquefaction risk, Anchor QEA recommends that piles be embedded to a minimum of tip elevation of 60 feet BGS, which would result in embedment at least 10 feet below the deepest zone of potential liquefaction.

Figure 4 presents the anticipated nominal capacity for 18-inch-diameter open-ended steel pipe piles and 14-inch H-piles. Nominal capacities should be evaluated considering loads that account for potential liquefaction-induced downdrag. Based on the neutral plane method, recommended in AASHTO Article 3.11.8, for 14-inch H-piles the estimated unfactored post-liquefaction downdrag load is 27 kips. For 18-inch pipe piles, the estimated unfactored post-liquefaction downdrag load is 46 kips (AASHTO 2012).

These nominal values should be assessed considering the resistance factors described in Section 3.5.5. Anchor QEA can provide recommendations for different pile sizes and types and deeper embedment at the request of KPFF Consulting Engineers.

Downdrag loads are not expected to occur in the static condition. The neutral point for friction piles with a minimum embedment depth of 60 feet is deeper than the organic soil layer expected to settle. Downdrag, as noted above, is only expected to occur during the post-liquefaction case (NAVFAC 1986).

3.5.3 Lateral Pile Design Recommendations

We understand KPFF Consulting Engineers will use LPILE or similar methods for lateral pile design. Table 3-2 presents recommended static soil parameters to be used in LPILE. Table 3-3 presents recommended dynamic soil parameters to be used in LPILE. Design of the channel to resist scour underneath the bridge is being evaluated by others. Because the Project will be designed to incorporate measures to prevent scour, KPFF does not need to consider potential scour depth in the pile design evaluations.

Table 3-2
Static LPILE Soil Parameters

Layer No.	Depth to Top of Layer Below Ground (feet)	Depth to Bottom of Layer (feet)	Soil Type A USCS	Effective Unit Weight γ' (pcf)	Friction Angle ϕ (°)	Undrained Shear Strength c_u (kip/ft^2)	P-Y Curve Model --	Soil Modulus; K (Es=Kx) k (pci)	Strain Factor; at 50% max E ε_{50}
1	0	5	SP	125	35	--	Sand (Reese)	0 (default)	--
2	5	14	SP	63	35	--	Sand (Reese)	0 (default)	--
3	14	22	OL	38	--	0.13	Soft Clay (Matlock)	--	0 (default)
4	22	50	GP	57	32	--	Sand (Reese)	0 (default)	--
5	50	--	GP	72	38	--	Sand (Reese)	0 (default)	--

Table 3-3
Dynamic LPILE Soil Parameters

Layer No.	Depth to Top of Layer Below Ground (feet)	Depth to Bottom of Layer (feet)	Effective Unit Weight γ' (pcf)	Friction Angle ϕ (°)	Undrained Shear Strength c_u (kip/ft^2)	P-Y Curve Model --	Option 1 SPT Blowcount	Spring Constant; K (Es=Kx) k (pci)	Strain Factor; at 50% max E ε_{50}
1	0	5	125	35	--	Sand (Reese)	--	0 (default)	--
2	5	14	63	35	--	Liquefied Sand (Hybrid Model)	15	0 (default)	--
3	14	22	38	--	0.13	Soft Clay (Matlock)	--	--	0 (default)
4	22	50	57	32	--	Liquefied Sand (Hybrid Model)	11	0 (default)	--
5	50	--	72	38	--	Sand (Reese)	--	0 (default)	--

3.5.4 Lateral Pile Group Effects

Table 3-4 presents recommended P-multiplier values to use when evaluating pile groups using P-Y methods. For intermediate spacing, the values presented in Table 3-4 may be interpolated. Row 1 is the pile row located farthest from the applied load.

For a single pile bent, P-multiplier values should be used as follows:

- Row 1 values only should be used for loading perpendicular to the bent.
- Rows 1, 2, and 3 (and higher) values, as appropriate, should be used for loading parallel to the bent.

Table 3-4
P-Multiplier Values for Group Effects

Pile Center-to-Center Spacing in the Direction of Loading	Row 1	Row 2	Row 3 and Higher
3B	0.8	0.4	0.3
5B	1.0	0.85	0.7

3.5.5 Recommended Resistance Factors for Driven Piles

The vertical compressive and uplift capacity recommendations presented in Section 3.5.2 are nominal values. To calculate factored capacity in accordance with the static analysis method detailed in *Static Analysis of the AASHTO LRFD Design* Section 10.7.3.8.6, Anchor QEA recommends using the resistance factors presented in Table 3-5 when planning the tip elevation for proposed piles (AASHTO 2012). Different resistance factors may be used to evaluate pile capacity during construction, depending on the level of construction observation as described in Section 5.

Table 3-5
Recommended Resistance Factors for Driven Piles

Limit State	Nominal Compressive Bearing Resistance φ_{stat}[2]	Nominal Uplift Resistance Single Piles φ_{up}[3]	Nominal Uplift Resistance Pile Groups φ_{ug}[4]	Lateral Geotechnical Resistance[5]
Strength	0.35	0.35	0.5	1.0
Service	1.0			
Extreme[1]	1.0	0.8	0.8	1.0

Notes:

1. Extreme limit state includes scour, earthquake, ice, vehicle, and vessel impact loads.
2. φ_{stat} = resistance factor for the bearing resistance of a single pile specified in Article 10.5.5.2.3 (AASTHO 2012).
3. φ_{up} = resistance factor for uplift resistance specified in Table 10.5.5.2.3-1 (AASHTO 2012).
4. φ_{ug}= resistance factor specified in Table 10.5.5.2.3-1 (AASHTO 2012).
5. Lateral geotechnical resistance of single pile or pile group for all soils and rock.

3.5.6 Pile Horizontal Spacing

The capacity of pile groups is not the same as the sum of individual pile capacities when piles are closely spaced. To minimize reduction in pile capacity due to group effects and potential for interference between closely spaced piles during installation, Anchor QEA recommends a minimum spacing of 30 inches or 2.5 pile diameters (center to center), whichever is greater.

3.6 Lateral Earth Pressures

Lateral earth pressures for the design of shoring and abutment walls depend on the type of structure its ability to deform, and the presence or absence of surface structures within the zone of deformation, which is defined by a line extending into the retained soil from the base of the wall at a slope of 1H:1V.

If the top of the wall is allowed to deform at least 0.001 to 0.002 times the height, and if no settlement-sensitive structures or utilities are in the zone of deformation, then shoring and abutment walls may be designed using active earth pressures. If settlement-sensitive structures or utilities exist within the potential zone of deformation, or where the wall system is too stiff to allow for sufficient lateral movement to develop an active condition, at-rest earth pressures should be used to design shoring and abutment. Theoretically, little movement should occur behind a wall that is properly designed and installed for at-rest conditions. We anticipate that the abutment walls will act as relatively stiff elements with little potential for deformation considering the short bridge-span lengths and recommend that at-rest earth pressures be used for design. Cantilevered shoring walls or portions of the abutment that are not braced could deflect more. If the deflection exceeds the deformation criteria described in this section, active earth pressures can be used.

Lateral earth pressures for the design of shoring and abutment walls are presented in Figure 4.

For the design of shoring and abutment walls we recommend the following:

- Place at least 12 inches of free-draining, well-graded sand and gravel (less than 3% fines based on the minus 3/4-inch fraction) against the wall to prevent the buildup of hydrostatic pressure. This drainage layer should be connected to a suitable positive drainage outlet.
- Active earth pressures can be computed assuming an equivalent fluid weight of 35 pounds per cubic foot (pcf) above the groundwater table and 19 pcf below the groundwater table to represent properly compacted structural backfill as described in this report.
- At-rest earth pressures are appropriate for the design of non-yielding walls. At-rest earth pressures can be computed assuming an equivalent fluid weight of 56 pcf above the groundwater table and 30 pcf below the groundwater table to represent properly compacted structural backfill as described in this report.

- To assess the wall's resistance to transient loads, ultimate passive earth pressures for soils can be computed assuming an equivalent fluid weight of 520 pcf above the groundwater table and 280 pcf below the groundwater table.
  - We recommend using a factor of safety of at least 1.5 when computing allowable passive pressure.
- To assess the wall's resistance to seismic loads, seismic earth pressures for soils behind the wall can be computed adding an incremental additional equivalent fluid weight of 21 pcf.
- We recommend that passive earth pressures in front of the wall be ignored in the upper 2 feet due to the possibility of erosion of this material during high-flow events. If high flow occurs, and material is lost, we recommend that this material be replaced as soon as possible to prevent potential undermining of the wall from continued erosion.

3.7 Pavement Design Geotechnical Recommendations

Paving is assumed to be completed using flexible (asphalt) paving or rigid (concrete) paving methods and materials. It is also assumed that these pavements will be lightly loaded with pedestrian traffic as well as occasional maintenance or service vehicles.

Flexible pavement to support the above loading criteria can be paved with a minimum of 3 inches of asphalt, and 2 inches of crushed rock surface course with 6 inches of 5/8-inch crushed rock base course or similar. In soft sediment subgrade areas, this can be increased to 8 inches of base course.

The subgrade should be firm and non-yielding before the placement of pavement. Remove any wet, organic, or soft, yielding soils and compact and loose granular materials before placing base course and pavement. Base course and subgrade should be proof rolled or tested with nuclear density gauge testing to confirm a 95% compaction before pavement or base course, respectively. If clean crushed rock is used and nuclear density gauge testing is unreliable, a roll test to prove compaction for subgrade and base material is acceptable, based on a field engineer decision.

4 Seismic Design Recommendations

This section discusses regional seismicity, seismic design criteria, and liquefaction potential.

4.1 Regional Seismicity

The site is located within the Puget Lowlands, which encompasses the Seattle and Tacoma Fault Zones located just north of the site and the Olympia Structure located just southwest of the site. Numerous other fault zones are also located near the site (Czajkowski and Bowman 2014). Because of the site's proximity to regional seismic zones, site seismic forces need to be considered for design as described in this section.

4.2 Site Seismic Design Criteria

For an earthquake with a 975-year return interval (the Safety Evaluation Earthquake [WSDOT 2022]; i.e., the event with a 7% probability of exceedance in 75 years) at the site, bedrock and site-modified seismic design parameters are as follows:

- Bedrock peak ground acceleration (PGA): 0.42
- 0.2-second period bedrock spectral acceleration (s_s): 0.97
- 1-second period bedrock spectral acceleration (s_1): 0.29

Based on subsurface conditions encountered in site explorations, Site Class D is appropriate to classify the seismic behavior of soils above bedrock at the Robinson Trail location and Site Class C is appropriate at the City Hall location. Deaggregation tools by the U.S. Geological Survey indicate that the predominant earthquake magnitude associated with the design level earthquake is 7.1.

Per the *WSDOT Geotechnical Design Manual,* Chapter 6 (WSDOT 2021), Table 4-1 provides site coefficients that should be used to modify the bedrock PGA and spectral accelerations when preparing design response spectra.

Table 4-1
Seismic Design Parameters

Parameter	Robinson Trail Bridge	City Hall Bridge
Site Class	D	C
F_{PGA}	1.2	1.2
F_a	1.1	1.2
F_v	2	1.5

4.3 Liquefaction and Liquefaction-Induced Settlement

Liquefaction occurs when soils experience a loss of internal strength due to the buildup of porewater pressures during strong ground movement. This loss of strength can result in ground settlement, lateral spreading, and/or sand boils. Soils most susceptible to liquefaction include loose to medium dense granular soils that can develop excess porewater pressures (Caltrans 2008). Anchor QEA assessed the potential for liquefaction and estimated liquefaction-induced settlement for soil units that were observed to be below the groundwater table. It was found that there is low to no susceptibility for the soil to liquefy beneath the shallow footings under the City Hall Bridge. This was concluded using the WSDOT *Geotechnical Design Manual*, Chapter 6-4.2.1 (WSDOT 2021).

Liquefaction analysis was also conducted for the Robinson Trail Bridge area. The portion of Unit 1 below the groundwater table and Unit 3 were identified as liquefaction susceptible. It is estimated that these layers could settle 12 inches during a design earthquake scenario. Damage associated with liquefaction-induced settlement could lead to pavement cracking, which would need to be addressed with post-earthquake repairs.

Anchor QEA also evaluated post-liquefaction lateral spreading and flow failure. Given the relatively level ground in the Project area, Anchor QEA did not identify a risk of post-liquefaction lateral spreading or flow failure associated with the liquefaction zone.

5 Construction Considerations

5.1.1 Pile Handing and Installation

Piles can be damaged if not handled and installed appropriately. Excessive driving in dense sand could damage the piles. A reasonable selection of the pile type, size, pile hammer, and cushion can reduce pile damage during driving. In addition, driving should be discontinued when refusal is met near the minimum tip elevation. Steel piles are less sensitive to handling than concrete piles.

5.1.2 Pile Installation Observations

Anchor QEA recommends that the installation of all piles be observed by a geotechnical engineer or experienced technician. The observer would evaluate the contractor's operation and collect and interpret the installation data. The pile capacities provided in this report are based on anticipated subsurface soil conditions; the soil conditions will most likely vary in density and type. By careful observation of pile installation, it is possible to monitor variations in subsurface conditions and verify that the required penetration depths and capacities are achieved.

Anchor QEA recommends monitoring of the following:

- Adequacy of hammer, cushion, and cap block prior to beginning driving
- Pile handling prior to driving
- Hammer operating characteristics such as fuel setting and stroke
- Hammer blows per each foot of penetration
- Delivered energy based on blows per minute for diesel hammers
- Capacity verification via the observed blow count
- Movement, if any, of adjacent piles during driving

5.1.3 Pile Capacity Determination

In accordance with WSDOT (2021), pile ultimate compressive capacity can be determined by recording blow counts during installation with an impact hammer. Equation 5-1 presents the recommended formula for computing ultimate resistance in tons.

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Equation 5-1

$P = F \times E \times Ln\,(10N)$

where:

P	=	Ultimate bearing resistance, in tons
F	=	1.8 for air/steam hammers
	=	1.2 for open-ended diesel hammers and precast concrete or timber piles
	=	1.6 for open-ended diesel hammers and steel piles
	=	1.2 for closed-ended diesel hammers
	=	1.9 for hydraulic hammers
	=	0.9 for drop hammers
E	=	Developed energy, equal to W times H_1, in foot-kips
W	=	Weight of ram, in kips
H	=	Vertical drop of hammer or stroke of ram, in feet
N	=	Average penetration resistance in blows per inch for the last 4 inches of driving
Ln	=	The natural logarithm, in base "e"

For closed-ended diesel hammers (double-acting), the developed hammer energy (E) should be determined from the bounce chamber reading. Hammer manufacturer calibration data may be used to correlate bounce chamber pressure to developed hammer energy. For double-acting hammer hydraulic and air/steam hammers, the developed hammer energy should be calculated from ram impact velocity measurements or other means acceptable to the engineer. For open-ended diesel hammers (single-acting), blows per minute may be used to determine the developed energy (E).

Equation 5.1 applies only when:

1. The hammer is in good condition and operating in a satisfactory manner.
2. A follower is not used.
3. The pile top is not damaged.
4. The pile head is free from broomed or crushed wood fiber.
5. The penetration occurs at a reasonably quick, uniform rate, and the pile has been driven at least 2 feet after any interruption in driving greater than 1 hour in length.
6. There is no perceptible bounce after the blow. If a significant bounce cannot be avoided, twice the height of the bounce shall be deducted from H to determine its true value in the formula.
7. For timber piles, bearing resistances calculated by the formula in Equation 5-1 should be considered applicable only when it is less than the crushing strength of the piles.
8. N is greater than or equal to 1.0 blow per inch.

If the N-value required to achieve the required ultimate bearing resistance using the formula in Equation 5-1 is less than 1.0 blow per inch, the pile should be driven until the penetration resistance is a minimum of 1.0 blow per inch for the last 2 feet of driving.

If water jets are used in driving, bearing resistances should be determined by either of the following methods: 1) calculating it with the driving data and the formula in Equation 5-1 after the jets have been withdrawn and the pile has been driven at least 2 feet; or 2) applying a test load.

The ultimate resistance computed by Equation 5-1 should be factored according to the monitoring program used during construction. If a wave equation analysis is conducted and hammer performance is confirmed, the resistance factor, φ_{dyn}, should be 0.50. Alternately, if pile blow counts are recorded and evaluated per Equation 5-1 to assess capacity, φ_{dyn} of 0.55 should be used (end-of-drive conditions only). Higher resistance factors could be justified with a more rigorous pile capacity testing program.

5.1.4 Dynamic Capacity Testing

Pile capacity testing can be performed using dynamic testing methods. Specialty contractors can instrument the pile during installation and provide a more accurate assessment of pile capacity using a pile driving analyzer system. The advantage of dynamic capacity testing is that more favorable resistance factors can be used. For example, if dynamic testing is used on 100% of production piles, a resistance factor (φ_{dyn}) of 0.75 can be used. If dynamic testing is conducted on a minimum of 2% (or 2, whichever is higher) production piles, a resistance factor (φ_{dyn}) of 0.65 can be used.

5.1.5 Recommended Additional Services During Construction

Before construction begins, we recommend that Anchor QEA undertake the following tasks:

- Review assumed pile capacities once pile sizes and embedment depths have been established.
- Perform a wave equation analysis to evaluate pile drivability, driving stresses, and hammer performance during construction.
- Evaluate the results of any dynamic testing during pile installation, if used.
- Review the final design plans to confirm that these geotechnical engineering recommendations have been properly interpreted and implemented in the design.

During the construction phase of the Project, we recommend that Anchor QEA be retained to review pile installation records and address other geotechnical considerations that may arise during construction.

The purpose of these observations is to review compliance with the design concepts, specifications, or recommendations and to allow design changes or evaluation of appropriate construction measures if subsurface conditions differ from those anticipated prior to the start of construction.

6 Limitations

Anchor QEA completed this work for the exclusive use of the design team (Anchor QEA, KPFF Consulting Engineers) for specific application to the Sequalitchew Creek Watershed Ecosystem Restoration Project. This work has been performed in accordance with generally accepted geotechnical engineering practices in the same or similar localities, at the time the work was performed. The recommendations discussed in this report were prepared based on observations from the exploration locations shown; subsurface conditions may vary at other locations at the Project area due to inherent subsurface variability. No warranty is made, expressed, or implied.

This report is intended only as a geotechnical engineering design study. Therefore, it does not include environmental site characterization or other associated environmental studies, which are outside the scope of this report.

Anchor QEA's recommendations were developed with the assumption that a proper level of field observation and construction review will be provided during the construction of the proposed improvements.

Please do not hesitate to contact Anchor QEA should there be any questions or comments, or if any clarification of the information provided is required. Anchor QEA appreciates the opportunity to continue to support South Puget Sound Salmon Enhancement Group on this Project.

7 References

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Figures

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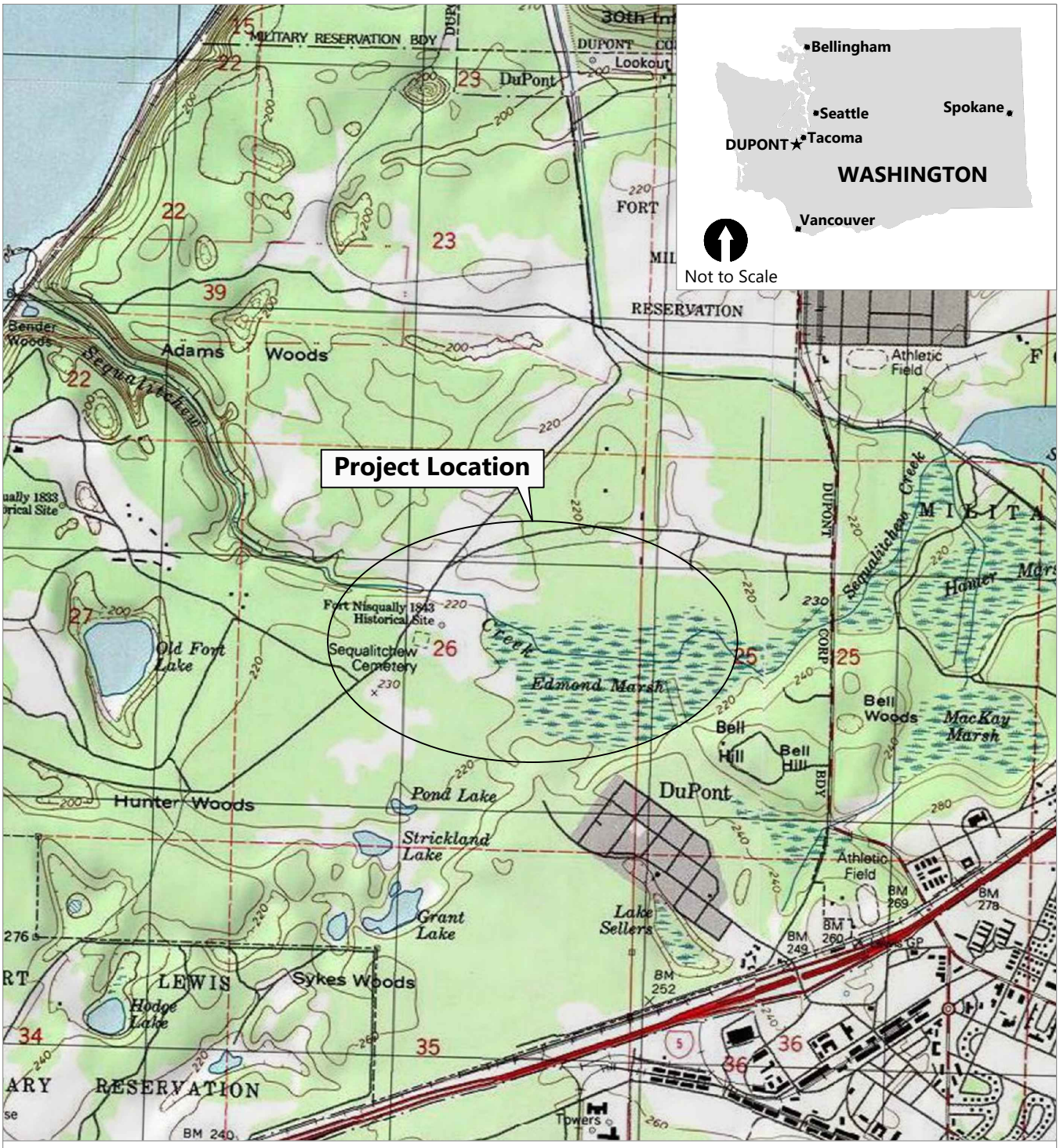

SOURCE: USA_Topo_Maps - Copyright:© 2013 National Geographic Society, i-cubed.
HORIZONTAL DATUM: Washington State Plane South Zone, NAD83, U.S. Survey Feet

Publish Date: 2022/11/07 3:11 PM | User: jfoster
Filepath: K:\Projects\0331-So. Puget Sound Salmon Enhancement Group\Sequalitchew Watershed Restoration Plan\0331-RP-005 (Vicinity-Geotech).dwg Figure 1

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Figure 1
Vicinity Map

Geotechnical Engineering Design Report
Sequaltichew Creek Watershed Ecosystem Restoration Report

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SOURCE: Aerial ©2022 Microsoft Corporation ©2022 Maxar ©CNES (2022) Distribution Airbus DS
HORIZONTAL DATUM: Washington State Plane South Zone, NAD83, U.S. Survey Feet

LEGEND:

- Geotechnical Boring Location
- Cone Penetrometer Location

0 300
Feet

Publish Date: 2022/11/07 3:12 PM | User: jfoster
Filepath: K:\Projects\0331-So. Puget Sound Salmon Enhancement Group\Sequalitchew Watershed Restoration Plan\0331-RP-006 (Sampling Plan-Geotech).dwg Figure 2

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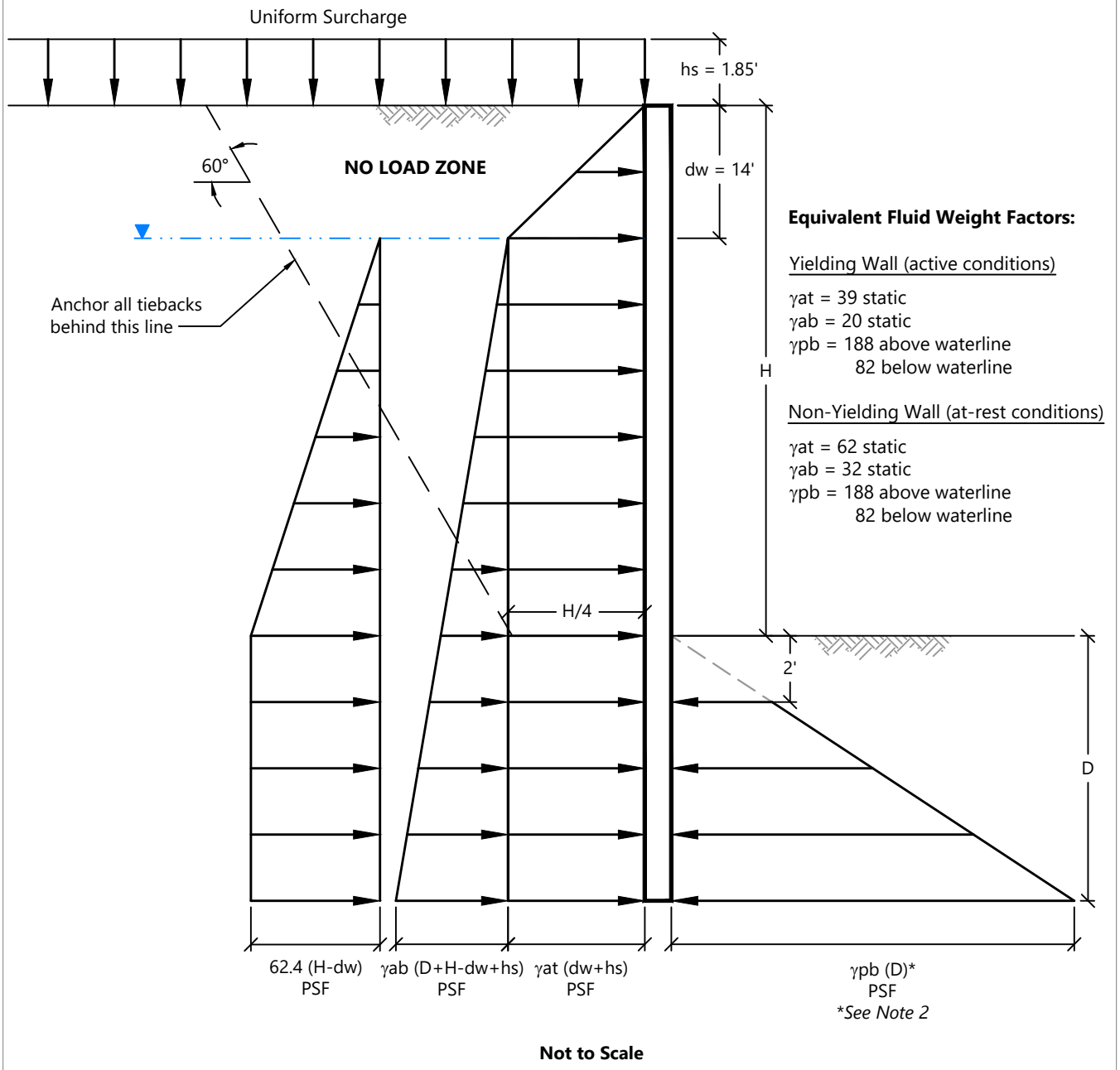
Figure 2
Geotechnical Boring Location Map

Geotechnical Engineering Design Report
Sequaltichew Creek Watershed Ecosystem Restoration Project



Not to Scale

NOTES:

1. Yielding walls are those walls that will deform at least 0.001 times the height of the wall.
2. Passive pressures are ultimate values and do not include a factor of safety. We recommend applying a factor of safety of at least 1.5 when computing static passive pressures.
3. Ignore the contribution of the upper 2 feet of soil at the base of the wall when computing passive pressures.
4. Active and at-rest earth pressures are for cantilever walls or walls supported by a single row of tiebacks.

Passive Earth Pressure Reduction Factors			
Offset Distance	Reduction Factor		
	2H:1V	1.5H:1V	1H:1V
0	0.75	0.56	0.38
2	0.85	0.66	0.48
4	0.95	0.76	0.58

Publish Date: 2022/11/07 4:24 PM | User: jfoster
Filepath: K:\Projects\0331-So. Puget Sound Salmon Enhancement Group\Sequalitchew Watershed Restoration Plan\0331-RP-001 Lateral Earth Pressures.dwg Figure 3

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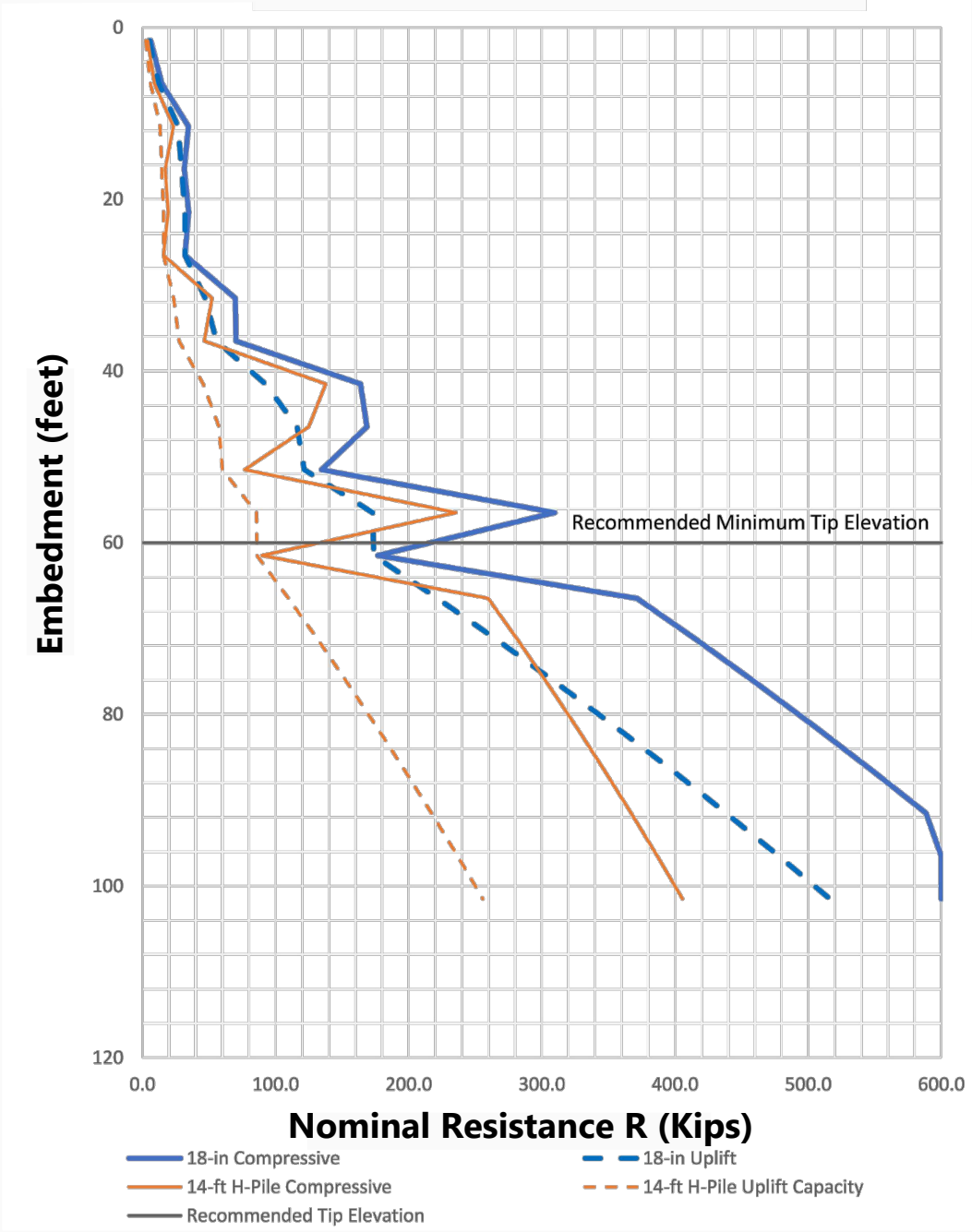
Figure 3
Lateral Earth Pressures

Geotechnical Engineering Design Report
Sequaltichew Creek Watershed Ecosystem
Restoration Report



Publish Date: 2022/11/07 4:26 PM | User: jfoster
Filepath: K:\Projects\0331-So. Puget Sound Salmon Enhancement Group\Sequalitchew Watershed Restoration Plan\0331-RP-001 Nominal Pile Vertical Capacity Chart.dwg Figure X

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Figure 4
Nominal Pile Vertical Capacity Chart

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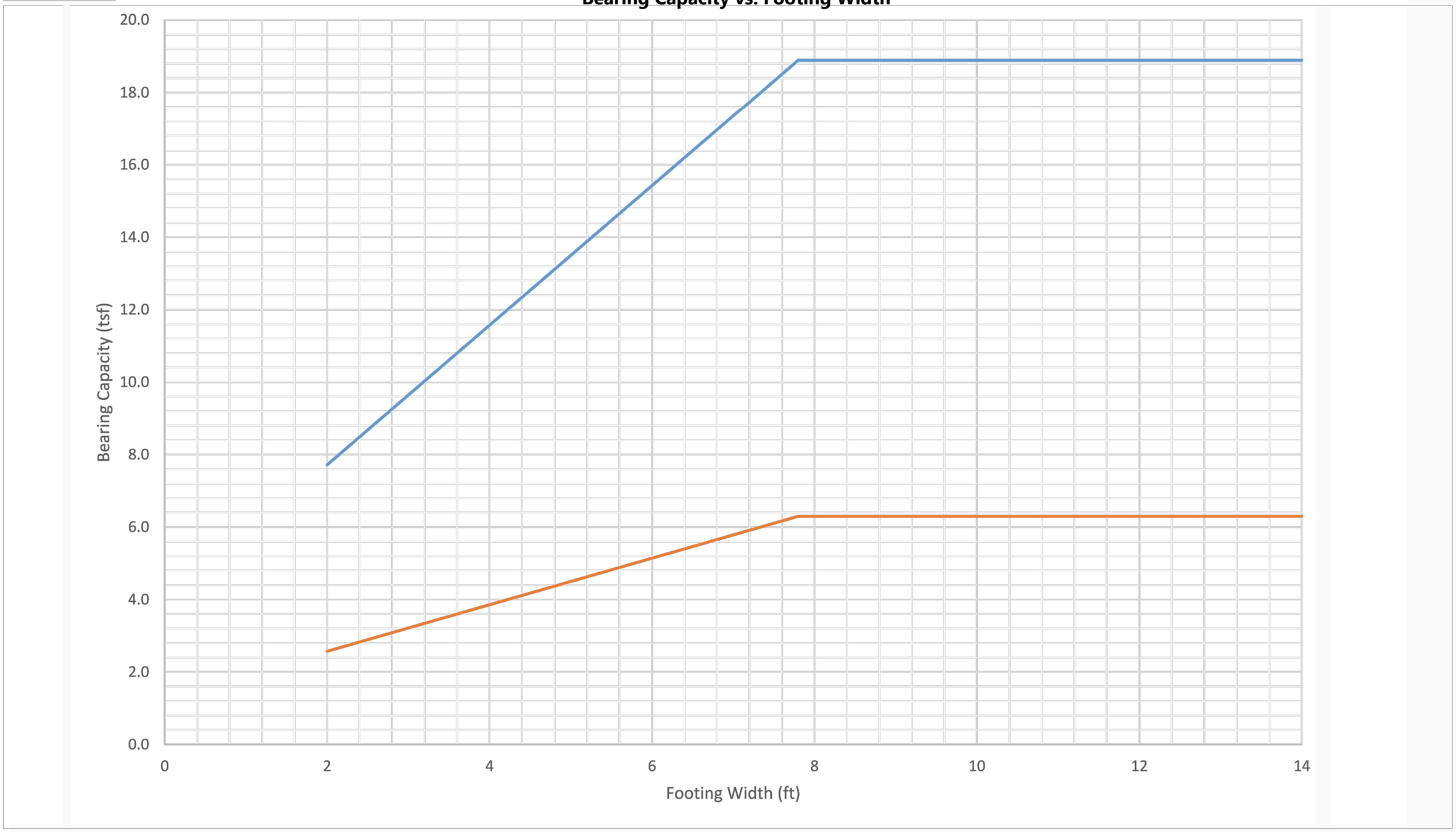

Publish Date: 2022/11/07 4:27 PM | User: jfoster
Filepath: K:\Projects\0331-So. Puget Sound Salmon Enhancement Group\Sequalitchew Watershed Restoration Plan\0331-RP-006 Bearing Capacity.dwg Figure 5

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Figure 5
Bearing Capacity Versus Footing Width Chart

Geotechnical Engineering Design Report
Sequaltichew Creek Watershed Ecosystem
Restoration Project

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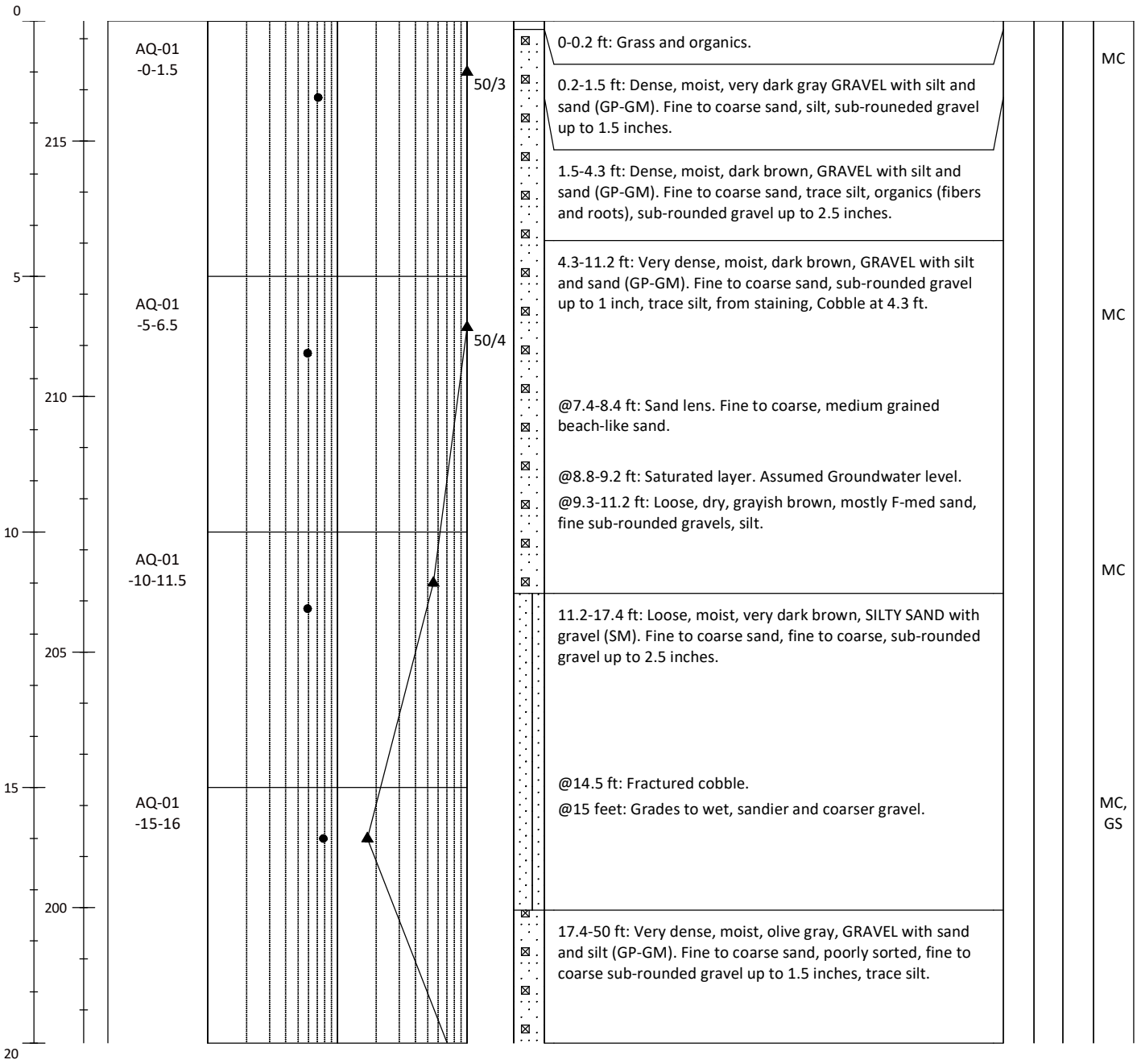
Appendix A
Boring Logs

[DRAFT] Soil Boring Log

AQ-BH-01

Project #: **Sequalitchew Creek**	Project: **Sequalitchew Creek Watershed Restoration**	Method: **Sonic**
Location: **DuPont, Washington**	Northing/Latitude: **47.1070266666667**	Total Depth (ft): **51.8**
Client: **SPSSEG**	Easting/Longitude: **-122.64674**	Observed Groundwater (ft bgs): **17.4**
Collection Date: **5/25/22**	Horiz. Datum: **X**	Ground Surface Elevation (ft): **217.35**
Contractor: **Holt Services Inc.**	Vert. Datum: **North American Vertical Datum of 1988**	Hammer: **140-lb Auto Hammer**
Logged By: **S. Strehl**	Sampler(s): **Split Spoon Sampler**	Hammer Efficiency (%): **NA**



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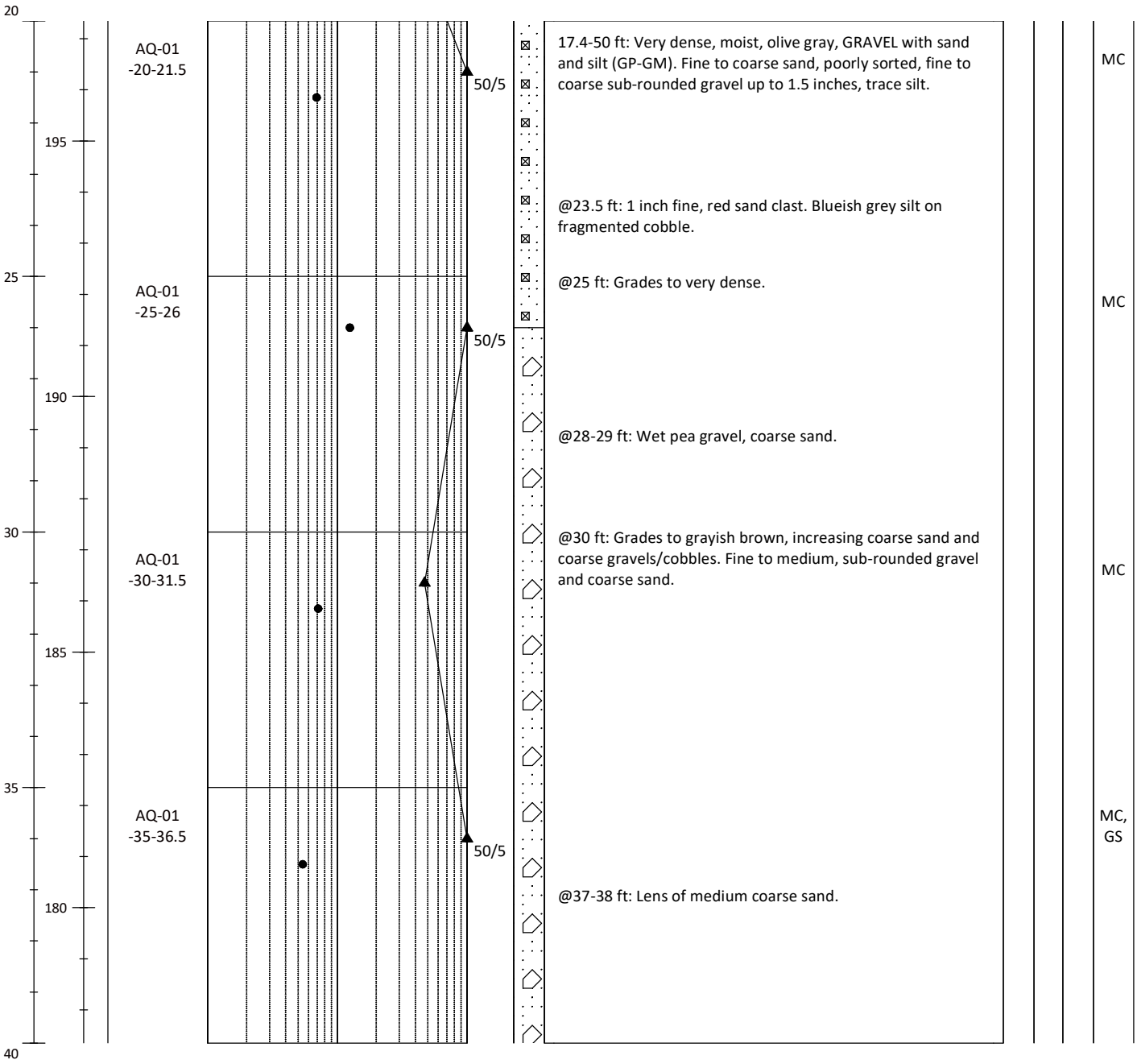
- SPT N-Value
- Moisture Content (%)
- Groundwater Level

Notes: 1) MC: Moisture Content, GS: Grain Size, SG: Specific Gravity

[DRAFT] Soil Boring Log

AQ-BH-01

Project #: **Sequalitchew Creek**	Project: **Sequalitchew Creek Watershed Restoration**	Method: **Sonic**
Location: **DuPont, Washington**	Northing/Latitude: **47.1070266666667**	Total Depth (ft): **51.8**
Client: **SPSSEG**	Easting/Longitude: **-122.64674**	Observed Groundwater (ft bgs): **17.4**
Collection Date: **5/25/22**	Horiz. Datum: **X**	Ground Surface Elevation (ft): **217.35**
Contractor: **Holt Services Inc.**	Vert. Datum: **North American Vertical Datum of 1988**	Hammer: **140-lb Auto Hammer**
Logged By: **S. Strehl**	Sampler(s): **Split Spoon Sampler**	Hammer Efficiency (%): **NA**



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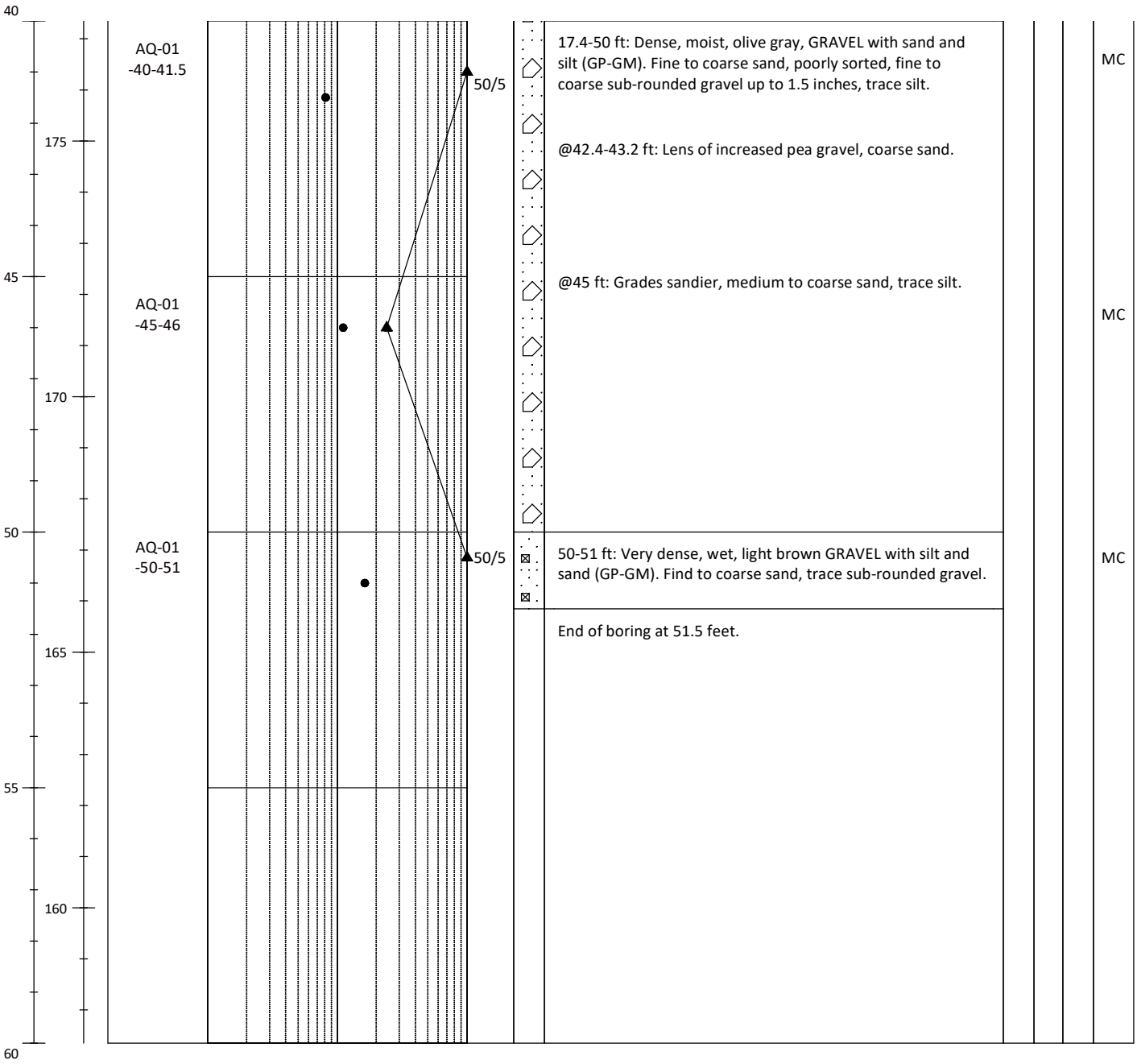
▲ SPT N-Value
● Moisture Content (%)
○ Groundwater Level

Notes: 1) MC: Moisture Content, GS: Grain Size, SG: Specific Gravity

[DRAFT] Soil Boring Log

AQ-BH-01

Project #: **Sequalitchew Creek**	Project: **Sequalitchew Creek Watershed Restoration**	Method: **Sonic**
Location: **DuPont, Washington**	Northing/Latitude: **47.1070266666667**	Total Depth (ft): **51.8**
Client: **SPSSEG**	Easting/Longitude: **-122.64674**	Observed Groundwater (ft bgs): **17.4**
Collection Date: **5/25/22**	Horiz. Datum: **X**	Ground Surface Elevation (ft): **217.35**
Contractor: **Holt Services Inc.**	Vert. Datum: **North American Vertical Datum of 1988**	Hammer: **140-lb Auto Hammer**
Logged By: **S. Strehl**	Sampler(s): **Split Spoon Sampler**	Hammer Efficiency (%): **NA**



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▲ SPT N-Value
● Moisture Content (%)
○ Groundwater Level

Notes: 1) MC: Moisture Content, GS: Grain Size, SG: Specific Gravity

[DRAFT] Soil Boring Log

AQ-BH-02

Project #: **Sequalitchew Creek**	Project: **Sequalitchew Creek Watershed Restoration**	Method: **Sonic**
Location: **DuPont, Washington**	Northing/Latitude: **47.1067366666667**	Total Depth (ft): **20**
Client: **SPSSEG**	Easting/Longitude: **-122.644816666667**	Observed Groundwater (ft bgs): **5**
Collection Date: **5/25/22**	Horiz. Datum: **X**	Ground Surface Elevation (ft): **209.86**
Contractor: **Holt Services Inc.**	Vert. Datum: **North American Vertical Datum of 1988**	Hammer: **140-lb Auto Hammer**
Logged By: **S. Strehl**	Sampler(s): **Split Spoon Sampler**	Hammer Efficiency (%): **NA**

Depth (ft)	Elevation (ft)	Samples ID's	Uncorrected Standard Penetration Resistance (blows per foot) and Moisture Content (%) (1 2 5 10 20 50 100)	Blows >100	Lithology	Soil Description (Samples and descriptions are in recovered depths. Classification scheme: USCS)	Gravel %	Sand %	Fines %	Lab Test
0						0-1 ft: Loose, moist, dark brown, GRAVEL with sand (GW). Fine to coarse sand, fine to coarse, sub-rounded gravel, organic material (grass and roots).				
						@2 ft: Gray, loose, angular gravel (pulverized cobble and dust).				
		AQ-02 -4-5				2-5 ft: Medium dense, moist, dark yellowish brown GRAVEL with silt and sand (GW-GM). Fine to coarse sand, fine to coarse gravel up to 1 inch, trace silt.				MC, GS
5	205					@5 ft: One foot of slough from top.				
						5-7 ft: Loose, wet, light brown, GRAVEL with silt and sand (GW-GM).				
						@7 ft: Grades to wet.				
10	200	AQ-02 -11-12				10.8-20 ft: Sand (SP) 5/90/5, Moist, medium dense, very dark brownish gray SAND (SP). Fine to coarse sand, trace fine sub-rounded gravels, trace silt.				MC
						@12.2-13.2 ft: Gravelly sand lens, sub-rounded up to 2 inches.				
15	195					@15-20 ft: Top one foot (15-16 ft) is slough.				
						@16-17 ft: Lens of clean sand, potential slough.				
						@19ft: Grades coarse, 15% gravel/coarse sand.				
20	190					End of boring at 20 feet.				

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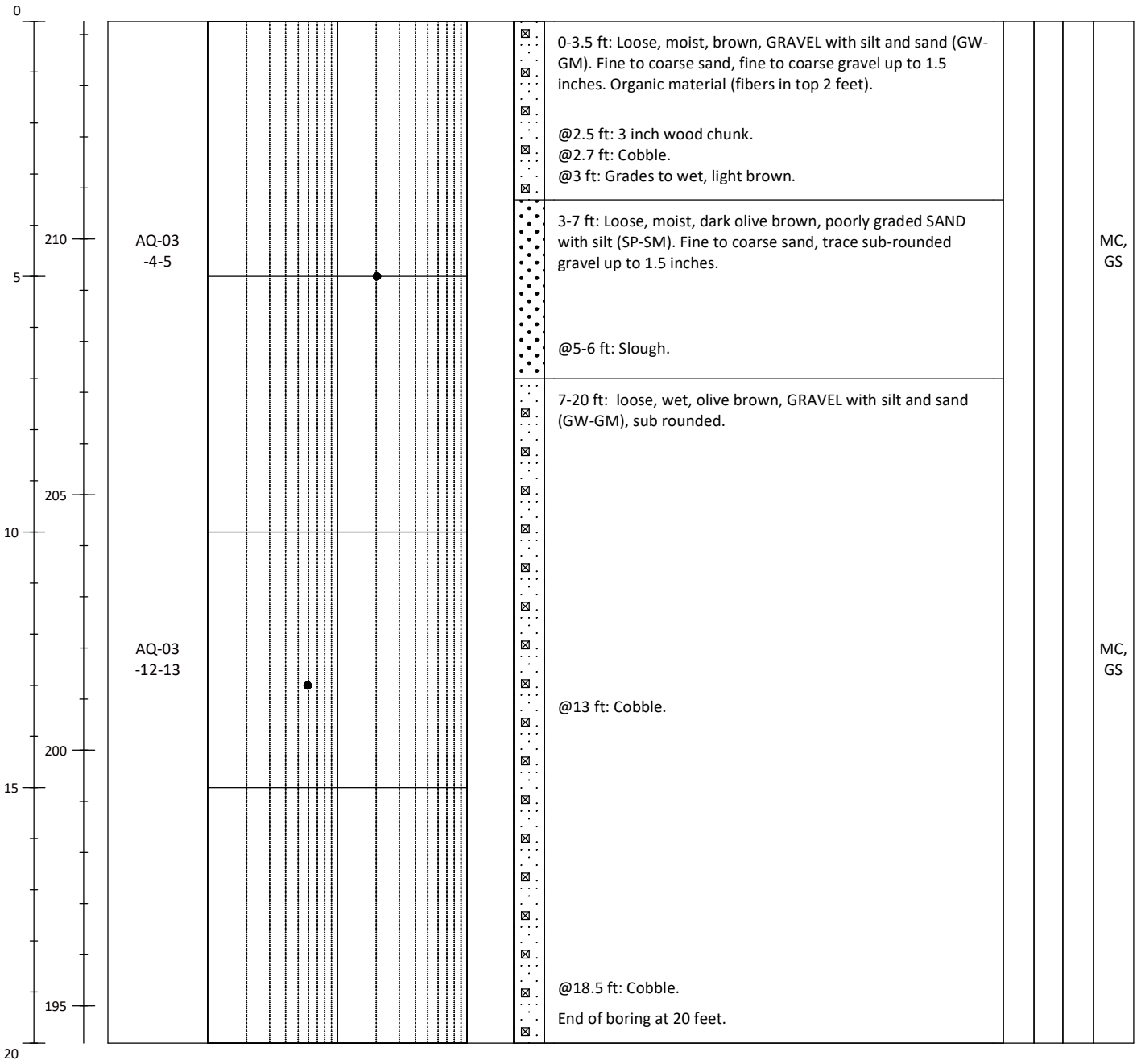
▲ SPT N-Value
● Moisture Content (%)
○ Groundwater Level

Notes: 1) MC: Moisture Content, GS: Grain Size, SG: Specific Gravity

[DRAFT] Soil Boring Log

AQ-BH-03

Project #: **Sequalitchew Creek**	Project: **Sequalitchew Creek Watershed Restoration**	Method: **Sonic**
Location: **DuPont, Washington**	Northing/Latitude: **47.1066516666667**	Total Depth (ft): **20**
Client: **SPSSEG**	Easting/Longitude: **-122.641423333333**	Observed Groundwater (ft bgs): **3**
Collection Date: **5/27/22**	Horiz. Datum: **X**	Ground Surface Elevation (ft): **214.27**
Contractor: **Holt Services Inc.**	Vert. Datum: **North American Vertical Datum of 1988**	Hammer: **140-lb Auto Hammer**
Logged By: **S. Strehl**	Sampler(s): **Split Spoon Sampler**	Hammer Efficiency (%): **NA**



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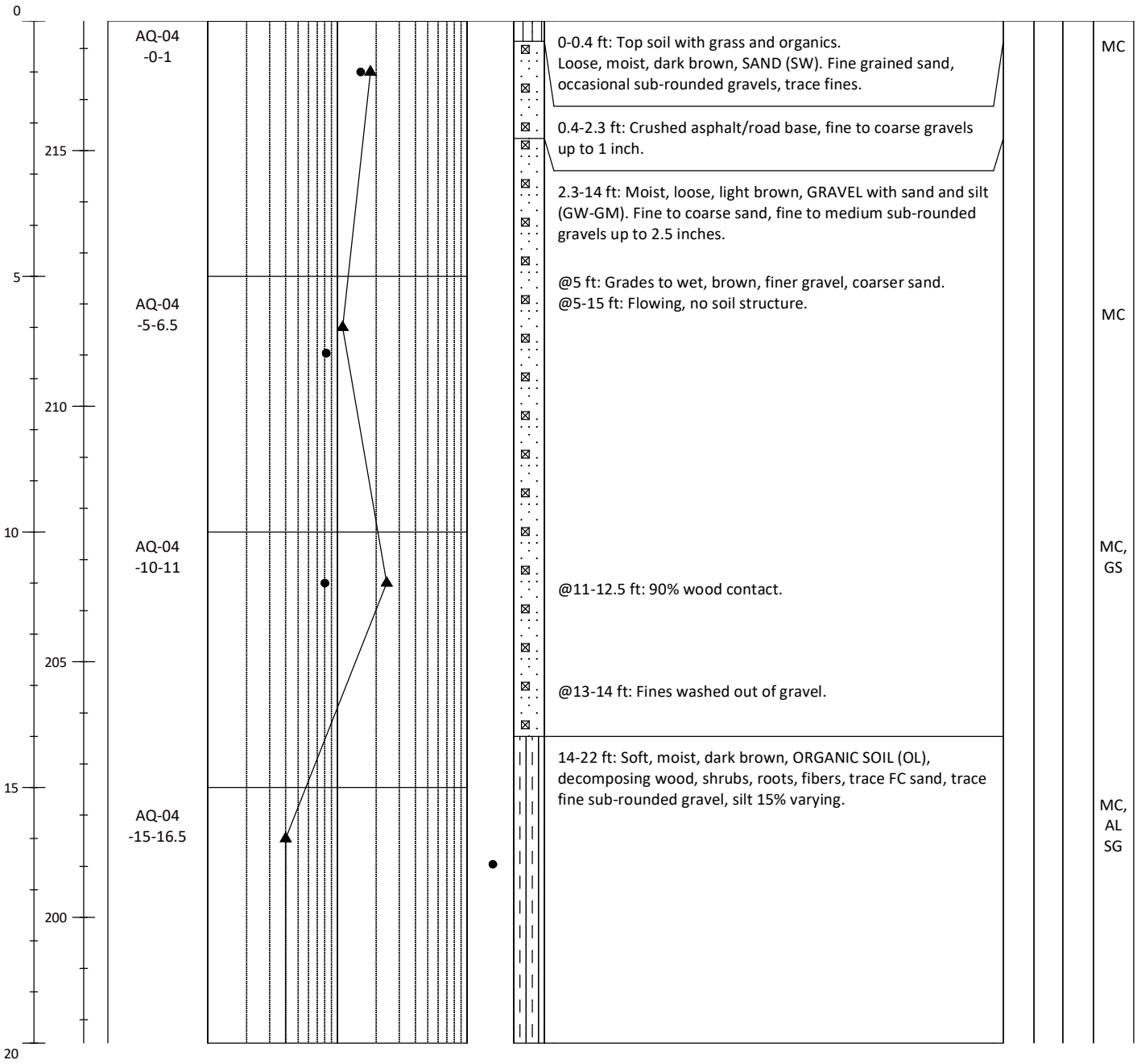
- SPT N-Value
- Moisture Content (%)
- Groundwater Level

Notes: 1) MC: Moisture Content, GS: Grain Size, SG: Specific Gravity

[DRAFT] Soil Boring Log

AQ-BH-04

Project #: **Sequalitchew Creek**	Project: **Sequalitchew Creek Watershed Restoration**	Method: **Sonic**
Location: **DuPont, Washington**	Northing/Latitude: **47.1028383333333**	Total Depth (ft): **71.5**
Client: **SPSSEG**	Easting/Longitude: **-122.631073333333**	Observed Groundwater (ft bgs): **5**
Collection Date: **5/26/22**	Horiz. Datum: **X**	Ground Surface Elevation (ft): **217.54**
Contractor: **Holt Services Inc.**	Vert. Datum: **North American Vertical Datum of 1988**	Hammer: **140-lb Auto Hammer**
Logged By: **S. Strehl**	Sampler(s): **Split Spoon Sampler**	Hammer Efficiency (%): **NA**



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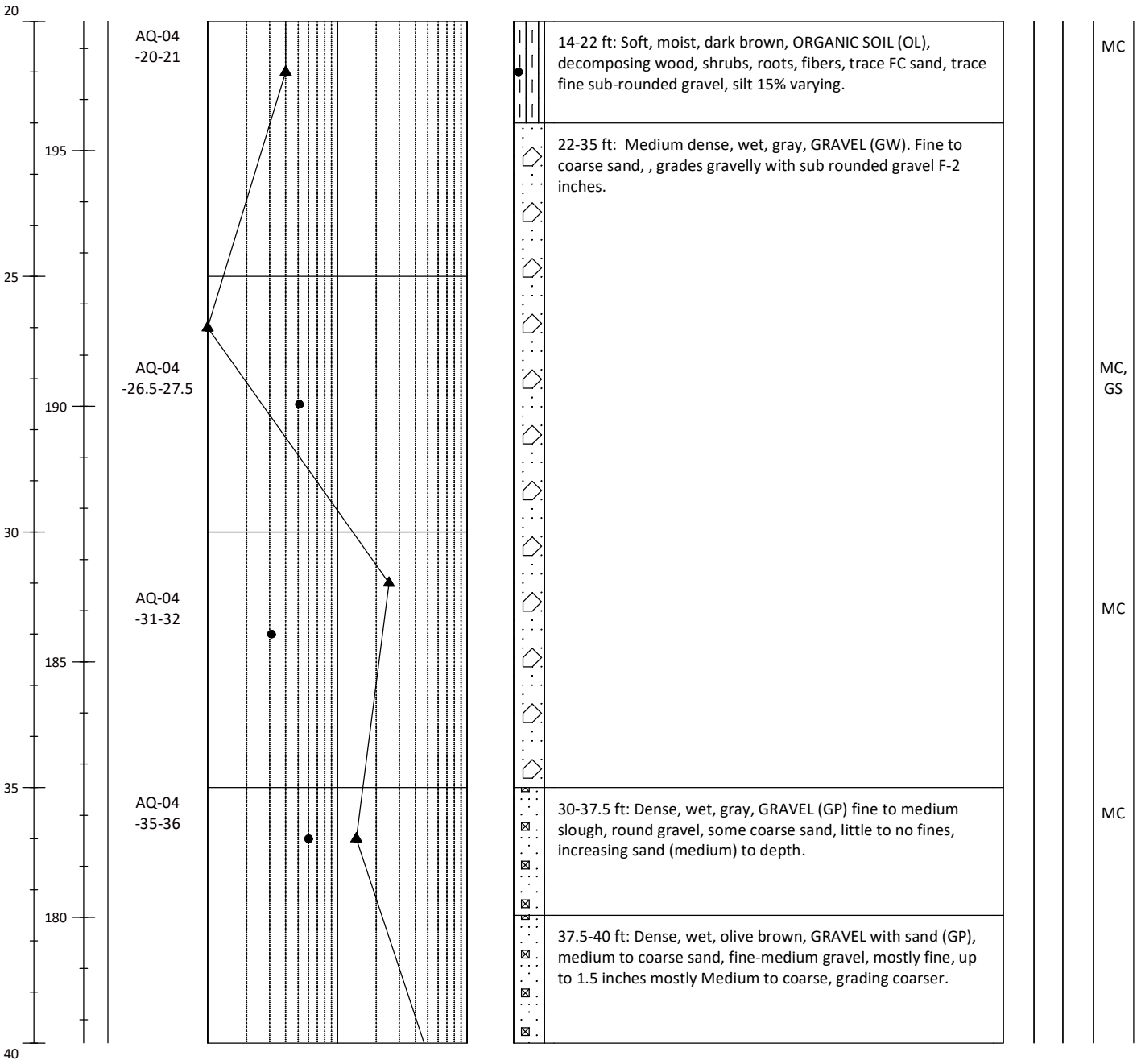
▲ SPT N-Value
● Moisture Content (%)
○ Groundwater Level

Notes: 1) MC: Moisture Content, GS: Grain Size, SG: Specific Gravity

[DRAFT] Soil Boring Log

AQ-BH-04

Project #: **Sequalitchew Creek**	Project: **Sequalitchew Creek Watershed Restoration**	Method: **Sonic**
Location: **DuPont, Washington**	Northing/Latitude: **47.1028383333333**	Total Depth (ft): **71.5**
Client: **SPSSEG**	Easting/Longitude: **-122.631073333333**	Observed Groundwater (ft bgs): **5**
Collection Date: **5/26/22**	Horiz. Datum: **X**	Ground Surface Elevation (ft): **217.54**
Contractor: **Holt Services Inc.**	Vert. Datum: **North American Vertical Datum of 1988**	Hammer: **140-lb Auto Hammer**
Logged By: **S. Strehl**	Sampler(s): **Split Spoon Sampler**	Hammer Efficiency (%): **NA**



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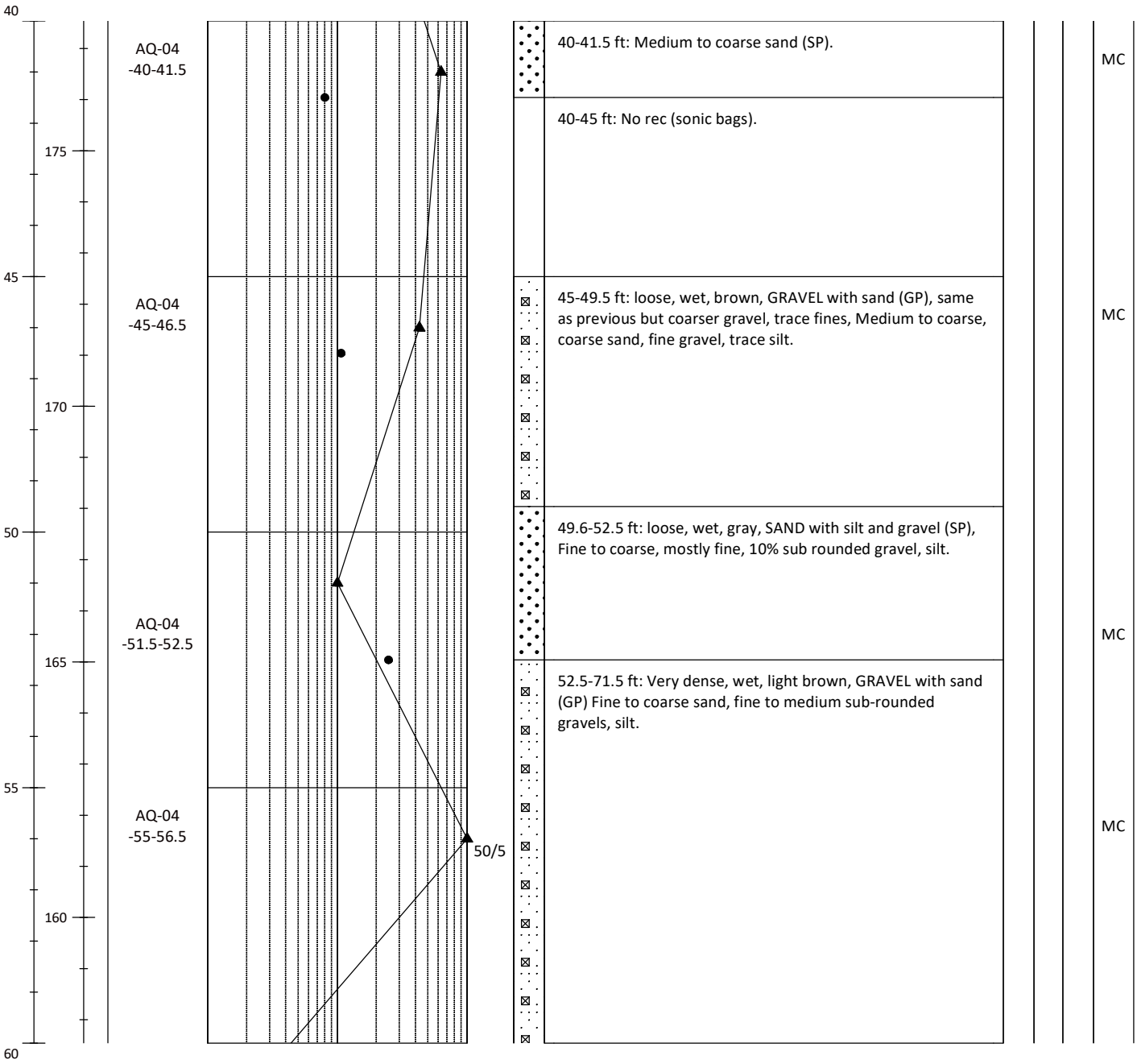
▲ SPT N-Value
● Moisture Content (%)
○ Groundwater Level

Notes: 1) MC: Moisture Content, GS: Grain Size, SG: Specific Gravity

[DRAFT] Soil Boring Log

AQ-BH-04

Project #: **Sequalitchew Creek**	Project: **Sequalitchew Creek Watershed Restoration**	Method: **Sonic**
Location: **DuPont, Washington**	Northing/Latitude: **47.1028383333333**	Total Depth (ft): **71.5**
Client: **SPSSEG**	Easting/Longitude: **-122.631073333333**	Observed Groundwater (ft bgs): **5**
Collection Date: **5/26/22**	Horiz. Datum: **X**	Ground Surface Elevation (ft): **217.54**
Contractor: **Holt Services Inc.**	Vert. Datum: **North American Vertical Datum of 1988**	Hammer: **140-lb Auto Hammer**
Logged By: **S. Strehl**	Sampler(s): **Split Spoon Sampler**	Hammer Efficiency (%): **NA**



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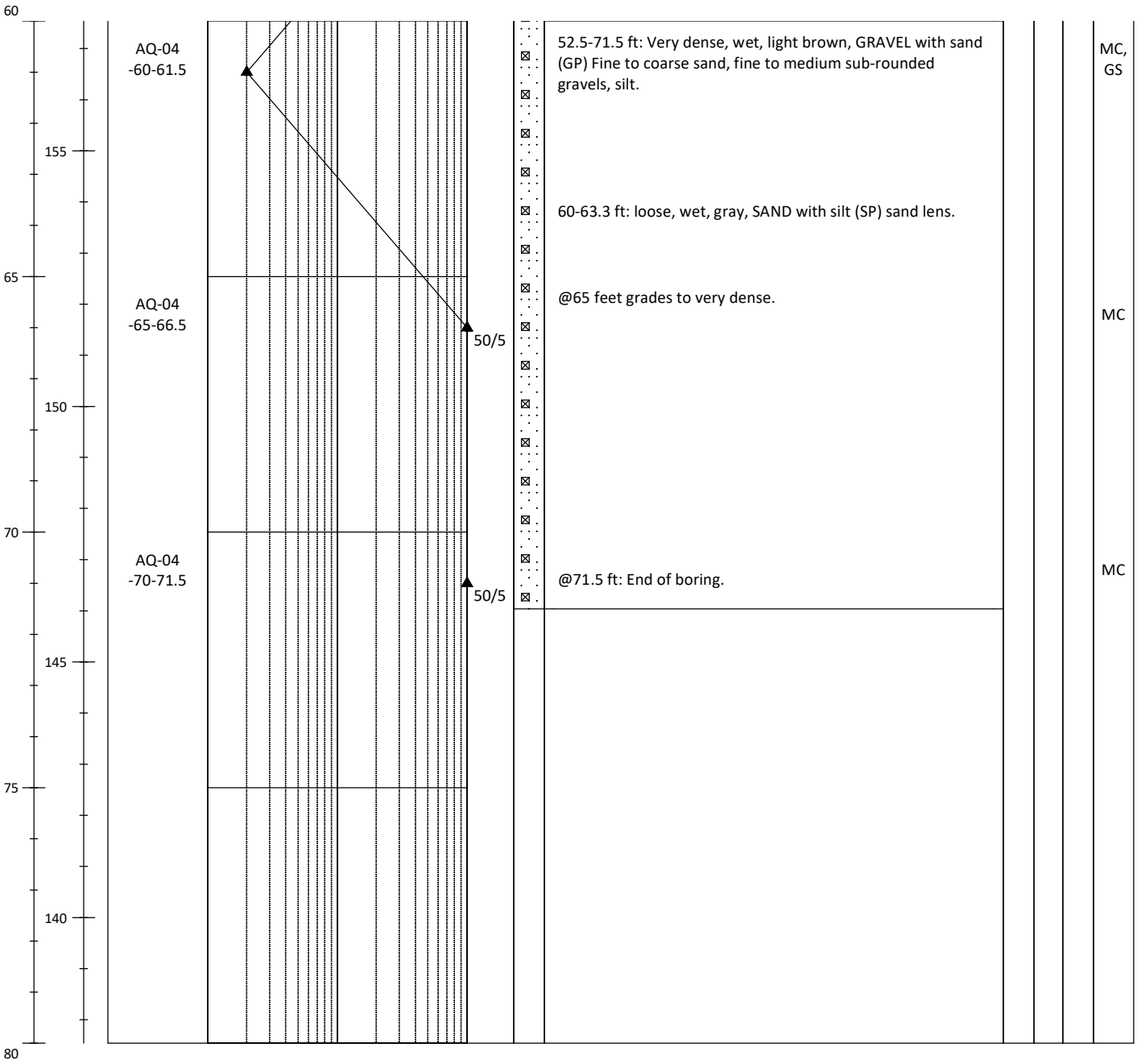
▲ SPT N-Value
● Moisture Content (%)
○ Groundwater Level

Notes: 1) MC: Moisture Content, GS: Grain Size, SG: Specific Gravity

[DRAFT] Soil Boring Log

AQ-BH-04

Project #: **Sequalitchew Creek**	Project: **Sequalitchew Creek Watershed Restoration**	Method: **Sonic**
Location: **DuPont, Washington**	Northing/Latitude: **47.1028383333333**	Total Depth (ft): **71.5**
Client: **SPSSEG**	Easting/Longitude: **-122.631073333333**	Observed Groundwater (ft bgs): **5**
Collection Date: **5/26/22**	Horiz. Datum: **X**	Ground Surface Elevation (ft): **217.54**
Contractor: **Holt Services Inc.**	Vert. Datum: **North American Vertical Datum of 1988**	Hammer: **140-lb Auto Hammer**
Logged By: **S. Strehl**	Sampler(s): **Split Spoon Sampler**	Hammer Efficiency (%): **NA**



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▲ SPT N-Value
● Moisture Content (%)
○ Groundwater Level

Notes: 1) MC: Moisture Content, GS: Grain Size, SG: Specific Gravity

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Appendix B
Laboratory Results

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	---	Tested By:	ckg
Sample ID:	---	Test Date:	06/24/22	Checked By:	bfs
Depth :	---	Test Id:	673615		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
---	AQ- 01-0-1.5	---	Moist, very dark gray silty sand with gravel	7.1
---	AQ- 01-5-6.5	---	Moist, dark brown sand	5.9
---	AQ- 01-10-11.5	---	Moist, very dark brown silty sand with gravel	5.9
---	AQ- 01-15-16	---	Moist, very dark brown silty sand with gravel	7.8
---	AQ- 01-20-21.5	---	Moist, dark gray silty sand with gravel	6.9
---	AQ- 01-25-26	---	Moist, dark gray silty sand with gravel	12.5
---	AQ- 01-30-31.5	---	Moist, olive gray gravel with silt and sand	7.1
---	AQ- 01-35-36.5	---	Moist, very dark grayish brown gravel with sand	5.4
---	AQ- 01-40-41.5	---	Moist, grayish brown silty sand with gravel	8.1

Notes: Temperature of Drying : 110º Celsius

GeoTesting EXPRESS

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	---	Tested By:	ckg
Sample ID:	---	Test Date:	06/23/22	Checked By:	bfs
Depth :	---	Test Id:	673624		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
---	AQ- 01-45-46	---	Moist, dark gray silty sand with gravel	11.1
---	AQ- 01-50-51	---	Moist, brownish gray silty sand with gravel	16.3
---	AQ- 02-4-5	---	Moist, dark yellowish brown gravel with silt and sand	5.8
---	AQ- 02-11-12	---	Moist, very dark brownish gray silty sand	24.2
---	AQ- 03-4-5	---	Moist, dark olive brown silty sand	20.2
---	AQ- 03-12-13	---	Moist, light grayish olive gravel with silt and sand	5.9
---	AQ- 04-0-1	---	Moist, very dark brown sandy silt with gravel	15.2
---	AQ- 04-5-6.5	---	Moist, brown silty sand with gravel	8.2
---	AQ- 04-10-11	---	Moist, dark grayish brown gravel with silt and sand	8.0

Notes: Temperature of Drying : 110º Celsius

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	---	Tested By:	ckg
Sample ID:	---	Test Date:	06/21/22	Checked By:	bfs
Depth :	---	Test Id:	673632		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
---	AQ- 04-15-16.5	---	Moist, very dark brown silt with gravel	158.5
---	AQ- 04-20-21	---	Moist, very dark brown silt	249.6
---	AQ- 04-26.5-27.5	---	Moist, very dark gray gravel with sand	5.1
---	AQ- 04-31-32	---	Moist, dark gray gravel	3.1
---	AQ- 04-35-36	---	Moist, gray sandy gravel	6.0
---	AQ- 04-40-41.5	---	Moist, dark gry silty sand with gravel	8.0
---	AQ- 04-45-46.5	---	Moist, dark gray silty sand with gravel	10.7
---	AQ- 04-51.5-52.5	---	Moist, dark gray silty sand	24.9

Notes: Temperature of Drying : 110º Celsius

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	---	Tested By:	ckg
Sample ID:	---	Test Date:	06/22/22	Checked By:	bfs
Depth :	---	Test Id:	673636		

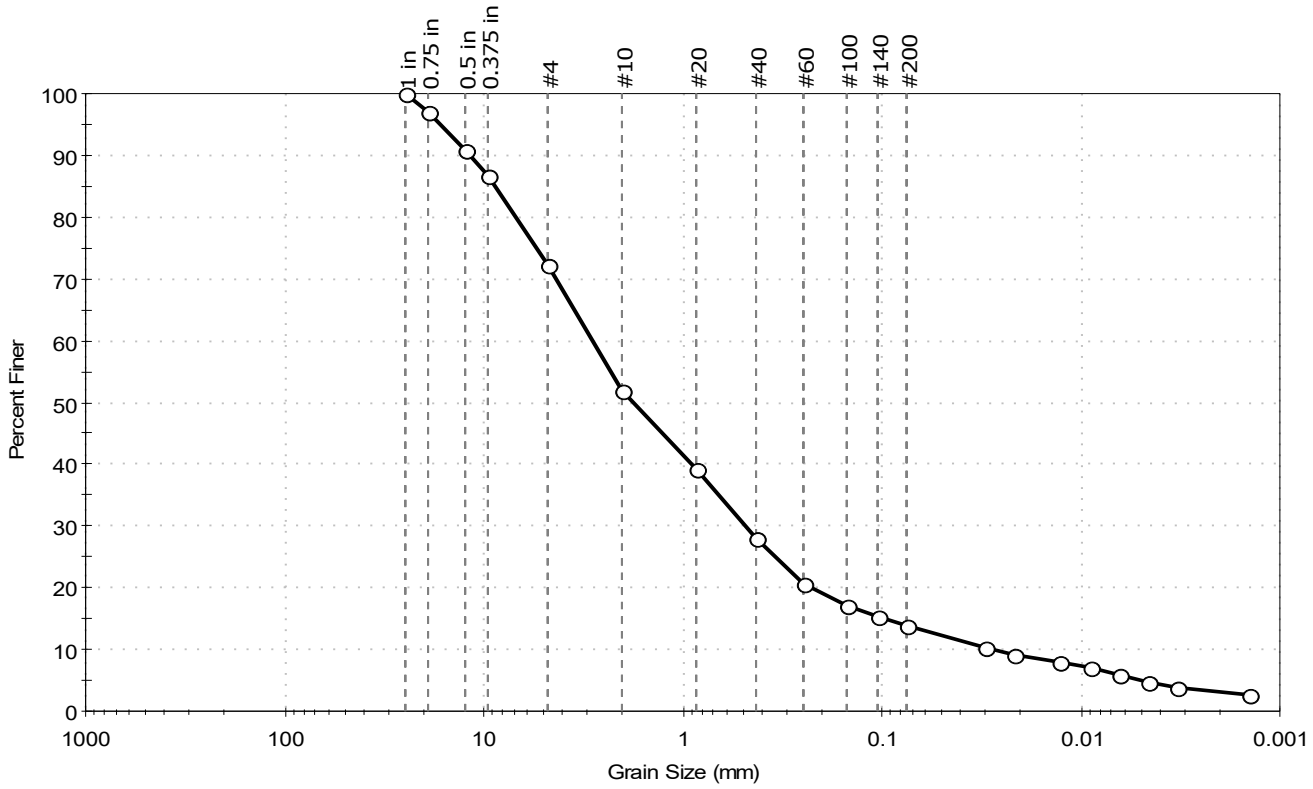
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
---	AQ- 04-55-56.5	---	Moist gray silty sand with gravel	5.6
---	AQ- 04-60-61.5	---	Moist, dark gray sand with silt	24.9
---	AQ- 04-65-66.5	---	Moist, yellowish brown silty sand with gravel	9.0
---	AQ- 04-70-71.5	---	Moist, yellowish brown silty sand with gravel	8.2

Notes: Temperature of Drying : 110º Celsius

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQ-01-15-16	Test Date:	06/24/22	Checked By:	bfs
Depth :	---	Test Id:	673639		
Test Comment:	---				
Visual Description:	Moist, very dark brown silty sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	27.7	58.6	13.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	97		
0.5 in	12.50	91		
0.375 in	9.50	87		
#4	4.75	72		
#10	2.00	52		
#20	0.85	39		
#40	0.42	28		
#60	0.25	21		
#100	0.15	17		
#140	0.11	15		
#200	0.075	14		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0301	10		
---	0.0215	9		
---	0.0129	8		
---	0.0091	7		
---	0.0065	6		
---	0.0046	5		
---	0.0033	4		
---	0.0014	3		

Coefficients

D_{85} = 8.7174 mm	D_{30} = 0.4793 mm
D_{60} = 2.8172 mm	D_{15} = 0.1006 mm
D_{50} = 1.7630 mm	D_{10} = 0.0280 mm
C_u = 100.614	C_c = 2.912

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

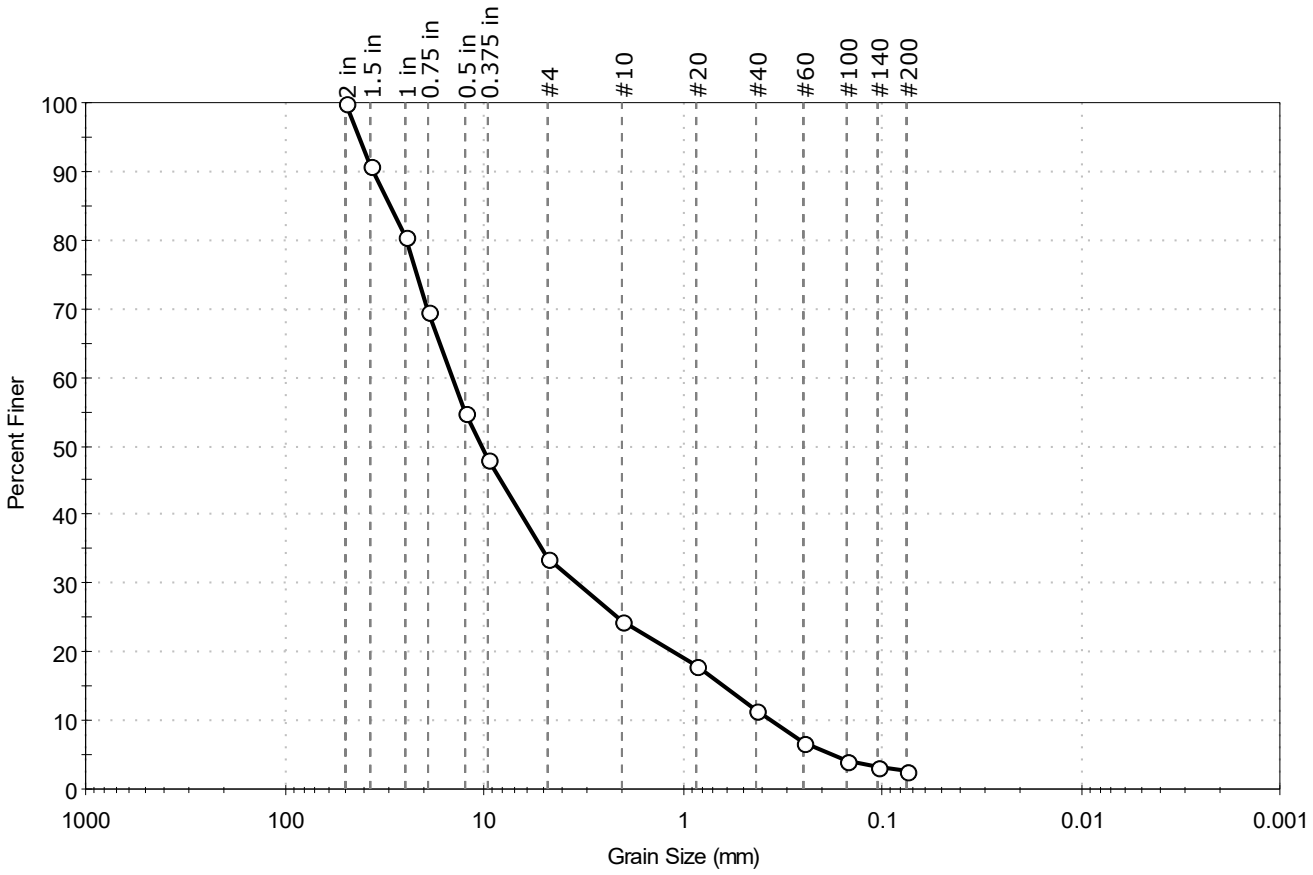
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQ-01-35-36.5	Test Date:	06/24/22	Checked By:	bfs
Depth :	---	Test Id:	673640		
Test Comment:	---				
Visual Description:	Moist, very dark grayish brown gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	66.4	30.9	2.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 in	50.00	100		
1.5 in	37.50	91		
1 in	25.00	81		
0.75 in	19.00	70		
0.5 in	12.50	55		
0.375 in	9.50	48		
#4	4.75	34		
#10	2.00	25		
#20	0.85	18		
#40	0.42	12		
#60	0.25	7		
#100	0.15	4		
#140	0.11	3		
#200	0.075	2.7		

Coefficients

D_{85} = 29.7725 mm	D_{30} = 3.3534 mm
D_{60} = 14.4536 mm	D_{15} = 0.6180 mm
D_{50} = 10.2170 mm	D_{10} = 0.3587 mm
C_u = 40.294	C_c = 2.169

Classification

ASTM — Well-graded GRAVEL with Sand (GW)

AASHTO — Stone Fragments, Gravel and Sand (A-1-a (1))

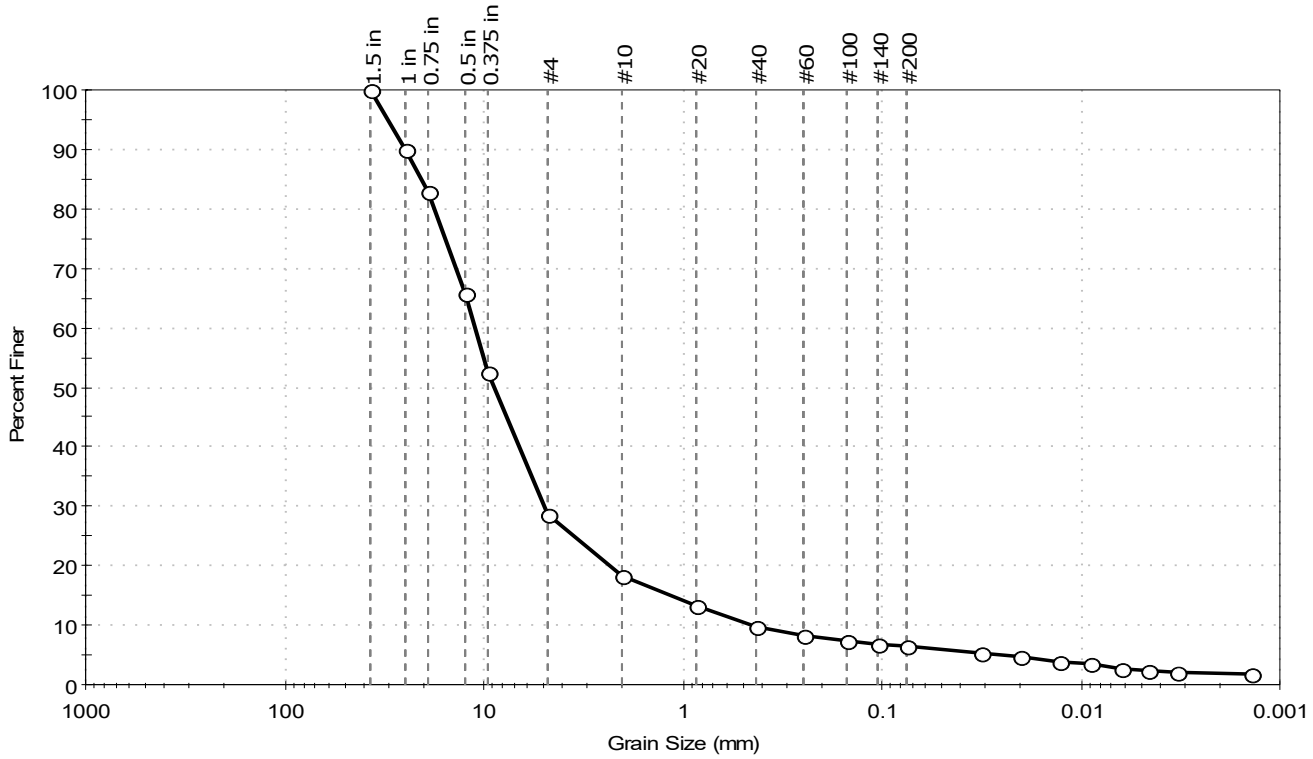
Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQ-02-4-5	Test Date:	06/24/22	Checked By:	bfs
Depth :	---	Test Id:	673641		
Test Comment:	---				
Visual Description:	Moist, dark yellowish brown gravel with silt and sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	71.4	22.1	6.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	90		
0.75 in	19.00	83		
0.5 in	12.50	66		
0.375 in	9.50	53		
#4	4.75	29		
#10	2.00	18		
#20	0.85	13		
#40	0.42	10		
#60	0.25	8		
#100	0.15	7		
#140	0.11	7		
#200	0.075	6.5		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0318	5		
---	0.0203	5		
---	0.0127	4		
---	0.0090	4		
---	0.0063	3		
---	0.0046	2		
---	0.0033	2		
---	0.0014	2		

Coefficients

D_{85} = 20.7215 mm	D_{30} = 4.9517 mm
D_{60} = 11.1081 mm	D_{15} = 1.1390 mm
D_{50} = 8.8335 mm	D_{10} = 0.4523 mm
C_u = 24.559	C_c = 4.880

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (1))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

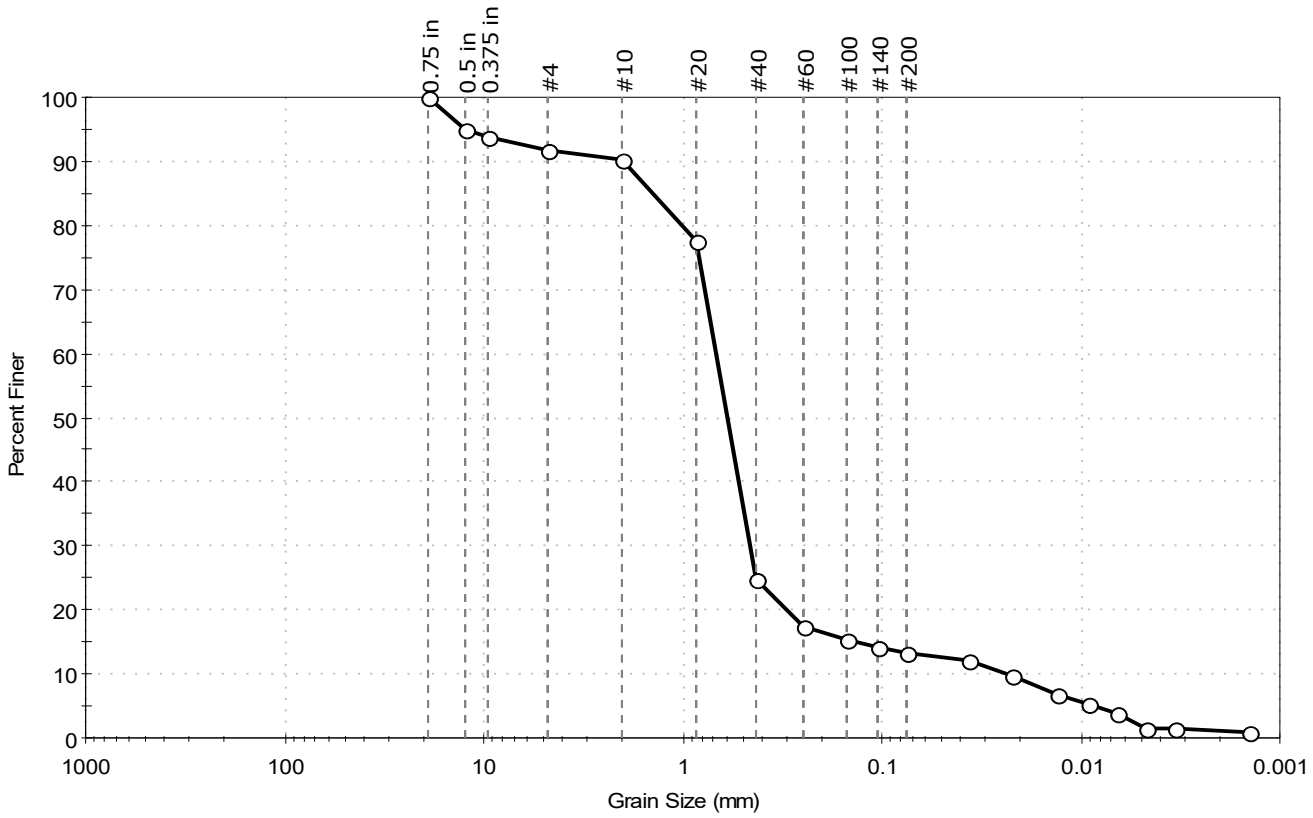
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQ-03-4-5	Test Date:	06/24/22	Checked By:	bfs
Depth :	---	Test Id:	673642		
Test Comment:	---				
Visual Description:	Moist, dark olive brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
–	8.3	78.4	13.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	95		
0.375 in	9.50	94		
#4	4.75	92		
#10	2.00	90		
#20	0.85	78		
#40	0.42	25		
#60	0.25	17		
#100	0.15	15		
#140	0.11	14		
#200	0.075	13		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0366	12		
---	0.0222	10		
---	0.0132	7		
---	0.0093	5		
---	0.0066	4		
---	0.0047	2		
---	0.0033	2		
---	0.0014	1		

Coefficients

D_{85} = 1.4119 mm	D_{30} = 0.4553 mm
D_{60} = 0.6752 mm	D_{15} = 0.1314 mm
D_{50} = 0.5921 mm	D_{10} = 0.0233 mm
C_u = 28.979	C_c = 13.177

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

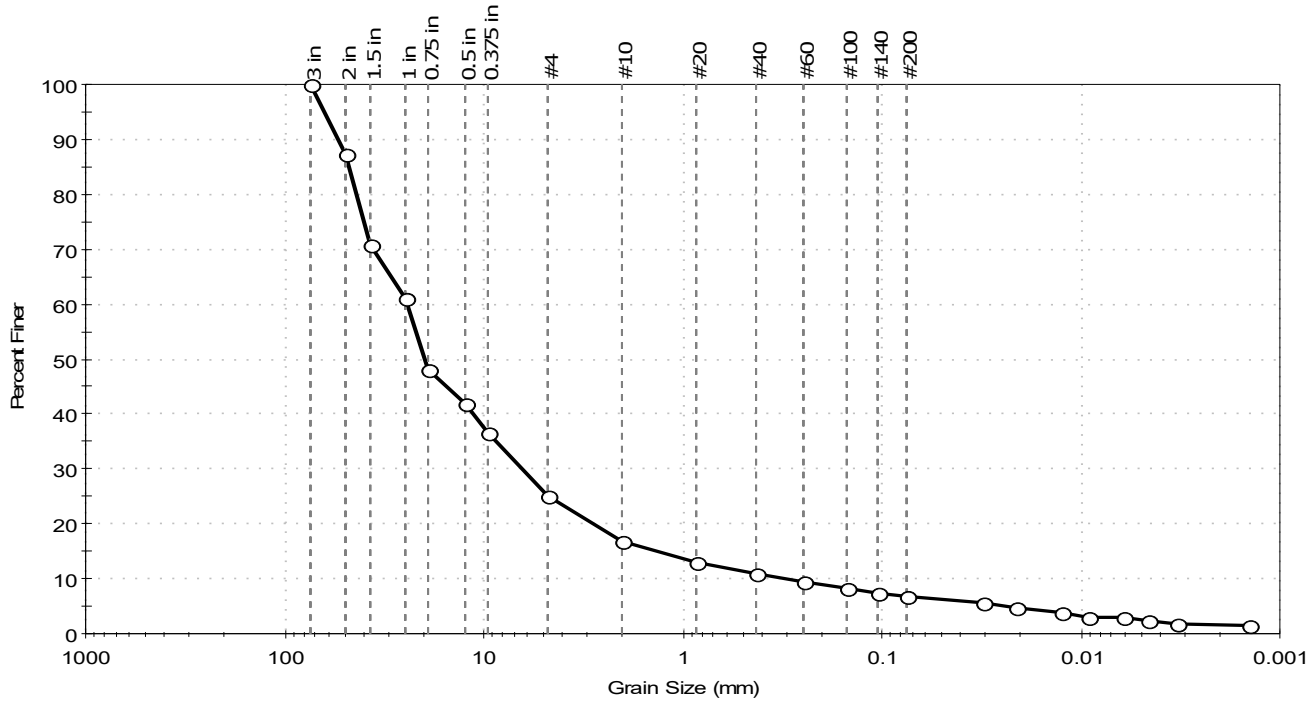
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQ-03-12-13	Test Date:	06/24/22	Checked By:	bfs
Depth :	---	Test Id:	673643		
Test Comment:	---				
Visual Description:	Moist, light grayish olive gravel with silt and sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	74.8	18.4	6.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 in	75.00	100		
2 in	50.00	87		
1.5 in	37.50	71		
1 in	25.00	61		
0.75 in	19.00	48		
0.5 in	12.50	42		
0.375 in	9.50	37		
#4	4.75	25		
#10	2.00	17		
#20	0.85	13		
#40	0.42	11		
#60	0.25	9		
#100	0.15	8		
#140	0.11	7		
#200	0.075	6.8		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0308	5		
---	0.0214	5		
---	0.0126	4		
---	0.0092	3		
---	0.0062	3		
---	0.0046	2		
---	0.0033	2		
---	0.0014	1		

Coefficients

D_{85} = 48.1138 mm	D_{30} = 6.3565 mm
D_{60} = 24.4644 mm	D_{15} = 1.3199 mm
D_{50} = 19.7462 mm	D_{10} = 0.3025 mm
C_u = 80.874	C_c = 5.460

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (1))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

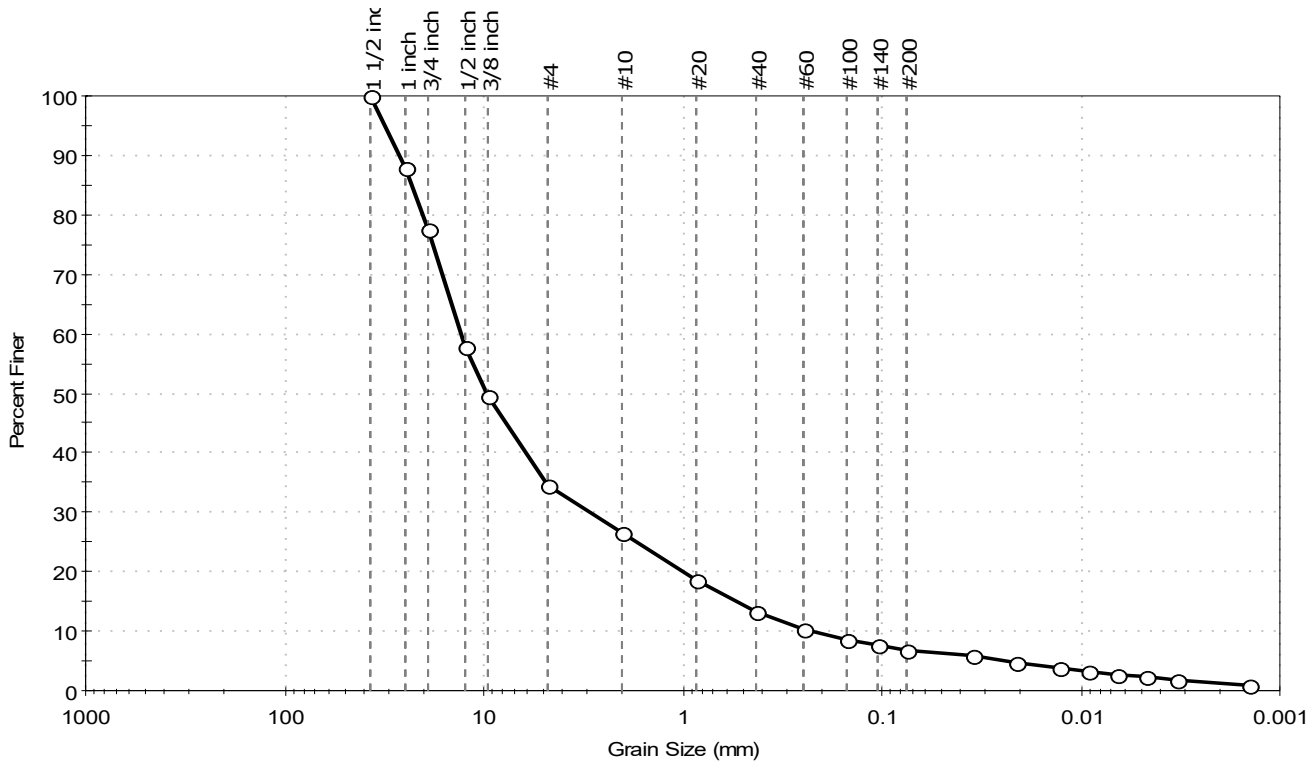
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQ-04-10-11	Test Date:	06/24/22	Checked By:	bfs
Depth :	---	Test Id:	673644		
Test Comment:	---				
Visual Description:	Moist, dark grayish brown gravel with silt and sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	65.5	27.7	6.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 1/2 inch	37.50	100		
1 inch	25.00	88		
3/4 inch	19.00	78		
1/2 inch	12.50	58		
3/8 inch	9.50	49		
#4	4.75	35		
#10	2.00	27		
#20	0.85	19		
#40	0.42	13		
#60	0.25	10		
#100	0.15	9		
#140	0.11	8		
#200	0.075	6.8		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0347	6		
---	0.0213	5		
---	0.0127	4		
---	0.0092	3		
---	0.0066	3		
---	0.0047	2		
---	0.0033	2		
---	0.0014	1		

Coefficients

D_{85} = 23.0807 mm
D_{30} = 2.9122 mm
D_{60} = 13.0862 mm
D_{15} = 0.5298 mm
D_{50} = 9.6840 mm
D_{10} = 0.2220 mm
C_u = 58.947
C_c = 2.919

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (1))

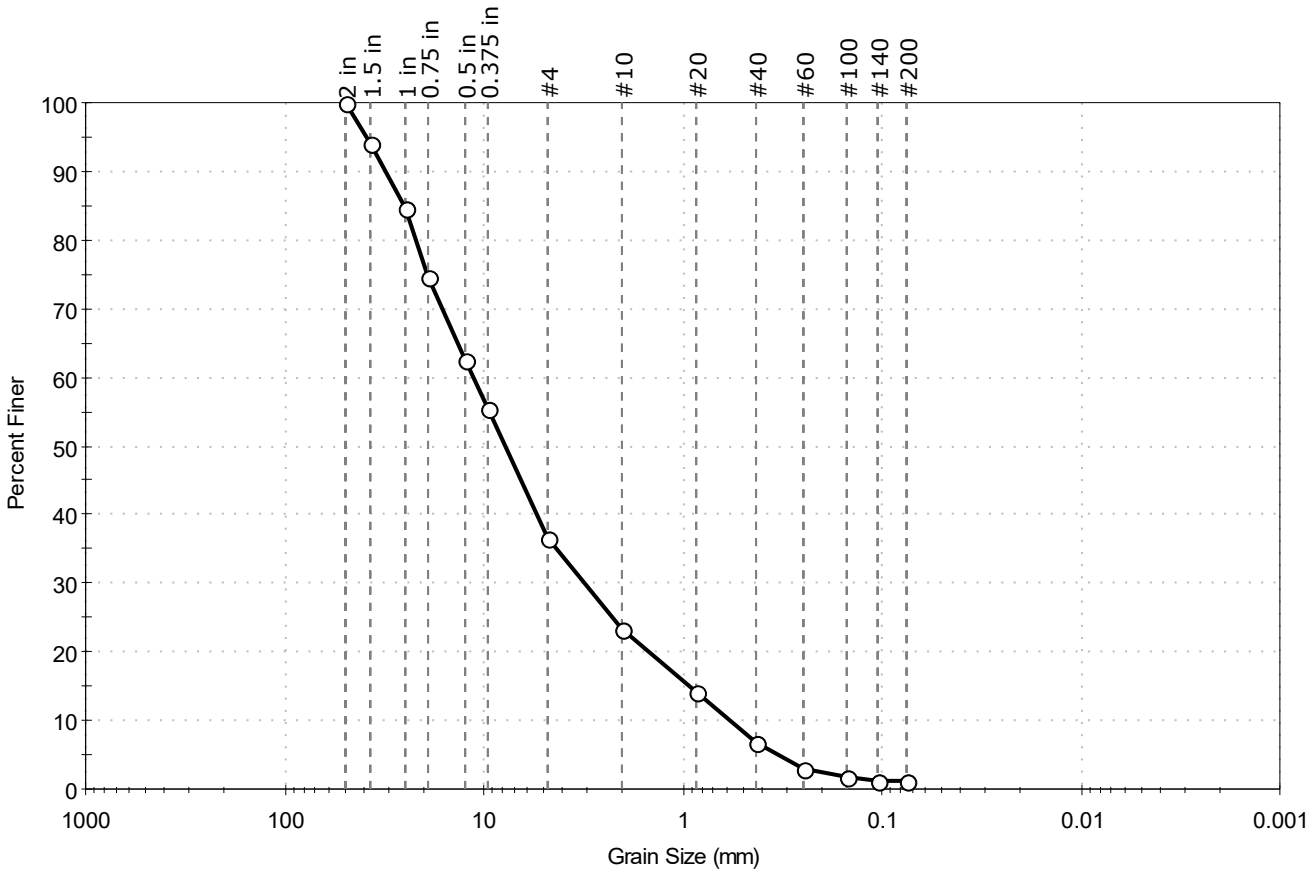
Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR
Sand/Gravel Hardness : HARD
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQ-04-26.5-27.5	Test Date:	06/24/22	Checked By:	bfs
Depth :	---	Test Id:	673645		
Test Comment:	---				
Visual Description:	Moist, very dark gray gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	63.3	35.6	1.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 in	50.00	100		
1.5 in	37.50	94		
1 in	25.00	85		
0.75 in	19.00	75		
0.5 in	12.50	63		
0.375 in	9.50	55		
#4	4.75	37		
#10	2.00	23		
#20	0.85	14		
#40	0.42	7		
#60	0.25	3		
#100	0.15	2		
#140	0.11	1		
#200	0.075	1.1		

Coefficients

D_{85} = 25.2302 mm	D_{30} = 3.0779 mm
D_{60} = 11.3106 mm	D_{15} = 0.9264 mm
D_{50} = 7.7715 mm	D_{10} = 0.5737 mm
C_u = 19.715	C_c = 1.460

Classification

ASTM: Well-graded GRAVEL with Sand (GW)

AASHTO: Stone Fragments, Gravel and Sand (A-1-a (1))

Sample/Test Description

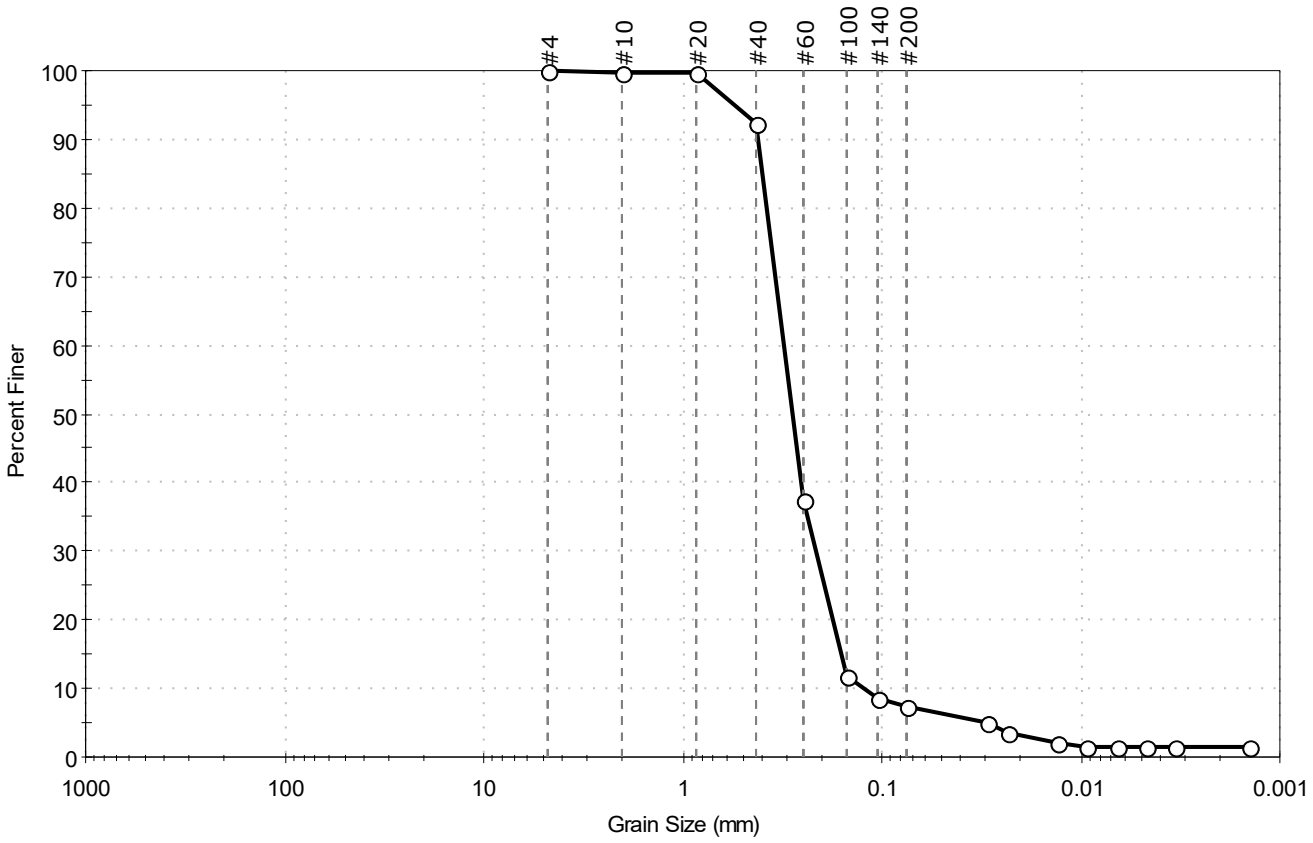
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

GeoTesting EXPRESS

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AQ-04-60-61.5	Test Date:	06/24/22	Checked By:	bfs
Depth :	---	Test Id:	673646		
Test Comment:	---				
Visual Description:	Moist, dark gray sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	92.7	7.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	92		
#60	0.25	37		
#100	0.15	12		
#140	0.11	9		
#200	0.075	7.3		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0299	5		
---	0.0232	4		
---	0.0132	2		
---	0.0095	1		
---	0.0066	1		
---	0.0048	1		
---	0.0034	1		
---	0.0014	1		

Coefficients

D_{85} = 0.3963 mm	D_{30} = 0.2153 mm
D_{60} = 0.3110 mm	D_{15} = 0.1597 mm
D_{50} = 0.2823 mm	D_{10} = 0.1232 mm
C_u = 2.524	C_c = 1.210

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (1))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

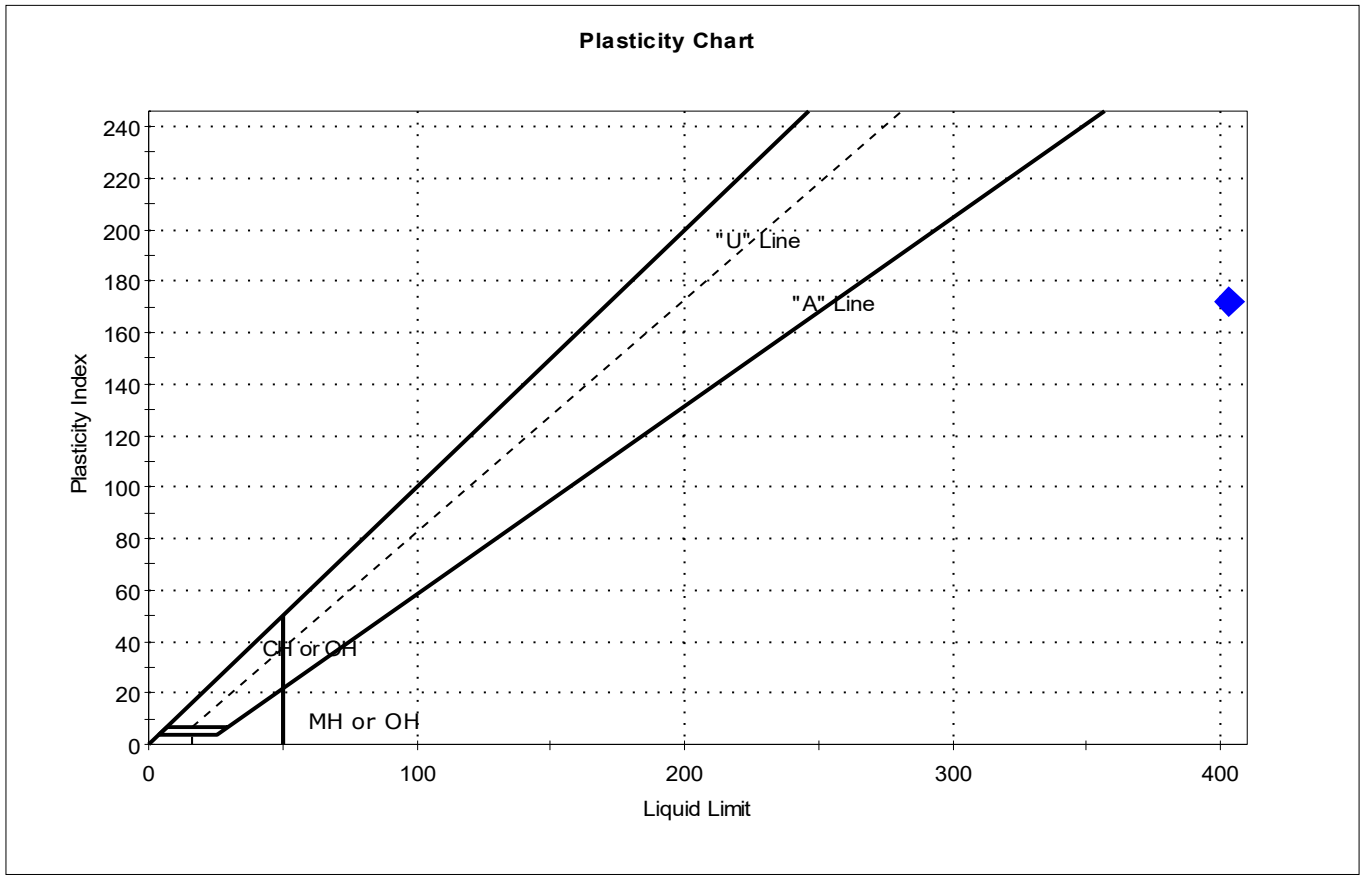
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	Anchor QEA, LLC				
Project:	Sequalitchew Geotech Investigation				
Location:				Project No:	GTX-315662
Boring ID:	---	Sample Type:	bag	Tested By:	cam
Sample ID:	AQ-04-15-16.5	Test Date:	06/24/22	Checked By:	bfs
Depth :	---	Test Id:	673637		
Test Comment:	---				
Visual Description:	Moist, very dark brown silt with gravel				
Sample Comment:	Sample contains organics				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	AQ-04-15-16.5	---	---	159	403	231	172	-0.4	

Sample Prepared using the WET method

Dry Strength: MEDIUM

Dilatancy: SLOW

Toughness: LOW

Appendix E
Bridge Basis of Design Report

Sequalitchew Pedestrian Bridges

Basis of Design

January 2023 | Draft

kpff Consulting Engineers

Basis of Design

January 2023

Prepared for:

South Puget Sound Salmon Enhancement Group
6700 Martin Way East, Suite 112
Olympia, WA 98516

Prepared by: (Structural Engineer)

KPFF Consulting Engineers
1601 Fifth Avenue, Suite 1600
Seattle, WA 98101
(206) 622-5822
Project No. 10042200464

With Input from: (Geotechnical Engineer)

Anchor QEA
1201 Third Ave, Suite 2600
Seattle, WA 98101

Prime Consultant:

Anchor QEA
1201 Third Ave, Suite 2600
Seattle, WA 98101

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1. Introduction and Existing Site Conditions

1.1 PROJECT DESCRIPTION

This Sequalitchew Creek Watershed Restoration Project Preliminary and Final Design Project are designed to restore flows to the Sequalitchew Creek. Included in this watershed restoration project are two new bridges: The Robinson Rail Bridge and the City Hall Bridge. The Robinson Rail Bridge will be a prefabricated steel truss vehicle bridge reconnecting flow East and West Edmonds Marsh. The City Hall Bridge will be a prefabricated steel truss pedestrian bridge and will replace an existing culvert located 400 feet downstream of Center Drive. See Figure 1 for the project location.

This document summarizes the existing conditions at the proposed crossing location, the geometric and design criteria for the structure, and preliminary estimated construction costs.

Figure 1: Vicinity Map

1.2 EXISTING SITE CONDITIONS

Geotechnical condition information was provided by Anchor QEA.

Geotechnical Conditions

Soil Conditions

The site soils described in this section are based on site borings completed by Anchor QEA. The upper portion of the soil at the site of the City Hall Bridge consists of fill and recessional outwash comprised of very dense gravel in the first half and medium dense to dense sand thereafter. Below 20 feet, the soil consists of advance outwash, which is primarily very dense gravel that ranges from silt to cobble.

Ground Water Conditions

The ground water was found to be 17.4 feet below ground surface at the City Hall Bridge site and 5 feet below ground surface at the Robinson Rail Bridge site based on site borings conducted in May 2022. Ground water is expected to vary with the time of year and is also likely to depend on distance from the stream. Shallow ground water is likely near the elevation of the stream bottom in the wet season.

Utilities

All utilities shall be located prior to completion of final design.

2. Design Criteria

1.1 DESIGN CODES AND REFERENCES

Tables 1 and 2 provide lists of publications to be used for design and construction. The list is not comprehensive; other applicable codes and references may be required as the design develops.

Table 1. Pedestrian and Bicycle Facilities Codes and References

Pedestrian and Bicycle Facilities Codes and References

• Referenced Codes
  • AASHTO A Policy on Geometric Design of Highways and Streets, 7th Edition, 2018
  • AASHTO Guide for the Development of Bicycle Facilities, 4th Edition, 2012
  • NACTO Urban Bikeway Design Guide
  • 2010 American with Disabilities Act Standards for Accessible Design
  • Public Rights of Way Accessibility Guidelines (PROWAG)
  • WSDOT Design Manual M22-01, September 2020
  • WSDOT Local Agency Guidelines Manual M36-63, March 2021

Table 2. Bridge and Structures Codes and References

Bridge and Structures Codes and References

• Governing Codes
  • AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges, 2nd Edition, December 2009, with Interim Revisions. (AASHTO Pedestrian).
  • AASHTO Guide Specifications for LRFD Seismic Bridge Design, 2nd Edition, 2011, with Interim Revisions (AASHTO Seismic)
  • AASHTO LRFD Bridge Design Specifications, 9th Edition, 2020, with Interim Revisions (AASHTO LRFD)
• Referenced Codes
  • AASHTO LRFD Bridge Construction Specifications, 3rd Edition, 2010, with Interim Revisions
  • AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, First Edition, 2015. (AASHTO Signs)
  • WSDOT Bridge Design Manual (LRFD) M23-50.18, June 2018. (WSDOT BDM)
  • Bridge Welding Code: AASHTO/ AWS D1.5M/D1.5: 2016 An American National Standard, 7th Edition with Interims through 2019.
  • IBC – International Building Code, International Code Council, 2018.
  • ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures, ASCE/SEI 7 Standards Committee, 2016.
  • ACI 318 – Building Code Requirements for Structural Concrete, ACI Committee 318, 2014
  • AISC 360 – Specification for Structural Steel Buildings, American Institute of Steel Construction, 15th Edition, 2016.
  • Structural Welding Code – Steel: AASHTO/AWS D.1M/D1.1M, 2015.

1.2 BRIDGE GEOMETRY

It is assumed that the horizontal alignment of both the City Hall Bridge and the Robinson Rail Bridge are similar to the alignment of the existing trail. Figures 2 and 3 show a preliminary bridge alignment for the City Hall Bridge and the Robinson Rail Bridge, respectively. There is no skew on either bridge.

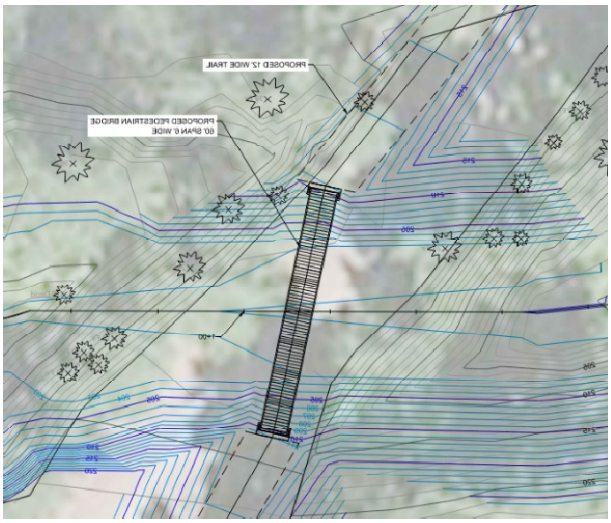


Figure 3: City Hall Bridge Horizontal Alignment

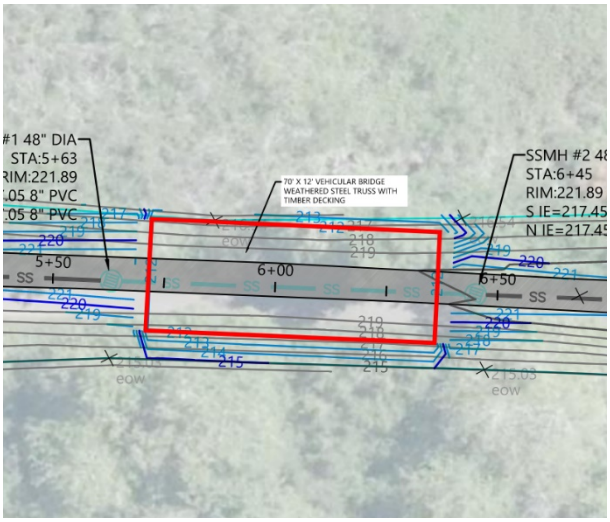


Figure 2: Robinson Rail Bridge Plan View

The vertical alignment of the City Hall Bridge is shown in Figure 4, where the proposed grade enters and exits 5% grade. The deck is assumed to have a flat slope with a crown and cross-slope of 1.5% or a timber deck to provide adequate drainage for the structure. The Robinson Rail Bridge with a proposed grade of 2%, shown in Figure 5, with a concrete deck.

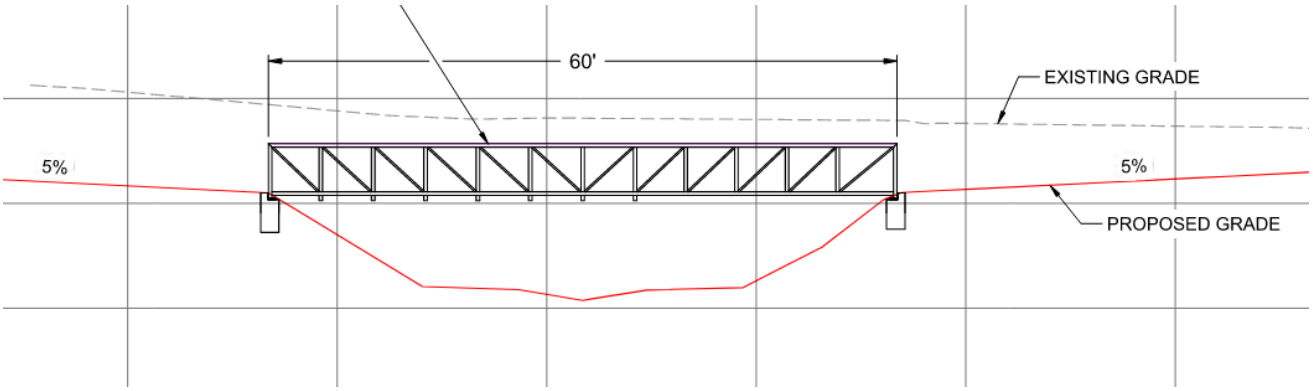


Figure 4: City Hall Bridge Elevation

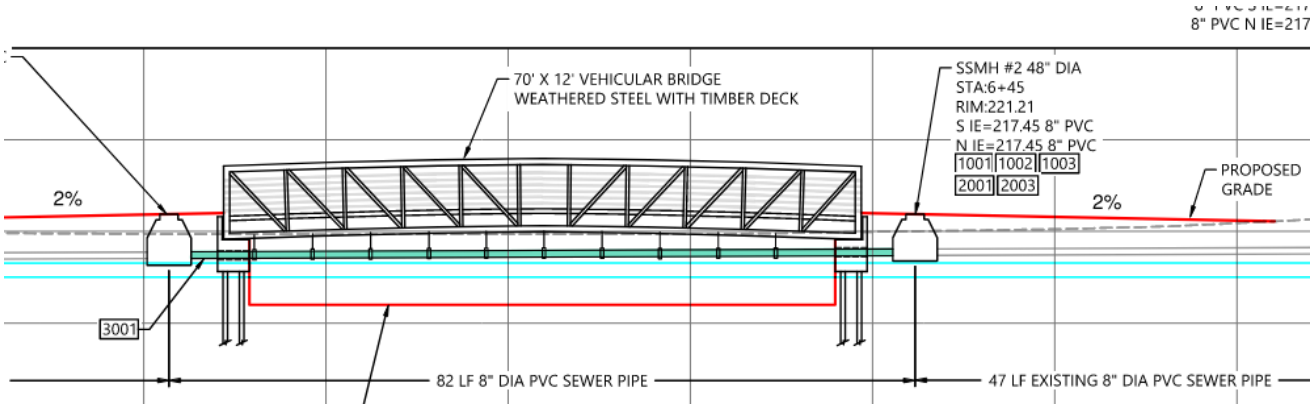


Figure 5: Robinson Rail Bridge Elevation

Typically, bridges over waterways are set at an elevation that provides a minimum of 3-feet of clearance between the lowest bridge member and the 100-year flood elevation. The minimum clearance is intended to allow the passage of floating debris without impacts to the structure and to allow for the aggradation of material over the life of the structure. A flood elevation for Sequalitchew Creek and required clearance has not been identified. These parameters will be finalized in the next design phase.

The bridge is assumed to have a total clear width of 6 feet between railings for the City Hall Bridge and 12 feet between railings for the Robinson Rail Bridge. This maintains the full trail width across the structure.

1.3 BRIDGE FEATURES

Superstructure

Both bridge superstructures are assumed to be a contractor-design, prefabricated steel truss. The City Hall Bridge will have a timber deck and the Robinson Rail Bridge will have a concrete deck. Steel structures must be corrosion-protected to ensure they are serviceable for the full extent of their design life. Options for corrosion protection include the use of weathering steel, galvanized steel, or painted steel. Both bridges are assumed to use weathering steel for corrosion protection.

The bridge railing height will be 54 inches, consistent with the requirements of the WSDOT Design Manual 1510.15(3)(a). This exceeds the 42-inch minimum requirement of AASHTO Pedestrian and AASHTO LRFD. The bridge railing will be a continuous barrier that prevents the passage of a 4-inch diameter sphere from the finished grade to the top of the railing (IBC 1015.4). The railing will not include a concrete curb or kick plate.

Bridge deck joints will meet ADA requirements and provide safe passage for bicycles.

Substructure

Preliminary Geotechnical Considerations

Based on the Geotechnical report from Anchor QEA, the shallow foundations will be used for the City Hall Bridge and driven pile foundations will be used for the Robinson Rail Bridge. It is also possible that construction dewatering could be required. Depth to ground water will vary based on the season and it would be prudent to construct the bridge during the dry season so that dewatering is not needed, or dewatering efforts will at least be reduced. If it is determined that it will be difficult to dewater within the gravelly soils, placement of precast concrete foundations placed in the wet could be considered in place of cast-in-place elements. Constructability of deep foundations will need to be evaluated, given the potential for caving of the gravelly soils and the likelihood that the soils will contain cobbles and boulders.

Substructure Basis of Design

Based on geotechnical information, the bridge abutments for the City Hall Bridge are assumed to be a cast-in-place concrete, cantilever abutment walls supported on spread footings. This wall and footing will support the bridge loads. The depth of the footing will depend on the depth of suitable bearing soils and scour considerations. The intent is to set the footing depth so that scour protection, for example riprap armoring, is not necessary. No scour is assumed at the City Hall Bridge.

For the Robinson Rail Bridge, the bridge abutments are assumed to be cast-in-place concrete, cantilever abutment walls supported on driven pile foundations. This wall and footing will support the bridge loads.

In addition to the abutment walls, wingwalls, on the sides of each abutment, will be required to retain approach fill material. These walls are anticipated to be cast-in-place concrete extensions of the main abutment wall.

1.4 BRIDGE STRUCTURAL DESIGN CRITERIA

Loads

- Dead Loads
    - Concrete, Normal-weight Reinforced — 155 lb/ft^3 — WSDOT BDM 3.8
    - Steel — 490 lb/ft^3 — AASHTO LRFD Table 3.5.1-1
- Live Loads
    - Pedestrian — 90 psf — AASHTO Pedestrian 3.1
    - HS-20 vehicle
- Wind Loads
    - Acting Horizontally, whichever governs between AASHTO Pedestrian 3.4 / AASHTO Signs 3.8 and AASHTO LRFD 3.8
    - Acting Vertically, per AASTHO LRFD 3.8.2
- Seismic Loads and Design Parameters are based on the Geotechnical Report provided by Anchor QEA as follows:

- City Hall Bridge
  - Site Class C
  - Design Spectral Ordinates
    - Peak Ground Acceleration Coefficient, A_S 0.504g
    - Short-Period (0.2 sec) Response Coefficient, S_{DS} 1.164g
    - Long-Period (1.0 sec) Response Coefficient, S_{D1} 0.435g
  - Seismic Zone (per AASHTO LRFD Table 3.10.6-1) 3
- Robinson Rail Bridge
  - Site Class D
  - Design Spectral Ordinates
    - Peak Ground Acceleration Coefficient, A_S 0.504g
    - Short-Period (0.2 sec) Response Coefficient, S_{DS} 1.067g
    - Long-Period (1.0 sec) Response Coefficient, S_{D1} 0.580g
  - Seismic Zone (per AASHTO LRFD Table 3.10.6-1) 4

- Temperature Loads per WSDOT BDM 3.16.6
  - Concrete Bridges 0° to 100°F
  - Steel Bridges 0° to 120°F

Allowable Deflections and Vibrations

- Deflections
  - Maximum deflection due to unfactored pedestrian load is 1/220 of the length for cantilever spans and 1/360 of the length for all other spans per the AASHTO Pedestrian Design Code.
  - Maximum horizontal deflection due to unfactored wind loading is 1/360 of the length.
- Vibrations
  - The fundamental frequency in a vertical mode of the pedestrian bridge without live load shall be greater than 3.0 hertz. The fundamental frequency in the horizontal direction shall be greater than 1.3 hertz.
  - Pedestrian induced vibration and acceleration limits prescribed in the SETRA Technical Guide to Footbridges 2016.

Maintenance and Emergency Access

The City Hall Bridge will not be designed for an HS-20 design vehicle or emergency response vehicles (e.g. ambulances or fire trucks).

The Robinson Rail Bridge will be designed for the HS-20 design vehicle. This would allow maintenance vehicles and smaller emergency vehicles to cross the bridge.

3. Cost Estimate

As part of the conceptual design development, a construction cost estimate was determined. It is intended to capture costs for the bridge structure: the superstructure truss, abutments, footings, and wingwalls.

The estimated construction cost of both bridges is $2,252,400 in 2023 dollars, which includes a 35% Design Contingency, but does not include Construction Management.

Appendix F
Opinion of Probable Construction Costs

Table 1
Opinion of Probable Construction Costs

Bid Item	Estimated Quantity	Unit	Item	Unit	Total
1.0			**Losing Reach Area**		**$1,173,033**
1.01	1	LS	Temporary Water Pollution/Erosion Control	$10,000.00	$10,000
1.02	1	LS	Utilities Locate and Protection	$2,000.00	$2,000
1.03	1	LS	Temporary Traffic Control	$4,000	$4,000
1.04	1	LS	Construction Surveying	$3,000.00	$3,000
1.05	2	AC	Clearing and Grubbing	$5,000.00	$10,000
1.06	1	LS	Removal of Structures and Obstructions	$5,000.00	$5,000
1.07	45,850	CY	Streambed Excavation, Haul, Place, and Compact	$6.50	$298,025
1.08	1,155	CY	Placement of Streambed Fill Material	$6.50	$7,508
1.09	20,000	CY	Import and Placement of Fines	$6.50	$130,000
1.10	20,000	CY	Placement of Streambed Gravel Material	$6.50	$130,000
1.11	2,840	SF	Removal of Concretre Sidewalk	$2.50	$7,100
1.12	3	AC	Restore Impacted Lawn - Hydroseeding	$5,500.00	$13,915
1.13	1	ALLOW	Restore Impacted Lawn - Irrigation	$2,000.00	$2,000
1.14	67,130	SF	Restore Upland and Riparian Area Irrigation	$1.20	$80,556
1.15	277	EA	Trees (5-6' Height)	$90.95	$25,193
1.16	1,136	EA	Upland Shrubs (1 Gallon)	$24.61	$27,957
1.17	772	EA	Wetland/Riparian Shrubs (1 Gallon)	$24.61	$18,999
1.18	7,275	EA	Wetland/Riparian Livestakes	$7.00	$50,925
1.19	484	EA	Emergent Shrubs (1 gallon)	$8.00	$3,872
1.20	2,949	EA	Emergent Livestakes	$7.00	$20,643
1.21	1,489	CY	Topsoil	$50.00	$74,450
1.22	8,938	SY	Mulch 3" depth	$5.00	$44,690
1.23	176	EA	Rootwad Log, 1.5' dia. 25' L Log, 4.5' dia. 3' L RW	$700.00	$123,200
1.24	1	LS	Installation (labor & equipment)	$80,000.00	$80,000
2.0			**Robison Trail**		**$629,614**
2.01	0.1	AC	Clearing and Grubbing	$5,000	$500
2.02	1	LS	Temporary Water Pollution/Erosion Control	$5,000	$5,000
2.03	1	LS	Utilities Locate and Protection	$2,000	$2,000
2.04	1	LS	Construction Surveying	$5,000	$5,000
2.05	1	LS	Mobilization and Demobilization	$53,000	$53,000
2.06	516	CY	Embankment Excavation, Haul, and Compact in Stockpile	$6.50	$3,354
2.07	117	CY	Placement of On-site Embankment Fill Material	$6.50	$761
2.08	30	CY	Processing and Placement of Crushed Surfacing for Access Roads	$6.50	$195
2.09	1	LS	Bridge, Abutment, and Pile Installation, complete in place	$530,000.00	$530,000
2.10	2	EA	Install 48" Manhole	$6,000.00	$12,000
2.11	82	LF	Install 8" PVC Sewer Pipe	$46.00	$3,772
2.12	82	LF	Install 10" Schedule 80 Galvanized steel pipe	$75.00	$6,150
2.13	1	LS	Misc. Metals	$3,500.00	$3,500
2.14	509	SF	Restore Upland and Riparian Area Irrigation	$1.20	$611
2.15	5	EA	Trees (5-6' Height)	$90.95	$455
2.16	24	EA	Upland Shrubs (1 Gallon)	$24.61	$591
2.17	12	EA	Wetland/Riparian Shrubs (1 Gallon)	$24.61	$295
2.18	108	EA	Wetland/Riparian Livestakes	$7.00	$756
2.19	21	CY	Topsoil	$50.00	$1,050
2.20	125	SY	Mulch 3" depth	$5.00	$625

Table 1
Opinion of Probable Construction Costs

Bid Item	Estimated Quantity	Unit	Item	Unit	Total
3.0			**City Hall Culvert**		**$1,242,875**
3.01	1	LS	Removal of Structures and Obstructions (CMP culvert, Timber Dam)	$8,000	$8,000
3.02	1	LS	Temporary Water Pollution/Erosion Control	$5,000	$5,000
3.03	1	LS	Utilities Locate and Protection	$2,000	$2,000
3.04	1	LS	Construction Surveying	$10,000	$10,000
3.05	1	LS	Mobilization and Demobilization	$106,000	$106,000
3.06	1	LS	Bridge, Abutment, and Pile Installation, complete in place	$1,040,000	$1,040,000
3.07	0.2	AC	Clearing and Grubbing	$5,000	$1,000
3.08	3,649	CY	Embankment Excavation, Haul, and Compact in Stockpile	$6.50	$23,719
3.09	7673	SF	Restore Upland and Riparian Area Irrigation	$1.20	$9,208
3.10	33	EA	Trees (5-6' Height)	$90.95	$3,001
3.11	320	EA	Upland Shrubs (1 Gallon)	$24.61	$7,875
3.12	16	EA	Wetland/Riparian Shrubs (1 Gallon)	$24.61	$394
3.13	132	EA	Wetland/Riparian Livestakes	$7.00	$924
3.14	35	EA	Emergent Shrubs (1 gallon)	$8.00	$280
3.15	180	EA	Emergent Livestakes	$7.00	$1,260
3.16	143	CY	Topsoil	$50.00	$7,150
3.17	853	SY	Mulch 3" depth	$5.00	$4,265
3.18	4	EA	Rootwad Log, 1.5' dia. 25' L Log, 4.5' dia. 3' L RW	$700.00	$2,800
3.19	1	LS	Installation (labor & equipment)	$10,000.00	$10,000
4.0			**Beaver Management**		**$69,000**
4.01	8	CY	Notch/Remove Dam	$1,000.00	$8,000
4.02	6	EA	Install 2 Flexible Pond Levelers	$7,000.00	$42,000
4.03	2	EA	Install Beaver Exclusion Device	$7,000.00	$14,000
4.04	1	EA	Install Beaver Dam Analog	$5,000.00	$5,000
			Project Elements Subtotal		**$3,114,522**
			Contingency	20.00%	$623,000
			Construction Subtotal		**$3,738,000**
			Sales Tax	10.00%	$374,000
			Total Project Cost		**$4,112,000**

NOTES:

(1) Design, permitting, construction administration, legal and administrative costs are not included with this estimate.

(2) Opinion of cost updated January 2023. Actual construction costs will vary based on materials and labor costs at time of construction.

(3) The Subtotals and Construction Total are rounded to the nearest $1,000.

Table 2
Opinion of Probable Construction Costs by Phase

Bid Item	Estimated Quantity	Unit	Item	Unit	Total	Phase 1	Phase 2
1.0			**Losing Reach Area**		**$1,173,033**	**$591,000**	**$582,000**
1.01	1	LS	Temporary Water Pollution/Erosion Control	$10,000.00	$10,000	$10,000	$0
1.02	1	LS	Utilities Locate and Protection	$2,000.00	$2,000	$1,000	$1,000
1.03	1	LS	Temporary Traffic Control	$4,000	$4,000	$0	$4,000
1.04	1	LS	Construction Surveying	$3,000.00	$3,000	$1,500	$1,500
1.05	2	AC	Clearing and Grubbing	$5,000.00	$10,000	$2,000	$8,000
1.06	1	LS	Removal of Structures and Obstructions	$5,000.00	$5,000	$5,000	$0
1.07	45,850	CY	Streambed Excavation, Haul, Place, and Compact	$6.50	$298,025	$0	$298,025
1.08	1,155	CY	Placement of Streambed Fill Material	$6.50	$7,508	$7,508	$0
1.09	20,000	CY	Import and Placement of Fines	$6.50	$130,000	$130,000	$0
1.10	20,000	CY	Placement of Streambed Gravel Material	$6.50	$130,000	$130,000	$0
1.11	2,840	SF	Removal of Concretre Sidewalk	$2.50	$7,100	$7,100	$0
1.12	3	AC	Restore Impacted Lawn - Hydroseeding	$5,500.00	$13,915	$0	$13,915
1.13	1	ALLOW	Restore Impacted Lawn - Irrigation	$2,000.00	$2,000	$0	$2,000
1.14	67,130	SF	Restore Upland and Riparian Area Irrigation	$1.20	$80,556	$0	$80,556
1.15	277	EA	Trees (5-6' Height)	$90.95	$25,193	$0	$25,193
1.16	1,136	EA	Upland Shrubs (1 Gallon)	$24.61	$27,957	$0	$27,957
1.17	772	EA	Wetland/Riparian Shrubs (1 Gallon)	$24.61	$18,999	$0	$18,999
1.18	7,275	EA	Wetland/Riparian Livestakes	$7.00	$50,925	$50,925	$0
1.19	484	EA	Emergent Shrubs (1 gallon)	$8.00	$3,872	$3,872	$0
1.20	2,949	EA	Emergent Livestakes	$7.00	$20,643	$20,643	$0
1.21	1,489	CY	Topsoil	$50.00	$74,450	$10,000	$64,450
1.22	8,938	SY	Mulch 3" depth	$5.00	$44,690	$8,000	$36,690
1.23	176	EA	Rootwad Log, 1.5' dia. 25' L Log, 4.5' dia. 3' L RW	$700.00	$123,200	$123,200	$0
1.24	1	LS	Installation (labor & equipment)	$80,000.00	$80,000	$80,000	$0
2.0			**Robison Trail**		**$629,614**	**629614.01**	**0**
2.01	0.1	AC	Clearing and Grubbing	$5,000	$500	$500	$0
2.02	1	LS	Temporary Water Pollution/Erosion Control	$5,000	$5,000	$5,000	$0
2.03	1	LS	Utilities Locate and Protection	$2,000	$2,000	$2,000	$0
2.04	1	LS	Construction Surveying	$5,000	$5,000	$5,000	$0
2.05	1	LS	Mobilization and Demobilization	$53,000	$53,000	$53,000	$0
2.06	516	CY	Embankment Excavation, Haul, and Compact in Stockpile	$6.50	$3,354	$3,354	$0
2.07	117	CY	Placement of On-site Embankment Fill Material	$6.50	$761	$761	$0
2.08	30	CY	Processing and Placement of Crushed Surfacing for Access Roads	$6.50	$195	$195	$0
2.09	1	LS	Bridge, Abutment, and Pile Installation, complete in place	$530,000.00	$530,000	$530,000	$0
2.10	2	EA	Install 48" Manhole	$6,000.00	$12,000	$12,000	$0
2.11	82	LF	Install 8" PVC Sewer Pipe	$46.00	$3,772	$3,772	$0
2.12	82	LF	Install 10" Schedule 80 Galvanized steel pipe	$75.00	$6,150	$6,150	$0
2.13	1	LS	Misc. Metals	$3,500.00	$3,500	$3,500	$0
2.14	509	SF	Restore Upland and Riparian Area Irrigation	$1.20	$611	$611	$0
2.15	5	EA	Trees (5-6' Height)	$90.95	$455	$455	$0
2.16	24	EA	Upland Shrubs (1 Gallon)	$24.61	$591	$591	$0
2.17	12	EA	Wetland/Riparian Shrubs (1 Gallon)	$24.61	$295	$295	$0
2.18	108	EA	Wetland/Riparian Livestakes	$7.00	$756	$756	$0
2.19	21	CY	Topsoil	$50.00	$1,050	$1,050	$0
2.20	125	SY	Mulch 3" depth	$5.00	$625	$625	$0
3.0			**City Hall Culvert**		**$1,242,875**	**$0**	**$0**
3.01	1	LS	Removal of Structures and Obstructions (CMP culvert, Timber Dam)	$8,000	$8,000	$0	$8,000
3.02	1	LS	Temporary Water Pollution/Erosion Control	$5,000	$5,000	$0	$5,000
3.03	1	LS	Utilities Locate and Protection	$2,000	$2,000	$0	$2,000
3.04	1	LS	Construction Surveying	$10,000	$10,000	$0	$10,000
3.05	1	LS	Mobilization and Demobilization	$106,000	$106,000	$0	$106,000
3.06	1	LS	Bridge, Abutment, and Pile Installation, complete in place	$1,040,000	$1,040,000	$0	$1,040,000
3.07	0.2	AC	Clearing and Grubbing	$5,000	$1,000	$0	$1,000
3.08	3,649	CY	Embankment Excavation, Haul, and Compact in Stockpile	$6.50	$23,719	$0	$23,719
3.09	7673	SF	Restore Upland and Riparian Area Irrigation	$1.20	$9,208	$0	$9,208
3.10	33	EA	Trees (5-6' Height)	$90.95	$3,001	$0	$3,001
3.11	320	EA	Upland Shrubs (1 Gallon)	$24.61	$7,875	$0	$7,875
3.12	16	EA	Wetland/Riparian Shrubs (1 Gallon)	$24.61	$394	$0	$394
3.13	132	EA	Wetland/Riparian Livestakes	$7.00	$924	$0	$924
3.14	35	EA	Emergent Shrubs (1 gallon)	$8.00	$280	$0	$280
3.15	180	EA	Emergent Livestakes	$7.00	$1,260	$0	$1,260
3.16	143	CY	Topsoil	$50.00	$7,150	$0	$7,150
3.17	853	SY	Mulch 3" depth	$5.00	$4,265	$0	$4,265
3.18	4	EA	Rootwad Log, 1.5' dia. 25' L Log, 4.5' dia. 3' L RW	$700.00	$2,800	$0	$2,800
3.19	1	LS	Installation (labor & equipment)	$10,000.00	$10,000	$0	$10,000
4.0			**Beaver Management**		**$69,000**	**$69,000**	$0
4.01	8	CY	Notch/Remove Dam	$1,000.00	$8,000	$8,000	$0
4.02	6	EA	Install 2 Flexible Pond Levelers	$7,000.00	$42,000	$42,000	$0
4.03	2	EA	Install Beaver Exclusion Device	$7,000.00	$14,000	$14,000	$0
4.04	1	EA	Install Beaver Dam Analog	$5,000.00	$5,000	$5,000	$0
			Project Elements Subtotal		**$3,114,522**	**$1,289,614**	**$582,000**
			Contingency	20.00%	$623,000	$258,000	$116,000
			Construction Subtotal		**$3,738,000**	**$1,548,000**	**$698,000**
			Sales Tax	10.00%	$374,000	$155,000	$70,000
			Total Project Cost		**$4,112,000**	**$1,703,000**	**$768,000**

NOTES:
(1) Design, permitting, construction administration, legal and administrative costs are not included with this estimate.
(2) Opinion of cost updated January 2023. Actual construction costs will vary based on materials and labor costs at time of construction.
(3) The Subtotals and Construction Total are rounded to the nearest $1,000.

Table 3

Opinion of Probable Construction Costs: Comparison to Earlier Estimate

Bid Item	Estimated Quantity	Unit	Item	Unit	Total	2015 ESTIMATE without design/ permitting	2023 ESTIMATE 40% inflation added
1			Losing Reach Area		$ 1,173,033	$ 295,000	$ 413,000
2			Robison Trail		$ 629,614	$ 554,466	$ 776,252
3			City Hall Culvert		$ 1,242,875	$ 326,096	$ 456,534
4			Beaver Management		$ 69,000	$ 61,222	$ 85,711
			Project Elements Subtotal		**$3,114,522**	**$1,236,784**	**$1,731,498**
			Contingency	20.00%	$623,000	$247,000	$346,000
			Construction Subtotal		**$3,738,000**	**$1,484,000**	**$2,077,000**
			Sales Tax	10.00%	$374,000	$148,000	$208,000
			Total Project Cost		**$4,112,000**	**$1,632,000**	**$2,285,000**

NOTES:

(1) Design, permitting, construction administration, legal and administrative costs are not included with this

(2) Opinion of cost updated January 2023. Actual construction costs will vary based on materials and labor

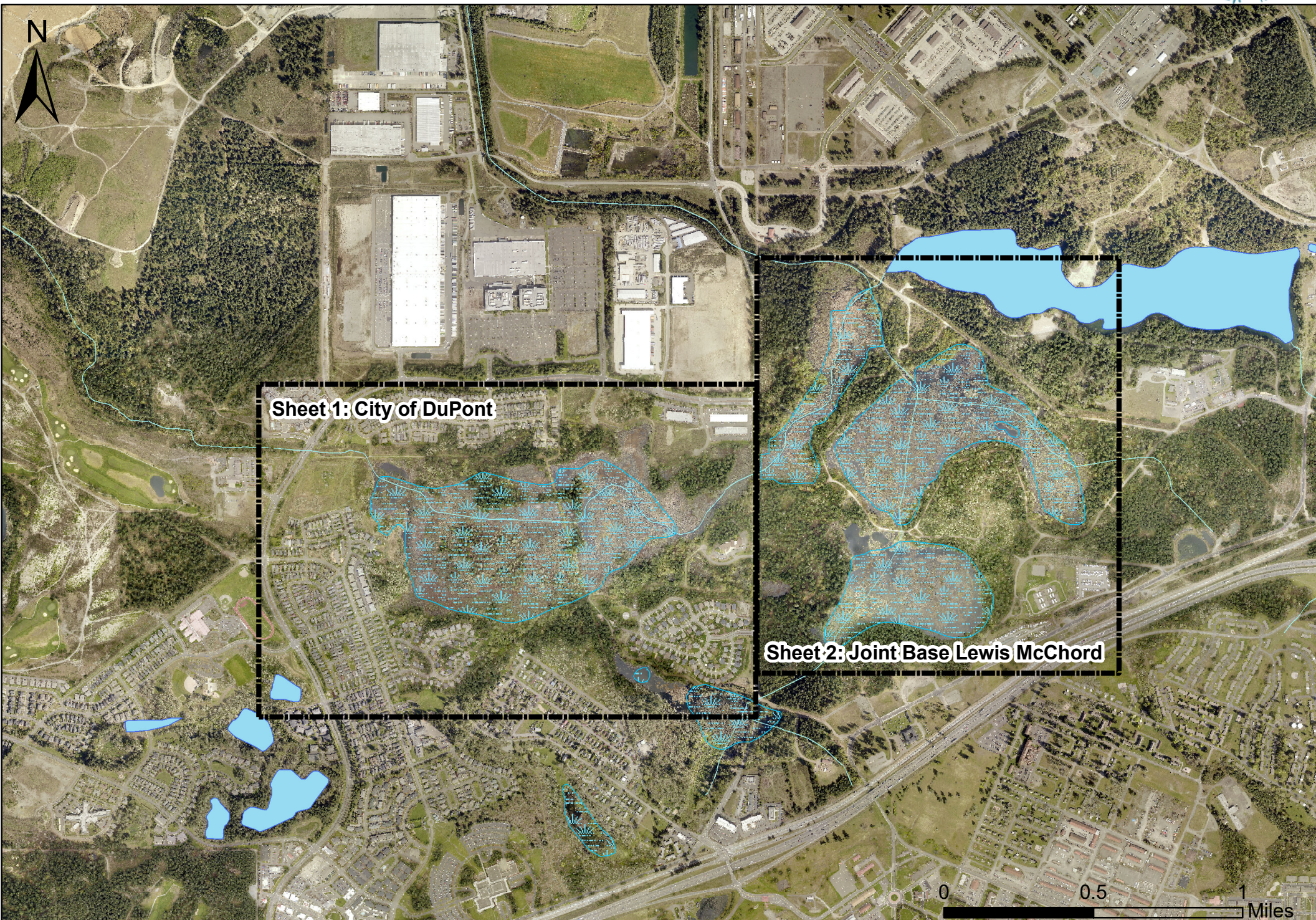
(3) The Subtotals and Construction Total are rounded to the nearest $1,000.

(4) 40% Inflation is based on historical change and assumes construction occurs in 2024 and 2025

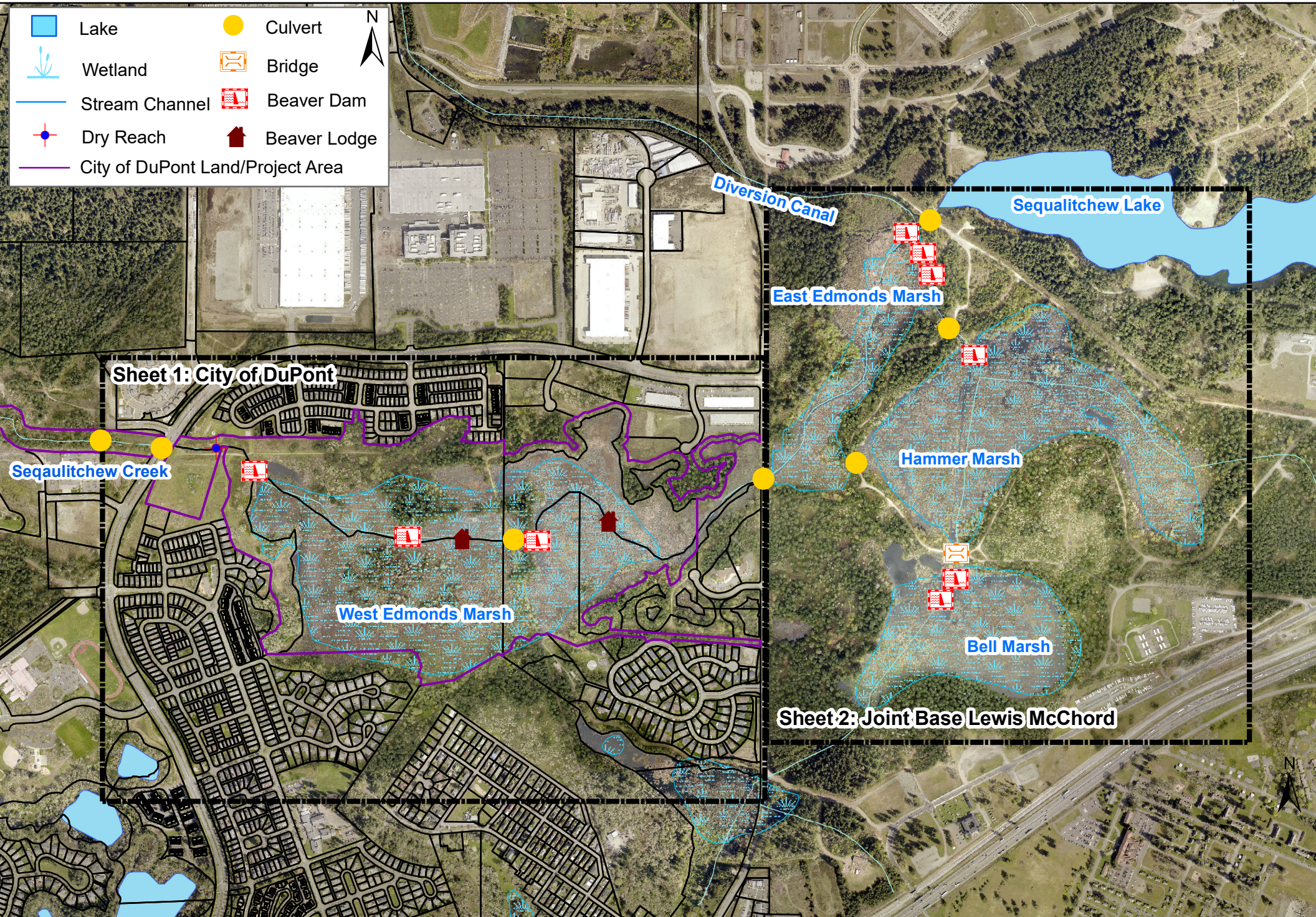
Heavy Construction Cost Index Comparison			
	Q1 2015	*Q2 2022*	*percent Increase*
CalTrans Fisher Index	*62.79*	*83.5*	*32.98%*
Turner Index	*927*	*1283*	*38.40%*

Appendix G
Beaver Management Design

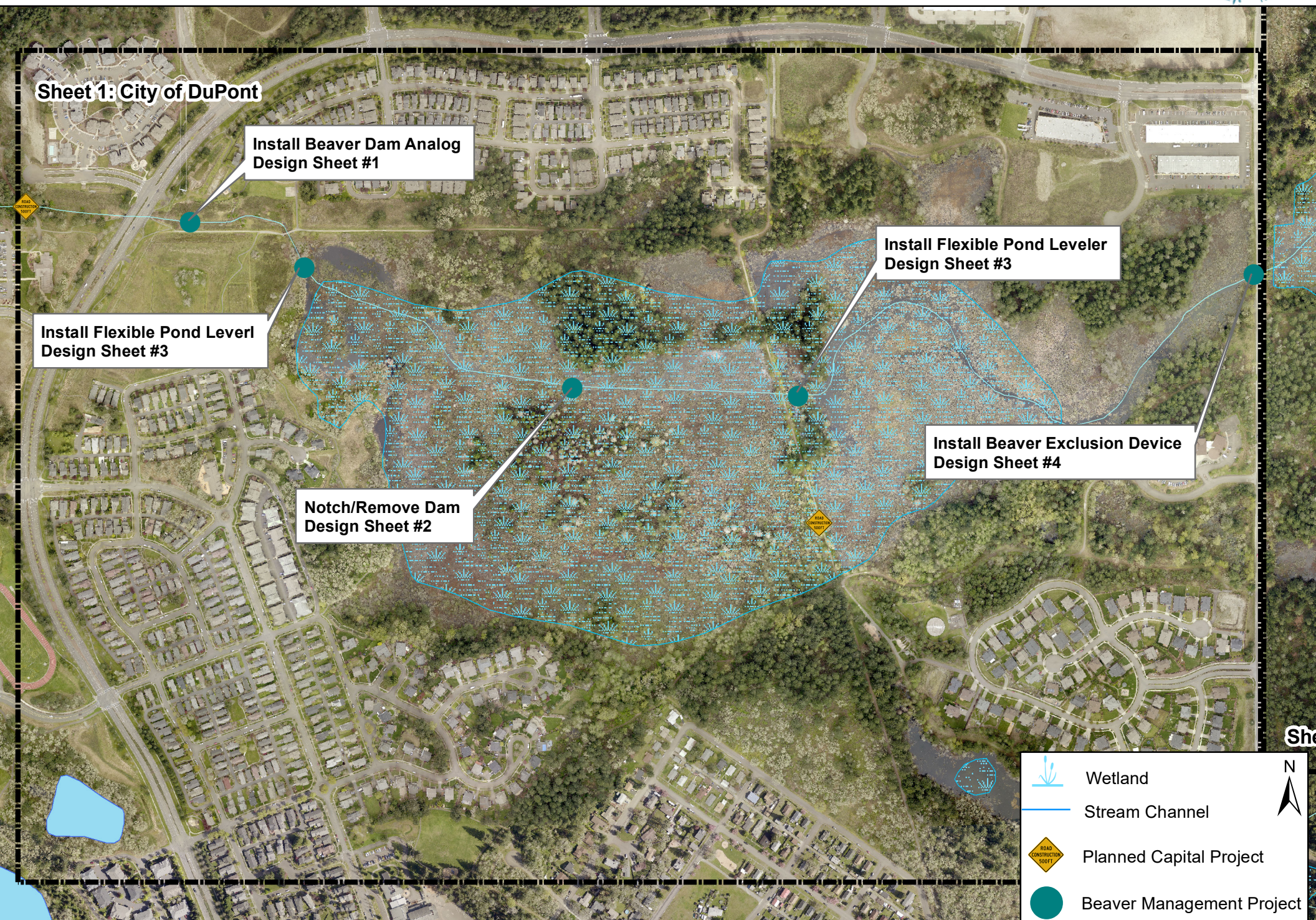
Sequalitchew Creek Restoration Plan - Beaver Management Design



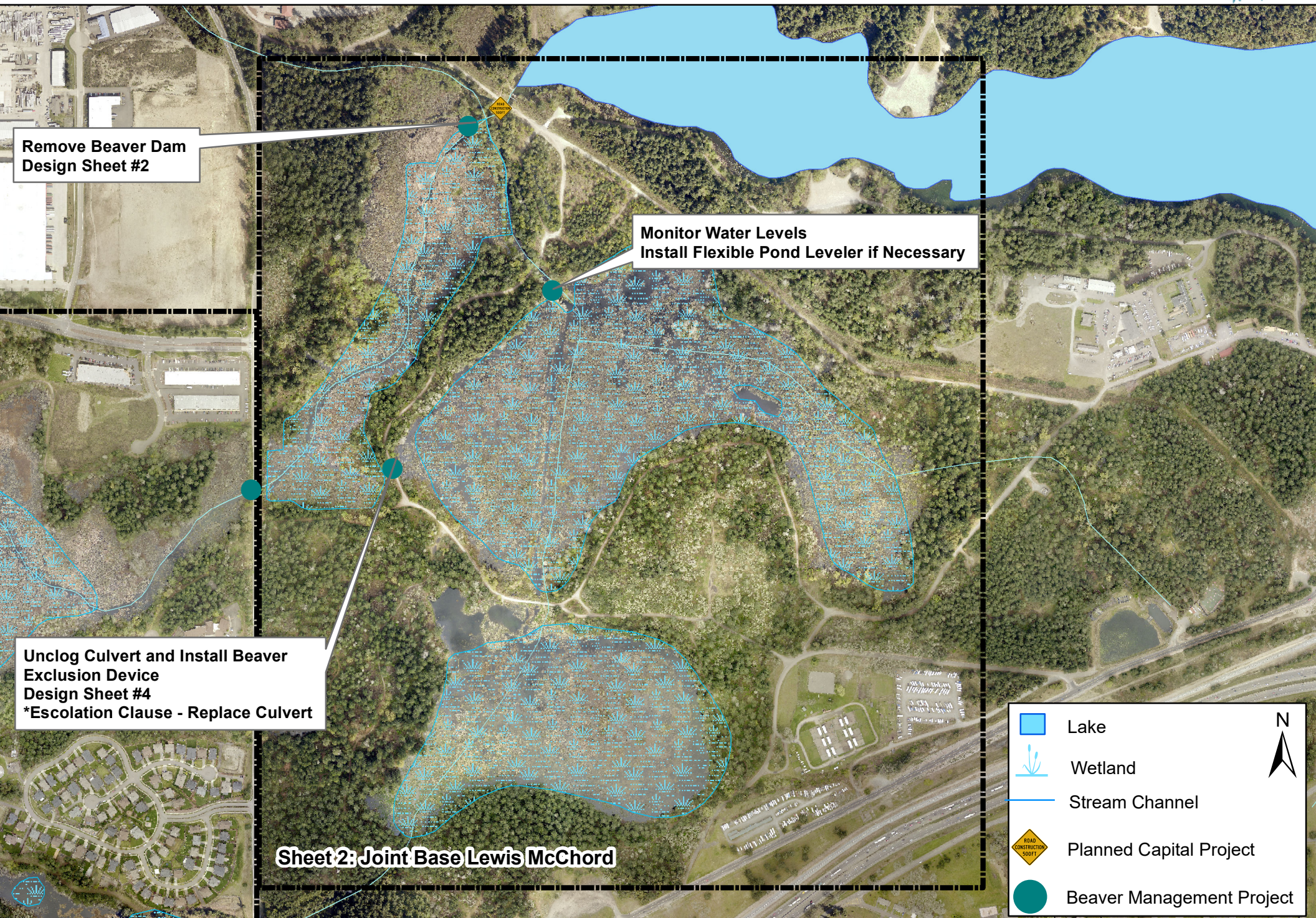
Joint Base Lewis McCord - Beaver Management Design



City of DuPont - Beaver Management Design



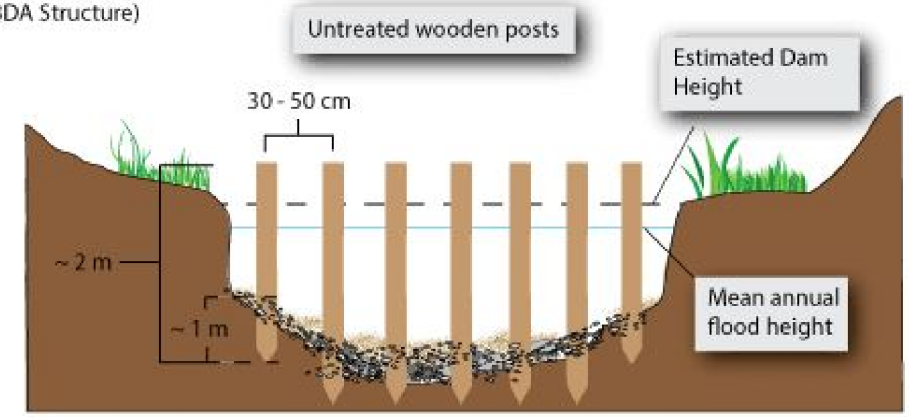
Joint Base Lewis McCord - Beaver Management Design



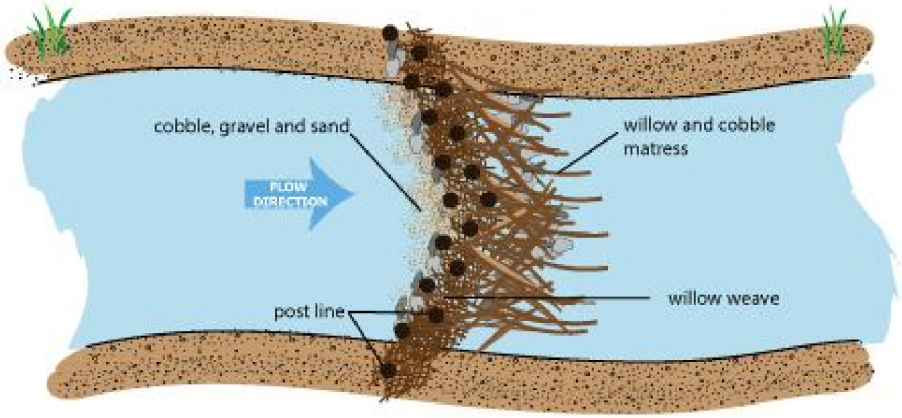
Design Sheet 1 & 2: Beaver Dam Analog & Dam Notch/Removal

Design Sheet 1: Beaver Dam Analog

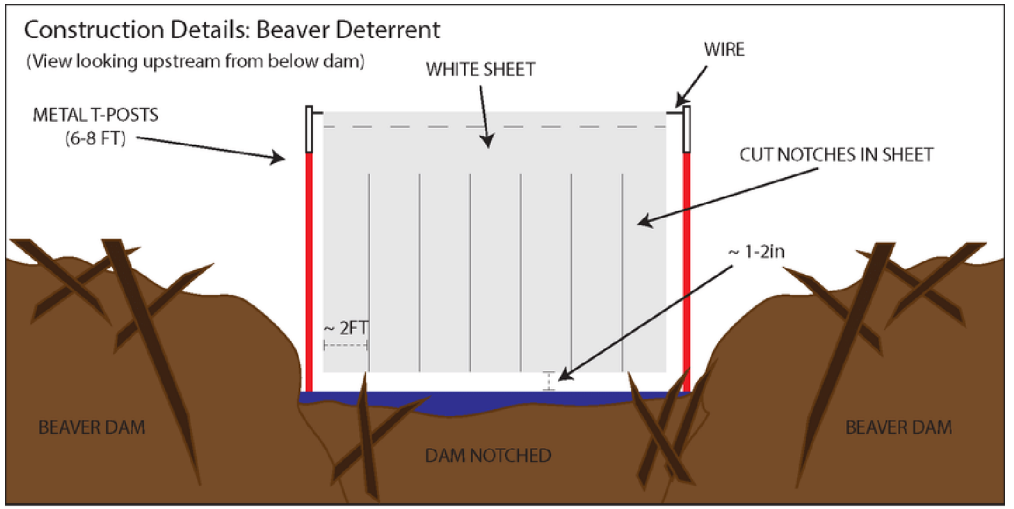
Cross Section View
(Generic BDA Structure)



Plan View
(Convex Primary Dam)



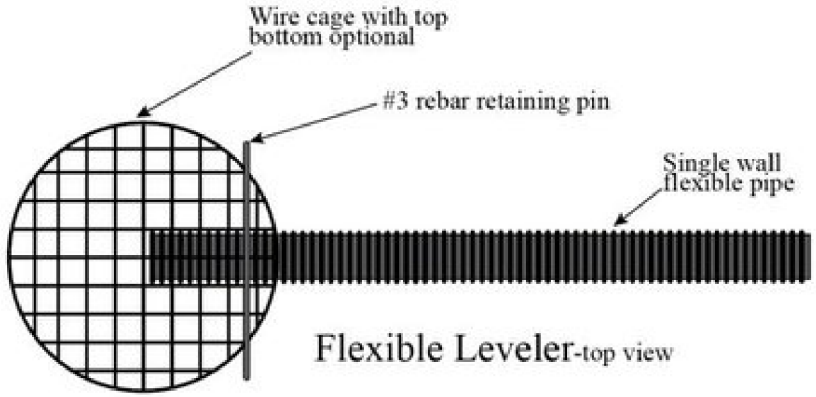
Design Sheet 2: Notch or Removal of Beaver Dam



Construction Notes

1. Notch dam to desired pond level height.
2. Pound 6-8 ft. metal fenceposts just upstream of dam notch. Fencepost length depends on depth of pond/height of dam)
3. Attach 11-gauge or baling wire between the tops of fenceposts.
4. Affix white sheet or Tyvek house wrap to wire between fenceposts ~1-2 inches above pond water level. Clamps, clothespins, or sewing a sleeve can all be used to attach the sheet to wire.
5. Cut slits into the sheet spaced ~ 2ft.

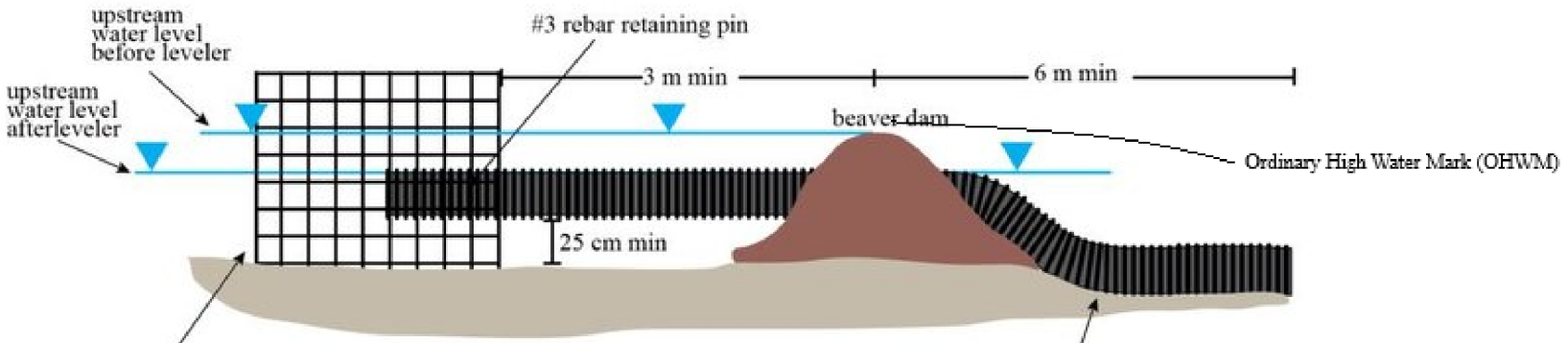
Design Sheet 3: Flexible Pond Leveler



Flexible Leveler-top view

Construction notes:

1. Construct wire cage using hog ring for fasteners. Overlap one section for cage wall.
2. Cut out hole for flexible pipe in cage wall.
3. If cage is built with no bottom, cut out lower horizontal wire between vertical wires to allow cage to settle into streambed.
4. remove dam as needed to place fliexble pipe, Replace dam after leveler is installed.
5. Stake single-wall HDPE pipe every 2 m to prevent it from floating or beaver from moving it. Use two T-posts and wire between them and over the top of the pipe to secure the pipe.
6. Drill hole in culvert for rebar sufficient to allow for friction fit.
7. One section of fencing 1.2 m x 4.8 m will construct one cage. An additional section is needed to construct the top and bottom of each cage.
8. Pipe diameter should be size to pass the stream base flow.
9. Pipe should be gently sloped to facilitate fish passage.



2 gauge 15 cm x 15 cm galvanized concrete reinforcing mesh or 15 cm x 20 cm cattle fencing. Cage: 1.5 m min diameter,1.2 m min height

Flexible Leveler-side view

30-40 cm single wall HDPE pipe (ABS or similar). Drill 6 mm holes in top of pipe to release air. Stake pipe with T-posts every 2 m or as needed, to prevent movement

Design Sheet 4: Beaver Exclusion Device

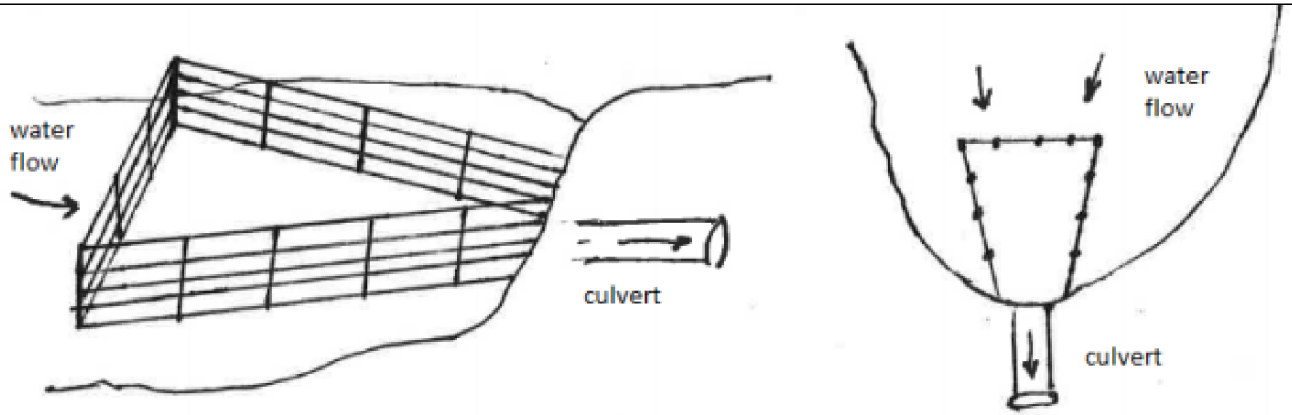


Figure 2. Culvert fencing, trapezoidal in shape, is installed on the upstream side of a culvert.

Figure 3. King County example: trapezoidal aquatic exclusionary fencing on box culvert inlet at Lower Stensland Creek.